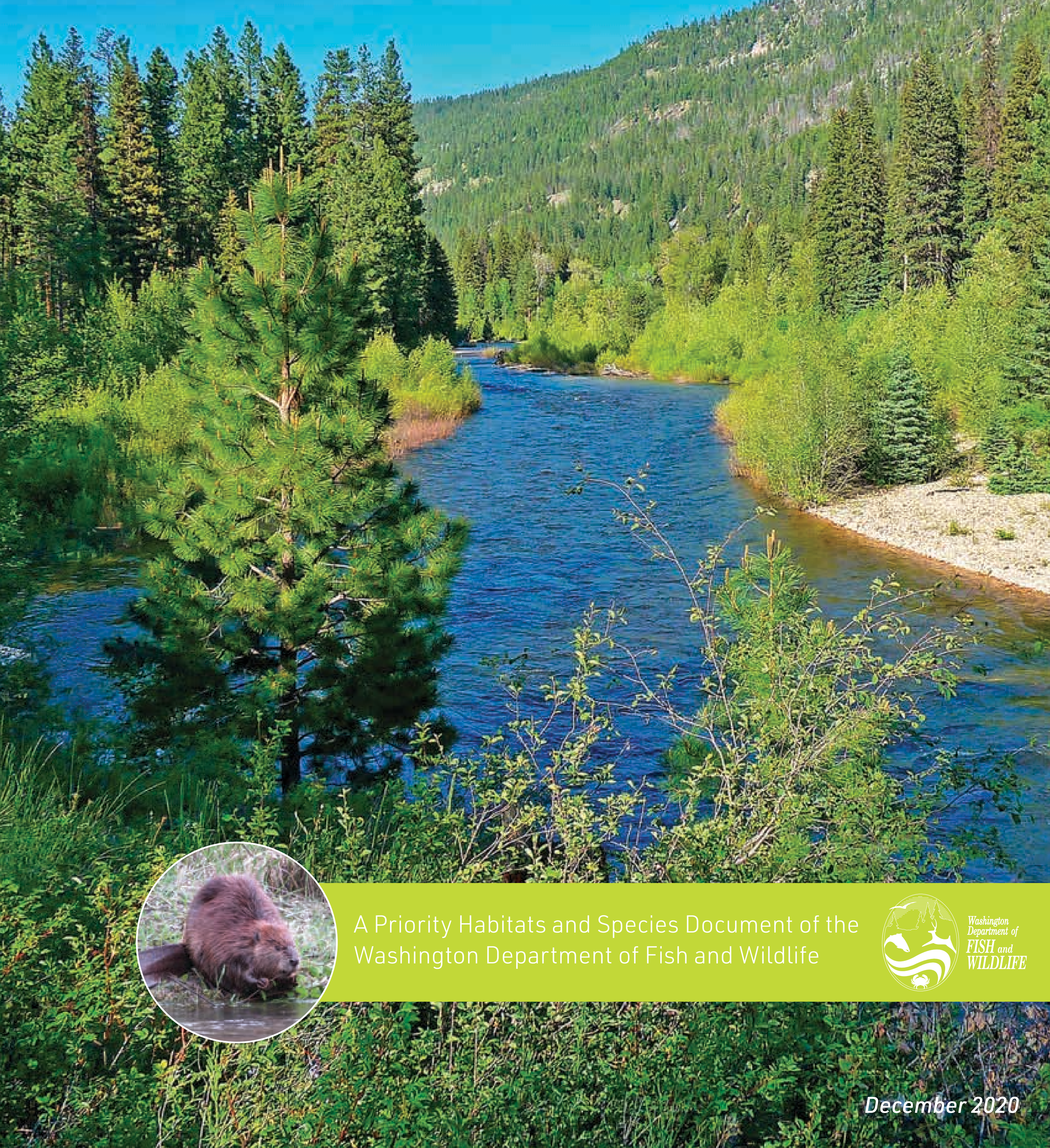
Riparian Ecosystems, Volume 2: Management Recommendations



A Priority Habitats and Species Document of the Washington Department of Fish and Wildlife

Washington Department of FISH and WILDLIFE

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Riparian Ecosystems, Volume 2: Management Recommendations

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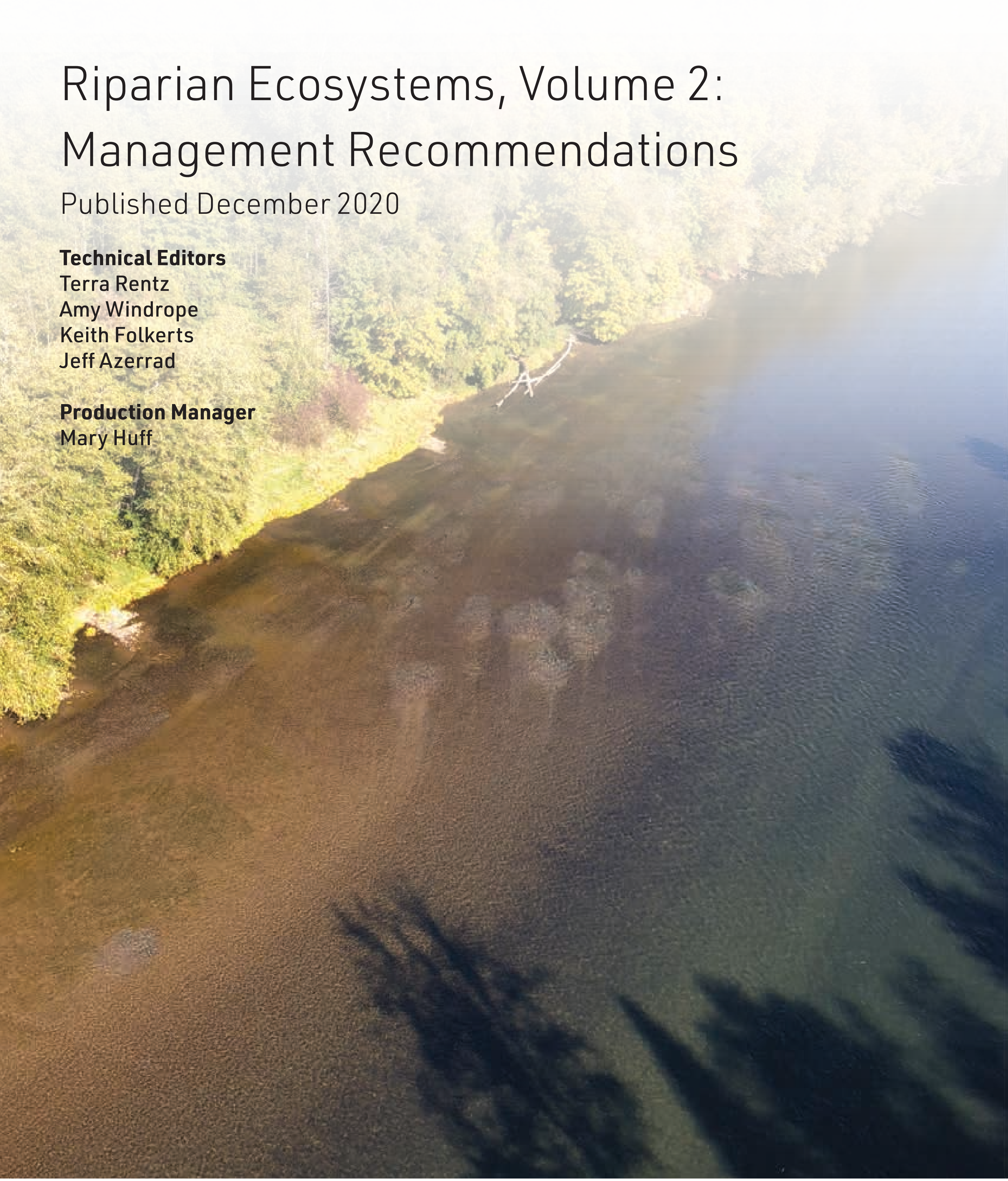

Salmon redds along the Cowlitz River, Lewis County/George Fornes, WDFW

Acknowledgements

Land Acknowledgement: We acknowledge the traditional, ancestral, territory of Washington state on which we are learning, working, and organizing today. We recognize the longstanding history that has brought us to reside on this land and seek to understand those who first lived here.

Many people were involved with creation of both Volumes 1 and 2 for Priority Habitats and Species (PHS) Riparian Ecosystems. WDFW extends our sincere appreciation to the following individuals and organizations that played important roles during development and/or review of both volumes.

The Washington Department of Ecology (Ecology) and U.S. Environmental Protection Agency (EPA) provided funds that made this document possible (Contract C1300107).

The Washington State Academy of Sciences, with coordination by Dr. Robert Bates, provided an independent peer review that improved the scientific rigor of Volume 1.

Federal (EPA and NOAA Fisheries) and tribal entities (individual tribes, the Northwest Indian Fisheries Commission, Columbia River Inter-Tribal Fish Commission, and Upper Columbia United Tribes) as well as numerous state agencies (Washington State departments of Ecology, Natural Resources, and Commerce; Recreation and Conservation Office; Washington State Conservation Commission; and Puget Sound Partnership) reviewed draft versions of this document. During the summer 2018 public comment period, local governments and members of the public provided valuable feedback that led to a more concise and user-friendly final version of Volume 2.

Within WDFW, Keith Folkerts led coordination, contract planning and budgeting for this work. Tim Quinn and George Wilhere were integral in ensuring a strong relationship with information in Volume 1 and provided additional valuable feedback on multiple drafts. Terry Johnson developed the Site-Potential Tree Height mapping tool and wrote the associated user guide information in the Appendix to this Volume 2. Alison Hart produced final graphics and ensured consistent formatting and stylistic usage throughout. Mary Huff provided editorial support, improved the document's organization, and (in late 2020) took it across the finish line.

WDFW recognizes and appreciates the significant role that tribes, local governments, conservation organizations, and others play in accomplishing our agency's mission. Indeed, we are certain that without these concerted efforts to designate and protect the riparian ecosystems that are essential for most of the state's fish and wildlife species, WDFW would be unable to fulfill its mandate on behalf of all of Washington's residents.

While we acknowledge and have deep appreciation for all the review and comments provided, WDFW bears sole responsibility for this document and any errors contained herein.

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Acronyms for Volume 2

CAO	Critical Areas Ordinance
CMZ	Channel Migration Zone
CREP	Conservation Reserve Enhancement Program
DFC	Desired Future Condition
DNR	Department of Natural Resources (Washington State)
EBM	Ecosystem Based Management
EPA	Environmental Protection Agency (U.S.)
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FEMAT	Forest Ecosystem Management Assessment Team
FPA	Forest Practices Act
FWHCA	Fish and Wildlife Habitat Conservation Area
GIS	Geographic Information System
GMA	Growth Management Act
HMP	Habitat Management Plan
HRCD	High Resolution Change Detection
LID	Low Impact Development
NHD	National Hydrography Dataset
NOAA	National Oceanographic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
OHWM	Ordinary High-Water Mark
OSS	On-site Sewage Systems
PHS	Priority Habitats and Species
RCO	Recreation and Conservation Office (Washington State)
RCW	Revised Code of Washington
RMZ	Riparian Management Zone
RZ	Riparian Zone
SMA	Shoreline Management Act
SMP	Shoreline Master Program
SPTH	Site-Potential Tree Height
$SPTH_{200}$	Site-Potential Tree Height (at age 200 years)
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service


Watershed lesson/Brittany Gordon, WDFW

UWCIG	University of Washington Climate Impacts Group
VSP	Voluntary Stewardship Program
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WFPB	Washington Forest Practices Board
WRIA	Water Resource Inventory Area
WSCC	Washington State Conservation Commission
WWRP	Washington Wildlife and Recreation Program

Chapter 1. Overview

1.1. Our Role as Washington's Conservation Agency

The mission of the Washington Department of Fish and Wildlife (WDFW) is to preserve, protect, and perpetuate the state's fish, wildlife, and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities. We offer the following science-based guidance to further that mission through the preservation, protection, and—where possible—restoration of healthy, intact, and fully functioning riparian ecosystems statewide. As described throughout this volume, we believe that protection *and* restoration[1] of Washington's riparian ecosystems is a foundational conservation action; considering a growing population and changing climate, it is also an urgent one.

Within the State of Washington's land use decision-making framework, WDFW's role is that of advisor. We provide information relative to our mission about the habitat needs of fish and wildlife, and the likely implications of various land use decisions on those resources over time. Through the Priority Habitats and Species (PHS) Program, we work cooperatively with land use decision makers and landowners to facilitate solutions that accommodate their needs and the needs of fish and wildlife. We provide this PHS document, *Riparian Ecosystems Volume 2: Management Recommendations* in support of that effort.

Priority Habitats are places that warrant special consideration for protection when land use decisions are made and should also be prioritized for restoration or enhancement wherever possible. To qualify as a "Priority Habitat" in WDFW's PHS program, an ecosystem or habitat component must provide unique or significant value to many species. Specifically, it must have one or more of the following attributes (WDFW 2008):

- Comparatively high fish and wildlife density
- Comparatively high fish and wildlife species diversity
- Important fish or wildlife breeding habitat
- Important fish or wildlife seasonal ranges
- Important fish or wildlife movement corridors
- Limited availability
- High vulnerability to habitat alteration
- Unique or dependent species

Riparian areas (comprised of riparian ecosystems, active floodplains, and riverine wetlands) meet all these criteria, and were among the first Priority Habitats described by WDFW. Riparian areas provide important ecological functions that help create and maintain aquatic habitats in addition to supporting terrestrial wildlife. Riparian areas alongside

1 Restoration of riparian ecosystems is critically important because legacy of environmental impacts resulting from the ways land use has affected riparian areas over the past 200 years. In other words, what remains available for protection is not enough to provide the full functions and values Washington's fish and wildlife need.

Hundreds of fish and widlife species, like this female Wood Duck, depend on or use the state's riparian areas. This includes over 150 species of birds, mammals, amphibians, reptiles, and invertebrates designated as Species of Greatest Conservation Need in the 2015 State Wildlife Action Plan./Jeanne Hannah

rivers and streams are the focus of this document, however much of the science reviewed in Volume 1 and the recommendations in this Volume 2 are relevant for lakes, ponds, and marine shorelines as well.

As previously mentioned, one role of WDFW in land use decision making is that of advisor. In that role, recommendations like those contained in this document and in complementary PHS documents (available at https://wdfw.wa.gov/species-habitats/at-risk/phs/recommendations) provide critical information for the protection (and where necessary, recovery) of Washington's fish and wildlife. We recognize landowners and land managers most often face situations where various human needs must also be met; and thus, considerations other than fish and wildlife will be incorporated into land use decision making.

The information presented in this management recommendation document is not, in and of itself, science. Rather, it consists of policy recommendations which are informed by the best available science

WDFW's Mission

To preserve, protect, and perpetuate Washington's fish, wildlife, and ecosystems while providing sustainable fish and wildlife recreational and commercial opportunities.

WDFW'S Riparian Values

We value the protection and restoration of healthy, intact, and fully functioning riparian ecosystems statewide.

WDFW'S Recommendation

Within the context of wise watershed management, preserve, protect, and—where possible—restore the full extent of riparian ecosystems.

Ecosystem Based Management & WDFW's Conservation Principles

In 2013, WDFW adopted ecosystem-based management principles into policy (WDFW Policy 5004). Ecosystem-based management is an integrated, science-based approach to natural resource management that aims to sustain the ability of ecosystems to provide goods and services upon which humans and other species depend. Importantly, ecosystem-based management recognizes the magnitude of humans as change agents in the ecosystem, and the role of social, economic, and ecological factors in managing complex and dynamic systems.

We believe that conservation is best achieved through employing the following ecosystem-based management principles:

1. We practice conservation by managing, protecting, and restoring ecosystems for the long-term benefit of people, and for fish wildlife and their habitats.

2. We work across disciplines to solve problems because of their connections among organisms, species and habitats.

3. We integrate ecological, social, economic, and institutional perspectives into our decision-making.

4. We embrace new knowledge and apply best science to address changing conditions through adaptive management.

5. We collaborate with our co-managers and conservation and community partners to help us achieve our shared goals.

summarized in Volume 1[2] and which reflect WDFW's mission and legislative mandate. To that end, these recommendations represent WDFW's guidance for the protection and restoration of healthy, intact, and fully functioning riparian ecosystems and for how land managers and land use regulators can utilize best available science to protect these ecosystems within the scope of their authority and/or ability.

For example, local governments are encouraged to use information provided through PHS to guide critical area ordinance (CAO) updates and other land use policies, plans, or regulations. More specifically, WDFW advises using the information in this PHS Riparian Volume 2 for designating riparian areas as Fish and Wildlife Habitat Conservation Areas (FWHCAs) and protecting them for their inherent value, rather than just as buffers for rivers and streams. This is because riparian areas are so important for helping sustain endangered, threatened, and sensitive species; providing habitat connectivity for both aquatic and terrestrial wildlife; and for their critical role in protecting salmonid habitat (WAC 365-190-130).

In short, Volumes 1 and 2 focus on the science and management, respectively, of riparian ecosystems to support fish and aquatic wildlife species. Volume 1 characterizes riparian ecosystem functions and essential processes, while Volume 2 provides management guidance for riparian ecosystems in the context of watershed processes. To be clear, these two volumes do not provide a summary of science or recommendations regarding the contribution of riparian ecosystems for the protection of terrestrial wildlife species. However, our first generation PHS Riparian-specific document, *Management Recommendations for Washington's Priority Habitats: Riparian* (Knutson and Naef 1997) does provide terrestrial species information related to riparian areas. Further, PHS has separate, species-specific management recommendations that address the needs of many terrestrial Priority Species.

This document provides recommendations applicable across the State of Washington but does not address unusual, site-scale environmental conditions or issues specific to particular ecological communities. We strongly encourage addressing such matters at a local level with the assistance of WDFW regional habitat biologists, and other technical experts and stakeholders such as tribal biologists and conservation organizations.

[2] The original manuscript of *Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications* was publicly released in May 2018. In 2020, the format of the document was professionally designed, which included making limited updates to content focused on copyediting and improving usability. In accordance with standard citation practice, Volume 1 is now cited as having a 2020 publication date, but substantively, the current document is equivalent to the original 2018 version.

1.2. Purpose and Applicability of Volume 2

The purpose of this document is to provide guidance to protect and—where possible—restore healthy, intact, and fully functioning riparian ecosystems, which are fundamental for clean water, healthy salmon populations, and climate resilient watersheds.

Volume 2 provides information to:

- Protect existing and restore degraded riparian ecosystem functions in support of aquatic and terrestrial species recovery;
- Assist local governments with their responsibilities to protect priority fish and wildlife and their habitats;
- Assist landowners and local groups in implementing voluntary restoration actions on and off working lands; and
- Incorporate monitoring and adaptive management to understand how well regulatory and non-regulatory efforts are protecting riparian functions and values.

This guidance is applicable to riparian ecosystems statewide. We offer a specific focus on lands within the purview of the Growth Management Act (GMA) and Shoreline Management Act (SMA), although a broader application by local governments and other users is also appropriate.

While many other federal, state, and tribal government programs and policies pertain to riparian ecosystems, they are not specifically addressed in this document. For instance, we do not discuss holistic protection of floodplains, nor do we discuss specific Endangered Species Act (ESA) requirements relative to listed salmonids and other species. Also, we do not address commercial forestlands that fall under the jurisdiction of the Forest Practices Act (FPA), or the Department of Ecology's clean water regulations. These other programs and policies were developed with specific goals and objectives that may be different from the goals of this document, and as such may differ with guidance provided herein.

1.3. Science Synthesis and Management Implications (Volume 1) Summary

As stated above, Volume 1 (Quinn et al. 2020; see footnote 2) provides important information integral to the development of these management recommendations. It includes both overarching as well as specific considerations important to all efforts, large and small, to protect rivers and streams for the benefit of the aquatic species associated with them. Volume 1 focuses on the science of riparian ecosystems—specifically, how riparian areas interact with large-scale drivers (e.g., topography, geology, climate, and land use) and watershed processes to create and maintain riparian and aquatic habitat in support of fish and wildlife. Thus, we provide here an explicit definition of riparian ecosystems from Volume 1 that combines a variety of conceptual riparian descriptions from the scientific literature:

> Riparian ecosystems are transitional between terrestrial and aquatic ecosystems, distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface

Many adult flying insects, such as the blue damselfly (above, left) spend their larval stage as freshwater macroinvertebrates. During this early period, some of those species, like the stonefly nymph (above, right) help fallen leaf litter to decompose by shredding it while feeding. At both life stages, these animals provide important food for fish and other aquatic and terrestrial widlife./Jim Cummins and Taylor Cotten, WDFW

hydrology connect waterbodies with adjacent uplands. They include those portions of terrestrial ecosystems (i.e., *a zone of influence*) that significantly influence exchanges of energy and matter with aquatic ecosystems and the portion of the ecosystem characterized by moist soils and plants adapted to periodically saturated soils – the *riparian zone* (RZ). The width of the riparian ecosystem is typically defined by the outer edge of the zone of influence, which, in forested regions, is based on site-potential tree height (SPTH) measured from the edge of the active channel. While our definition of riparian ecosystem does not include the water in river or streams, it does include riverine wetlands and recognizes the riparian zone as a distinctive area within riparian ecosystems.

To assist managers in understanding important implications of the science synthesized in Volume 1, we reiterate the ten overarching findings of that document below. These findings are also discussed in more detail in later chapters.

1. Protection and restoration of riparian ecosystems continues to be critically important because: (a) they are disproportionately important, relative to area, for aquatic species (e.g., salmon) and terrestrial wildlife; (b) they provide ecosystem services such as water purification and fisheries (Naiman and Bilby 2001, NRC 2002, Richardson et al. 2005); and (c) by interacting with watershed-scale processes, they contribute to the creation and maintenance of aquatic habitats.

2. Stream riparian ecosystems encompass the riparian zone; the active floodplain, including riverine wetlands and the terraces; and adjacent uplands that contribute matter and energy to the active channel or active floodplain (Gregory et al. 1991, Naiman and Bilby 1998). Such terraces and adjacent uplands are called the zone of influence.

3. The width of the riparian ecosystem is estimated by one 200-year SPTH measured from the edge of the active channel or active floodplain. Protecting functions within at least one 200-year SPTH is a scientifically supported approach if the goal is to protect and maintain full function of the riparian ecosystem.

4. Where the riparian zone is narrow (<100 ft [30 m]) and the zone of influence lacks tall trees (<100 ft), (e.g., in parts of the Columbia Plateau Ecoregion), the pollution removal function may determine the width of the zone of influence.

5. The riparian ecosystem begins at the edge of the active channel or active floodplain, whichever is wider. As the active channel moves back and forth across the channel migration zone (CMZ), the riparian ecosystem moves with it. Consequently, there are times when the riparian ecosystem lies adjacent to or overlaps the CMZ (see Figure 2.3). Hence, to maintain riparian ecosystem functions, management must anticipate and protect future locations of the riparian ecosystem.

6. A near consensus of scientific opinion holds that the most effective and reliable means of maintaining viable self-sustaining fish, especially salmon, and wildlife populations is to maintain/restore ecosystems to conditions that resemble or emulate their historical range of natural variability (Swanson et al. 1994, Reeves et al. 1995, Bisson et al. 2009). This opinion is based in part on the complexity of processes that affect the expression of habitats over time and space.

7. The protection and restoration of watershed-scale processes, especially related to hydrology, water quality, connectivity, and inputs of wood, shade, and sediment are important for aquatic system function, and help maximize the ecological benefits of riparian ecosystem protections.

8. Riparian areas and surrounding watersheds are complex and dynamic systems comprised of many interacting components. Natural disturbances (flood, fire, and landslides) across the watershed and through time create the mosaic of conditions necessary for self-sustaining populations of fish, especially salmon, and other aquatic organisms.

9. Impending changes to aquatic systems as a result of climate change increase risk to species already threatened by human activities. The effects of climate change on rivers and streams threaten to reduce fish distribution and viability throughout the Pacific Northwest (Beechie et al. 2013).

10. The use of the precautionary principle and adaptive management are particularly appropriate when dealing with complex and dynamic systems, and when we have uncertainty related to exactly how management activities affect functioning of watersheds and riparian ecosystems.

1.4. Key Findings and Recommendations

WDFW recognizes that there is a significant amount of work currently being done throughout the state to protect and restore riparian areas. This focus is longstanding and has ranged from regulatory protections that guide Washington's growing population to voluntary conservation on our working lands. Below, we highlight what we believe—based on best available science and our agency's mission—are the most important recommendations to ensure healthy, intact, and fully functioning riparian ecosystems that provide for the preservation, protection and perpetuation of Washington's fish and wildlife:

A tributary stream (lower left of photo) contributes sediment to a side channel of the Stillaguamish River as precipitation levels rise in autumn. Snohomish County/Mary Huff, WDFW

1. **Designate riparian ecosystems as critical areas:** WDFW recognizes riparian ecosystems as a Priority Habitat for fish and wildlife and recommends that local jurisdictions designate those ecosystems as Fish and Wildlife Habitat Conservation Areas (FWHCAs), a type of critical area. We define the bounds of the riparian ecosystem as the riparian management zone (RMZ), and this RMZ should be designated as the location where protection and restoration of riparian ecosystem functions and values are addressed. RMZs provide a framework for delineating, evaluating, planning, and managing functions and values. In this volume, we provide a process for RMZ delineation (Chapter 2).

2. **Include watershed–scale management considerations:** Watershed-scale management is critical to realizing the full benefits of riparian ecosystem protection and restoration. Certain types of anthropogenic changes at the watershed scale can dramatically reduce the effectiveness of riparian ecosystems to protect aquatic habitat. For example, unmitigated delivery of stormwater from impervious surfaces like roads, parking lots, and rooftops to streams, for example, dramatically increases peak stream flows, alters channel form, and short-circuits the capacity of riparian areas to remove pollutants from runoff. Similarly, road-crossing culverts that are impassible to fish can reduce stream-network connectivity and dramatically reduce amounts of otherwise suitable habitat.

3. **Use reference points to locate the inner edge of the RMZ:**

   - For streams without Channel Migration Zones (CMZs), the inner edge of the RMZ should be delineated starting at theouter edge of active floodplain, if this has or can be determined; otherwise, from the active channel, as delineated by the Ordinary High-Water Mark (OHWM)[3].

   - For streams with CMZs, the unpredictable nature of channel migration should be accommodated through delineation of an RMZ that encompasses both the entire CMZ and future locations of the riparian ecosystem. In these instances, the inner edge of the RMZ should be located at the outer edge of the CMZ.

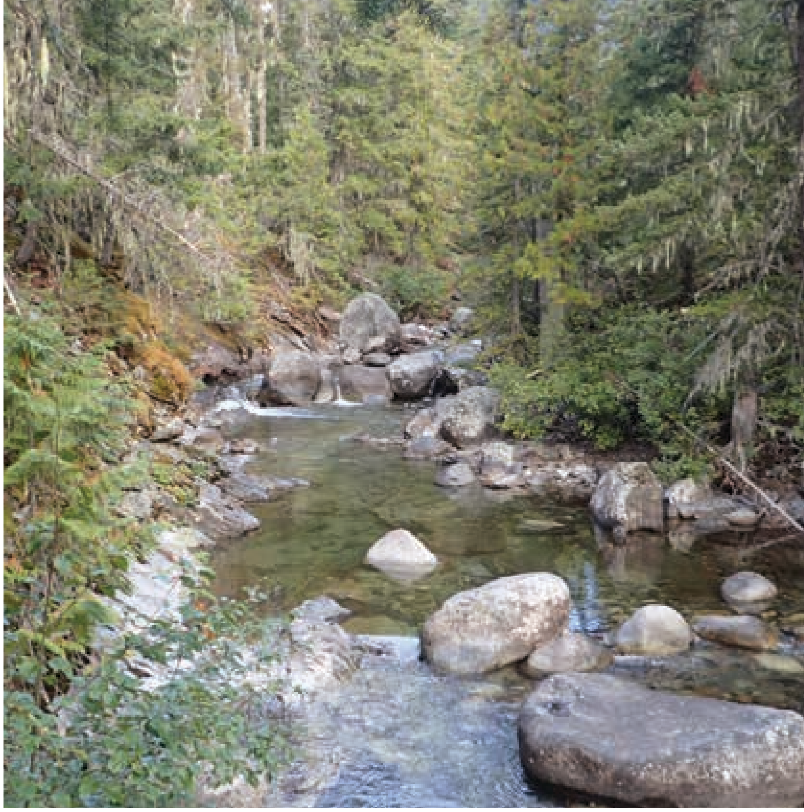
Whether or not a stream has a CMZ, the distance from the inner edge of the RMZ to the outer edge of the RMZ should be one $SPTH_{200}$.

4. **Include CMZs in delineation of the RMZ:** CMZs are important to protect for maintaining riparian functions and values, and so are included in the delineation of RMZs. Over time, a riparian ecosystem will occupy different parts of the CMZ and uplands outside the CMZ. Lateral channel migration and related streambank erosion processes can pose risks to homes and communities located near rivers; however, when channels are constrained from moving, aquatic and riparian ecosystems may degrade over time. To maintain riparian ecosystem functions, land managers must anticipate and protect future locations of the riparian ecosystem and thus delineate the RMZ accordingly.

5. **Establish RMZ widths based on site-specific conditions:** From the perspective of those riparian ecosystem functions affecting aquatic systems, the width of the riparian ecosystem varies with ecological conditions. The most efficient way to protect riparian functions is to adopt protections that recognize these differences, rather than uniform-width (i.e., one-size-fits-all) RMZs, as these may result in over-protection in some places and under-protection in others.

3 Active floodplain delineations are rarely available, and we currently lack a repeatable, well-vetted, and widely accepted method for the delineation of active floodplains. Therefore, until such a process is developed, we recommend delineating the RMZ's inner edge using the OHWM for streams without CMZs.

Dryland ecoregion riparian area, Whitman County/Michael Townsend



Forested ecoregion riparian area, Chelan County/George Wilhere, WDFW

a. **In forested ecoregions, start with SPTH$_{200}$**: At most riparian areas in forested ecoregions, SPTH$_{200}$ is 100 feet or greater, and so the RMZ is delineated using one SPTH$_{200}$. If SPTH$_{200}$ is less than 100 feet, the RMZ is delineated by the pollution removal function (see below).In highly altered areas where soil data are not available, it may be necessary to estimate SPTH$_{200}$ values based on nearby soils.

b. **In dryland ecoregions, start with SPTH$_{200}$** (if available), or the width of the riparian vegetation community: If site conditions do not support tree species or SPTH$_{200}$ is less than 100 feet, then RMZ width is determined by the full extent of all riparian vegetation (the riparian zone) or by the pollution removal function—see below.

c. **For both forested and dryland ecoregions, use the pollution removal function when appropriate:** Where the SPTH$_{200}$ and/or the width of the riparian vegetative community is less than 100 feet, we recommend that RMZ width be delineated at a minimum of 100 feet, as this provides the width necessary for 95% pollution removal target for most pollutants (approximately 85% for surface nitrogen.)[4]

To aid with site-specific RMZ delineation, WDFW created an internet-based mapping tool that reports recommended widths for RMZs (Appendix 1) statewide based on SPTH$_{200}$. The tool also notes instances where a 100-foot RMZ should be applied to support the pollution removal function.

6. **Apply the recommended RMZ delineation steps to all streams, whether or not they are fish-bearing:** In 1997, WDFW recommended a lower level of protection for non-fish bearing streams than fish-bearing streams. In reviewing the current science literature for Volume 1, we found no evidence that full riparian ecosystem functions

[4] See Chapter 2, Section 2.3.5 for more information about surface nitrogen removal and other site-specific characteristics that may require RMZ distances greater than 100 feet in order to ensure an adequate pollution removal function.

Deer tracks and fallen leaves near Scatter Creek, Thurston County/Janet Anthony, WDFW

along non-fish-bearing streams are less important to aquatic ecosystems than full riparian ecosystem functions along fish-bearing streams. This recommendation is based on four additional considerations. Non-fish-bearing streams:

- Support a unique community of aquatic and riparian-obligate wildlife;
- Provide movement corridors for wildlife, particularly in the face of changing climate conditions;
- Provision fish-bearing streams with matter and energy; and
- Provide cool water to downstream reaches. Washington State has already experienced increased stream
- temperatures due to climate change and expect further increases, which have direct implications for the persistence of fish.

7. **Establish monitoring and adaptive management frameworks:** We believe it is critical to understand if riparian ecosystems protections are working as intended, and if not, to adjust them accordingly. We recommend the establishment of monitoring and adaptive management designed to improve (where necessary) local permit implementation and compliance, and to increase effectiveness of actions intended to protect aquatic species.

8. **Consider needs of relevant terrestrial species:** As stated earlier, a review of new literature related to the needs of terrestrial Priority Species was not a focus of Volume 1. Nonetheless, riparian areas provide important functions for threatened, endangered, and sensitive terrestrial wildlife that require consideration by landowners and land managers. WDFW regional habitat biologists, tribal biologists and/or other local habitat experts can assist in identification of site-specific terrestrial species needs. Because riparian protections benefit both aquatic and many terrestrial wildlife species, concentrating protections around riparian areas may also be an efficient use of resources.

1.5. Relationship with Washington's Development Laws and Regulations

1.5.1. Relationship with the Growth Management Act (GMA)

The GMA requires local jurisdictions to designate and protect critical areas, and in so doing, use best available science and give special consideration to anadromous species[5]. The GMA also encourages state agencies to provide technical assistance to counties and cities in the review of their critical areas ordinances (CAOs), comprehensive plans, and development regulations [RCW **36.70A.130(6)(g)**]. While the Washington State Department of Commerce (Commerce) administers the GMA, WDFW is the lead state agency for advising local governments on matters related to one type of critical area: Fish and Wildlife Habitat Conservation Areas (FWHCAs), and we produce PHS Management Recommendations like this Volume 2 in support of that role.

This document provides guidance that is consistent with the GMA, under which local governments exercise their land use responsibilities: specifically, protection of the functions and values of critical areas. It also reflects the legal and policy framework within which WDFW and the PHS program operate, which includes among other things providing a source of best available science necessary to support local governments in distinguishing and delineating those critical areas (e.g., FWHCAs).

WAC 365-190-130
FISH AND WILDLIFE HABITAT CONSERVATION AREAS

(1) "Fish and wildlife habitat conservation" means land managed for maintaining populations of species in suitable habitats within their natural geographic distribution, so that the habitat is sufficient to support viable populations over the long term and isolated subpopulations are not created. This does not mean maintaining all individuals of all species at all times, but it does mean not degrading or reducing populations or habitats so that they are no longer viable over the long term. Counties and cities should engage in cooperative planning and coordination to help assure population viability.

Fish and wildlife habitat conservation areas contribute to the state's biodiversity and occur on both publicly- and privately-owned lands. Designating these areas is an important part of land use planning for appropriate development densities, urban growth area boundaries, open space corridors, and incentive-based land conservation and stewardship programs."

WDFW understands that local jurisdictions have existing critical area regulations that have been approved by elected officials and in many cases have been found to be compliant with GMA through the Growth Management Hearings Board and courts. We acknowledge that revising a critical area regulation can be a lengthy, expensive, and contentious process, and so jurisdictions frequently do not make updates to their CAOs more frequently than required by law or rule. In this volume, we aim to be more precise about where recent science has improved our certainty around the need for riparian protections, as well as for specific practices; and how to incorporate best available science and WDFW's management recommendations.

WDFW also recommends local jurisdictions continue considering PHS best available science (e.g., Volume 1; PHS maps), incorporating PHS Management Recommendations, and seeking technical assistance from WDFW's regional habitat biologists not just when updating and implementing critical area policies and regulations, but in all land use planning efforts.

[5] RCW 36.70A.172(1): "In designating and protecting critical areas under this chapter, counties and cities shall include the best available science in developing policies and development regulations to protect the functions and values of critical areas. In addition, counties and cities shall give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries."

1.5.2. Relationship with the Shoreline Management Act (SMA)

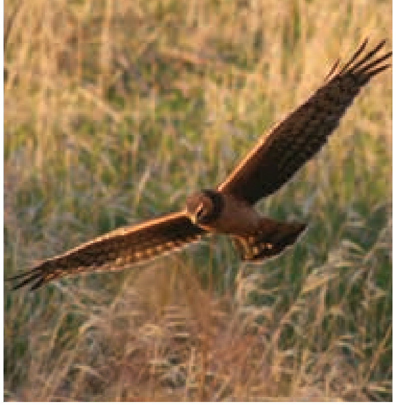
As with GMA, WDFW plays a role of technical advisor under SMA, working directly through locally led development processes, with the goal of addressing needs for fish and wildlife. Under SMA, the Department of Ecology (Ecology) has a role approving Shoreline Master Program (SMP) updates when they are deemed consistent with all statutory and regulatory requirements. Ecology also has a direct role in implementation of SMPs, including issuing the final decision to approve, deny, or put conditions on locally issued conditional use permits and variances. [Under GMA, Commerce does not approve comprehensive plan updates or CAOs.]

The goal of SMA is "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines" (RCW 90.58.020). To achieve that end, WDFW recommends local jurisdictions designate riparian areas and provide the same levels of protection for them within the SMA jurisdiction areas as they do under GMA. While the SMA does not apply to streams with 20 cubic feet per second (cfs) or less mean annual flow, we recommend the application of the guidelines in this Volume 2 to all rivers and streams, regardless of size.

WAC 173-26-186 GOVERNING PRINCIPLES OF THE [SMP] GUIDELINES

(8) "Through numerous references to and emphasis on the maintenance, protection, restoration, and preservation of "fragile" shoreline "natural resources," "public health," "the land and its vegetation and wildlife," "the waters and their aquatic life," "ecology," and "environment," the act makes protection of the shoreline environment an essential statewide policy goal consistent with other policy goals of the act. It is recognized that shoreline ecological functions may be imparted not only by shoreline development subject to the substantial development permit requirements of the act but also by past actions, unregulated activities, and development that is exempt from the act's permit requirements. The principle regarding protecting shoreline ecological systems is accomplished by these guidelines in several ways, and in the context of related principles."

The Shoreline Management Act includes a goal to balance multiple uses, including protecting natural resources and providing public access to waters of the state./ Andy Walgamott

Riparian areas provide habitat for many types of birds at one or more life stages, especially during breeding season and for food year round. Photo credits: Sandpiper chicks in nest/Laura Rogers; Northern Harrier foraging low over marshy vegetation/Brad Collins; male Belted Kingfisher watching for fish from fallen tree limb/Anna Owen; Purple Martin pair resting on piling above their nest-box/Kim Eggleston

1.6. Organization of Volume 2

Chapter 1 aims to establish Volume 2's purpose and intent; articulate WDFW's values; and provide policy context regarding protection and designation of riparian ecosystems.

In Chapter 2, we define the RMZ based on $SPTH_{200}$ with special considerations for urban and dryland landscapes; and provide a stepwise process for identifying and delineating the RMZ both for requiring riparian protections and for classifying RMZs as a FWHCA under GMA.

Chapter 3 articulates policies, plans, and practices that protect riparian ecosystems. WDFW recognizes that counties and cities have a long history of providing such protections, and the responsibility to include best available science when updating CAOs. The protection recommendations described in this chapter are intended to help counties and cities moving forward with reviewing and updating their CAOs and other relevant policies and plans.

Chapter 4 explains the importance of restoration in riparian management, which is necessary for recovery of the degraded riparian functions present in many locations and is critical to recover salmon stocks and preserve Washington's riparian-dependent Priority Species. To that end, we outline voluntary approaches to improve riparian functions. Although Volume 2 is not a restoration guide, it is applicable to restoration practitioners in that it describes management actions that enhance riparian functions and values. We do not address restoration project design or standards but provide links within this chapter to resources that do.

Chapter 5 will assist with developing monitoring programs in support of adaptive management, designed to ensure transparent programs that consistently deliver sufficient protection of riparian functions. Careful monitoring and adaptive management are particularly important when a land use may harm a critical area and scientific information about the likely severity of harm is lacking. Although specific to local governments, this chapter provides valuable resources for any land manager interested in engaging in adaptive management.

Finally, this volume includes an appendix that contains a "how-to" process for utilizing WDFW's SPTH mapping tool to help determine recommended minimum RMZ widths around the state. The tool itself is available at wdfw.maps.arcgis.com/apps/MapSeries/index.html?appid=919ea98204eb4f5fa70eca99cd5b0de1.

Chapter 2. Riparian Management Zone Delineation

2.1. Introduction

We define the extent of the riparian ecosystem as the area that provides full ecological function for bank stability, shade, pollution removal, contributions of detrital nutrients, and recruitment of large woody debris. For the purposes of management or regulatory protection, the riparian management zone (RMZ) encompasses the riparian ecosystem, and—when present—the channel migration zone (CMZ) to account for lateral movement of the riparian ecosystem over time. RMZs can also provide habitat for many terrestrial wildlife species including movement corridors. WDFW categorizes the riparian ecosystem as a Priority Habitat, and thus recommends local jurisdictions designate all riparian areas as critical areas: specifically, Fish and Wildlife Habitat Conservation Areas (FWHCAs), as mentioned in Chapter 1.

The RMZ provide an initial framework for delineating, assessing, planning, and managing riparian ecosystems. The RMZ as defined here is not necessarily the same as setbacks or buffers. Setbacks are areas meant to protect an important feature (e.g., a stream or wetland) from certain types of adjacent activities, e.g., the area separating a building from the bank of a river. Setbacks are not typically designed to provide ecological function. On the other hand, buffers, which also protect important features, are commonly undeveloped, naturally vegetated areas that can contribute habitat and in the case of a stream, to riparian functions. In this document, we reserve the use of the term RMZ to mean the area capable of providing full function and managed to that end.

2.2. Foundational Concepts in RMZ Determinations

2.2.1. Desired Future Condition

A major goal in fulfilling WDFW's mission to preserve, protect, and perpetuate Washington's fish, wildlife, and ecosystems is the protection and restoration of healthy, intact, and fully functioning riparian areas. More specifically, the goal will be achieved through management strategies that result in ecosystem composition and structure that provides the five key ecological functions associated with riparian ecosystems. A useful benchmark for this goal is desired future condition (DFC) for riparian areas. DFC describes what land managers are attempting to achieve, often in terms of composition and structure (e.g., vegetation or land-use), over a period of time in a given geographic area. The DFC we recommend results in fully functioning riparian ecosystems as measured by the five key ecological functions (bank stability, shade, pollution removal, contributions of detrital nutrients, and recruitment of large woody debris) in western

Washington. The DFC for composition and structure is old, structurally complex conifer-dominant forest. Such forests exhibit large diameter trees, contain numerous large snags and logs, and have multi-layered canopies and canopy gaps, which promote understory plant diversity.

Throughout the Columbia Plateau, differences in hydrology and geomorphology manifest substantial site-level differences in composition and structure of riparian vegetation, and hence, the DFC for composition and structure is more site-dependent in the Columbia Plateau than in western Washington. Nonetheless, the DFC in the Columbia Plateau is based on the same concepts of ecosystem composition and structure that support the same five key ecological functions in forested regions; specifically, biologically diverse vegetation communities consisting of native trees, shrubs, grasses and forbs. In addition, the DFC for the upland portion of the riparian ecosystem which serves as the zone of influence and contributes to the pollution removal function in the Columbia Plateau is often intact native shrub-steppe or prairie vegetation.

2.2.2. Site-Potential Tree Height (SPTH) Background

A fundamental component of our recommendation is the use of site-potential tree height (SPTH). In this section, we provide background information on its origin, applicability, and usefulness (see also Volume 1, Chapter 9).

In 1993, a group of experts (Forest Ecosystem Management Assessment Team [FEMAT]) was convened to develop a conceptual model to determine how to protect riparian areas in forested landscapes. This model has come to be known as the FEMAT curves (FEMAT 1993). Though this model is over 25 years old, it continues to be one of the most useful conceptual models informing riparian management.

The FEMAT curves provide a conceptual model of important riparian functions and how those functions change with increased distance from the stream channel (Figure 2.1). The model conveys two important points: (1) four of the five riparian ecosystem functions or processes occur within one 200-year SPTH; and (2) the marginal return for each function or process decreases as distance from the stream channel increases. Thus, designating a riparian area based on at least one $SPTH_{200}$ is a scientifically supported approach if the goal is to protect and maintain full function of the riparian ecosystem for aquatic habitat and species, including salmon.

The FEMAT curves and SPTH have been used to describe the lateral extent of riparian ecosystems, and accordingly, the width of the RMZ needed to provide full riparian ecosystem function.

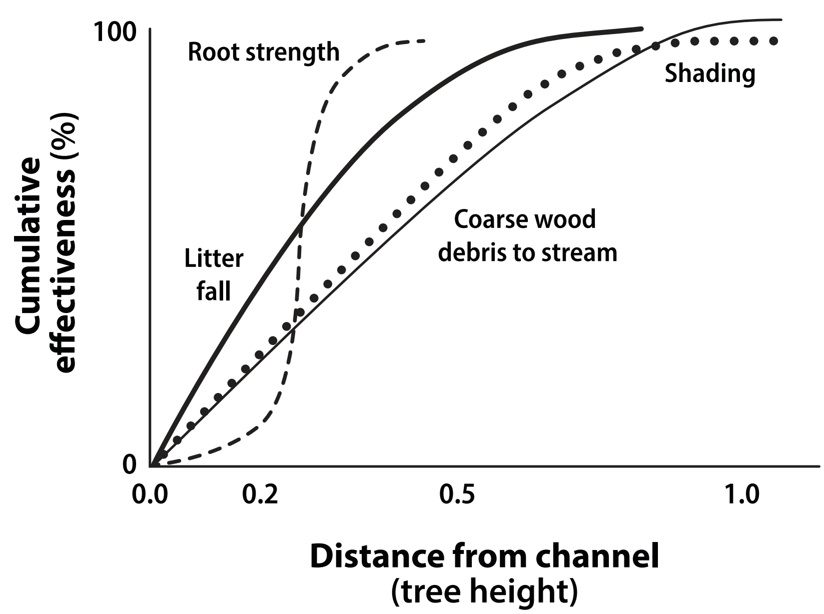


Figure 2.1. The "FEMAT Curves" (FEMAT 1993): a generalized conceptual model describing contributions of key riparian ecosystem functions to aquatic ecosystems as the distance from a stream channel increases. "Tree height" refers to average height of the tallest dominant tree (200 years old or greater); referred to as site-potential tree height (SPTH).

FEMAT (1993, p. V-34) defined SPTH as "the average maximum height of the tallest dominant trees (200 years or more) for a given site class." The key phrase in this definition is "200 years or more" which refers to the approximate minimum age of old-growth forests. This reflects FEMAT's underlying assumption that old-growth forest conditions are needed for full riparian ecosystem functions. WDFW uses SPTH at 200 years (abbreviated $SPTH_{200}$) in our recommendations in this Volume 2.

FEMAT defined Site potential tree height (SPTH) as "the average maximum height of the tallest dominant trees (200 years or more) for a given site class."

"200 years or more" is the approximate minimum age of old-growth forests which are thought to be necessary for full riparian ecosystem functions.

Given its utility, the height of site-potential trees has been described for a variety of tree species and can be readily found in silvicultural literature. Mean heights of dominant trees in riparian old-growth forest of Washington range from 100 to 240 feet (Fox 2003). The wide range of heights reflects differences in site productivity, i.e., local differences in soil nutrients and moisture, light and temperature regimes, and topography. Site productivity is described quantitatively through a site index, which is the average height that dominant trees of a species are expected to obtain at a specified tree age at a given location.

2.2.3. The Importance of Channel Migration Zones (CMZs)

Not all streams have CMZs, but where CMZs are present, it is necessary to map the CMZ in order to establish an RMZ. The Washington Forest Practices Board Manual (DNR 2004) provides a useful definition of the CMZ as "the area where the active channel of a stream is prone to move and this results in a potential near-term loss of riparian function and associated habitat adjacent to the stream, except as modified by a permanent levee or dike" (DNR 2004, Section M2).

Protecting the CMZ from incompatible land uses (e.g., development) is important for providing riparian ecosystem functions. Human alterations to river channels that limit channel migration and bank erosion can degrade aquatic and riparian habitats. For these reasons, geomorphologists have developed protocols for delineating CMZs. Further, RMZ delineation along streams with CMZs ensures that riparian functions do not degrade as a channel moves. Proper delineation also helps landowners avoid siting homes and infrastructure in CMZs that coincide with geologically hazardous critical areas and floodplains (WAC 365-190-120[6f]).

2.2.4. Relationship of CMZs and Floodplains

This document does not include guidance on the integration of floodplains into RMZ delineation (see footnote 4 for a brief explanation about the active floodplain). However, a general understanding of floodplains and their relationship to CMZs is valuable, as the two often overlap.

Beavers are considered to be ecosystem engineers. The dams they build, the resulting ponds created, and the surrounding areas from which they fell trees all provide habitat for many other animals./Liz Bocksteigel, WDFW

Both federal and state regulations establish floodplain protections. Floodplain data and maps (typically 100-year floodplains) are readily available through the Federal Emergency Management Agency's National Flood Insurance Management Program. Ecology is the state's authority as lead on floodplain management and we support their recommendations for management of Frequently Flooded Areas (another type of critical area specified in GMA) and the use of the Floodplains by Design grant program to reduce hazards and restore natural functions. Proper floodplain delineation and protection helps landowners and land managers avoid placing homes and infrastructure in areas at high-risk of flooding.

The Bureau of Land Management provides common clues to help determine the presence of an active floodplain (BLM 2015) such as visual evidence of frequent inundation, which may include but is not limited to:

- Fresh deposits of fine sediment;
- Floodplain vegetation matted down or lying flat on floodplain from overbank flow or by deposition or overbank sediment;
- Debris piled on the upstream side of tree trunks; or
- High water marks seen on rocks, trees, or other stationary objects; and ice-rafted deposits on the floodplain.

However, BLM advises caution when relying on these visual clues. Furthermore, looking for signs that an active floodplain is present is only the first step toward delineating the outer edge of an active floodplain. We recommend reviewing BLM's technical reference titled *Proper Functioning Condition Assessment for Lotic Areas* (BLM 2015) and to consult Ecology for assistance regarding floodplain delineation and protections.

Good floodplain management is not only beneficial for human communities, it is also good for fish and wildlife. Although we do not describe use of the 100-year floodplain to measure the RMZ in Volume 2, we recommend that landowners and land use decision makers treat floodplains similarly to RMZs due to their importance to instream health, as habitat, and for their ecological services.

2.3. Procedures for RMZ Delineation

To conserve riparian habitat, one must first establish the lateral extent (i.e., width) of the RMZ. In Chapter 1, we noted that an RMZ encompasses the riparian zone and zone of influence (Figure 2.2), and, where present, considers the CMZ (Figure 2.3). In this section, we outline general steps for collecting site-specific information essential to map an RMZ. These steps will help you identify a site's proximity to streams as well as essential site characteristics. With this information, we then explain how to delineate an RMZ.

In the rest of this section, we explain how to:

- Identify the ecoregion in which the riparian ecosystem is located (e.g., forested or dryland);
- Verify the presence of a stream;
- Identify the inner edge of the RMZ; and finally
- Determine the RMZ width.

2.3.1. Determining Ecosystem Location

We have identified two distinct types of ecoregions statewide, each with a slightly different RMZ delineation procedure: (1) Forested, and (2) Dryland. In general, forested ecoregions dominate western Washington, northeastern Washington, and portions of southeast, north central, and eastern Cascades. Dryland ecosystems are more readily contained in the Columbia Plateau Ecoregion east of the Cascade Range.

Landowners and land use planners should utilize the SPTH mapping tool, described in Appendix 1, to determine the ecoregion where the river or stream lies. Appendix 1 also provides instructions for using this tool to determine the 200-year site-potential tree height ($SPTH_{200}$) at a given location.

Site visits are important because small streams are often unmapped, including in GIS tools commonly used for planning and permitting. Shaner Creek, Thurston County/Janet Anthony, WDFW

2.3.2. Verifying the Presence of a Stream

Once you have identified which ecoregion you are in (e.g., Columbia Plateau), a qualified professional[6] should visit the site to verify the stream's location on or near the project area. It is very important not to rely solely on "stream maps" (e.g., DNR stream layer, National Hydrography Dataset) in place of a site visit (which is also important for mapping RMZs) because existing mapped stream layers often have errors, including streams whose locations are mapped inaccurately on the landscape, and streams actually present on the landscape that are missing from maps. Instead, use the site visit to validate existing stream maps.

[6] Qualified professionals can be entities and individuals identified by the jurisdiction, WDFW regional habitat biologists, tribal biologists, Ecology staff, and/or other individuals familiar with stream verification and who have local expertise (e.g., Conservation District staff, Stream Teams, etc.).

2.3.3. Identifying the Inner Edge of the RMZ

Once you have verified a stream's location, proceed to locate the inner edge of the RMZ. Accurate RMZ delineation is dependent on using the correct starting point. In this section, we describe how to determine the location of the RMZ's inner edge using either the Channel Migration Zone (CMZ), if one is present; or the Ordinary High-Water Mark (OHWM). Ecology, as the state's water quality lead, provides extensive guidance and resources associated with OHWM or CMZ, and those resources are referenced here forward.

2.3.3 (A). Identifying Ordinary High-Water Mark (OHWM)

Delineate the RMZ's inner edge by identifying the OHWM along both sides of the stream following the procedure in Chapter 3 of Ecology's OHWM delineation manual (Anderson et al. 2016).

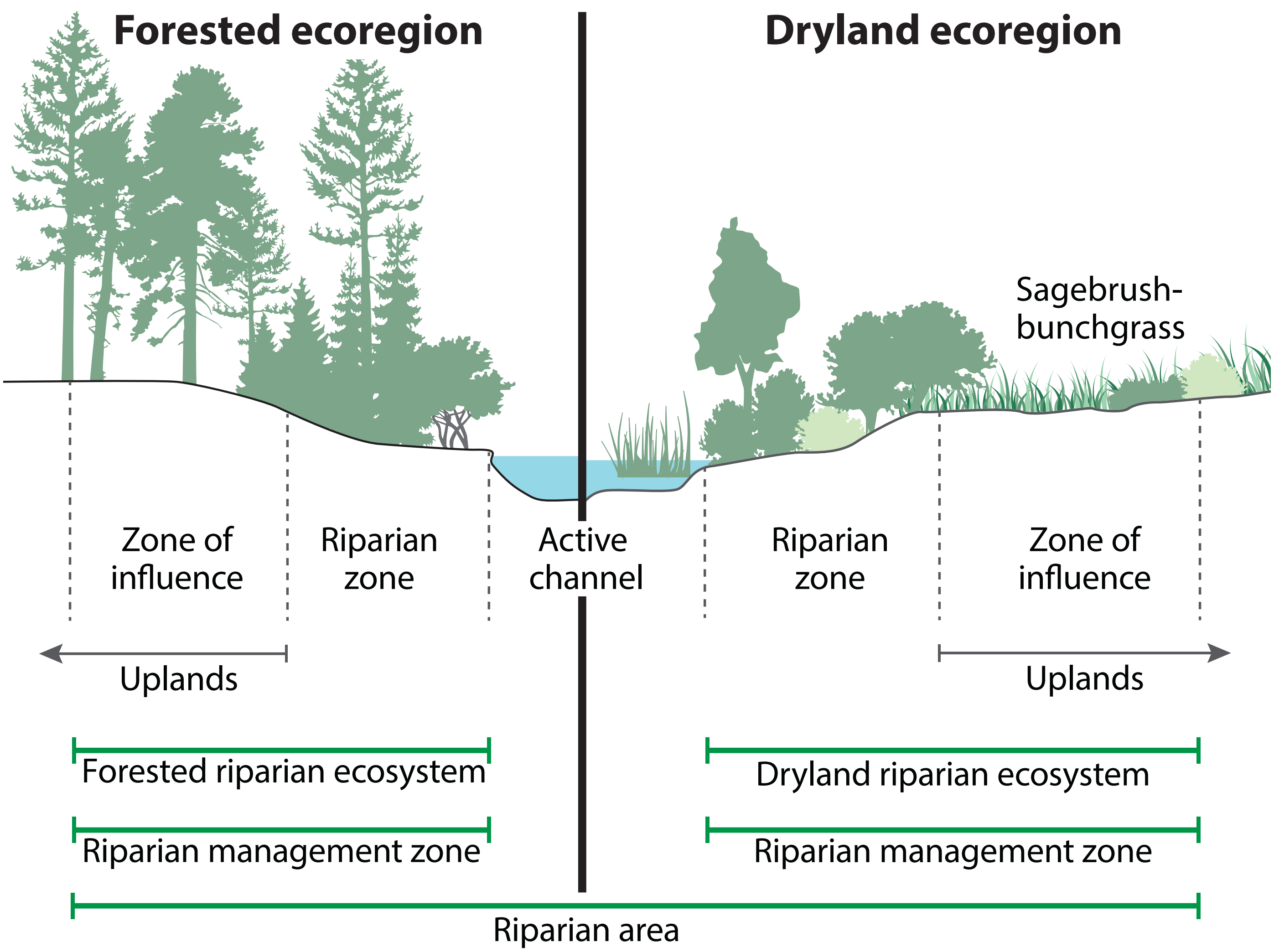


Figure 2.2. The diagram depicts the riparian management zone (RMZ) for both forested (left) and dryland (right) ecoregions. The RMZ is coincident with the riparian ecosystem, *which consists of the* riparian zone *(riparian vegetative community) and* the zone of influence. *The* riparian zone *extends from the edge of the active channel towards the uplands and it includes areas where vegetation is influenced at least periodically by flowing waters. The* zone of influence *includes areas where ecological processes significantly influence the stream, at least periodically.*

A drone photo showing an area of the Nooksack River in Whatcom County. Taken during summertime low flows, the existence of multiple braided channels is evident./Ross Zimmerman, Department of Natural Resources

2.3.3 (B). Identifying the Channel Migration Zone

Delineate the RMZ's inner edge by identifying the edge of the CMZ. Information about CMZs is available for certain streams in the state. For example:

- **SMA-Covered Shorelines** – During Shoreline Master Program comprehensive updates, many jurisdictions map the general location of CMZs associated with shorelines that fall under the jurisdiction of SMA (RCW 36.70A.480). Note that even smaller streams not subject to SMA jurisdiction can have CMZs. In these cases, we recommend jurisdictions still identify and analyze CMZs to protect riparian ecosystems and public health and safety.
- **Puget Sound Streams** – The federal Endangered Species Act may require CMZ delineation in Puget Sound basin streams under the FEMA National Flood Insurance Program Biological Opinion for Puget Sound.
- **Other Local Examples** – Check with your jurisdiction to see if they have more detailed CMZ maps.

Ecology provides the following resources which can help landowners and land managers assess the presence and extent of CMZs where maps and data on CMZs do not currently exist:

- CMZ Home Page provides a high-level look at CMZ identification, and references useful documents;
- Channel Migration Processes and Patterns in Western Washington (Legg and Olson 2014) describes the general channel migration processes that occur in western Washington;
- A Methodology for Delineating Planning-Level Channel Migration Zones (Olson et al. 2014) provides a process for delineating "planning-level" CMZs and gives a few good examples in the appendices;
- A Framework for Delineating Channel Migration Zones (Rapp and Abbe 2003) is a more in-depth guide on how to develop "detailed" CMZs; and
- Screening Tools for Identifying Migrating Stream Channels in Western Washington (Legg and Olson 2015) outlines the "CHAMP" (channel migration potential) GIS layer with guidance on using it to identify high-risk CMZs.

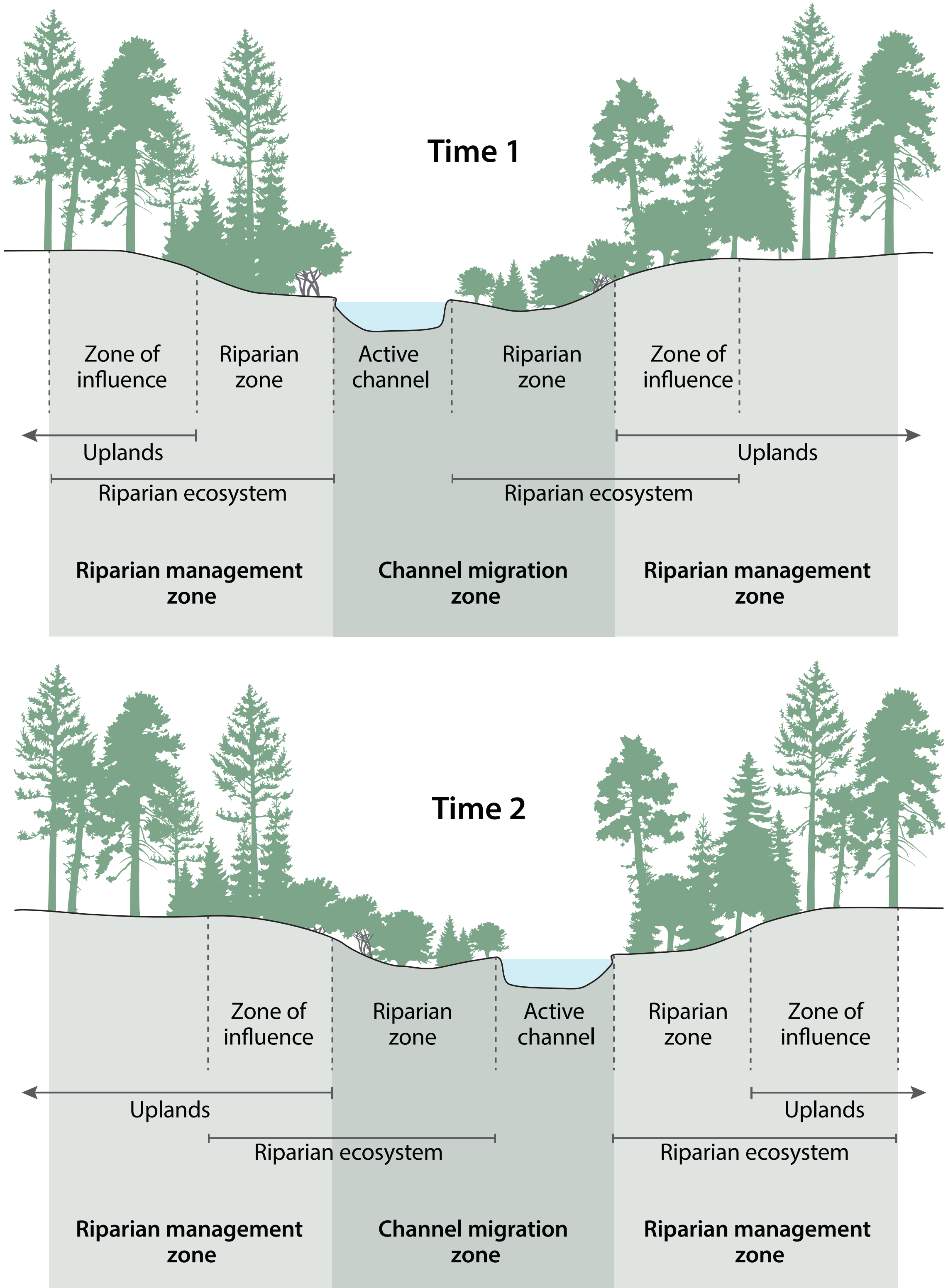


Figure 2.3. This diagram depicts the spatial relationship between the riparian management zone (RMZ) and channel migration zone (CMZ) over time. As the active channel moves laterally within the CMZ, the riparian ecosystem moves with it. As a result, when considering the establishment of an RMZ, delineation should occur at the edge of the CMZ to account for the full extent of both the present day and future riparian ecosystems. Time 1 and Time 2 could be separated by days or centuries. This depiction of a forested system is one representation of a CMZ, which are also present in dryland systems: both should be managed for accordingly.

2.3.4. Determining RMZ Width

Once you have determined the location of the RMZ's inner edge, you then establish the width of the RMZ. The following stepwise process aims to establish recommended minimum delineation distances based on $SPTH_{200}$, vegetation composition, and pollution removal function (Figure 2.4). We say "recommended minimum" because upland adjacent land uses may require further adjustment of the RMZ to provide adequate pollution removal functions. Landowners and land use regulators should also consider additional actions to support wildlife connectivity and/or to protect riparian adjacent Priority Habitats.

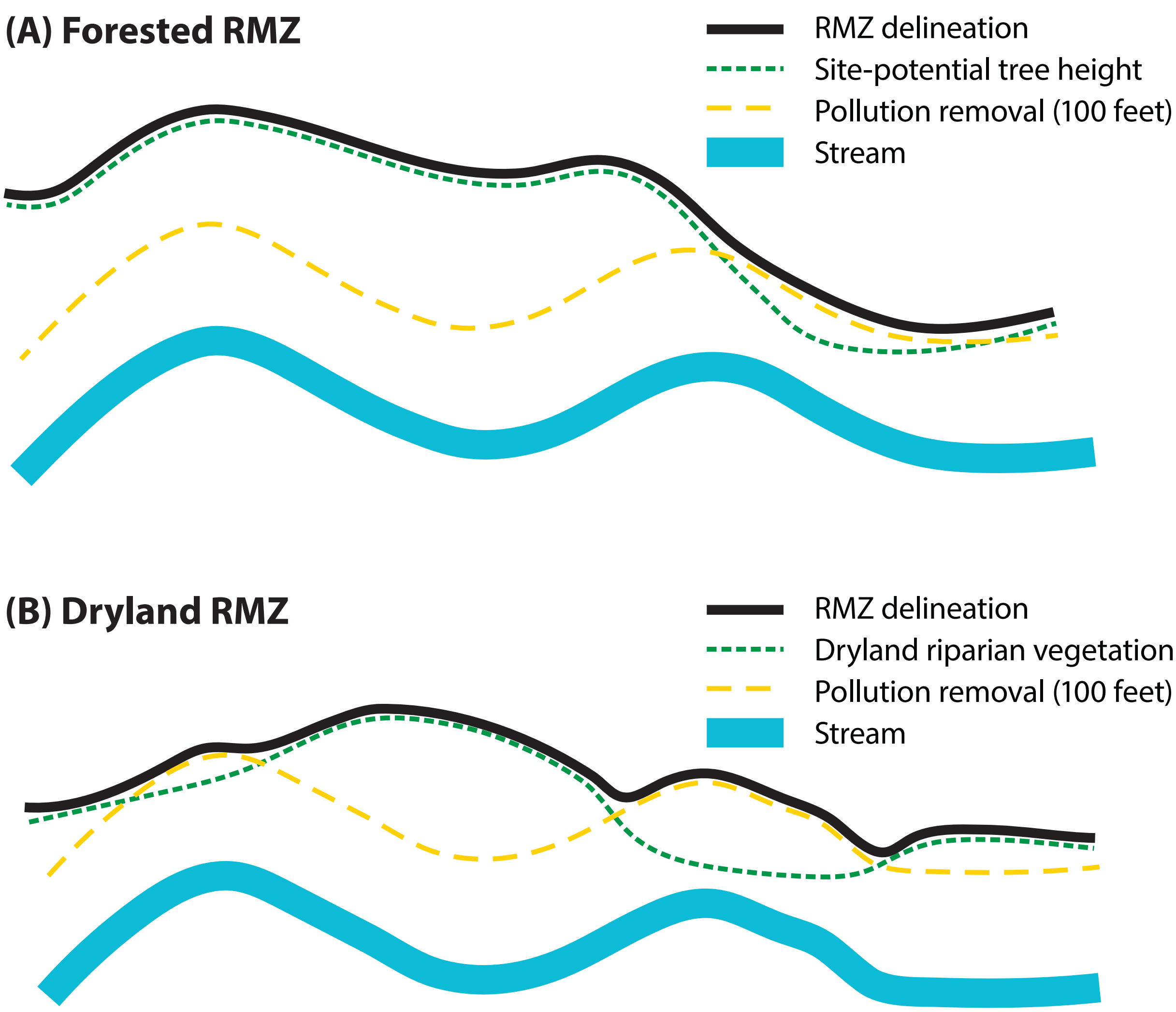


Figure 2.4. Aerial view of variable width RMZ delineation process for forested (A) and dryland (B) systems.

- *Step 1: Identify the SPTH or full extent of the riparian vegetative community (green);*
- *Step 2: Overlay a 100-foot pollution removal distance (yellow);*
- *Step 3: Delineate the RMZ (black) as the greater of the two distances.*

We tailor the following guidance based on two types of ecoregion: (1) Forested and (2) Dryland.

2.3.4 (A). Forested Ecoregions

Forested ecoregions are well-suited for using $SPTH_{200}$ consistently to establish RMZ widths, and so for these areas, landowners and land managers can rely on the $SPTH_{200}$ information provided in the SPTH mapping tool (see Appendix 1). The tool provides the derived average height attained by the dominant tree species at age 200 years ($SPTH_{200}$) using the U.S. Natural Resource Conservation Service (NRCS) forest productivity site index values, which we recommend for delineation of RMZs (see Sec 9.3 in Volume 1 for background on the origin and use of $SPTH_{200}$). In forested ecoregions, contributions of large wood as a riparian ecosystem function often define the farthest lateral extent of the RMZ.

Occasionally, the $SPTH_{200}$ may be less than 100 feet, in which case the pollution removal function (described in more detail in Section 2.3.5 below) defines the lateral extent of the RMZ.

In Washington, $STPH_{200}$ can be as large as 260 feet: therefore, be sure to evaluate each soil polygon within 260 feet of the stream channel to ensure that RMZ delineation is in fact being driven by the largest dominant tree species.

2.3.4 (B). Dryland Ecoregion

Riparian ecosystems in arid and semi-arid regions of North America (also referred to as the dryland ecoregion) make up less than 1 to 3 percent of the landscape (Patten 1998). Dryland riparian ecosystems are hydrologically linked to and influenced by adjacent surface waters; as a result, surface waters sustain riparian vegetation that is clearly distinct from upland vegetation.

Riparian ecosystems in dryland environments are highly variable due to various site-level conditions. While these ecosystems may support large trees in low gradient floodplains, tree presence in riparian ecosystems throughout the dryland ecoregion is much more varied than in forested ecoregions, and so in many cases, the contribution of large wood no longer serves as the outermost ecological function for RMZ delineation. Further, riparian vegetation may be minimal or even non-existent, particularly along degraded, incised streams. In dryland ecoregions, the outermost of

Protecting Columbia Plateau's Priority Habitats Supports Riparian Health

Native shrub-steppe vegetation and other drought-tolerant plant communities dominate Washington's dryland environments. Approximately 450 plant community associations occur in this region, with over 20% of these associations considered vulnerable (WDFW 2005, p. 523). Among the most imperiled ecosystems in North America, historical shrub-steppe has been greatly reduced due to conversion to other land uses (Vander Haegen 2007).

Riparian areas are critical to most animal species using shrub-steppe. Biodiversity in these vegetative communities increases dramatically where surface water occurs, and riparian areas directly support numerous species found only in or near water (Rogers et al. 1988, Johnson and O'Neil 2001). Linking and protecting upland adjacent Priority Habitat(s) not only aims to support Washington's wildlife and their associated habitat conservation goals, but also works to protect and maintain riparian ecosystem integrity.

three factors drives delineation of the RMZ: (1) $SPTH_{200}$ (if trees are present); (2) riparian vegetative community; or (3) pollution removal function.

2.3.4 (C). Considerations in Highly Modified and Urban Systems

In some locations, riparian systems have been substantially modified, and current site-specific conditions may not provide adequate indication of where riparian vegetation would naturally occur. On the whole, this is particularly true of riparian systems in dryland ecoregions. In these instances, we recommend considering nearby sites with unaltered vegetation or selecting a representative site with similar bank height and gradient conditions to identify adequate riparian vegetation delineation for both protection and restoration.

A modified riparian area within an agricultural landscape in Kittitas County. The stream channel was likely straightened decades ago. More recently, small bridges were built across the stream for pivot sprinklers to move back and forth. To allow ease of sprinkler movement, no woody vegetation is allowed to grow./Jennifer Nelson, WDFW

Similarly, four major urban areas (Seattle, Spokane, Tacoma, and Bellingham) in forested ecoregions lack NRCS soils data. For these areas, WDFW identified nearby NRCS soils polygons and calculated weighted averages as estimates reflective of the surrounding environment ("imputed $SPTH_{200}$"). Much like in forested areas where $SPTH_{200}$ data are available, we recommend using the imputed $SPTH_{200}$ values specified for each of these urban areas to delineate RMZs within them.

2.3.5. Width delineation steps

Step 1: Use $SPTH_{200}$ if it is at least 100 feet.

In **forested ecoregions,** WDFW recommends full protection within one $SPTH_{200}$, identified with the use of our SPTH mapping tool (https://arcg.is/1ueq0a). The mean $SPTH_{200}$ in western Washington ranges from 100 to 240 feet (Fox 2003). Some soil polygons have $SPTH_{200}$ information for multiple tree species; therefore, each soil polygon within one $SPTH_{200}$ should be evaluated to ensure RMZ delineation is driven by the largest dominant tree species. Occasionally the $SPTH_{200}$ in forested ecoregions is less than 100 feet; for example, red alder is a fairly common riparian tree species, yet the $SPTH_{200}$ for this species does not always exceed 100 feet. If red alder is the only species for which $SPTH_{200}$ information is available for a certain location, and it is less than 100 feet, then skip to Step 3.

In **dryland ecoregions,** it is less common, but still possible to find riparian vegetation which includes—and may even be dominated by—large trees. Examples of large tree species in these areas are black cottonwood (*Populus trichocarpa*) and ponderosa pine (*Pinus ponderosa*). If $SPTH_{200}$ in dryland ecoregions exceeds 100 feet, then it should be used for the RMZ width.

Step 2: In dryland ecoregions, if $SPTH_{200}$ is less than 100 feet or if no large trees are present, identify the extent of the riparian vegetative community.

In **dryland ecoregions,** the riparian vegetative community is often comprised of shrubs, sedges, grasses, and forbs that are distinct from upland communities. For example, in the Columbia Plateau, vegetation within riparian ecosystems often exhibits an abrupt demarcation between the riparian zone and zone of influence. Phreatophytic[7] trees and shrubs and hydrophytic[8] herbaceous plants are confined to moist streamside areas, but the upland zone of influence may consist of sagebrush or bunchgrass communities [for more information, see Volume 1, Chapter 7 (Section 7.1.1)]. Where trees are not present or consist only of small species (less than 100 feet tall), WDFW recommends full protection of the entire riparian vegetative community. In some places the community may only be a few feet wide but in others it may extend up to several hundred feet, particularly when associated with a wetland or floodplain (Bermingham et al. 2013). Where the riparian vegetative community is less than 100 feet wide, go to step 3.

Step 3: Overlay 100-foot pollution removal delineation

The following applies to both **forested and dryland ecoregions.**

Our recommendation to protect full riparian function recognizes the importance of the pollution removal function of riparian ecosystems. Because pollution removal depends on multiple factors, including slope, soils, plant community composition, and upland uses, establishing a standard RMZ width for 100% pollution removal even at the site scale was impractical.

Where neither $SPTH_{200}$ nor the extent of the riparian vegetative community is at least 100 feet, we recommend RMZ delineation of a *minimum* distance of 100 feet, because this distance will achieve 95% or more removal efficacy of phosphorous, sediment, and most pesticides. To be clear, we value a similar removal efficacy for nitrogen, and at a 100-foot width, an RMZ would achieve only 80% removal efficacy for surface runoff containing excess nitrogen. However, the literature reflects that both the actual risk posed by excess nitrogen, as well as the efficacy of its removal, are very site-specific. In recognition of this, we strongly recommend that, where upland uses contribute nitrogen, the 100-foot minimum pollution removal distance be extended accordingly when determining the appropriate RMZ width.

Further, if RMZ widths are being based on a minimum pollution removal function at locations with steep slopes or poorly drained soils, distances greater than 100 feet should also be considered: this applies for all pollutants. Additionally, WDFW recommends cities and counties identify high intensity land uses that may be located adjacent to riparian areas within their jurisdiction and establish wider RMZs to enhance the pollution removal function in these locations as well, following guidance from Ecology.

When dealing with variables such as those outlined above, it may be necessary to seek expert assistance in determining the appropriate adjustments to RMZ widths based on the pollution removal function.

7 A phreatopyhtic plant is a species that obtains water from the subsurface zone of saturation either directly or through the capillary fringe (Thomas 2014).

8 Hydrophytic plants are those that are adapted to growing conditions associated with periodically saturated soils. They include obligate wetland plants that almost always occur in wetlands under natural conditions, facultative wetland plants that usually occur in wetlands but are occasionally found in non-wetlands, and facultative plants that equally likely to occur in wetlands or non-wetlands (Lichvar et al. 2012).

Chapter 3. Riparian Regulatory Protections

3.1. Introduction

This chapter gives guidance to help local governments review, develop, and implement regulatory tools to protect riparian ecosystems as critical areas, i.e., Fish and Wildlife Habitat Conservation Areas (FWHCAs). We describe key steps toward creating effective programs to protect riparian ecosystems consistent with the goals of the Growth Management Act (GMA), Shoreline Management Act (SMA), and Voluntary Stewardship Program (VSP). More specifically, this chapter describes recommendations for carrying out common land use activities and provides steps for developing Habitat Management Plans (HMPs). The riparian management zone (RMZ) should serve as the focal area to apply our recommendations.

Parcel-scale regulations are foundational to Washington's traditional land use regulatory approaches for protecting rivers and streams and their adjacent riparian ecosystem. However, sole reliance upon a regulatory approach at this site scale may result in loss of aquatic system function over the long term (see Volume 1). Thus, we believe that site-scale regulations must work in coordination with watershed-scale planning (Chapter 4) and that both should be monitored and adaptively managed (Chapter 5). In this chapter, we present considerations and recommendations for managing and protecting riparian ecosystems at both site- and watershed-scales.

3.2. Recommendations to Local Jurisdictions

Protection of watersheds commonly falls under the purview of agencies other than WDFW. Nonetheless, we encourage local jurisdictions (and their long-range planners in particular) to consider how land use patterns at all scales collectively affect fish and wildlife and other important ecosystem services.

The scientific literature review (**see Volume 1**) informs WDFW's position that protecting the area within one $SPTH_{200}$ from the edge of a stream channel maintains full riparian ecosystem functions for all aquatic species, including salmon, and promotes healthy, intact riparian ecosystems. This recommendation provides the greatest level of certainty that land use activities do not impair functions and values of riparian ecosystems. We recommend the use of monitoring and adaptive management (see Chapter 5) to inform regulations and evaluate the complement of both regulatory and voluntary conservation measures in achieving outcomes.

Land use decision makers should ensure all programs that can affect riparian habitat (e.g., CAOs; SMPs; and ordinances for clearing and grading, fire hazard reduction, and tree protection) are coordinated to optimize the ability of local policies, rules, and management activities to protect those habitats. Further, jurisdictions should look for gaps such as inconsistencies, exemptions and loopholes, or inefficient practices (e.g., inspection and monitoring protocols) that could impede protection of or cause harm to riparian ecosystems.

To that end, we provide important questions to consider when reviewing CAOs, Comprehensive Plans, or other plans that can affect riparian ecosystems:

The Coweeman River Joint Wetland and Conservation Bank in Cowlitz County includes riparian areas as a focus for both restoration and preservation./Chuck Stambaugh-Bowey, WDFW

1. Conservation Strategies:

- What external strategies exist (e.g., salmon recovery plans, reach-scale assessments, and incentive-based plans) to maintain, protect and restore riparian areas?
- Which of these strategies (if any) currently inform your regulatory, planning, and/or voluntary processes or programs?
- If these strategies are not in your current programs, could they be incorporated to provide additional benefits to riparian ecosystems? Are there other strategies that could also (or instead) benefit riparian ecosystems?
- Which of these strategies may help your jurisdiction satisfy mitigation obligations?
- How are riparian restoration and/or enhancement programs informed by these strategies?

2. Regulatory Buffers:

- Does your jurisdiction rely on $SPTH_{200}$ for delineating regulatory riparian buffers?
- If your jurisdiction does not rely on $SPTH_{200}$ for delineating those buffers, does your jurisdiction currently have regulatory buffers for riparian areas that are equal to or greater than the distance equal to $SPTH_{200}$?
- Are there buffer exemptions? If so, how do those affect riparian function across your jurisdiction?
- Do your buffers consider the CMZ?
- Do your buffers consider adjacent wetlands and appropriate wetland delineation methodology as prescribed by Ecology?
- If your jurisdiction's CAO or SMP buffers are less than $SPTH_{200}$, can you use the RMZ to identify areas to do mitigation or areas impacted that will require mitigation?

3. Restoration and Adaptive Management (see also Chapter 5):

- Can your jurisdiction use the RMZ to identify areas for incentive-based restoration?
- Do you have a monitoring and adaptive management program for improving permit implementation?

- Is your jurisdiction collecting information on effectiveness of protecting riparian areas?
- If you collect effectiveness information, what programs (e.g., incentives, regulations) could you improve to increase riparian conservation?

4. Other Programs and Regulations

- What other regulations separate from CAOs, may inadvertently affect riparian areas (e.g., clearing and grading ordinance that lack safeguards for riparian protection)?
- Are there opportunities to connect riparian areas with other protected areas (e.g., frequently flooded areas, geologically hazardous areas, green belts, parks, wetlands, and aquifer recharge areas)?

3.2.1. Recommendations for Common Activities in the RMZ

Local governments should regulate all land use activities that are likely to impact functions of a riparian ecosystem found within the RMZ to ensure, at a minimum, that the existing functions and values are protected from development actions. For the purposes of meeting requirements under GMA, SMA, and VSP, we describe the RMZ as the area in which functions and values are contributed to the riparian ecosystem: providing a delineated space not just for protection, but also for mitigation and management. We also recommend prioritizing the RMZ as the space for restoration[9]. We provide specific information and recommendations for the following ten common activities: (Note that neither the list of activities nor the recommendations themselves are exhaustive; for more information, contact your WDFW regional habitat biologist.)

1. On-site Sewage Systems (OSS)
2. Bank hardening
3. Clearing, grading, and placement of fill
4. Removal of noxious weeds
5. Forest practices and conversions
6. Firewise and wildfire hazard reduction
7. Removal of hazard trees
8. Non-compensatory restoration and enhancement
9. Emergency activities
10. Educational or Recreational Areas

1. **On-site Sewage Systems (OSS)** – Historically, developers sited OSS at lower elevations bordering streams, lakes and wetlands in order to use passive gravity flow. The disadvantage of these systems is that when drain fields are located near water features, they can more easily contaminate water with high loads of nutrients and toxic pollutants, causing significant impacts to flora, fauna and water quality. The State Department of Health adopted rules establishing public health standards for location, design, installation, operation, maintenance, and monitoring of OSS, including requiring setbacks from waterbodies (WAC 246-272A) which modern OSS systems, using pump systems, can support. Some OSS may meet public health standards even if located within RMZs; nevertheless, jurisdictions should exercise authority to require HMPs to ensure project proponents protect habitat functions of riparian critical areas.

[9] As explained previously, many riparian areas had already experienced a substantial degree of degradation before laws like GMA, SMA, and VSP were passed, so while protecting what level of riparian functions and values remain is essential, protection alone will not be sufficient for meeting the needs of the state's fish and wildlife species.

2. **Bank Hardening** – We recommend jurisdictions avoid allowing new development that requires bank protection now or is likely to in the future (consider channel migration, wind and wave action, and climate change), unless it addresses an imminent threat as an emergency activity (*see* Emergency Activities in this section below). Always look to alternative places to site a project so that no bank protection measures are needed. If measures cannot be avoided, require that a project proponent evaluate the effectiveness of bioengineering alternatives (also known as soft armoring) prior to proposing hard armoring. Follow bank protection recommendations in the Washington State Integrated Streambank Protection Guidelines (Cramer et al. 2002) when bank protection is unavoidable.

3. **Clearing, Grading, and Filling** – We recommend jurisdictions acknowledge impacts of clearing, grading, and filling on riparian areas in their CAOs by limiting these activities to areas outside the RMZ (unless directly related to restoration) as they can negatively affect riparian areas. If a clearing, grading, or filling project must encroach in an RMZ, limit disturbance and minimize effects to the greatest extent possible. Require that a qualified professional prepare an HMP describing how the project proponent will follow the mitigation sequence.

   Jurisdictions that exempt small areas from filling or grading ordinances in riparian ecosystems should calculate cumulative impacts from these exemptions. They should also mitigate impacts and subsequently establish monitoring to ensure that mitigation measures are effectively negating potential losses to habitat function.

4. **Invasive and/or Noxious Plant Removal** – Many CAOs do not require a permit for control and removal of invasive and/or noxious weeds within riparian ecosystem. We support this when weed control efforts (1) employ hand weeding with light equipment; (2) use only Ecology-approved aquatic herbicides and adjuvants (a substance added to herbicides to improve application); avoid use of hazardous substances; and (3) do not result in soil compaction. Local governments should retain some oversight authority for more extensive invasive and/or noxious plant control projects to ensure adequate protections of riparian functions, especially water quality. Most communities issue an exemption letter or permit, which should include conditions to ensure impacts to fish, wildlife, and habitat are minimal. It is important to note that even plants native to the region can, in certain circumstances, be detrimental to riparian areas. An example is in Puget Sound Prairies, where in the absence of periodic fire events (typically prescribed fire), common western Washington conifer species like Douglas fir outcompete native deciduous species (primarily Oregon white oak). In these circumstances, conifer removal and re-establishment of historical riparian conditions (oak and prairie vegetation) should occur under an approved HMP. WDFW regional habitat biologists can assist in preparing, reviewing, and implementing such a plan.

5. **Forest Practices and Conversions** – The state's Forest Practices Act (RCW 76.09 and WAC 222) regulates forest practice activities on forestland. We recommend that the proponent always contact DNR prior to conducting forest practice activities and seek technical assistance from a WDFW regional habitat biologist to ensure protections for Priority Habitats and Species. When conducting commercial forest practice activities, the forest practice rules—not the CAO—apply for protection of resources on site. Lands converted from forestry to another use require a special forest practice permit, and when converting land, local CAOs are applied. If conversion occurs, WDFW recommends timber harvests not be allowed within $SPTH_{200}$.

6. **Wildfire Hazard Reduction** – Wildfire is a concern in Washington, though the threat varies across the state. Local regulations to reduce wildfire hazards should be coordinated with a Firewise program in order to require landowners to consult with a Firewise professional (http://www.dnr.wa.gov/firewise) before removing trees or

manipulating vegetation in an RMZ. Understanding the composition of historical forest stands and shrub-steppe can help ensure retention of riparian functions when carrying out wildfire hazard reduction activities. When fuel (vegetation) reduction efforts involve the removal of merchantable trees, the proponent should check with the local jurisdiction and DNR, which may require a permit for tree removal.

7. **Removing Hazard Trees** – Tree trimming or removal in RMZs is sometimes necessary to address public safety concerns but should be balanced with the potential impacts to riparian ecosystem function. Jurisdictions should define a "hazard tree" (sometimes referred to as a "danger tree") as a threat to life, property or public safety, and require that the method of tree removal not adversely affect riparian ecosystem functions if possible. Specifically, we recommend that any removal of hazard trees involve an avoidance and minimization of damage to remaining trees and vegetation within the RMZ. We further recommend that local governments require a qualified arborist to evaluate requests for hazard tree removal.

   The qualified arborist should be able to establish when a tree presents an imminent threat to life, property or public safety. It is important to note that snags (dead trees) are a Priority Habitat feature for wildlife, and so should be preserved if not hazardous.

Like many dead and dying trees, this snag along the Chehalis River shows evidence of woodpecker activity. Grays Harbor County/Mary Huff, WDFW

   Some local governments use Forest Practice Rules (WAC 222-21-010[4]), which define a hazard tree as "any qualifying timber reasonably perceived to pose an imminent danger to life or improved property." This applies to any tree within 1.5 tree-lengths of the structure. A DNR forester can verify during a site visit that a tree is a hazard based on this definition, and thus removing the hazard would not be subject to the Forest Practice jurisdiction or require a Forest Practice Application.

8. **Restoration and Enhancement** – We encourage local governments to include in their CAOs allowances for restoration and/or enhancement of the riparian ecosystem, including in-channel or streamside work, especially on lands set aside for conservation. To the extent possible, jurisdictions should promote incentives and set up a streamlined review process for restoration or enhancement projects to help facilitate project proponents not just meeting the minimum requirements of the local CAO, but instead going "above and beyond". Significant resources are available to jurisdictions that address limiting factors in riparian areas or undertake high priority restoration activities that benefit salmon or other listed species (see Chapter 4 for information on restoration).

9. **Emergency Activities** – Local codes typically have provisions for emergency activities (e.g., bank stabilization to address imminent threats to homes) that provide relief from time delays related to procedural code requirements.

Local regulations should distinguish the immediate need to permit an emergency activity from the need to compensate for its impacts after-the-fact.

10. **Educational or Recreational Areas** – Public access to shorelines is a priority use under the SMA and providing educational and/or recreational developments such as trails, viewing platforms, or similar facilities may also enhance the public's understanding and appreciation of riparian areas, streams, and habitats. Thus, some focused use of the RMZ for educational and recreational activities may be desirable, if it does not create significant disturbances. Most CAOs include allowances for unpaved access to a stream for aesthetic or recreational enjoyment with defined limits on clearing to avoid impacts and minimizing soil, vegetation, and habitat disturbances: this is an allowance we support. That said, construction of trails could allow greater access for pets and other high intensity recreation, which may increase predation on, and/or disturbance of fish and wildlife species. Regulations should minimize impacts from recreational trails and interpretive facilities to the extent practicable, informed by PHS data and associated management recommendations.

A sculpture titled "The Indian Chief" greets visitors at the entrance to the Beebe Springs Natural Area along the Columbia River near Chelan./Alan Bauer

3.2.2. Project-specific Riparian Habitat Management Plans

When reviewing proposed projects near streams, local governments typically require applicants to provide detailed site-specific HMPs (often called a Critical Area Report). Here we describe six aspects of Riparian HMPs that we recommend be addressed in CAOs:

1. When HMPs are required;
2. Which additional critical areas must be delineated, and how;
3. Which specific land use actions must be identified, and how;
4. Mitigation requirements;
5. Monitoring and Adaptive Management requirements; and
6. Articulate who must prepare and review the HMP.

1. **When required** – We recommend jurisdictions require an HMP whenever someone proposes a land use activity in an RMZ (regardless of the jurisdiction's regulatory RMZ delineation) or when a proposal likely could affect riparian or aquatic functions. In cases where there is less confidence in the spatial accuracy of the RMZ, consider requiring a Riparian HMP when impacts occur adjacent to the RMZ's zone of influence.

It is not uncommon for riparian areas to overlap with other types of critical areas, including geologically hazardous areas, where landslides may bring input like large wood to streams./ Terra Hegy, WDFW

Maps, DNR's stream layers, the National Hydrography Dataset (NHD), and other (e.g., local) stream layers are important for triggering HMPs. An HMP should be required whenever a stream is present near proposed development activities, including but not limited to subdivisions (plats, short plats, and large lot subdivisions), land/vegetation disturbing activities (e.g., clearing and grading, septic drain field siting), and stormwater routing.

2. **Critical Area Delineation** – HMPs should have the extent of critical areas within and adjacent to a proposed project site identified, along with ecosystem functions that need protection. Follow the RMZ delineation procedure outlined in Chapter 2, along with locations of other critical areas on or near the site (e.g., wetlands, geologic hazards, frequently flooded, critical aquifer recharge areas; informed by Ecology). Also, identify salmon and other priority aquatic species that use the stream network in the immediate vicinity as well as up- and downstream. Likewise, HMPs should identify Priority Species that may use the riparian corridor and any other Priority Habitats to which the corridor is connected. Attach the delineation map (1) to the property's title to inform future property owners of the site's critical areas, and (2) use it to update the jurisdiction's critical areas maps.

3. **Land Use Action Identification** – A complete HMP should describe relevant management recommendations for Priority Habitats and Species found on or near the site. Include a map in the HMP showing the location of proposed land use actions. It should identify and quantify current and proposed disturbances to the RMZ and other FWHCAs.

4. **Mitigation** – The HMP should have a description of the project proponent's mitigation sequencing. It should describe in detail measures to avoid impacts and minimize unavoidable impacts (e.g., clustering, conservation easements, and seasonal construction restrictions). If mitigation or compensation is necessary, the HMP should identify ways to improve riparian ecosystem function by enhancing riparian corridor connectivity (e.g., removal of stream barriers) or by improving the quality of the riparian area (e.g., replacing invasive vegetation with appropriate native vegetation).

5. **Monitoring and Adaptive Management** –The HMP should describe requirements for monitoring and adaptive management. In addition, it should identify measurable standards and expectations to monitor compliance (e.g., areal extent of vegetative cover, composition of riparian tree species, maximum invasive plant cover). The HMP should identify frequency of visits to monitor the site (e.g., at year 1, 2, 3, 5, 8, and 10) as well as measurable triggers for requiring more actions (e.g., maximum percent area coverage of invasive plants). The HMP should specify who is responsible for preparing, reviewing, and submitting reports. Finally, if deemed necessary by the jurisdiction, the report should include a cost estimate for monitoring, and the project proponent should post a bond for this amount or more to allow for overages.

6. **Preparer and Reviewer** – A qualified professional biologist, botanist, or ecologist should prepare the HMP; additional expertise related to CMZs, unstable slopes, and wetlands may also be necessary. Additionally, an independent professional with similar qualifications should review the HMP. WDFW's regional habitat biologists can often serve in this role, especially for larger projects. USFWS or NOAA Fisheries should also review the HMP if the project might affect a federally listed fish or wildlife species.

3.3. Riparian Management in Urban Areas

Some people have raised questions about the applicability of RMZs to urban and urbanizing areas. These concerns generally fall into two categories: (1) the science on RMZs comes largely from agricultural and forestry settings, and so is perceived to be irrelevant to urban areas; and (2) there is a belief that the need to maximize density of development in urban areas is in direct conflict with the protection of riparian areas.

Concerns over the relevancy of literature on riparian functions to urban areas is largely unfounded. While most riparian ecosystem studies are from non-urban settings, the principles are the same. Functions of shade, bank stability, large wood recruitment, nutrient inputs, and pollutant removal operate similarly in urban areas as they do in other settings. However, within urban areas, these riparian ecosystem functions are often greatly diminished or even absent altogether.


Fish-bearing stream within an urban area of King County/Elizabeth Torrey, WDFW

The role that urban RMZs play in delivering habitat functions for aquatic and many terrestrial species is also like that in non-urban areas. Factors that may be different in urban areas are that urban riparian ecosystems may perform some functions at reduced levels due to their position in developed watersheds, which are often heavily degraded. However, intact RMZs in urban areas function as wildlife corridors that link habitat patches, which is critical for many species. In fact, sometimes RMZs in urban areas may be more important from a habitat standpoint, because within urban areas, adjacent uplands are often even more degraded than the RMZs, which then are often the only remaining areas where habitat functions are provided. Thus, a key element to maintain in urban RMZs is connectivity, both in and along streams.

Many Puget Sound salmon move through channelized streams, traversing heavily urbanized areas prior to reaching spawning grounds and as juveniles on a reciprocal journey to marine waters. Salmon must pass through a wide spectrum of development. For example, adults returning to spawn often start in urban cores (e.g., downtown Seattle), where streams are often channelized; then pass through areas with small lots and high urban density and into suburban creeks where larger lots allow for more riparian protection; and finally, to rural lots with less development and better ecosystem health. When juveniles make their journeys in reverse, they generally spending more time in each of these areas than their parents did, and yet because of their small size, they are also at much greater risk of not surviving any of them. While the decades-long decline of many of our native salmon stocks illustrate just how challenging this is, their persistence—especially the subspecies which are showing signs of improvement—shows us what is possible. Therefore, it is critical that the urban environment maintain and enhance the ability of different species and ages of salmon to not just survive, but thrive, while in these disturbed areas.

Many of the actions we recommend urban communities focus on are the same or similar to those appropriate in less densely developed areas. For example, it is critical to maintain connectivity through properly sized culverts such that all fish can pass through at all relevant life stages. Additional riparian function can be achieved through revegetation efforts using native plants and by improving connectivity between habitat patches. A landscape analysis can help identify existing connections to protect, as well as areas where restoring connectivity is a priority. On the other hand, some actions are particularly well-suited to urban jurisdictions, like standards for Low Impact Development (LID) and state-of-the-art stormwater management. Further, when changes are made to urban infrastructure, this may create opportunities to improve riparian functions while contributing to new or improved public open spaces.

Recommendations for urban riparian ecosystems:

1. Delineate urban RMZs to protect what areas remain and to highlight lost or degraded areas to target for restoration.
2. Quantify current conditions, with a goal of maintaining and improving functions through regulatory and voluntary means.
3. Identify and prioritize restoration opportunities and projects within the RMZ:
    - Protect riparian functions that remain, especially in places that are relatively high functioning; implement actions that enhance degraded functions (see Chapter 4).
    - Prioritize opportunities to maintain and restore in-stream and riparian connectivity.
    - Adopt a stormwater design manual equivalent to Ecology’s most current manual for western and eastern Washington.
    - Manage stormwater by adopting Ecology’s latest manual regarding LID for new development, redevelopment and retrofit projects.

4. When replacing or removing existing infrastructure within an RMZ:
    - Map RMZ to pinpoint the best sites to restore – consider connectivity and adjacency to other Priority Habitats;
    - Improve aquatic connectivity by replacing culverts and removing barriers to movement;
    - Revegetate with native plants and consider improvements for wildlife by integrating structures necessary for nesting, breeding, and foraging;
    - As infrastructure is remodeled or replaced, incorporate additional setbacks from streams;
    - Control access to RMZ to limit soil compaction;
    - Avoid operating equipment near the stream to reduce sedimentation and soil compaction; and
    - Avoid using chemicals in the RMZ which are not approved for use there by Ecology.

3.4. Managing Watersheds


Tieton River on Oak Creek Wildlife Area in Yakima County, looking west toward the Cascade Mountains./Justin Haug, WDFW

As described in Chapter 8 of Volume 1, land use activities in a watershed can affect the stream network, even when the riparian ecosystem itself is relatively undisturbed. "Watershed management" is a land management approach that seeks to minimize negative effects of upland land uses on aquatic systems, which include riparian areas. The remainder of this chapter focuses on key watershed elements important to managing and protecting functional aquatic systems. Many of the approaches we outline here are non-regulatory and can complement regulatory efforts; as previously stated, we recommend cities and counties inventory current conditions of critical areas and, based on that inventory, develop watershed scale management plans accordingly.

Fully functional riparian ecosystems, in combination with targeted watershed protections, provide significant benefits to humans. These benefits, often described as ecosystem goods and services, include clean water; decreased flooding; increased nutrient cycling, sediment and pollutant filtering; reduced erosion; carbon sequestration; and cultural services such as recreational, spiritual, and other nonmaterial benefits. These services provide real but often unquantified economic benefits to individuals and society that largely go unnoticed until they are lacking.

3.4.1. Watershed-Scale Recommendations to Protect Aquatic Systems

To achieve desired ecosystem goods and services watershed managers should focus on influencing watershed processes that act upon water, wood, sediment, nutrients, vegetation, and pollutants at both the site- and watershed-scale. This section focuses on watershed-scale management.

Restore and Protect Watershed Processes – Efforts to improve watershed conditions should first focus on protecting and restoring watershed processes (e.g., natural disturbances) that create and retain habitat for fish and wildlife. Maintain the frequencies, magnitudes, and durations of natural disturbances (flood and fire being the most common) to the greatest extent that surrounding land uses can tolerate.

Manage Land for Stormwater – Stormwater runoff can change the timing, quality, and quantity of water provided to streams. Land uses should avoid/minimize changes to surface water flows. Protection and restoration efforts should focus on attenuating peak flows and reducing pollutants. Primary tools available to local governments include land use designations/zoning code, and stormwater regulations. See City of Redmond Watershed Management Plan (City of Redmond 2013).

Chum salmon gathered at a blocked culvert in Kitsap County./Brittany Gordon, WDFW

Manage Land for Stream Temperatures – Reduced riparian vegetation cover, decreased streamflow, and simplified stream channels (e.g., increased width-to-depth ratio and reduced groundwater exchange) can lead to increased water temperature (Volume 1, Chapter 4). Modifications like these are often the result of land use activities such as riparian vegetation removal; water diversions; unmanaged livestock grazing; and stream channelization associated with roads, levees, and other forms of development. Identify and restore thermally sensitive stream reaches at the watershed scale to maintain optimal stream temperatures for sensitive aquatic species such as salmonids.

Restore and Protect Connectivity – Manage watersheds to avoid creating longitudinal (e.g., dams, road crossings), lateral (e.g., levees and roads/buildings that cut off riparian areas and floodplains from their stream), and vertical (water withdrawals, reductions of floodplains) barriers to fish and wildlife movement and fragmentation of their habitat. This is especially important for highly mobile species that require a variety of habitat components across large areas. For example, where CMZs interact with floodplains, dikes and levees restrict the movement of the river or stream and also serve as a barrier for fish and many forms of wildlife.

Restoration to correct existing barriers to movement of water, wood, sediment, and species (e.g., removing blocking culverts) is a high priority with proven benefits for salmon. Connectivity to achieve nearly or completely contiguous RMZs is important to water quality and to achieve connectivity among patches. Ensuring connectivity both for terrestrial and aquatic wildlife works towards a more interconnected and healthy riparian system.

Plan for Climate Change – Impending changes to aquatic systems caused by climate change increases risk to species already threatened, and riparian ecosystem protection is one of the most useful responses to ameliorate those risks. For example, because more intense rainfall events will lead to wider streams, larger culverts will be necessary to support fish passage. WDFW, in collaboration with the University of Washington's Climate Impacts Group, created an online tool (UWCIG 2017) that estimates how much a stream's channel width will increase with climate change in the years 2040 and 2080. Connectivity within the RMZ allows voluntary migration for species and helps minimize temperature change and increase off-channel storage of water to reduce low flows.

Conduct Monitoring and Adaptive Management – Monitoring and adaptive management are important elements to both site-scale and watershed-scale; this is addressed further in Chapter 5.

3.4.2. Tools and Key References for Assessing Current Watershed Conditions

Washington's State agencies, including WDFW, have developed multiple tools to assist local government in assessing watershed conditions. Jurisdictions can utilize these resources—many available at no cost—to quantify changes in land cover, tailor planning for specific species, coordinate monitoring activities, inform restoration, and assess watershed health.

WDFW's High Resolution Change Detection (HRCD) is a spatial dataset that characterizes changes in land cover. This tool allows jurisdictions to evaluate in specific ways how watersheds are changing at a sub-parcel scale over 2- to 3-year intervals. This dataset is currently available throughout the entire Puget Sound basin and in some Eastern Washington watersheds. HRCD data is available at https://hrcd-wdfw.hub.arcgis.com/.

WDFW's Priority Habitats and Species program has several resources of interest to watershed planners. In addition to this two-volume document on riparian ecosystems, readers will find useful ideas in Land Use Planning for Salmon, Steelhead and Trout: A land use planner's guide to salmonid habitat protection and recovery (Knight 2009) and Landscape Planning for Washington's Wildlife: *Managing for Biodiversity in Developing Areas* (Azerrad et al. 2009).

Since 2004, the Pacific Northwest Aquatic Monitoring Partnership has collaborated with West Coast federal, state, and tribal agencies to coordinate monitoring activities and develop common approaches. This partnership provides best practices, mapping tools, and protocols, and serves as a voluntary clearinghouse for a wide variety of monitoring projects.

Since 2009, Ecology's Watershed Health Monitoring Project has been monitoring sites throughout the state to assess watershed health. This project's protocols can be adapted by jurisdictions and scaled to watersheds of various sizes. Data is stored in the Environmental Information Management database. This sophisticated database allows users to input and retrieve data via the web, reliably store it, and make it available for analysis. Quality assurance/quality control measures ensure data put into the database are of high quality.

Ecology's Puget Sound Watershed Characterization is a Puget Sound-wide tool that compares areas based on their suitability and value for restoration and protection. This tool informs two fundamental questions: (1) where to focus protection and restoration on the landscape first, and (2) what types of activities and actions (i.e., restoration, protection, conservation, or development) are most appropriate to that place. With insights gained by this tool, decision-makers can incorporate information regarding watershed processes to improve plans (e.g., comprehensive plans, subarea plans, CAOs, stormwater plans) and conservation efforts (e.g., in-lieu fee programs, open space tax credits, open space land acquisitions).

In 2016, the Washington Department of Commerce (Commerce) published Building Cities in the Rain (Ballash 2016) to help communities improve watersheds while redeveloping and revitalizing urban areas. The guidance describes an optional three-step process for prioritizing watersheds for stormwater retrofits in urban areas. Commerce's Puget Sound Mapping Project uses an interactive map to help users develop insights about how current and expected development patterns might affect the region's environmental health. The tool is designed to help decision makers consider information from the Puget Sound Watershed Characterization (described above) when making decisions regarding development projects, urban growth boundaries, and compensatory mitigation.

Finally, the University of Washington's Climate Impacts Group has developed a suite of tools, many in concert with WDFW, which may be useful for landowners and land use decision makers including climate trends, culvert design projections, and habitat connectivity.

Chapter 4. Restoring Riparian Ecosystems

4.1. Introduction

This chapter provides high-level guidance to landowners, land use decision makers, and conservation partners to promote restoration of riparian areas. Despite recent efforts to protect existing riparian systems, imperiled salmon stocks and other riparian dependent endangered species are not recovering as hoped (Table 4.1). Since non-indigenous settlement of Washington began in the 1800s, between 50 percent and 90 percent of riparian ecosystems have been lost or extensively modified (RCO 2019). While two subspecies (Hood Canal summer chum and Snake River fall Chinook) are moving towards recovery, most listed salmon in Washington are below recovery goals (Table 4.1).

The lack of recovery is also evidenced in the ongoing decline of salmon fishing, which affects the long-term health of Washington's tribes, Washington's economy, and our shared cultural heritage. The lack of salmon is one of the primary reasons Southern Resident Killer Whales are at risk of extinction, in addition to other impacts such as vessel disturbance and pollutants. (Lacy et al. 2017, Murray et al. 2019)

Table 4.1. Non-statistical evaluation of natural origin (wild) fish that returned to spawn with consideration for threats and factors affecting health including habitat, harvest, and hydropower. (Adapted from RCO 2019; Data sources: WDFW, Indian tribes, NOAA).

Below Goal (Endangered Species Act-Listed Salmon in Washington)			**Near Goal**
Getting Worse	*Not Making Progress*	*Showing Signs of Progress*	*Approaching Goal*
Upper Columbia River Spring Chinook Puget Sound Chinook	Upper Columbia River Steelhead Lower Columbia River Chum Lower Columbia River Coho Lower Columbia River Fall Chinook Lower Columbia River Spring Chinook Snake River Spring Chinook Snake River Summer Chinook	Mid-Columbia River Steelhead Lake Ozette Sockeye Lower Columbia River Steelhead Snake River Steelhead Puget Sound Steelhead	Hood Canal Summer Chum Snake River Fall Chinook

Former lake-bed above the area where the Glines Canyon Dam once stood on the Elwha River, Clallam County. Following dam removal, salmonids returned even faster than expected./Rachel Blomker, WDFW

Given the extent of historical loss, WDFW recognizes that protection alone of remaining riparian ecosystems, will not recover salmon or the Southern Resident Killer Whale population. Therefore, WDFW recommends restoring and enhancing riparian ecosystems to achieve healthy, intact, and fully functioning riparian systems statewide. Continued investments in restoration will be required at all levels of government and in concert with Washington tribes.

4.2. Restoration Actions

Although this section focuses on restoring riparian areas for the benefit of salmon, emulating historical conditions benefits many other aquatic and terrestrial species as well. WDFW is available to provide technical assistance and species-specific guidance for terrestrial species-focused restoration and recovery efforts. To recover salmon, we must protect all remaining existing riparian and watershed functions, while seeking opportunities to restore functions that have been lost over time. We provide the following information to assist the restoration community[10] in understanding what is important to restore.

4.2.1. Developing a Restoration Strategy

Aquatic restoration strategies typically start with a clear set of goals and objectives. The selection of appropriate restoration strategies is informed by the political, social, and ecological context of the watershed, and bounded by the extent of opportunities and constraints. It is important in ecosystem restoration to consider the habitat attributes and scale necessary for a desired suite of species, be they aquatic or terrestrial. At a watershed scale, restoration efforts should focus first on projects that offer the greatest potential for success. The Stream Habitat Restoration Guidelines (Cramer 2012) suggest the following prioritization of stream habitat restoration strategies that are specific to instream related activities most often geared at anadromous fish:

1. **Protect existing habitat.** Protect areas that provide healthy, high-quality habitat functions (strongholds, refugia, and key sub-watersheds) to prevent further degradation. Secure, expand, and link protected areas.

2. **Connect habitat.** Connect and provide access to isolated habitat, including instream, off-channel, and estuarine habitat made inaccessible by culverts, levees, fragmentation, or other man-made obstructions.

3. **Restore habitat-forming processes.** Employ land use recovery and watershed restoration techniques to restore processes that create, maintain, and connect habitats (including restoring sediment dynamics, large wood dynamics, and flow regimes; avoiding/removing manmade disturbances within the riparian ecosystem; and maintaining water quality, floodplain connectivity, and channel evolutionary processes). Employ a combination of active or passive restoration techniques, as necessary. Active restoration involves accelerating processes or attempting to change the trajectory of succession; passive restoration simply involves ceasing environmental stressors such as agriculture, grazing, or timber harvest, and then allowing nature to take its course.

10 Many watersheds in Washington have salmon recovery restoration goals that can be obtained from regional Salmon Recovery Boards or Lead Entities for Salmon Recovery. Lead Entities and Salmon Recovery Boards are in every region of the state, including those areas without salmon or other anadromous fish (https://www.rco.wa.gov/salmon_recovery/regions/regional_orgs.shtml).

4. **Create new or enhance existing habitat.** Improve existing or create new habitat for specific species by installing instream structures such as large woody debris; reconfiguring channel shape, cross-section, or profile to reduce incision or restore flow; or constructing one or more new side channels.

In conjunction with other state agencies and partners, WDFW provides multiple technical guidance documents to help design and implement riparian restoration projects that have proven successful in different types of landscapes, including on marine shorelines, and on river- and streambanks. These are part of a suite of Aquatic Habitat Guidelines found at https://wdfw.wa.gov/licenses/environmental/hpa/application/assistance. They include:

- Water Crossing Design Guidelines (Barnard et al. 2013)
- Stream Habitat Restoration Guidelines (Cramer 2012)
- Integrated Streambank Protection Guidelines (Cramer et al. 2002)
- Land Use Planning for Salmon, Steelhead and Trout: A land use planner's guide to salmonid habitat protection and recovery (Knight 2009)
- Draft Fishway Guidelines for Washington State (Bates 2000)
- Draft Fish Protection Screen Guidelines for Washington State (Nordlund and Bates 2000) Marine Shoreline Design Guidelines (Johannessen et al. 2014)
- Your Marine Waterfront (WDFW 2016)
- Protecting Nearshore Habitat and Functions in Puget Sound (AHGP 2010)

4.3. Implementing Riparian Strategies Through Incentives

There are several types of conservation incentives available to individuals and local governments:

- **Financial assistance:** grant programs that provide funding for conservation activities
- **Tax adjustment:** tax reductions for landowners undertaking conservation activities
- **Technical assistance:** advice and/or hands-on help for landowners on tools or techniques
- **Recognition:** promotion of landowners who undertake conservation actions

Each of these will be described (and examples provided) in more detail, below.

4.3.1. Financial Assistance

State and federal grant funds are available for riparian ecosystem conservation and restoration projects on public and private lands through the Recreation and Conservation Office (RCO) and Salmon Recovery Funding Board. To access these funds and to learn more, go to https://www.rco.wa.gov. Grant programs include:

- Aquatic Lands Enhancement Account
- Washington Wildlife and Recreation Program (Farmland, Forestland, Habitat, and Recreation categories)
- Estuary and Salmon Restoration Program—a program of WDFW
- Land and Water Conservation Fund
- Salmon Recovery and Puget Sound Acquisition and Restoration

Land trusts also help land owners conserve habitat for key aquatic and terrestrial species, often leveraging funds from foundations and other non-governmental sources; see www.walandtrusts.org for a county-specific list of land trusts.

For agricultural property owners, local conservation districts and the Washington State Conservation Commission (WSCC) can provide technical assistance to find an approach that works for the farmer and improves riparian ecosystem function. Technical assistance is also available from the federal Natural Resources Conservation Service (NRCS), Washington State University Extension, and WDFW. Additionally, a host of state and federal financial incentives to expand and maintain riparian functions within the riparian management zone (RMZ) are available, some of which are listed below. For example, the Conservation Reserve Enhancement Program (CREP) provides funding to landowners for riparian preservation and is the most successful riparian buffer program in Washington. Since CREP's 1999 inception in our state, more than 900 miles of stream buffers have been planted, and as of October 2020, producers had over 13,500 acres actively enrolled in CREP. Contact your local conservation district or the RCO to learn more.

- Conservation Reserve Enhancement Program (NRCS)
- Environmental Quality Incentives Program (NRCS)
- Conservation Stewardship Program (NRCS)
- Conservation Reserve Program (NRCS)
- Regional Conservation Partnership Program (NRCS)
- Agricultural Conservation Easement Program (NRCS)
- Agricultural Land Easements (NRCS)
- WWRP Farmland Preservation Grants (RCO)

Timber landowners have access to a variety of forestry-oriented conservation incentive programs (see list, below) and can also receive technical assistance from DNR's Forest Stewardship Program (foreststewardship@dnr.wa.gov, 360-902-1428):

- Forestry Riparian Easement (DNR)
- Rivers and Habitat Open Space Program (DNR)
- Healthy Forests Reserve Program (NRCS)
- Family Forest Fish Passage Program (DNR)
- Forest Legacy (USFS)
- WWRP Forestland Preservation Grants (RCO)

The federal Conservation Reserve Enhancement Program (CREP) funded this vegetation planting project along a stream in Skagit County./Wendy Cole, WDFW

4.3.2. Tax Reduction Incentives

Landowners can receive a substantial tax reduction by converting land into "open space" status because of the Open Space Taxation Act (WAC 458-30), enacted in 1970. Lands with riparian areas often qualify for this incentive; see your county assessor and local planning department for details.

4.3.3. Technical Assistance

Local governments and individual landowners who want to improve riparian habitat for a suite of species can request land use advice from a variety of sources, including:

- WDFW regional habitat and district wildlife biologists. Go to http://arcg.is/1SgsHqk to find the names and direct contact information for your local biologists, or call the regional office in your area:
    - Region 1 – Eastern: 509-892-1001
    - Region 2 – North Central: 509-754-4624
    - Region 3 – South Central: 509-575-2740
    - Region 4 – North Puget Sound: 425-775-1311
    - Region 5 – Southwest: 360-696-6211
    - Region 6 – Coastal: 360-249-4628

- Salmon Recovery Lead Entities or Regional Fisheries Enhancement Groups
- Tribal natural resource departments
- Local Conservation Districts

4.4. Suggested Restoration Practices

The following section provides a series of suggested restoration practices promoted by WDFW, other state and federal agencies, and conservation partners. We encourage consideration of these activities and others within and adjacent to the RMZ, as delineated in accordance with our recommendations in Chapter 2. Further, it is not unusual to find other types of Priority Habitats (e.g., wetlands, shrub-steppe) adjacent to riparian areas. In such cases, restoration practices should not degrade or disturb the adjacent habitat, but rather—if feasible—improve it in addition to improving the riparian habitat. The same approach should be used where riparian-adjacent Priority Species areas are present.

Like most restoration practices, the ones recommended below can range in complexity, both biologically and technically, so landowners are strongly encouraged to seek technical assistance from WDFW and other experts before taking any action: This will help save money, time, and greatly increase the likelihood of success for any restoration activity. Landowners should also be aware that many of these activities may require permits[11,12] issued by one or more

11 The Governor's ORIA Office provides additional assistance for general permitting questions (https://www.oria.wa.gov/site/alias__oria/347/Permitting.aspx)
12 Larger projects may also trigger permit requirements with federal agencies, such as the U.S. Army Corps of Engineers (USACE).

agencies such as WDFW for the [Hydraulic Code rules], and DNR for the [Forest Practices rules]; as well as permits from the local jurisdiction.

Cooperative riparian enhancement project led by the Lower Columbia Fish Enhancement Group along the Toutle River, Cowlitz County/Josh Nicholas, WDFW

1. Improve quality of vegetation for both aquatic and terrestrial wildlife by removing invasive species wherever present. Further, to avoid the likely return of invasive species, cleared areas should be replaced with native riparian vegetation: specifically, native vegetation that provides needed ecosystem functions as described in Volume 1 and throughout this document (e.g., shade, large wood, pollution removal).

2. Where riparian areas already possess some native vegetation, enhance them with a greater mixture of native plants that provide necessary habitat components (forage, cover, breeding, roosting, etc.) for a diversity of species and multiple riparian functions (e.g., streambank stability, wood recruitment, organic litter input, and pollutant removal). The specific mix of vegetation will vary by ecoregion and local needs, but likely includes conifers, grasses, and herbaceous plants.

3. Increase off-channel habitat and improve natural flow regimes by removing dikes or levees and restoring access to and within the floodplain.

4. In areas of incised channels, reintroduce beaver or construct beaver dam surrogates to store sediments, raise streambed elevation, raise water table elevation, and restore riparian vegetation.

5. Remove reed canary grass, which can greatly inhibit channel morphology and aquatic species movement. (Management techniques for reed canary grass vary and are often site-specific: contact your local WDFW regional habitat biologist for technical assistance.)

6. Through proper consultation with WDFW and tribal biologists, increase the presence of large wood in streams and rivers to improve habitat for salmon, resident fish species, and aquatic amphibians.

7. Increase connectivity through removal of non-fish passing culverts. If replacement culverts are needed, ensure they are adequately sized and climate-change-resilient; see WDFW's online resource on [Incorporating Climate Change into the Design of Water Crossing Structures] (Wilhere et al. 2016).

8. Reduce soil erosion by increasing vegetation complexity and density, excluding (or substantially minimizing) soil compacting activities, and implementing upland soil management techniques where applicable.

9. For agricultural operators: add and/or improve fencing structures to increase the amount of riparian area acreage from which livestock are excluded to reduce compaction, erosion, and overgrazing.

Chapter 5. Improving Protection Through Adaptive Management

5.1. Introduction

Adaptive management is widely recognized as an essential component of effective natural resource management because it provides a systematic process for continually improving policies and management through outcome-based learning. The adaptive management process is a continual cycle of planning, acting, monitoring, evaluating, and adjusting (Figure 5.1). This feedback loop provides information for making adjustments that focus on improving decisions in all phases of resource management. The utility of adaptive management programs should be considered by conservation practitioners, landowners, and land use planners to ensure that conservation actions achieve desired outcomes: in the case of this document, that means preserving, protecting, and restoring healthy, intact, and fully functioning riparian areas. In addition to improving ecosystem outcomes, adaptive management should improve clarity of regulations—resulting in increased transparency to all stakeholders.

All cities and counties are currently protecting critical areas, including riparian ecosystems, through a variety of regulatory and non-regulatory mechanisms. One regulatory challenge is understanding how well these mechanisms meet their intent of protecting ecosystem functions and values and how to make improvements where they are falling short. This chapter was written in collaboration with the Washington Department of Commerce (Commerce) and relies heavily on the Commerce's 2018 update of the Critical Areas Ordinance Handbook (Bonlender 2018), with one exception, as noted.

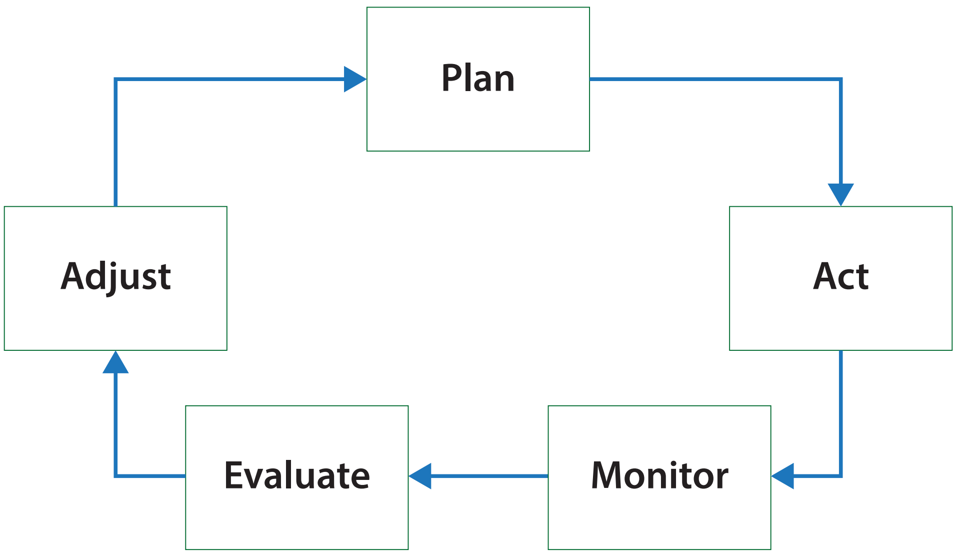


Figure 5.1. A simple depiction of the adaptive management cycle (modified from Bormann et al. 1994).

The process for monitoring we describe here supports both local and larger-scale actions that improve our collective efforts to protect riparian ecosystems throughout the state. For example, the Puget Sound Partnership (Partnership) uses "Vital Signs" of ecosystem health and recovery, such as riparian forest cover, to understand ecosystem condition, articulate shared goals and progress, and inspire action towards meeting those goals.

Adopting an adaptive management program can allow local governments to respond more quickly and meaningfully as new information become available. A willingness to address issues identified through this process is critical to the idea of adaptive management.

5.2. Common Questions Addressed by Adaptive Management

Adaptive management does not have to be expensive or complicated to be useful. We believe local jurisdictions can maximize their investment in adaptive management by focusing on two types of monitoring related to their own regulatory process (explained in more detail in the next section).

We begin by discussing three basic types of monitoring because we have found it instructive to understand how different monitoring types can be hierarchically or sequentially staged, based on the types of questions they seek to answer: implementation monitoring[13], effectiveness monitoring , and validation monitoring.

5.2.1. Implementation Monitoring

Implementation monitoring typically helps the permit issuer (permittor) answer the following questions about its permitting system, by looking at the outcomes of individual permits:

- Are permits consistent with regulations?
- Do permits contain all necessary conditions or provisions for a project?
- Does the permittor issue consistent permits (same requirements) for all permittees?

Implementation monitoring can also include:

- Permit *compliance monitoring,* which asks if the permitte followed or complied with each permit condition or provision and refrained from conducting unpermitted activities. Compliance monitoring usually takes place very soon after completion of permitted work.
- Keeping track of unpermitted activities; that is, finding changes in land use or management that require a permit but where no permit of any kind was issued.

13 As explained further in Section 5.2.2, we describe and use the term effectiveness monitoring somewhat differently than how it is described in Commerce's 2018 Critical Areas Handbook.

Fast-growing alder trees, like these shown in a low area along the Methow River in Okanogan County, can improve bank stability and increase summer shade more quickly than most conifers./Scott Fitkin, WDFW

5.2.2. Effectiveness Monitoring

In Commerce's 2018 Critical Areas Handbook, effectiveness monitoring is a form of long-term implementation monitoring. In other words, effectiveness monitoring looks at permit compliance as a while to determine whether permit conditions/provisions (e.g., buffer widths) are followed over time.

For the purposes of this document, we describe effectiveness monitoring a bit differently: Specifically, effectiveness monitoring is a way to determine whether permit conditions/provisions are working relative to intended environmental outcomes. For example, "Are permit conditions/provisions leading to the riparian function(s) (e.g., shade, bank stability) that they were intended to provide?" Effectiveness monitoring typically involves some on-the-ground measurement of environmental variables affected by land use activities.

5.2.3. Validation Monitoring

Research within the adaptive management framework is often referred to as validation monitoring. In the context of land use regulations, the questions relate to how management of critical areas (e.g., riparian) affects the specific environmental resource it was intended to protect (e.g., water quality, salmon). Validation monitoring may be beyond the fiscal means of most local governments. Moreover, it often involves questions that must be addressed over large spatial extents (e.g., at watershed or multi-watershed scale). In comparison, implementation and effectiveness monitoring are often tied to local jurisdiction's regulatory processes at the site scale: For these reasons, the next two sections focus more on these two types of monitoring.

5.3. Recommended Implementation Monitoring Efforts

We advise local governments to focus first on using implementation monitoring to evaluate their regulatory processes that affect riparian ecosystems. Implementation monitoring tracks execution of the permitting system from the perspective of both the permit issuer (permittor) and permit holder (permittee) (Figure 5.2). This effort can result in regular status reports that help demonstrate how well local governments and permittees are working together to meet resource objectives in a fair and consistent manner.

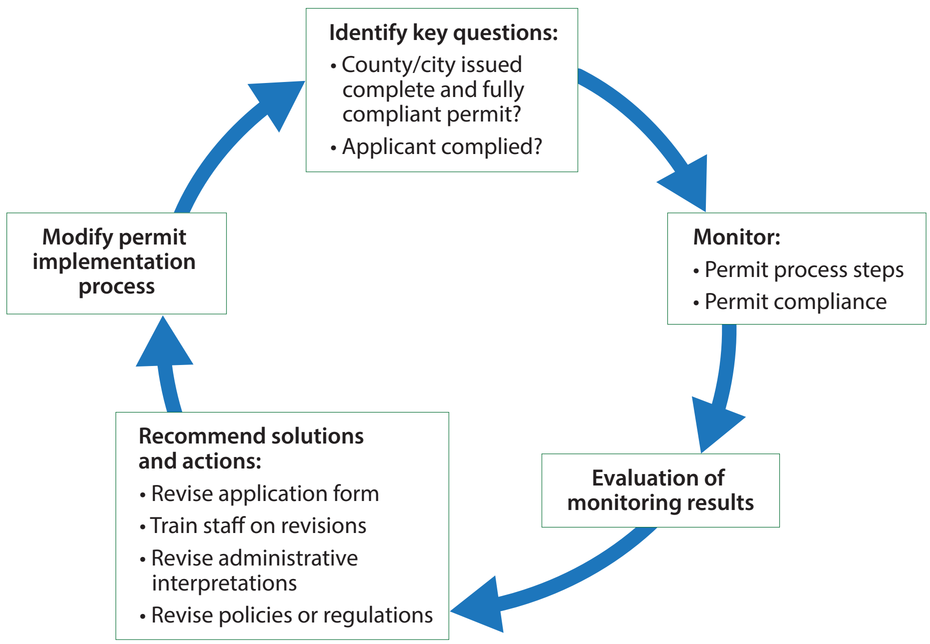


Figure 5.2. Depiction of the adaptive management cycle specific to permit compliance.

Implementation monitoring provides key information for permitting process improvement (5.2; Table 5.1). Even in situations where local governments cannot monitor all steps in their permitting process, monitoring any step—regulations to permit conditions/provisions, permit provisions to construction, construction to inspections, or inspections to enforcement—can provide valuable feedback about the quality of regulatory processes.

Monitoring does not have to be complicated. Even if a city or county chooses to do only permit implementation monitoring, this will provide key information that can improve the permit process, and an individual landowner can check whether choices like enhancing native plantings produce the desired results.

Table 5.1. Key questions for implementation monitoring during the Critical Areas permit review process.

Process Steps	**Key study questions to evaluate permit implementation**	**Proposed metrics**
Application	Was adequate information gathered from the permit applicant? Did the local government provide timely and necessary technical assistance to the permit applicant?	Number and percent of complete applications. i.e., include all information necessary to issue a permit. Number and percent by type of permit applications missing information.
Permit	Do permit provisions follow the local government code?	Number and percent of permit provisions by type consistent with code.
Permit	Do permit provision identify intent of protection and how it can be accomplished? (e.g., area of tree retention, distance of structure from stream, clearing, grading, or storm water provisions, replanting requirements, extent of impervious surface.)	Number and percent of (complete) permits (i.e., include all provisions that enable a permittee to be fully compliant with the permit). Number, percent, and type of missing provision/information.
Permit (variance)	If a variance was granted, is the reason for the variance clearly stated?	Percent of variances by type justified by code or policy. Percent of permits with variances by type.
Permit (mitigation)	If compensatory mitigation was required, were the unavoidable impacts clearly identified/quantified? Was the rationale clearly stated?	Number and percent of permits by type with unavoidable impacts. Percent of permits by type with quantified mitigation requirements
Compliance	Post-Construction Visit: Did the permittee comply with the permit? (Requires field measurements of some or all the provisions in the permit. For riparian ecosystems, key provisions to inspect include RMZ width, retention of trees, replanting, structure distances from stream, area of impervious surface, and implementation of storm water provisions.)	Number and percent by type of provision that were out of compliance.
Enforcement	Are enforcement actions necessary to meet permit provisions and/or the regulations?	Number and percent by type of permit enforcement actions.

Because little or no fieldwork is required, the easiest and least expensive step to monitor is the link between regulations and permit provisions: that is, whether local land use regulations have been translated into permit provisions that can be understood easily by permittees. We recommend that some implementation monitoring become part of all local regulatory programs, even if it only on a relatively small subset of permits selected at random. A database for storing information on each step (i.e., a permit tracking system—see Table 5.1, Figure 5.3) is a critical tool for creating a complete system of accountability.

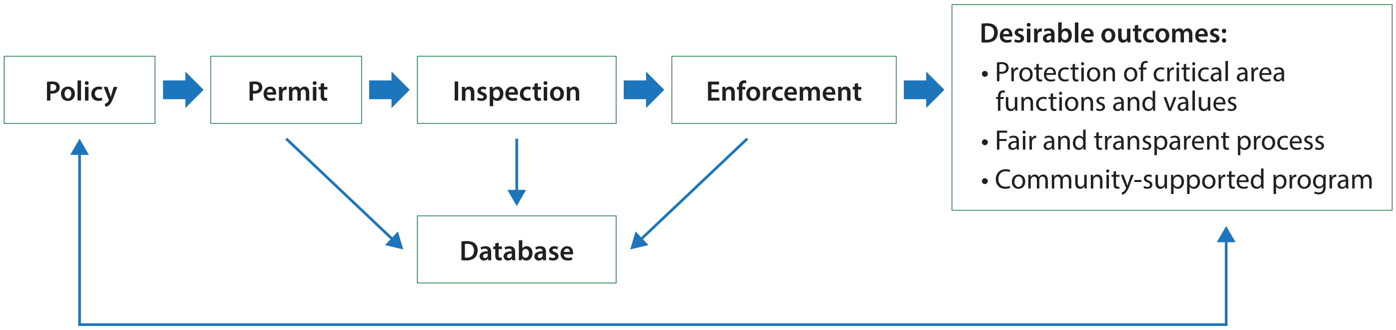


Figure 5.3. One system of permit accountability that includes implementation monitoring of internal permit processes, inspection for permit compliance, a database from which to judge outcomes, and a feedback loop connecting outcomes with policy intent.

Long-term implementation monitoring can help answer additional questions, such as: "Are rules/regulations intended to provide long-term protection of critical areas (e.g., RMZs) actually followed or maintained over time?" One way to answer this is by looking at changes in land cover, which describes the type and amount of vegetation, roads, and buildings occurring on the landscape. By comparing high quality aerial photographs taken of the same locations over time, change can be quantified and attributed to specific activities, both from natural disturbances (e.g., wildfires, river channel migration) and human activities (e.g., timber harvesting, residential subdivision construction, highway widening). In Section 5.5, we describe one such process WDFW developed and for which information for many parts of the state are already available.

5.4. Effectiveness of Regulatory Protections of Critical Areas

Where implementation monitoring has been successful, that is, either documenting a highly functional permitting process or improving poorly performing permitting process, we encourage additional effort on effectiveness monitoring. As described above, our primary goal for effectiveness monitoring would focus on understanding how well the permit conditions/provisions lead to measurable outcomes on the ground (e.g., protection/restoration of one or more riparian functions or values) over an extended period.

5.5. Using Land Cover Change to Understand Long-term Regulatory Protection

High Resolution Change Detection (HRCD) is a tool that is useful for detecting changes in two specific types of land cover (tree canopy and impervious surfaces) over set time periods. Land cover change analysis like HRCD can show jurisdictions the degree to which critical area regulations are maintaining RMZs as intended. This information can then help shape if, where, why, and how adjustments to permitting processes should occur. By combining land cover change analysis with targeted questions about permitting processes, jurisdictions can begin to adaptively manage changes to their overall regulatory system.

Adaptive Management Framework in the Voluntary Stewardship Program

The Voluntary Stewardship Program (VSP) was authorized by the Legislature in 2011 through RCW 36.70A.705. The goals of VSP are to protect and enhance critical areas where agricultural activities are conducted, maintain and improve the long-term viability of agriculture in the State of Washington, and reduce conversion of farmland to other uses. The program provides counties with an alternative approach from traditional development regulations that require protection (and encourage enhancement) of critical areas at the individual parcel scale. Instead, VSP relies upon voluntary practices and incentive programs to protect (and enhance) at a watershed scale. Counties "opted-in" to VSP, and as of 2019, 27 of the state's 39 counties are participating.

Under VSP, local workgroups created work plans that include benchmarks for protection and enhancement of critical areas designed to be achieved through voluntary and incentive-based actions. VSP requires monitoring and adaptive management to maintain and enhance critical areas, including riparian ecosystems, and directs workgroups to monitor at the watershed or sub-watershed scale. Key requirements for county-level programs include:

1. Establishing a durable system to track and report goals, benchmarks, and performance metrics.
2. Developing implementation and effectiveness monitoring programs and conducting monitoring on a pre-determined schedule.
3. Establishing an adaptive management program with (a) "triggers"; (b) subsequent actions to take; and (c) a process to review/update both the triggers and actions over time.
4. Reporting on the achievement of protection and enhancement goals and benchmarks at specified intervals.

Numerous counties have utilized WDFW's recommended VSP Adaptive Management Matrix in approved VSP Work Plans. Examples include:

- Chelan County, Appendix I (Approved April 2017)
- Grant County, Tables 5-7 through 5-10 (Approved June 2017)
- Asotin County, Tables 5-3 through 5-5 (Approved May 2018)
- Okanogan County, Chapter 6 (Approved September 2018)
- Spokane County, Section 4 (Approved November 2018)

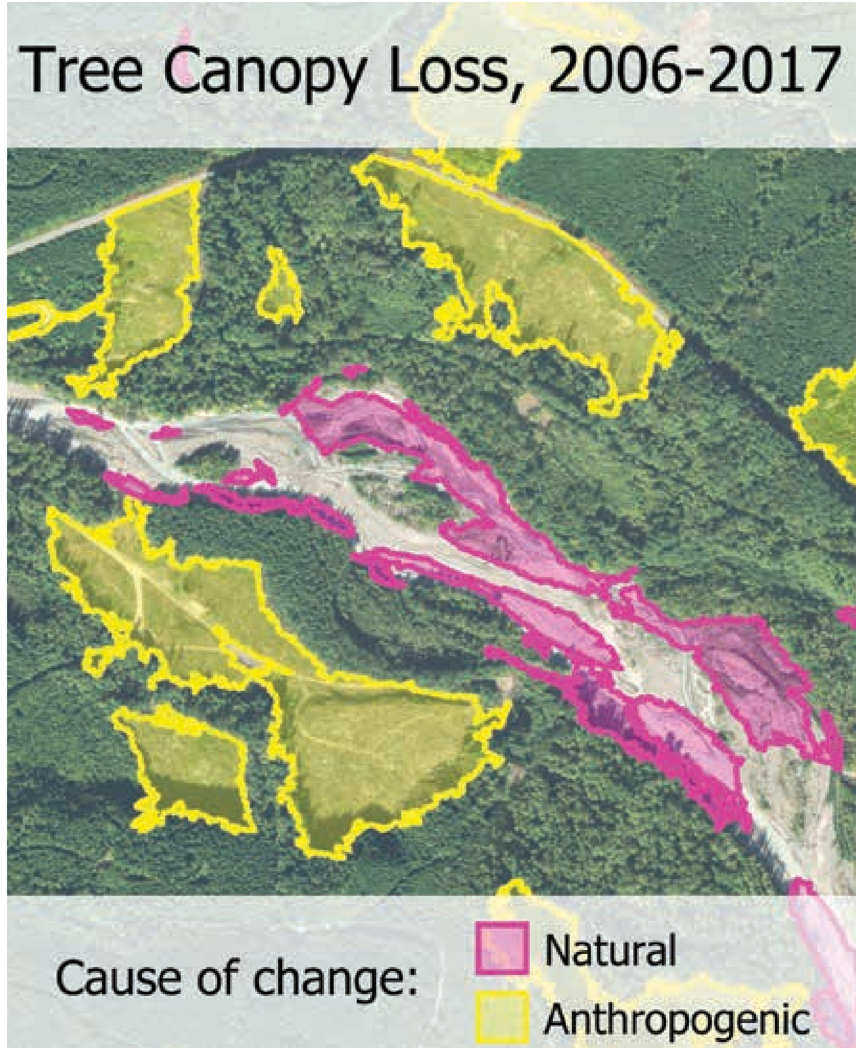
Jurisdictions can adapt matrices as templates for connecting goals, benchmarks, performance metrics, monitoring, and adaptive management for other uses beyond VSP. These matrices can be modified as frameworks to identify specific elements of any adaptive management plan.

The example in the following section is adapted from Commerce's Critical Areas Handbook (Bonlender 2018). Chapter 7 of that document provides a number of similar monitoring program examples, nearly all of which were developed by cities or counties.

5.5.1. Example: WDFW/Thurston County Shoreline Master Program

In 2015, Thurston County and WDFW utilized a National Estuary Program grant to quantify shoreline vegetation, land cover change, and evaluate land use permit compliance. Specifically, Thurston County used WDFW's HRCD data to monitor compliance within the County's Shoreline Master Program (SMP) jurisdiction. This project developed a protocol manual for using HRCD for this purpose, available to all jurisdictions within the Puget Sound region.

One goal of the pilot project was to answer several related sets of questions:



High Resolution Change Detection (HRCD) analysis showing changes in tree canopy along and above a river in Thurston County. Pink polygons show where trees that existed prior to 2017 are no longer standing, apparently due to natural causes (e.g., where the river meandered). Yellow polygons show places where trees were removed as a result of timber harvesting./HRCD team, WDFW

For Thurston County:

- What land cover change is happening within designated SMP areas? What change is happening throughout the Deschutes River watershed (WRIA 13)?
- How does change known by permit records compare with detected changes by HRCD?
- What changes, if any, can be made to the land use permits or permitting process that could increase the relevancy or efficacy in utilizing the HRCD in compliance monitoring?

For WDFW:

- How well can HRCD detect changes relative to land use permit records?
- Using Thurston County's SMP area as an example test area, what land cover changes are happening which HRCD is not capturing?
- With the development of a HRCD user manual, can HRCD be successfully utilized by other entities in the absence of direct assistance by WDFW?

The pilot quantified increases in impervious surfaces and decrease in tree canopy within marine areas of the SMP jurisdiction and checked for relevant permits issued. It consisted of five phases:

Phase 1: Initial SMP Change Analysis: Staff from WDFW's Habitat Program and the County's Long-Range Planning Department intersected the HRCD dataset with the County's SMP area and tax parcel data within ArcGIS for three time periods of HRCD availability (2006 to 2009, 2009 to 2011, and 2011 to 2013). Staff compared known areas of change to those locations with the county's land use permit records to find locations of observed change via HRCD without any permit record. During this phase, land cover change statistics were also produced, including total area of change and discrete occurrences of land cover change events.

Phase 2: Learning What the HRCD Misses: Using the SMP area in the County, WDFW staff manually looked for land cover changes not captured by the HRCD analysis, to understand how accurate HRCD was in capturing all land cover change situations (rates of omission error).

Phase 3: Developing a Standardized Method for Utilizing the HRCD: A major goal of this project was to develop support materials for others to be able to utilize HRCD to answer land use management questions independent of WDFW staff assistance. Using lessons learned in Phases 1 and 2, WDFW and the County agreed upon a recommended method for applying HRCD to a specific management question, and collaboratively developed a "how-to" manual. In this phase, WDFW staff also developed a web-based service (https://hrcd-wdfw.hub.arcgis.com) where users can download the HRCD dataset, detail the methodology of HRCD construction, find WDFW contact information, and more.

Phase 4: Testing the Manual through Remaining SMP Analysis in WRIA 13: Using only the HRCD dataset and the manual produced in Phase 3, County staff examined land cover change within the remaining SMP areas within WRIA 13 successfully for the same three time periods that HRCD data was available and utilized in the earlier phase.

Phase 5: Training and Outreach: With the lessons learned and products derived from Phases 1 through 4 of the project, staff worked in conjunction with the Coastal Training Program, managed by Ecology, to develop and deliver a workshop for planning staff within other state agencies, local governments, and some non-governmental organizations. WDFW also used this opportunity to train internal staff on the benefits, limitations, and uses of HRCD.

The evaluators analyzed land cover change within Thurston County's SMP area between 2006 and 2013, pulling permit records from timeframes that corresponded with the available HRCD datasets. The project's findings were very helpful, not only because of the information collected, but also in providing proof of concept for several of the steps/tools. For example: The utility of HRCD in analyzing patterns of land cover change in a specific geographic area of concern were well demonstrated. The HRCD analysis found that, from 2006 to 2013, less than half of one percent (0.39%) of the riparian area contained within the SMP had land cover change – approximately two-thirds of this was due to canopy loss, with one-third due to new impervious surfaces. The HRCD analysis did not find any permitted developments that were out of compliance, though it did find unpermitted events (e.g., tree removal) in each time period studied.

Furthermore, the HRCD dataset proved to be relatively simple to use. With the development of standard application methods, Thurston County was able to complete an analysis of their remaining SMP area without any further assistance from WDFW.

On the flip side, Thurston County found that comparing actual permit compliance with HRCD data was "tedious and difficult" because of limitations with the county's permit tracking database. For example, in many cases, land use permits did not include enough information to determine conclusively that a parcel with observed change via HRCD was out of compliance or determine that the parcel had a permit record during the study's timeframe in question.

Local governments can use HRCD analysis at the start to find land cover changes that are otherwise unknown; as they begin to understand patterns, HRCD analysis provides indications to identify locations that warrant closer investigation through other methods.

5.6. Conclusion

Implementation and effectiveness monitoring are important parts of adaptive management and can be undertaken relatively easily by local governments. Many of our riparian ecosystems are already degraded and stressed, so it is worth our while to investigate whether the actions put in place to protect them are being carried out as required and leading to the specific environmental responses that were intended. This is now more important than ever, because in spite of advances in science and efforts to improve regulatory processes, climate change and population pressures are increasingly confronting many parts of the state. Using monitoring and adaptive management to track successes and failures and then learning from both will make our challenges easier to overcome.

To install the lawn seen on the right of this photo, all vegetation was removed from the riparian area except a single row of cottonwood trees at the water's edge./Jennifer Nelson, WDFW

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Riparian area below the south slope of Mt. St. Helens. The area is still recovering from the mountain's volcanic eruption in May 1980. Skamania County/Brendan O'Doherty

Glossary of Terms

Active channel: The active channel is defined by the lower limit of continuous riparian vegetation (Naiman et al. 1998) and may be delineated by absence of both moss on rocks and rooted vegetation (USFS 2008). The upper most elevation of the active channel is sometimes equated with the ordinary high-water mark.

Active floodplain: Located between the active channel and adjacent terrace or hillslopes (Fetherston et al. 1995; Harris 1987). Depending on the watershed, the flood return interval of the active floodplain varies between 1 and 10 years (Wolman and Leopold 1957; Ward and Stanford 1995; Lichvar et al. 2006; Williams et al. 2009; BLM 2015).

Adaptive management: The systematic acquisition and application of reliable information to improve management over time. It often includes treating management decisions as experiments in order to address critical uncertainties and learn more quickly from experience. It involves setting objectives, monitoring conditions, and adjusting management based on results. Hallmarks of a sound adaptive management program include: (1) adequate funding for monitoring and research, (2) a willingness to change course when pre-established triggers are reached, and (3) a commitment to gather data and evaluate conditions at appropriate spatial extents and time scales. See Ecosystem-based management and WAC 365-195-920(2).

Anadromous fisheries: The commercial, recreational or subsistence harvest of fish that are born in freshwater, rear at sea, and return to freshwater to spawn. Anadromous fisheries of Washington include salmon (Chinook, coho, chum, sockeye, and pink), steelhead, bull trout, coastal cutthroat trout, green sturgeon, white sturgeon, eulachon, longfin smelt, and Pacific lamprey.

Aquatic species: Wildlife species that live in marine or freshwater including fish, shellfish (e.g., clams, snails, mussels), amphibians (e.g., frogs, salamanders), reptiles (e.g., turtles), crustaceans (e.g., crayfish), insects (e.g., larval mayflies, stoneflies, caddisflies, dragonflies) and various other invertebrates.

Best Available Science: Information produced through a valid scientific process that WDFW or another local, state or federal agency has determined represents the best available science consistent with criteria set out in WAC 365-195-900 through 365-195-925. (Volume 1 of this document is an example of Best Available Science regarding riparian ecosystems.)

Biota: The animal and plant life of a region, habitat, or geological period.

Buffer: The area around a critical area that separates the critical area from incompatible uses. For example, a 200m buffer may be established around a heron-nesting colony (the critical area) to keep suburban land uses from disrupting the colony. See WAC 365-190-130(3)(a). Riparian ecosystems are both buffers (for instream habitat) and critical areas on their own merit.

Channel Migration Zone: The area within which a river channel is likely to migrate and occupy over a specified time period (e.g., 100 years).

Channel slope or gradient: The average steepness of a stream segment measured as its change in elevation divided by its length. Typically, a segment's gradient is considered low if less than 2%, moderate between 2% and 4%, and high if greater than 4%.

Classification (critical area): Defining categories to which critical areas are assigned. The Priority Habitats and Species (PHS) program provides WDFW's recommended classification scheme for Fish and Wildlife Habitat Conservation Areas. Classification precedes designation in counties' and cities' effort to protect critical areas.
See WAC 365-190-040(4).

Complexity: The complicated state seen in dynamic environments that contain multiple components and processes that interact with one another in a web of interactions whose outcomes are often unpredictable. Complexity can be described with conceptual models; outcomes of well-understood complex phenomena can be partially predicted using computer models.

Connectivity: Landscape connectivity is the physical relationship between landscape elements. Functional connectivity describes the degree to which landscapes facilitate or impede the movement of organisms between areas of habitat.

Critical Aquifer Recharge Area: Areas with an essential recharging effect on aquifers used for potable water. One of five types of Critical Areas identified in the Growth Management Act.

Critical Area(s): Places that the Growth Management Act requires all counties and cities to designate and protect, specifically, (1) Wetlands; (2) Critical Aquifer Recharge Areas; (3) Fish and Wildlife Habitat Conservation Areas (e.g., Riparian Management Zones); (4) Frequently Flooded Areas; and (5) Geologically Hazardous Areas. In developing policies and regulations to protect the functions and values of critical areas, counties and cities are required to include best available science and give special consideration to conservation or protection measures necessary to preserve or enhance anadromous fisheries. *See* RCW 36.70A.172(1). The presence of a critical area may limit some land development options. *See* WAC 365-190-040(6).

Delineation (critical area): The act of applying definitions or performance standards in the field to identify the boundary of a critical area.

Designation (critical area): Assigning critical areas into established categories and specifying their general distribution, location, and extent. Designation can be made by maps (which are useful for public awareness and for identifying if a proposal may affect a critical area) and by performance standards or definitions (which allow for specific identification and site-scale delineation during permit review). WDFW's Priority Habitats and Species (PHS) program provides the agency's recommended designation maps and performance standards/definitions for Fish and Wildlife Habitat Conservation Areas. Designation occurs after classification in counties' and cities' efforts to protect critical areas. *See* WAC 365-190-040(5).

Disturbance regime: The frequency, magnitude, and duration of disturbance events.

Disturbance: A pronounced, temporary change in environmental conditions within an ecosystem. Disturbances often act quickly and can alter ecosystem composition, structure, and function.

Ecological (biological) **integrity:** Ability of an ecological system to support and maintain a community of organism that has species composition, diversity, and functional organization comparable to those of natural habitats within a region. An ecological system has integrity when its dominant ecological characteristics (composition, structure, function, and processes) occur within their historical ranges of natural variability. See Historical condition and Range of natural variability.

Ecosystem(s): A spatially explicit unit of the Earth that includes all the organisms, along with all components of the abiotic (chemical and physical) environment. Ecosystems have composition, structure, and functions.

Ecosystem composition (or ecological composition): All living (biotic) and nonliving parts of an ecosystem.

Ecosystem function(ing) (or ecological function): (1) The process or cause and effect relationship underlying two or more interacting components, e.g., terrestrial plant material as food/substrate for aquatic invertebrates. (2) The sum of processes that sustain the system. (3) The capacity of natural processes and components to provide goods and services that satisfy human needs, either directly or indirectly. Ecosystem functions can be conceived as a subset of ecological processes (See *Ecosystem process*).

Ecosystem process (or ecological process): Interactions among components of an ecosystem, biotic (living organisms) and abiotic (chemical and physical) components. Many processes involve transfer, conversion, or storage of matter or energy (See *Ecosystem process*).

Ecosystem structure (or ecological structure): The arrangement of and relations among the parts or elements (components) of an ecosystem.

Ecosystem-based management (EBM): Management driven by explicit goals; executed by policies, protocols, and practices; and made adaptable by monitoring and research; based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function. EBM acknowledges that humans are an important ecosystem component and focuses on managing human activities within ecosystems. EBM often involves balancing ecological, economic, and social objectives within the context of existing laws and policies.

Enhance: To improve a critical area's existing ecosystem processes, structure, and/or functions so that its ecological integrity is more like its historical condition.

Erosion: The loosening and transport of soil particles and other sediment by water. Terrestrial erosion includes raindrop splash erosion, overland flow sheet erosion, surface flow rill (shallow) and gully (deeper) erosion. Channel erosion includes streambank erosion and channel incision (gouging). Rill and gully erosion diminish the ability of the riparian area to trap sediment and pollutants and can often be avoided with intact riparian vegetation.

Fish and Wildlife Habitat Conservation Areas (FWHCA): A type of Critical Area specified in the Growth Management Act. The intent of FWHCAs are to maintain populations of species in suitable habitats within their natural geographic distribution so that (1) the habitat available is sufficient to support viable populations over the long term, and (2) isolated subpopulations are not created. FWHCAs come in a variety of types including waters of the state, places with which listed species have a primary association, habitats and species of local importance, and riparian ecosystems. See WAC 365-190-130.

Flow regime (stream): The distribution of stream flow through space and time. Flow regimes can be described by their magnitude (e.g., mean annual, hourly maximum), timing, frequency or return periodicity, duration, spatial distribution, and rate of change. The pathways that water takes to reach a stream (e.g., surface runoff) and within a stream exert a strong influence on the flow regime.

Function: Physical, chemical, or biological processes that occur within an ecosystem. WAC 365-196-830 says, "Functions are the conditions and processes that support the ecosystem. Conditions and processes operate on varying geographic scales ranging from site-specific to watershed and even regional scales." See also *Ecosystem function(ing)* and *Ecosystem process.*

Habitat: The resources and conditions presented in an area that support the functional needs of a species (e.g., hiding, migration, resting, feeding, breeding, and rearing), and which are necessary for its survival and reproduction. Habitat is species-specific, scale dependent, and more than vegetation composition or structure.

Hazard Tree: A tree that a jurisdiction's building official or other recognized professional (e.g., certified arborist, registered landscape architect, or certified forester) has determined poses a near-term hazard to public safety or to an existing permanent structure or public utility.

Herbaceous: Non-woody plants such as grasses and ferns.

Historical condition: *See* Ecological integrity and Range of natural variability.

Hydrology: Description of the properties, distribution, movement, and storage of water on and below the Earth's surface.

Impervious surface: Ground surfaces that resist or prevent water infiltration, e.g., roofs of houses, roadways.

Imputed: Estimated; a value assigned to missing data by inference from the values of data within the same dataset.

Infiltration: The rate or process by which water on the ground enters the soil.

Instream: Within flowing freshwater; also, the area waterward of the Ordinary High-Water Mark.

Large Woody Debris: Large dead woody material (such as fallen trees and branches) in various stages of decomposition that provide nutrient capital to forest and aquatic resources and serve as habitat in forest and riparian ecosystems. Large wood is usually defined as having diameter greater than 4 in (10 cm) and length greater than 6 ft (≈ 2 m).

Low Impact Development (LID): A storm water and land-use management strategy that tries to mimic natural hydrologic conditions by emphasizing pre-disturbance hydrologic processes of infiltration, filtration, storage, evaporation, and transpiration.

Mitigation: General category of measures that a proponent may take to avoid, minimize, and compensate for impacts.

Mitigation sequence: The stepwise process of protecting a critical area through, first (1) avoiding harm to the critical area to the maximum extent practicable, then (2) minimizing unavoidable harm to the maximum extent practicable, and finally (3) providing compensation for all unavoidable harm by restoring, creating, enhancing, or preserving the critical area's ecological functions and values to replace those impacted or lost through permitted activities.

Monitoring: The process of observing and checking the progress or quality environmental conditions for the purposes of adaptive management. Often described as having three types – implementation, effectiveness, and validation.

Morphology (stream channel, aka fluvial geomorphology): A stream channel's shape and how it changes over time. Channel morphology is influenced by the abundance and variation in sediment sources, the ability of water to transport sediment downstream, and interactions of sediment with riparian vegetation and woody debris.

Off-Channel Habitat: Overflow channels, sloughs, alcoves, wetlands, and small streams found within the floodplains of larger river channels. Off-channel habitat consists of waters connected to and draining into rivers and streams by inundation during peak flow events (Smith 2005; WAC 222-16-031). Off-channel habitat provides habitat for salmonids and other aquatic species which often afford (1) spawning habitat that does not experience scouring high flows; and (2) summer rearing habitat that does not experience loss of stream flow.

Ordinary High Water Mark (OHWM): (1) That mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a character distinct from that of the abutting upland (Washington Department of Ecology 2016). (2) That line on the shore established by the fluctuations of water and indicated by physical characteristics such as a clear, natural line impressed on the bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas (U.S. Army Corps of Engineers, 2014).

Organic litter: Plant, leaf, tree, or soil litter, and duff are dead plant materials that have fallen to the ground. In this document, organic litter is referenced as available for contributions to the stream system.

Passive Restoration: Allowing natural succession to occur in an ecosystem after removing a source of disturbance.

Population viability (local): The likelihood that a population of a species will persist for some length of time.

Precautionary principle: Erring on the side of not harming resources when faced with uncertainty, especially for potential harm that is essentially irreversible. Utilizing a precautionary approach in land use planning involves: (1) taking preventive action (avoiding impacts); (2) shifting the burden of proof to the project proponents; (3) exploring a wide range of potential alternatives; and/or (4) including multiple stakeholders and disciplines in decision making.

Priority Area: The area within a Priority Species' natural geographic distribution within which protective measures and/or management actions are needed to (1) support viable populations over the long term and (2) avoid creating isolated subpopulations.

Priority Habitat: A State of Washington habitat type with unique or significant value to many species; an area with one or more of the following attributes: (1) comparatively high fish and wildlife density; (2) comparatively high species diversity; (3) important breeding habitat; (4) important seasonal ranges; (5) important movement corridors; (6) limited availability; (7) high vulnerability to habitat alteration; or (8) unique or dependent species. Examples of Priority Habitats include but are not limited to instream, riparian, shrub steppe, Oregon white oak woodlands, freshwater wetlands, and marine nearshore.

Priority Habitats & Species (PHS): WDFW's primary means of transferring fish and wildlife information from resource experts to local governments, landowners, and others for the protection of fish, wildlife, and habitat. Includes endangered, threatened, sensitive, candidate, and vulnerable species and habitats deemed priorities of WDFW and reflective of best available science. See WAC 365-190-130.

Priority Species: A State of Washington fish or wildlife species requiring protective measures and/or management actions to ensure its survival. A Priority Species fits one or more of the following criteria: (1) is a state-listed endangered, threatened, sensitive, or candidate species, (2) has vulnerable aggregations, or (3) is of recreational, commercial, and/or tribal importance. Examples of Priority Species include but are not limited to steelhead/rainbow trout, bull trout/Dolly Varden, great blue heron, cavity-nesting ducks, sage grouse, fisher, orca, and elk.

Process: See *Ecosystem process.*

Protect: To prevent the degradation of existing ecosystem functions and values.

Range of natural variability (or Historical range of natural variability): Refers to the range of ecological conditions (components, structures and functions) in a time period before widespread anthropogenic changes.

Recruitment (wood): The process of wood moving from a riparian area to the stream channel. Sources of recruitment include bank erosion, windthrow, landslides, debris flows, snow avalanches, and tree mortality due to, for example, fire, ice storms, beavers, insects, or disease. Dominant factors include, but are not limited to, channel width, slope steepness, slope stability, forest composition and structure, and local wind patterns.

Refugia (singular Refugium): sites to which biota retreat, persist in and potentially expand from under changing environmental conditions (Keppel et al. 2012).

Riparian: An adjective meaning alongside a waterbody: stream, river, lake, pond, bay, sea, and ocean. Riparian areas are sometimes referred to by different names: riparian ecosystems, riparian habitats, riparian corridors, or riparian zones. Depending on the contexts, these terms may have somewhat different meanings.

Riparian area: A defined area encompassing both sides of a water body, composed of aquatic ecosystems (i.e., the river or stream), riparian ecosystem, and riverine wetlands. Riparian areas are three dimensional: longitudinal up and down streams, lateral to the width of the riparian ecosystem, and vertical from below the water table to above the canopy of mature site-potential trees (NRC 2002).

Riparian buffer: Buffer refers to its purpose, which is to reduce or prevent adverse impacts to water quality, fisheries, and aquatic biodiversity from human activities occurring upslope of the buffer. Riparian buffers managed specifically for pollutant removal may also be called a vegetated filter strip.

Riparian ecosystem: Riparian areas are transitional between terrestrial and aquatic ecosystems and distinguished by gradients in biophysical conditions, ecological processes, and biota. They are areas through which surface and subsurface hydrology connect waterbodies with their adjacent uplands. They include those portions of the ecosystem distinguished by gradients (i.e., riparian zones) and portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (i.e., the Zone of Influence). Our definition of riparian ecosystem does not include adjacent waters (i.e., rivers or streams, but does include riverine wetlands) and recognizes the riparian zone as a distinctive area within riparian ecosystems.

Riparian Management Zone: A delineable area defined in a land use regulation; often synonymous with riparian buffer. For the purposes of this document, we define the RMZ as the area that has the potential to provide full riparian functions. In many forested regions of the state this area occurs within one 200-year site-potential tree height measured from the edge of the stream channel. In situations where a CMZ is present, this occurs within one site-potential tree height measured from the edges of the CMZ. In non-forest zones the RMZ is defined by the greater of the outermost point of the riparian vegetative community or the pollution removal function, at 100-feet.

Riparian values: The benefits that riparian ecosystems provide to society, including but not limited to flood damage reduction, water quality improvement, provision of harvestable populations of salmon, and provision of recreational opportunities. Riparian values have direct economic consequences to local communities through fishing opportunities, and flood and water quality protection, among others.

Riparian zone: A distinctive area within riparian ecosystems. The riparian zone contains wet or moist soils and plants adapted to growing conditions associated with periodically saturated soils. See *Riparian ecosystem.*

Risk: A situation involving exposure to danger, harm, or loss. Risk reflects the magnitude of the adverse impact and its probability of occurring. Risk is appropriately managed by applying the precautionary principle (especially for irreversible losses) and through adaptive management.

Salmonid: A family of fish comprised of salmon, trout and whitefish. Native salmonid species in Washington State include: Chinook Salmon (*Oncorhynchus tshawytscha*), Chum Salmon (*O. keta*), Coho Salmon (*O. kisutch*), Pink Salmon (*O. gorbuscha*), Sockeye Salmon/Kokanee (*O. nerka*), Steelhead/Rainbow Trout (*O. mykiss*), Cutthroat Trout (*O. clarki*), Bull Trout (*Salvelinus confluentus*), Dolly Varden (*S. malma*), Pygmy Whitefish (*Prosopium coulteri*), and Mountain Whitefish (*P. williamsoni*). This list does not include names of subspecies. (See *Anadromous* fisheries).

Site class: The classification of a site based on the productivity of its dominant tree species. Site classes vary based on local differences in soil nutrients and moisture, light and temperature regimes, and topography. Site classes are typically described as most productive (I) through least productive (V).

Site-Potential Tree Height: The average maximum height of the tallest dominant trees for a given age and site class.

Stronghold: Habitat strongholds are refugia watersheds that contain high quality habitat with depressed or weak populations. The habitat in these areas has a high to very high potential to support these species. The population level in these areas is not considered to be a function of habitat, but other factors (USFS2001).

Structure: See *Ecosystem structure.*

Succession: Ecological succession is the process by which the biological community composition recovers over time following a disturbance event.

Uncertainty (scientific): The absence of information about the state of something or a relevant variable. Sources of uncertainty include, but are not limited to natural variation (i.e., because outcomes vary in difficult-to-predict ways through time and space), model uncertainty (i.e., we do not understand how things interact with each other), systematic error (e.g., poorly designed experiments or calibrated instruments), or measurement error. See *Risk*.

Values: The level of benefits that the space, water, minerals, biota, and all other factors that make up a natural ecosystem provide to support native life forms, including humans (Cordell et al. 2005).

Vegetative filter strips: A riparian buffer designed to capture nutrients, contaminant compounds, and sediment transported by run-off. Filter strips are sometimes synonymous with riparian buffers.

Water quality: Physical, chemical, and biological characteristics of water that describe its suitability to meet human needs or habitat requirements for fish and wildlife.

Watershed processes: The fluxes of energy (e.g., sunlight, wildfire) and materials (particularly water and sediment) that interact with biota (e.g., vegetative cover, salmon, beavers, soil microbes) to form a watershed's physical features and characteristics, which give rise to its instream physical and ecological conditions. These processes occur within a context that reflects the watershed's climate, geology, topography, and existing human land use. See *Ecosystem process.*

Watershed: A land area that drains to a common waterbody.

Wetland: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support—and that under normal circumstances do support—a prevalence of vegetation typically adapted for life in saturated soil conditions. Examples include but are not limited to swamps, marshes, and bogs.

Zone of Influence: The portions of terrestrial ecosystems that significantly influence exchanges of energy (e.g., sunlight) and matter (e.g., large wood, sediment, nutrients) with aquatic ecosystems.

Appendix. Site-Potential Tree Height Mapping Tool

The Site-Potential Tree Height (SPTH) Mapping Tool helps users find information they need to conserve, protect, and restore riparian ecosystems within a project site. The SPTH mapping tool works on personal computers (PCs) and mobile devices (tablets and smartphones).

Site-Potential Tree Height Map Data

The SPTH mapping tool contains several GIS data layers, explained below:

1. Site-potential Tree Height at 200 Years ($SPTH_{200}$),
2. Imputed[14] $SPTH_{200}$ Values for Urban areas,
3. Dryland Ecosystems – No SPTH Values, and
4. Other Lands – No SPTH Values.

Site-potential Tree Height at 200 Years ($SPTH_{200}$)

WDFW derived the $SPTH_{200}$ values from forest productivity site index information using Natural Resource Conservation Service (NRCS) soil polygons and its Soil Data Viewer tool for ArcGIS. The NRCS-provided forest productivity site index values, in feet, were for ages 50 years in Western Washington and typically 100 years in Eastern Washington. WDFW determined $SPTH_{200}$ values using tree site index equations. Each soil polygon has one or more tree species records with associated $SPTH_{200}$. When multiple tree species records with associated $SPTH_{200}$ are available, WDFW recommends using the largest $SPTH_{200}$ value of the tree species historically present at the site (such trees may currently be found on the site, but also may not). For example, if a project site contains mostly red alder but Douglas-fir is present (or was present prior to modern human alterations), use the Douglas-fir $SPTH_{200}$ for that soil polygon.

Imputed $SPTH_{200}$ Values

Four large urban areas (Seattle, Spokane, Tacoma, and Bellingham) lacked NRCS soil polygons; therefore, forest productivity information could not be mapped for most locations within those areas. Similarly, numerous soil polygons labelled as “Urban Land” lacked forest productivity information. For each of these four urban areas, WDFW calculated an imputed $SPTH_{200}$ by using an area-weighted average for 200-year site index values within a two-mile buffer around the perimeter. WDFW recommends the use of this imputed $SPTH_{200}$ as a guide for delineating RMZs in these urban areas. At the time of publication, WDFW had calculated imputed $SPTH_{200}$ information for those large urban areas. WDFW expects to continue to update the map.

14 Imputed: estimated; a value assigned to something by inference from the value of the products or processes to which it contributes.

Dryland Ecosystems and Other Lands

Not all soil polygons are forested, or have forest productivity information from NRCS; therefore, not all of them have associated $SPTH_{200}$ values. In addition, Benton, Franklin, Grant, and Adams counties had no forest productivity information in their NRCS soil polygons. These areas without $SPTH_{200}$ values were classified in one of two ways: as "dryland ecosystems", or "other lands."

- WDFW approximated the area contained within "dryland ecosystems" using the Arid Lands Initiative study area boundary (Arid Lands Initiative, 2014) and have developed associated process steps that we recommend be used to derive RMZ widths (Volume 2, Section 2.2.3).

- The "other lands" comprise the remaining soil polygons and are small and dispersed across the landscape. These polygons include the NRCS soil map unit name, if applicable, and often represent soils that do not support tree growth, such as beaches and wetlands, as well as certain types of heavily modified sites like gravel pits. Please consult with a WDFW regional habitat biologist on deriving RMZs for "other lands" and consider following a similar process for delineation in dryland ecosystems.

Using the Site-Potential Tree Height Mapping Tool

The mapping tool can be accessed from several locations:

- WDFW website (https://wdfw.wa.gov/species-habitats/at-risk/phs/recommendations),
- Washington Geospatial Open Data Portal (http://geo.wa.gov/), and
- ArcGIS Online (AGOL) (https://wdfw.maps.arcgis.com/apps/MapSeries/index.html?appid=919ea98204eb4f5fa70eca99cd5b0de1).

The mapping tool consists of the statewide map with the four riparian datasets described above; user tools; and a sidebar explaining map contents, how to use the map, and links to supporting documents.

The four riparian datasets have unique colors indicating where the information occurs.

- **Green:** Area where $SPTH_{200}$ has been calculated.
- **Orange:** Areas where $SPTH_{200}$ values have been imputed.
- **Pale brown:** Dryland ecosystems where there is no tree height information.
- **Beige:** Places for which no SPTH site index information is available.

Tribal and publicly owned/managed lands federal and tribal lands are typically subject to different riparian regulations. Tribal, federal, and state lands are displayed in shades of grey. County-owned lands are shown in lavender, and city-owned lands are light blue.

The mapping tool contains the following tools (Figure A1):

- **Zoom slider:** zoom in or out on the center of the map.
- **Address search tool:** zooms to a street address, place name, or latitude and longitude.
- **Legend:** displays the map layers currently visible. For example, map layers displayed at a site-specific scale will not appear in the legend when zoomed out to the statewide extent.
- **Home icon:** resets map to statewide extent.
- **Target icon:** allows the user to zoom directly to their current location.
- **Measurement tool:** use this to measure the distance between objects (e.g. edge of stream to another point), or to measure an area (square feet of an area surrounding a project site).
- **Basemap selector:** change the basemap to show a different view of the landscape: aerial imagery (default), topographic map, open street map, terrain with labels, and USGS national map.
- **Scale bar:** shows the scale that the map is zoomed to. At a statewide extent, the scale bar will show 0 to 60 miles. When zoomed to a scale where you can view the project area, the scale bar will show 0 to 100 feet or 200 feet.
- **Coordinates:** latitude and longitude (decimal degrees) are shown where the cursor is located on the map.
- **Panning:** move the map by placing the cursor over a desired location and dragging it to the center of the map display.

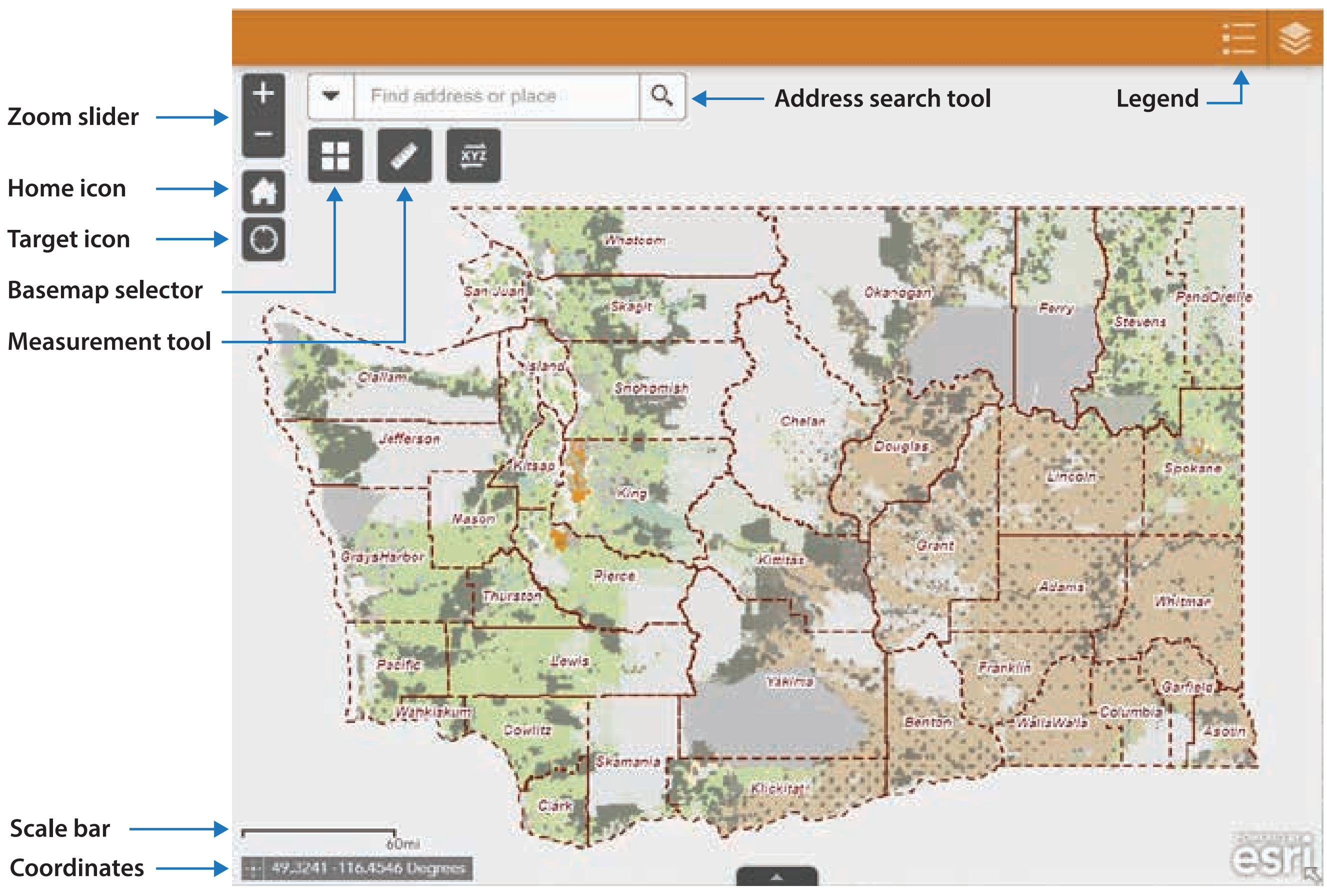


Figure A1. Tools available on the $SPTH_{200}$ and RMZ Online Map.

To zoom to a site location, use the Address Search tool or use a combination of the Zoom Slider and panning. (If using the Address Search tool, select the "ArcGIS World Geocoding Service" from the dropdown menu to the left of the search field for faster results.) Once the site is located, a click (on PCs) or tap (on mobile devices) of the cursor will open a popup window with information about that location. Be sure to review each window if multiple records are selected.

The NRCS soil polygons form a complex mosaic across the landscape, so you must zoom in close enough to clearly see your project site. Clicking (or tapping, on mobile devices) on the map when it is zoomed out will result in erroneous returns of the $SPTH_{200}$ values. Below is an example of using these tools to obtain riparian information at a project site.

Mapping Tool Example #1

1. Start up the Online Map.

2. Type the project location into the Address Search tool (Figure A2). If the address is unknown, use a nearby place name or latitude and longitude. This example uses 16018 Mill Creek Boulevard, Mill Creek, Washington.

3. Select the correct address from the drop-down menu or continue to enter manually. Click (on a **PC**) or tap (on a **mobile device**) the search button. The map will zoom to that location, shown as a small blue box and a popup titled "Search result" (Figure A3).

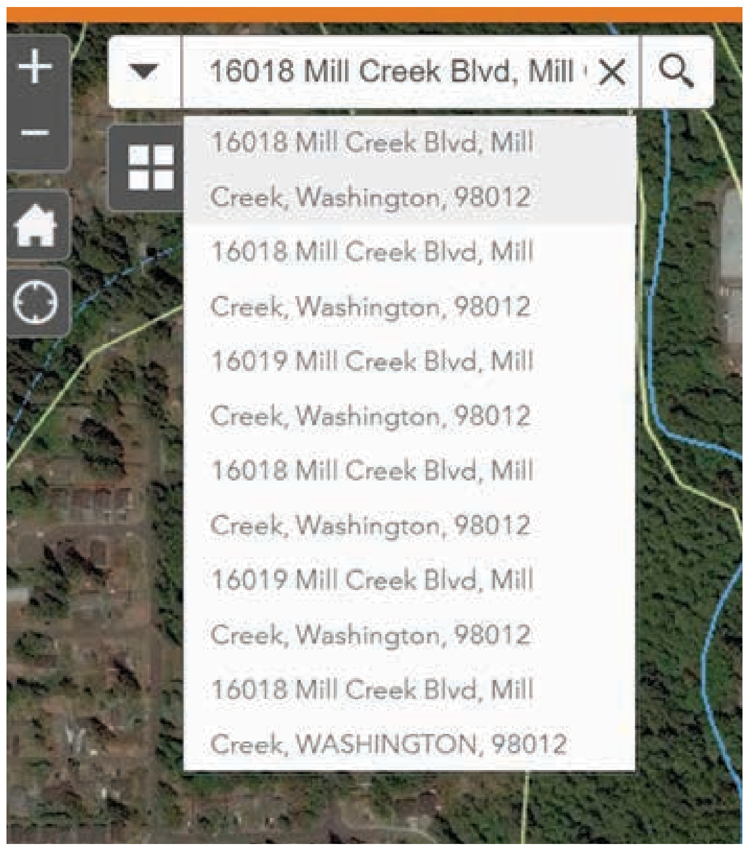


Figure A2. Using the Address Search tool.

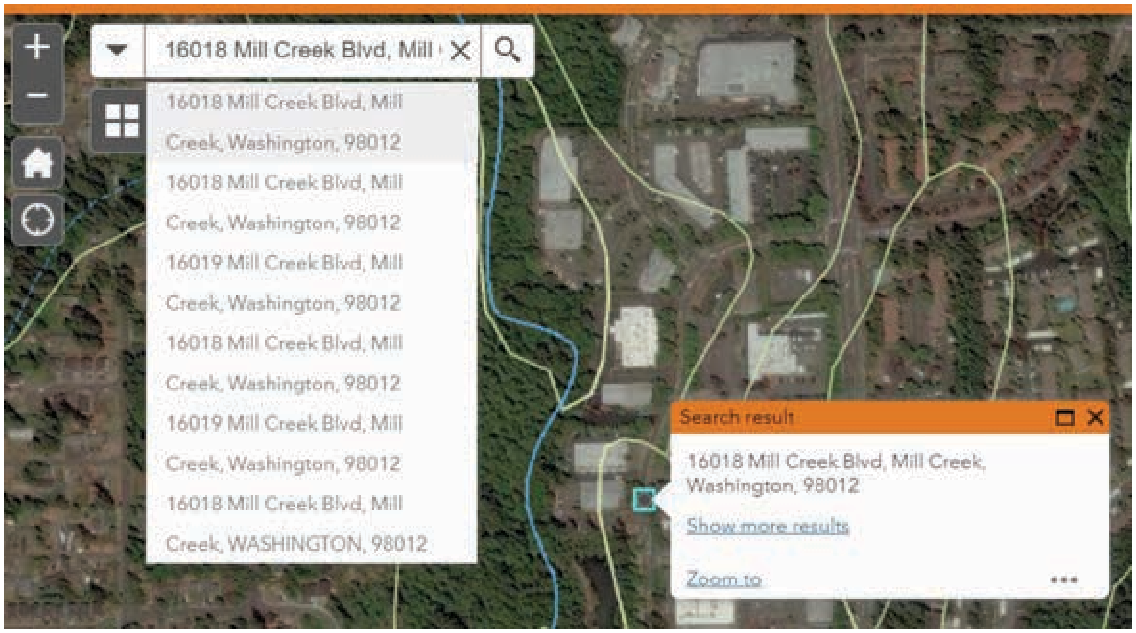


Figure A3. Zoomed in aerial image of the site address.

4. Click (or tap) on the "X" in the Address Search tool to close the popup. Zoom and pan until you can clearly see where the project site is on the landscape (Figure A4).

   In this example, the project site lies in a wooded area to the west of the address selected in the previous screen. We panned west to center the map display over the project site. In this screen, you can see outlines of the soil polygons.

Figure A4. Adjusting the map display over the project site.

5. Click (or tap) near a stream on the project site. The outline of the soil polygon selected will turn blue, and a popup window will provide information about the $SPTH_{200}$ (Figure A5). On a PC, the popup should automatically show (1) the $SPTH_{200}$ in feet, (2) the species of tree it is based on, and (3) the reference study used to derive the height value. On a mobile device, tap the arrow on the right side of the popup to display this information.

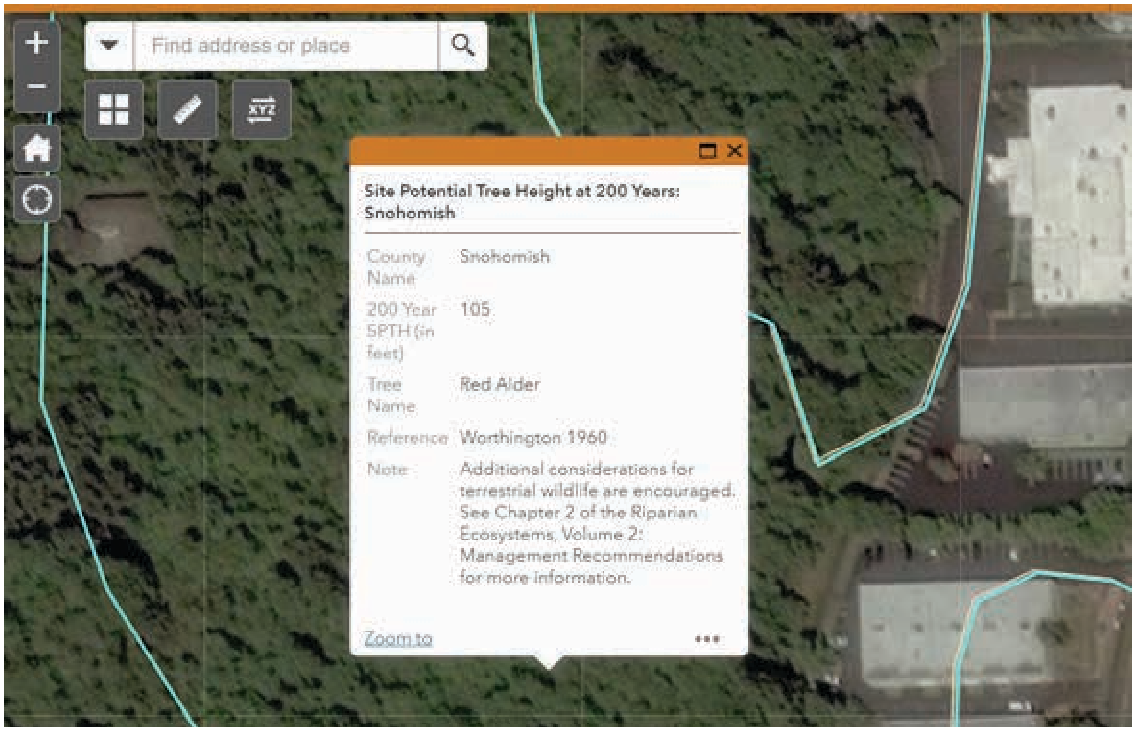


Figure A5. Bringing up the SPTH200 information at the project site.

In Example #1, the soil polygon for the project site only showed one tree species: Red Alder. Sometimes soil polygons will list more than one tree species, as shown in Example #2.

Mapping Tool Example #2

Example #2, the project site was at a different location. Steps 1-3 in Example #1 were repeated to zoom to the project site. For this site, the popup window for the selected soil polygon looked different:

- The upper left corner of the popup window says "(1 of 2)"; and
- There is a small arrow near the upper right corner of the popup window.

This means that this soil polygon has two different associated tree species. The first is Douglas-fir (see Figure A6a).

To view the information for the second tree species, click on the small arrow. The second tree species is western hemlock (see Figure A6b).

For project locations with multiple tree species, WDFW recommends using the largest $SPTH_{200}$ value, even if the largest tree species is not the most numerous (or even currently present) onsite.

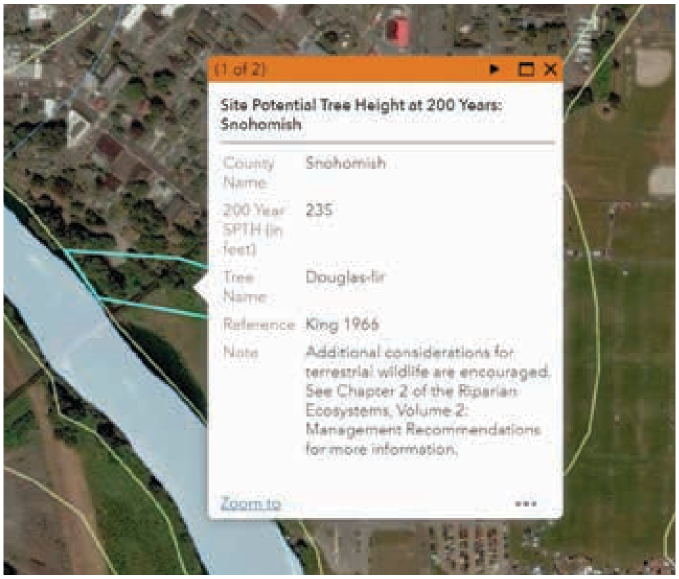


Figure A6a. SPTH information for the first of multiple tree species at a given site.

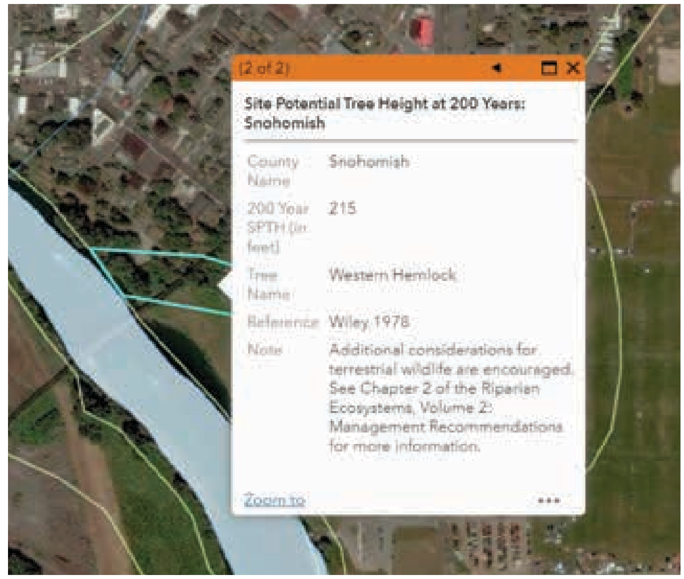


Figure A6b. SPTH200 information for the second of multiple tree species at a given site.

Appendix References: Tree Site Index Curves

The following studies were used to determine SPTH200 throughout the state:

Alexander, R.R. 1966. Site indexes for lodgepole pine, with corrections for stand density: instructions for field use. Research Paper RM-24. U.S., Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Alexander, R.R. 1967. Site indexes for Engelmann spruce. Research Paper RM-32. U.S., Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado.

Baker, F.S. 1925. Aspen in the Central Rocky Mountain Region. Bulletin 1291. United States Department of Agriculture, \Washington, D.C.

Barnes, G.H. 1962. Yield of even-aged stands of western hemlock. Technical Bulletin 1273. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

British Columbia Forest Service (BCFS). 1977. Site index curves for cottonwood (as adapted by W.J. Sauerwein). pp. 852-853 *in* Pocket Woodland Handbook. U.S. Department of Agriculture, Soil Conservation Service, Portland, Oregon.

Cochran, P.H. 1979a. Gross yields for even-aged stands of white or Douglas-fir and white or grand fir east of the Cascades in Oregon and Washington. Research Paper PNW-263. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Cochran, P.H. 1979b. Site index and height growth curves for managed, even-aged stands of Douglas-fir east of the Cascades in Oregon and Washington. Research Paper PNW-251. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Cochran, P.H. 1985. Site index, height growth, normal yields, and stocking levels for larch in Oregon and Washington. Research Note PNW-424. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Haig, I.T. 1932. Second-growth yield, stand, and volume tables for the western white pine type. Technical Bulletin 323. United States Department of Agriculture, Washington, D.C.

Hegyi, F., J.J. Jelinek, J. Viszlai, and D.B. Carpenter. 1979. Site index equations and curves for the major tree species in British Columbia. Forest Inventory Report No. 1. Ministry of Forestry, Victoria, British Columbia.

Herman, F.R., R.O. Curtis, and D.J. Demars. 1978. Height growth and site index estimates for noble fir in high-elevation forests of the Oregon-Washington Cascades. Research Paper PNW-243. U.S. Forest Service Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Hoyer, G.D., and F.R. Herman. 1989. Height-age and site index curves for Pacific silver fir in the Pacific Northwest. Research Paper RP-418. U.S., Forest Service. Pacific Northwest Research Station, Portland, Oregon.

King, J.E. 1966. Site index curves for Douglas-fir in the Pacific Northwest. Forestry Paper 8. Weyerhaeuser Company, Forestry Research Center, Centralia, Washington.

Kurucz, J.F. 1978. Preliminary, polymorphic site index curves for western red cedar (*Thuja plicata Donn*) in coastal British Columbia. Forest Research Note No. 3. MacMillan Bloedel, Nanaimo, British Columbia.

Meyer, W.H. 1961. Yield of even-aged stands of ponderosa pine. Technical Bulletin 630 (revised 1961). United States Department of Agriculture, Washington, D.C.

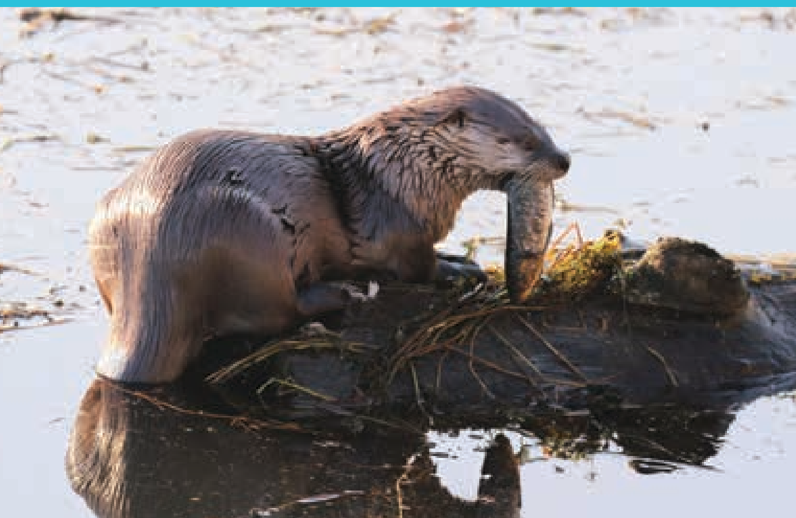
Meyer, W.H. 1937. Yield of even-aged stands of Sitka spruce and western hemlock. Technical Bulletin 544. United States Department of Agriculture, Washington, D.C.

Monserud, R.A. 1985. Applying height growth and site index curves for inland Douglas-fir. Research Paper INT-347. U.S. Forest Service. Intermountain Research Station, Ogden, Utah.

Schmidt, W.C., R.C. Shearer, and A.L. Roe. 1976. Ecology and silviculture of western larch forests. Technical Bulletin 1520. U.S. Forest Service, Washington, D.C.

Wiley, K.N. 1978. Site index tables for western hemlock in the Pacific Northwest. Forestry Paper No. 17. Weyerhaeuser Company, Western Forestry Research Center, Centralia, Washington.

Worthington, N.P., F.A. Johnson, G.R. Staebler, and W.J. Lloyd. 1960. Research Paper No. 36. Normal yield tables for red alder. U.S. Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.



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