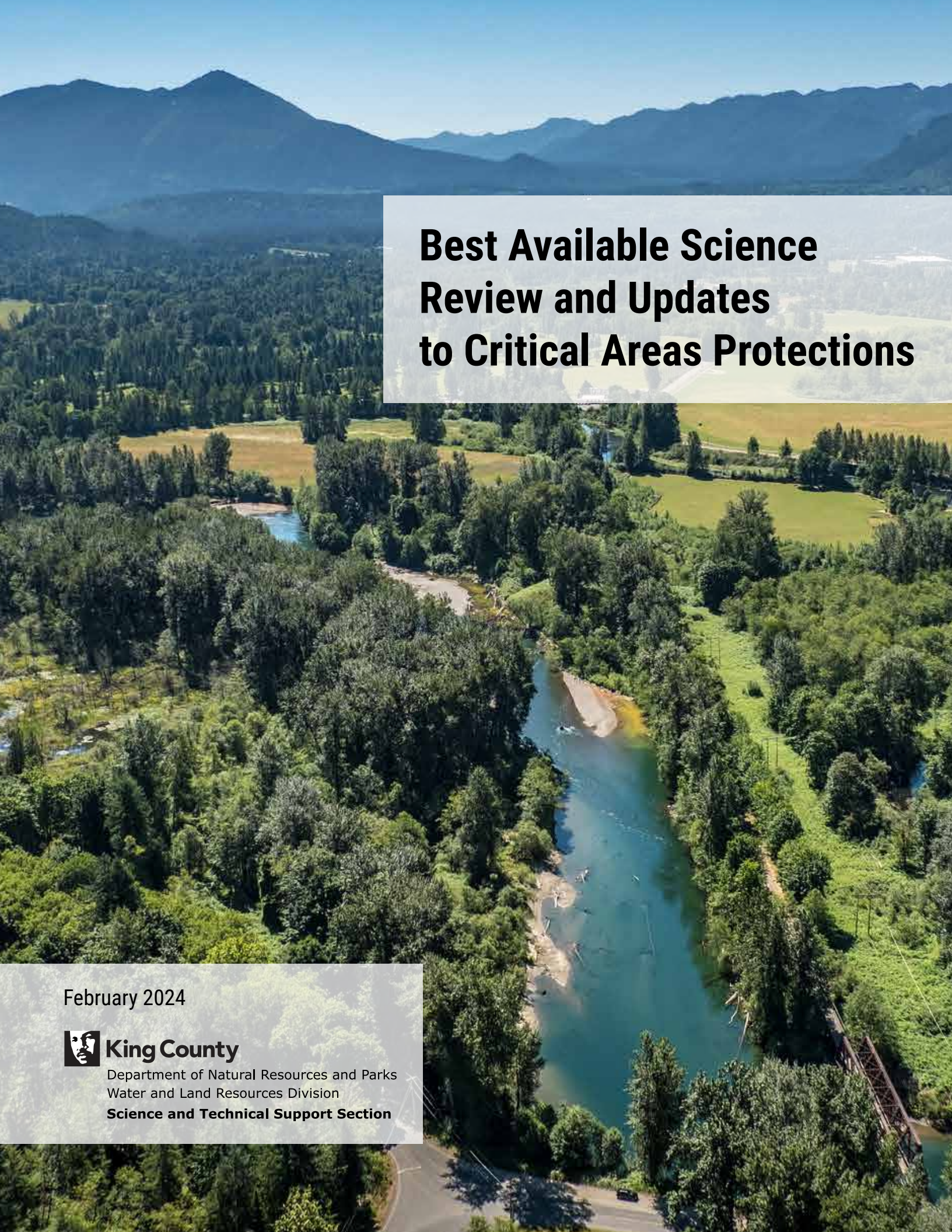
Best Available Science Review and Updates to Critical Areas Protections



February 2024

King County
Department of Natural Resources and Parks
Water and Land Resources Division
Science and Technical Support Section

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Table of Contents

Figures

Tables

Executive Summary

King County is currently updating its Comprehensive Plan to comply with the Washington State Growth Management Act (GMA). As part of this update, which is required by state law to be adopted by the end of 2024, King County must review and update Comprehensive Plan policies and associated development regulations that protect critical areas. Critical areas include wetlands, critical aquifer recharge areas (CARA), fish and wildlife habitat conservation areas (FWHCA), geologically hazardous areas (GHA), and frequently flooded areas. Each type of critical area provides unique ecological functions and values to communities across the local landscape. Some types of critical areas, such as GHAs, also pose risks to public health and safety.

The GMA establishes 15 goals to guide the development of comprehensive plans and development regulations. In addition, the GMA requires that King County include the best available science (BAS) as it updates critical areas policies and development regulations and give special consideration to conserve or protect anadromous fish, such as salmon and steelhead trout. Where policies and development regulations depart from BAS, the County must provide the rationale, including legal, social, cultural, economic, and political information, and identify potential risks associated with the departure. When King County adopted critical areas policies and development regulations in 2004, it departed from BAS in some areas, such as adopting narrower riparian area widths (formerly aquatic area buffers) in Unincorporated King County's (UKC) Urban Growth Area (UGA).

In 2010, Washington State updated the GMA, adding a requirement that jurisdictions ensure no net loss of existing critical areas functions and values. It also directed jurisdictions to protect critical areas through a combination of regulatory measures and nonregulatory programs. The GMA also requires that jurisdictions plan for effects of a changing climate when updating protections for critical areas (see Section 1.1).

To inform the 2024 BAS review, the County reviewed state law, guidance from the Washington State Department of Commerce, and updated BAS from state agencies, including the Washington State Department of Ecology (Ecology) and the Washington State Department of Fish and Wildlife. King County's 2024 BAS review was designed to expand on its 2004 BAS review. It aims to ensure compliance with current GMA requirements and administrative guidance with a heightened emphasis on incorporating significant state agency-issued BAS updates and achieving no net loss of critical areas functions and values. King County's 2024 BAS affirmed that many County policies and development regulations protecting critical areas in UKC are well aligned with GMA mandates and BAS. The 2024 BAS review also identified regulatory updates necessary to improve alignment with BAS and satisfy GMA mandates. These regulatory updates are summarized below by critical area and are described in detail in the body of this report.

King County combines regulatory and nonregulatory measures to protect critical areas functions and values to ensure no net loss at the scale of watersheds and ecosystems.

Regulatory protections for critical areas are primarily in King County Code (K.C.C.) Chapter 21A.24. However, stormwater management, clearing and grading, and shorelines regulations as well as land use designation and zoning requirements are also key parts of the County's regulatory approach. Additionally, the County implements nonregulatory plans, initiatives, programs, and projects to protect and restore critical areas functions and values. Key examples of programs and outcomes described in this report include the Clean Water Healthy Habitat Strategic Plan, Land Conservation Initiative, watershed-based salmon recovery plans and habitat restoration projects, and the fish passage restoration program. Collectively, these efforts supplement development regulations, including critical areas regulations applied to sites undergoing new development.

Key findings, recommendations for regulatory updates, and companion nonregulatory actions for each critical area type are briefly summarized below; additional detail can be found in the body of this report.

Wetlands

Commonly called marshes, swamps, or bogs, wetlands help protect communities from pollution and flooding. Wetlands attenuate floodwaters, trap sediment, and filter pollutants from stormwater runoff. Wetlands also provide critical habitat for animals, including migratory birds, amphibians, and commercially and culturally important salmon.

King County reviewed Washington State Department of Commerce (Commerce) guidance documents, recent Ecology BAS and regulatory guidance, King County's 2004 BAS, critical areas monitoring data, and supplemental literature to inform updates to policies and development regulations that protect wetlands. This review identified the need to increase protections for some wetlands (see Section 4.1.3) and to update requirements for select wetland mitigation activities (see Section 4.2.3).

Wetland development regulation updates improve environmental protections, with a focus on protecting rare wetlands that are difficult or impossible to recreate through restoration activities while also limiting impacts to the wildlife habitat functions of common wetlands. These updates help ensure County compliance with GMA mandates, including requirements that counties plan for climate resilience and ensure no net loss of critical areas functions and values. Updates to these critical areas protections consider competing GMA goals and comprehensive planning priorities, including supporting housing development in the UGA, maintaining and enhancing the local agricultural industry, and administering a fair and timely permitting process.

In addition to updating wetland regulations, King County is investing in nonregulatory programs that will improve the management and protection of local wetlands. This includes updating its advisory wetland maps to better inform permitting staff and community members of the location and types of wetlands present in King County and

establishing a monitoring and adaptive management (MAM) program to evaluate and improve the effectiveness of wetland regulations and nonregulatory programs.

Fish and Wildlife Habitat Conservation Areas

King County designates and regulates a variety of Fish and Wildlife Habitat Conservation Areas (FWHCAs) to sustain local populations of terrestrial animals and fish species, including anadromous fish like salmon and steelhead trout. King County reviewed Commerce guidance documents, recent Washington State Department of Fish and Wildlife (WDFW) BAS and regulatory guidance, King County's 2004 BAS, critical areas monitoring data, and supplemental literature to inform updates to policies and development regulations that protect FWHCAs.

The County's 2024 BAS review identified the need to update protections for aquatic areas and for riparian areas, formerly characterized as aquatic area buffers. Riparian areas are the transitional areas between terrestrial and aquatic ecosystems. Riparian areas are diverse, dynamic, and complex ecosystems that support an abundance and variety of fish and wildlife. Updates to aquatic and riparian area protections include increasing the protected width of all types of riparian areas (see Section 5.1.3), clarifying how riparian areas are measured with respect to Channel Migration Zones (CMZs) (see Section 5.2.3), and revising riparian area mitigation requirements (see Section 5.3.3).

Updates to riparian area development regulations improve environmental protections for aquatic and riparian areas with a focus on protecting riparian area functions and values such as bank stability, shade and temperature control, pollution removal and water purification, recruitment of habitat-forming large wood, natural erosion and sediment delivery, and habitat cover for aquatic and terrestrial animals. Updates help ensure County compliance with GMA mandates, including requirements that counties plan for climate resilience, ensure no net loss of critical areas functions and values, and demonstrate special consideration for anadromous fisheries. Updates to these critical areas protections consider competing GMA goals and comprehensive planning priorities, including supporting housing development in the UGA, maintaining and enhancing the local agricultural industry, and administering a fair and timely permitting process.

To complement updates to riparian area regulations, King County is investing in nonregulatory programs that will improve the management and protection of riparian areas and aquatic areas. This includes updating its advisory stream maps to better inform permitting staff and community members of the location and types of streams present in King County and establishing a riparian monitoring and adaptive management (MAM) program to evaluate and improve the effectiveness of regulations and nonregulatory programs that protect aquatic and riparian areas.

In addition to updating riparian area regulations, the 2024 BAS review identified the need to update King County's Species of Local Importance (SOLI) and Habitats of Local

Importance (HOLI) lists in the Comprehensive Plan (see Section 6.1.3). The BAS review also identified the need to conduct a climate gradient analysis for wildlife habitat in the County. This mapping exercise will use climate-informed wildlife migration models and updated stream and wetland mapping resources to identify and map areas and corridors critical to the protection of local wildlife biodiversity as the climate changes over time. Together, updating SOLI and HOLI lists and wildlife mapping resources will inform the County's future conservation efforts, which are aimed at preserving the County's last, most important natural lands and urban green spaces.

Critical Aquifer Recharge Areas (CARA)

Critical aquifer recharge areas (CARA) are the geographic areas that have a critical recharging effect on aquifers used for potable water. Protecting groundwater is an important regional issue because groundwater provides approximately 30 percent of the water used in King County and is the primary source of water in Unincorporated King County (UKC) outside of the Urban Growth Area (UGA). On Vashon-Maury Island and in other sole-source aquifer areas, it is the only source of drinking water.

King County reviewed Commerce guidance documents, King County's 2004 BAS, and supplemental literature to inform updates to policies and development regulations that protect CARA in UKC. The County's 2024 BAS review determined that King County's existing methodology of delineating CARA follows the state guidance from Ecology and Commerce and that minor updates to development regulations were necessary to clarify how King County classifies CARA according to both aquifer vulnerability and susceptibility (see Section 7.1.3).

In addition to updating CARA regulations, King County will continue investing in programs to monitor groundwater resources and support engagement with communities about the importance of protecting groundwater supplies.

Geologically Hazardous Areas (GHAs)

Geologically Hazardous Areas (GHAs) are areas that are susceptible to erosion, sliding, earthquake, or other geological events that present risks to public health and safety. King County reviewed Commerce guidance and the scope of King County's 2004 BAS literature to inform the scope of 2024 BAS review for GHAs. This process identified that BAS review was necessary for the management of alluvial fans, which are designated by the State as a type of GHA critical area.

Alluvial fans naturally occur along stream channels at the base of a slope. Hazardous geologic processes occur on alluvial fans, increasing risks to infrastructure and public health and safety. Debris flows and floods transport sediment and rocks at fast rates that can damage property or harm people. King County reviewed BAS and alluvial fan critical areas protections in other regional jurisdictions and determined that regulatory updates are necessary to establish development regulations for alluvial fans in UKC.

New alluvial fan development regulations in the K.C.C. define the County's role in alluvial fan and Alluvial Fan Hazard Areas (AFHA) management by implementing development standards that reduce public health and safety risks associated with this type of GHA (see Section 8.1.3). This includes limiting clearing and grading and prohibiting new development in AFHAs while allowing select emergency actions to be permitted to reduce alluvial fan hazard risks to existing development and land uses. Updates satisfy the GMA requirement that the County designate and regulate GHAs while improving the County's ability to reduce GHA risks to public health and safety.

In addition to updating GHA regulations, King County will continue to coordinate with communities and other partners to guide investment in nonregulatory programs that support the management of critical areas, including GHAs, alluvial fans, and AFHAs. This includes operating nonregulatory open space acquisition programs, such as the Land Conservation Initiative (LCI) which seeks to protect the high conservation value lands across the County through voluntary acquisition of properties with high ecological value or that pose a significant risk to public health and safety.

Frequently Flooded Areas

King County reviewed Commerce guidance documents, state BAS, King County's 2004 BAS, the Federal Emergency Management Agency (FEMA) Biological Opinion (BiOp) model ordinance, supplemental literature, and available critical areas monitoring data related to frequently flooded areas, including wetlands, aquatic areas, riparian areas, and alluvial fans. King County's 2024 BAS review and regulatory updates for these critical areas are discussed in relevant sections of this report.

King County updated the King County Code (K.C.C.) in 2020 to comply with regulatory guidance and standards from FEMA and Ecology. King County participates in the FEMA National Flood Insurance Program (NFIP) and is required to comply with the FEMA BiOp for the State of Washington, Puget Sound Region.

Tribal Consultation and Community Engagement

Engaging communities and consulting tribes during the comprehensive planning process strengthens King County efforts to protect the environment and comply with GMA mandates, including the requirements that development regulations be informed by BAS and that counties ensure no net loss of critical areas functions and values. King County engaged a diverse group of community organizations and consulted with Indian tribes as it completed its 2024 BAS review and updated critical areas policies and development regulations. Engaging community organizations and tribal governments allowed King County to make informed updates to critical areas policies and development regulations that satisfy GMA mandates while supporting an array of comprehensive planning goals that, at times, may intersect with the protection and management of critical areas.

During tribal consultation on the BAS review, a request was made for written recognition of Traditional Ecological Knowledge (TEK) and commitments for its use where possible be included as part of this BAS report. State law definitions and descriptions of BAS do not include TEK. State law and guidance do not otherwise define or require TEK in the context of local governments conducting BAS reviews. However, the federal government has issued guidance to federal agencies to recognize Indigenous Knowledge or TEK. The County recognizes the valuable contributions of Indigenous Knowledge that Tribal Nations and Indigenous People have gained and passed from one generation to the next. The County Executive and tribal relations staff will develop further guidance for (1) increasing awareness and understanding of Indigenous Knowledge, (2) growing and maintaining the mutually beneficial relationships with Tribal Nations and Indigenous People to appropriately identify and access Indigenous Knowledge, and (3) when to consider, include, and/or apply Indigenous Knowledge.

King County is committed to protecting and sustaining the functions and values provided by critical areas. To achieve this outcome, the County must establish regulations that reflect both values and the best available science. But that is not enough. Success also relies on a deep and lasting commitment to invest in effective nonregulatory approaches, including strategic plans and initiatives to drive action on the ground, and restoration programs driven by massive investment and a learning mindset that ensures continuous improvement. Programmatic actions and individual projects are also vital to success. Each of these mechanisms for protecting critical areas is vital—none are sufficient on their own. Together, they represent the best chance to achieve the best possible environmental outcomes within a generation, ensuring everyone in King County can enjoy the benefits of a healthy environment.

1 Introduction

In 1990, Washington State passed the Growth Management Act (GMA), which required King County and other local jurisdictions to prepare comprehensive plans and implement development regulations. In 1994, King County adopted its first Comprehensive Plan under the GMA. Subsequently, the GMA was amended to require local jurisdictions to develop policies and regulations to protect critical areas. The GMA specifies that this process must include best available science (BAS). In 2004, King County enacted critical areas development regulations in the King County Code (K.C.C.). Critical areas include wetlands, areas with a critical recharging effect on aquifers used for potable water, fish and wildlife habitat conservation areas (FWHCA), geologically hazardous areas, and frequently flooded areas. In King County, areas with a critical recharging effect on aquifers used for potable water are referred to as critical aquifer recharge areas or CARA.

King County is currently updating its Comprehensive Plan to comply with the GMA mandate that jurisdictions substantively review and update their comprehensive plan at least once every 10 years. As part of this update, due by the end of 2024, King County must review and update Comprehensive Plan policies and associated development regulations that protect critical areas. The GMA requires these updates to include BAS. The GMA also requires that jurisdictions give special consideration to the conservation or protection of anadromous fish, such as salmon and steelhead trout.

This report documents King County's BAS review process and introduces updates to Comprehensive Plan policies and associated development regulations. The remainder of Section 1 describes GMA goals and requirements. Section 2 describes the scope of King County's 2024 BAS review. Section 3 describes King County's use of regulatory and nonregulatory measures to protect critical areas. Sections 4 through 8 are organized by critical area and introduce policies and development regulations that are being updated to include current BAS and meet GMA requirements. For clarity, two categories of FWHCA, riparian areas and wildlife habitat, are discussed in separate sections.

This report is primarily written in plain language to improve reader accessibility. Scientific concepts and regulatory requirements are generally discussed at a summary level, though some technical discussion is included to ensure BAS review findings and regulatory requirements are accurately represented. Technical experts reviewing this document can find greater detail in cited references. Readers can review updates to critical areas policies and development regulations in the 2024 King County Comprehensive Plan and the K.C.C.

1.1 GMA Goals

The GMA is codified under Chapter 36.70A of the Revised Code of Washington (Chapter 36.70A RCW). The GMA establishes 15 goals to guide the development of comprehensive plans and development regulations (RCW 36.70A.020). This includes a

newly adopted “climate change and resiliency” goal, with which the County will be required to comply by 2029. The goals of the GMA are not listed in order of priority and are summarized below:

1. **Urban growth:** Encourage development in urban areas.
2. **Reduce sprawl:** Reduce the inappropriate conversion of undeveloped land into sprawling low-density development.
3. **Transportation:** Encourage efficient multimodal transportation systems.
4. **Housing:** Plan for and accommodate all economic segments.
5. **Economic development:** Encourage economic development throughout the state.
6. **Property rights:** Private property shall not be taken for public use without just compensation.
7. **Permits:** Applications should be processed in a fair and timely manner.
8. **Natural resource industries:** Maintain and enhance productive timber, agricultural, and fisheries industries.
9. **Open space and recreation:** Retain open space and enhance recreational opportunities.
10. **Environment:** Protect the environment, including air and water quality, and the availability of water.
11. **Citizen participation and coordination:** Encourage public involvement.
12. **Public facilities and services:** Ensure public facilities and services necessary to support development are adequate.
13. **Historic preservation:** Identify and encourage preservation.
14. **Climate change and resiliency:** Adapt to and mitigate the effects of a rapidly changing climate and rising sea levels.
15. **Shoreline management:** Goals and policies of the Shoreline Management Act (RCW 90.58.020).

1.2 GMA Requirements for BAS Review and Updates to Critical Areas Protections

In addition to the goals described in Section 1.1, the GMA requires that King County protect critical areas. The GMA states that,

> “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” (RCW 36.70A.172).

Additional GMA regulations and planning guidance are offered to jurisdictions in the Washington Administrative Code (WAC). WAC 365-196-830 details requirements for protection of critical areas. Chapter 365-195 WAC describes requirements for including

BAS in County decision-making processes. These elements of the WAC are further described below.

1.2.1 WAC 365-196-830 Protection of Critical Areas

Adopted in 2010, WAC 365-196-830 details requirements and guidance for the protection of critical areas under the GMA. Protection in this context means preservation of the functions and values of the natural environment or safeguarding the public from hazards to health and safety. It requires that jurisdictions ensure no net loss of existing critical areas functions and values and directs jurisdictions to protect critical areas through a combination of regulatory measures, nonregulatory programs, and best management practices (BMPs). It states that, while avoidance is the most effective way to protect critical areas, development regulations may impact critical areas if compensatory mitigation is required, or other corresponding mitigation efforts occur.

1.2.2 Chapter 365-195 WAC Best Available Science

Chapter 365-195 WAC provides guidance to jurisdictions as they locate and include scientific information in their planning processes. The six sections within this chapter of the WAC are summarized below.

WAC 365-195-900 Background and Purpose

Describes BAS requirements of the GMA and references relevant sections of the RCW. States that the inclusion of BAS is especially important to salmon recovery efforts and to other decision-making affecting threatened or endangered species.

WAC 365-195-905 Criteria for Determining Which Information is the "Best Available Science"

Provides guidance on what information obtained during development of critical areas policies and regulations qualifies as BAS. Directs jurisdictions to conduct a BAS review when updating critical areas regulations, stating that the complexity of BAS review should reflect the scope of amendments to critical areas policies and development regulations. Jurisdictions are directed to use information that local, state, or federal natural resource agencies have identified as BAS. This section identifies common sources of scientific and nonscientific information.

WAC 365-195-915 Criteria for Obtaining the Best Available Science

Directs jurisdictions to obtain scientific information through consultation with state natural resource agencies and tribes or through a jurisdiction's own efforts.

WAC 365-195-920 Criteria for Addressing Inadequate Scientific Information

Offers decision-making guidance to jurisdictions when there is an absence of valid scientific information or incomplete scientific information relating to a critical area. Jurisdictions are instructed to use a “precautionary or a no-risk approach” until uncertainty is sufficiently resolved. Adaptive management is offered as an interim approach.

WAC 365-195-925 Criteria for Demonstrating “Special Consideration” Has Been Given to Conservation or Protection Measures Necessary to Preserve or Enhance Anadromous Fisheries

Offers additional guidance related to the GMA requirement that jurisdictions conserve, protect, and enhance anadromous fisheries, such as salmon and steelhead trout. This section references relevant sections of the RCW and states that special consideration should be given to habitat protection measures relevant to stream flows, water quality and temperature, and other environmental factors important to all life stages of anadromous fish. Such special consideration should be evidenced in the record.

1.3 Community Engagement and Tribal Consultation

Engaging communities and consulting tribes during the comprehensive planning process aligns with GMA goals (see Section 1.1) and strengthens King County efforts to protect the environment and comply with GMA mandates, including the requirements that development regulations be informed by BAS and that counties ensure no net loss of critical areas functions and values (see Section 1.2).

King County's Comprehensive Plan includes policies to guide community engagement and consultation with tribal governments. Chapter 1 of the Comprehensive Plan, Regional Growth Management Planning, describes King County's commitment to supporting broad participation in local planning processes. Policies RP-101, RP-102, and RP-103 describe how King County engages communities and consults tribes to inform comprehensive planning and provide a high quality of life to King County community members.

Chapter 5 of the Comprehensive Plan, Environment, details how community engagement and tribal consultation inform King County's use of development regulations and nonregulatory programs to protect the natural environment, which includes critical areas. Policy E-104 of the 2016 King County Comprehensive Plan, as amended, states,

> "Development of environmental regulations, restoration and mitigation projects, and incentive and stewardship programs should be coordinated with local jurisdictions, federal and state agencies, tribes, special interest groups and residents when conserving and restoring the natural

environment consistent with Urban Growth Area, Rural Area and designated Natural Resource Land goals."

The County is committed to developing and sustaining a robust government-to-government relationship with sovereign Tribal Nations and promoting self-governance by their membership. The County and tribes frequently partner on habitat restoration projects and scientists from King County and tribes have served together on research and planning teams.

King County invited Indian tribes to participate in government-to-government consultation during the BAS review process, including the Suquamish Tribe, Muckleshoot Indian Tribe, Tulalip Tribes, Snoqualmie Tribe, and Puyallup Tribe. At the time this report was produced in February 2024, King County has met with representatives from the Suquamish Tribe, Tulalip Tribes, and Snoqualmie Tribe to review and discuss BAS findings and regulatory updates and has responded to follow-up questions. These meetings provided King County valuable input and feedback to inform updates to King County Comprehensive Plan policies and associated development regulations in the King County Code (K.C.C.).

King County also engaged a diverse group of community organizations with varied interests in agriculture, housing development, environmental stewardship, and growth management as it reviewed and drafted BAS and updated Comprehensive Plan policies and associated development regulations related to the management of critical areas. These organizations included:

- CARE / SWAN
- Fish, Farm, Flood Implementation Oversight Committee
- Futurewise
- Joint Rural Area Team
- King Conservation District
- King County Agricultural Commission
- Master Builders Association of King and Snohomish Counties
- Puget Soundkeeper
- Seattle King County Realtors Association
- Skyway Coalition
- Watershed Resource Inventory Areas and Salmon Recovery Forums
- White Center Community Development Association

1.4 Application of Indigenous Knowledge or Traditional Ecological Knowledge

King County conducted this BAS review in accordance with state law establishing the definition and requirements for BAS (see Section 1.2). During tribal consultation on the BAS review, a request was made for written recognition of Traditional Ecological Knowledge (TEK) and commitments for its use where possible be included as part of this BAS report. State law definitions and descriptions of BAS do not include TEK or otherwise define or require TEK in the context of local governments conducting BAS

reviews. However, the federal government has issued guidance to federal agencies recognizing Indigenous Knowledge or TEK for more than a decade:

> "Traditional Ecological Knowledge, also called by other names including Indigenous Knowledge or Native Science, (hereafter, TEK) refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment. This knowledge is specific to a location and includes the relationships between plants, animals, natural phenomena, landscapes, and timing of events that are used for lifeways, including but not limited to hunting, fishing, trapping, agriculture, and forestry. TEK is an accumulating body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (human and non-human) with one another and with the environment. It encompasses the world view of indigenous people which includes ecology, spirituality, human and animal relationships, and more." (US Fish and Wildlife Service, Traditional Ecological Knowledge for Application by Service Scientists, February 2011)

The Biden-Harris Administration has formally recognized Indigenous Knowledge, also referred to as TEK, as one of many important bodies of knowledge that contributes to the scientific, social, and economic advancement of communities in the United States. The County has reviewed federal guidance, including definitions and principles, as presented by the Council on Environmental Quality in its November 30, 2022, Guidance Memorandum.

The County recognizes the valuable contributions of Indigenous Knowledge that Tribal Nations and Indigenous People have gained and passed down from generation to generation. The County has sought and applied Indigenous Knowledge to inform design and implementation of capital projects and land management. recent examples include:

- Harbor Island Dock Demolition Project in the Duwamish Estuary
- The Čakwab Levee Setback Project on the Middle Green River
- Lower Russell Road Levee Setback Project on the Lower Green River
- Kokanee Salmon Recovery Efforts on Lake Sammamish and tributary streams

The County Executive and tribal relations staff will develop further guidance for (1) understanding Indigenous Knowledge, (2) growing and maintaining the mutually beneficial relationships with Tribal Nations and Indigenous People that are needed to appropriately identify and access Indigenous Knowledge, and (3) when to consider, include, and/or apply Indigenous Knowledge. The County will also request that the state provide guidance for local governments regarding use of Indigenous Knowledge in the context of reviewing and including BAS as required by state law.

2 King County's 2024 BAS Review

King County completed an extensive best available science (BAS) review when updating its Comprehensive Plan and establishing critical areas development regulations in 2004. The 2004 BAS report, *Volume I: A Review of Scientific Literature*, documented King County's review of BAS applicable to protection of critical areas. A companion report, *Volume II: Assessment of Proposed Ordinances*, documented King County's inclusion of BAS in the development of its Comprehensive Plan and development regulations.

King County reviewed BAS to inform the 2024 updates to its Comprehensive Plan and development regulations. The County's 2024 BAS review builds on the County's 2004 BAS review and was informed by state guidance documents and technical assistance tools. The 2024 BAS review process included review of King County's 2004 BAS report, BAS documents provided by state natural resource agencies, and supplemental scientific literature. This section introduces state guidance documents and BAS resources, and documents King County's approach to the 2024 BAS review.

2.1 Washington State Resources for Critical Areas Protection Updates

The Washington State Department of Commerce (Commerce) has produced two key resources that guided King County's 2024 BAS review:

- Commerce's 2023 Critical Areas Handbook: an in-depth guidance document designed to help communities review and revise locally adopted programs for designating and protecting critical areas under the Growth Management Act (GMA). The handbook also provides recommendations for monitoring the implementation and effectiveness of critical areas regulations in support of adaptive management.
- Commerce's 2022 Critical Areas Checklist: a concise technical assistance tool designed to help communities review local policies and critical areas regulations for GMA compliance.

2.2 Washington State BAS Resources

After King County prepared its 2004 BAS report, the State of Washington produced BAS documents for some critical areas. These BAS documents are briefly introduced here and are discussed in detail in later sections of this report.

2.2.1 Washington State BAS Documents for Wetlands

The Washington State Department of Ecology (Ecology) has worked in partnership with the Washington State Department of Fish and Wildlife (WDFW) to produce BAS documents for the management of wetlands:

- Volume 1: A Synthesis of the Science (Sheldon 2005): summarizes literature relevant to the science and management of freshwater wetlands.

- Volume 2: Guidance for Protecting and Managing Wetlands (Granger 2005): provides guidance for the protection and management of wetlands in Washington State. Based on the science provided in the 2005 Volume 1 companion document.
- Update on Wetland Buffers: The State of the Science (Hruby 2013): revisits key points of the 2005 Volume 1 science report. Reviews previous conclusions against new scientific literature published between 2003 and 2012.
- Wetland Guidance for CAO Updates: Western Washington Version (Bunten 2016): provides updated guidance in the protection and management of wetlands in western Washington State.
- Wetland Mitigation in Washington State Part 1: Agency Policies and Guidance, Version 2 (Ecology 2021): provides updated guidance for improving wetland protections and quality and effectiveness of compensatory wetland mitigation in Washington State.
- Wetland Guidance for Critical Areas Ordinance (CAO) Updates: Western and Eastern Washington (Ecology 2022): provides wetland guidance and tools for jurisdictions working on implementing the requirements of Washington State Growth Management Act (GMA), specifically, designating and protecting wetland critical areas.

2.2.2 Washington State BAS Documents for Riparian Areas

WDFW has produced BAS documents for riparian areas, a type of Fish and Wildlife Habitat Conservation Area (FWHCA). These resources, available online, are:

- Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications (Quinn et al. 2020): summarizes literature relevant to the science and management of riparian areas.
- Riparian Ecosystems, Volume 2: Management Recommendations (Rentz et al. 2020): offers guidance in the protection and management of riparian areas.

The WDFW BAS documents primarily address the needs of aquatic species and include only limited consideration for terrestrial species. WDFW committed to review BAS for the needs of terrestrial species in the future (Quinn et al. 2020).

2.3 King County's 2024 BAS Review Scope

King County's 2024 BAS review was designed to expand on King County's 2004 BAS review. It aims to ensure compliance with current GMA requirements and administrative guidance with a heightened emphasis on achieving no net loss of critical areas functions and values. Additionally, it seeks to incorporate significant state agency updates to BAS for riparian areas and wetlands while bolstering local management and protection of critical areas.

King County relied on the Commerce Critical Areas Handbook and Checklist (Commerce 2023 and Commerce 2022) as the primary guidance to scope the 2024 BAS review for each critical area. The review included comprehensive planning considerations, including nonscientific information, for each critical area and recognized the importance of both regulatory and nonregulatory measures in effectively managing and preserving critical areas functions and values. The scope of King County's 2024 BAS review is summarized below for each critical area.

2.3.1 Wetlands

King County reviewed Commerce guidance documents, Ecology BAS updates, King County's 2004 BAS, supplemental literature, and County critical areas monitoring data. This review found that regulatory updates are necessary to improve environmental protections and comply with GMA mandates, including requirements that cities and counties plan for climate resilience and ensure no net loss of critical areas functions and values.

2.3.2 Riparian Areas

King County reviewed Commerce guidance documents, WDFW BAS, King County's 2004 BAS, supplemental literature, and County critical areas monitoring data. This review found regulatory updates are necessary to improve environmental protections and comply with GMA mandates, including the requirements that cities and counties plan for climate resilience, ensure no net loss of critical areas functions and values, and demonstrate special consideration for the protection of anadromous fisheries.

2.3.3 Wildlife Habitat

King County reviewed Commerce guidance documents, King County's 2004 BAS, and supplemental literature. This review found regulatory and nonregulatory updates are necessary to improve protections for wildlife and wildlife habitat and to comply with state requirements that cities and counties plan for climate resilience.

2.3.4 Critical Aquifer Recharge Areas (CARA)

King County reviewed Commerce guidance documents, King County's 2004 BAS, and supplemental literature. This review found regulatory updates are necessary to clarify County CARA protections.

2.3.5 Geologically Hazardous Areas (GHAs)

King County reviewed Commerce guidance documents and the scope of King County's 2004 BAS literature. This process identified BAS review was necessary for the management of alluvial fans, a type of Geologically Hazardous Area (GHA). King County reviewed relevant BAS and found that regulatory updates are necessary to establish development standards for alluvial fans. These regulatory updates reduce

risks to public health and safety and improve environmental protections while complying with state requirements that cities and counties manage critical areas to protect public health and safety and plan for climate resilience.

2.3.6 Frequently Flooded Areas

King County reviewed Commerce guidance documents, King County's 2004 BAS, the Federal Emergency Management Agency (FEMA) Biological Opinion (BiOp) model ordinance, supplemental literature, and available critical areas monitoring data related to frequently flooded areas including wetlands, aquatic areas, riparian areas, and alluvial fans. King County's 2024 BAS review and regulatory updates for these critical areas are discussed in relevant sections of this report.

King County updated the King County Code (K.C.C.) in 2020 to comply with regulatory guidance and standards from FEMA and Ecology. King County participates in the FEMA National Flood Insurance Program (NFIP) and is subject to compliance with the FEMA BiOp for the Puget Sound.

In addition to regulatory updates discussed in this report, King County is proposing revisions to its CAO to streamline regulatory review for habitat restoration and fish passage projects. These revisions are intended to better support vital salmon recovery projects and to advance the County's goals related to reconnecting functioning floodplain and removing barriers to fish passage while maintaining compliance with the BiOp provisions, FEMA NFIP standards, Ecology standards, and local regulatory standards.

In addition to preserving salmon habitat, the BiOp also addresses the need to avoid, rectify, or compensate for floodplain storage loss. Current K.C.C. requires cut and fill balance documentation for projects in the floodplain in order to prevent floodplain storage loss. Salmon recovery projects often involve floodplain reconnection and restoration, which can increase floodplain storage and resilience by removing flood facilities that prevent surface water connection to the floodplain, creating complexity that allows river water to enter the ground and mix with groundwater or re-emerge as cool springs downstream, and removing impervious surfaces.

According to Appendix 4 to the BiOp, the minimum criteria for maintaining natural streams and floodplains restricts development in the floodplain but explicitly allows "restoration or enhancement of floodplains, riparian areas, and streams that meets Federal and State standards." Consistent with the intent of the BiOp, the CAO revisions streamline these requirements for salmon recovery projects to allow for grading and installation of floodplain complexity that provides rearing habitat and fish refugia during flood events.

This BAS Report describes King County's regulatory and nonregulatory programs that ensure no net loss of critical areas functions and values at both the parcel and watershed scale. By modifying King County floodplain standards for salmon recovery

projects to streamline regulatory review—while adhering to FEMA minimum standards—King County strives to better protect salmon and orca populations and critical habitats consistent with the BiOp. Current floodplain development standards would still be applied to nonrestoration projects such as buildings and new impervious surfaces.

2.3.7 Critical Areas Summary Graphic

King County's 2024 BAS review evaluated BAS and local protection of critical areas, including wetlands, riparian areas, wildlife habitat, CARAs, and GHAs. This document discusses these critical areas in separate sections, but BAS review considered that these areas are ecologically integrated elements of the local landscape. Figure 2.1 displays and introduces the essential functions and values of each critical area discussed in this report.

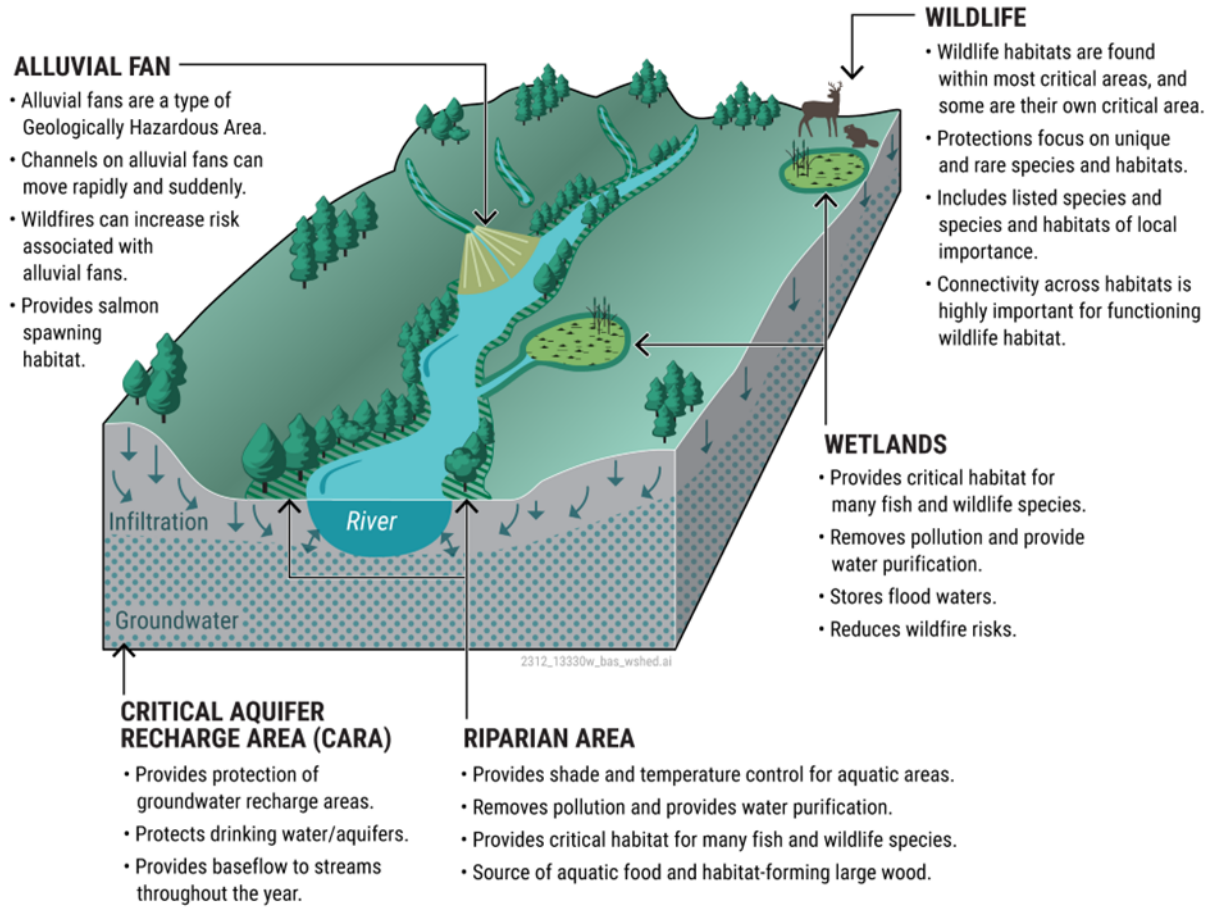


Figure 2.1 Critical areas and essential ecological functions and values.

2.4 References

Bunten, D., R. Mraz, L. Driscoll, A. Yahnke. 2016. *Wetland Guidance for CAO Updates: Western Washington Version (2016)*. Washington State Department of Ecology Publication #16-06-001. https://apps.ecology.wa.gov/publications/summarypages/1606001.html

Granger, T., T. Hruby, A. McMillan, D. Peters, J. Rubey, D. Sheldon, S. Stanley, E. Stockdale. 2005. *Wetlands in Washington State – Volume 2: Guidance for Protecting and Managing Wetlands*. Washington State Department of Ecology Publication #05-06-008. https://apps.ecology.wa.gov/publications/summarypages/0506008.html

Hruby, T. 2013. *Update on Wetland Buffers: The State of the Science, Final Report, October 2013*. Washington State Department of Ecology Publication #13-06-11. https://apps.ecology.wa.gov/publications/SummaryPages/1306011.html

King County. 2004. *Volume I: A Review of Scientific Literature*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v1.pdf

King County. 2004. *Volume II: Assessment of Proposed Ordinances*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v2.pdf

Quinn, T., G. F. Wilhere, and K. L. Krueger, technical editors. 2020. *Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications*. Habitat Program, Washington Department of Fish and Wildlife. https://wdfw.wa.gov/publications/01987

Rentz, R., A. Windrope, K. Folkerts, and J. Azerrad. 2020. *Riparian Ecosystems, Volume 2: Management Recommendations*. Habitat Program, Washington Department of Fish and Wildlife. https://wdfw.wa.gov/publications/01988

Sheldon, D., T. Hruby, P. Johnson, K. Harper, A. McMillan, T. Granger, S. Stanley, and E. Stockdale. 2005. *Wetlands in Washington State – Volume 1: A Synthesis of the Science*. Washington State Department of Ecology Publication #05-06-006. https://apps.ecology.wa.gov/publications/summarypages/0506006.html

Washington State Department of Commerce (Commerce). 2022. Critical Areas Checklist – A Technical Assistance Tool from Growth Management Services. https://deptofcommerce.box.com/s/5su5ugh9h5cmkv9oj1m3trjfql5r68c6

Washington State Department of Commerce (Commerce). 2023. *Critical Areas Handbook – A Handbook for Reviewing Critical Areas Regulations (Version 3)*. https://deptofcommerce.box.com/s/rlysjrfvrxpxwnm9jvbcd3lc7ji19ntp

Washington State Department of Ecology (Ecology). 2022. *Wetland Guidance for Critical Area Ordinance (CAO) Updates: Western and Eastern Washington*. Washington State Department of Ecology Publication #22-06-014. https://apps.ecology.wa.gov/publications/SummaryPages/2206014.html

Washington State Department of Ecology, U.S. Army Corps of Engineers (Seattle District), U.S. Environmental Protection Agency (Region 10). 2021. *Wetland Mitigation in Washington State: Part 1 – Agency Policies and Guidance (Version 2)*. Washington State Department of Ecology Publication #21-06-003. https://apps.ecology.wa.gov/publications/SummaryPages/2106003.html

3 King County's Approach to Protecting Critical Areas

King County has successfully implemented requirements of the Growth Management Act (GMA) since 1994. After King County enacted development regulations to protect critical areas in 2004, the State of Washington introduced a heightened regulatory requirement in 2010 requiring jurisdictions to ensure no net loss of critical areas functions and values (see Section 1.2). In order to satisfy the no net loss requirement and achieve other GMA and Comprehensive Plan goals, King County is strengthening critical areas protections through the Comprehensive Plan policy updates, regulatory updates, land use designation and zoning requirements, and continued implementation of existing regulatory requirements of the King County Code (K.C.C.), including stormwater management and clearing and grading requirements, and a broad array of nonregulatory programs. Many of these nonregulatory programs have been active for decades and have protected the functions and values of critical areas and the broader King County landscape. Updates to critical areas protections are also informed by the GMA requirement that jurisdictions plan for effects of a changing climate (see Section 1.1). This section introduces King County's critical areas regulations and discusses the County's approach to managing risks to the functions and values of critical areas. King County's nonregulatory programs that protect critical areas functions and values and frame a coordinated approach to protection of ecosystems are discussed as well, including examples of the County's history of success in achieving landscape-scale environmental protection.

3.1 Regulatory Measures

King County protects critical areas functions and values through regulatory measures, including Comprehensive Plan policies and development regulations in the K.C.C. King County Comprehensive Plan policies and development regulations guide and regulate development and land use in unincorporated King County (UKC). Development and land use activities taking place in UKC are also subject to applicable state and federal laws, such as the State Environmental Policy Act (SEPA), State Forest Practices Act, State Hydraulic Project Approval, federal Clean Water Act, and federal Endangered Species Act (ESA).

While the King County Comprehensive Plan and development regulations provide significant protections to critical areas at both the ecosystem and parcel scales, the 2024 best available science (BAS) review indicates the need to update some policies and development regulations to strengthen protection of critical areas functions and values. King County's ability to protect the functions and values of critical areas through regulatory measures at the individual parcel scale is limited in some circumstances where governments are required to allow reasonable use of private property.

3.1.1 King County Comprehensive Plan Policies

Comprehensive Plan policies outline King County's approach to achieving GMA goals. Policies related to critical areas management and protection are primarily found in Chapter 5 (Environment) of the 2024 Comprehensive Plan.

Updates to King County's 2024 Comprehensive Plan policies include BAS and are informed by GMA goals. In some cases, policy updates depart from BAS to accommodate GMA goals that intersect with the protection and management of critical areas. Relevant GMA goals and King County comprehensive planning considerations that inform departures from BAS are described in the individual sections for each Critical Area.

Updates to critical areas policies are summarized where applicable in Sections 4 through 8 of this report. To review detailed 2024 changes to policy language, please see the 2024 Comprehensive Plan legislation.

3.1.2 King County Code

King County's Department of Local Services uses the K.C.C. to regulate development and land use activities in UKC. Development regulations that offer protections to critical areas are primarily found in K.C.C. Chapter 21A.24. Standards in portions of the K.C.C., such as Title 9 (Surface Water Management), Chapter 16.82 (Clearing and Grading), and Title 19A (Land Segregation), also provide land use controls and development standards that protect critical areas. For example, surface water management, also known as stormwater management, includes requirements for controlling the volume and rate of stormwater runoff as well as treating pollution that is carried in runoff from impervious surfaces like rooftops and paved areas. Stormwater management requirements for new development play an important role at the watershed and site-specific scales in protecting the functions and values of critical areas like wetlands and riparian areas as well as protecting public health and safety by preventing flooding, erosion, sedimentation, landslides, and exposure of salmon and other wildlife to pollutants.

Updates to development regulations in the K.C.C. include BAS and are informed by GMA and Comprehensive Plan goals. In some cases, updates to development regulations include BAS departures to accommodate GMA and Comprehensive Plan goals that intersect with the protection and management of critical areas. Relevant GMA goals and King County comprehensive planning considerations are discussed where updates depart from BAS.

BAS-informed updates to development regulations are described in Sections 4 through 8 of this report. To review the most current adopted county codes, please see K.C.C. Title 21A. For the 2024 proposed updates codes, please see the 2024 Comprehensive Plan legislation.

3.1.3 Reasonable Use and Critical Areas Alteration Exceptions

To allow for reasonable use of private property, the K.C.C. allows permit applicants to request Reasonable Use Exceptions (RUE) when all reasonable uses of a site, as allowed by adopted zoning, are denied as a result of a critical area. King County's legal authority and the definition of reasonable use are included in K.C.C. Title 21A.

In addition to the RUE process, the K.C.C. allows permit applicants to request Critical Areas Alteration Exceptions (CAAE). A CAAE allows adjustments to the application of zoning code standards to critical area buffers on a particular property. County CAAE decisions are subject to appeal. King County's legal authority and code language related to alteration exceptions are included in K.C.C. Title 21A.

3.2 Risk Management and Critical Areas Protections

As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C, it must balance critical areas protections (see Section 1.2.1) with the need to address other GMA goals (see Section 1.1). There is no approach to regulating critical areas that completely eliminates risk of harm to critical areas, as any change in land use or development at the parcel scale inherently has some level of impact on complex natural ecological processes that occur at both a site and landscape scale. King County generally aims to take low- and moderate-risk approaches to regulate and protect critical areas. In limited circumstances, King County may take a higher-risk approach to regulating critical area functions to account for comprehensive planning considerations and meet competing GMA goals. King County seeks to limit the use of higher-risk regulatory approaches. Where higher-risk regulatory approaches are used, King County employs a broad array of nonregulatory measures to protect critical areas and reduce risk to critical areas functions and values. King County documents the rationale for regulatory updates in detail in later sections of this report.

3.2.1 Risk Assessment of Regulatory Updates

The GMA directs King County to assess development regulations and identify potential risks to the functions and values of critical areas (see Section 1.2.2). King County's 2004 BAS review included a qualitative assessment of potential risks to critical areas functions and values by comparing proposed development regulations with BAS. Regulations departing or nearly departing from BAS were identified according to best professional judgement. Regulatory approaches to critical areas management were then classified as being low, moderate, or high risk of degrading critical areas.

King County's 2024 BAS review follows a similar approach to the 2004 risk assessment. Regulatory updates discussed in this report are qualitatively classified as being low, moderate, or high risk when compared with BAS review findings. In this document, low- and moderate-risk approaches are those that generally align with regulatory strategies and values (e.g., the width of a given wetland buffer) discussed in BAS and, as applicable, in state agency guidance documents. Low-risk approaches are more

precautionary relative to moderate-risk approaches. This means that activities regulated by low- and moderate-risk approaches are expected to have low- or moderate-risk of impacting critical areas functions and values, respectively. Regulatory approaches that depart from BAS recommendations are considered to have higher risk of negative impacts to critical areas. Activities regulated using high-risk approaches are expected to have a high-risk of impacting critical areas functions and values. The complexity of risk assessment included in each critical area section is informed by the scale of change to regulatory standards.

3.3 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County collaborates with communities and other partners to guide investment in and implementation of nonregulatory programs that protect natural resources, including critical areas. Nonregulatory measures that offer protections to critical areas are discussed at a summary level below. Paired with King County's Comprehensive Plan policies and development regulations, these nonregulatory measures help King County satisfy the GMA's requirement that cities and counties ensure no net loss of critical areas functions and values at both the parcel scale and watershed scale.

3.3.1 Natural Resource Management Planning and Initiatives

King County develops and implements plans and initiatives to ensure the effective and equitable management of natural resources across the county landscape, including critical areas. King County initiatives and plans related to natural resource management include the Clean Water Healthy Habitat (CWHH) Strategic Plan, the Land Conservation Initiative (LCI), the 30-Year Forest Plan, the Strategic Climate Action Plan (SCAP), and the Equity and Social Justice (ESJ) Strategic Plan. Readers can learn more about these plans and initiatives by visiting linked webpages and reviewing relevant reports and strategic plans. Additional information about these plans and the management of specific critical areas is discussed where applicable in later sections of this report.

The plans and initiatives listed bolster ongoing protection, restoration, and resiliency of ecosystems across the county at a landscape and watershed scale. Collectively, these plans and initiatives supplement development regulations, including critical areas regulations, that are applied to new development at the site-development scale. They are supported by policies in the adopted 2016 Comprehensive Plan. Additionally, the 2024 Comprehensive Plan includes policy updates that reinforce the foundation for ongoing protection and restoration of critical areas functions and values as well as ecosystem-scale protection and restoration.

While not an exhaustive review of the plans and initiatives listed above, following are some key examples to illustrate how these efforts result in outcomes that strengthen the protection, restoration, and resiliency of critical areas.

The CWHH Strategic Plan aims to align the County's work around six enterprise-wide goals and 13 strategies to deliver faster, better results for people and the environment. The six goals include:

1. Healthy Forests and More Green Space
2. Cleaner, Controlled Stormwater Runoff
3. Reduced Toxics and Fecal Pathogens
4. Functional River Floodplains
5. Better Fish Habitat
6. Resilient Marine Shorelines

The CWHH Strategic Plan articulates outcomes and measures for each of these goals as well as strategies for improving environmental and community outcomes at an ecosystem scale. For example, the Better Fish Habitat goal includes measures for restoration of fish passage and the Functional River Floodplains goal includes a focus on reconnecting functioning floodplains. The CWHH Strategic Plan identifies specific strategies and helps guide investments in protection and restoration to meet these goals in the face of new and emerging threats from climate change, population growth, and chemicals of emerging concern.

The Land Conservation Initiative (LCI) establishes strategies for conserving 65,000 acres of high conservation value land in the next 30 years in six categories: urban green space, trails, natural lands, rivers, farmlands, and forests. This effort builds on previous protections of 190,000 acres since 1970. This initiative guides landscape-scale conservation strategies, including:

- "Fee title" acquisitions through which King County acquires all property rights and owns and manages the land.
- Conservation easement acquisitions through which the county acquires select property rights to protect conservation values in perpetuity.
- Working with landowners to enroll in voluntary incentive programs that result in conservation.

Land conservation, with priorities set at an ecosystem and watershed scale, strengthens protection of critical areas functions and values and works in tandem with development regulations that are focused on addressing new development at a parcel scale. For example, wetland and riparian area functions and values for wildlife exist at scales that may vastly exceed the size of an individual parcel. Conservation of forested headwaters and river corridors helps to create protected corridors for wildlife to reach vital habitats, which may vary among seasons or over a species life cycle. The overarching goal is to create a resilient, connected, and dynamic mosaic of protected habitats benefiting the environment, wildlife, and people of the region.

Other planning efforts, such as SCAP and 30-year Forest Plan, provide frameworks for achieving various environmental outcomes and building resilience in the face of climate change. These efforts aim to mitigate ongoing impacts from climate change and to adapt to changing conditions.

In summary, King County's suite of nonregulatory plans and initiatives complement regulatory measures to create a livable region for people while retaining, restoring, and enhancing functions and values derived from healthy, intact ecosystems.

3.3.2 Natural Resource Management Programs and Projects

In addition to plans and initiatives, King County invests in innovative and effective programs and implements specific projects to protect, enhance, and restore the natural environment. These programs and projects implement actions recommended by the overarching plans and initiatives mentioned above to safeguard and restore critical areas as well as to protect, restore, and enhance natural systems at a watershed scale. These ongoing programs and specific projects constitute a proactive approach to improving the functions and values of healthy ecosystems, complementing development requirements that address the impacts of new development at the site or parcel scale.

For the purpose of illustration, a subset of King County's programs and projects that protect, restore, and enhance critical areas and broader ecosystem functions and values are listed below.:

- The Transfer of Development Rights (TDR) program creates permanent land conservation and allows the transfer of development potential from protected rural areas to urban areas where infrastructure can better support new development.
    - Outcome: More than 146,000 acres have been conserved through TDR.
- The Basin Steward Program strategically plans acquisition and restoration projects in ecologically important areas of the county. Working closely with partners in the Watershed Resource Inventory Area (WRIA) Forums, and informed by WRIA Salmon Recovery Plans, the program identifies, funds, and implements Habitat Restoration Projects for each major watershed.
    - Outcome: Over the past 20 years, King County and WRIA partners have constructed hundreds of habitat projects in strategic locations spanning all of King County's watersheds as well as Vashon and Maury Islands, ranging from small planting projects to major floodplain restoration projects. Since 2020, the County has completed four major multi-benefit flood risk reduction projects that reconnect more than 250 acres of floodplain.
- King County's 3 Million Trees project has been preparing for a climate-resilient future.
    - Outcome: Since 2021, the project has contributed to planting of the equivalent of more than 1.5 million trees.
- The Small Habitat Restoration Program (SHRP) enhances streams and wetlands through implementation of small projects.
    - Outcome: Since 1995, SHRP has implemented more than 675 projects, planted more than 265,000 trees, and restored more than 15 miles of riparian habitat on public and private land.

- The Fish Passage Restoration Program (FPRP) has completed a comprehensive inventory of more than 3,000 sites along County-owned roads and trails and on County property that are potential barriers to upstream habitat. Prioritization analysis determined that completing 50 restoration projects would restore access to at least half of the habitat that is currently blocked by County structures, impeding salmon from swimming upstream.
    - Outcome: Since 2018, County fish passage restoration projects have reopened access to 26.7 miles of stream habitat. FPRP is using information from the inventory to inform prioritization of County fish passage project investments and grant applications with the goal of restoring access to half of the habitat in the next 10 years.

Readers can learn more about nonregulatory programs by visiting linked webpages and reviewing relevant reports. Additional information about nonregulatory programs related to the management of each critical area is discussed in later sections of this report.

3.3.3 Implementing Development Regulations

Regulations can only be effective when they are used consistently and correctly. Thus, in addition to plans, initiatives, and programs, King County is also updating maps and improving communications materials to ensure development regulations in the K.C.C. are implemented correctly and consistently.

Updated Stream and Wetland Mapping

King County is updating its stream and wetland maps to better inform residents, landowners, permit applicants, and permitting staff of the location and types of streams and wetlands present in King County. King County permitting staff currently use stream and wetland mapping resources first produced in the 1980s and 1990s to inform critical areas permitting processes. To improve implementation of policy and the K.C.C., King County will update its stream and wetland maps by the end of 2024. These resources are being created using the latest data, technologies, and methods to produce vastly more accurate maps. More accurate maps benefit community members by instilling greater confidence about the type(s) of critical areas that occur on a given parcel, leading to fewer surprises when people seek to develop or alter land use. Better maps should also help King County efficiently process permit applications, which could benefit both applicants and permitting staff. These maps are advisory, meaning the extent of critical areas and their buffers are subject to field verification.

Permitting Bulletins

King County is producing permitting bulletins to inform permit applicants of regulatory changes. These advisory bulletins offer summary guidance to applicants as they navigate new permitting requirements. King County is producing these documents for wetlands, riparian areas, wildlife habitat, and alluvial fans as the County adopts updates to the Comprehensive Plan and the K.C.C.

Code Enforcement Updates

King County is responsible for enforcing codes. The King County Auditor's Office recently completed an audit of the code enforcement process. The audit report makes recommendations focused on prioritization, streamlining enforcement processes, data and management, communication with property owners, and collaboration across agencies to improve efficiency and effectiveness of King County's code enforcement. The King County Permitting Division is beginning to update policies and practices for code enforcement. The scope of this work includes analyzing potential adjustments to civil penalties to ensure adequate funding for code enforcement operations and updating policies and practices to prioritize and allocate resources to achieve the best environmental outcomes.

Farm Management Plans and Forest Stewardship Plans

Farm Management Plans and Forest Stewardship Plans are property-specific plans composed of best management practices (BMPs) that, when implemented, can help protect critical areas while supporting continued agriculture or forestry operations, respectively. These plans are not required but may offer landowners some regulatory flexibility in how they manage their properties and may also help landowners understand and adhere to applicable regulatory requirements of the K.C.C.

4 Wetlands

Commonly called marshes, swamps, or bogs, wetlands are those areas that are saturated or inundated by surface or ground water with a frequency sufficient to support plants that depend on saturated or seasonally saturated soil conditions for growth and reproduction. Healthy wetlands help protect communities, infrastructure, and ecosystems from storms and flooding by attenuating stormwater and trapping sediment (Rasmussen et al. 2018). Population growth has led to increased application of fertilizer (Cheng et al. 2020) and other chemicals (Zhu et al. 2022), resulting in more nutrients and pollutants that can runoff into the watershed. Wetlands can help filter out those contaminants (Hruby 2013) and thereby reduce their impacts on human and environmental health. Wetlands also provide critical habitat for animals, including migratory birds, amphibians, and commercially and culturally important salmon (Graff and Middleton 2001), and provide opportunities for recreation like hiking and bird watching. The benefits of these wetland ecosystem functions and values generally increase as total wetland cover increases in a watershed.

The Growth Management Act (GMA) requires Counties to designate and protect the functions and values of critical areas, including wetlands, using best available science (BAS) (see Sections 1.2.1 and 1.2.2). The GMA defines wetlands in RCW 36.70A.030. Washington's wetlands vary widely in their functions and values. Some types of wetlands are common while others are rare. The Washington State Department of Ecology (Ecology) produces resources and tools for jurisdictions to effectively protect wetland functions and values while managing community growth and development. These resources include BAS reports and guidance documents (see Section 2.2.1) as well as the Washington State Wetland Rating System for Western Washington (Hruby 2014).

Land use development can negatively affect wetlands through both direct and indirect impacts (Ecology et al. 2021). Direct impacts, such as wetland loss or degradation, result from activities that occur within wetlands, such as dredging, filling, and draining. Indirect impacts include impacts to wetlands and wetland buffers caused by inputs of stormwater and pollutants generated by land development or other activities within the contributing drainage area to the wetland. Agricultural activities can also harm wetlands by disturbing the physical structure of wetlands directly through conversion of wetlands to fields or pasture, often leading to the elimination of wetlands themselves. Conversion to land development and agriculture (Chappell 2001) is the primary cause of wetland loss in western Washington.

Wetland functions and values face additional threats related to climate change. Wetlands are at the leading edge of climate change because they are water resources and therefore sensitive to the hydrological changes that will occur as a result of climate change (Glick 2011). Potential climate change impacts to wetlands include changes to the timing, volumes, and frequency of flooding and inundation (hydroperiod). These hydroperiod changes are expected to lead to changes and losses to wetlands and the functions and values they provide (Fay 2016), particularly the types of habitats they

provide, and their ability to manage water quality and flooding (Ecology 2023). Climate changes will also make wetlands more sensitive to both direct and indirect impacts from human land use activities (Salimi et al. 2021). The combination of wetland disturbance from human activities and changes in climate will have greater impacts on wetland functions than either stressor would alone.

Climate projections indicate an increase in flooding in many Pacific Northwest watersheds over the course of the 21st century, a result of both decreasing snowpack and more intense heavy rain events (Salathé Jr. et al. 2014). For example, by the 2080s, the amount of flow associated with a 10-year peak flow is projected to increase by 72 percent for the Snoqualmie River near Snoqualmie, by 72 percent for the South Fork Skykomish River near Index, and by 58 percent for the Green River near Auburn (Lee 2018). Flows associated with the 100-year flood event are projected to increase by 18 to 55 percent for large rivers. Stream temperatures in the Puget Sound region are projected to increase +4.0°F to +4.5°F by the 2080s in response to increasing air temperature and declining summer streamflow (Morgan 2016). Heavy rainfall events, typically caused by "atmospheric rivers," are expected to become more intense with 24-hour rain events intensifying by an average of 22 percent (Morgan 2016).

The predicted increases in precipitation and elevated summer temperatures will create a cascade of ecosystem impacts that will directly affect wetlands by modifying their hydroperiods and biological communities. Upland plant communities that buffer wetlands will also be affected. Ecology (Ecology 2023) identified potential impacts of climate change to wetlands, including:

- Loss of carbon stores in the soil.
- Changes in soil structure.
- More frequent drying or flooding.
- Changes in plant or animal communities.
- Saltwater intrusion into freshwater coastal wetlands.
- Changes in the timing and amount of water available to wetlands fed by snowmelt.

This section discusses BAS, comprehensive planning considerations, development regulations, and King County programs related to the protection of wetlands and wetland functions and values. King County's 2024 BAS review for wetlands was informed by Washington State guidance (see Section 2.1) and included review of King County's 2004 BAS report, BAS documents produced by the Washington State Department of Ecology (see Section 2.2.2), and other published resources and peer-reviewed literature.

4.1 Wetland Buffers

Wetland buffers are defined in the King County Code (K.C.C.) 21A.06.122 as a designated area contiguous to and intended to protect and be an integral part of a wetland. Wetland buffers protect wetland functions and values from adjacent

development and land use. Wetland buffers offer protection from both direct and indirect impacts, including reducing sedimentation, reducing pollutant and nutrient input, reducing direct human and animal disturbance, reducing noise and glare, and providing visual separation. In addition to protecting wetland functions and values, buffers provide wetland-associated species with essential habitat needed for feeding, roosting, breeding, and rearing of young, and cover for safety, mobility, and thermal protection.

The width of a buffer is based on the minimum distance necessary to protect the most sensitive functions provided by the wetland. Development regulations in the K.C.C. designate wetland buffer widths, or level of protection for wetland functions, based on wetland category and the intensity of the impact of adjacent land use, designated as high, moderate, or low impact. Wetland buffer widths and the definition of high-, moderate-, and low-impact land uses are defined in K.C.C. 21A.24.325. Previous wetland buffer widths are also shown in Table 4.1 below.

Table 4.1 Previous wetland buffer widths.

Wetland Category and Characteristics	Intensity of Impact of Adjacent Land Use		
	High Impact	**Moderate Impact**	**Low Impact**
Category I			
Wetlands of High Conservation Value	250 feet	190 feet	125 feet
Bog	250 feet	190 feet	125 feet
Estuarine	200 feet	150 feet	100 feet
Coastal Lagoon	200 feet	150 feet	100 feet
Forested	Buffer width to be based on score for habitat functions or water quality functions		
Habitat score 8 to 9 points (high level of function)	300 feet	225 feet	150 feet
Habitat score 6 to 7 (moderate level of function)	150 feet	110 feet	75 feet
Category I wetlands not meeting any of the criteria above	100 feet	75 feet	50 feet
Category II			
Estuarine	150 feet	110 feet	75 feet
Habitat score 8 to 9 points (high level of function)	300 feet	225 feet	150 feet
Habitat score 6 to 7 (moderate level of function)	150 feet	110 feet	75 feet

Wetland Category and Characteristics	Intensity of Impact of Adjacent Land Use		
	High Impact	Moderate Impact	Low Impact
Category II wetlands not meeting any of the criteria above	100 feet	75 feet	50 feet
Category III			
Habitat score 8 to 9 points (high level of function)	300 feet	225 feet	150 feet
Habitat score 6 to 7 (moderate level of function)	150 feet	110 feet	75 feet
Category III wetlands not meeting any of the criteria above	80 feet	60 feet	40 feet
Category IV	50 feet	40 feet	25 feet

The K.C.C. provides regulatory allowances to accommodate new development, including allowed alterations (K.C.C. 21A.24.045), buffer averaging (K.C.C. 21A.24.325.B.), and buffer reduction (K.C.C. 21A.24.325.C.6.). Allowed alterations and buffer averaging require that avoidance criteria (K.C.C. 21A.24.125), mitigation requirements (K.C.C. 21A.24.130), and other applicable requirements in the K.C.C. are met. Buffer reductions alter the required buffer width from high impact to moderate impact land use intensity (a 25 percent reduction) for residential parcels located within the Urban Growth Area (UGA) provided all impact minimization measures in K.C.C. 21A.24.325.C.6 are implemented. This reduction allows for the creation of additional lots and residential housing within the UGA.

In addition to the regulatory allowances discussed above, King County offers regulatory allowances to applicants seeking permits for select commercial agricultural activities. This includes regulatory allowances for livestock activities detailed in the Livestock Management Ordinance (LMO) (K.C.C. Chapter 21A.30). The regulatory allowances offered by the LMO are dependent on whether the applicant obtains a farm plan (Table 4.2).

Table 4.2 Previous Livestock Management Ordinance grazing area buffer widths.

Wetland Category	Grazing area buffer width (feet) with a Farm Plan (K.C.C. 21A.30.045)	Grazing area buffer width (feet) without a Farm Plan (K.C.C. 21A.30.060)
Category I, II, or III (excluding grazed wet meadows)	0 – 25	50
Category IV (excluding grazed wet meadows)	0	0

4.1.1 2024 BAS Review

King County's 2024 BAS review for wetland buffer widths was informed by Washington State guidance (see Section 2.1) and included review of King County's 2004 BAS report (see Section 2.0), BAS documents produced by Ecology (see Section 2.2.2), and other published resources and peer-reviewed literature. Ecology states that, "the scientific literature is clear that buffers are necessary to protect wetland functions and values" and identifies buffers as one of the most important tools available to protecting wetlands at the site level in Washington (Ecology 2022).

The following sections discuss wetland functions and values, which are grouped into three main categories—habitat, improving water quality, and hydrologic functions—and also discuss state guidance for protection of wetland buffers.

Habitat Functions

Wetlands are well-recognized as biodiversity hotspots with up to 40 percent of the world's species living in or breeding in wetlands (Convention on Wetlands 2021). Their role as transitional areas between aquatic and terrestrial ecosystems, together with the structural habitat diversity they provide and their high nutrient inputs and primary productivity, contribute to supporting biodiversity (Convention on Wetlands 2021; Barbier et al. 2011). Wetlands are significantly correlated with species richness within taxonomic groups, including amphibians, birds, mammals, reptiles, and endemic terrestrial species (Dertien et al. 2020). Estuarine wetlands and tidal marshes are important nurseries for a wide range of species (Barbier et al. 2011), including fish and birds.

Conserving wetland habitats, habitat patches, and vegetated corridor networks in urban areas and throughout the watershed is critical for certain species and provides migration and refuge from drought and increasing temperatures due to climate change (Hruby 2013). BAS recommends buffer widths ranging from 100 feet to 1,000 feet to protect habitat function for wildlife and for protecting existing vegetated corridors (Environmental Law Institute 2008). Research indicates that a broader approach to protecting wildlife such as mammals, birds, and amphibians is needed, as larger buffers alone may not prevent the populations of these animals from declining.

Wetlands located in urban areas are generally less common and are more impacted by adjacent light and noise pollution, often contain non-native and invasive plant species, and lack intact vegetated corridors or habitat patches connecting adjacent habitat. Urban wetlands can help decrease the "heat island" effect, in which urbanized areas experience higher relative temperatures than surrounding rural areas. Wetlands are more effective at decreasing the heat island effect when they are larger and more aggregated (Ecology et al. 2021). In addition, BAS indicated that degraded emergent wetlands should not be ignored because they can support amphibians that may use lower-quality wetland habitats, including Category IV wetlands that are often dominated by reed canary grass (Ecology et al. 2021).

Water Quality Functions

BAS documents reviewed addressed wetland water quality functions, including removal of sediment, nutrients like phosphorus and nitrogen, metals, toxic compounds, and pathogens (Verhoeven et al. 2006; Duffy 2011; Hruby 2013; Ecology et al. 2021). Ecology's BAS notes that assuming the width, slope, and vegetation of a buffer are sufficient to protect water quality in a wetland may not be a fully effective approach. Soil infiltration, surface roughness (partially caused by vegetation), slope length, and adjacent land use practices are also important environmental factors that play a role in buffer effectiveness (Hruby 2013).

In some cases, if the soils in a buffer are saturated with phosphorus, changes in temperature, pH, and volume of the flows coming through the buffer can lead to the release of the stored phosphorus resulting in pulses of much higher than typical phosphorus concentrations to the wetland (Hruby 2013). Other studies found that buffers may become saturated with sediment over time and become less effective at removing pollutants. A review of the literature on vegetated buffers in agricultural areas concluded that the efficiency of trapping sediments depended on vegetation type, the density and spacing of plants, the size of sediment particles, the slope gradient and length, and flow convergence as well as the buffer width (Hruby 2013).

BAS review found that the following buffer widths are generally effective at pollutant removal (Environmental Law Institute 2008):

- 30 to 100 feet for sediment removal
- 100 to 180 feet for nitrogen removal
- 30 to 100 feet for phosphorus removal

Hydrologic Functions

During floods, buffers and wetlands can slow runoff and absorb excess water. This reduces peak flows and can lessen downstream flooding. Wetlands higher in watersheds, including restored and isolated wetlands, can store precipitation and runoff and slowly release it to minimize downstream flooding. Coastal wetlands have the capacity to attenuate wave energy and dissipate the impacts of flood waters associated with rising seas and storm surges, especially during flood events (Van Coppenolle and Temmerman 2019), preserving significant economic value to human infrastructure (Salgado, 2017). Freshwater and riverine wetlands can decrease the frequency and magnitude of floods by storing water and slowing peak flow events (Kadykalo and Findlay 2016), and even isolated wetlands within leveed systems still have flood protection value (Theiling 2013). Montane wet meadows provide a wide range of water supply regulation benefits, including flood attenuation, groundwater storage, and extended dry season base flows (Ramstead et al. 2012; Hunt et al. 2018).

King County's review of Ecology BAS indicates that buffers around depressional wetlands can protect wetland hydrologic functions by storing water and releasing it more slowly than the surrounding uplands (Hruby 2013). However, the amount of stormwater a wetland can store will be reduced if surface flows coming into the wetland contain sediment and fill the depression. Buffers may also lose their effectiveness to disperse surface flows over time as flows create rills and channels, causing erosion within a wetland buffer.

Wetland Buffer Widths

King County reviewed Ecology BAS and guidance documents that include recommendations for wetland buffer widths based on a moderate-risk approach (Ecology 2022). Ecology states,

> "Adopting narrower buffers represents a higher-risk approach, and [jurisdictions] need to be prepared to justify, using BAS, why such an approach is necessary and to offer alternative means of protecting wetland functions that help reduce the risk. Jurisdictions may choose to adopt a lower-risk approach. Implementation of such an approach should be based on BAS and may necessitate such things as wider buffers with limited exemptions, exceptions, and averaging; and no administrative buffer reductions" (Ecology 2022).

Ecology's 2022 guidance document offers multiple examples of how local jurisdictions may apply wetland buffer widths. These options are presented in Appendix C of Wetland Guidance for Critical Area Ordinance (CAO) Updates: Western and Eastern Washington (Ecology 2022). Options presented by Ecology offer varying levels of complexity and flexibility and are based on the following assumptions:

- Wetlands are categorized using the Washington State Wetland Rating System (Hruby 2014).
- Buffer widths are measured along the horizontal plane.
- Specified buffers remain relatively undisturbed over time.
- Wetland buffers are well-vegetated with native plant species appropriate for the ecoregion or that perform similar functions.
- Unvegetated or sparsely vegetated buffers, or those vegetated with invasive species that do not perform needed functions, are planted with appropriate plant species. If buffers are not planted, they are widened to ensure adequate buffer functions are provided.
- Buffers disturbed by activities like grazing or mowing are rehabilitated with native plant species appropriate for the ecoregion or that perform similar functions.

Ecology indicates that, generally, improving vegetation within the buffer (i.e., restoring the structure, composition, and increasing plant diversity) will be more effective than widening the buffer (Ecology 2022). In addition, Ecology states that buffer widths should not be reduced in exchange for planting.

4.1.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating wetland buffer widths. As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C., it must balance required increases in environmental protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1) and King County Comprehensive Plan priorities (see Section 3.1.1).

Widening wetland buffers heightens environmental protections by increasing the distance maintained between permitted land use activities and wetlands. By increasing this distance, the amount of land available for activities such as housing development is decreased. Increases in wetland buffer widths may also reduce flexibility around the placement of farm infrastructure. The K.C.C. offers regulatory allowances for commercial agriculture and allows existing agricultural activities within wetland buffers to continue, with limitations for grazing set forth under the LMO (see Section 4.1).

Ecology Buffer Width Assumptions

Ecology's recommended buffer widths (see Section 4.1) assume that wetland buffers are densely vegetated with native plant species appropriate for the ecoregion or that perform similar functions. Where buffers are unvegetated or vegetated with invasive species that do not perform needed functions, Ecology guidance recommends that buffers are widened to ensure adequate buffer functions are provided. While BAS indicates that dense, native vegetation will generally be more effective than widening the buffer, this presents an additional cost to permit applicants and creates additional needs for County monitoring and code enforcement.

Ecology Guidance on Buffer Averaging

Ecology guidance for updates to development regulations indicates that buffer averaging may be reasonable if standard buffer widths are adequate and buffer averaging is not combined with other buffer reductions (Ecology 2022). Ecology also states that the width of buffers may be averaged if this will improve the protection of wetland functions or if it is the only way to allow for reasonable use of a parcel (Ecology 2022).

King County's use of buffer averaging creates regulatory flexibility in support of housing development, a GMA goal (see Section 1.1). This approach largely maintains environmental protections for wetland functions and values while supporting housing development in King County.

Buffer Reduction and Housing Development in the Urban Growth Area (UGA)

To support housing development in urban areas, a GMA goal (see Section 1.1), King County may allow a reduction of the required buffer width for high impact land use intensity to the required buffer width for moderate impact land use intensity (a 25 percent reduction) when residential parcels are located within the UGA, provided it meets criteria in K.C.C. 21A.24.325.C.6.

King County's approach to reducing buffer widths for residential parcels in the UGA creates a regulatory allowance in support of housing development. This approach reduces but does not eliminate environmental protections for wetland functions and values while supporting housing development in King County.

Buffer Reduction and Agricultural Regulatory Allowances

Ecology guidance recommends that most agricultural land uses (dairies, nurseries, greenhouses, growing and harvesting crops requiring annual tilling, and raising and maintaining animals, etc.) be classified as having a high-intensity land use impact, and that less intensive agricultural land uses (orchards, hay fields, light or rotational grazing, etc.) be classified as having a moderate-intensity land use impact (Ecology 2018). This classification would require most newly permitted agricultural land uses in Unincorporated King County (UKC) to adhere to high-intensity land use buffers to ensure protection of wetland functions and values.

To support the economic viability of agriculture, a GMA goal (see Section 1.1), King County classifies agricultural land uses as having either a low- or moderate-intensity land use impact. Specifically, commercial agricultural uses carried out in accordance with an approved farm management plan and in accordance with conditions in K.C.C. 21A.24.045.D.53 and K.C.C. 21A.24.045.D.54 are classified as having a low-intensity land use impact, based on the assumption that having a farm plan is likely to reduce environmental impacts. These same agricultural land use activities are classified as having a moderate-intensity land use impact when carried out without an approved farm management plan or when not qualifying as a commercial farm.

King County's approach to classifying levels of land use intensity creates a regulatory allowance for agriculture. This approach reduces but does not eliminate environmental protections for wetland functions and values while supporting the economic viability of King County's local agricultural economy.

4.1.3 Regulatory Updates

Based on 2024 BAS review and King County comprehensive planning considerations, King County is updating the K.C.C. with increased buffer widths for Category I and IV wetlands. King County is not updating buffer widths for Category II and III wetlands. These changes to the K.C.C. help ensure that rare habitats are not lost in King County

and align County regulations with Ecology's moderate-risk approach to protecting wetland functions (see Section 4.1.1 and Section 4.1.4).

Category I wetlands provide rare habitat and wetland functions and values that are generally difficult or impossible to recreate through restoration or mitigation activities. King County is increasing environmental protections for these wetlands to help ensure that their functions and values are not lost in King County (see Section 1.2.1). Increasing protections for estuarine wetlands and coastal lagoons, which are important habitats for salmon and other fish, also helps demonstrate King County's special consideration of anadromous fisheries (see Section 1.2.2). Increasing protections for bogs aligns with King County policy protecting habitats of local importance (see Section 6.1), which include sphagnum-dominated peat bogs.

Category IV wetlands are more common in King County's landscape, especially urban areas where they are subject to increased indirect impacts such as adjacent light and noise pollution, often contain non-native and invasive plant species, and lack intact vegetated corridors or habitat patches connecting adjacent habitat. King County is increasing environmental protections for these wetlands to help ensure that habitat functions and values are adequately protected at the watershed scale (see Section 1.2.1). These increases also address Ecology's recommendation (see Section 4.1) that wetland buffers with limited native vegetation be planted with native species or widened. This change better aligns King County with Ecology guidance for a moderate-risk approach to wetland management without introducing the need for permit applicants to plant and maintain Category IV wetland buffers with native plant species.

Development regulations in the K.C.C. will continue to designate wetland buffer widths, or level of protection for wetland functions, based on wetland category and the intensity of the impact of adjacent land use, designated as high, moderate, or low impact. Updates to wetland buffer widths are shown in Table 4.3 below. For ease of interpretation, updates to values in this table are shown as being struck and replaced in parentheses.

Table 4.3 Updated wetland buffer widths.

Wetland Category and Characteristics	Intensity of Impact of Adjacent Land Use		
	High Impact	**Moderate Impact**	**Low Impact**
Category I			
Wetlands of High Conservation Value	~~250 feet~~ (300 feet)	~~190 feet~~ (225 feet)	~~125 feet~~ (150 feet)
Bog	~~250 feet~~ (300 feet)	~~190 feet~~ (225 feet)	~~125 feet~~ (150 feet)
Estuarine	~~200 feet~~ (300 feet)	~~150 feet~~ (225 feet)	~~100 feet~~ (150 feet)

Wetland Category and Characteristics	Intensity of Impact of Adjacent Land Use		
	High Impact	**Moderate Impact**	**Low Impact**
Coastal Lagoon	~~200 feet~~ (300 feet)	~~150 feet~~ (225 feet)	~~100 feet~~ (150 feet)
Forested	Buffer width to be based on score for habitat functions or water quality functions		
Habitat score 8 to 9 points (high level of function)	300 feet	225 feet	150 feet
Habitat score 6 to 7 (moderate level of function)	150 feet	110 feet	75 feet
Category I wetlands not meeting any of the criteria above	100 feet	75 feet	50 feet
Category II			
Estuarine	150 feet	110 feet	75 feet
Habitat score 8 to 9 points (high level of function)	300 feet	225 feet	150 feet
Habitat score 6 to 7 (moderate level of function)	150 feet	110 feet	75 feet
Category II wetlands not meeting any of the criteria above	100 feet	75 feet	50 feet
Category III			
Habitat score 8 to 9 points (high level of function)	300 feet	225 feet	150 feet
Habitat score 6 to 7 (moderate level of function)	150 feet	110 feet	75 feet
Category III wetlands not meeting any of the criteria above	80 feet	60 feet	40 feet
Category IV	~~50 feet~~ (60 feet)	~~40 feet~~ (45 feet)	~~25 feet~~ (35 feet)

King County will continue to include regulatory allowances in development regulations, including allowed alterations (K.C.C. 21A.24.045), buffer averaging (K.C.C. 21A.24.325.B.), and buffer reduction (K.C.C. 21A.24.325.C.6.) to help satisfy GMA goals, such as prioritizing housing development and economic growth in urban areas. To limit impacts to wetland critical areas and satisfy the GMA requirement that counties ensure no net loss of critical areas functions and values, these regulatory allowances are being updated with new conditions. Updated code language can be reviewed in referenced sections of the K.C.C.

King County is maintaining regulatory allowances for agricultural activities. Regulatory allowances are being updated with new conditions to limit impacts to wetland functions and values in addition to updating the LMO to reduce livestock grazing impacts on wetland functions and values (Table 4.4).

Table 4.4 Updated Livestock Management Ordinance grazing area buffer widths.

Wetland Category	Grazing Area Buffer Width (feet) with a Farm Plan (K.C.C. 21A.30.045)		Grazing Area Buffer Width (feet) without a Farm Plan (K.C.C. 21A.30.060)	
	Previous	Updated	Previous	Updated
Category I, II, or III (excluding grazed wet meadows)	0 – 25	40	50	50
Category IV (excluding grazed wet meadows)	0	20	0	25

4.1.4 Risk Assessment of Regulatory Updates

As King County updates its development regulations in the K.C.C, it must balance critical areas protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1). King County's approach to managing risks to critical areas functions and values is discussed in Section 3.2.

Wetland Buffer Widths

King County's 2024 BAS review for wetland buffer widths was informed by Washington State guidance (see Section 2.1), Ecology BAS documents (see Section 2.2.1), and other published resources and peer-reviewed literature. The 2024 BAS review process identified the need to widen buffers for select wetlands (see Section 4.1.3).

Regulatory updates to wetland buffer widths (see Section 4.1.3) generally align King County with Ecology's buffer recommendations, which are based on a moderate-risk approach to protecting critical area functions and values (Ecology 2022). Widening buffers for Category I wetlands reduces the risk of losing rare wildlife habitat and wetland functions and values that are generally difficult or impossible to recreate through restoration or mitigation activities. Widening buffers for more common Category IV wetlands account for Ecology regulatory buffer assumptions (see Section 4.1.2) and help ensure that water quality functions and values are sufficiently protected at the site level and that wildlife habitat functions are better protected at the watershed scale.

Buffer Averaging

King County is maintaining general regulatory flexibility in the form of buffer averaging to support a variety of land uses in UKC (see Section 4.1.2). King County limits ecological risks associated with buffer averaging by requiring permit applicants to satisfy

avoidance criteria (K.C.C. 21A.24.125) and by prohibiting permit applicants from combining buffer averaging with buffer reduction allowances. Permit applicants are additionally required to mitigate indirect impacts to wetlands and to demonstrate that buffer averaging will result in equal or greater wetland buffer functions and values. This approach to providing regulatory flexibility through buffer averaging is well aligned with Ecology's recommended moderate-risk approach to wetland critical areas management (Ecology 2022).

Buffer Reduction

In addition to providing general regulatory flexibility, King County is maintaining regulatory allowances that allow for the reduction of wetland buffers in certain circumstances. These allowances support housing development in the County's unincorporated UGA (see Section 4.1.2) as well as commercial agriculture in UKC (see Section 4.1.2). Providing regulatory allowances in the form of buffer reduction introduces additional risks to wetland functions and values.

Buffer reduction for housing development in the UGA allows for a 25 percent reduction in buffer width, reducing ecological protections in areas where high-intensity land uses are common. King County limits this risk by requiring permit applicants to implement additional protection measures on site to minimize wetland impacts (K.C.C. 21A.24.325.C.6), including an updated K.C.C. requirement to plant an area of dense, native vegetation within the edge of the remaining buffer equal to the area by which the buffer was reduced. By adding this new planting condition and increasing buffer widths for category I and IV wetlands, this buffer reduction allowance is aligned with Ecology's recommended moderate-risk approach to wetland critical areas management (Ecology 2022).

For moderate-intensity agriculture that does not qualify as commercial or does not have an approved farm plan, King County's wetland buffers are in alignment with Ecology guidance. King County departs from Ecology guidance by also applying a moderate-intensity land use classification to agricultural activities that Ecology considers to be high-intensity, and further departs by allowing a low-intensity land use classification for commercial agricultural uses carried out in accordance with an approved farm management plan and in accordance with K.C.C. 21A.24.045.D.53 and K.C.C. 21A.24.045.D.54. This likely presents a high risk to wetland functions and values when applying the low-intensity land use buffer to commercial agricultural because buffers may depart from Ecology guidance by 50 percent. King County employs a broad array of nonregulatory measures to protect critical areas and reduce risk to critical areas functions and values (see Section 3.3 and Section 4.1.5).

King County limits risks associated with the greater regulatory allowance by updating and clarifying requirements for existing farms in K.C.C. 21A.24.045.D.53. Code updates clarify the definition for "continuous existence," stating that a fallow period is not to exceed 7 years. Once a 7-year fallow period is exceeded, and a grazed wet meadow or buffer that was previously grazed or tilled has revegetated, the agricultural activity is no

longer considered to be in continuous existence, and the revegetated wetland and buffer areas must be protected and cannot be cleared or graded. Language in K.C.C. 21A.24.045.D.54 has been updated to clarify that code applies to commercial agriculture and that new or expansion of existing agricultural activities are prohibited where a wetland, wetland buffer, or a riparian area contains a predominantly native forest overstory, shrub, or herbaceous layer. King County is also updating the LMO K.C.C. Chapter 21A.30 to reduce grazing impacts to wetland functions and values to a greater extent than the previous LMO. In wetland buffers that have been previously cleared for agriculture, and therefore grazing is allowed, the LMO requires livestock to be excluded from a portion of the wetland buffer closest to the wetland edge, called the grazing area buffer, except where the wetland is a grazed wet meadow. The LMO updates increase the width of the grazing area buffer required for properties with a farm plan and establish a grazing area buffer for category IV wetlands, although these updates are only required to be implemented where the need for a new farm plan is triggered. It is expected that reduced buffer widths based on lower land use intensity classifications offered to support agricultural land uses present a moderate to high risk to wetland critical areas functions and values in watersheds where agriculture is the predominant land use. King County employs a broad array of nonregulatory measures to protect critical areas and reduce risk to critical areas functions and values (see Section 3.3 and Section 4.1.5).

4.1.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County coordinates with communities and other partners to guide investment in nonregulatory programs that restore and protect natural resources, including critical areas. Nonregulatory programs that offer protections to wetlands are discussed at a summary level below. Readers can learn more by visiting linked webpages.

Critical Areas Monitoring and Adaptive Management

King County is currently protecting critical areas, including wetlands, through a variety of regulatory and nonregulatory actions. One of the nonregulatory activities the County undertakes is environmental monitoring as it is important to verify that programs and regulations are being implemented fully, and as intended. Accordingly, the GMA encourages Counties to undertake monitoring and adaptive management (MAM) programs to evaluate and improve the effectiveness of critical areas polices and regulations. In general, MAM programs answer key questions, compare outcomes to benchmarks, driving changes that lead to continuous improvement and are useful if the County wants to quantitatively show it is meeting the GMA no net loss requirement or achieving net ecological gain.

Collectively, a MAM program helps to fully understand if and how regulations are protecting wetlands, their functions, and how regulatory and nonregulatory actions (net effect) influence watershed conditions. Currently, King County implements several

monitoring programs or projects that help to address these MAM needs. King County conducted an evaluation of critical area protections in 2007 focused on permit compliance, land use change, stream condition, and 'build-out' scenarios (Lucchetti et al. 2014). Components of the evaluation were repeated in 2023 to compare changes in watershed conditions from the prior study (Bower et al. in prep). Both studies can be used as part of a comprehensive MAM program. It would be beneficial to periodically repeat this study to capture changes in watershed conditions related to updated and ongoing regulations.

In addition, King County is updating its wetland inventory and maps. Based on the latest GIS technology, remote sensing, and field surveys, the new maps are significantly more comprehensive and accurate than previous versions. Additionally, King County is developing a critical areas MAM program for wetlands. The new wetland monitoring program, developed with support from the Washington Natural Heritage Program, will use consistent methods, a statistically robust sampling design, and be representative at multiple spatial scales (e.g., site and watershed). Long term wetland monitoring sites will be established for assessing conditions (e.g., classification, extent, functions) and detect meaningful changes related to wetland regulations and mitigation.

King County is positioned to integrate targeted studies with long-term monitoring to expand its critical areas MAM efforts. As part of this integration, King County is planning to start status and trends monitoring to document changes in condition of wetlands. King County's critical area monitoring would be improved by integrating a permit tracking system with the environmental monitoring programs, developed and coordinated between King County's Department of Local Services and Department of Natural Resources and Parks. All of these monitoring programs and studies could help determine the conditions of critical areas, whether regulations are fully implemented and consistently interpreted, permit conditions are met, and actions are being taken to mitigate losses so the County can show it is meeting the no net loss intent of the GMA.

Fencing and Livestock Best Management Practices

King County operates a number of nonregulatory programs to ensure the continued economic vitality of agriculture in the County while reducing impacts to water quality and critical areas. This includes offering cost sharing for implementation of livestock best management practices (BMPs) aimed at reducing critical areas impacts on agricultural properties with an approved farm management plan. These BMPs include installing fencing to exclude livestock from portions of critical areas or their buffers, revegetating critical areas and critical areas buffers, improving stream crossings, and developing manure management systems.

This nonregulatory program improves outcomes for species and critical areas, and advances King County's progress in satisfying GMA goals for maintaining and enhancing natural resource industries, environmental protection, shoreline management, and climate resiliency (see Section 1.1).

Clean Water Healthy Habitat

Over the next 10 years, King County plans to invest more than $9 billion to protect water quality and habitat through implementation of its Clean Water Healthy Habitat (CWHH) Strategic Plan. This investment will benefit King County communities as well as the environment by restoring wetlands and expanding habitat and open space while reducing impacts to water quality.

About half of the $9 billion will be put toward maintenance of existing infrastructure, which helps to treat more than 66 billion gallons of wastewater and stormwater each year. King County is working with tribal governments, regulatory agencies, cities, environmental advocates, and community-based organizations to ensure that the investment of remaining funds creates a resilient system that is prepared for a changing climate and a growing population.

This work is guided by the CWHH Strategic Plan, which aims to align the County's work around 6 enterprise-wide goals and 13 strategies to deliver faster, better results for people and the environment. The 6 goals are as follows:

1. Healthy Forests and More Green Space
2. Cleaner, Controlled Stormwater Runoff
3. Reduced Toxics and Fecal Pathogens
4. Functional River Floodplains
5. Better Fish Habitat
6. Resilient Marine Shorelines

This nonregulatory program will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for environmental protection, shoreline management, climate resiliency, open space and recreation, natural resource industries, public facilities and services, and community coordination (see Section 1.1).

Land Conservation in King County

King County operates nonregulatory open space acquisition programs, such as the Land Conservation Initiative (LCI), using funding from King County's Conservation Futures grant program and other sources. The LCI is a regional collaboration between King County, cities, business associations, agricultural communities, environmental partners, and other groups aimed at preserving the County's last, most important natural lands and urban green spaces over the next 30 years. King County has mapped and prioritized 65,000 acres of land for protection in six categories, including urban green space, trails, natural lands, rivers, farmlands, and forestlands. New protections called for under the Land Conservation Initiative will add to successful conservation efforts that have permanently protected more than 190,000 acres of the King County landscape, including forests, farms, river valleys, wetlands, upland natural areas, and parks for people.

By conserving land across these categories, King County will ensure that lower income communities gain better access to natural lands and parks, limit development threats to forests and farms, and reduce pollution and runoff that puts wetlands at risk.

This nonregulatory program will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for urban growth, reducing sprawl, environmental protection, shoreline management, climate resiliency, open space and recreation, natural resource industries, public facilities and services, and community coordination (see Section 1.1).

Wetland Mapping

King County is updating its wetland mapping to better illustrate the location, extent, and categories of wetlands present in King County. Updates to these advisory maps inform community members and King County permitting staff of which wetland critical areas development regulations may apply to a given property. In turn, these updated maps improve King County's ability to effectively implement and enforce development regulations that protect wetlands while supporting King County's ability to issue development permits in a fair and timely manner. King County mapping resources are available online through King County's interactive mapping tool, King County iMap.

This nonregulatory investment will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for environmental protection, shoreline management, climate resiliency, community coordination, and permitting (see Section 1.1).

4.2 Wetland Compensatory Mitigation

King County defines mitigation in K.C.C. 21A.06.750 as "an action taken to compensate for adverse impacts to the environment resulting from a development activity or alteration." King County's requirements for mitigation and monitoring are detailed in K.C.C. 21A.24.130. Additional development standards are listed in K.C.C. 21A.24.335. Permit applicants seeking to mitigate unavoidable impacts must first demonstrate compliance with K.C.C. 21A.24.125. This means that development proposals must first limit adverse impacts to critical areas by avoiding, minimizing, or rectifying the impacts to a critical area or its buffer before seeking to compensate for adverse impacts through mitigation and monitoring.

Compensatory mitigation requirements for adverse impacts to wetlands can be found in K.C.C. 21A.24.340. Mitigation requirements are expressed as a ratio of area required to compensate for the area of impact (mitigation: impact). The ratio of mitigation is based on the category of wetland impacted and type of proposed mitigation. Previous wetland mitigation ratios in K.C.C. 21A.24.340 are shown in Table 4.5 and Table 4.6. The previous buffer mitigation ratio was 1:1.

Table 4.5 Previous wetland mitigation ratios for direct impacts.

Category and Type of Wetland	Wetland Re-establishment or Creation	Wetland Rehabilitation	1:1 Wetland Re-establishment or Wetland Creation (R/C) and Wetland Enhancement	Wetland Enhancement Only
Category IV	1.5:1	3:1	1:1 R/C and 2:1 E	6:1
Category III	2:1	4:1	1:1 R/C and 2:1 E	8:1
Category II estuarine	Case-by-case	4:1 rehabilitation of an estuarine wetland	Case-by-case	Case-by-case
All other Category II	3:1	8:1	1:1 R/C and 4:1 E	12:1
Category I forested	6:1	12:1	1:1 R/C and 10:1 E	Case-by-case
All other Category I	4:1	8:1	1:1 R/C and 6:1 E	Case-by-case
Category I wetlands of high conservation value	Not allowed	6:1 rehabilitation of a wetland of high conservation value	Case-by-case	Case-by-case
Category I coastal lagoon	Not allowed	6:1 rehabilitation of a coastal lagoon	Case-by-case	Case-by-case
Category I bog	Not allowed	6:1 rehabilitation of a bog	Case-by-case	Case-by-case
Category I estuarine	Case-by-case	6:1 rehabilitation of an estuarine wetland	Case-by-case	Case-by-case

Table 4.6 Previous wetland mitigation ratios for temporary impacts.

Wetland Category	Permanent conversion of forested and shrub wetlands into emergent wetlands			Mitigation for temporal loss of forested and shrub wetlands when the impacted wetlands will be revegetated to forest or shrub communities		
	Enhancement	Rehabilitation	Creation or restoration	Enhancement	Rehabilitation	Creation or restoration
Category I	6:1	4.5:1	3:1	3:1	2:1	1.5:1
Category II	3:1	2:1	1.5:1	1.5:1	1:1	.75:1
Category III	2:1	1.5:1	1:1	1:1	.75:1	.5:1
Category IV	1.5:1	1:1	.75:1	Not applicable	Not applicable	Not applicable

4.2.1 2024 BAS Review

King County's 2024 BAS review for wetland mitigation requirements was informed by Washington State guidance (see Section 2.1) and included review of King County's 2004 BAS report (see Section 2.0), BAS documents produced by Ecology (see Section

2.2.2), and other published resources and peer-reviewed literature. Ecology states that, "unavoidable impacts to wetlands must be offset by compensatory mitigation to achieve no net loss of wetland function" (Ecology 2022). The following sections discuss BAS review findings related to compensatory mitigation, including essential information from Ecology's Wetland Mitigation in Washington State Part 1: Agency Policies and Guidance (Version 2).

Compensatory Mitigation Methods and Ratios

Ecology defines compensatory mitigation as including one or more of the following methods (Ecology et al. 2021):

- **Restoration:** Wetland and buffer area and functions are restored to a location where those functions formerly occurred.
- **Creation or Establishment**: New wetland and buffer area and functions are created or established at a location where they did not previously occur.
- **Preservation:** An existing high-quality wetland is preserved, protecting it from future loss or degradation. (Note: the K.C.C. does not allow preservation as a type of compensatory mitigation.)
- **Enhancement**: Existing wetland or buffer functions are enhanced.

Wetland re-establishment and rehabilitation are Ecology's preferred approaches for compensatory mitigation because each result in restoration of environmental processes (Ecology et al. 2021). Because enhancement results in a net loss of wetland and buffer area, and in some cases can lead to a tradeoff of wetland functions, Ecology prefers to see it used in combination with re-establishment and/or creation (Ecology et al. 2021).

Compensatory mitigation ratios are discussed in depth in Ecology's Wetland Mitigation in Washington State Part 1: Agency Policies and Guidance (Version 2). Table 4.7 introduces Ecology's recommended compensation ratios for permanent wetland impacts in western Washington.

Table 4.7 Ecology's recommended compensation ratios for permanent impacts in Western Washington.

Category of Impacted Wetland	Re-establishment or Creation	Rehabilitation	Preservation	Enhancement
Category IV	1.5:1	3:1	6:1	6:1
Category III	2:1	4:1	8:1	8:1
Category II	3:1	6:1	12:1	12:1
Category I	4:1	8:1	16:1	16:1

There are several types of forested wetlands with special characteristics. Because forested wetlands may take more than 100 years to establish, Ecology recommends higher ratios for this type of Category I wetland in western Washington (Table 4.8).

Table 4.8 Ecology's recommended compensation ratios for forested wetlands in Western Washington.

Category of Impacted Wetland	Re-establishment or Creation	Rehabilitation	Preservation	Enhancement
Category I forested	6:1	12:1	24:1	24:1

Ecology recommends the following mitigation ratios be used to regulate combination compensation in western Washington (Table 4.9). Combining different methods of compensation introduces greater complexity in calculating adequate compensation but can provide flexibility to those seeking to mitigate adverse wetland impacts.

Table 4.9 Ecology's recommended combination compensation ratios for forested wetlands in Western Washington.

Category of Impacted Wetland	Re-establishment or Creation (R/C) plus Rehabilitation (RH)	Re-establishment or Creation (R/C) plus Preservation (P)	Re-establishment or Creation (R/C) plus Enhancement I
Category IV	1:1 R/C plus 1:1RH	1:1 R/C plus 2:1 P	1:1 R/C plus 2:1 E
Category III	1:1 R/C plus 2:1 RH	1:1 R/C plus 4:1 P	1:1 R/C plus 4:1 E
Category II	1:1 R/C plus 4:1 RH	1:1 R/C plus 8:1 P	1:1 R/C plus 8:1 E
Category I	1:1 R/C plus 6:1 RH	1:1 R/C plus 12:1 P	1:1 R/C plus 12:1 E

Direct and Indirect Impacts to Wetlands and Wetland Buffers

The 2008 Federal Mitigation Rule (73 Fed. Reg. 19594, April 10, 2008) defines adverse impacts as those impacts that change the chemical, physical, and biological conditions of a wetland. These adverse impacts can occur directly through alteration of a wetland or wetland buffer or indirectly through alteration of areas adjacent to a wetland or wetland buffer. Impacts include land use development activities that may result in reduced habitat, water quality, or hydrologic functions. Though indirect impacts degrade the functions and values of wetlands and wetland buffers, they generally do not result in a complete loss of wetland and buffer area functions. Therefore, indirect impacts may require less compensation than direct impacts (Ecology et al. 2021).

Assessing the cumulative effects of direct and indirect impacts to a wetland and direct impacts to a wetland buffer is critical to protecting wetland functions and values over time. Mitigation requirements should account for both direct and indirect impacts to wetlands and direct impacts to wetland buffers.

Ecology provides a method for assessing indirect wetland impacts, stating "where a wetland, the buffer, or both would be impacted, superimpose the recommended width of

buffer from the edge of the proposed development extending into the wetlands. The superimposed area within the wetland would be the area of indirect impact" (Ecology et al. 2021).

Figure 4.1 illustrates a proposed development that would have permanent direct and indirect impacts on a wetland and wetland buffers.

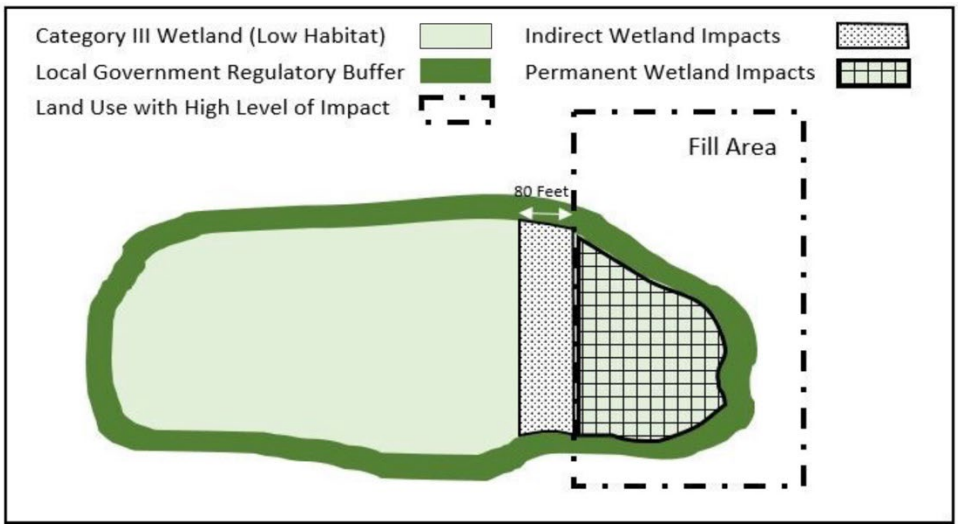


Figure 4.1 Direct and indirect wetland impacts Example 1 (Ecology et al. 2021).

Figure 4.2 illustrates a proposed development that would have permanent direct impacts to a wetland buffer and indirect impacts to the protected wetland.

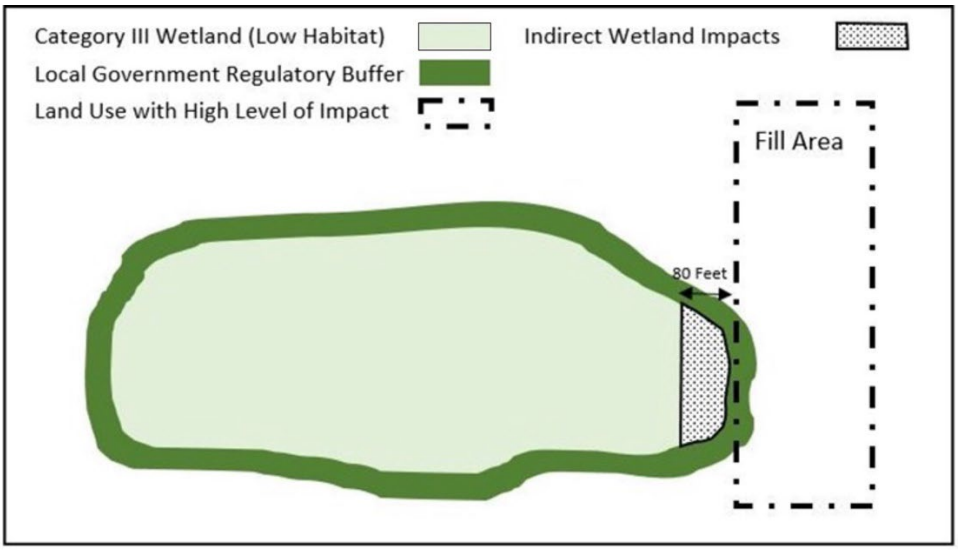


Figure 4.2 Direct and indirect wetland impacts Example 2 (Ecology et al. 2021).

When indirect impacts are proposed, typically required compensation is at one-half of the recommended ratio for permanent impacts. When determining the amount of

compensation needed for indirect impacts, an analysis of how the proposed actions will affect the functions of the remaining wetland and its buffer is required. The permitting agency may adjust the indirect impact ratio up or down, based upon case-specific circumstances (Ecology et al. 2021).

Wetland Plant Biodiversity and Climate Change

Restoration of freshwater depressional wetlands can increase biodiversity relative to degraded wetlands. Restored wetlands showed 36 percent higher levels of provisioning, regulating, and supporting ecosystem services than did degraded wetlands. In fact, restored wetlands showed levels of provisioning and cultural ecosystem services comparable to those of natural wetlands; however, their levels of supporting and regulating ecosystem services were, respectively, 16 percent and 22 percent lower than in natural wetlands (Meli et al. 2014). Riparian restoration projects that incorporate a greater diversity of trees, including heat- and drought-tolerant species and varieties may be more resilient to more extreme climate conditions while also helping to mitigate the impacts of heat and drought on wildlife by continuing to provide shade and resources (Seavy et al. 2009; Perry et al. 2015; Millar 2007). Wetland restoration on private property, while often small-scale and supported by minimal funding and expertise, can increase plant biodiversity and soil carbon with soil benefits increasing in saturated conditions, with the greatest gains occurring in riverine wetlands (Bentley et al. 2022).

Forecasts of future vegetation communities in the face of rapid global climate change point to highly dynamic changes to terrestrial vegetation. Long-lived trees and other woody plants are sensitive to land use legacies and are likely to be in disequilibrium with climate. Meaning that, as the climate warms, there may be lags in both decline at the trailing edge and establishment at the leading edge of ranges with large-scale forest mortality and lack of re-establishment resulting from extreme climate events (drought) or climate-driven disturbance (fire, pest outbreaks) (Franklin et al. 2016). “Assisted” or “managed” migration is an approach to addressing this problem through the deliberate movement and establishment of a new population of a species or genetic type outside its current geographic range to introduce better adaptive traits. The implementation of assisted migration does not come without economic, legal, political, ecological, and ethical issues (Jenkins and Jenkins 2017).

One approach for assisted migration is to plant a mixture of local seed sources along with seed sources from lower elevations and farther south. This could be combined with higher planting density plus thinning to allow for some selection of better trees depending on future climate conditions. Another approach is to develop genetically improved seedlings, a standard procedure in commercial forestry. Assisted migration is already being deployed in British Columbia (BC), where the degree of warming over the last 35 years has raised immediate concerns about maladaptation. Seed transfer standards in parts of BC were changed starting in 2008 to allow moving seed of Douglas-fir and other species 200 meters higher in elevation and one seed zone further north (up to 300 kilometers or 2 degrees of latitude). In addition, standards in BC were amended to allow planting western larch in some areas outside of its current range of

occurrence, up to 10 percent of the species mix in new plantings (O'Neill et al. 2008). For landowners planting the next generation of trees, there appear to be a few basic options to consider with climate change in mind:

- Planting native seedling stock within current seed zones matching your planting site (status quo).
- Choosing a mix of seed origins, some from local seed zones, some from zones further south or lower in elevation.
- Planting genetically improved stock from existing tree breeding programs.

4.2.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating wetland mitigation ratios. As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C., it must balance required increases in environmental protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1) and King County Comprehensive Plan priorities (see Section 3.1.1).

Increasing wetland mitigation ratios helps ensure that unavoidable adverse impacts to wetlands are reliably offset. This heightened regulatory standard expands environmental protections and helps King County meet the GMA requirement that local jurisdictions ensure there is no net loss of critical areas functions and values (see Section 1.2.1).

Increasing mitigation requirements may increase the costs of select development and land use practices on properties encumbered by wetlands or wetland buffers. Changes to compensatory mitigation ratios do not impact the costs of development and land use that are able to address adverse impacts to riparian areas through mitigation sequencing steps, including avoiding, minimizing, rectifying, or eliminating adverse impacts to riparian areas. Maintaining wetland and wetland buffer mitigation ratios also enables King County to allow for reasonable use of private property (see Section 3.1.3).

Washington State Climate Change Mitigation Actions

Wetlands play a key environmental role by providing opportunities for increasing climate resiliency through wetland protection and restoration activities. Prioritizing wetland protection and restoration can enhance climate adaptation by contributing to carbon sequestration, plant and animal biodiversity, flood reduction, water quality improvement, and wildland fire risk reduction. King County's 2004 BAS review did not include consideration of climate change and therefore the K.C.C. does not incorporate climate change mitigation actions. Legislation passed and signed into law in 2023 (HB 1181) adds a climate goal to the GMA and requires local comprehensive plans to have a climate element with resilience and greenhouse gas emissions mitigation sub-elements. King County is required to comply with HB 1181 legislation by 2029.

4.2.3 Regulatory Updates

Based on 2024 BAS review and King County comprehensive planning considerations, mitigation ratios in the K.C.C. are being updated to better align with Ecology's recommended mitigation requirements. Mitigation ratio updates are generally limited to compensatory mitigation ratios that combine re-establishment or creation and wetland enhancement mitigation methods. Mitigation ratios associated with the enhancement method of mitigation are relatively high as enhancement results in a loss of wetland area. Aligning with Ecology's recommendations for these ratios is necessary to ensure that King County protects wetland functions and values as required by the GMA (see Section 1.2.1).

Updated mitigation ratios in K.C.C. 21A.24.340 are shown in Table 4.10 and Table 4.11. For ease of interpretation, updates to values in these tables are shown as being struck and replaced in parentheses. Ratios for onsite buffer mitigation have not been increased from previous code (1:1). Offsite buffer mitigation is being increased from a ratio of 1:1 to 2:1. Compensation for indirect impacts to wetlands has been added to code at one-half of the recommended ratio for permanent wetland impacts based on the wetland category and type of mitigation.

Table 4.10 Updated wetland mitigation ratios for permanent impacts.

Category and Type of Wetland	Wetland Re-establishment or Creation	Wetland Rehabilitation	1:1 Wetland Re-establishment or Wetland Creation (R/C) and Wetland Enhancement	Wetland Enhancement Only
Category IV	1.5:1	3:1	1:1 R/C and 2:1 E	6:1
Category III	2:1	4:1	1:1 R/C and ~~2:1~~ (4:1) E	8:1
Category II estuarine	Case-by-case	~~4:1~~ (6:1) rehabilitation of an estuarine wetland	Case-by-case	Case-by-case
All other Category II	3:1	~~8:1~~ (6:1)	1:1 R/C and ~~4:1~~ (8:1) E	12:1
Category I forested	6:1	12:1	1:1 R/C and ~~10:1~~ (16:1) E	Case-by-case
All other Category I	4:1	8:1	1:1 R/C and ~~6:1~~ (12:1) E	Case-by-case
Category I wetlands of high conservation value	Not allowed	~~6:1~~ (8:1) rehabilitation of a wetland of high conservation value	~~Case-by-case~~ (Not allowed)	Case-by-case
Category I coastal lagoon	Not allowed	~~6:1~~ (8:1) rehabilitation of a coastal lagoon	~~Case-by-case~~ (Not allowed)	Case-by-case
Category I bog	Not allowed	~~6:1~~ (8:1) rehabilitation of a bog	~~Case-by-case~~ (Not allowed)	Case-by-case

Category I estuarine	Case-by-case	~~6:1~~ (8:1) rehabilitation of an estuarine wetland	Case-by-case	Case-by-case

Table 4.11 Updated wetland mitigation ratios for temporary impacts.

Wetland Category	Permanent conversion of forested and shrub wetlands into emergent wetlands			Mitigation for temporal loss of forested and shrub wetlands when the impacted wetlands will be revegetated to forest or shrub communities		
	Enhancement	Rehabilitation	Creation or restoration	Enhancement	Rehabilitation	Creation or restoration
Category I	~~6:1~~ (8.1)	4.5:1	3:1	~~3:1~~ (4:1)	2:1	1.5:1
Category II	~~3:1~~ (6:1)	~~2:1~~ (3:1)	1.5:1	~~1.5:1~~ (3:1)	~~1:1~~ (1.5:1)	.75:1
Category III	~~2:1~~ (4:1)	~~1.5:1~~ (2:1)	1:1	~~1:1~~ (2:1)	~~.75:1~~ (1:1)	.5:1
Category IV	~~1.5:1~~ (3:1)	~~1:1~~ (1.5:1)	.75:1	~~Not applicable~~ (1.5:1)	~~Not applicable~~ (.75:1)	~~Not applicable~~ (.25:1)

In addition to updating mitigation ratios, King County is updating development regulations for sites containing wetlands and wetland buffers (K.C.C. 21A.24.335). Previously, these development regulations limited wetland mitigation and restoration projects to the use of plants indigenous to the Puget Sound lowland unless otherwise authorized by a state or federal permit or approval. Because climate change impacts are making plants native to the Puget Sound lowland vulnerable to disease and die-offs, King County is updating these regulations to allow projects to use climate-smart plants as identified by King County's Department of Natural Resources and Parks (DNRP) in approved mitigation or restoration projects. King County is reviewing plants for inclusion in the approved climate-smart plants list with a focus on those indigenous to the Willamette Valley-Puget Trough-Georgia Basin Ecoregion. This ecoregion includes the Puget Sound but extends to include parts of British Columbia and Oregon. King County will produce its first technical report identifying DNRP-approved climate-smart plants in early 2024. King County may produce additional reports identifying climate-smart plants in the future as climate change continues to impact ecological conditions in the County.

4.2.4 Risk Assessment of Regulatory Updates

As King County updates its development regulations in the K.C.C., it must balance critical areas protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1). King County's approach to managing risks to critical areas functions and values is discussed in Section 3.2.

Wetland Compensatory Mitigation

King County's 2024 BAS review for wetland and buffer compensatory mitigation for direct and indirect impacts was informed by Washington State guidance (see Section 2.1) and Ecology BAS documents (see Section 2.2.1). This process confirmed that most

wetland mitigation ratios in the K.C.C. align with those recommended by Ecology while identifying a limited number of ratios for updates to align with Ecology guidance. The updates to wetland mitigation ratios described in Table 4.9 (see Section 4.2.3) bring development regulations in the K.C.C. into alignment with Ecology's recommended moderate-risk approach to wetland critical areas management (Ecology 2022).

Additional updates increasing buffer mitigation requirements and introducing compensatory mitigation requirements for indirect impacts are consistent with BAS and help to align the K.C.C. with the State Environmental Policy Act (SEPA) that requires local governments to mitigate land use and development impacts on wetlands (including indirect impacts).

4.2.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs related to wetland mitigation are discussed at a summary level below. Readers can learn more by visiting linked webpages.

King County's Mitigation Reserves Program

King County's Mitigation Reserves Program is a state and federally authorized In-Lieu Fee Mitigation Program that provides an option for permittees with unavoidable impacts to wetlands to pay a fee to King County when there are no mitigation opportunities on site. Fees collected are used to design and construct mitigation projects that restore wetlands in King County.

Wetland Mapping and Potentially Restorable Wetlands

King County plans to create a Potentially Restorable Wetland (PRW) map inventory to identify opportunities for recovering and restoring degraded wetlands. The PRW data will be developed after completion of the existing wetlands inventory. The PRW inventory will provide agencies, consultants, and property owners with a tool to identify potential wetland restoration opportunities for restoring degraded wetlands. This tool will support both land use development planning and conservation planning by expediting the capacity for agencies to rapidly identify potential wetland restoration and mitigation opportunities at the watershed and parcel scale.

4.3 References

Barbier E. B., S. D. Hacker, C. Kennedy, E. W. Koch, A. C. Stier, and B. R. Silliman. 2011. The Value of Estuarine and Coastal Ecosystem Services. *Ecological Monographs* 81(2): 169–193.

Bentley, S. S., S. A Tomscha, and J. R Deslippe. 2022. Indictors of Wetland Health Improve Following Small-scale Ecological Restoration on Private Land. *Science of the Total Environment* 1:837:155760. Doi: 10.1016/j.scitotenv.2022.155760

Bunten, D., R. Mraz, L. Driscoll, and A. Yahnke. 2016. *Wetland Guidance for CAO Updates: Western Washington Version*. Washington State Department of Ecology Publication #16-06-001. https://apps.ecology.wa.gov/publications/summarypages/1606001.html

Chappell, C. R. 2001. Wildlife Habitats: Descriptions, Status, Trends, and System Dynamics. In *Wildlife-Habitat Relationships in Oregon and Washington.* (Pp. 22–114). Corvallis, OR: Oregon State University Press.

Cheng, F., K. Van Meter, D. Byrnes, and N. Basu. 2020. Maximizing U.S. Nitrate Removal through Wetland Protection and Restoration. *Nature* 588(7839): 1–6.

Convention on Wetlands. 2021. Global Wetland Outlook: Special Edition 2021. Gland, Switzerland: Secretariat of the Convention on Wetlands.

Cowardin, L. 1979. Classification of Wetlands and Deepwater Habitats of the United States. Fish and Wildlife Service, U.S. Department of the Interior.

Dertien J. S., S. Self, B. E. Ross, K. Barrett, and R. F. Baldwin. 2020. The Relationship Between Biodiversity and Wetland Cover Varies Across Regions of the Conterminous United States. *PloS ONE* 15(5): e0232052. Doi.org/10.1371/journal.pone.0232052

Duffy, W. K. 2011. Wetland Ecosystem Services in California's Central Valley and Implications for the Wetland Reserve Program. *Ecological Applications* 21(sp1): S128–S134.

Environmental Law Institute. 2008. State Wetland Protection: Status, Trends & Model Approaches. A 50-state Study by the Environmental Law Institute. Washington, D.C.

Fay, P. G. (2016). Climate Change Impacts on Freshwater Wetland Hydrology and Vegetation Cover Cycling along a Regional Aridity Gradient. *Ecosphere* 7(10): e01504. Doi.org/10.1002/ecs2.1504

Federal Register. Volume 73, pages 19594 to 19705. April 10, 2008. Final rule: Compensatory Mitigation for Losses of Aquatic Resources.

Franklin, J., J. M. Serra-Diaz, A. D. Syphard, and H. M. Regan. 2016. Global Change and Terrestrial Plant Community Dynamics. *PNAS* 113(14): 3725–3734. Doi.org/10.1073/pnas.1519911113

Glick, P. S. 2011. Scanning the Conservation Horizon: A Guide to Climate Change Vulnerability Assessment. National Wildlife Federation, Washington, D.C. 176 pages.

Graff L. and J. Middleton. 2001. Wetlands and Fish: Catch the Link. Gaithersburg, MA: Izaak Walton League of America. Prepared for the National Marine Fisheries Service.

Granger, T., T. Hruby, A. McMillan, D. Peters, J. Rubey, D. Sheldon, S. Stanley, and E. Stockdale. 2005. *Wetlands in Washington State – Volume 2: Guidance for Protecting and Managing Wetlands*. Washington State Department of Ecology Publication #05-06-008. https://apps.ecology.wa.gov/publications/summarypages/0506008.html

Hunt, L. J., J. Fair, and M. Odland. 2018. Meadow Restoration Increases Baseflow and Groundwater Storage in the Sierra Nevada Mountains of California. *Journal of the American Water Resources Association* 54(5): 1127–1136.

Hruby, T. 2013. *Update on Wetland Buffers: The State of the Science, Final Report, October 2013*. Washington State Department of Ecology Publication #13-06-11. https://apps.ecology.wa.gov/publications/SummaryPages/1306011.html

Hruby, T. 2014. Washington State Wetland Rating System for Western Washington: 2014. Washington State Department of Ecology, Olympia, WA.

Jenkins, J. and M. W. Jenkins. 2017. Managed Migration of Coast Redwoods: Subjectivity of Stakeholders in Oregon's Land Use Planning Community. *Environment and Natural Resources Research* 7(3) [online]. doi:10.5539/enrr.v7n3p1

Kadykalo A. N. and C. S. Findlay. 2016. The Flow Regulation Services of Wetlands. *Ecosystem Services*, 20: 91–103.

King County. 2004. *Volume I: A Review of Scientific Literature*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v1.pdf

King County. 2004. *Volume II: Assessment of Proposed Ordinances*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v2.pdf

Lee, S. Y. 2018. Effect of Climate Change on Seattle: Climate Impacts Group, University of Washington.

Meli P., J. M. Rey Benayas, P. Balvanera, M. Martínez Ramos. 2014. Restoration Enhances Wetland Biodiversity and Ecosystem Service Supply, but Results Are Context-Dependent: A Meta-Analysis. PloS ONE 9(4): e93507. Doi.org/10.1371/journal.pone.0093507

Millar, C. I. 2007. Climate Change and Forests of the Future: Managing in the Face of Uncertainty. *Ecological Applications* 17(8): 2145–2151.

Morgan, H., L.W. Binder, 2016. Climate Change Impacts Climate Change Impacts for Stormwater Management in Puget Sound on Puget Sound Floodplains. Retrieved from Climate Impacts Group. Integrating-Climate-Resilience-in-Puget-Sound-Floodplain-and-Working-Lands-Programs_StormwaterBrief.pdf (uw.edu)

Retrieved from Climate Impacts Group: https://cig.uw.edu/wp-content/uploads/sites/2/2021/06/Integrating-Climate-Resilience-in-Puget-Sound-Floodplain-and-Working-Lands-Programs_Brief.pdf

O'Neill, G. A., N. Ukrainetz, M. Carlson, C. Cartwright, B. Jaquish, J. King, J. Krakowski, J. H. Russell, M. Stoehr, C-Y. Xie, and A. Yanchuk. 2008. Assisted Migration to Address Climate Change in British Columbia: Recommendations for Interim Seed Transfer Standards. Technical Report 048. BC Ministry of Forest and Range: Forest Science Program.

Perry L. G., L. V. Reynolds, T. J. Beechie, M. J. Collins, and P. B. Shafroth. 2015. Incorporating Climate Change Projections into Riparian Restoration Planning and Design. *Ecohydrology* 8(5): 863–879.

Ramstead, K. A., J. A. Allen, and A. E. Springer. 2012. Have Wet Meadow Restoration Projects in the Southwestern US been Effective in Restoring Geomorphology, Hydrology, Soils and Plant Species Composition? *Environmental Evidence* 1(1) [online]. doi:10.1186/2047-2382-1-11

Rasmussen, T.C., Deemy, J.B., Long, S.L. (2018). Wetland Hydrology. In: Finlayson, C.M., et al., *The Wetland Book*: 201-216. Springer. doi:10.1007/978-90-481-9659-3_71

Salathé Jr., E. P., A. F. Hamlet, C. F. Mass, S-Y. Lee, M. Stumbaugh, and R. Steed 2014. Estimates of 21st Century Flood Risk in the Pacific Northwest Based on Regional Climate Model Simulations. *Journal of Hydrometeorology* 15(5): 1881–1899.

Salgado, K. 2017. Is Ecosystem-based Coastal Defense a Realistic Alternative? Exploring the Evidence. *Journal of Coastal Conservation* 21(6): 837–848.

Salimi, S., S. A. A. A.N. Almuktar, and M. Scholz. 2021. Impact of Climate Change on Wetland Ecosystems: A Critical Review of Experimental Wetlands. *Journal of Environmental Management* 286: 112160 [online]. doi.org/10.1016/j.jenvman.2021.112160

Seavy N. E., T. Gordali, G. H. Golet, and F. O. Griggs. 2009. Why Climate Change Makes Riparian Restoration More Important than Ever: Recommendations for Practice and Research. *Ecological Restoration* 27(3): 330–338.

Sheldon, D., T. Hruby, P. Johnson, K. Harper, A. McMillan, T. Granger, S. Stanley, and E. Stockdale. 2005. *Wetlands in Washington State – Volume 1: A Synthesis of the Science*. Washington State Department of Ecology Publication #05-06-006. https://apps.ecology.wa.gov/publications/summarypages/0506006.html

Theiling, C. B. 2013. Flood Inundation Mapping for Integrated Floodplain Management: Upper Mississippi River System. *River Research and Applications* 29(8): 961–978.

Van Coppenolle, R. T. and S. Temmerman. 2019. A Global Exploration of Tidal Wetland Creation for Nature-based Flood Risk Mitigation in Coastal Cities. *Estuarine, Coastal and Shelf Science* 226: 106262 [online]. doi: 10.1016/j.ecss.2019.106262

Verhoeven, J. T. A., B. Arheimer, C. Yin, and M. M Hefting. (2006). Regional and Global Concerns over Wetlands and Water Quality. *Trends in Ecology & Evolution* 21(2): 96–103. doi: 10.1016/j.tree.2005.11.015

Washington State Department of Commerce (Commerce). 2022. *Critical Areas Checklist – A Technical Assistance Tool from Growth Management Services*. https://deptofcommerce.box.com/s/5su5ugh9h5cmkv9oj1m3trjfql5r68c6

Washington State Department of Commerce (Commerce). 2023. *Critical Areas Handbook – A Handbook for Reviewing Critical Areas Regulations (Version 3)*. https://deptofcommerce.box.com/s/rlysjrfvrxpxwnm9jvbcd3lc7ji19ntp

Washington State Department of Ecology (Ecology). 2018. Modified Habitat Score Ranges. Appendix 8-C: Guidance on Buffers and Ratios for Western Washington Wetlands in Washington State Volume 2 – Protecting and Managing Wetlands. Ecology Publication No. 05-06-008 1.

Washington State Department of Ecology (Ecology). 2022. *Wetland Guidance for Critical Area Ordinance (CAO) Updates: Western and Eastern Washington*. Washington State Department of Ecology Publication #22-06-014. https://apps.ecology.wa.gov/publications/SummaryPages/2206014.html

Washington State Department of Ecology (Ecology). 2023. Wetlands & Climate Change. https://ecology.wa.gov/Water-Shorelines/Wetlands/Tools-resources/Wetlands-climate-change

Washington State Department of Ecology, U.S. Army Corps of Engineers (Seattle District), U.S. Environmental Protection Agency (Region 10). 2021. *Wetland Mitigation in Washington State: Part 1 – Agency Policies and Guidance (Version 2)*. Washington State Department of Ecology Publication #21-06-003. https://apps.ecology.wa.gov/publications/SummaryPages/2106003.html

Zhu, J., I. I. Wallis, H. Guan, K. Ross, H. Whiley, and H. Fallowfield. 2022. Juncus sarophorus, a Native Australian Species, Tolerates and Accumulates PFOS, PFOA and PFHxS in a Glasshouse Experiment. *Science of the Total Environment* Epub 2022 Feb 26 [online]. doi: 10.1016/j.scitotenv.2022.154184

5 Riparian Areas (a Type of Fish and Wildlife Habitat Conservation Area)

Riparian areas are the transitional areas between terrestrial and aquatic ecosystems. Riparian areas are diverse, dynamic, and complex ecosystems that support an abundance and variety of fish and wildlife. Riparian areas provide ecological functions, including bank stability, shade and temperature control, pollution removal and water purification, contribution of nutrients and detritus, sources and recruitment of habitat-forming large wood, natural erosion and sediment delivery, habitat cover for aquatic and terrestrial animals, terrestrial-based food supply, and others (Quinn et al. 2020). These ecological functions support both terrestrial and aquatic ecosystems and are especially important for anadromous fish species. Riparian areas also support a myriad of terrestrial wildlife; however, only minimal discussion of wildlife needs is included in this section. In addition to ecological functions, riparian areas also provide a variety of environmental services, such as flood flow attenuation, nutrient cycling, pollutant filtering, and carbon sequestration (Reid et al. 2005).

Several attributes influence how riparian areas function, including the width of riparian areas, vegetation height, longitudinal (upstream to downstream) and lateral (river to upland) connectivity, and vegetation species composition and diversity (Figure 5.1). Specifically, key riparian area functions like large wood recruitment and shade vary based on the width of mature riparian areas, and the effectiveness of functions like pollution removal and sediment delivery are closely related to the residence time of water and connectivity of riparian areas and the residence time of water (Quinn et al. 2020; Rentz et al. 2020). Riparian area functions decrease as land use fragments and reduces the width of riparian areas.

Protection and restoration of riparian areas is one of several strategies that provide special consideration for anadromous fish and their habitats (detailed in Section 1.2.8) (Knight 2009; Commerce 2023). Riparian vegetation connectivity, quality, and quantity are key to functioning salmonid habitat (Quinn et al. 2020; Rentz et al. 2020); therefore, riparian areas should be protected across all aquatic areas (Knight 2009). In order to meet the special consideration for anadromous fish, protection measures should consider cool, well-oxygenated, unpolluted water, streambed gravels that are relatively free of fine sediments, instream structural diversity, unimpeded migratory access to and from spawning and rearing areas, and complex habitats that support food production (Commerce 2023). Riparian areas adjacent to both fish- and non-fish-bearing streams support these habitat functions either directly in fish-bearing streams or indirectly in non-fish-bearing streams by contributing water, sediment, nutrients, wood, and other materials downstream to fish-bearing streams.

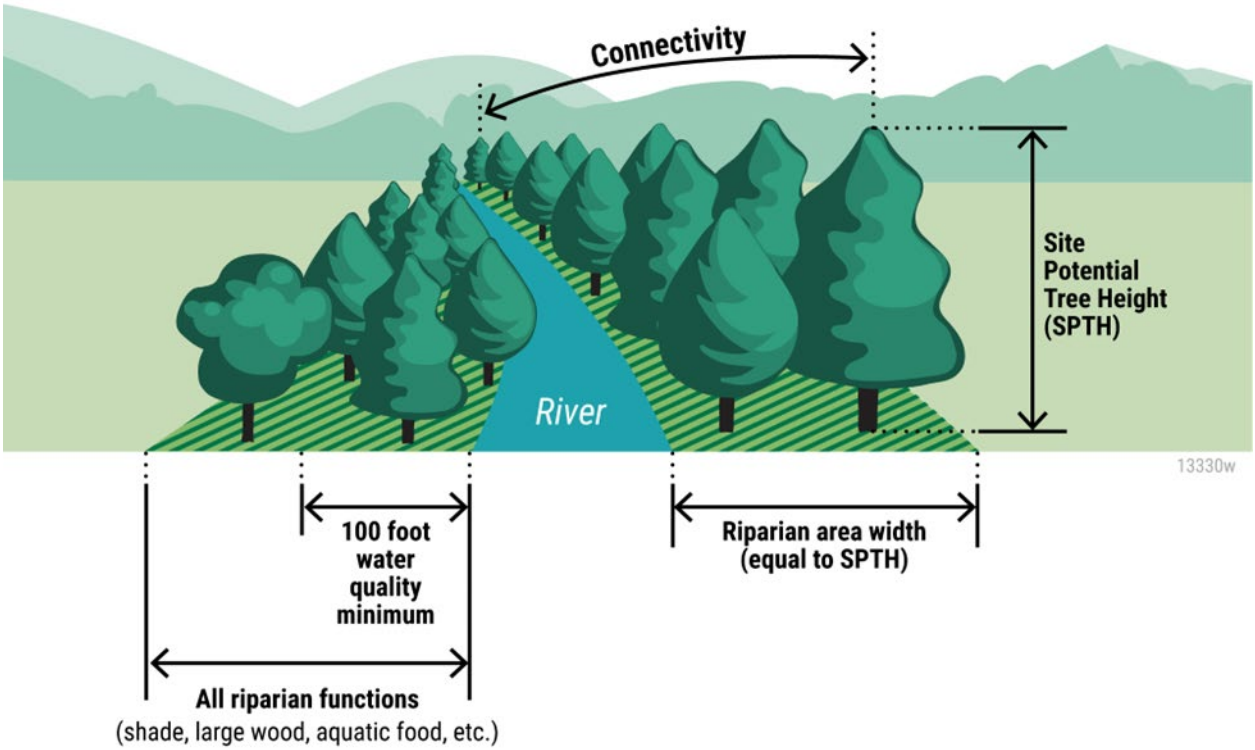


Figure 5.1 Key riparian concepts discussed and integrated into the BAS review.

Riparian areas are especially susceptible to climate impacts compared to upland forests as they tend to be highly exposed to extreme climatic events, including floods, droughts, and intense storms, which are expected to increase in frequency and intensity due to climate change (Capon et al. 2013). Climate change is expected to result in a warmer and drier climate, shifts in precipitation and hydrologic regimes, higher frequency and severity of droughts, decreased soil moisture, greater fire risk, increased insect outbreaks, loss of or shift in riparian vegetation, and other impacts (Mote et al. 2005; Barnett et al. 2008; Mantua et al. 2010; Isaak et al. 2012; Mauger et al. 2015; Dwire et al. 2018). These climate impacts will negatively affect riparian vegetation presence, productivity, vigor, spatial extent, and community composition. Additionally, temperature increases associated with climate change will impact the extent and magnitude of riparian microclimate conditions, which will negatively affect associated plants and animals. Specifically, climate change is likely to alter the ability of riparian areas to moderate and cool air temperatures, which reduces the rate at which water in adjacent aquatic areas warms up.

Riparian area protection and restoration can help mitigate climate impacts. Protection measures that support wider and more contiguous riparian areas provide more shade to streams, greater microclimate benefits, decreased sensitivity of surface waters to warming during increasingly lower summer low flows, and bolstered resiliency to climate change (Quinn et al. 2020). Resiliency refers to the ability of the riparian area to absorb and recover from disturbances with limited loss of ecological function. Protection and

restoration strategies are especially important because riparian areas provide longitudinal habitat connectivity, link aquatic and terrestrial ecosystems, and create temperature refugia for fish and wildlife (Seavy et al. 2009).

King County has previously described riparian areas as “aquatic area buffers” or “riparian corridors” in Comprehensive Plan policies and the King County Code (K.C.C.), due to the protections they offer aquatic ecosystems such as shorelines, rivers, streams, and lakes. Riparian areas should be designated and protected as a Fish and Wildlife Habitat Conservation Area (FWHCA) rather than just a buffer to aquatic areas because they are their own ecosystem, provide benefits to adjacent aquatic areas, and have inherent value as fish and wildlife habitat (Rentz et al. 2020). To provide clarity and align with concepts used in state guidance and best available science (BAS) documents, “aquatic area buffers” and “riparian corridors” will now be referenced as “riparian areas” in King County Comprehensive Plan Policies and the K.C.C.

Similar to the designation of riparian area as a FWHCA, Washington State BAS and guidance documents (Quinn et al. 2020; Commerce 2023) emphasize that floodplains are critical components of properly functioning aquatic and riparian ecosystems and provide critical habitats and functions for a variety of fish and wildlife. Specifically, BAS has shown that floodplains provide critical juvenile salmon rearing habitat, support life history diversity, promote elevated growth rates, and provide abundant, high-quality food resources (Sommer et al. 2001, 2005; Jeffres et al. 2008, 2020; Takata et al. 2017; Cordoleani et al. 2022). Based on the description of Fish and Wildlife Habitat Conservation Areas (FWHCAs) in Washington Administrative Code (WAC) 365-190-130(2) as well as several King County Comprehensive Plan policies (e.g., E-498a, S-635), floodplains should be designated as their own FHWCA and should be protected for ecological functions and values. While floodplains are an important component of properly functioning aquatic and riparian ecosystems, the topic of floodplains as FWHCAs is beyond the scope of the following riparian area protections discussion.

For clarity, riparian areas are discussed in Section 5 of this report. Wildlife habitat protections other than riparian areas are discussed in Section 6.

A condensed summary table of all riparian areas subsections is provided in Section 5.5.

5.1 Riparian Area Widths

King County riparian area widths are the distances that must be maintained between permitted land use activities and aquatic areas. The K.C.C. designates riparian area widths, or level of protection for riparian and aquatic area functions, based on the location of the riparian area in relation to the urban growth boundary and the type of adjacent aquatic area. Riparian areas outside the Urban Growth Area (UGA), which includes rural and natural resource lands, have greater widths than those found within the UGA. In addition, riparian area widths can be modified based on the presence of a severe channel migration zone (CMZ) (see Section 5.2). In addition, livestock activities

can occur within previously cleared riparian areas, subject to the Livestock Management Ordinance (LMO). The K.C.C. has a variety of allowed alterations and reasonable use exceptions from permitted activities that allow reductions in width or fragmentation of riparian areas. The range of degradation from allowed alterations includes major and minor intrusions into riparian and aquatic areas.

King County's aquatic area definitions, found in K.C.C. 21A.24.355, are similar to the state's stream typing classification system and are summarized here: Type S aquatic areas are Shorelines of the State, as defined under the Shoreline Management Act and in K.C.C. Chapter 21A.25. Type F aquatic areas are perennial or ephemeral waterbodies that have known fish presence or fish habitat. Type F aquatic areas include streams with a defined channel of 2 feet bank full width or greater and a gradient less than 20 percent. All channels found within mapped 100-year floodplains are considered type S or F. Type N aquatic areas are connected via perennial or ephemeral surface flow to type S or F aquatic areas but do not contain fish or fish habitat. Type O aquatic areas do not have a surface connection to type S, F, or N aquatic areas and primarily infiltrate into the ground.

Previous riparian area widths can be found in K.C.C. 21A.24.358. Riparian area widths for different aquatic area types in the UGA and outside the UGA are summarized in Table 5.1.

Table 5.1 Previous riparian area widths inside and outside the Urban Growth Area (UGA) for Unincorporated King County.

Aquatic Area Type	Description	Previous Riparian Area Width Inside UGA (feet)	Previous Riparian Area Width Outside UGA (feet)
Shoreline (S)	Shorelines of the State.	115	165
Fish (F)	Not S type; contain fish or fish habitat.	115	165
Non-fish-bearing (N)	Not S or F type; connected by surface water to S or F.	65	65
Other (O)	Not S, F, or N type.	25	25

King County offers regulatory allowances to applicants seeking permits for select agricultural activities. Regulatory allowances for livestock activities are detailed in the LMO and found in K.C.C. Chapter 21A.30. The regulatory allowances offered by the LMO are dependent on whether the applicant obtains a farm plan (Table 5.2).

Table 5.2 Previous Livestock Management Ordinance grazing area buffer widths.

Aquatic Area Type	Grazing Area Buffer Width (feet) with a Farm Plan (K.C.C. 21A.30.045)	Grazing Area Buffer Width (feet) without a Farm Plan (K.C.C. 21A.30.060)
Shoreline (S) or Fish (F)	0–25	50
Non-fish-bearing (N) or Other (O)	0	0

5.1.1 2024 BAS Review

King County's 2024 BAS review for riparian area widths was informed by Washington State guidance (see Section 2.1) and included review of King County's 2004 BAS report (see Section 2.0), BAS documents produced by Washington State Department of Fish and Wildlife (see Subsection 2.2.2), as well as other published resources (e.g., Washington State Department of Ecology 2021), the Federal Emergency Management Agency (FEMA) Biological Opinion (BiOp) model ordinance, peer-reviewed literature, and BAS syntheses (e.g., King County 2019). King County primarily used the comprehensive BAS documents produced by Washington State Department of Fish and Wildlife (Subsection 2.2.2) rather than conducting a separate extensive review of all relevant peer-reviewed riparian literature.

Site Potential Tree Height and Riparian Area Width

The width of riparian areas is estimated by one 200-year site potential tree height (SPTH) (Figure 5.1), which is the average maximum height of the tallest dominant trees that are 200 years or more in age (FEMAT 1993; Reeves et al. 2018). Riparian area tree heights vary based on age and site characteristics, including differences in elevation, soil nutrients and moisture, light and temperature regimes, and topography (Avery and Burkhart 2015). Two-hundred-year-old trees are used because the minimum age of old-growth forests is commonly understood to be "200 years or more" (Franklin and Spies 1991) and using SPTH for estimating riparian area widths is appropriate because several functions, including large wood recruitment, stream shading, and litter fall, are strongly associated with tree height (FEMAT 1993; Spies et al. 2013; Reeves et al. 2018). Protecting riparian functions within at least one 200-year SPTH is well supported in the literature to protect and maintain full riparian functions (Rentz et al. 2020).

The Washington State Department of Fish and Wildlife (WDFW) used Natural Resources Conservation Service soil class data and growth curves for three tree species to estimate SPTH for riparian areas across Washington State. These SPTH estimates are available online (WDFW SPTH Webtool). WDFW recommends that a site-by-site approach be used for SPTH determination; however, this approach would result in over 50 different riparian area widths across King County (unpublished evaluation of WDFW SPTH data). Such a high number of riparian area widths would not only be difficult to implement from a permitting and enforcement point of view but would likely also cause confusion for community members. Additionally, the WDFW webtool is

based on soil class data that is too coarse for suitable application at a parcel scale but appropriate for broader evaluations of SPTH patterns. In addition, one of the three tree species WDFW used was not appropriate for the analysis. Subsequently, an alternative approach developed from WDFW SPTH data was used to estimate SPTHs for riparian areas in King County.

Estimation of Site Potential Tree Height for King County

As discussed above, a combination of soil class data and published tree growth curves can be used to estimate SPTH (e.g., WDFW SPTH Webtool). However, for this approach to best represent SPTHs across riparian areas, appropriate scale and riparian tree species should be used. In King County, the WDFW SPTH webtool includes Douglas-fir, western hemlock, and red alder, which are only three of several large, tall, or dominant riparian trees in King County. WDFW included these three tree species because they have well-documented growth curves. WDFW used red alder for areas with wetter soil types; however, tree species such as black cottonwood, western redcedar, and Sitka spruce are not only large, tall, or dominant riparian trees that thrive in wetter soils, but are likely more appropriate for SPTH estimation due to their size and age at maturity. Among the species included in the WDFW webtool, red alder is the least suitable because it is a relatively short-lived riparian tree, maturing at about 60 to 70 years and reaching a maximum age closer to about 100 years (Worthington and Ruth 1962; Harrington 2006). A more appropriate longer-lived tree species for King County riparian areas would be black cottonwood, which can mature as early as 60 years, can occasionally live up to 200 years, and is frequent within riparian areas throughout King County. There is less information on published western Washington black cottonwood growth curves; however, suitable estimates can be made by estimating the height of existing tallest-largest trees in King County riparian areas.

King County used tree height data for Douglas-fir, western hemlock, and black cottonwood to estimate the range of SPTHs across Unincorporated King County (UKC). The range in height across these riparian species helps determine an appropriate fixed width for riparian area protections. The range in heights for Douglas-fir and western hemlock was pulled from the WDFW SPTH geodatabase for areas in UKC. As mentioned, black cottonwood was used rather than red alder as a more suitable tall-large riparian tree species. Black cottonwoods were identified across King County with aerial imagery and high-resolution LiDAR. The maximum height was calculated using highest hit return LiDAR data through a desktop Geographic Information System (GIS) evaluation. Based on the WDFW SPTH geodatabase for Douglas-fir and western hemlock and the measured heights of black cottonwood, the SPTH for 200-year-old trees across riparian areas in King County range from 128 to 243 feet.

A large proportion of UKC streams are located within the Forest Production District (FPD) (Figure 5.2). Because the width of riparian areas in the FPD are largely set by Washington Department of Natural Resources Forest Practices Rules (Title 222 WAC), these areas were not included in further analyses of SPTH data. The primary outcome of excluding the FPD was that most streams in UKC that have SPTH based on western

hemlock are located within the FPD. Across UKC, excluding the FPD, one third of stream miles had an SPTH less than 195 feet, one third between 195 to 205 feet, and one third was greater than 205 feet (Figure 5.3). Approximately 84 percent of UKC stream miles had an SPTH between 180 and 215 feet. Subsequently, based on best professional judgement, a riparian area width of 200 feet was determined to be representative of the SPTH range and a suitable width for riparian area protections. A width of 200 feet was selected because it was the center of the middle third of stream miles (195 to 205 feet) and because 200 feet was the average SPTH for Douglas-fir, western hemlock, and black cottonwood across riparian areas in UKC. Departures from this width across aquatic area types, in relation to the UGA boundary, and in the LMO are discussed in Subsections 5.1.2, 5.1.3, 5.1.5, and 5.4.

Riparian Area Widths and Aquatic Area Types

As noted in Section 5.1, the K.C.C. designates riparian area widths based on aquatic area type. The BAS indicates that there is “no evidence that full riparian ecosystem functions along non-fish-bearing streams are less important to aquatic ecosystems than full riparian ecosystem functions along fish-bearing streams” (Rentz et al. 2020). Specifically, non-fish-bearing streams support unique communities of aquatic and riparian-obligate wildlife and provide movement corridors for wildlife, provision fish-bearing streams with matter and energy, and provide cool water to downstream reaches (Knight 2009; Rentz et al. 2020). The BAS suggests that using aquatic area types based on fish presence for riparian area width alignment may no longer be appropriate. However, it may still be a useful approach for differentiating other Growth Management Act (GMA) policy goals and showing special consideration for salmonids.

Riparian Area Widths Inside and Outside the Urban Growth Area (UGA)

Guidance from WDFW acknowledges that designating riparian area widths based on SPTH may be difficult to implement in urban areas. However, WDFW notes that while challenging for implementation, there is no scientific reason to have different riparian area widths inside the UGA versus outside the UGA. Functions of shade, bank stability, large wood recruitment, nutrient inputs, and pollutant removal operate similarly regardless of land use designation (Rentz et al. 2020). The UGA is a planning boundary, not an ecological one. Additionally, riparian areas inside the UGA may sometimes be more important from a habitat standpoint because within the UGA adjacent uplands are often even more degraded than riparian areas, which means that riparian areas may be the only remaining areas where habitat functions are provided.

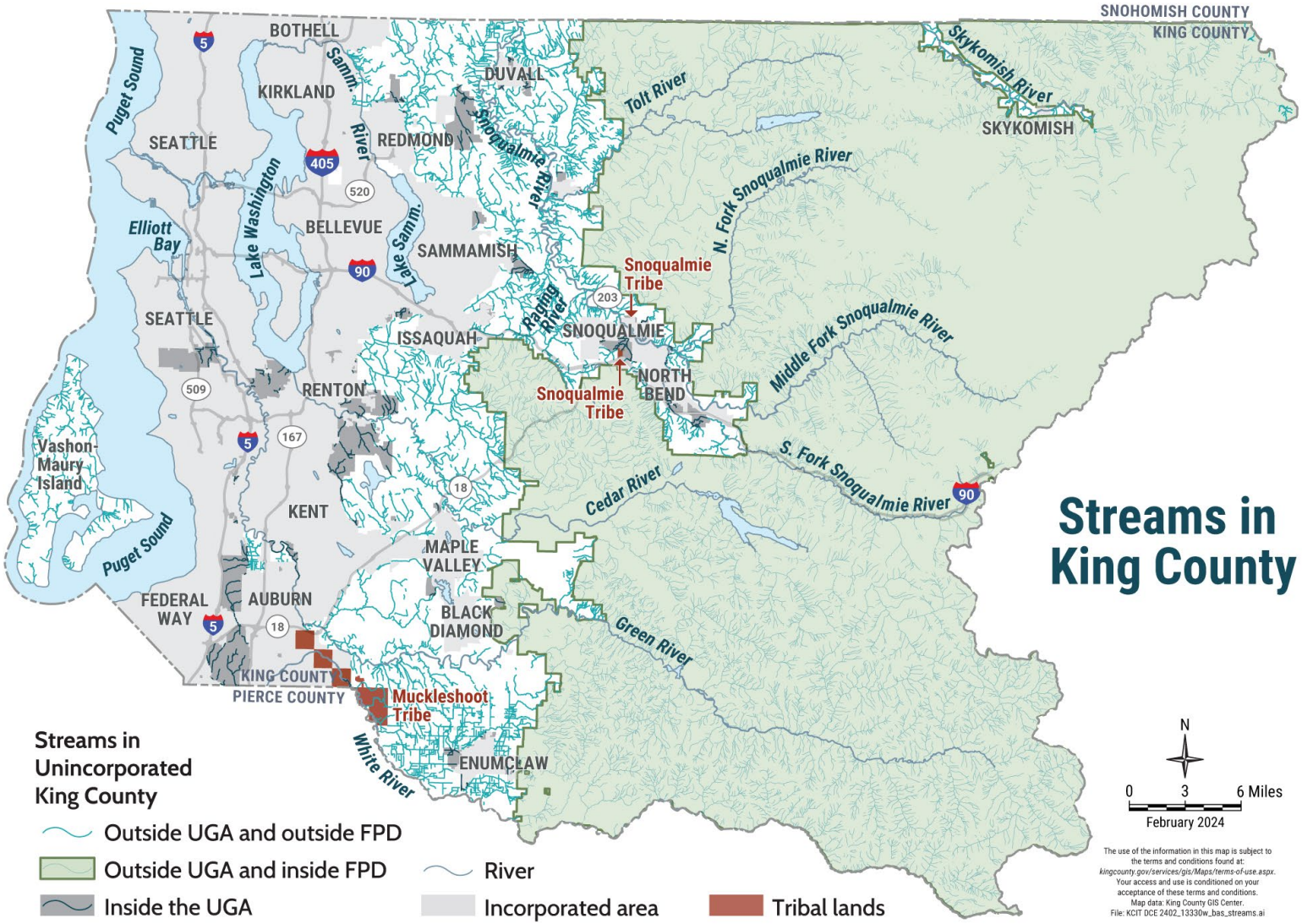


Figure 5.2 Streams in Unincorporated King County, including those inside/outside the Urban Growth Area (UGA) and inside/outside the Forest Production District (FPD).

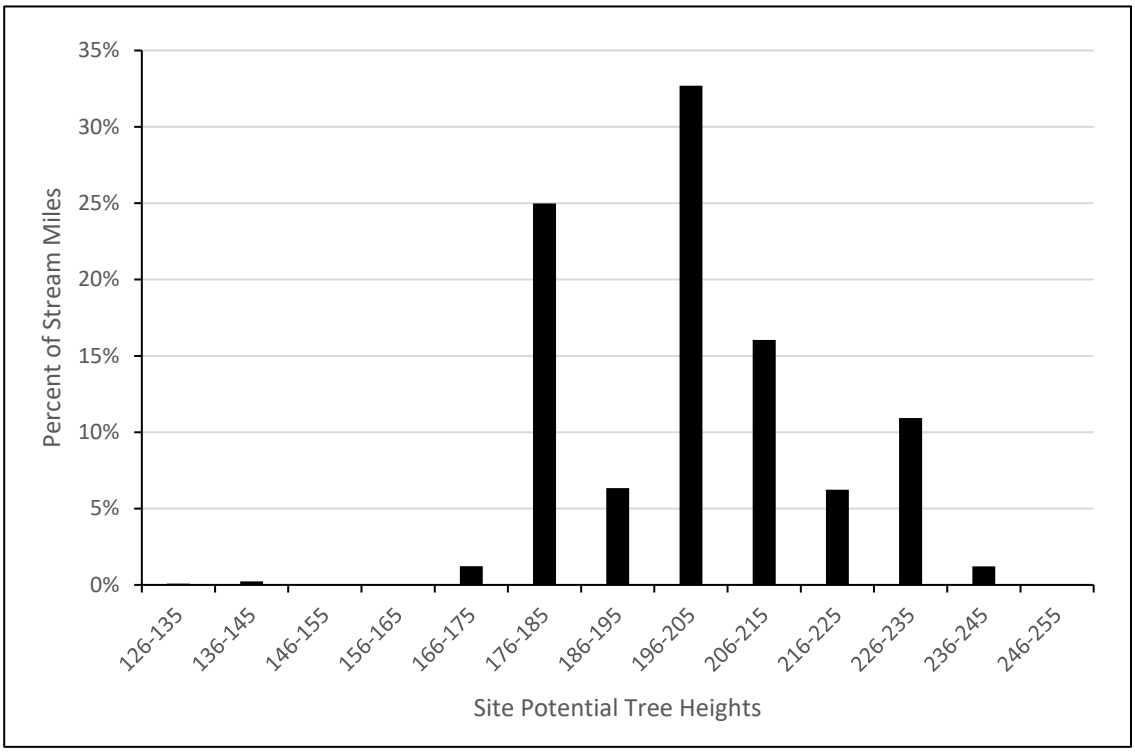


Figure 5.3 Percent of stream miles by site potential tree height of riparian areas for UKC, excluding the Forest Production District.

Riparian Area Connectivity

Maintaining riparian area longitudinal (upstream to downstream) and lateral (river to upland) connectivity is not only important for riparian area functions but is key to functioning salmonid habitat and maintaining stream channel stability (Quinn et al. 2020; Rentz et al. 2020). Riparian area connectivity along aquatic areas is especially important for several riparian functions, including the removal of nutrients, pollutants, and sediment (Scarsbrook and Halliday 1999; Bunzel et al. 2014; Sweeney and Newbold 2014); water temperature control (Rutherford et al. 2004; Cole and Newton 2013); invertebrate prey (Davies and Nelson 1994; Stewart et al. 2001; Wooster and DeBano 2006); and protection of microclimate (Brosofske et al. 1997; Rykken et al. 2007)[1]. Riparian area connectivity is especially important along headwater streams and creeks for several reasons. At the headwaters of the creek, water quality will tend to be at its best as it hasn't accumulated impacts from upstream areas like areas lower in the watershed. Degradation to headwater water quality is generally not improved or mitigated by downstream riparian areas. In addition, the headwater creek channels tend

[1]Microclimate is the smaller-scale climate produced by a combination of sunlight, air temperature, wind, precipitation, and humidity, which can influence many ecosystem processes including air, soil, and water temperatures (Brosofske et al. 1997; Moore et al. 2005).

to be very small and more susceptible and responsive to any impacts in the riparian area.

Despite the importance of connectivity to riparian area functions, there is little evidence-based guidance for managing connectivity and fragmentation aside from a general need to protect entire riparian networks to achieve nearly or completely contiguous riparian areas (Rentz et al. 2020). The impacts from activities along the outer portions of riparian areas (i.e., intrusions into riparian areas) are generally smaller than impacts from activities that entirely dissect riparian areas (e.g., roads, trails, and utility crossings, or livestock water access points) (Figure 5.4). These activities impact the functions of both riparian and aquatic areas. Riparian area connectivity and fragmentation are largely addressed through regulatory riparian area protections; however, direct consideration of connectivity is necessary when evaluating the potential impacts of development proposals that are allowed to intrude into or along riparian areas.

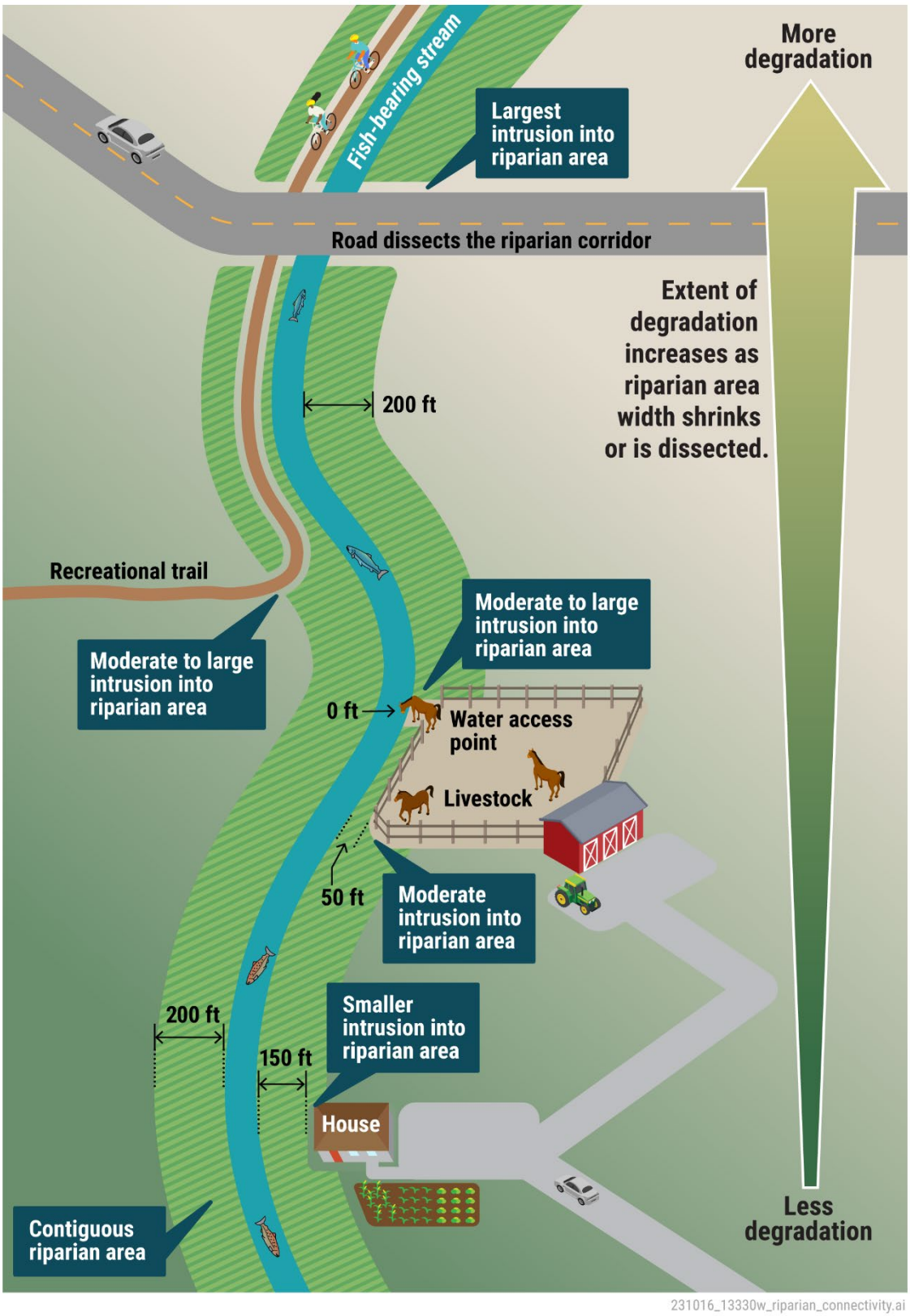


Figure 5.4 Types and relative scale of impacts to riparian area connectivity.

Minimum Riparian Area Widths

Guidance from WDFW recommends that the width of riparian areas should be a minimum of 100 feet (Rentz et al. 2020). While this width only provides a portion of several important riparian area functions, it does provide at least 95 percent pollution removal for phosphorous, sediment, and most pesticides, and 85 percent for surface nitrogen (Rentz et al. 2020; Quinn et al. 2020). The focus on water quality and pollution removal for the minimum riparian area width is based on extensive scientific evidence that riparian areas reduce pollutants, including sediments, excess nutrients, metals, organic compounds such as pesticides, and pathogens (Barling and Moore 1994; Tabacchi et al. 2000; Hickey and Doran 2004; Polyakov et al. 2005; Dosskey et al. 2010). Riparian area widths should be a minimum of 100 feet to be protective of these water quality and pollutant removal benefits. In addition to water quality benefits, a considerable portion of several other riparian functions are also achieved within 100 feet, including large wood recruitment, litter fall, and bank erosion resistance associated with tree roots (FEMAT 1993; Spies et al. 2013; Reeves et al. 2018).

5.1.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating riparian area widths. As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C., it must balance required increases in environmental protections (see Subsection 1.2.1) with the need to satisfy other Growth Management Act (GMA) goals (see Section 1.1) and King County Comprehensive Plan priorities (see Subsection 3.1.1). These goals and priorities include planning for and accommodating housing needs, property rights, and enhancing and conserving agricultural lands.

Increasing the width of riparian areas heightens environmental protections by increasing the distance maintained between permitted land use activities and aquatic areas. By increasing this distance, the amount of land available for activities such as housing development is decreased. Increases in riparian area widths may reduce flexibility around the placement of farm infrastructure and may reduce availability of land for grazing of livestock. Livestock activities within riparian areas are allowed to continue under the K.C.C., with best management practices set forth under the Livestock Management Ordinance.

Regulating Riparian Area Widths by Aquatic Area Type

King County agrees with Quinn et al. (2020) that a 200-year SPTH is an appropriate scalar for determining the width of riparian areas. Using SPTH as the only determinant of width results in highly variable-width riparian areas as soil conditions and tree growth varies across watercourses and watersheds. During the 2004 review of BAS (King County 2004a, 2004b), King County determined that fewer variable-width riparian areas, based on aquatic area types (Table 5.1), reduced the complexity of implementation compared to a fully variable-width approach. King County finds value in continuing to

align riparian area widths with aquatic area types because it corresponds to shoreline regulation, is supported by the prior BAS evaluation (King County 2004a, 2004b), and provides higher riparian protections for fish-bearing aquatic areas. Greater riparian area protections for fish-bearing watercourses demonstrates King County's special consideration for anadromous fish and their habitats, as required by WAC 365-195-925. Higher protections are apparent because most streams in UKC, excluding the FPD, are type S and F aquatic areas.

Regulating Riparian Areas Inside and Outside the Urban Growth Area (UGA)

Current King County stream maps show that there are approximately 5,500 miles of mapped streams, or "stream miles," in UKC. The distribution of stream miles is summarized in Table 5.3 and shown in Figure 5.2.

Table 5.3 Stream distribution in Unincorporated King County.

Area of Unincorporated King County	Stream Miles	Percent
Inside the UGA	100	2%
Outside the UGA (Not within the Forest Production District)	1,300	24%
Outside the UGA (Within the Forest Production District)	4,100	74%
Total	5,500	100%

King County maintains different levels of protection for riparian and aquatic areas inside and outside the UGA (Table 5.1). Riparian area widths are smaller inside the UGA, where 2 percent of stream miles are found (Table 5.3). Riparian areas are wider outside the UGA, where 98 percent of stream miles are found. Approximately 400 miles (8 percent) of streams in UKC outside the UGA are located in areas zoned for agriculture.

Riparian area protections based on aquatic area types and location inside or outside of the UGA is a suitable compromise between balancing critical areas protections with GMA goals (e.g., agriculture and housing development). This approach improves ease of implementation and interpretation for community members. Furthermore, the reduced complexity helps King County to provide a fair, timely, and predictable permitting process.

Critical Areas Screening Trends and Housing Development

Most housing development permit applications processed by King County's Department of Local Services (DLS) now require a critical areas screening. King County reviewed housing development permit data (2019–2021) to determine what percentage of

processed housing permits include critical areas conditions for riparian areas (see Appendix D). Analysis determined that 17 percent of the 933 housing permits processed included critical areas conditions for riparian areas. Any increase in riparian area width will result in greater encumbrances on parcels where riparian areas are already present while also increasing the number of parcels with a riparian area present.

National Flood Insurance Program (NFIP) Requirements

FEMA requires that King County comply with the BiOp for the Puget Sound in order to participate in the National Flood Insurance Program (NFIP). The BiOp requires certain changes in the implementation of the NFIP to ensure compliance with the Endangered Species Act (ESA). Additional information about the BiOp requirements may be found in guidance documents produced by the Washington State Department of Commerce (see Section 2.1).

One pathway for demonstrating compliance with the BiOp is adoption of a FEMA BiOp model ordinance, which the County reviewed as a source of BAS for this report. Riparian area widths in the model ordinance range from 150 to 250 feet with a median value of 200 feet across categories. Larger widths are recommended for shorelines of the state and non-fish-bearing streams with unstable slopes. Smaller widths are recommended for non-fish-bearing streams with stable slopes, lakes, and fish-bearing aquatic areas less than 5 feet wide. King County's 2024 BAS review has determined 200 feet to represent site potential tree height and therefore is a suitable width for riparian area protections (see Subsection 5.1.1). This demonstrates that riparian area widths in the model ordinance are generally aligned with the findings of King County's 2024 BAS review.

King County will demonstrate compliance with the BiOp by completing a "programmatic checklist" that uses this BAS report as supporting documentation to demonstrate the County is implementing all reasonable and prudent alternatives to protect ESA-listed species. As King County updates riparian area widths, it must continue to demonstrate that environmental protections, including riparian area widths, are sufficient to protect ESA-listed species.

5.1.3 Regulatory Updates

Based on 2024 BAS review and comprehensive planning considerations, King County is updating the K.C.C. with increased riparian area widths both inside and outside the UGA. King County will continue to designate riparian area widths based on adjacent aquatic area type. Designating riparian area widths based on aquatic area type (see Subsection 5.1.1) allows King County to efficiently and effectively regulate and protect critical area functions and values while providing a fair, timely, and predictable permitting pathway (see Section 1.1).

Updated riparian area widths for different aquatic areas inside and outside the UGA are summarized in Table 5.4.

Table 5.4 Updated riparian area widths inside and outside the Urban Growth Area (UGA) for Unincorporated King County.

Aquatic Area Type	Description	Riparian Area Widths (feet) inside the UGA		Riparian Area Widths (feet) outside the UGA	
		Previous	Updated	Previous	Updated
Shoreline (S)	Shorelines of the state.	115	180	165	200
Fish (F)	Not S type; contain fish or fish habitat.	115	180	165	200
Non-fish-bearing (N)	Not S or F type; connected by surface water to S or F.	65	100	65	100
Other (O)	Not S, F, or N type.	25	50	25	50

Riparian Area Protections for Shoreline (S) and Fish (F) Type Aquatic Areas

King County's 2024 BAS review determined 200 feet to be a suitable width for riparian area protections (see Subsection 5.1.1). King County is updating riparian area widths for shorelines and fish-bearing aquatic areas outside of the UGA to be 200 feet to align with the County's 2024 BAS review findings.

The County is updating riparian area widths for shorelines and fish-bearing aquatic areas inside of the UGA to be 180 feet. This width reflects the lower end of the distribution of SPTH in UKC (see Subsection 5.1.1 and Figure 5.3). King County's decision to maintain a relatively lower level of protection for riparian areas inside the UGA is informed by comprehensive planning considerations (see Subsection 5.1.2) and supports the County's ability to satisfy the GMA goal that development be encouraged in urban areas (see Section 1.1).

King County's regulatory updates heighten protections for shorelines and aquatic areas that contain fish or fish habitat in UKC. These changes to the K.C.C. are necessary to satisfy GMA requirements that the County protect and ensure no net loss of riparian area functions and values (see Subsection 1.2.1) and demonstrate special consideration for anadromous fisheries (see Subsection 1.2.2).

Riparian Area Protections for Non-fish-bearing (N) Aquatic Areas

King County's 2024 BAS review determined 200 feet to be a suitable width for riparian area protections (see Subsection 5.1.1) and identified WDFW guidance that non-fish-bearing streams be offered equivalent levels of protection as shorelines and fish-bearing aquatic areas (see Subsection 5.1.1).

The County is increasing riparian area widths for non-fish-bearing aquatic areas both inside and outside of the UGA to 100 feet. This aligns with the WDFW recommendation that riparian areas widths should be a minimum of 100 feet to support pollution removal and water quality functions (see Subsection 5.1.1).

King County's decision to implement lower relative levels of protection for non-fish-bearing aquatic areas is informed by comprehensive planning considerations (see Subsection 5.1.2). Through this decision the County satisfies multiple GMA goals by increasing protections for riparian areas, encouraging development in urban areas, limiting regulatory impacts to agriculture, and supporting a timely and predictable permitting process (see Section 1.1).

The County's regulatory updates heighten protections for non-fish-bearing aquatic areas. Protecting non-fish-bearing aquatic areas is important as they provide water, sediment, nutrients, wood, and other materials to downstream fish-bearing aquatic areas. These changes to the K.C.C. improve alignment with BAS and increase protections to help satisfy GMA requirements that the County protect and ensure no net loss of riparian area functions and values (see Subsection 1.2.1) and demonstrate special consideration for anadromous fisheries (see Subsection 1.2.2).

Riparian Area Protections for Other (O) Aquatic Areas

King County is updating riparian area widths for other aquatic areas inside and outside the UGA. Type O aquatic areas do not have a surface connection to Type S, F, or N aquatic areas and primarily infiltrate into the ground. These aquatic areas are infrequently encountered and represent a small minority of aquatic areas in King County.

The County is updating riparian area widths for other aquatic areas both inside and outside of the UGA to 50 feet. This is half of the 100-foot value recommended by WDFW to support pollution removal and water quality functions (see Subsection 5.1.1).

King County's decision to maintain lower relative levels of protection for type O aquatic areas is informed by comprehensive planning considerations (see Subsection 5.1.2). Through this decision the County satisfies multiple GMA goals by increasing protections for riparian areas, encouraging development in urban areas, limiting regulatory impacts to agriculture, and supporting a timely and predictable permitting process (see Section 1.1).

Updated Livestock Management Ordinance Grazing Area Buffer Widths

Maintaining a local, economically viable agricultural industry is a King County priority. King County will continue allowing farmers to raise livestock in riparian areas previously cleared for agricultural use. The portion of the riparian area that livestock are excluded from was previously called a buffer in the LMO but will be updated to be called an LMO

grazing area buffer. To provide greater protection of riparian area functions and to reduce potential impacts to anadromous species, the County is increasing the widths of grazing area buffers (Table 5.5 and Figure 5.5). The increased grazing area buffer widths will generally be required for properties that were not in compliance with the previous LMO code by the end of 2024, agricultural properties converting from crops to livestock, or when a new farm plan is created (as required with a change in ownership).

Table 5.5 Updated Livestock Management Ordinance grazing area buffer widths.

Aquatic Area Type	Grazing Area Buffer Width (feet) with a Farm Plan (K.C.C. 21A.30.045)		Grazing Area Buffer Width (feet) without a Farm Plan (K.C.C. 21A.30.060)	
	Previous	Updated	Previous	Updated
Shoreline (S) or Fish (F)	0–25	40	50	50
Non-fish-bearing (N)	0	35	0	50
Other (O)	0	0	0	0

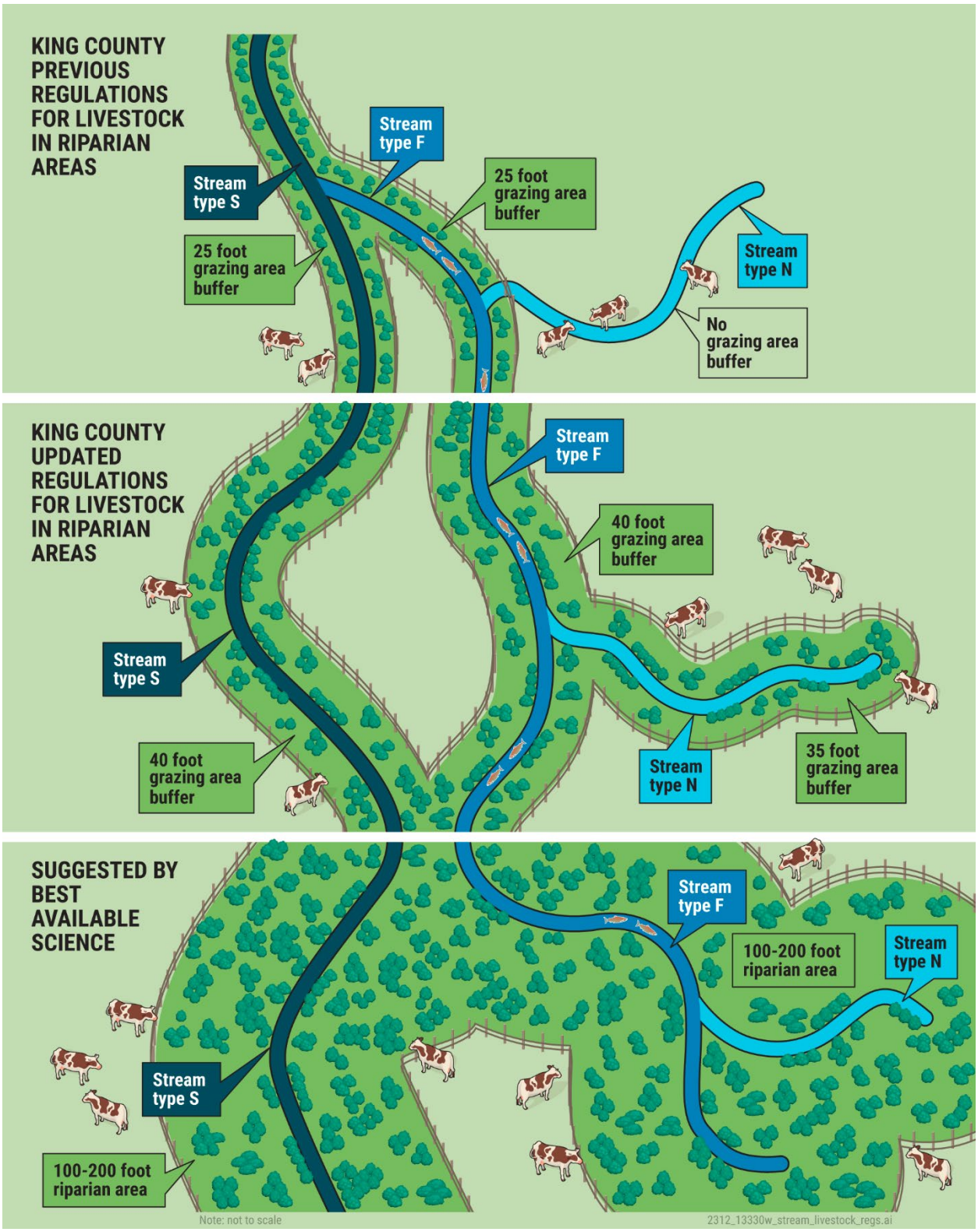


Figure 5.5. Riparian area protections and the Livestock Management Ordinance (LMO) across previous regulations, updated regulations, and best available science.

5.1.4 Risk Assessment of Regulatory Updates

Rationale for King County's riparian areas regulatory updates and how different levels of protection align with GMA requirements and comprehensive planning considerations is discussed previously in Subsections 5.1.2 and 5.1.3. The risks associated with these different levels of riparian area protections are discussed in this subsection.

The risk assessment in this subsection includes a short description of the risk and then uses four factors to describe different aspects of the risk. First is an evaluation of how well the County's proposed updates align with BAS-specific riparian area functions based on the magnitude of the lost function or functions compared to a fully functioning mature riparian area, with larger departures from BAS indicating a higher-risk approach. Second includes the time scale at which the risks operate, with short term being less than 10 years, moderate term being 10 to 25 years, and long term being greater than 25 years. Third, the physical scale at which the risk operates is described by whether the risk is associated with smaller individual sites, or if it applies to a larger area of the landscape. Fourth is a brief description of the staff's level of certainty or confidence associated with the risks. These factors were evaluated and described in the context of the qualitative level of risk, which were binned based on best professional judgement into low-, moderate-, or high-risk approaches.

Nonregulatory measures that reduce and mitigate risks to riparian areas are discussed in Subsection 5.1.5 (see also Section 3.3).

Riparian Area Widths Inside and Outside the Urban Growth Area

As highlighted by King County (2023a), improvements to development policies and regulations over the last 50 years, among other factors, appears to have benefitted stream health (measured through aquatic benthic invertebrate communities) with newer development impacting aquatic communities less than older development. However, new development continues to harm stream health because there remains a strong, negative response of aquatic communities to urban development (King County 2023a). One of the primary drivers of stream health is the extent and condition of riparian vegetation (King County 2019b, 2023a; Quinn et al. 2020). Thus, regulatory updates for riparian areas include increased widths for all aquatic areas both inside and outside the UGA across UKC (Table 5.4 and Table 5.5). Generally, type S and F aquatic areas align with BAS outside the UGA and to a lesser degree inside the UGA. Riparian widths for type N and O aquatic areas depart from BAS both inside and outside the UGA. Riparian area widths for livestock properties, which are primarily found outside the UGA, depart from BAS.

As previously noted, riparian area widths should be based on the SPTH of the tallest and/or most dominant riparian trees. The riparian area widths for types S and F aquatic areas outside the UGA (excluding the FPD) is 200 feet, which aligns with BAS because it is representative of the middle third of SPTHs across stream miles in UKC and because it is the average SPTH for Douglas-fir, western hemlock, and black cottonwood

across riparian areas in UKC (see Subsection 5.1.1). Therefore, King County has high certainty that the updated riparian area widths result in low risk to riparian area functions outside the UGA among type S and F aquatic areas. The riparian area width for type S and F aquatic areas inside the UGA is 180 feet, which largely aligns with BAS though to a lesser degree than for the widths outside the UGA. The riparian area width for type S and F aquatic areas inside the UGA aligns with the lower end of appropriate SPTHs with around 84 percent of King County stream miles having an SPTH between 180 and 215 feet. Evaluation of recent water quality trends data from King County (2023b) indicate that water quality in urban streams is lower than in rural streams. One possible explanation is that the existing lower riparian protections in those areas are inadequate to prevent harm. The updated and increased riparian area widths for aquatic areas inside the UGA may help to minimize further degradation to water quality in urban areas. While the updated riparian area widths will create higher protections, the risk to riparian functions is slightly greater inside the UGA because the riparian area widths align with the lower end of the range of appropriate SPTHs. However, this risk is considered only moderate at the County scale, because only a small number of stream miles are inside the UGA (2 percent of total stream miles across UKC). King County has high certainty that riparian areas adjacent to type S and F aquatic areas will be well protected because the updated riparian area widths are based on King County-specific SPTHs, and because staff believe the majority of the aquatic areas that the County regulates are type S and F aquatic areas.

Across aquatic areas both inside and outside the UGA, there remains moderate to high risk for microclimate and wildlife because the updated riparian area widths are structured around a single SPTH, whereas full protection of these functions probably requires a width equivalent to two to three SPTHs. The risk to microclimate and wildlife is likely long term because areas outside of protected widths may be cleared or altered and not replaced over time. This results in a high confidence that full protection of microclimate and wildlife will not be achieved with the updated riparian area widths. The long-term risk for microclimate is likely magnified by the impacts of climate change. Climate change will likely result in warmer and drier conditions, which may decrease the health of riparian vegetation. To the extent that these climate change impacts cause riparian vegetation to die at higher rates, they will likely reduce the extent and magnitude of riparian microclimate conditions, altering the moderation and cooling of air and aquatic area temperatures. Reducing the extent of riparian areas can influence all riparian functions but will likely have the most impacts on microclimate and wildlife, as these are generally the least protected functions with updated riparian area widths. Animals and plants that may be most impacted by altered microclimate conditions are those that are either extremely sensitive to environmental changes and/or those that are highly dependent on microclimate for their persistence.

Climate change will increase wildfire risk in riparian areas, which directly impacts riparian vegetation, especially along boundaries or edges. Additionally, climate change may increase the incidence of hazard trees and requests to remove them. Due to buildings being built near or within riparian areas in the past along with ongoing allowed alterations of new buildings in riparian areas, select strategies for fire risk reduction,

including hazard tree removal and fire-fuel-free zones, will impact riparian vegetation and reduce riparian area extents. These impacts will become greater as the extent of fire risk reduction measures are increased.

BAS emphasizes that riparian areas along non-fish-bearing streams that flow into fish-bearing aquatic areas are important because they provide water, sediment, nutrients, wood, and other materials to downstream fish-bearing aquatic areas. The updated riparian area width for type N aquatic areas (100 feet) aligns with the minimum width needed for the protection of pollution removal functions. However, the updated type N riparian area width does not align with BAS for protecting all other riparian functions because it is well below the lower end of the range of SPTHs across UKC. The riparian area width for type N aquatic areas applies both inside and outside the UGA. King County has high confidence that the riparian area width for type N aquatic areas results in lower risk for pollution removal functions because the width aligns with the minimum width necessary as detailed in BAS. However, there remains moderate to high risk for other functions like shade, leaf litter and detritus inputs, and large wood recruitment because while a portion of these functions are achieved in the first 100 feet, full functions aren't maximized until the width of a full SPTH. Additionally, large wood recruitment remains a moderate rather than a high risk because the smaller stream width of type N aquatic areas means that relatively smaller pieces of wood can be habitat forming compared to relatively larger wood in larger streams and rivers (type S and F). There is high risk for microclimate and wildlife because of the reasons detailed for type S and F aquatic areas; however, the risk is even greater because the 100-foot riparian area width for type N aquatic areas differs even more from the widths needed for microclimate and wildlife (approximately 400–600 feet).

King County has moderate confidence that there will be low cumulative impacts from the narrower riparian area protections associated with type N aquatic areas. The staff's confidence is only moderate because most type N aquatic areas are not mapped and their extent across the landscape is poorly documented. Based on several fully classified smaller subbasins and best professional judgment, type N aquatic areas are less frequent than type S and F aquatic areas; thus, the limited number of type N aquatic areas results in less risk of cumulative impacts. While a portion of riparian functions can be achieved in the first 100 feet, especially pollution removal, King County has high confidence that there is high risk to riparian area functions over the long term because the areas between 100 feet and SPTH (approximately 200 feet) will lack protections. The long-term risk will be greatest for microclimate and wildlife because of the reasons discussed for type S and F aquatic areas and furthermore because type N riparian widths depart even more from fully protective widths. In summary, the overall risk to type N aquatic areas is considered moderate to high because, aside from pollution removal, there remains considerable risk to other riparian area functions.

The updated riparian area width for type O aquatic areas (50 feet) does not align with BAS nor does it align with the minimum width necessary for pollution removal (i.e., 100 feet). King County has high confidence that while some degree of functions will be achieved, there is at least moderate risk to pollution removal because the riparian area

width for type O aquatic areas is only half the minimum width recommended by BAS. Additionally, King County has high confidence that there is high risk for all other riparian functions because the type O riparian area width is less than a third of appropriate SPTHs. The narrower width provides minimal protections for all riparian area functions. However, the cumulative impacts of these lesser protections are likely minimal because type O aquatic areas occur much less frequently than type S, F, and N aquatic areas and because type O aquatic areas do not have a surface water connection with other aquatic areas. While a small portion of riparian functions can be achieved in the first 50 feet, King County has high confidence that there is high risk to riparian area functions over the long term because the areas between 50 feet and SPTH (approximately 200 feet) will lack protections. Similar to type N aquatic areas, there is high long-term risk to microclimate and wildlife in type O aquatic areas because of the reasons discussed for type S and F aquatic areas and because type O widths have the greatest departure from BAS across all updated riparian area widths. In summary, the overall risk to type O aquatic areas is considered high because of the considerable risk to all riparian area functions. King County employs a broad array of nonregulatory measures to protect critical areas and reduce risk to critical areas functions and values (see Section 3.3 and Section 5.1.5).

Grazing Area Buffer Widths for the Livestock Management Ordinance

As noted in Subsection 5.1.3, the portion of the riparian area that livestock are excluded from was previously called a buffer in the LMO but will be updated to be called an LMO grazing area buffer. This update was intended to resolve confusion with the existing K.C.C. and terminology. A grazing area buffer is a subset of the riparian area that is adjacent to the aquatic area, has previously been cleared, and where the LMO applies.

Water quality was recently evaluated for a limited number of agricultural streams and showed that water quality in these streams is more degraded than streams associated with other land uses (King County 2023b). This higher degradation is associated with higher nutrients and fecal coliform concentrations. While the grazing area buffer widths associated with livestock properties have increased with updates to the K.C.C. for the LMO (Table 5.5), they depart considerably from BAS riparian area widths for all aquatic areas. It should be noted that the updated riparian area widths set forth in Table 5.4 would apply where new grazing areas are being established in areas that haven’t previously been cleared for agriculture. The 50-foot grazing area buffer width for livestock properties is smaller than the updated riparian area widths for type S, F, and N aquatic areas. The alignment is lowest with type S and F aquatic areas, where the LMO grazing area buffer width is one quarter or less than the updated riparian area widths. Consistent with a prior assessment of the K.C.C. and BAS (King County 2004b), the updated LMO grazing area buffer widths represent a significant departure from BAS. While a portion of riparian functions can be achieved in the first 50 feet, there is high certainty that there is high risk to riparian area functions over the long term because areas between 50 feet and SPTH (approximately 200 feet) will lack protections.

The LMO grazing area buffer width of 50 feet can be reduced to 35 or 40 feet if a livestock owner obtains a farm plan (Table 5.5). Requirements for farm plans are included in K.C.C. 21A.24.051 and the King County Farm Plan Public Rule 2005; however, the requirements are limited and topics and BMPs included in each farm plan are negotiated with the landowner and thus vary considerably. King County's 2004 review of the then-proposed Critical Areas Ordinance (CAO) noted that there were high risks to critical areas functions and values using the flexible farm plan approach but determined that risks could be reduced through farm planning, forest clearing limits, and adaptive management of farm plans. The forest clearing limits were later struck down in court and there is no adaptive management plan for the farm planning process.

The LMO grazing area buffer widths of 35 to 50 feet for type S, F, and N aquatic areas are half or less than the minimum width suggested by BAS to address water quality functions. This creates high confidence that there is high risk to riparian area functions that protect water quality. This is especially apparent when considering that these relatively narrow riparian areas are adjacent to lands with large and congregated animals and results in a concentrated source of pollutants, which the 100-foot minimum riparian area width associated with pollution removal is intended to address. In addition, risk remains high because the increased grazing area buffer widths will only be applied to a property under the following limited circumstances. The increased grazing area buffer widths will be required for properties that were not in compliance with the previous LMO code by the end of 2024, agricultural properties converting from crops to livestock activities, when a new farm plan is created (as required with a change in ownership), or if the landowner requests a permit for an associated farm structure on the site. Type O aquatic areas currently have no grazing area buffer protections so there is high risk for all riparian area functions; however, type O aquatic areas are generally infrequent and the least common aquatic area across UKC. Additionally, type O aquatic areas may have slightly lower risk for water quality functions in comparison to other aquatic areas because they are not connected via surface water to type S, F, or N aquatic areas. However, by definition and classification, type O aquatic areas all infiltrate into the ground and thus pose a potential risk to groundwater contamination.

Spatially, the risks associated with the LMO grazing area buffer widths occur mostly outside the UGA because there is very limited raising of livestock occurring inside the UGA. While the risks are somewhat concentrated to the five Agricultural Production Districts, the LMO grazing area buffer widths apply to all livestock properties, not just commercial agricultural properties as other critical areas codes do. This means that the risks associated with LMO grazing area buffer widths are dispersed throughout UKC, with higher risks within the Agricultural Production Districts due to the higher concentration of livestock properties.

King County has high confidence that there will be significant site and cumulative impacts from the limited protections for riparian areas adjacent to livestock properties because the updated widths of all grazing area buffers depart considerably from BAS and the adjacent land use is generally a large source of pollutants. In addition, the updated grazing area buffer widths will only be applied under very limited

circumstances, meaning the previous LMO grazing area buffer widths (25 feet for type S and F; 0 feet for type N) will continue to apply on most properties. There is high risk for microclimate and wildlife because of the reasons discussed for updated riparian area widths long type S and F aquatic areas; however, there is high certainty that the risk is greatest among LMO grazing area buffer widths because these depart the most from widths needed to fully protect microclimate and wildlife.

5.1.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs that offer protections to riparian areas and aquatic areas are discussed at a summary level below. Readers can learn more by visiting linked webpages. The following nonregulatory programs and measures reduce and mitigate the various risks discussed in Subsection 5.1.4.

Critical Areas Monitoring and Adaptive Management

King County is currently protecting critical areas, including riparian areas, through a variety of regulatory and nonregulatory actions. One of the nonregulatory activities the County undertakes is environmental monitoring as it is important to verify that programs and regulations are being implemented fully, and as intended. Accordingly, the GMA encourages Counties to undertake monitoring and adaptive management (MAM) programs to evaluate and improve the effectiveness of critical areas polices and regulations. In general, MAM programs answer key questions, compare outcomes to benchmarks, driving changes that lead to continuous improvement and are useful if the County wants to quantitatively show it is meeting the GMA no net loss requirement or achieving net ecological gain.

Collectively, a MAM program helps to fully understand if and how regulations are protecting riparian areas, their functions, and how regulatory and nonregulatory actions (net effect) influence watershed conditions. Currently, King County implements several monitoring programs or projects that help to address these MAM needs. King County conducted an evaluation of critical area protections in 2007 focused on permit compliance, land use change, stream condition, and ‘build-out’ scenarios (Lucchetti et al. 2014). Components of the evaluation were repeated in 2023 to compare changes in watershed conditions from the prior study (Bower et al. in prep). Both studies can be used as part of a comprehensive MAM program. It would be beneficial to periodically repeat this study to capture changes in watershed conditions related to updated and ongoing regulations.

In addition to this focused study, King County has been monitoring stream health, as represented by benthic macroinvertebrate communities, for over twenty years. This program is statistically robust, representative at the scale of sites, streams, and watersheds, and able to assess current condition and detect changes in stream health.

The stream health monitoring uses, when possible, streamflow data from King County's network of stream and weather measurement stations operated by King County. Results from the extensive stream health monitoring can inform a critical areas MAM program by ensuring that new monitoring locations, measured factors, and analyses are specifically connected to hypotheses and assumptions of critical area regulations.

In addition, King County operates numerous long-term monitoring programs to detect changes in the water quality and aquatic food webs of streams, lakes, and Puget Sound. While these programs were not designed to evaluate critical area regulations, they complement critical areas monitoring by providing context on changes in watershed and water quality conditions.

King County is positioned to integrate targeted studies with long-term monitoring to expand its critical areas MAM efforts. As part of this integration, King County is planning to start status and trends monitoring to document changes in condition of riparian areas. King County's critical area monitoring would be improved by integrating a permit tracking system with the environmental monitoring programs, developed and coordinated between King County's Department of Local Services and Department of Natural Resources and Parks. All of these monitoring programs and studies could help determine the conditions of critical areas, whether regulations are fully implemented and consistently interpreted, permit conditions are met, and actions are being taken to mitigate losses so the County can show it is meeting the no net loss intent of the GMA.

Fencing and Livestock Best Management Practices

King County operates a number of nonregulatory programs to ensure the continued economic vitality of agriculture in the County while reducing impacts to water quality and riparian areas. This includes offering cost sharing for implementation of livestock best management practices (BMPs) aimed at reducing critical areas impacts on agricultural properties with an approved farm management plan. These BMPs include installing fencing to exclude livestock from portions of critical areas or their buffers, revegetating critical areas and critical areas buffers, improving stream crossings, and developing manure management systems.

This nonregulatory program can improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for maintaining and enhancing natural resource industries, environmental protection, and shoreline management.

Snoqualmie River Valley Fish, Farm, and Flood

In 2013, King County launched a collaborative effort (Snoqualmie Fish, Farm, and Flood) to explore the issues that were creating obstacles and conflicts around salmon recovery, flood protection, and agriculture across agricultural areas of the Snoqualmie River valley. The Snoqualmie Fish, Farm, and Flood (also known as FFF) effort established several task forces, including a riparian Buffer Task Force, which was

established in 2018. The Buffer Task force was composed of stakeholders from salmon recovery, agricultural production, and flood risk reduction backgrounds and produced recommendations on the size and location of voluntary restoration of riparian area plantings in the Snoqualmie Valley Agricultural Production District (SVAPD). Plantings are intended to improve ecological conditions for salmon while limiting impacts to and the reduction of the agricultural land base.

The Buffer Task Force riparian restoration recommendations differ from riparian area protections in that they are voluntary and nonregulatory. They are not focused on protecting all riparian functions or full riparian functions but rather providing meaningful ecological lift while minimizing the impact to and loss of agriculture lands. Because the recommendations are a compromise to achieve some riparian restoration, several recommendations depart from BAS for fully functioning riparian areas. Buffer Task Force recommendations do not follow King County's water typing model and instead use 20 distinct classifications of river, watercourse, and other aquatic areas. The full range of Buffer Task Force recommendations can be found in the Balancing Fish, Farm, Floods in King County's Snoqualmie Watershed report (King County 2020). Several assumptions guided the work, including that recommendations would pertain only to voluntary King County funded plantings and not regulatory requirements, and that recommendations would not negate or dismiss existing regulations or BAS.

This nonregulatory effort to restore riparian areas in the SVAPD advances King County's progress in satisfying GMA goals for maintaining and enhancing natural resource industries, environmental protection, shoreline management, climate resiliency, and community coordination.

Clean Water Healthy Habitat

Over the next 10 years, King County will invest more than $9 billion to protect water quality and habitat through implementation of its Clean Water Healthy Habitat (CWHH) Strategic Plan. This investment will benefit King County communities as well as aquatic species such as salmon and orca by retaining and expanding fish habitat and open space while reducing impacts to water quality.

About half of the $9 billion will be allocated to maintaining existing infrastructure, which helps to treat more than 66 billion gallons of wastewater and stormwater each year. King County is working with tribal governments, regulatory agencies, cities, environmental advocates, and community-based organizations to ensure that the investment of remaining funds creates a resilient system that is prepared for a changing climate and a growing population.

This nonregulatory program will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for environmental protection, shoreline management, climate resiliency, open space and recreation, natural resource industries, public facilities and services, and community coordination.

Land Conservation in King County

King County operates nonregulatory open space acquisition programs, such as the Land Conservation Initiative (LCI), using funding from King County's Conservation Futures grant program and other sources. The LCI is a regional collaboration between King County, cities, business associations, agricultural communities, environmental partners, and other groups aimed at preserving the County's last, most important natural lands and urban green spaces over the next 30 years. King County has mapped and prioritized 65,000 acres of land for protection in six categories, including urban green space, trails, natural lands, rivers, farmlands, and forestlands. New protections called for under the Land Conservation Initiative will add to successful conservation efforts that have permanently protected more than 190,000 acres of the King County landscape, including forests, farms, river valleys, wetlands, upland natural areas, and parks for people.

By conserving land across these categories, King County will improve the access to green space in densely populated urban areas, ensure that lower income communities gain better access to natural lands and parks; limit development threats to forests, farms, and areas of ecological importance; and reduce pollution and runoff that puts rivers and salmon habitat at risk.

This nonregulatory program will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for urban growth, reducing sprawl, environmental protection, shoreline management, climate resiliency, open space and recreation, natural resource industries, public facilities and services, and community coordination.

Stream Mapping

King County is updating its stream maps to better illustrate the location, extent, and types of streams present in King County. Updates to these advisory maps inform community members and King County permitting staff of what riparian area development regulations may apply to a given property. In turn, these updated maps improve King County's ability to effectively implement and enforce development regulations that protect riparian areas and aquatic areas. They also support King County's ability to issue development permits in a fair and timely manner. King County mapping resources are available online through King County's interactive mapping tool, King County iMap. In addition, over the next 5 years it is expected that the U.S. Geological Survey will update stream maps across the United States with a higher resolution method, which will likely add considerably more stream miles.

This nonregulatory investment will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for environmental protection, shoreline management, climate resiliency, community coordination, and permitting.

5.2 Riparian Area Boundaries

Riparian area protections (see Section 5.1) can be augmented by including the severe CMZs as part of the riparian area (Figure 5.6). K.C.C. 21A.24.358.A.1. uses the ordinary high-water mark (OWHM) as the primary location to start measuring riparian area widths. However, when a CMZ is mapped, the riparian area protections are extended to the area within the severe CMZ when that zone is larger than the riparian area width measured from the OWHM (K.C.C. 21A.24.358.A.2.). The K.C.C. does not protect riparian areas within the moderate CMZ or along the outer edge of either the severe or moderate zones.

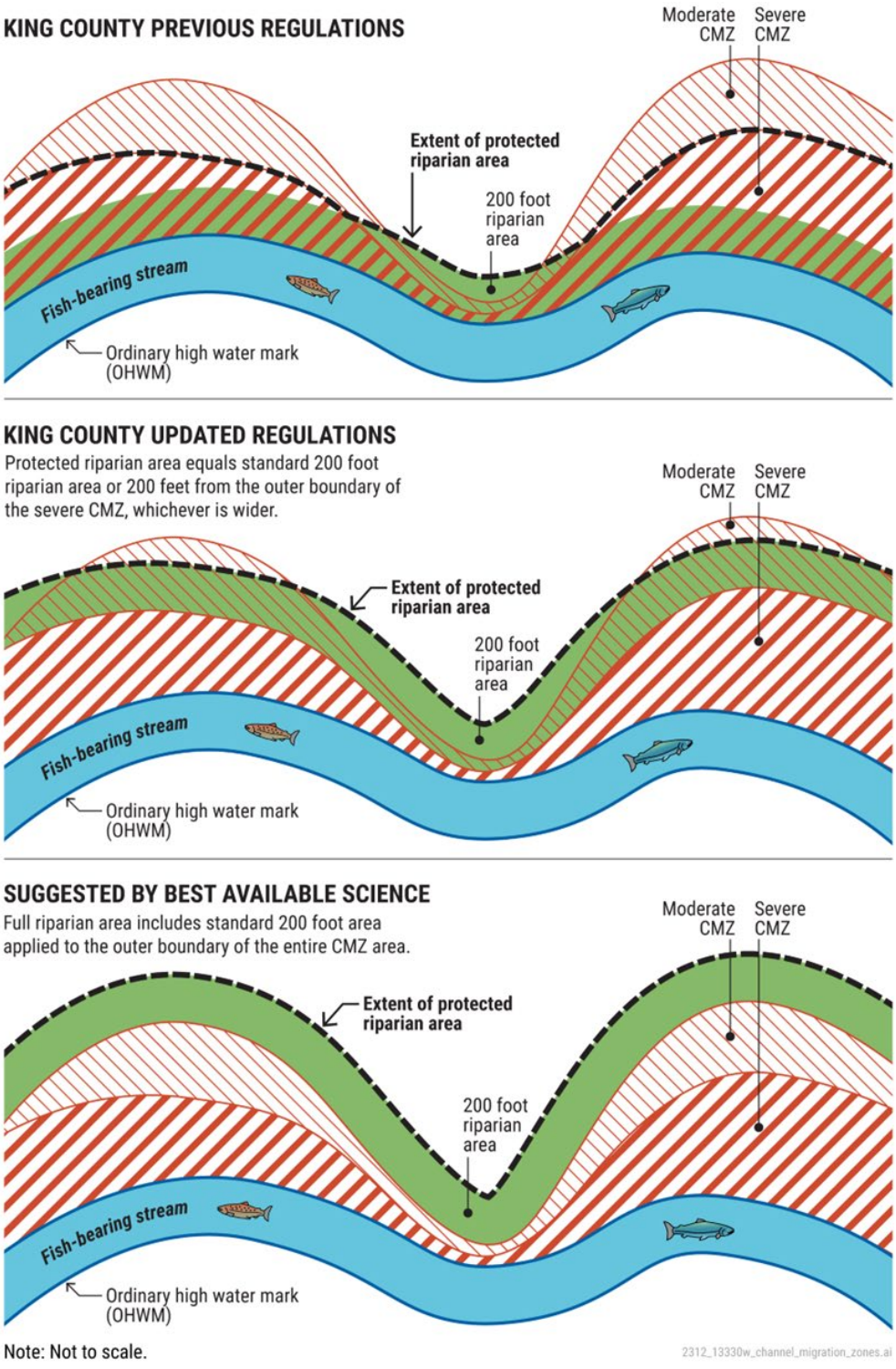


Figure 5.6. Riparian area protections and channel migration zones (CMZs) across previous regulations, updated regulations, and best available science. King County classifies CMZs as either severe (25 – 50 year of migration) or moderate (50 additional years).

5.2.1 2024 BAS Review

King County's 2024 BAS review of riparian area boundaries was informed by Commerce guidance documents, Washington State Department of Fish and Wildlife (WDFW) BAS, King County's 2004 BAS, and supplemental literature. King County primarily used the comprehensive BAS documents produced by WDFW (Subsection 2.2.2) rather than conducting a separate extensive review of all relevant peer-reviewed riparian literature.

WDFW BAS states that riparian areas should be measured from the outside edge of CMZs (Figure 5.6) (Rentz et al. 2020). A CMZ is the area within which a river channel is likely to move laterally over a given period. Where CMZs are not mapped, WDFW BAS states that riparian areas should be measured from the edge of the active channel (Rentz et al. 2020). The active channel is the portion of an aquatic area at the lower limit of continuous riparian vegetation, usually estimated based on the location of the OHWM (Rentz et al. 2020). Including the CMZ in riparian area protections is important because the lateral movement of a channel affects sediment erosion and deposition, local topographic relief, flood inundation patterns, the structural characteristics of the river bed, alluvial architecture, and riparian vegetation patterns, which in turn results in a complex arrangement of aquatic and riparian habitats across a river's floodplain (Naiman et al. 1993; Rapp and Abbe 2003).

Measuring riparian areas from the outer edge of the CMZ is appropriate because it accounts for river migration and acknowledges that the active channel will eventually move to and even past the outer edge of the CMZ. Maintaining riparian vegetation at the edge of the CMZ ensures that the functions of riparian areas are protected in current and future locations as rivers migrate (Rentz et al. 2020). If no riparian vegetation is maintained at the outer edge of the CMZ, ecological conditions will degrade as the river migrates and result in a loss of ecological function.

Most rivers and streams in King County migrate but do not have mapped CMZs. Where mapped, King County classifies moderate and severe CMZ hazard areas rather than a single hazard area as described by WDFW (Rentz et al. 2020). King County's CMZ mapping methods have changed since the County's 2004 BAS review (King County 2004a, 2004b). In 2004, the severe CMZ accounted for an estimated 100 years of channel migration (King County 2004a). In the current classification method, the severe CMZ accounts for an estimated 25 to 50 years of channel migration. The moderate CMZ represents an additional 50 years of channel migration outside of the severe CMZ (Designation, Classification and Mapping of Channel Migration Zones, King County Public Rule 2020; personal communication Judi Radloff).

5.2.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating riparian area protections. As King County updates its Comprehensive Plan

policies and associated development regulations found in the K.C.C., it must balance required increases in environmental protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1) and King County Comprehensive Plan priorities (see Section 3.1.1).

Expanding riparian area protections in areas prone to channel migration heightens environmental protections and reduces risks to public health and safety. By increasing the area in which riparian area protections apply, the amount of land available for activities such as housing development and agriculture is decreased. Increases in riparian area widths may reduce flexibility around the placement of farm infrastructure and may reduce availability of land for grazing of livestock. Existing grazing activities within riparian areas are allowed to continue under the K.C.C., with limitations set forth under the LMO (see Section 5.1).

CMZ Hazards and Mapping in King County

Channel migration can happen over years, decades, or centuries as a river moves sand and gravel from one side of a riverbank to the other. Channel migration can also happen as an abrupt movement of the river to a new location, which is called an avulsion. An avulsion can happen in a single flood event.

There are many areas in King County where migrating river channels may endanger houses, barns, roads, bridges, and other development and land uses that were built within the CMZ. To better understand natural channel migration processes and assess risks to public health and safety, King County has studied CMZs along local rivers since the 1990s. King County continues to study channel migration, hosting public meetings to review and gather comment on draft maps as they are produced.

Current CMZ maps are prepared using mapping methods specified in the King County Channel Migration Zone Public Rule, consistent with the King County Flood Hazard Management Plan, Washington State Shoreline Management Act, and the Washington State Department of Ecology Channel Migration Assessment. A summary of channel migration hazard mapping in King County is available online.

National Flood Insurance Program (NFIP) Requirements

FEMA requires that King County comply with the BiOp for the Puget Sound in order to participate in the NFIP. The BiOp requires certain changes in the implementation of the NFIP to ensure compliance with the Endangered Species Act (ESA). Additional information about the BiOp requirements may be found in guidance documents produced by the Washington State Department of Commerce (see Section 2.1).

In compliance with the BiOp, King County will complete a “programmatic checklist” that uses this BAS report as supporting documentation to demonstrate the County is implementing all reasonable and prudent alternatives to protect ESA-listed species. As King County reviews and proposes updates to critical areas regulations, it must

continue to demonstrate that environmental protections, including riparian area widths and CMZ protections, regulations, policies, and nonregulatory actions, are sufficient to protect ESA-listed species.

Based on the BAS review, the County is updating standards applied to new development in riparian areas and wetlands to strengthen protection of critical areas functions and values with special consideration to salmonids. To protect ESA-listed species and reduce risks to public health and safety, King County also maintains special development regulations for areas of severe and moderate CMZ hazard. New development is not allowed within the severe hazard area of the CMZ and new development may be restricted within the moderate hazard area of the CMZ. A summary of channel migration hazard regulations in King County is available online. Development regulations that offer protections to CMZs are primarily found in K.C.C. Chapter 21A.24. Based on BAS review, King County is proposing updates to how riparian areas widths are applied to areas with mapped CMZs. As noted above, the County is also proposing updates to standards for Frequently Flooded Areas to better support salmon habitat restoration and fish passage projects, which are key nonregulatory actions that are part of the County's strategy for ensuring no net loss of critical areas functions and values and for advancing commitments for salmon recovery.

5.2.3 Regulatory Updates

King County is updating the K.C.C. to expand riparian area protections to include more of the channel migration zone. As noted in Section 5.2, the existing riparian area protections in K.C.C. include the area within the severe CMZ hazard area if that area is wider than the protected riparian area width. The updated K.C.C. will extend riparian area protections outside the severe CMZ hazard area to include the riparian area width associated with the adjacent aquatic area as measured from the outer edge of the severe CMZ where mapped. All currently mapped CMZs are located along type S aquatic areas, which equates to a 200-foot riparian area or 200 feet from the outer edge of the severe CMZ, whichever is wider (Figure 5.6).

5.2.4 Risk Assessment of Regulatory Updates

Rationale for King County's riparian areas regulatory updates and how different levels of protection align with GMA requirements and comprehensive planning considerations is discussed previously in Subsections 5.2.2 and 5.2.3. The risks associated with these different levels of riparian area protections are discussed in this subsection. Nonregulatory programs and measures that can reduce and mitigate risk are discussed in Subsection 5.2.5.

The risk assessment in this subsection includes a short description of the risk and then uses four factors to describe different aspects of the risk. First is an evaluation of how well the County's proposed updates align with BAS-specific riparian area functions based on the magnitude of the lost function or functions compared to a fully functioning mature riparian area, with larger departures from BAS indicating a higher-risk approach.

Second includes the time scale at which the risks operate, with short term being less than 10 years, moderate term being 10 to 25 years, and long term being greater than 25 years. Third, the physical scale at which the risk operates is described by whether the risk is associated with smaller individual sites, or if it applies to a larger area of the landscape. Fourth is a brief description of staff's level of certainty or confidence associated with the risks. These factors were evaluated and described in the context of the qualitative level of risk, which were binned based on best professional judgement into low-, moderate-, or high-risk approaches.

Development regulations in the K.C.C. do not fully align with BAS because riparian areas are not measured starting at the outer edge of the entire CMZ. The K.C.C. only accounts for a portion of the CMZ where they are mapped, and most streams and rivers have not had CMZs delineated.

For areas with mapped CMZs, the riparian area width is measured from the OHWM or from the edge of the severe CMZ hazard area, whichever is wider. The riparian protections do not apply to the moderate CMZ hazard area or areas outside the moderate hazard area unless those areas overlap with the riparian area as measured from the outer edge of the severe CMZ (see Figure 5.6). Because most of King County's mapped CMZs have wide severe CMZ hazard areas and relatively narrower moderate CMZ hazard areas, the overall risk of not extending riparian area protections to the moderate CMZ hazard area is low within the near to moderate time frames. This is partly because the Public Rule, Designation, Classification and Mapping of Channel Migration Zones, King County 2020, indicates that King County should update CMZ maps every 20 years; however, this is not required in K.C.C. Updating the CMZ maps might reduce the overall risk to the outer edge of the CMZ because the area that is protected as riparian area will shift with the updated CMZ maps, but that is highly dependent on if prior unprotected areas have stayed undeveloped. While updating CMZ maps every 20 years will likely reduce the risks to some degree, it does not address that some rivers have migrated beyond the severe CMZ hazard area within a single flood event, and that those areas will be unprotected from future degradation until the CMZ maps have been updated. Thus, in the long term, there is high confidence that there is at least moderate risk that riparian areas adjacent to migrating channels will not be fully protected because of several factors including that the K.C.C. does not measure riparian areas starting at the outer edge of the entire CMZ, the severe CMZ only represents 50 years or less of channel migration, and CMZ maps may only be updated approximately every 20 years. In summary, for riparian areas with mapped CMZs there is low near-term risk and moderate long-term risk of degradation to riparian and aquatic area functions because riparian area protections are limited to the outer edge of the severe CMZ hazard area rather than the outer edge of the full CMZ.

Furthermore, most rivers and streams migrate, and migrating rivers are critical habitat for important for anadromous salmonids, but only a few river reaches have had CMZs mapped by King County. This means that the majority of King County's riparian areas will be measured from the OHWM, with no riparian protections for areas of future channel migration. Thus, there is high certainty that King County riparian area

protections will be smaller than BAS suggests, resulting in a net loss of ecological function over moderate to longer time frames as those rivers and streams migrate into unprotected areas. The cumulative effect is that when most rivers and streams migrate beyond the protected riparian areas, they will eventually experience a degraded or very degraded riparian condition that will lead to a loss of some aquatic area functions.

5.2.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. Such approaches reduce and mitigate the various risks discussed above in Subsection 5.2.4. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs that offer protections to riparian areas and aquatic areas are discussed at a summary level below.

Channel Migration Zone Mapping

As noted above, the County recommends that currently mapped channel migration areas be remapped approximately every 20 years. Updates to these advisory maps inform community members and King County permitting staff of safety risks as well as where riparian area development regulations may apply to a given property. In turn, these updated maps improve King County's ability to effectively implement and enforce development regulations that protect riparian areas and aquatic areas. They also support King County's ability to issue development permits in a fair and timely manner. King County mapping resources are available online through King County's interactive mapping tool, King County iMap. This nonregulatory investment will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for safety, environmental protection, shoreline management, climate resiliency, community coordination, and permitting.

Stream Mapping

See Subsection 5.1.4 for discussion of updates to King County stream mapping.

5.3 Riparian Area Compensatory Mitigation

King County requires permittees to follow a mitigation sequence (K.C.C. 21A.24.125 and 21A.25.080) for any impacts to critical areas. Mitigation is a sequence of steps used to reduce the severity of negative impacts from activities that could individually or cumulatively impact an environment. Compensatory mitigation is the stage of the mitigation sequence where impacts to the functions and values of an environment are replaced through creation, restoration, or enhancement of similar environment(s). Compensatory mitigation is intended to offset unavoidable adverse impacts that remain after all appropriate and practicable avoidance and minimization has been achieved.

Previous King County requirements (K.C.C. 21A.24.380; framed as "aquatic area – specific mitigation requirements") focused on addressing adverse impacts to both riparian and aquatic areas with specific compensatory mitigation ratios set to achieve equivalent or greater ecological functions. The compensatory mitigation ratios were set based on the area of mitigation to area of alteration. Compensatory mitigation ratios for riparian areas differ based on adjacent aquatic area type and whether mitigation takes place on site or off site (Table 5.6).

Table 5.6 Previous riparian area Compensatory Mitigation Ratios (area of mitigation to area of alteration).

Adjacent Aquatic Area Type	On-site Compensatory Mitigation Ratio	Off-site Compensatory Mitigation Ratio
Shoreline (S) and Fish (F)	1:1	3:1
Non-fish-bearing (N) and Other (O)	1:1	2:1

5.3.1 2024 BAS Review

King County's 2024 BAS review for riparian area compensatory mitigation was informed by Washington State Department of Fish and Wildlife BAS, King County's 2004 BAS report, BAS documents produced by the Washington State Department of Ecology (Ecology 2005, 2021), and supplemental literature.

BAS emphasizes that jurisdictions should acknowledge impacts to riparian areas from clearing, grading, and filling in addition to the direct and indirect impacts from allowed alterations or alteration exceptions (Rentz et al. 2020). When encroachment and impacts to riparian areas occur, the mitigation sequence (WAC 197-11-768) should be followed: 1) avoid impacts, 2) minimize impacts, 3) rectify impacts, 4) reduce or eliminate impacts, and 5) compensate for or mitigate impacts. When compensatory mitigation is necessary, an appropriate quantity of mitigation should be identified and generally equates to a ratio of area of impact to area of mitigation or compensation (i.e., mitigation ratio) (Ecology 2021). The most detailed and comprehensive guidance for mitigation ratios pertain to wetlands and aquatic areas; however, the general principles and considerations are also broadly applicable to riparian area mitigation.

Mitigation ratios can be based on a range of factors, including compensation mechanism (e.g., restoration or preservation), equivalence of the mitigation (in-kind or out-of-kind), conservation significance (unique or common), location (on site or off site), time lags between project impacts and mitigation maturity (temporal loss), and risks of mitigation failure (uncertainty) (Moilanen et al. 2009; McKenney and Kiesecker 2010; Maron et al. 2012; Ecology 2021). Even with consideration of these factors, there can be unavoidable time lags before replacement functions are realized (Zedler and Callaway 1999; Hilderbrand et al. 2005; Morris et al. 2006), future functions could be less than estimated (Moilanen et al. 2009), and it may be inadequate to compensate

immediate loss with hypothetical gains in the future (Moilanen et al. 2009; Quétier and Lavorel 2011). Given the complexity, there is less certainty around how large the mitigation ratios need to be to achieve no net loss of ecological functions.

Generally, the greater the mitigation ratio, the higher likelihood of mitigation success. The amount of mitigation should almost always be greater than the area of impact (i.e., greater than a 1:1 ratio) and the most common reason cited for successful mitigation is having relatively high mitigation ratios (Quigley and Harper 2006; Moilanen et al. 2009; Moilanen and Kotiaho 2021). A basic mitigation ratio of 3:1 can help account for replacement, risk of failure, and temporal loss (Ecology 2005; Ecology 2021). Mitigation ratios below 3:1 are considered to be generally inadequate to support mitigation success (Minns and Moore 2003; Quigley and Harper 2006; Bradford 2017; Moilanen and Kotiaho 2021). Additionally, off-site mitigation ratios should be even greater due to the chance that off-site areas are too dissimilar to support the same conditions, functions, and biodiversity that was lost (Tallis et al. 2015). However, off-site mitigation that occurs at larger scales and provides contiguous, well-functioning areas may provide similar or greater benefits than small-scale or fragmented on-site mitigation.

Pairing riparian area mitigation ratios with additional ecological enhancements provides near-term compensation for lost functions and greater confidence in mitigation success. Ecological enhancements can improve the processes, structure, and functions of riparian and aquatic areas and can help to directly offset temporal loss of functions. Enhancements can include, but are not limited to, placing large wood in aquatic, riparian, and floodplain areas; restoring main-channel, off-channel, or floodplain habitat; removing fish passage barriers or aquatic area crossings; removing shoreline armoring; planting areas lacking native vegetation, including those contiguous and adjacent to riparian areas; removing and managing invasive or noxious plant species; adding wildlife snags; removing floodplain fill; mitigation banking; and others (Knight 2009; Maron et al. 2012; ELI 2016; Ecology 2021).

King County continues to follow the mitigation sequence (WAC 197-11-768; K.C.C. 21A.24.125 and 21A.25.080). When impacts to aquatic and riparian areas require compensatory mitigation, the mitigation must achieve equivalent or greater biological functions than the area impacted by development (K.C.C. 21A.24.380). The K.C.C. emphasizes that riparian area compensatory mitigation should be on site when practical. When off site is necessary, the compensatory mitigation should be within the same drainage basin or shoreline reach and should have greater mitigation ratios than on-site mitigation. King County (2004b) previously highlighted that appropriate mitigation ratios paired with enhancements may provide greater confidence in mitigation success.

5.3.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating riparian area widths. As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C., it must balance required

increases in environmental protections (see Subsection 1.2.1) with the need to satisfy other GMA goals (see Section 1.1) and King County Comprehensive Plan priorities (see Subsection 3.1.1).

Increasing riparian area mitigation ratios helps ensure that unavoidable adverse impacts to riparian areas are appropriately offset. These heightened regulatory requirements expand environmental protections and help King County meet the GMA requirement that local jurisdictions ensure no net loss of critical area functions and values.

Increasing mitigation requirements may increase the costs of select development and land use practices on private properties encumbered by riparian areas. Changes to compensatory mitigation ratios do not impact the costs of development and land uses that are able to address adverse impacts to riparian areas through mitigation sequencing steps, including avoiding, minimizing, rectifying, or eliminating adverse impacts to riparian areas. Maintaining riparian area mitigation ratios also enables King County to allow for reasonable use of private property (see Subsection 3.1.3).

5.3.3 Regulatory Updates

King County is updating the K.C.C. to include riparian area mitigation criteria specific to the functions, values, and design criteria for riparian areas as well as revising both on-site and off-site compensatory mitigation ratios. Riparian area compensatory mitigation ratios will increase for all aquatic area types, both on site and off site (Table 5.7). In addition, on-site mitigation will include a new alternative pathway to mitigate impacts that includes smaller compensatory mitigation ratios combined with a choice of required supplemental actions (Table 5.8). These updates are informed by King County's 2024 BAS review and help ensure mitigation actions account for impacts to critical area functions and values (see Section 1.2.1).

Table 5.7 Updated riparian area Compensatory Mitigation Ratios (area of mitigation to area of alteration).

Adjacent Aquatic Area Type	On-site Compensatory Mitigation Ratio		Off-site Compensatory Mitigation Ratio	
	Previous	Updated	Previous	Updated
Shoreline (S)	1:1	3:1	3:1	4:1
Fish (F)	1:1	3:1	3:1	4:1
Non-fish-bearing (N)	1:1	3:1	2:1	4:1
Other (O)	1:1	2:1	2:1	3:1

Table 5.8 Alternative On-site Mitigation Ratios with required supplemental actions.

Adjacent Aquatic Area Type	Trees and Shrubs	Non-woody Vegetation or No Vegetated Cover
S, F, and N	2:1 ratio with at least one primary action or three secondary actions	1:1 ratio with at least two secondary actions
O	1:1 ratio with at least one primary action or two secondary actions	1:1 ratio with at least one secondary action

Primary actions:

a) Placing large wood in adjacent aquatic areas, if not associated with shoreline stabilization or flood protection facilities;
b) Removing a fish passage barrier, if not required by the development permit;
c) Removing an aquatic area transportation crossing, such as roads, bridges, or trails, and revegetating as appropriate. Utility crossings are not included under this action, unless their removal is part of an integrated transportation crossing removal project;
d) Removing shoreline armoring, revetments or levees; or
e) Other similar actions as determined by the department.

Secondary actions:

a) Planting native trees and shrubs in areas of riparian area addition lacking native vegetation that are adjacent to and contiguous with existing riparian areas, within an area equal to one-half of the area of impact. This action cannot be applied where the riparian area addition requires enhancement to achieve equal function to the impact area;
b) Placing large wood in riparian areas or an adjacent floodplain;
c) Treating or removing invasive and noxious plant species within an additional area equal to one-half of the area of impact and replanting with native species as necessary to prevent regrowth of noxious species. This action may only be applied if at least one other secondary action is also implemented;
d) Installing wildlife snags or similar wildlife nesting or rearing habitat;
e) Removing floodplain fill and replanting with native vegetation as appropriate; or
f) Other similar actions as determined by the department.

5.3.4 Risk Assessment of Regulatory Updates

Rationale for King County's riparian areas regulatory updates and how different levels of protection align with GMA requirements and comprehensive planning considerations is discussed previously in Subsections 5.3.2 and 5.3.3. The risks associated with these different levels of riparian area protections are discussed in this subsection. Nonregulatory programs and measures that can reduce and mitigate risk are discussed in Subsection 5.3.5.

The risk assessment in this subsection includes a short description of the risk and then uses four factors to describe different aspects of the risk. First is an evaluation of how well the County's proposed updates align with BAS-specific riparian area functions based on the magnitude of the lost function or functions compared to a fully functioning

mature riparian area, with larger departures from BAS indicating a higher-risk approach. Second includes the time scale at which the risks operate, with short term being less than 10 years, moderate term being 10 to 25 years, and long term being greater than 25 years. Third, the physical scale at which the risk operates is described by whether the risk is associated with smaller individual sites, or if it applies to a larger area of the landscape. Fourth is a brief description of staff's level of certainty or confidence associated with the risks. These factors were evaluated and described in the context of the qualitative level of risk, which were binned based on best professional judgement into low-, moderate-, or high-risk approaches.

Updates to the K.C.C. for riparian area compensatory mitigation are informed by BAS and best professional judgement because there is no specific WDFW guidance on riparian area mitigation ratios. As recommended by WAC 365-195-920, with limited guidance and information, a precautionary approach should be taken for critical areas protections. King County followed this approach when determining updated riparian area compensatory mitigation ratios. Previous King County riparian area mitigation ratios do not align with BAS because they do not account for temporal loss and uncertainty in mitigation success (risk of failure). King County's updates for riparian area mitigation ratios are in better alignment with BAS because they are within the range of mitigation ratios in BAS that account for replacement of lost or impacted area, temporal loss, and uncertainty in mitigation success. Increasing riparian area mitigation ratios will help support mitigation success in achieving equivalent or greater functions. Additionally, having different mitigation ratios based on aquatic area types helps to align mitigation with expected functions likely achieved for each aquatic area type.

Higher off-site mitigation ratios than on-site ratios align with BAS because there is even greater uncertainty with off-site mitigation as areas may or may not provide similar functions and conditions as on-site areas. Previous King County off-site riparian area mitigation ratios were greater than on-site ratios to prioritize on-site mitigation and to partially account for uncertainty in off-site conditions and success. However, further increasing off-site mitigation ratios will provide even greater certainty and help mitigate for temporal loss of riparian area functions and values. Off-site mitigation that occurs at larger scales can provide contiguous, well-functioning areas, which may provide comparable benefits. Having higher off-site mitigation ratios will help ensure that mitigation occurring off-site is at an appropriate scale and extent.

As highlighted in BAS, pairing mitigation ratios with supplemental actions can provide near-term compensation for lost functions and greater confidence in mitigation success. The alternative compensatory mitigation strategies added to the K.C.C. will provide flexibility for applicants with reduced area-based mitigation ratios. However, these ratios are paired with required supplemental actions to ensure adequate compensatory mitigation. Including supplemental actions will help to offset the lower area-based mitigation requirements because the specific supplemental actions are known to directly benefit riparian and aquatic area functions.

BAS emphasizes that use of mitigation to achieve no net loss of functions is difficult and comes with a high risk of failure. It is difficult to know how large mitigation ratios should be to achieve no net loss. A comprehensive accounting for all relevant mitigation factors can result in very large mitigation ratios. Generally, increasing mitigation ratios reduces risk and improves the likelihood of mitigation success. King County's updated mitigation ratios likely have moderate, longer-term risk to impaired or lost riparian functions. Moderate risk remains because potential future functions may be less than expected or inadequate to compensate for immediate and temporal loss of riparian area functions. Additionally, longer-term risk remains because riparian trees take considerable and variable time to mature and related riparian functions develop across various time horizons. These risks are likely magnified with climate change because future conditions are expected to be less suitable for fully functioning riparian areas, climate change may impact riparian vegetation health, and newly established smaller vegetation may be less resilient to extreme environmental changes.

Risk will likely be at a site-by-site scale based on where mitigation is needed, the suitability of mitigation sites, and the extent of mitigation planning, construction, and monitoring. Off-site mitigation may have greater risk than on-site because conditions and habitats may be too dissimilar to support equivalent functions. However, off-site mitigation in appropriate and well-functioning mitigation banks, reserves, and conservation areas can increase certainty of successful mitigation. Supplemental actions may reduce risk because riparian and aquatic functions can be realized in the near term. Additionally, supplemental actions may help provide functions that are equivalent or greater than those being impacted.

5.3.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. Such approaches reduce and mitigate the various risks discussed above in Subsection 5.3.4. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs that offer protections to riparian areas and aquatic areas are discussed at a summary level below.

Stream Mapping

See Subsection 5.1.4 for discussion of updates to King County stream mapping.

5.4 Summary and Assessment of Updates

A summary assessment of regulatory updates discussed in Section 5 is discussed below. The assessment includes review of increased protections for riparian areas, remaining risks to critical areas functions and values, and the County's demonstration of compliance with no net loss and special consideration for anadromous fisheries mandates.

5.4.1 Primary Improvements to Riparian Area Protections with Updated Riparian Area Widths in the King County Code

Updated riparian area widths in the K.C.C. provide improved protections of riparian area functions and values that better align with BAS. Aligning type S and F aquatic areas with appropriate SPTHs provides additional protections compared to prior riparian area widths, with benefits realized both inside and outside the UGA. While the riparian area width for type S and F aquatic areas is smaller inside the UGA than outside the UGA, the increase from prior widths is relatively greater inside the UGA. Type N aquatic areas have a modest increase in additional protection because they align with the minimum widths for water quality functions, specifically pollution removal, but will have lesser benefits for other riparian functions because the updated width is only half the SPTH. Type O aquatic areas will have the least improvement in additional protection. While type N and O aquatic areas will have smaller riparian area widths, they are generally less frequent across the landscape. The greatest overall increase in riparian area protections will be in rural type S and F aquatic areas because the riparian widths more closely align with BAS and because these are the most common aquatic area types in UKC. Updated grazing area buffers widths in the K.C.C. related to livestock properties (i.e., LMO) will provide minimal additional protections because updated widths will only apply in limited circumstances, are only half of or less than the minimum recommended water quality riparian area width, and are only a quarter of the SPTH. In sum, updated riparian area widths in the K.C.C. more closely align with BAS than the previous widths and provide improved protection for riparian area functions.

The updated riparian area compensatory mitigation requirements will result in improvements in offsetting unavoidable adverse impacts from development in riparian areas because previous riparian area mitigation ratios in K.C.C. are insufficient to ensure the County meets GMA requirement for no net loss of riparian area functions and values. Increasing both on-site and off-site compensatory mitigation ratios will provide certainty that mitigation will address impacts and achieve equivalent or greater functions. Maintaining greater off-site mitigation ratios than on-site will continue to account for greater uncertainty associated with off-site areas. Including alternative on-site mitigation ratios with required supplemental actions will improve mitigation success because supplemental actions provide functions that can be realized in the near term and are equivalent to or greater than those being impacted. Increased mitigation requirements align with BAS and will help King County meet the GMA no net loss requirement for ecological functions.

5.4.2 Remaining Risks Associated with Riparian Area Width Updates in the King County Code

Updating riparian area widths in the K.C.C. provide improved protections for riparian areas; however, there are several components of the updated riparian area widths that do not fully align with BAS and create risks for the long-term protection of riparian area functions and values (see Sections 5.1.4, 5.2.4, and 5.3.4). The primary remaining risks

to riparian area functions associated with the updated riparian area widths are briefly summarized below.

The updated riparian area width for type N aquatic areas (100 feet) is a moderate-to-high risk approach that aligns with the minimum width needed for the protection of pollution removal functions but does not align with BAS for protecting all functions because the width is well below the lower end of SPTHs in UKC. There is high certainty that over the long term, riparian area functions will be lost because areas between 100 feet and SPTH (approximately 200 feet) will lack protections.

There is high certainty that high risk remains for all riparian area functions on livestock properties, especially water quality functions, with the updated LMO grazing area buffer widths of 35 to 50 feet. King County has high certainty that there will be cumulative impacts from the limited protections for riparian areas adjacent to livestock properties because the updated grazing area buffer widths associated with all aquatic areas depart considerably from BAS and the adjacent land use can be a large source of pollutants.

There is high certainty that riparian area microclimate and wildlife will not be fully protected with the updated riparian area widths because the widths are based on a single SPTH whereas full protection of these functions required a width equivalent to multiple SPTHs. The risks associated with microclimate are long term because areas outside of protected widths will be cleared or altered and not replaced over time. The long-term risk for microclimate and wildlife will be magnified by the impacts of climate change, which will likely decrease the health of riparian vegetation, especially along boundaries or edges.

The updated K.C.C. will increase riparian area protections by adding the associated aquatic area riparian area width to the outer edge of severe CMZ hazard area versus just within the severe CMZ or being measured from the OHWM. However, moderate risk to riparian areas remains because protections do not extend to the outer edge of the full CMZ, specifically the outer edge of the moderate CMZ hazard area. Over the long term, as a river migrates outside the severe CMZ hazard area, it will likely encounter unvegetated and degraded riparian areas as those areas were not protected from development. Additionally, because only a few river reaches have had CMZs mapped by King County, there is high certainty that riparian areas will be less protected than BAS suggests, resulting in a net loss of ecological function over the long term.

Updated riparian area widths in the K.C.C. provide additional protections for riparian area lateral and longitudinal connectivity through increased riparian area widths and tailored compensatory mitigation requirements. However, due to requirements to provide for reasonable use of property, the K.C.C. continues to include many allowed alterations (see Section 3.2.3) that require mitigation and yet still impact riparian area connectivity and functions. These alterations include relatively minor impacts from activities like new or remodeled buildings that generally occur within the outer portion of riparian areas as well as more significant impacts from activities like trails, roads, and utilities that frequently transect riparian and aquatic areas. In addition, there are permit

exempt activities, such as farm field access drives, which can be located within riparian areas and may have related BMPs but are not required to provide any compensatory mitigation to offset impacts.

Nonregulatory measures that reduce and mitigate risks to riparian areas are discussed in Subsection 5.1.5 (see also Section 3.3).

5.4.3 Updating the King County Code and the GMA No Net Loss Requirement (WAC 365-196-830)

As noted in Section 1.2.1, King County can meet the GMA no net loss requirement in WAC 365-196-830 through a combination of regulatory measures and nonregulatory programs and actions. An evaluation of no net loss for critical areas is not defined or described in the WAC, but Washington Department of Ecology (Ecology 2017) provides useful guidance on how to evaluate no net loss for shoreline master programs, which can be adapted to evaluate no net loss for critical areas.

The primary purpose of the no let loss evaluation is to verify that the required mitigation for any new development fully offsets the impacts of the proposed development. The updated compensatory mitigation requirements in the K.C.C. minimize the chance of new development activities that result in a net loss of riparian functions. In addition to compensatory mitigation, additional losses of function can occur through regulatory protections being set below what BAS recommends and through unmitigated violations of critical areas codes. To meet no net loss, these additional losses of ecological function need to be offset by nonregulatory actions that create ecological gains, such as voluntary restoration of salmonid habitat. The lower the regulatory protections, the more nonregulatory actions King County will need to undertake to offset allowed impacts.

Protection and restoration are necessary for achieving both no net loss and functioning riparian areas because in limited circumstances King County's regulatory protections are set below BAS. However, the GMA only requires protection of critical areas from further harm and does not impose a corresponding requirement for enhancement or restoration (Commerce 2023). While critical areas restoration cannot be mandated, King County supports and promotes habitat restoration and enhancement through its Comprehensive Plan, large capital improvement projects, Strategic Climate Action Plan, and with coordination and implementation of Watershed Resource Inventory Area (WRIA) salmon recovery plans and projects. In addition, King County implements a variety of initiatives supporting riparian protection and restoration, including the 3 Million Trees Initiative, Clean Water Healthy Habitat, and the Land Conservation Initiative. King County also provides technical assistance through Watershed Stewards and provides restoration programs such as the Small Habitat Restoration Program and the Fish Passage Restoration Program. Finally, King County has tax reduction programs and a few additional incentives for landowners aimed at protecting and restoring critical areas.

King County would have greater certainty that there are enough nonregulatory actions to fully offset deviations from BAS and unpermitted activities with a comprehensive monitoring and adaptive management program. With information from existing critical areas monitoring efforts, the updated riparian area widths and ongoing nonregulatory actions indicate that King County is likely achieving no net loss at the watershed scale. This could be verified through a comprehensive monitoring and adaptive management program, especially in regard to regulatory effectiveness, which would help quantify how well the County is achieving no net loss.

5.4.4 Updating the King County Code and Special Considerations for Anadromous Fisheries

Updated riparian area widths in the K.C.C. for type S and F aquatic areas are aligned with BAS and correspond to areas that directly support salmonids and salmonid habitat. While riparian area widths inside the UGA are smaller than widths outside the UGA, they are now within the range of SPTHs supported by BAS. Type S and F aquatic areas are the most abundant aquatic area types in UKC and are mostly found outside the UGA, where the larger riparian area width applies. Because these aquatic areas are the most frequent across UKC, increased protections through greater riparian area widths should result in widespread improvement in protections of riparian and aquatic areas that directly benefit salmonids and anadromous fisheries. The updated riparian area width for type N aquatic areas aligns with the minimum water quality widths suggested by BAS. The updated type O riparian area and LMO grazing area buffer widths represent minor improvements in conditions for salmonids. In sum, the combined updates in the K.C.C. as well as all the nonregulatory actions and programs the County undertakes to preserve and restore salmonid habitat (see Section 5.4.3) demonstrates that King County has provided special consideration for anadromous fisheries.

5.5 Riparian Areas Summary Table

Critical Area Topic	2024 Best Available Science (BAS) Review	Previous King County Code	Updated King County Code	Qualitative Risk Assessment of Regulatory Updates	Comprehensive Plan Considerations and Nonregulatory Measures
Riparian Area Width	The width of riparian areas should be based on site potential tree height (SPTH) of tallest dominant 200-year-old riparian trees. Tallest dominant riparian trees in King County include Douglas-fir, western hemlock, and black cottonwood. The SPTH of these trees range from 128 to 243 feet. Two thirds of stream miles in King County have SPTH greater than 195 feet and 84% of stream miles have a SPTH between 180 and 215 feet. A riparian area width of 200 feet is the average SPTH for riparian trees in unincorporated King County. No BAS evidence that riparian functions are less important in non-fish-bearing streams or that riparian area widths should differ between urban and rural areas. Riparian areas should have a minimum width of 100 feet to protect water quality functions.	Outside the Urban Growth Area Shoreline (S)[1] – 165’ Fish-bearing (F)[1] – 165’ Non-fish-bearing (N)[1] – 65’ Other (O)[1] – 25’ Inside the Urban Growth Area Shoreline (S) – 115’ Fish-bearing (F) – 115’ Non-fish-bearing (N) – 65’ Other (O) – 25’ Livestock Management Ordinance Grazing Area Buffer [with/without farm plan] Shoreline (S)/Fish (F) – 0-25’/50’ Non-fish-bearing (N) – 0’ Other (O) – 0’	Outside the Urban Growth Area Shoreline (S)[1] – 200’ Fish-bearing (F)[1] – 200’ Non-fish-bearing (N)[1] – 100’ Other (O)[1] – 50’ Inside the Urban Growth Area Shoreline (S) – 180’ Fish-bearing (F) – 180’ Non-fish-bearing (N) – 100’ Other (O) – 50’ Livestock Management Ordinance Grazing Area Buffer[2] [with/without farm plan] Shoreline (S)/ Fish (S) – 40’/50’ Non-fish-bearing (N) – 35’/50’ Other (O) – 0’	Low risk to riparian area functions for type S and F aquatic areas because updated riparian area widths align with BAS. Moderate risk remains for type S and F in the Urban Growth Area (UGA) because riparian area widths align with the lower end of SPTHs; however, there are only a small number of stream miles inside the UGA. Moderate to high risk to riparian area functions for type N aquatic areas because aside from pollution removal (achieved at a 100-foot width), riparian area widths do not align with BAS for full protection of all functions. Moderate to high and long-term risk for microclimate and wildlife across all riparian area widths because full protection would require a riparian area widths equivalent to multiple SPTHs. High risk to riparian area functions for all aquatic areas associated with livestock properties because grazing area buffer widths have the largest departures from BAS and updated widths apply in limited circumstances[2].	Increasing riparian area widths heightens environmental protections; however, these also decreases the amount of land available for housing development and livestock agricultural operations. King County continues to align riparian area widths with adjacent aquatic area types [1] to reduce complexity of implementation, correspond to shoreline regulation, and provide higher protections for fish-bearing aquatic areas. To balance comprehensive planning considerations and GMA goals, King County maintains different levels of protection for riparian areas inside and outside the UGA, for non-fish-bearing aquatic areas (N and O), and for properties with livestock activities. Nonregulatory measures including stream mapping, initiatives, best management practices, stakeholder coordination, and critical areas monitoring and adaptive management reduce and mitigate risks and improve outcomes of critical areas protections.
Riparian Area Boundaries	Riparian areas should be measured from the outside edge of mapped channel migration zones (CMZs) to allow for migrating channels to have functional riparian areas. Where CMZs are not mapped, riparian areas should be measured from the edge of the active channel (ordinary high water mark). King County classifies CMZs as either severe (25 to 50 year of migration) or moderate (50 additional years). Most King County rivers and streams do not have mapped CMZs.	Riparian areas start at the edge of ordinary high water mark. If a CMZ is mapped, the riparian area protections apply to the area within the severe CMZ when that area is wider than the riparian area width.	Riparian areas start at the edge of ordinary high water mark. If a CMZ is mapped, the riparian area protections will extend outside the severe CMZ, to include the riparian area width associated with the adjacent aquatic area, as measured from the outer edge of the severe CMZ.	Updated riparian area protections do not fully align with BAS because the entire CMZ is not protected. Low near-term risk to riparian area functions because most CMZs have wide severe CMZ areas (protected with updates), and moderate long-term risk because protections are limited to the outer edge of severe CMZ areas rather than the outer edge of the full CMZ. High certainty that riparian areas are under protected because only a few channels in King County have CMZs mapped and CMZ mapping occurs infrequently.	Expanding riparian area protections associated with CMZs heightens environmental protections and reduces risks to public health and safety; however, also decreases the amount of land available for housing development and agriculture. Nonregulatory measures including CMZ mapping and stream mapping help reduce and mitigate risks and improve outcomes of critical areas protections.
Riparian Area Compensatory Mitigation	Compensatory mitigation requires an appropriate ratio of area of impact to area of mitigation. Ratios should at a minimum account for replacement of impacted area, risk of failure, and time lags between project impacts and mitigation maturity. Compensatory mitigation occurring at an off-site location should be greater than mitigation occurring on site. Pairing mitigation with additional actions provides near-term compensation for lost functions and greater confidence in mitigation success.	Compensatory Mitigation Ratios [area of mitigation to area of alteration] On site (all aquatic areas) – 1:1 Off site (S, F) – 3:1 Off site (N, O) – 2:1	Compensatory Mitigation Ratios [area of mitigation to area of alteration] On site (S, F, N) – 3:1 On site (O) – 2:1 Off site (S, F, N) – 4:1 Off site (O) – 3:1 Alternative on-site compensatory mitigation includes smaller ratios combined with a choice of required supplemental actions, based on aquatic area type and existing vegetation.	Increased on-site and off-site compensatory mitigation ratios help account for replacement of lost or impacted area, temporal loss, and uncertainty in mitigation success; all which reduce risk and improve success. Updated ratios have moderate, longer-term risk, because potential future functions may be less than expected and riparian trees take time to mature. Off-site mitigation may have greater risk than on-site mitigation because conditions and habitats may be too dissimilar to support equivalent functions. Supplemental actions may reduce risk because they can provide near-term compensation for lost functions and greater confidence in mitigation success.	Increasing riparian area mitigation ratios helps ensure that unavoidable adverse impacts to riparian areas are appropriately offset. Heightened regulatory requirements expand environmental protections and ensure no net loss of riparian functions and values. Increasing mitigation requirements may increase the costs of select development and land use practices on private properties encumbered by riparian areas. Nonregulatory measure including stream mapping help reduce and mitigate risks and improve outcomes of critical areas protections.

[1] Aquatic Area Types: Shoreline (S) – Shorelines of the state; Fish (F) – Not S type, contain fish or fish habitat, fish present, or a defined channel 2 feet or greater in width with a gradient less than 20%, or a channel in the 100-year floodplain of a type S or F; Non-fish-bearing (N) – Not S or F type and connected by surface water to type S or F; Other (O) – Not S, F, or N type and not connected to type S, F, or N by surface water.

[2] Updated grazing area buffer widths under the Livestock Management Ordinance (LMO) will only be required for properties that were not in compliance with the previous LMO code by the end of 2024, when agricultural properties that were previously compliant convert uses from crops to livestock, when a new farm plan for a property is created, including when a landowner requests a permit for an associated farm structure on the site.

5.6 References

Avery, T. E., and H. E. Burkhart. 2015. *Forest Measurements*. Waveland Press.

Barling, R. D., and I. D. Moore. 1994. Role of Buffer Strips in Management of Waterway Pollution: A Review. *Environmental Management* 18: 543–558.

Barnett, T. P., D. W. Pierce, H. G. Hidalgo, C. Bonfils, B. D. Santer, T. Das, G. Bala, A. W. Wood, T. Nozawa, and A. A. Mirin. 2008. Human-induced Changes in the Hydrology of the Western United States. *Science* 319(5866): 1080–1083.

Bradford, M. J. 2017. Accounting for Uncertainty and Time Lags in Equivalency Calculations for Offsetting in Aquatic Resources Management Programs. *Environmental Management* 60: 588–597.

Brosofske, K. D., J. Chen, R. J. Naiman, and J. F. Franklin. 1997. Harvesting Effects on Microclimatic Gradients from Small Streams to Uplands In Western Washington. *Ecological Applications* 7(4): 1188–1200.

Bunzel, K., M. Liess, and M. Kattwinkel. 2014. Landscape Parameters Driving Aquatic Pesticide Exposure and Effects. *Environmental Pollution* 186: 90–97.

Capon, S. J., L. E. Chambers, R. Mac Nally, R. J. Naiman, P. Davies, N. Marshall, J. Pittock, M. Reid, T. Capon, and M. Douglas. 2013. Riparian Ecosystems in the 21st Century: Hotspots for Climate Change Adaptation? *Ecosystems* 16: 359–381.

Cole, E., and M. Newton. 2013. Influence of Streamside Buffers on Stream Temperature Response Following Clear-cut Harvesting in Western Oregon. *Canadian Journal of Forest Research* 43(11):993–1005.

Cordoleani, F., E. Holmes, M. Bell-Tilcock, R. C. Johnson, and C. Jeffres. 2022. Variability in Foodscapes and Fish Growth Across a Habitat Mosaic: Implications for Management and Ecosystem Restoration. *Ecological Indicators* 136: 108681.

Davies, P. E., and M. Nelson. 1994. Relationships Between Riparian Buffer Widths and the Effects of Logging on Stream Habitat, Invertebrate Community Composition and Fish Abundance. *Marine and Freshwater Research* 45(7): 1289–1305.

Dosskey, M. G., P. Vidon, N. P. Gurwick, C. J. Allan, T. P. Duval, and R. Lowrance. 2010. The Role of Riparian Vegetation in Protecting and Improving Chemical Water Quality in Streams. *Journal of the American Water Resources Association* 46(2): 261–277.

Dwire, K. A., S. Mellmann-Brown, and J. T. Gurrieri. 2018. Potential Effects of Climate Change on Riparian Areas, Wetlands, and Groundwater-dependent Ecosystems in the Blue Mountains, Oregon, USA. *Climate Services* 10: 44–52.

Environmental Law Institute (ELI). 2016. *Assessing Stream Mitigation Guidelines at the Corps District and State Levels*. Part of a White Paper Series on Stream Compensatory Mitigation Prepared under a Wetland Program Development Grant from the U.S. Environmental Protection Agency.

Federal Emergency Management Agency (FEMA). 2012. *Floodplain Management and the Endangered Species Act: A Model Ordinance*. U.S. Federal Emergency Management Agency (FEMA) Region 10.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. *Forest Ecosystem Management: An Ecological, Economic, and Social Assessment*. U.S. Government Printing Office, Washington, D.C.

Franklin, J. F., and T. A. Spies. 1991. Composition, Function, and Structure of Old-growth Douglas-fir Forests. U.S. Forest Service, Pacific Northwest Research Station, Portland, OR In *Wildlife and Vegetation of Unmanaged Douglas-fir Forests*. PNW-GTR-285.

Harrington, C. A. 2006. *Biology and Ecology of Red Alder*. United States Department of Agriculture Forest Service General Technical Report PNW 669:21.

Hickey, M. B. C., and B. Doran. 2004. A Review of the Efficiency of Buffer Strips for the Maintenance and Enhancement of Riparian Ecosystems. *Water Quality Research Journal* 39(3): 311–317.

Hilderbrand, R. H., A. C. Watts, and A. M. Randle. 2005. The Myths of Restoration Ecology. *Ecology and Society* 10(1) 19. [online] https://www.jstor.org/stable/26267738.

Isaak, D. J., S. Wollrab, D. Horan, and G. Chandler. 2012. Climate Change Effects on Stream and River Temperatures Across the Northwest US from 1980–2009 and Implications for Salmonid Fishes. *Climatic Change* 113(2): 499–524.

Jeffres, C. A., E. J. Holmes, T. R. Sommer, and J. V. Katz. 2020. Detrital Food Web Contributes to Aquatic Ecosystem Productivity and Rapid Salmon Growth in a Managed Floodplain. *PLOS ONE* 15(9):e0216019.

Jeffres, C. A., J. J. Opperman, and P. B. Moyle. 2008. Ephemeral Floodplain Habitats Provide Best Growth Conditions for Juvenile Chinook Salmon in a California River. *Environmental Biology of Fishes* 83(4): 449–458.

King County. 2004a. *Volume I: A Review of Scientific Literature*. King County Department of Natural Resources and Parks.

King County. 2004b. *Volume II: Assessment of Proposed Ordinances*. King County Department of Natural Resources and Parks.

King County. 2019a. *Riparian Buffers in the Lower Snoqualmie Valley: Synthesis of Riparian Best Available Science to Inform Variable-Width Buffers*. King County Water and Land Resources Division, translator. King County, Seattle, WA.

King County. 2019b. *Stressor Identification and Recommended Actions for Restoring and Protecting Select Puget Lowland Stream Basins*. Prepared by Kate Macneale and Beth Sosik, King County Water and Land Resources Division. Seattle, Washington.

King County. 2019c. *WRIA 9 Marine Shoreline Monitoring and Compliance Project Phase 2 Final Report*. Prepared by Kollin Higgins, King County Water and Land Resources Division, Science and Technical Support Section. Seattle, WA.

King County. 2020. Balancing Fish, Farm and Floods in King County's Snoqualmie Watershed. Prepared by Beth leDoux and Josh Kubo. Water and Land Resources Division, Seattle, WA.

King County. 2023a. *The Impact of Urban Development on Stream Macroinvertebrate Communities is Influenced by When that Development Occurred*. Prepared by Kate Macneale, King County Water and Land Resources Division. Seattle, Washington.

King County. 2023b. *Water Quality Status and Trends in 75 King County Streams (2016–2020)*. Prepared by Jeremy Walls and Timothy Clark, King County Water and Land Resources Division. Seattle, Washington.

Knight, K. 2009. *Land Use Planning for Salmon, Steelhead and Trout*. Washington Department of Fish and Wildlife. Olympia, Washington.

Latterell, J., K. Higgins, K. Lynch, K. Bergeron, T. Patterson, and E. Ostergaard. 2012. *WRIA 9 Status and Trends Monitoring Report: 2005–2010*. Prepared for the WRIA 9 Watershed Ecosystem Forum, Seattle, WA.

Mantua, N., I. Tohver, and A. Hamlet. 2010. Climate Change Impacts on Streamflow Extremes and Summertime Stream Temperature and Their Possible Consequences for Freshwater Salmon Habitat in Washington State. *Climatic Change* 102(1–2): 187–223.

Maron, M., R. J. Hobbs, A. Moilanen, J. W. Matthews, K. Christie, T. A. Gardner, D. A. Keith, D. B. Lindenmayer, and C. A. McAlpine. 2012. Faustian bargains? Restoration Realities in the Context of Biodiversity Offset Policies. *Biological Conservation* 155: 141–148.

Mauger, G. S., J. H. Casola, H. A. Morgan, R. L. Strauch, B. Jones, B. Curry, T. M. Busch Isaksen, L. Whitely Binder, M. B. Krosby, and A. K. Snover. 2015. *State of Knowledge: Climate Change in Puget Sound*. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington.

McKenney, B. A., and J. M. Kiesecker. 2010. Policy Development for Biodiversity Offsets: a Review of Offset Frameworks. *Environmental Management* 45: 165–176.

Minns, C. K., and J. E. Moore. 2003. Assessment of Net Change of Productive Capacity of Fish Habitats: the Role of Uncertainty and Complexity in Decision Making. *Canadian Journal of Fisheries and Aquatic Sciences* 60(1): 100–116.

Moilanen, A., and J. S. Kotiaho. 2021. Three Ways to Deliver a Net Positive Impact with Biodiversity Offsets. *Conservation Biology* 35(1): 197–205.

Moilanen, A., A. J. Van Teeffelen, Y. Ben-Haim, and S. Ferrier. 2009. How much compensation is enough? A Framework for Incorporating Uncertainty and Time Discounting When Calculating Offset Ratios for Impacted Habitat. *Restoration Ecology* 17(4): 470–478.

Moore, R. D., D. L. Spittlehouse, and A. Story. 2005. Riparian Microclimate and Stream Temperature Response to Forest Harvesting: A Review. *Journal of the American Water Resources Association* 41(4): 813–834.

Morris, R. K., I. Alonso, R. G. Jefferson, and K. J. Kirby. 2006. The Creation of Compensatory Habitat—Can it secure sustainable development? *Journal for Nature Conservation* 14(2): 106–116.

Mote, P. W., A. F. Hamlet, M. P. Clark, and D. P. Lettenmaier. 2005. Declining Mountain Snowpack in Western North America. *Bulletin of the American Meteorological Society* 86(1): 39–50.

Naiman, R. J., H. Decamps, and M. Pollock. 1993. The Role of Riparian Corridors in Maintaining Regional Biodiversity. *Ecological Applications* 3(2): 209–212.

Polyakov, V., A. Fares, and M. H. Ryder. 2005. Precision Riparian Buffers for the Control of Nonpoint Source Pollutant Loading into Surface Water: A Review. *Environmental Reviews* 13(3): 129–144.

Quétier, F., and S. Lavorel. 2011. Assessing Ecological Equivalence in Biodiversity Offset Schemes: Key Issues and Solutions. *Biological Conservation* 144(12): 2991–2999.

Quigley, J. T., and D. J. Harper. 2006. Effectiveness of Fish Habitat Compensation in Canada in Achieving No Net Loss. *Environmental Management* 37: 351–366.

Quinn, T., G. Wilhere, and K. Krueger. 2020. *Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications*. Habitat Program, Washington Department of Fish and Wildlife, Olympia, Washington.

Rapp, C. F., and T. B. Abbe. 2003. A Framework for Delineating Channel Migration Zones. Washington State Department of Ecology and Department of Transportation, Publication # 30-06-027.

Reeves, G. H., D. H. Olson, S. M. Wondzell, P. A. Bisson, S. Gordon, S. A. Miller, J. W. Long, and M. J. Furniss. 2018. The Aquatic Conservation Strategy of the Northwest Forest Plan—A review of the Relevant Science after 23 years. In Spies, TA, P.A. Stine, R. Gravenmier, J. W. Long, M. J. Reilly, technical coordinators. *Synthesis of Science to Inform Land Management within the Northwest Forest Plan Area. General Technical Report PNW-GTR-966*. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station 966: 461–624.

Reid, W. V., H. A. Mooney, A. Cropper, D. Capistrano, S. R. Carpenter, K. Chopra, P. Dasgupta, T. Dietz, A. K. Duraiappah, and R. Hassan. 2005. *Ecosystems and Human Well-being-synthesis: A Report of the Millennium Ecosystem Assessment*. Island Press.

Rentz, R. A., A. Windrope, K. Folkers, and J. Azerrad. 2020. *Riparian Ecosystems, Volume 2: Management Recommendations*. Habitat Program, Washington Department of Fish and Wildlife.

Rutherford, J. C., N. A. Marsh, P. M. Davies, and S. E. Bunn. 2004. Effects of Patchy Shade on Stream Water Temperature: How Quickly Do Small Streams Heat and Cool? *Marine and Freshwater Research* 55(8): 737–748.

Rykken, J. J., S. S. Chan, and A. R. Moldenke. 2007. Headwater Riparian Microclimate Patterns Under Alternative Forest Management Treatments. *Forest Science* 53(2): 270–280.

Scarsbrook, M. R., and J. Halliday. 1999. Transition From Pasture to Native Forest Land-use Along Stream Continua: Effects on Stream Ecosystems and Implications for Restoration. *New Zealand Journal of Marine and Freshwater Research* 33(2): 293–310.

Seavy, N. E., T. Gardali, G. H. Golet, F. T. Griggs, C. A. Howell, R. Kelsey, S. L. Small, J. H. Viers, and J. F. Weigand. 2009. Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research. *Ecological Restoration* 27(3): 330–338.

Sommer, T. R., W. C. Harrell, and M. L. Nobriga. 2005. Habitat Use and Stranding Risk of Juvenile Chinook Salmon on a Seasonal Floodplain. *North American Journal of Fisheries Management* 25(4): 1493–1504.

Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer. 2001. Floodplain Rearing of Juvenile Chinook Salmon: Evidence of Enhanced Growth and Survival. *Canadian Journal of Fisheries and Aquatic Sciences* 58(2): 325–333.

Spies, T. A., M. M. Pollock, G. H. Reeves, and T. J. Beechie. 2013. *Effects of Riparian Thinning on Wood Recruitment: A Scientific Synthesis*. Science Review Team Wood Recruitment Subgroup. U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Corvalis, OR.

Stewart, J. S., L. Wang, J. Lyons, J. A. Horwatich, and R. Bannerman. 2001. Influences of Watershed, Riparian-Corridor, and Reach-Scale Characteristics on Aquatic Biota in Agricultural Watersheds. *Journal of the American Water Resources Association* 37(6): 1475–1487.

Sweeney, B. W., and J. D. Newbold. 2014. Streamside Forest Buffer Width Needed to Protect Stream Water Quality, Habitat, and Organisms: A Literature Review. *Journal of the American Water Resources Association* 50(3): 560–584.

Tabacchi, E., L. Lambs, H. Guilloy, A.-M. Planty-Tabacchi, E. Muller, and H. Decamps. 2000. Impacts of Riparian Vegetation on Hydrological Processes. *Hydrological Processes* 14(16-17): 2959–2976.

Takata, L., T. R. Sommer, J. L. Conrad, and B. M. Schreier. 2017. Rearing and Migration of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) in a Large River Floodplain. *Environmental Biology of Fishes* 100(9): 1105–1120.

Tallis, H., C. M. Kennedy, M. Ruckelshaus, J. Goldstein, and J. M. Kiesecker. 2015. Mitigation for One & All: An Integrated Framework for Mitigation of Development Impacts on Biodiversity and Ecosystem Services. *Environmental Impact Assessment Review* 55: 21–34.

Vanderhoof, J., S. Stolnack, K. Rauscher, and K. Higgins. 2011. *Lake Washington/ Cedar/ Sammamish Watershed (WRIA 8) Land Cover Change Analysis*. Prepared for WRIA8 Technical Committee by King County Water and Land Resources Division, Department of Natural Resources and Parks. Seattle, WA.

Washington Department of Ecology (Ecology). 2005. *Wetlands in Washington State - Volume 2: Guidance for Protecting and Managing Wetlands*. Washington State Department of Ecology, Olympia, WA.

Washington Department of Ecology (Ecology). 2017. *Shoreline Master Programs Handbook*. Washington State Department of Ecology, Olympia, WA.

Washington State Department of Commerce (Commerce). 2023. *Critical Areas Handbook - A Handbook for Reviewing Critical Areas Regulations*. Growth Management Services. Washington Department of Commerce.

Washington State Department of Ecology (Ecology). 2021. *Wetland Mitigation in Washington State–Part 1: Agency Policies and Guidance (Version 2)*. Washington State Department of Ecology, Olympia, WA.

Wooster, D. E., and S. J. DeBano. 2006. Effect of Woody Riparian Patches in Croplands on Stream Macroinvertebrates. *Archiv für Hydrobiologie* 165(2): 241–268.

Worthington, N. P., and R. H. Ruth. 1962. *Red Alder: Its Management and Utilization*. U.S. Department of Agriculture, Forest Service.

Zedler, J. B., and J. C. Callaway. 1999. Tracking Wetland Restoration: Do mitigation sites follow desired trajectories? *Restoration Ecology* 7(1): 69–73.

6 Wildlife Habitat (a Type of Fish and Wildlife Habitat Conservation Area)

Fish and Wildlife Habitat Conservation Areas (FWHCAs) contribute to wildlife and plant biodiversity and occur on both publicly and privately owned lands. Designating FWHCAs is an important part of land use planning, ensuring that species maintain sufficient habitat to support viable populations over the long term. In addition to protecting habitats and species of local importance, designating FWHCAs in development regulations found in the King County Code (K.C.C.) ensures protection of areas where endangered, threatened, and sensitive species have a primary association (WAC 365-190-130).

King County protects wildlife by designating and protecting species and habitats of local importance, designating and protecting wildlife corridors, conserving land and habitat through nonregulatory programs, and by prioritizing development in the County's Urban Growth Area (UGA). Wildlife and wildlife habitat in King County are also protected in part through development regulations and nonregulatory measures related to the management of wetlands and wetland buffers (see Section 4) and riparian areas (see Section 5).

Development impacts and climate change are two of the greatest threats facing wildlife habitat and biodiversity (Bellard et al. 2022; Weiskopf et al. 2020; Bateman et al. 2020; Mantyka-Pringle et al. 2015; Staudinger et al. 2013; Jetz et al. 2007). Development results in direct loss of habitat and further impacts wildlife by fragmenting habitat at the landscape scale (Haddad et al. 2015; Newbold et al. 2015; Bennett and Saunders 2010). Climate change is already impacting wildlife populations (Roman-Palacios and Wiens 2020; Schloss et al. 2012). In Washington State, climate change is shifting the amount, extent, and quality of habitat available to species, resulting in shifts in species composition, distribution, and biodiversity (WDFW 2015).

This section discusses best available science (BAS), comprehensive planning considerations, development regulations, and King County programs related to the protection of local wildlife and wildlife habitat.

6.1 Wildlife Habitat Protections

King County's Comprehensive Plan includes policies listing Species of Local Importance (SOLI) and Habitats of Local Importance (HOLI). These policies, E-435 and E-437, respectively, are included in Chapter 5 of the Comprehensive Plan. Development regulations in K.C.C. 21A.24.382 require protection of an active breeding site of any federal- or state-listed endangered, threatened, sensitive, and candidate species, and any SOLI. HOLI listed in the Comprehensive Plan are not explicitly protected in code, though some instances of HOLI are offered varying levels of protection through wetland, riparian area, and geologically hazardous area (GHA) development regulations.

King County offers additional protections to wildlife and wildlife habitat by protecting a designated wildlife habitat network (WHN). The WHN, defined in K.C.C. 21A.06.1424, was created and codified in 1994. It maps and protects a network of wildlife habitat, critical areas, trails, parks, open space, and other areas. This mapped network is intended to allow for wildlife migration and alleviate habitat fragmentation. Development regulations for the WHN are listed in K.C.C. 21A.24.386.

6.1.1 2024 BAS Review

BAS addresses conservation of populations and species through the lens of protecting large areas of land, including corridors and unique and rare habitat types, such as old-growth forest, snag, and talus. Climate change must also be considered when designing protection measures for biodiversity. This section first summarizes how climate change is expected to affect biodiversity, then examines species of local importance and the protection of unique and rare habitat types. Finally, the science on corridor protection is summarized.

Climate Change Impacts to Species and Habitats

Washington's State Wildlife Action Plan (WDFW 2015) summarizes some of the primary ways that climate change will affect habitats and species:

- Shifts in habitat amount, extent, and quality.
- Shifts in species composition, distribution, and biodiversity as well as shifts in species interactions.
- Impaired biological, ecological, and biogeochemical processes.
- Declines in certain vegetation types and expansions in others as suitable habitat ranges shift.
- Shifts in phenology, affecting plant reproduction and/or productivity and animal life histories, survival, reproduction, and growth.
- Increases in forest disease susceptibility due to moisture stress.
- Altered aquatic organism behavior, health, growth, reproductive success, and survival.
- Increased sensitivity to pollutants and contaminants.
- Increased risk of invasive species spread and/or establishment.

The impacts on individual species will vary and it is impossible to fully anticipate the cascading effects that will unfold as one change leads to more changes in the coming years and decades. Species interactions are complex and are often not well understood until something happens that causes an obvious change, such as a population crash or a pest invasion. Species interactions occur at many levels and include both animal-to-animal and animal-to-plant interactions. These relationships sustain functioning ecosystems. Examples of important relationships include predator-prey relationships (Bretagnolle and Gillis 2010; Beschta and Ripple 2009; Abrams 2000); pollination (Torezan-Silingardi et al. 2021); seed dispersal (McConkey et al. 2012); herbivore effects on plants (e.g., Brodie et al. 2011); and parasitism (Frainer et al. 2018). While it

is relatively easy to identify which species are at highest risk of extinction in the short term (e.g., American pike, white-tailed ptarmigan, Olympia oyster), it is far less obvious how changing phenologies (the timing of natural events, such as flowering in plants) (Piao et al. 2019; Tang et al. 2016) combined with global climate change (Tylianakis et al. 2008) will have long-term, cascading effects on wildlife populations.

Species and Habitats of Local Importance

King County reviewed the following resources when considering updates to SOLI and HOLI lists:

- Washington State Priority Habitats and Species (PHS) List (WDFW 2023)
- Washington's State Wildlife Action Plan (WDFW 2015)
- Survival by Degrees—389 bird species on the brink (Wilsey et al. 2019)
- Washington Department of Natural Resources (DNR) Natural Heritage Program Vascular Plant Species of Concern list (Fertig 2021)

Using these resources, King County created a table to determine which animals should be considered for inclusion in the County's SOLI list. The table, found in Appendix A of this report, groups species by animal type and provides state and federal status, habitat use in the State of Washington, vulnerability to climate change, and reason for inclusion in the County's SOLI list.

In addition to assessing which animals may be included in the SOLI list, King County reviewed DNR's Natural Heritage Program Vascular Plant Species of Concern list (Fertig 2021) and identified plants (Table 6.1) to be considered for inclusion in King County's SOLI list.

Table 6.1 Plants considered for inclusion in King County's Species of Local Importance (SOLI) list.

Common Name	Species	Federal Status	State Status
Alaska harebell	*Campanula lasiocarpa*	None	SS
Branched montia	*Montia diffusa*	None	SS
Brewer's cliffbrake	*Pellaea breweri*	None	SS
Choriso's bog-orchid	*Platanthera chorisiana*	None	SS
Few-flowered sedge	*Carex pauciflora*	None	SS
Flat-leaved bladderwort	*Utricularia intermedia*	None	SS
Golden paintbrush	*Castilleja levisecta*	Threatened (proposed for delisting)	ST
Harvest brodiaea	*Brodiaea rosea ssp. rosea*	None	SS
Kamchatka fritillary	*Fritillaria camschatcensis*	None	SS
Long-styled sedge	*Carex stylosa*	None	SS
Northern bog clubmoss	*Lycopodiella inundata*	None	SS

Old field blue toadflax	*Nuttallanthus canadensis*	None	SS
One-cone clubmoss	*Lycopodium lagopus*	None	SS
Pacific peavine	*Lathyrus vestitus var. ochropetalus*	None	SE
Spleenwort-leaved goldthread	*Coptis asplenifolia*	None	SS
Spotted Joe-pye weed	*Eutrochium maculatum var. bruneri*	None	SS
Stalked moonwort	*Botrychium pedunculosum*	None	ST
Swamp gentian	*Gentiana douglasiana*	None	SS
Tall bugbane	*Actaea elata var. elata*	None	SS
Tree clubmoss	*Dendrolycopodium dendroideum*	None	SS
Triangular-lobed moonwort	*Botrychium ascendens*	None	ST
Water lobelia	*Lobelia dortmanna*	None	SS
Weak thistle	*Cirsium remotifolium var. remotifolium*	None	SE
Western moonwort	*Botrychium hesperium*	None	SS
White meconella	*Meconella oregana*	None	SE
Whitebark pine	*Pinus albicaulis*	Proposed Threatened	SS

King County's review of PHS guidance indicates that westside (Camas) prairie, Oregon white-oak woodlands, and herbaceous balds should be considered for inclusion in King County's HOLI list (WDFW 2023). Each of these habitat types contain species with narrow habitat requirements not found elsewhere.

Connectivity and Conservation

There are two primary components to creating a system of protected and connected fish and wildlife habitat: larger blocks of habitats/open spaces, sometimes called "reserves," and "corridors" that connect reserves to one another with fish and wildlife habitat. Designating and protecting these areas are important for local and ecoregional biodiversity. This subsection includes a short discussion on the size of reserves then examines the science of identifying habitat corridors to be protected.

Important habitat blocks may be large or small. Not all high-value reserves must be large blocks of habitat (Riva and Fahrig 2023). Island biogeography theory (MacArthur and Wilson 1967), which has been embraced in conservation science for five decades, contends, among other things, that species richness increases with the size of the habitat patch. Many conservation practitioners have thus prioritized the protection of larger habitat areas over relatively smaller ones (Pickett and Thompson 1978). However, recent studies illuminate the importance small habitat patches have for conservation (Yan et al. 2021; Wintle et al 2019; Hunter 2017). Riva and Fahrig (2022) contend that "acknowledging the conservation value of small patches, even very small patches, will be a necessary step for stemming biodiversity loss in the Anthropocene."

King County's 2004 BAS review defined habitat corridors as "contiguous, vegetated, dispersal conduits of variable length and width that connect isolated habitat patches to other patches or larger landscape habitat components" (King County 2004). The concept focused heavily on corridors for the movement of species, and it secondarily acknowledged the habitat value of the corridors themselves.

In conservation science, connectivity was first conceptualized to facilitate wildlife movement and gene flow (Harris and Scheck 1991; Rosenberg et al. 1997). Connectivity is now considered a primary climate adaptation strategy for biodiversity conservation (Beier 2012) that must be retained across the landscape not only for short-term movement needs, such as dispersal and seasonal range shifts, but also for long-term range shifts as species evolve (Schloss et al. 2022).

Regardless of uncertainties of the fate of any particular species, it can be assumed that some species will adapt without moving to new locations (Román-Palacios and Wiens 2020; Virkkala et al. 2020). Some species' ranges may expand such that they remain where they currently are and expand into additional places (Tape et al. 2018, 2022), whereas other species will go extinct (Román-Palacios and Wiens 2020). Extinctions may be local or global, as "the combination of the pace of climatic changes, dispersal limitations, and habitat fragmentation patterns will make movement an infeasible adaptation strategy" (Schloss et al. 2022, 2012). Further, it should not be assumed that all species whose ranges overlap under current conditions will continue to overlap in the future (Costanza 2020). "As species' niches shift individualistically, species whose distribution coincidentally overlaps under current climate may diverge in distribution under future climates" (Carroll et al. 2010).

Schloss et al. (2022) summarize why planning for habitat connectivity for climate adaptation is different from present-day connectivity planning in several ways. First, "connectivity for climate adaptation will need to facilitate movement outside a species' present range…to future suitable habitats" (Keeley et al. 2018; Groves 2012; Schmitz 2015). Second, "connectivity for climate change-driven movement needs to facilitate movement over many generations and will therefore need to incorporate habitats that support feeding, cover, and reproduction over longer periods of time." And third, "geophysical features are likely to play an important role in facilitating connectivity in a changing climate, because terrain and soil features remain relatively constant as climate changes and a diversity of these features creates conditions that support a diversity of microclimates and habitats (Dobrowski et al. 2009, Anderson and Ferree 2010, Brost and Beier 2012)."

Early work connected the current distributions of focal species to their projected future distributions (Williams et al. 2005; Phillips et al. 2008). Beier (2012) argued that accommodating species' range shifts to future climate space can be achieved by a combination of conservation of large, topographically, and climatically diverse natural landscape blocks and coarse-filter corridors between those blocks. This approach would result in a system of connected biodiversity areas. Beier (2012) proposed three non-

mutually exclusive ways to design the coarse-filter corridors: (1) climate gradient corridors, (2) linkages defined by landscape units of relatively uniform topography and soils, and (3) river riparian areas as climate corridors. Each of these ways to design corridors are briefly addressed in the following subsections.

Climate Gradient Corridors

Earlier work in connectivity mapping commonly used a cost-distance corridor approach that drew the shortest connection between two habitat patches (WHCWG 2010). Nuñez et al. (2013) mapped climate gradient corridors, a new approach that provides the most unidirectional change in the temperature gradient. Instead of the shortest line between habitat patches, a climate gradient is often a longer route with fewer temperature extremes. This approach combines temperature gradients with land use patterns and mapped corridors with the potential to facilitate climate-driven movements of biota in the Pacific Northwest. First, they identified habitat patches with a low degree of human modification relative to the surrounding landscape. Next, they identified pairs of these patches that, if connected, would allow species to move from warmer to cooler areas. Finally, they mapped corridors between linked patches using a cost-distance model that delineated routes that (a) had the most unidirectional changes in present-day temperature between the patches, (b) avoided extreme deviations in temperature, and (c) remained within areas of lowest human influence. Nuñez et al. (2013) contended that the network of patches and corridors in their resulting maps “are likely to be robust to uncertainty in the magnitude and direction of future climate change because they are derived from gradients and land-use patterns.”

Littlefield et al. (2017) found it imperative to incorporate future climate projections into connectivity modeling to facilitate species movement and population persistence in a changing climate. They used historical climate data sets and future climate projections to map “potential species’ movement routes that link current climate conditions to analogous climate conditions in the future (i.e., future climate analogs).” They did this by using a novel moving-window analysis based on electrical circuit theory. What they found was by including future climate projections into their models, priority areas both shifted and were more limited, and that movement routes that connect present-day landscapes may differ from those needed to track changing climatic conditions.

Most recently, Schloss et al. (2022) explicitly incorporate land use, topographic complexity, and climate projections into their modeling approach to attempt to provide “enduring ecological benefits in the face of environmental change.” They found that in places that are already highly fragmented, the remaining connections are critical to conserve. Additionally, including land use, topography, and climate projections is important for identifying priority corridors in landscapes that are not yet highly fragmented. Finally, their work reinforces the importance of conserving aquatic areas and riparian areas for connectivity in the long term. Regulatory and nonregulatory protections for these critical areas are discussed in Section 5 of this report.

Uncertainty is inherent in modeling connectivity, even without addressing climate change (Lawler and Michalak 2017). Uncertainty increases further when trying to incorporate climate change because of a significant lack of information about species' responses to climate change (Urban et al. 2016). Second, climate change happens continuously, but the models used to understand how species respond to it usually aren't continuous. Most studies that address species' movements or future ranges either treat climate change as a single event at some point in the future or average changes over time. However, in reality, climate change is unpredictable and comes with extreme events and fluctuations (Littlefield et al. 2019, citing Garcia et al. 2014). And third, long-term model effectiveness is nearly impossible to test: "At present, few large-scale connectivity models – and to staff's knowledge, no connectivity models explicitly designed to account for climate change – have been directly evaluated for long-term effectiveness" (Littlefield et al. (2019), citing Gilbert-Norton et al. 2010; Gregory and Beier 2014).

Landscape Units

Brost and Beier (2012) advocate using landscape units of relatively uniform topography and soils as a part of designing linkages in order to "conserve the arenas of biological activity rather than the temporary occupants of those arenas." Anderson and Ferree (2010) asked what factors ultimately control total diversity, thinking that if they could define those factors, the major drivers of total species richness could be protected in the long term. They hypothesized that if geophysical diversity drives regional diversity, "then conserving geophysical settings may offer an approach to conservation that protects diversity under both current and future climates." Their results indicate that four geophysical factors (the number of geological classes, latitude, elevation range, and the amount of calcareous bedrock) predicted species diversity with certainty (Anderson and Ferree 2010). They next ran an independent test to confirm the species-geology relationships for 885 rare species and found that 40 percent of the species were restricted to a single geology. Additionally, each geology class supported from 5 to 95 endemic species, and calcareous bedrock and extreme elevations had significantly more rare species than expected by chance (Anderson and Ferree 2010). Their results provide a strong argument for protecting geophysical settings to "conserve the stage for current and future biodiversity and may be a robust alternative to species-level predictions" (Anderson and Ferree 2010). Because of the important role that geophysical features are likely to play in facilitating connectivity in a changing climate, Schloss et al. (2022) also include them in their "no regrets" approach to connectivity planning.

Riparian Areas

The science supporting the protection of riparian areas for the benefit of water quality and fish habitat, especially in the face of climate change, is reviewed in Section 5. Riparian habitat is also well documented to disproportionately contribute to species richness and provide habitat for many upland species as well as riparian specialists (for example, Olson et al. 2007; Sabo et al. 2005; Naiman et al. 1993). Graziano et al.

(2022) provides a review of the nexus of riparian areas and biodiversity, ecological function of riparian areas, threats and conservation challenges, and conservation efforts, including an examination of the fixed buffer width approach to protection. They write, “The synergism of intermediate flood-induced disturbances, moist microclimates, constant nutrient influx, high productivity, and resource heterogeneity make riparian zones disproportionately rich in biodiversity” (Graziano et al. 2022). The protection of riparian habitat is a fundamental requirement for the conservation of biodiversity.

Seavy et al. (2009) succinctly summarize the importance of riparian area corridors to climate adaptation: “Riparian ecosystems are naturally resilient, provide linear habitat connectivity, link aquatic and terrestrial ecosystems, and create thermal refugia for wildlife: all characteristics that can contribute to ecological adaptation to climate change.” Additionally, “they span climatic gradients and have cool, moist microclimates relative to surrounding areas” (Krosby et al. 2018). A riparian climate-corridor index developed by Krosby et al. (2018) to quantify the degree to which riparian areas may promote species range shifts and provide climate refugia reached conclusions highly relevant to King County: “high-value riparian climate-corridors are least protected in flat, lowland areas, suggesting that such corridors should be high priorities for future conservation effort.”

Because of their linear nature and the level of protection already afforded them to varying degrees via regulations, the inclusion of riparian corridors into a connectivity network makes logical sense. For their “no regrets” approach to corridor mapping, Schloss et al. (2022) did not explicitly model movement from, to, or along riparian corridors, but the climate linkages they identified still tended to follow riparian valleys. Fremier et al. (2015) explored the use of riverine corridors as a potential contributor to a more resilient network of protected areas. They argue that scientific evidence supports the conservation value of a riparian connectivity network to help mitigate the impacts of climate change and upland habitat fragmentation. They also argue that conservation is better served if riparian connectivity is part of a larger landscape connectivity strategy.

6.1.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating wildlife protections. As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C., it must balance required increases in environmental protections (see Section 1.2.1) with the need to satisfy other Growth Management Act (GMA) goals (see Section 1.1) and King County Comprehensive Plan priorities (see Section 3.1.1).

Codifying additional protections for specific habitats and species heightens environmental protections by limiting development in areas where species or habitats of primary association are present. Identifying species or habitats of local importance typically requires professional technical assistance. Depending on the circumstances and the species or habitats identified, protections may apply temporarily or indefinitely. Protecting habitats and species of local importance at the scale of individual properties

or parcels is inherently challenging given the number of listed species and habitats, the technical assistance required to identify those species and habitats, and the migratory nature of wildlife.

WAC 365-190-130 Fish and Wildlife Habitat Conservation Areas

WAC 365-190-130 outlines requirements and guidance related to the management of FWHCA in the State of Washington. It emphasizes the importance of maintaining suitable habitats for species to support viable populations over the long term while acknowledging that it does not mean maintaining all individuals of all species at all times.

This WAC directs counties to consider classifying and protecting FWHCAs, including areas where endangered, threatened, and sensitive species have a primary association. Counties are also directed to consider protections for HOLI and SOLI, as determined locally. Counties must consult BAS and information provided by state and federal agencies as species and habitats are classified and designated.

In addition to classifying species and habitats, counties are instructed to consider creating interconnected systems of FWHCAs to offer further protections to wildlife and wildlife habitat at the landscape scale. These protections can be achieved through regulatory or nonregulatory approaches.

6.1.3 Regulatory Updates

Based on BAS review and comprehensive planning considerations, King County is updating SOLI and HOLI lists found in the King County Comprehensive Plan.

Table 6.2 identifies animal species that are newly included in the County's SOLI list (Comprehensive Plan policy E-435). Appendix A of this report includes a table with additional information about these species. Species with a state or federal listed status as well as candidate species were already protected by previous King County policy and code but have been included in the SOLI list to improve consistency and accessibility.

Table 6.2 Animals considered for inclusion in King County's Species of Local Importance (SOLI) list.

COMMON NAME	SCIENTIFIC NAME	Federal Status	State Status	New SOLI in 2024
BIRDS				
Common Loon	*Gavia immer*	none	SS	Yes
Marbled Murrelet*	*Brachyramphus marmoratus*	FT	SE	Yes
Western Grebe	*Aechmophorus occidentalis*	none	SC	No

COMMON NAME	SCIENTIFIC NAME	Federal Status	State Status	New SOLI in 2024
Black Scoter	*Melanitta nigra*	none	none	No
Surf Scoter	*Melanitta perspicillata*	none	none	No
White-winged Scoter	*Melanitta fusca*	none	none	No
Western High Arctic Brant	*Branta bernicla*	none	none	Yes
Harlequin Duck	*Histrionicus histrionicus*	none	none	No
Cinnamon teal	*Anas cyanoptera*	none	none	No
Bufflehead	*Bucephala albeola*	none	none	Yes
Barrow's Goldeneye	*Bucephala islandica*	none	none	No
Common Goldeneye	*Bucephala clangula*	none	none	No
Wood duck	*Aix sponsa*	none	none	No
Hooded merganser	*Lophodytes cucullatus*	none	none	No
Trumpeter Swan	*Cygnus buccinator*	none	none	No
Tundra Swan	*Cygnus columbianus*	none	none	No
Pelagic Cormorant	Phalacrocorax pelagicus	none	none	Yes
Pigeon Guillemot	Cepphus columba	none	none	Yes
Caspian Tern	Hydroprogne caspia	none	none	Yes
Waterfowl Concentrations (Anatidae excluding Canada Geese in Urban Areas)	Varies	NA	NA	Yes
Western Washington nonbreeding concentrations of plovers (Charadriidae) and sandpipers (Scolopacidae)	Varies	NA	NA	Yes
Northern Spotted Owl*	*Strix occidentalis*	FT	SE	Yes
Western Screech Owl	*Otus kennicotii macfarlanei*	none	none	Yes
Bald Eagle*	*Haliaeetus leucocephalus*	none	none	Yes
Golden Eagle	*Aquila chrysaetos*	none	SC	Yes
Osprey*	*Pandion haliaetus*	none	none	No
Northern Goshawk*	*Accipiter gentilis*	none	SC	Yes
Peregrine Falcon*	*Falco peregrinus*	none	none	Yes
American bittern	*Botaurus lentiginosus*	none	none	No
Great Blue Heron*	*Ardea herodias*	none	none	No
Hairy Woodpecker	*Picoides villosus*	none	none	No
Pileated Woodpecker	*Dryocopus pileatus*	none	none	Yes

COMMON NAME	SCIENTIFIC NAME	Federal Status	State Status	New SOLI in 2024
Black-Backed Woodpecker	*Picoides arcticus*	none	SC	Yes
American three-toed woodpecker	*Picoides tridactylus*	none	none	Yes
Belted kingfisher	*Ceryle alcyon*	none	none	No
Pacific coast band-tailed pigeon	*Columba fasciata*	none	none	No
Oregon Vesper Sparrow	*Pooecetes gramineus affinis*	Petitioned for listing	SE	Yes
Yellow-Billed Cuckoo	*Coccyzus americanus*	FT	SE	Yes
Vaux's Swift*	*Chaetura vauxi*	none	none	Yes
Western Meadowlark	*Sturnella neglecta*	none	none	No
Olive-sided Flycatcher	*Contopus cooperi*	none	none	No
Red-eyed Vireo	*Vireo olivaceus*	none	none	Yes
Purple Finch	*Carpodacus purpureus*	none	none	No
Purple Martin	*Progne subis*	none	none	Yes
Sooty grouse	*Dendragapus fuliginosus*	none	none	No
FISH				
Chinook Salmon (Puget Sound)	*Oncorhynchus tshawytscha*	FT	none	Yes
Steelhead (Puget Sound)	*Oncorhynchus mykiss*	FT	SC	Yes
Rainbow trout	*Oncorhynchus mykiss*	none	none	No
Bull Trout	*Salvelinus confluentus*	FT	SC	Yes
Dolly Varden	*Salvelinus malma*	none	none	No
Chum salmon	*Oncorhynchus keta*	none	none	No
Coastal resident/searun cutthroat	*Oncorhynchus clarki clarki*	none	none	No
Coho/silver salmon	*Oncorhynchus kisutch*	none	none	No
Pink salmon	*Oncorhynchus gorbuscha*	none	none	No
Sockeye/red salmon	*Onchorhynchus nerka*	none	none	No
Kokanee salmon	*Onchorhynchus nerka*	none	none	No
Bocaccio Rockfish	*Sebastes paucispinis*	FE	none	Yes
Brown Rockfish	*Sebastes auriculatus*	none	none	Yes
Canary Rockfish	*Sebastes pinniger*	FT	none	Yes
Copper Rockfish	*Sebastes caurinus*	none	none	Yes
Quillback Rockfish	*Sebastes maliger*	none	none	Yes
Yelloweye Rockfish	*Sebastes ruberrimus*	FT	none	Yes
English sole	*Parophrys vetulus*	none	none	No

COMMON NAME	SCIENTIFIC NAME	Federal Status	State Status	New SOLI in 2024
Southern rock sole	*Pleuronectes bilineatus*	none	none	No
Pacific cod	*Gadus macrocephalus*	none	none	Yes
Lingcod	*Ophiodon elongatus*	none	none	No
Pacific Herring	*Clupea pallasi*	none	none	No
Pacific sand lance	*Ammodytes hexapterus*	none	none	No
Surf smelt	*Hypomesus pretiosus*	none	none	No
Longfin smelt	*Spirinchus thaleichthys*	none	none	No
White sturgeon	*Acipenser transmontanus*	none	none	No
Pacific lamprey	*Entosphenus tridentatus*	none	none	No
Western River Lamprey	*Lampetra ayresii*	none	SC	Yes
Pygmy Whitefish	*Prosopium coulteri*	none	SS	Yes
MAMMALS				
Fisher	*Martes pennanti*	none	SE	Yes
Pacific Marten	*Martes caurina*	none	none	Yes
Gray Wolf	*Canis lupus*	FE	SE	Yes
Wolverine	*Gulo gulo*	FT	SC	Yes
Cascade Red Fox	*Vulpes vulpes cascadensis*	none	SE	Yes
Townsend's Big-Eared Bat*	*Corynorhinus townsendii*	none	SC	Yes
Myotis bats	*Myotis* spp.	none	none	Yes
Pallid bat	*Antrozous pallidus*	none	none	Yes
Big Brown Bats, roosting concentrations	*Eptesicus fuscus*	none	none	Yes
Douglas Squirrel	*Tamiasciurus douglasii*	none	none	Yes
Roosevelt elk	*Cervus canadensis roosevelti*	none	none	No
Mountain goat	*Oreamnos americanus*	none	none	No
Pika	*Ochotona princeps*	none	none	No
Northern flying squirrel	*Glaucomys sabrinus*	none	none	Yes
Hoary marmot	*Marmota caligata*	none	none	Yes
Townsend's Chipmunk	*Tamias townsendii*	none	none	Yes
Killer (Orca) Whale	*Orcinus orca*	FE	SE	Yes
Gray Whale	*Eschrichtius robustus*	FE	SS	Yes
Harbor Porpoise	*Phocoena phocoena*	none	SC	Yes
Dall's Porpoise	*Phocoenoides dalli*	none	none	Yes

COMMON NAME	SCIENTIFIC NAME	Federal Status	State Status	New SOLI in 2024
Harbor Seal	*Phoca vitulina*	none	none	Yes
California sea lion (haul-outs)	*Zalophus californianus*	none	none	Yes
Steller Sea Lion	*Eumetopias jubatus*	none	none	Yes
AMPHIBIANS				
Larch Mountain Salamander	*Plethodon larselli*	none	SS	Yes
Oregon Spotted Frog	*Rana pretiosa*	FT	SE	Yes
Northern Red-legged frog	*Rana aurora*	none	none	No
Western Toad	*Bufo boreas*	none	SC	Yes
REPTILES				
Northwestern Pond Turtle	*Actinemys marmorata*	Petitioned for listing	SE	Yes
Western fence lizard	*Sceloporus occidentalis*	none	none	No
INVERTEBRATES				
Western pearlshell mussel	*Margaritifera falcata*	none	none	No
Western ridged mussel	*Gonidea angulata*	none	none	No
Oregon floater	*Anodonta oregonensis*	none	none	No
Blue-gray taildropper	*Prophysaon coeruleum*	none	SC	Yes
Olympia Oyster	*Ostrea lurida*	none	none	Yes
Butter Clam	*Saxidomus giganteus*	none	none	Yes
Native Littleneck Clam	*Leukoma staminea*	none	none	Yes
Dungeness crab	*Cancer magister*	none	none	No
Pandalid shrimp	*Pandalus* species	none	none	No
Beller's Ground Beetle	*Agonum belleri*	none	SC	Yes
Hatch's Click Beetle	*Eanus hatchii*	none	SC	Yes
Pacific clubtail	*Phanogomphus kurilis*	none	SC	Yes
Western bumble bee	*Bombus occidentalis*	Under review	SC	Yes
Johnson's Hairstreak	*Mitoura johnsoni*	none	SC	Yes
Valley Silverspot	*Speyeria zerene bremnerii*	none	SC	Yes

*Development regulations specified in K.C.C. 21A.24.382.

In addition to animal species, plant species in Table 6.3 are newly included in the County's SOLI list (Comprehensive Plan policy E-435). In alignment with WAC 365-190-

130 (see Section 6.1.2), King County reviewed DNR's Natural Heritage Program Vascular Plant Species of Concern list (Fertig 2021) to inform these additions.

Table 6.3 Plants newly included in King County's Species of Local Importance (SOLI) list.

Common Name	Species	Federal Status	State Status	new SOLI in 2024
Alaska harebell	*Campanula lasiocarpa*	None	SS	Yes
Branched montia	*Montia diffusa*	None	SS	Yes
Brewer's cliffbrake	*Pellaea breweri*	None	SS	Yes
Choriso's bog-orchid	*Platanthera chorisiana*	None	SS	Yes
Clubmoss mountain-heather	*Cassiope lycopodioides*	None	SS	No
Columbia white-topped aster	*Sericocarpus rigidus*	None	SS	No
Few-flowered sedge	*Carex pauciflora*	None	SS	Yes
Flat-leaved bladderwort	*Utricularia intermedia*	None	SS	Yes
Golden paintbrush	*Castilleja levisecta*	Threatened (proposed for delisting)	ST	Yes
Harvest brodiaea	*Brodiaea rosea ssp. rosea*	None	SS	Yes
Kamchatka fritillary	*Fritillaria camschatcensis*	None	SS	Yes
Large St. Johns'-wort	*Hypericum majus*	None	SS	No
Long-styled sedge	*Carex stylosa*	None	SS	Yes
Northern bog clubmoss	*Lycopodiella inundata*	None	SS	Yes
Old field blue toadflax	*Nuttallanthus canadensis*	None	SS	Yes
One-cone clubmoss	*Lycopodium lagopus*	None	SS	Yes
Oregon goldenweed	*Heterotheca oregona*	None	SS	No
Pacific peavine	*Lathyrus vestitus var. ochropetalus*	None	SE	Yes
Spleenwort-leaved goldthread	*Coptis asplenifolia*	None	SS	Yes
Spotted Joe-pye weed	*Eutrochium maculatum var. bruneri*	None	SS	Yes
Stalked moonwort	*Botrychium pedunculosum*	None	ST	Yes
Swamp gentian	*Gentiana douglasiana*	None	SS	Yes
Tall bugbane	*Actaea elata var. elata*	None	SS	Yes
Tree clubmoss	*Dendrolycopodium dendroideum*	None	SS	Yes
Triangular-lobed moonwort	*Botrychium ascendens*	None	ST	Yes
Water lobelia	*Lobelia dortmanna*	None	SS	Yes
Weak thistle	*Cirsium remotifolium var. remotifolium*	None	SE	Yes
Western moonwort	*Botrychium hesperium*	None	SS	Yes

White meconella	*Meconella oregana*	None	SE	Yes
Whitebark pine	*Pinus albicaulis*	Proposed Threatened	SS	Yes

Based on review of the State of Washington's PHS list, the habitat types Table 6.4 are included in the County's HOLI list (Comprehensive Plan policy E-437).

Table 6.4 Habitat types included in King County's Habitats of Local Importance (HOLI) list.

Habitat of Local Importance	New to list in 2024
Old growth forest	No
Sphagnum-dominated peat bogs	No
Westside prairie	Yes
Oregon white oak woodlands	Yes
Herbaceous balds	Yes
Caves	No
Cliffs	No
Talus	No
Snag-rich areas	No

6.1.4 Risk Assessment of Regulatory Updates

King County protects wildlife by designating and protecting SOLI and HOLI, designating and protecting wildlife corridors, conserving land and habitat through nonregulatory programs, and by prioritizing development in the County's UGA. Wildlife and wildlife habitat in King County are also protected in part through development regulations and nonregulatory measures related to the management of wetlands and wetland buffers (see Section 4) and riparian areas (see Section 5).

This approach is informed by BAS and aligns with WAC 365-190-130, which states that FWHCA protections must maintain "populations of species in suitable habitats within their natural geographic distribution so that the habitat available 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" (see Section 6.1.2).

King County is adding animal and plant species as SOLI in Comprehensive Plan policy E-435. In addition to expanding the list of SOLI, King County is adding three types of habitat as HOLI in Comprehensive Plan policy E-437. These additions are informed by BAS and state guidance. Updating SOLI and HOLI lists aligns Comprehensive Plan policies with BAS and allows the County to better implement nonregulatory land

conservation programs (see Section 6.1.5) that consider the full variety of locally important species and habitats.

6.1.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs that offer protections to wildlife and wildlife habitat are discussed at a summary level below. Readers can learn more by visiting linked webpages.

Land Conservation in King County and Wildlife Habitat Climate Gradient Analysis

King County operates nonregulatory open space acquisition programs, such as the Land Conservation Initiative (LCI), using funding from King County's Conservation Futures program and other sources. The LCI is a regional collaboration between King County, cities, business associations, agricultural communities, environmental partners, and other groups aimed at preserving the County's last, most important natural lands and urban green spaces over the next 30 years. King County has mapped and prioritized 65,000 acres of land for protection in six categories: urban green space, trails, natural lands, rivers, farmlands, and forestlands.

To inform conservation efforts moving forward, King County plans to conduct a climate gradient analysis for wildlife habitat in the county. This mapping exercise will use climate-informed wildlife migration models and updated stream and wetland mapping resources (see Section 3.2.5) to identify and map areas and corridors critical to the protection of local wildlife biodiversity as the climate changes over time. Completing this mapping using climate-informed models will help King County, local jurisdictions, and community members understand the relative habitat value of different habitat areas and wildlife corridors in the County. The outcomes of this analysis will inform King County's efforts to protect critical wildlife biodiversity areas and corridors and preserve connectivity through land conservation efforts.

This nonregulatory program will improve outcomes for wildlife and wildlife habitat, advancing King County's progress in satisfying GMA goals for urban growth, reducing sprawl, environmental protection, shoreline management, climate resiliency, open space and recreation, natural resource industries, public facilities and services, and community coordination.

6.2 References

Abrams, Peter A. 2000. The Evolution of Predator-Prey Interactions: Theory and Evidence. *Annual Review of Ecology and Systematics* 31(1): 79-105.

Anderson, M. G., and C. E. Ferree. 2010. Conserving the Stage: Climate Change and the Geophysical Underpinnings of Species Diversity. *PLOS ONE* 5:e11554.

Bateman, Brooke L., Lotem Taylor, Chad Wilsey, Joanna Wu, Geoffrey S. LeBaron, Gary Langham. 2020. Risk to North American Birds from Climate Change-related Threats. *Conservation Science and Practice* 2(8) https://doi.org/10.1111/csp2.243

Beier P. 2012. Conceptualizing and Designing Corridors for Climate Change. *Ecological Restoration* 30: 312–319. https://doi.org/10.3368/er.30.4. 312

Bellard, C., C. Marino, and F. Courchamp. 2022. Ranking Threats to Biodiversity and Why It Doesn't Matter. *Nature Communications* 13(1): 2616. https://doi.org/10.1038/s41467-022-30339-y

Bennett, A. F., and D. A. Saunders. 2010. Habitat Fragmentation and Landscape Change, Chapter 5. *In Conservation Biology for All*, edited by Sodhi, N. S., and P. R. Ehrlich, 88–106.

Beschta, Robert L., and William J. Ripple. 2009. Large Predators and Trophic Cascades in Terrestrial Ecosystems of the Western United States. *Biological Conservation* 142(11): 2401–2414. https://doi.org/10.1016/j.biocon.2009.06.015

Bretagnolle, V., and J. Terraube. 2019. Predator–prey Interactions and Climate Change. In *Effects of Climate Change on Birds. Second Edition*, edited by Peter O. Dunn and Anders Pape Møller: Oxford University Press. DOI: 10.1093/oso/9780198824268.003.0015

Brodie, Jedediah, Eric Post, Fred Watson, and Joel Berger. 2012. Climate Change Intensification of Herbivore Impacts on Tree Recruitment. *Proceedings of the Royal Society B: Biological Sciences* 279(1732): 1366–70. https://doi.org/10.1098/rspb.2011.1501

Brost, B. M., and P. Beier. 2012. Use of Land Facets to Design Linkages for Climate Change. *Ecological Applications* 221: 87–103.

Carroll, C., J. R. Dunk, and A. Moilanen. 2010. Optimizing Resiliency of Reserve Networks to Climate Change: Multispecies Conservation Planning in the Pacific Northwest, USA. *Global Change Biology* 16: 891–904. Doi: 10.1111/j.1365-2486.2009.01965.x

Costanza, J. K., J. Watling, R. Sutherland, C. Belyea, B. Dilkina, H. Cayton, D. Bucklin, S. S. Romañach, and N. M. Haddad. 2020. Preserving Connectivity Under

Climate and Land-use Change: No One-size-fits-all Approach for Focal Species in Similar Habitats. *Biological Conservation* 248 108678, https://doi.org/10.1016/j.biocon.2020.108678

Dobrowski, S. Z., J. T. Abatzoglou, J. A. Greenberg, and S. G. Schladow. 2009. How much influence does landscape-scale physiography have on air temperature in a mountain environment? *Agricultural and Forest Meteorology* 149: 1751–1758.

Fahrig, L. 2020. Why do several small patches hold more species than few large patches? *Global Ecology and Biogeography: A Journal of Macroecology* 29: 615–628.

Fertig, W. 2021. 2021 *Washington Vascular Plant Species of Conservation Concern*. Washington Natural Heritage Program Report Number: 2021-04. 43 pages.

Frainer, André, Brendan G. McKie, Per-Arne Amundsen, Rune Knudsen, and Kevin D. Lafferty. 2018. Parasitism and the Biodiversity-Functioning Relationship. *Trends in Ecology and Evolution* 3(4): 260–268. DOI:https://doi.org/10.1016/j.tree.2018.01.011

Fremier, A. K., M. Kiparsky, S. Gmur, J. Aycrigg, R. K. Craig, L. K. Svancara. 2015. A Riparian Conservation Network for Ecological Resilience. *Biological Conservation* 191: 29–37.

Garcia R. A., M. Cabeza, C. Rahbek, and M. B. Araújo. 2014. Multiple Dimensions of Climate Change and Their Implications for Biodiversity. *Science* 344(6183): 1247579.

Gilbert, F., Andrew Gonzalez, and Isabel Evans-Freke. 1998. Corridors Maintain Species Richness in the Fragmented Landscapes of a Microecosystem. Proceedings: Biological Sciences 265(1396): 577–582.

Gilbert-Norton L., R. Wilson, J. R. Stevens, and K. H. Beard. 2010. A Meta-analytic Review of Corridor Effectiveness. *Conservation Biology* 24: 660–68.

Graziano, M.P., A. K. Deguire, and T. D. Surasinghe. 2022. Riparian Buffers as a Critical Landscape Feature: Insights for Riverscape Conservation and Policy Renovations. Diversity 14(3): 172. https://doi.org/10.3390/d14030172

Gregory, A. J. and P. Beier. 2014. Response Variables for Evaluation of the Effectiveness of Conservation Corridors. *Conservation Biology* 28: 689–95.

Groves, Craig R., Edward T. Game, Mark G. Anderson, Molly Cross, Carolyn Enquist, Zach Ferdaña, Evan Girvetz, et al. 2012. Incorporating Climate Change into Systematic Conservation Planning. *Biodiversity and Conservation* 21: 1651–1671.

Haddad, N. M, L. A. Brudvig, J. Clobert, K. F. Davies, A. Gonzalez, R. D. Holt, T. E. Lovejoy, et al. 2015. Habitat Fragmentation and Its Lasting Impact on Earth's Ecosystems. *Science Advances* 1(2): e1500052.

Harris, L. D., and F. Scheck. 1991. From Implications to Applications: The Dispersal Corridor Principle Applied to the Conservation of Biological Diversity. In *Nature Conservation 2: The Role of Corridors*, edited by D. A. Saunders and R. I. Hobbs, pp. 189–220. Surrey Beatty and Sons.

Hunter, M. L., Jr. 2017. Conserving Small Natural Features with Large Ecological Roles: An Introduction and Definition. *Biological Conservation* 211(Part B) 1—2. ISSN 0006-3207. https://doi.org/10.1016/j.biocon.2016.12.019

Jetz, Walter, David S. Wilcove, and Andrew P. Dobson. 2007. Projected Impacts of Climate and Land-use Change on the Global Diversity of Birds. *PlOS Biology* 5(6): e157. doi: 10.1371/journal.pbio.0050157

Keeley, A. T. H., D. D. Ackerly, D. R. Cameron, N. E. Heller, P. R. Huber, C. A. Schloss, J. H. Thorne, and A. M. Merenlender. 2018. New Concepts, Models, and Assessments of Climate-wise Connectivity. *Environmental Research Letters* 13: 073002. https://doi.org/10.1088/1748-9326/aacb85

King County. 2004a. *Volume I: A Review of Scientific Literature*. King County Department of Natural Resources and Parks.

Krosby, M., D.M. Theobald, R. Norheim, and B.H. McRae. 2018. Identifying Riparian Climate Corridors to Inform Climate Adaptation Planning. *PLOS ONE* 13(11): e0205156. https://doi.org/10.1371/journal.pone.0205156

Lawler, J. J., and J. Michalak. 2018. Planning for climate change without climate projections? In *Effective Conservation Science: Data Not Dogma*, edited by Peter Kareiva, Michelle Marvier, and Brian Silliman: Oxford University Press Oxford University Press. DOI: 10.1093/oso/9780198808978.003.0021

Littlefield, Caitlin E., Meade Krosby, Julia L. Michalak, and Joshua J. Lawler. 2019. Connectivity for Species on the Move: Supporting Climate-driven Range Shifts. *Frontiers in Ecology and the Environment* 17(5): 270–278. Doi:10.1002/fee.2043

MacArthur, R. H., and E. O. Wilson. 1967. *The Theory of Island Biogeography*. Princeton University Press, Princeton, NJ.

Mantyka-Pringle, Chrystal S., Piero Visconti, Moreno Di Marco, Tara G. Martin, Carlo Rondinini, and Jonathan R. Rhodes. 2015. Climate Change Modifies Risk of Global Biodiversity Loss Due to Land-cover Change. *Biological Conservation* 187: 103—111. https://doi.org/10.1016/j.biocon.2015.04.016

McConkey, Kim R., Soumya Prasad, Richard T. Corlett, Ahimsa Campos-Arceiz, Jedediah F. Brodie, Haldre Rogers, and Luis Santamaria. 2012. Seed Dispersal in Changing Landscapes. *Biological Conservation* 146(1): 1–13. https://doi.org/10.1016/j.biocon.2011.09.018

Naiman R. J., H. Decamps, and M. Pollock. 1993. The Role of Riparian Corridors in Maintaining Regional Biodiversity. *Ecological Applications* 3: 209–212. https://doi.org/10.2307/1941822 PMID: 27759328

Newbold, Tim, Lawrence N. Hudson, Samantha L. L. Hill, Sara Contu, Igor Lysenko, Rebecca A. Senior, Luca Börger, et al. 2015. Global Effects of Land Use on Local Terrestrial Biodiversity. *Nature* 520: 45–50. https://doi.org/10.1038/nature14324

Nuñez, T. A., J. J. Lawler, B. H. McRae, D. J. Pierce, M. B. Krosby, D. M. Kavanagh, P. H. Singleton, and J. J. Tewksbury. 2013. Connectivity Planning to Address Climate Change. *Conservation Biology* 27: 407–416. https://doi.org/10.1111/cobi.12014

Olson, D. H.; Anderson, P. D.; Frissell, C. A.; Welsh, and H. H.; Bradford, D. F. 2007. Biodiversity Management Approaches for Stream–riparian Areas: Perspectives for Pacific Northwest Headwater Forests, Microclimates, and Amphibians. Forest Ecology and Management 246(1): 81–107. DOI:10.1016/j.foreco.2007.03.053

Phillips, S. J., P. Williams, G. Midgley, and A. Archer. 2008. Optimizing Dispersal Corridors for the Cape Proteaceae Using Network Flow. *Ecological Applications* 185: 1200–1211.

Piao, S., Q. Liu, A. Chen, I. A. Janssens, Y. Fu, J. Dai, L. Liu, X. Lian, M. Shen, X. Zhu, et al. 2019. Plant Phenology and Global Climate Change: Current Progresses and Challenges. *Global Change Biology* 25(6): 1922–1940. https://doi.org/10.1111/gcb.14619

Pickett, S. T. A., and J. N. Thompson. 1978. Patch Dynamics and the Design of Nature Reserves. *Biological Conservation* 13(1): 27–37. https://doi.org/10.1016/0006-3207(78)90016-2

Riva, F., and L. Fahrig. 2022. The Disproportionately High Value of Small Patches for Biodiversity Conservation. Conservation Letters 15(3): e12881

Riva, F., and L. Fahrig. 2023. Obstruction of Biodiversity Conservation by Minimum Patch Size Criteria. Conservation Biology 37(5): e14092. doi: 10.1111/cobi.14092.

Román-Palacios, C., and J. J. Wiens. 2020. Recent Responses to Climate Change Reveal the Drivers of Species Extinction and Survival. *Proceedings of the National Academy of Sciences of the United States of America* 117: 4211–4217.

Sabo, J. L., R. Sponseller, M. Dixon, K. Gade, T. Harms, J. Heffernan., A. Jani, et al. 2005. Riparian Zones Increase Regional Species Richness by Harboring Different, Not More, Species. *Ecology* 86: 56–62. doi.org/10.1890/04-0668

Schloss, C. A., T. A. Nuñez, and J. J. Lawler. 2012. Dispersal Will Limit Ability of Mammals to Track Climate Change in the Western Hemisphere. *Proceedings of the National Academy of Sciences of the United States of America* 109: 8606–8611.

Schmitz, O. J., Joshua J. Lawler, Paul Beier, Craig Groves, Gary Knight, Douglas A. Boyce, Jason Bulluck, et al. 2015. Conserving Biodiversity: Practical Guidance about Climate Change Adaptation Approaches in Support of Land-use Planning. *Natural Areas Journal* 351: 190–203.

Seavy N. E., T. Gardali, G. H. Golet, F. T. Griggs, C. a. Howell, R. Kelsey, et al. 2009. Why Climate Change Makes Riparian Restoration More Important Than Ever: Recommendations for Practice and Research. *Ecological Restoration* 27: 330–338.

Staudinger, M. D., Shawn L. Carter, Molly S. Cross, Natalie S. Dubois, J. Emmett Duffy, Carolyn Enquist, Roger Griffis, et al. 2013. Biodiversity in a Changing Climate: A Synthesis of Current and Projected Trends in the U.S. Frontiers in Ecology and the Environment 11(9): 465–473. doi:10.1890/120272

Stoffyn-Egli, Patricia, and J. H. Martin Willison. 2011. Including Wildlife Habitat in the Definition of Riparian Areas: The Beaver (*Castor canadensis*) as an Umbrella Species for Riparian Obligate Animals. *Environmental Reviews* 19: 479–494.

Tang, J., C. Körner, H. Muraoka, S. Piao, M. Shen, S. J. Thackeray, and X. Yang. 2016. Emerging Opportunities and Challenges in Phenology: A Review. *Ecosphere* 7(8): e01436. 10.1002/ecs2.1436

Tape, K. D., B. M. Jones, C. D. Arp, I. Nitze, and G. Grosse. 2018. Tundra Be Dammed: Beaver Colonization of the Arctic. Global Change Biology 24: 4478–4488.

Tape, K. D., J. A. Clark, B. M. Jones, S. Kantner, B. V. Gaglioti, G. Grosse, and I. Nitze. 2022. Expanding Beaver Pond Distribution in Arctic Alaska, 1949 to 2019. Scientific Reports 12: 7123. doi.org/10.1038/s41598-022-09330-6

Torezan-Silingardi, H. M., I. Silberbauer-Gottsberger, and G. Gottsberger. 2021. Pollination Ecology: Natural History, Perspectives and Future Directions. In *Plant-Animal Interactions*, edited by K. Del-Claro and H. M. Torezan-Silingardi. Springer, Cham. doi.org/10.1007/978-3-030-66877-8_6

Tylianakis, J. M., R. K. Didham, J. Bascompte, and D. A. Wardle. 2008. Global Change and Species Interactions in Terrestrial Ecosystems. *Ecology Letters* 11: 1351–1363. doi.org/10.1111/j.1461-0248.2008.01250.x

U.S. Department of Agriculture Forest Service, U.S. Department of Interior Bureau of Land Management. 1994. *Final Supplemental Environmental Impact Statement on Management of Habitat for Late-successional and Old-growth Forest Within the Range of the Northern Spotted Owl*. USDA Forest Service Portland, Oregon.

Virkkala, R., J. Aalto, R. K. Heikkinen, A. Rajasärkkä, S. Kuusela, N. Leikola, and M. Luoto. 2020. Can Topographic Variation in Climate Buffer Against Climate Change-induced Population Declines in Northern Forest Birds? *Diversity* 12(2): 56. doi.org/10.3390/d12020056

Washington Department of Fish and Wildlife (WDFW). 2015. *Washington's State Wildlife Action Plan: 2015 Update*. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Washington Department of Fish and Wildlife (WDFW). 2023. *Washington State Priority Habitats and Species List 2008*, updated June 2023. Olympia, WA. 291 pages.

Washington Wildlife Habitat Connectivity Working Group (WHCWG). 2010. *Washington Connected Landscapes Project: Statewide Analysis*. Washington Departments of Fish and Wildlife, and Transportation, Olympia, WA

Washington Wildlife Habitat Connectivity Working Group (WHCWG). 2011. *Washington Connected Landscapes Project: Climate-Gradient Corridors Report*. Washington Departments of Fish and Wildlife, and Transportation, Olympia, WA.

Washington Wildlife Habitat Connectivity Working Group (WHCWG). 2013. *An Evaluation of the Utility of Fine-scale, Downscaled Climate Projections for Connectivity Conservation Planning in Washington State*. Washington Departments of Fish and Wildlife, and Transportation, Olympia, WA.

Weiskopf, Sarah R., Madeleine A. Rubenstein, Lisa G. Crozier, Sarah Gaichas, Roger Griffis, Jessica E. Halofsky, Kimberly J.W. Hyde, et al. 2020. *Climate Change Effects on Biodiversity, Ecosystems, Ecosystem Services, and Natural Resource Management in the United States*. *Science of the Total Environment* 733: 137782. doi.org/10.1016/j.scitotenv.2020.137782

Williams, P., L. Hannah, S. Andelman, G. Midgley, M. Ara´ujo, G. Hughes, L. Manne, E. Martinez-Meyer, and R. Pearson. 2005. Planning for Climate Change: Identifying Minimum Dispersal Corridors for the Cape Proteaceae. *Conservation Biology* 194: 1063–1074.

Wilsey, C., B. Bateman, L. Taylor, J. X. Wu, G. LeBaron, R. Shepherd, C. Koseff, S. Friedman, and R. Stone. 2019. Washington State Brief, from: *Survival by Degrees: 389 Bird species on the Brink*. National Audubon Society: New York.

Wintle, B.A., Heini Kujala, Amy Whitehead, Alison Cameron, Sam Veloz, Aija Kukkala, Atte Moilanen, et al. 2019. Global Synthesis of Conservation Studies Reveals the Importance of Small Habitat Patches for Biodiversity. *Proceedings of the National Academy of Sciences of the United States of America* 116: 909–914.

Yan Y, S. Jarvie, Q. Zhang, S. Zhang, P. Han, Q. Liu, and P. Liu. 2021. Small Patches are Hotspots for Biodiversity Conservation in Fragmented Landscapes. *Ecological Indicators* 130: 108086.

7 Critical Aquifer Recharge Areas (CARA)

Critical aquifer recharge areas (CARA) are the geographic areas that have a "critical recharging effect on aquifers used for potable water" (RCW 36.70A.030). King County is reviewing and updating its Comprehensive Plan policies and associated development regulations in the King County Code (K.C.C.) for the protection of CARAs, which were first enacted in 1994 (King County 2004a). Protecting groundwater is an important regional issue because groundwater provides approximately 30 percent of the water used in King County and is the primary source of water in Unincorporated King County (UKC) outside of the Urban Growth Area (UGA). On Vashon-Maury Island and in other sole-source aquifer areas, it is the only source of drinking water (King County 2016).

Many land use activities can potentially affect the quality or quantity of groundwater recharge. All groundwater is vulnerable, but some areas where strategic public groundwater resources are located are more vulnerable than other areas (Ecology 2005). Any potential land use activity that stores, uses, or produces known contaminants of concern (constituents found to be a risk to human health and capable of groundwater transport) and has a sufficient likelihood of releasing such contaminants to the environment at detrimental levels is considered a threat. Any land use that can reduce the quantity of recharge to the aquifer to a significant degree is also considered to be a threat. If these activities occur above aquifer recharge areas critical to groundwater quality and quantity, it is prudent to implement groundwater protection measures in those areas to protect the groundwater resources of the County (King County 2004b).

Mapping CARA provides the general framework for groundwater quality and quantity protection policy. CARA identification methods have evolved substantially in the resource management and land use planning literature since the 1980s. The most recent advancement in prioritizing aquifer recharge areas requires two major tasks. The first task is to map the aquifer susceptibility and the second task is to map the areas where the value of the groundwater resource is high. The most common areas mapped for this second step are water supply protection areas (commonly called wellhead protection areas and sole-source aquifers). The final overlay of these two maps delineates CARA (King County 2004a).

Climate change has the potential to impact future groundwater availability. Warmer temperatures in the Pacific Northwest are projected to lead to greater demand for water in the summer and fall, while reduced snowpack and associated stream flows could reduce seasonal groundwater recharge. Understanding the potential effects of climate variability and change on groundwater is more complex than with surface water (Holman 2006). Groundwater residence times can range from days to hundreds of years or more, which delays and disperses the effects of climate and challenges efforts to detect responses in the groundwater to climate variability and change (Gurdak 2009). Climate variability affects subsurface water resources both directly by altering surface water flux and indirectly via changes in groundwater extraction patterns (Gupta 2021). Assessment of climate change effects on groundwater recharge and water supplies is

needed to understand and mitigate for potential impacts. King County has ongoing monitoring of groundwater resources to assess changes in groundwater resources.

This section discusses CARA regulations in King County and associated Growth Management Act (GMA) CARA classification requirements. Relevant best available science (BAS) and comprehensive planning considerations are discussed along with updates to the K.C.C.

7.1 CARA Classification

King County's Comprehensive Plan has a *Groundwater Resources* section in the Environment chapter. These policies (E-493 – E-498) are important components of the County's responsibility to protect groundwater resources.

King County defines CARA as areas of recharge potential (susceptibility) and areas of critical importance for potability (wellhead protection areas and sole-source areas), which are classified into three categories (K.C.C. 21A.24.313):

- Category I CARA are mapped areas that are designated as highly susceptible to groundwater contamination and are located within a sole-source aquifer or a wellhead protection area.
- Category II CARA are mapped areas that are designated as having medium susceptibility to ground water contamination and are located within a sole-source aquifer or a wellhead protection area.
- Category III CARA are mapped areas that are designated as having low susceptibility to groundwater contamination and are located over an aquifer underlying an island that is surrounded by saltwater.

The County also classifies areas of high recharge potential (without wellhead protection or sole-sources areas) as equally important to protect for effects on streams, lakes, and wetlands that provide critical fish and wildlife habitat. These areas are also classified as Category II CARA.

King County codified an additional method for determining Category I CARA for protecting drinking water sources in 2008. This Category I CARA is defined as an area where hydrogeologic mapping or a numerical flow transport model in a Washington Department of Health approved wellhead protection plan demonstrate that the area is within the 1-year time of travel to a wellhead for a Group A water system independent of the mapped susceptibility.

7.1.1 2024 BAS Review

Various methods of vulnerability assessment of groundwater have been developed using different approaches. The following methods, GOD, AVI, DRASTIC, SINTACS, and SI, have a variety of parameters that are based on overlay and indexing

techniques, depending on the type of aquifer, the type of pollutant, and the availability of data (Maria 2018):

- DRASTIC considers seven parameters: depth to water (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of the vadose zone (I), and hydraulic conductivity (C).
- SINTACS involves seven parameters: static level depth (S), net recharge (I), nonsaturated zone (N), soil type (T), aquifer type (A), hydraulic conductivity (C), and topographic slope (S).
- AVI bases groundwater vulnerability on two physical parameters: 1) thickness (d) of each sedimentary layer above the uppermost, saturated aquifer surface, and 2) estimated hydraulic conductivity (K) of each of these sedimentary layers.
- GOD utilizes three main parameters: the groundwater occurrence, the lithology of the overlying layers, and the depth to groundwater.
- SI involves five layers: Depth to water, Net Recharge, Aquifer media, Topography, and Land Use (LU).

Current literature review reveals that subsets or variations of the parameters of the DRASTIC methodology are commonly used for defining areas of aquifer susceptibility and vulnerability. DRASTIC is one of the most widely known and used methods for the assessment of aquifer vulnerability (Fannakh 2022).

Each of these methodologies has advantages and limitations in assessing vulnerability. A sensitivity analysis of DRASTIC suggests that depth to water table (D) is the key factor determining vulnerability, followed by impact to the vadose zone (I) and soil type (S) (Maria, 2018). King County's current susceptibility mapping uses parameters D, S, and I of the DRASTIC method. CARA classification methodology is detailed in King County 2004a and 2004b. No changes to the County's methodology for delineating CARA were proposed based on the recent literature review of aquifer susceptibility and vulnerability. With no changes in the methodology, no update to the existing CARA map was necessary as part of the BAS review.

King County reviewed existing guidance documents from Ecology and Commerce. The guidelines from Ecology help jurisdictions designate CARA (Ecology, 2005; update 2021). King County's existing methodology of delineating CARA follows the state guidance from Ecology. The Critical Areas Handbook from Washington Department of Commerce (Commerce 2023) provides guidance and resources for drafting critical areas ordinances including CARA. King County designates CARA based on important considerations outlined in the Handbook. The Handbook references Washington Administrative Code (WAC) 365-190-100, which states,

"Counties and cities must classify recharge areas for aquifers according to the aquifer vulnerability."

As noted in Section 7.1.3, King County is updating the CARA classifications to include aquifer vulnerability designations.

7.1.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information when updating CARA protections. As King County updates its Comprehensive Plan policies and associated development regulations found in the K.C.C., it must balance required increases in environmental protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1) and King County Comprehensive Plan priorities (see Section 3.1.1).

CARA Mapping

King County updates its Comprehensive Plan and development regulations every 10 years as required by the GMA. Environmental policy E-493 states, “The county shall periodically update [the CARA] map with new information from adopted groundwater and wellhead protection studies and other relevant sources”. King County’s plans to update its CARA map before the next 10-year Comprehensive Plan update in 2034.

State Agency Guidance

King County values preserving aquifer functions and values, reflected in current code and policy. Ecology’s CARA guidance document (2021 update) includes identifying the following:

- Where drinking water aquifers are located.
- What the underground characteristics are that transmit recharge and any associated contaminants, to the extent that is practical and available.
- Where groundwater is currently used for drinking water.
- Where groundwater will be needed for drinking water in the future.
- What contamination threats to drinking water already exist.
- What measures need to be in place to protect recharge availability.
- What measures need to be in place to prevent contamination of recharge.
- For special consideration for anadromous fisheries, how surface water depends on groundwater.

7.1.3 Regulatory Updates

King County is updating the K.C.C. to clarify that CARA is classified according to aquifer vulnerability. The updated code links aquifer vulnerability with existing CARA categories. The Commerce Critical Areas Handbook (2023) outlines high and low vulnerability. King County is updating the existing CARA categories I and II (see Section 7.1) as “high vulnerability areas” due to their potential impact on drinking water sources if degraded by contamination and hydrogeologic conditions that facilitate degradation. King County is adding “medium vulnerability areas” to the existing CARA category III.

This special area refers only to Vashon-Maury Island as an island surrounded by salt water. The potential impact on drinking water if degraded by contamination is due to the sole-source nature of the Island's drinking water. The lower hydrogeologic susceptibility infers a lower and slower pathway of degradation, but the physical nature of being an island surrounded by saltwater means the impact would be greater. At this time, King County is not mapping "low vulnerability areas" that have a lower risk of impact from contaminants that will degrade groundwater and by hydrogeologic conditions that do not facilitate degradation.

Along with this update, King County is adding relevant definitions within the K.C.C. Updates improve clarity and include references to other relevant K.C.C. sections, including K.C.C. 21A.24.314.

7.1.4 Risk Assessment of Regulatory Updates

As King County updates its development regulations in the K.C.C., it must balance critical areas protections (see Section 1.2.1) with the need to satisfy other GMA goals (see Section 1.1). King County's approach to managing risks to critical areas functions and values is discussed in Section 3.2.

CARA Classification

King County's 2024 BAS review for CARA was informed by Washington State guidance (see Section 2.1) and included review of published resources and peer-reviewed literature. Findings from the 2024 BAS review process continue to support King County's methodology for delineating CARA. The development standards and the classification methodology are not changing with these updates. Because there was no change in the methodology, the CARA map is not being updated as part of the BAS process (see Section 7.1.2, CARA Mapping).

King County is making minor changes to the K.C.C. to clarify that CARA is classified according to aquifer vulnerability as required by the state. Updates to the K.C.C. are not expected to meaningfully change critical areas protections for CARA or effect County permit processing. Updates clarify that CARA is classified according to aquifer vulnerability, bringing the K.C.C. up to date with state requirements. The BAS review continues to support the County's methodology for delineating CARA.

7.1.5 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs that offer protections to riparian areas and aquatic areas are discussed at a summary level below.

King County Groundwater Monitoring and Community Engagement

King County has ongoing monitoring of groundwater resources in critical areas that provide understanding of functions and values of County aquifers. In addition to groundwater resource protections in K.C.C. Chapter 21A.24, groundwater resources are protected by K.C.C. Chapters 9.04 (Stormwater Runoff and Surface Water And Erosion Control), 9.12 (Water Quality) and 9.14 (Groundwater Protection).

Since 2001, King County has monitored groundwater resources in critical areas, providing understanding of functions and values of this ecosystem. Monitoring provides a long-term data set for assessing functions and values of County aquifers as well as assessing the effects of climate change on groundwater resources.

King County also utilizes education and outreach to enhance groundwater protection. An ongoing example of this effort is the County partnership with the Vashon-Maury Island Groundwater Protection Committee to assist residents with being good stewards of their island aquifer system.

7.2 References

Duda, R., K. Iwona, and Z. Robert. 2020. Groundwater Pollution Risk Assessment Based on Vulnerability to Pollution and Potential Impact of Land Use Forms. *Polish Journal of Environmental Studies* 29 (1): 87–99.

Fannakh, A. and A. Farsang. 2022. DRASTIC, GOD, and SI Approaches for Assessing Groundwater Vulnerability to Pollution: A Review. *Environmental Sciences Europe* 34 (77): 34-77.

Gupta, P.K., B. Y. Yadav, and D. Sharma. 2022. "Chapter 9—Impacts of Climatic Variability on Subsurface Water Resources." In *Advances in Remediation Techniques for Polluted Soils and Groundwater.* Pankaj Kumar Gupta, Basant Yadav, Sushil Kumar Himanshu, eds., 171–189. Elsevier.

Gurdak, J.J., R.T. Hanson, and T. R. Green. 2009. *Effects of Climate Variability on Groundwater Resources of the United States*. U.S. Geological Survey Fact Sheet ages3074, 4 pages.

Holman, I.P. 2006. Climate Change Impacts on Ground-water Recharge—Uncertainty, Shortcomings, and the Way Forward? *Hydrogeology Journal* 14 (5): 637–647.

King County. 2004a. *Volume I: A Review of Scientific Literature – Chapter 6 Critical Aquifer Recharge Areas*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v1.pdf

King County. 2004b. *Volume II: Assessment of Proposed Ordinances*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v2.pdf

King County. 2016. *Comprehensive Plan*; Ordinance 18427. https://kingcounty.gov/council/CompPlan/2016compplan/adopted.aspx

Maria, R. 2018. Comparative Studies of Groundwater Vulnerability Assessment. In *IOP Conference Series: Earth and Environmental Science* 118 (1) 012018.

Washington State Department of Commerce (Commerce). 2023. *Critical Areas Handbook – A Handbook for Reviewing Critical Areas Regulations (Version 3)*. Washington State Department of Commerce. https://deptofcommerce.box.com/s/rlysjrfvrxpxwnm9jvbcd3lc7ji19ntp

Washington State Department of Commerce (Commerce). 2022. *Critical Areas Checklist – A Technical Assistance Tool from Growth Management Services*. Washington State Department of Commerce. https://deptofcommerce.box.com/s/5su5ugh9h5cmkv9oj1m3trjfql5r68c6

Washington State Department of Ecology (Ecology). 2005. *Critical Aquifer Recharge Areas Guidance Document*. January 2005 – Revised 2021 (draft). Publication No. 05-10-028. https://apps.ecology.wa.gov/publications/documents/0510028.pdf

8 Geologically Hazardous Areas

Geologically Hazardous Areas (GHAs) are “areas that because of their susceptibility to erosion, sliding, earthquake, or other geological events, are not suited to the siting of commercial, residential, or industrial development consistent with public health or safety concerns” (RCW 36.70A.030). Landslide Hazard Areas (LHAs) are a type of GHA that include “areas subject to landslides based on a combination of geologic, topographic, and hydrologic factors,” including “areas located in a canyon or on an active alluvial fan, presently or potentially subject to inundation by debris flows or catastrophic flooding” (WAC 365-190-120).

King County reviewed Commerce guidance documents (2022 and 2023) and the scope of King County’s 2004 best available science (BAS) literature to inform the 2024 BAS review for GHAs. This process identified that BAS review was necessary for the management of alluvial fans, designated by the State as a type of landslide hazard area within the state-defined GHA critical area. King County reviewed BAS and alluvial fan critical areas protections in place at other regional jurisdictions. This review found that regulatory updates are necessary to establish development standards for alluvial fans.

Alluvial fans naturally occur along stream channels at the base of a slope. Hazardous geologic processes occur on alluvial fans, creating risks to infrastructure and public health and safety. Debris flows and floods transport sediment and rocks at fast rates that can damage property or harm community members. Debris flows, debris floods, and flash flooding can occur on both public and private property, depositing sediment in areas such as residential and commercial properties, farmlands, floodplains, or stream channels. These events can damage or destroy homes and decrease farmland productivity. In addition, these events can have lasting negative and positive effects on wildlife habitat.

8.1 Alluvial Fan Hazard Management

Prior to the 2024 Comprehensive Plan Update, King County’s Comprehensive Plan and the King County Code (K.C.C.) included limited policies and development regulations for the management of alluvial fans. King County previously regulated alluvial fans using LHA critical areas regulations, limiting King County’s ability to reduce public health and safety risks associated with alluvial fans, such as flooding or debris flow. King County LHA regulations are primarily found in K.C.C. 21A.06.680.

8.1.1 2024 BAS Review

King County’s 2004 BAS review included limited review of scientific literature associated with alluvial fans and debris flows (King County 2004a and 2004b) and instead focused on assessing other GHAs, including seismic, erosion, landslide, volcanic, and coal mine hazard areas. King County’s 2024 BAS review included review of scientific literature related to the identification, protection, and management of alluvial fans and Alluvial Fan Hazard Areas (AFHAs).

To inform the creation of development standards for alluvial fans, King County also reviewed alluvial fan development standards in place at other jurisdictions, many located in the Pacific Northwest. Whatcom County, WA, San Diego County, CA, and the City of Mt. Vernon, WA are examples of jurisdictions implementing AFHA development standards and structural management alternatives to manage risks from these hazards. Some jurisdictions have updated mapping to identify where alluvial fans exist and where hazards related to an alluvial fan may occur.

King County's 2024 BAS review findings for alluvial fans are summarized below.

General Information about Alluvial Fans

Alluvial fans are broad, gently sloping, cone-shaped landforms made up of sediment and debris caused by a buildup of deposits immediately below a significant change in the stream channel slope or valley confinement (WALERT 2023a; Mickelson et al. 2022). An alluvial fan typically occurs where a stream emerges from a steeper slope channel onto a low gradient area such as a floodplain (Mickelson et al. 2022). Fan hazards are triggered by short, intense periods of rainfall or an outburst flood (WALERT 2023c). Hazards associated with alluvial fans include flash floods, debris flows, debris floods, mudflows, and outburst floods.

An outburst flood is a quick burst of water released into a stream channel, which can be triggered by the failure of a blocked stream channel or a beaver dam. Flash floods are a rapid increase in flow along a stream channel that may allow water to overflow channel banks and cause a flood. If a flood contains rocks, trees, and other debris, it is termed a debris flow (Mickelson et al. 2023). Debris flow deposits can recruit gravel, cobbles, boulders, and large woody debris while flowing downslope and damaging trees next to the channel from rock or debris impact and scarring. Mud and gravel may be splashed onto trees and other channel-adjacent objects (Mickelson et al. 2022). Because of the ability of a debris flow to carry these materials to the front of the flowing mass, debris flows are extremely dangerous to public safety and infrastructure (Mickelson et al. 2022).

Debris flows range in size from a few square yards to hundreds of acres in area and from a few inches to 50 feet thick. Even smaller debris flows can be locally dangerous (WALERT 2023c). Debris flows can travel a considerable distance from the upland areas to the valley floor, where they can disrupt roadways and other infrastructure lifelines, destroy property, and cause flooding. Typically, there is little time between a rainfall event upstream and the arrival of the flood downstream in the lowlands, often under an hour (WALERT 2023b). Due to their speed and destructive capability, debris flows pose an immediate and critical threat to public safety (Mickelson et al.2023) and can be catastrophic, sweeping away everything in their path, including huge boulders, homes, and cars (WGS 2023).

Alluvial fans are continually evolving over time and often have several active and inactive stream channels. Stream channels on alluvial fans can experience avulsion, where the active stream channel can quickly move by the process of erosion into a new pathway. The active stream channel that is currently filled with water may not be the same active channel after a flood or debris flow event. A structure previously considered safe from harm could quickly become inundated or in the path of a surging wall of mud and debris or high bedload flooding (WGS 2023).

Some conditions that contribute to debris flows include steep slopes, heavy rainfall, seismic events, weak or loose rock and soil, changes in runoff patterns, improper grading or construction of roads, and wildfire (WALERT 2023c).

Functions and Values of Alluvial Fan Hazard Areas (AFHAs)

Alluvial fans can function to transport sediment and wood to larger, downstream fish-bearing channels. The processes that deliver sediment downstream may affect salmonids in a variety of ways, from benefiting salmon habitat to overloading streams with sediment in the short term (Commerce 2023). Debris flows are a source of recruitment for large wood and branches that contribute to habitat in forest and riparian ecosystems (Quinn et al. 2020).

Climate Change and Alluvial Fan Hazard Areas (AFHAs)

Climate change projections of warmer summer and winter weather and increasing winter rainfall (Mass et al. 2022) influence AFHAs and increase public health and safety risks on alluvial fans. Wetter and more frequent wet weather increase the number of hazards on alluvial fans and areas that may have debris flows. Though streams feeding alluvial fans may have no or low flow for most of the year, they can quickly become flooded with fast moving water after or during a small rainstorm.

Warmer and drier weather increases risks to wildfire hazards, which in turn increase risk of post-wildfire debris flows. Wildfires dramatically change landscape and ground conditions so that even small rainstorms can produce dangerous flash floods and debris flows (WGS 2023; WALERT 2023b; Mickelson et al. 2022). The burning of vegetation can cause soils to become temporarily water repellent after the fire. This change in soil infiltration capacity and the loss of vegetated cover can lead to high runoff, which can trigger flash floods and debris flows during rain events.

The risk of these hazards may remain elevated for several years after a wildfire has been extinguished (Mickelson et al. 2023). The lowlands may still be at risk even if the immediate upland area has not been burned. A burned area far up on a hillside could trigger debris flows that would flow into the lowlands below (Figure 8.1) (WALERT 2023b). Figure 8.1 shows a typical scenario of alluvial fans at the base of steep drainages and creeks (Figure 8.1a). After a wildfire (Figure 8.1b), the burned upland areas (Figure 8.1c) are highly susceptible to the initiation of debris flows and floods that then travel downslope to the lowlands and alluvial fans, where homes or property may

be in the path of the destructive hazard (Figure 8.1c). It is increasingly important to consider post-wildfire flooding as the frequency, intensity, and distribution of wildfires increase because of the changing climate.

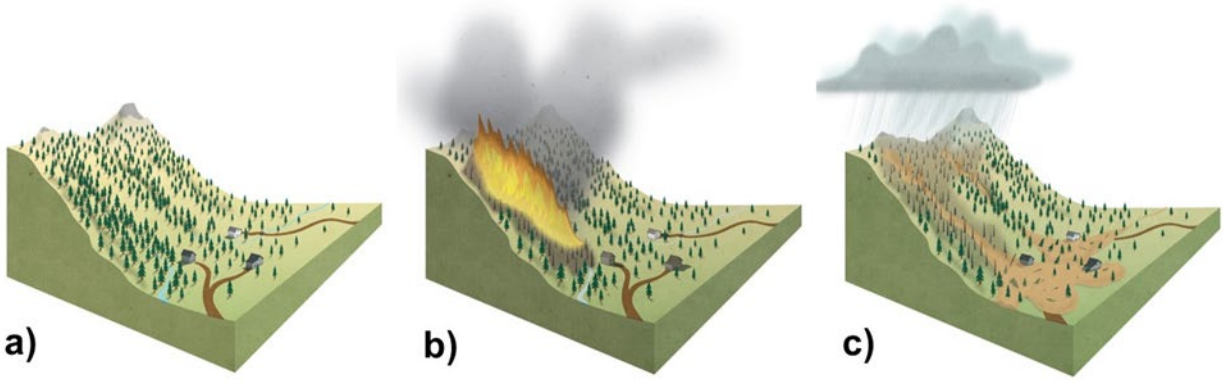


Figure 8.1 Debris flows after wildfire (WALERT 2023b).

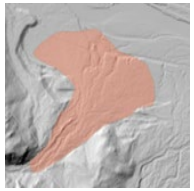
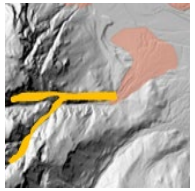
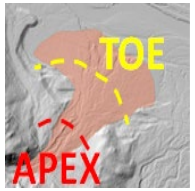
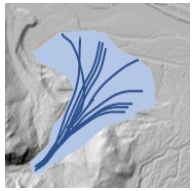
As an example, King County experienced a large wildfire in September 2022, burning 60 square kilometers in the area north of Baring and Skykomish, WA (Mickelson et al. 2022) causing property loss, power outages, traffic delays on a state highway, interrupted access to homes and businesses, and significant poor air quality throughout the Pacific Northwest (Breda et al. 2022). After the fire, Washington State Department of Transportation (WSDOT) identified potential debris flow and high-risk areas (WSDOT 2022) and recommended remedial mitigation options to limit future highway closures (WSDOT 2023).

Mapping Alluvial Fans

GHA maps, including maps for AFHAs, are essential to effective management, protection, and restoration efforts and are used for many purposes, including comprehensive resource management planning, environmental impact assessment, capital project design, land use permitting, and landslide geohazard assessment. Mapping can include classifying hazards and identification of risks to public health and safety. In some cases, mapping can include risk assessments and detailed path analysis of flows.

Table 8.1 compares common mapping approaches for alluvial fan hazards and identifies key features of different approaches.

Table 8.1 Comparison of mapping approaches.

	(a) Maps outline	(b) Maps drainage path and outline	(c) Model's likelihood of debris flows on alpine fans	(d) Maps and identifies if active	(e) Maps general level of hazards	(f) Flood and sediment models	(g) Risk-based models
Identifies or Informs on							
Boundary	✓	✓	✓	✓	✓	✓	✓
Potential Hazard	✓	✓	✓	✓	✓	✓	✓
Level of hazard of fans			✓	-	-	✓	-
Location of hazards					-	✓	✓
Types of hazards					-		-
Runout or flow path						✓	✓
Source drainage path		✓					✓
Climate impacts							✓
Rank or classify risk			✓	✓	✓	✓	✓
Management strategies			✓	✓	✓	✓	✓

Note:
Images are artistic depictions of mapping approaches.
✓ implies items on left side are addressed with above mapping approach.
- implies items indirectly addressed with mapping approach.

The mapping of alluvial fans generally includes the more traditional and commonly used method of mapping the physical outline of an alluvial fan on a map using LiDAR, aerial imagery, other mapping tools, and field observation to identify the footprint of an alluvial fan, indicating where alluvial fan hazards have occurred in the past (column (a) in Table 8.1; Figure 8.2; Mickelson et al. 2023). This method is often the first step to identifying AFHAs. The Washington Geological Survey (WGS) follows a version of this approach when mapping alluvial fans (Mickelson et al. 2023) and is publishing reports that include updated alluvial fan hazard maps in the state's counties (Mickelson et al. 2023).

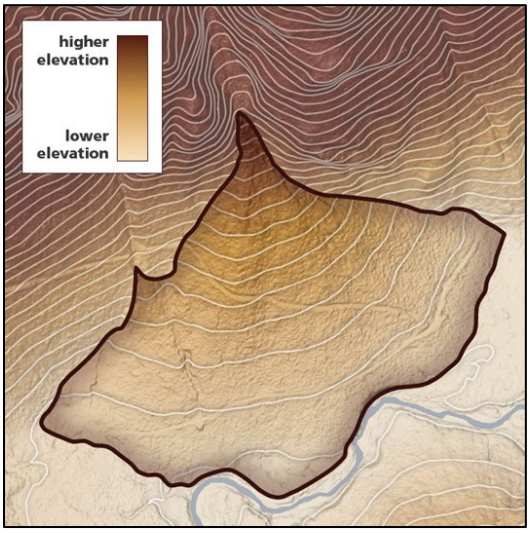


Figure 8.2 Mapping of an alluvial fan outline showing a 40-foot contour interval (Mickelson et al. 2023).

A similar method includes also mapping the contributing watershed or evidence where a debris flow already was initiated above a mapped fan (column (b) in Table 8.1; Bornaetxea et al. 2023). This is commonly seen in watershed analyses and more sophisticated predictive modeling approaches. The pathway of a debris flow is often visible as bare scars along dry or flowing creeks, hillslopes, and drainages.

Mapping approaches that can classify hazards or rank associated risks consist of methods shown in columns (c) through (g) of Table 8.1. Column (c) shows a method that identifies which alluvial fans are more likely to be subjected to debris flows or floods using maps and a computational mapping analysis (e.g., Melton's ratio or the relative relief ratio) (Davies et al. 2023; Wilford et al 2009). Maps showing active areas of fans (column (d)) are created using digital datasets and informed by field observations to determine the boundaries of the alluvial fan and whether the alluvial fan is currently active. Active areas of alluvial fans pose higher risks of damage to structures and property and increase risks to public safety and health.

Mapping often also includes identifying and classifying hazards based on their location in a drainage area or the alluvial fan. This is based on field observation, aerial imagery, and expert knowledge of fan processes (column (e)). This can consist of mapping boundaries of the apex (the top of the alluvial fan) where larger impacts occur. Impacts

in the distal area (or toe) of the alluvial fan experience lower impacts but can pose a significant risk to public health and safety.

Modelling approaches (columns (f) and (g) of Table 8.1) can be used to map flooding depth and location and sediment deposition, predict flow paths, and calculate impact forces on structures resulting from alluvial fan hazards like debris floods, debris flows, mudflows, and flash floods. These more time consuming but useful methods can be costly for applicants wanting to make alterations within an AFHA and are best used in combination with field observations. Modeling channelized debris and using risk-based models (Figure 8.1 column g; Burns et al. 2022; Sturzenegger et al. 2021; EGBC 2023) is a more current and sophisticated method that models the level of hazards and locations where alluvial fan hazards are likely to start, travel, and end. Some drainages do not have alluvial fans at their base and the potential for debris flows may not be realized (Davies et al. 2023). The Oregon Department of Geology and Mineral Industries (DOGAMI) has also mapped landslide hazards and has recently developed a standardized protocol to identify areas prone to channelized debris flow (CDF) (Burns et al. 2022). The protocol creates an inventory where CDFs have occurred, may start and travel, and identifies watersheds where CDFs are likely to occur. The results are presented in a report and summarized in a map that categorizes hazard areas according to a channelized debris flow potential ranking: none-very low, low, moderate, and high (Burns et al. 2022).

King County developed an Environmentally Sensitive Areas Landslide Hazards Map in the 1990s, using it as the basis for applying development regulations and prioritizing capital investments. In 2004, this map was renamed the Critical Areas Landslide Hazards Map (King County 2016) and was updated with new hazards if observed as part of the permitting process. These maps were not produced using modern mapping technology and don't identify different types of landslide hazards. In 2014, landslide mapping updates were initiated by both the County and Washington State. The current mapping inventory of alluvial fans provides incomplete geographical coverage and consists of four sources:

- 2016 King County Landslide Mapping Update along Major River Corridors.
- 2016 King County Critical Areas Potential Landslide Hazard Areas and Potential Steep Slope Hazard Areas mapping update in areas of permitting interests.
- 2017 Washington Geological Survey Protocol for Landslide Inventory Mapping from Lidar Data in Washington.
- 2019 Washington Geological Survey Landslide Mapping of Western Washington.

Collectively, these data sets do not provide complete alluvial fan mapping coverage for King County. Not all alluvial fans are mapped, and existing maps do not depict the location or severity of hazards on a fan. As a result, potential hazards and subsequent risks to public health and safety are not accounted for in all planning and permitting decisions, capital projects, and habitat restoration efforts. Decisions based on poor or limited data can undermine planning efforts and investment in capital projects.

Management Practices on Alluvial Fans

Issues associated with alluvial fans and debris flows in the Puget Lowland areas of King County can be different than other places, such as British Columbia, Canada, and Whatcom County, WA, where development at the base of creeks on alluvial fans is more common. While there are some differences between King County geography, vegetative cover, and climate with other places dealing with alluvial fans, management practices can be similar. Within King County, the Puget Lowland also has geologic processes that differ to the western slope of the Cascades in eastern King County.

The complexity of any given alluvial fan is a function of many factors, including surrounding land use, stratigraphy, soils or geology, topography or landforms, clearing and grading activities, surcharge loading, total rainfall over a sustained period, and presence of a geologic contact on top of which the groundwater or subsurface flow regime may run or in some cases may even liquefy the underlying soils (Iverson et al. 2015; Snohomish County, WA 2015a).

As a result of population pressures and urbanization along the County coastline due to rail and roads infrastructure and development along the shoreline, it is expected that there will be an increased risk of urban landslides (Hampton et al. 2004). To mitigate that risk, various strategies can be employed to reduce risk to public health and safety and to minimize environmental impacts. Some jurisdictions implement development regulations and best management practices to reduce risks from these types of hazards. In addition, regulatory interpretation and guidance to applicants and developers on management practices are provided at some jurisdictions. As wildfire awareness increases, jurisdictions can look to Washington State for guidance on mapping and managing risks of debris flows and floods caused post-wildfire debris flows.

Some examples of management practices in the industry and at jurisdictions are:

- Establish monitoring and adaptive management programs (KWL 2010)
- Public education (Hofmeister et al. 2002; Whatcom County, WA 2012)
- Warning systems that include traffic alerts and road closures (KWL 2010; Hofmeister et al. 2002)
- Planned retreat (land acquisition where hazards are deemed too high) (KWL 2003, 2010; Commerce 2023; Davies et al. 2023)
- Watershed-scale consideration and management (KWL 2010; Commerce 2023)
- Debris basins, barriers, and deflection berms; debris flow and flood impact walls; levees; enhanced channels; debris fences; grade control structures; and sediment storage basins and traps (Utah Silver Jackets Team 2022; Girard 2005; KWL 2010; Whatcom County, WA 2012; Hofmeister et al. 2002)
- Raised structures (San Diego County, CA 2023)

Limitations of some management practices include short- and long-term environmental effects, the requirement for ongoing maintenance, difficulties in developing appropriate

design parameters, and the possibility that structures may relocate the hazard and shift the impact to adjacent properties (Hofmeister et al. 2002).

8.1.2 Comprehensive Planning Considerations

In addition to BAS review, King County considered nonscientific information during the development of alluvial fan development standards. As King County updates its Comprehensive Plan policies and associated development regulations in the K.C.C., it must balance required increases in environmental protections (see Section 1.2.1) with the need to satisfy other Growth Management Act (GMA) goals (see Section 1.1) and King County Comprehensive Plan priorities (see Section 3.1.1).

Establishing development standards for alluvial fans heightens environmental protections by limiting development and permitted land use activities in designated hazard areas. As a result, the amount of land available for activities such as housing development is decreased.

Regulatory Guidance and Regional Approaches to Alluvial Fan Management

While there are some differences in alluvial fans, the geologic processes that build alluvial fans and create hazard areas are similar. King County shares geology, topography, and climate with relevant regional governing bodies in the Pacific Northwest, including jurisdictions in both the United States and Canada. These areas share similar challenges in managing alluvial fans and AFHAs while meeting goals associated with housing development, agriculture, forestry, and critical areas protections.

The Washington State Department of Ecology recommends limiting development in channel migration zones (CMZs), alluvial fans, and other areas that are likely to see unpredictable floodwater and debris flow events (Commerce 2023). Provincial guidelines published by the British Columbia Ministry of Water Land and Air Protection include discouraging development where local knowledge, experience, or studies indicate a concern that there may be a debris flow hazard (BC MWLAP 2004).

To inform development of alluvial fan development standards, King County completed a review of alluvial fan development standards and regulations in place in the western United States and Canada, with a focus on cities, counties, states, and provinces in the Pacific Northwest, including Whatcom County. References to alluvial fans and debris flows are present in code and policy language at jurisdictions reviewed as part of this BAS. However, these references are commonly incorporated into the LHA code and policy. This means that development standards are the same as those for all other types of landslides that fall within the LHA, regardless of the differences of the hazards, mapping technologies, and circumstances for proposed development or land use action.

Some jurisdictions have language that defines alluvial fans as a separate hazard area type within the GHA having definitions specific to geomorphic features on alluvial fans

(Whatcom County, WA). Code and policies should reflect the geomorphic differences and types of impacts that occur on AFHAs than other GHAs, including LHAs, to mitigate hazards. Some jurisdictions that address alluvial fans and related hazards also include definitions on various types of hazards (mudflows, debris flows, debris floods, and flash floods).

The following are examples of code definitions, development standards, or AFHA management concepts that were identified during the 2024 BAS review process:

- AFHA as a separate type of LHA with different code and policy.
- AFHA management plans.
- Mapping requirements.
- Setbacks and buffers.
- Notice on title or property covenants.
- Requirements on factor of safety for hazard occurrences.
- Consideration of debris flow or flow runout.
- Management strategies to mitigate hazards.
- Considerations of long-term impacts of hazard mitigation.
- Requirements that minimize risks to public safety.
- Minimize impacts to other critical areas.
- Avoiding the use of dredging or other activities that can potentially harm habitat functions.
- Qualifications for professionals who can prepare reports.
- Technical requirements for a critical areas report specifically prepared for GHAs, LHAs, and AFHAs.

Some jurisdictions (e.g., cities of Anacortes and Edmonds, WA and Whatcom County, WA) have adopted language in code on additional technical requirements for critical area reports addressing GHAs and who is qualified to prepare these technical reports. Geological Critical Area Reports generally provide criteria for the review and reporting of the AFHA.

A review by the City of Anacortes in 2017 revealed that property covenants are included in regulations when developments occur in landslide hazard areas in the City of Everett, City of Seattle, and Island County (Geoengineers 2017). In 2015, Snohomish County followed suit and amended their code to include additional notice, disclosure, and covenant requirements where the covenant runs with the land and states that the property is in a LHA, the owner accepts the responsibility for the risks, describes the risks, and informs future purchasers and provides indemnification (Snohomish County, WA 2015b).

The Washington State Department of Natural Resources (DNR) and DOGAMI released a guide (WGS and DOGAMI 2023) that provides general guidance that homeowners should consider regarding their home and property, including landslide warning signs and who to contact if they suspect active landslides on their property. DOGAMI's 2019 "Preparing for Landslide Hazards: A Land Use Guide for Oregon Communities" is

published as a quick-reference guide (DOGAMI 2019b) and a more extended document (DOGAMI 2019a). These guides bring together strategies and examples from a variety of sources to help communities make good decisions to become more resilient to landslide hazards through community land use options and strategies.

8.1.3 Regulatory Updates

Based on the 2024 review of BAS and comprehensive planning considerations, King County is updating its Comprehensive Plan and the K.C.C. to improve the management of alluvial fans and AFHAs. Updates are intended to:

- Define the County's role in alluvial fan and AFHA management.
- Implement development standards for alluvial fans that reduce public health and safety risks.
- Limit clearing and grading and prohibit new development in AFHAs.
- Allow select emergency actions to be permitted to reduce alluvial fan hazard risks to existing development and land uses.

Updates satisfy the GMA requirement that the County regulate GHAs and LHAs to reduce risk to public health and safety. The majority of policy updates defining AFHAs as a new type of GHA can be found in Chapter 5 of the Comprehensive Plan and in K.C.C. Chapters 21A.06 and 21A.24. Alluvial fan development standards, which in part define allowed, conditionally allowed, and non-allowed activities in AFHAs, can be found in K.C.C. 21A.24.045. Additional development regulations pertaining to alluvial fans can be found in a new section of the K.C.C. specific to alluvial fan management. Having updated, clear, and comprehensive development standards for AFHAs in the K.C.C. is intended to reduce risks to public health and safety associated with alluvial fans.

8.1.4 Nonregulatory Measures

King County recognizes the importance of protecting critical areas through both regulatory and nonregulatory approaches. King County coordinates with communities and other partners to guide investment in nonregulatory programs that protect natural resources, including critical areas. Nonregulatory programs that offer protections to alluvial fans are discussed at a summary level below. Readers can learn more by visiting linked webpages.

Alluvial Fan Mapping

King County permitting staff currently use landslide hazard mapping resources updated in 2016 (see Section 8.1.1) to inform critical areas permitting processes. King County plans to update its alluvial fan mapping to support implementation of alluvial fan policies and development regulations. Updated alluvial fan mapping will better inform permitting staff, County project managers, and members of the public of the location and types of alluvial fan hazards present in King County. These resources can be updated using the latest data, technologies, and methods to produce more accurate maps. King County

mapping resources are available online through King County's interactive mapping tool, King County iMap.

This nonregulatory investment will improve outcomes for species and critical areas, advancing King County's progress in satisfying GMA goals for environmental protection, shoreline management, climate resiliency, community coordination, and permitting.

Land Conservation in King County

King County operates nonregulatory open space acquisition programs, such as the Land Conservation Initiative (LCI), using funding from King County's Conservation Futures grant program and other sources. The LCI is a regional collaboration between King County, cities, business associations, agricultural communities, environmental partners, and other groups aimed at preserving the County's last, most important natural lands and urban green spaces over the next 30 years. King County has mapped and prioritized 65,000 acres of land for protection in six categories: urban green space, trails, natural lands, rivers, farmlands, and forestlands.

Updating King County Comprehensive Plan policies and establishing alluvial fan development regulations will reduce risk to public health and safety while preserving natural lands and wildlife habitat. To complement regulatory protection of these areas, King County intends to use updated alluvial fan mapping to inform the voluntary acquisition of areas with high habitat value or that pose a significant risk to public health and safety.

This nonregulatory effort will improve outcomes for people and critical areas, advancing King County's progress in satisfying GMA goals for urban growth, reducing sprawl, environmental protection, shoreline management, climate resiliency, open space and recreation, natural resource industries, and community coordination.

8.1.5 Risk Assessment of Regulatory Updates

Prior to the 2024 Comprehensive Plan Update, King County's Comprehensive Plan and the K.C.C. included limited policies and development regulations for the management of alluvial fans. King County previously regulated alluvial fans using LHA critical areas regulations, limiting King County's ability to reduce public health and safety risks associated with alluvial fans, such as flooding or debris flow.

Designating and managing AFHAs is an important part of land use planning. Ensuring alluvial fan hazards are identified and that policies and development regulations address alluvial fan hazards reduces risk to public health and safety and improves protection of the ecological functions and values of alluvial fans. The GMA requires that cities and counties regulate GHAs to reduce risk to public health and safety (see Section 1.2.1).

Regulatory updates and nonregulatory commitments discussed in this section generally align BAS and with alluvial fan management practices in place at other regional jurisdictions. Collectively, these updates and nonregulatory commitments represent a moderate improvement in managing the public health and safety risks and ecological functions and values of alluvial fans and AFHAs.

Nonregulatory commitments, including alluvial fan mapping and voluntary acquisition of high-risk properties, enables King County to better manage public health and safety risks. Identifying and managing GHAs, including alluvial fans and AFHAs is essential as King County's population continues to grow, and climate change increases the risk of alluvial fan hazards such as debris flow and catastrophic flooding.

Alluvial fan management practices continue to evolve. Reviewing BAS and revising or expanding alluvial development standards in future Comprehensive Plan updates will allow King County to better manage alluvial fan hazards. Future updates to alluvial fan regulations and nonregulatory programs should also consider updated mapping resources and King County's Flood Hazard Management Plan.

8.2 References

Bornaetxea, T., A. Blais-Stevens, B. Miller. 2022. Landslide Inventory Map of the Valemount Area, British Columbia, Canada. A Detailed Methodological Description. In: Alcántara-Ayala, I., et al. In *Progress in Landslide Research and Technology, Volume 1 Issue 2*. Springer, Cham. doi.org/10.1007/978-3-031-18471-0_27

Breda, I., and N. Turner. 2022. Inside the Bolt Creek fire — and the Newly Burning Forests of the Western Cascades. *In Seattle Times.* Oct. 19, 2022. https://www.seattletimes.com/seattle-news/environment/inside-the-bolt-creek-fire-and-the-newly-burning-forests-of-the-western-cascades/#:~:text=The%20Bolt%20Creek%20fire%20has,Heybrook%20Ridge%20on%20the%20west.

British Columbia Ministry of Water Land and Air Protection (BC MWLAP). 2004. *Flood Hazard Area Land Use Management Guidelines*. https://a100.gov.bc.ca/pub/eirs/lookupDocument.do?fromStatic=true&repository=EPD&documentId=4631

Burns, W. J., J. J. Franczyk, and N. C. Calhoun 2022. *Protocol for Channelized Debris Flow Susceptibility Mapping.* Oregon Department of Geology and Mineral Industries (DOGAMI) Special Paper 53. https://pubs.oregon.gov/dogami/sp/SP-53/p-SP-53.htm

Davies, T., M. Bloomberg, D. Palmer, and T. Robinson. 2023. Debris-flow Risk-to-life: Upper-bound Preliminary Screening. E3S Web of Conferences 415: 07005. doi.org/10.1051/e3sconf/202341507005

Engineers and Geoscientists British Columbia (EGBC). 2023. *Professional Practice Guidelines – Landslide Assessments in British Columbia*. Version 4.1. March 1. https://www.egbc.ca/app/Practice-Resources/Individual-Practice/Guidelines-Advisories/Document/01525AMW2FC5GZAROI4ZBZ7KMIRPIFG7JN/Landslide%20Assessments%20in%20British%20Columbia

Geoengineers, Inc. 2017. *Best Available Science Review-Critical Areas Regulations Update: Critical Aquifer Recharge Areas, Geologically Hazardous Areas, and Frequently Flooded Areas, Anacortes, WA*. Prepared for the City of Anacortes, WA. July 26. https://www.anacorteswa.gov/DocumentCenter/View/240/Best-Available-Science-Report-for-GHAs-CARAs-and-FFAs-GeoEngineers-July-2017

Hampton, M. A. and Gary B. Griggs 2004. *Formation, Evolution, and Stability of Coastal Cliffs: Status and Trends*. USGS Professional Paper 1693. 123 pages. https://pubs.usgs.gov/pp/pp1693/

Hofmeister, R. J., D. J. Miller, K. A. Mills, and J.C. Hinkle. 2002. *GIS Overview Map of Potential Rapidly Moving Landslide Hazards in Western Oregon*; Oregon Department of Geology and Mineral Industries (DOGAMI) IMS-22. https://pubs.oregon.gov/dogami/ims/p-ims-022.htm

Iverson, R. M., D. L. George, K. Allstadt, M. E. Reid, B. D. Collins, J. W. Vallance, S. P. Schilling, et al. 2015. Landslide Mobility and Hazards: Implications of the 2014 Oso Disaster. *Earth and Planetary Science Letters* 412: 197–208. doi.org/10.1016/j.epsl.2014.12.020

Kerr Wood Leidal Associates Limited (KWL). 2003. *Canyon Creek Alluvial Fan Risk Assessment - Final Report*. September. https://www.whatcomcounty.us/DocumentCenter/View/31068/CanyonCr_RiskAssessment_FINAL2003?bidId=

Kerr Wood Leidal Associates Limited (KWL). 2010. *Review of Debris Flow Mitigation for Jones Creek. Final Draft Report*. Prepared for the Jones Creek Debris Flow Study. May. https://www.whatcomcounty.us/DocumentCenter/View/32549/JonesCr-Debris-Flow-Mitigation-final-draft-May-2010?bidId=

King County. 2004a. *Volume I: A Review of Scientific Literature*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v1.pdf

King County. 2004b. *Volume II: Assessment of Proposed Ordinances*. King County Department of Natural Resources and Parks. https://your.kingcounty.gov/dnrp/library/2004/kcr1562/kcr1562v2.pdf

King County. 2016. *Potential Landslide Hazards Areas. Spatial Data Layer*. Accessed 09/12/23. https://gismaps.kingcounty.gov/arcgis/rest/services/Environment/KingCo_SensitiveAreas/MapServer/1

Mass, C. F., E. P. Salathé, R. Steed, and J. Baars. 2022: The Mesoscale Response to Global Warming over the Pacific Northwest Evaluated Using a Regional Climate Model Ensemble. *Journal of Climate* 35: 2035–2053. doi.org/10.1175/JCLI-D-21-0061.1

Mickelson, K. and M. Allen. 2022. *Wildfire-associated Landslide Emergency Response Team Report: Bolt Creek, Suiattle River, Boulder Lake, and Lake Toketie Fires, King and Snohomish Counties, Washington*. October https://www.dnr.wa.gov/sites/default/files/publications/ger_hazards_landslide_walert_report_bolt_creek_suiattle_boulder_toketie_2022.pdf

Mickelson, K. A., T. Adams, and C. Lambert. 2023. *Alluvial Fan Inventory of Klickitat County, Washington: Washington Geological Survey Report of Investigations 44*. 5 pages. https://fortress.wa.gov/dnr/geologydata/publications/ger_ri44_klickitat_county_fan_inventory.pdf

Quinn, T., G. F. Wilhere, and K. L. Krueger, technical editors. 2020. *Riparian Ecosystems, Volume 1: Science Synthesis and Management Implications*. Habitat Program, Washington Department of Fish and Wildlife, Olympia. https://wdfw.wa.gov/sites/default/files/publications/01987/wdfw01987.pdf

San Diego County, CA. 2023. Code of Regulatory Ordinances. SEC. 91.1.104.10.1. Modifications in Flood Hazard Areas. (Added by Ord. No. 10464 (N.S.), effective 4-14-17; repealed and adopted by Ord. No. 10651 (N.S.), effective 2-28-20; repealed and adopted by Ord. No. 10829 (N.S.), effective 3-10-23). Accessed 09/26/23. https://codelibrary.amlegal.com/codes/san_diego/latest/sandiego_regs/0-0-0-96338

Snohomish County, WA. 2015a. *Snohomish County, 2015 Best Available Science Review for Critical Area: Regulation Update. Draft Summary*. https://snohomishCountywa.gov/DocumentCenter/View/22501/CAR-BAS-addedum_v-11_22315?bidId=

Snohomish County, WA. 2015b. *Summary of Amendments to Chapter 30.62B SCC – Geologically Hazardous Areas*. September. https://snohomishCountywa.gov/DocumentCenter/View/28157/2015-CAR-Update---Summary-of-Amendments-to-Chapter-3062B-SCC?bidId=

State of Oregon Department of Geology and Mineral Industries (DOGAMI). 2019a. *Preparing for Landslide Hazards: A Land Use Guide for Oregon Communities*. October. https://digital.osl.state.or.us/islandora/object/osl%3A938201/datastream/OBJ/view

State of Oregon Department of Geology and Mineral Industries (DOGAMI). 2019b. *Quick Reference — Preparing for Landslide Hazards: A Land Use Guide for Oregon Communities*. October. https://www.oregon.gov/lcd/Publications/Landslide_Guide_QuickReference_2019.pdf

State of Oregon Department of Geology and Mineral Industries (DOGAMI). 2023. *Channelized Debris Flow Susceptibility: Understanding Channelized Debris Flow Susceptibility in Oregon, USA*. Story map web publication. https://storymaps.arcgis.com/stories/a1483761839b4712a33baf5061d601c8

Sturzenegger, M., K. Holm, C. Lau, and M. Jakob. 2021. Debris-Flow and Debris-Flood Susceptibility Mapping for Geohazard Risk Prioritization. *Environmental & Engineering Geoscience* XXVII(2) 179–194. https://pubs.geoscienceworld.org/aeg/eeg/article-abstract/27/2/179/595278/Debris-Flow-and-Debris-Flood-Susceptibility

Utah Silver Jackets Team. 2022. *Community Guide for Flood Risk Reduction on Alluvial Fans*. Created in partnership with the U.S. Army Corps of Engineers Flood Risk Management Program. https://floodhazards.utah.gov/wp-content/uploads/2022/04/AlluvialFanFloodRiskReductionGuide_ADA.pdf

Washington Geological Survey (WGS). 2023. *Floods After Fires -What You Should Know and What You Can Do*. Washington Department of Natural Resources. Accessed 07/03/2023. https://www.dnr.wa.gov/wildfire-debris-flows#alluvial-fans

Washington Geological Survey (WGS) and Oregon Department of Geology and Mineral Industries (DOGAMI). 2023. *A Homeowners Guide to Landslides for Washington and Oregon*. Accessed 07/03/2023. https://www.dnr.wa.gov/publications/ger_homeowners_guide_landslides.pdf

Washington Geological Survey's Wildfire-Associated Landslide Emergency Response Team (WALERT). 2023a. *Wildfire-Associate Debris Flows - Alluvial Fans*. Washington Department of Natural Resources. Accessed 07/03/2023. https://www.dnr.wa.gov/wildfire-debris-flows#alluvial-fans

Washington Geological Survey's Wildfire-Associated Landslide Emergency Response Team (WALERT). 2023b. *Wildfire-Associated Debris Flows: Debris Flows after Wildfires*. Washington Department of Natural Resources. Accessed 07/03/2023. https://www.dnr.wa.gov/wildfire-debris-flows#debris-flows-after-wildfires

Washington Geological Survey's Wildfire-Associated Landslide Emergency Response Team (WALERT). 2023c. *Wildfire-Associate Debris Flows - What is a Debris Flow*. Washington Department of Natural Resources. Accessed 07/03/2023. https://www.dnr.wa.gov/wildfire-debris-flows#what-is-a-debris-flow?

Washington State Department of Commerce (Commerce). 2022. Critical Areas Checklist – A Technical Assistance Tool from Growth Management Services. https://deptofcommerce.box.com/s/5su5ugh9h5cmkv9oj1m3trjfql5r68c6

Washington State Department of Commerce (Commerce). 2023. *Critical Areas Handbook – A Handbook for Reviewing Critical Areas Regulations (Version 3)*. https://deptofcommerce.box.com/s/rlysjrfvrxpxwnm9jvbcd3lc7ji19ntp

Washington State Department of Transportation (WSDOT). 2022. *US 2, MP 40 to 50, Bolt Creek Fire Debris Flow Assessment & Recommendations*. WSDOT Geotechnical Office Memorandum. November 8. 20 pages.

Washington State Department of Transportation (WSDOT). 2023. *US 2, MP 44.2, XL6701 and US 2 / Grotto Vicinity – Debris Flow Barriers Geotechnical Recommendations*. WSDOT Geotechnical Office Memorandum. May 15. 35 pages.

Whatcom County, WA. 2012. *Swift Creek Sediment Management Action Plan. Draft*. Prepared by Whatcom County Public Works staff on behalf of Whatcom County Flood Control Zone District. http://www.whatcomCounty.us/DocumentCenter/View/1083/69-Swift-Creek-Sediment-Management-Action-Plan-SCSMAP-PDF

Wilford, D. J., M. E. Sakals, J. L. Innes, R. C. Sidels, and W. A. Bergerud. 2009. Recognition of Debris Flow, Debris Flood and Flood Hazard Through Watershed Morphometrics. *Landslides* (1): 61–66. doi.org/10.1007/s10346-003-0002-0.

Appendix A: Animal Species of Local Importance (SOLI)

King County uses the following resources to identify local animal species of local importance (SOLI):

- Washington State Priority Habitats and Species List (WDFW 2023)
- Washington's State Wildlife Action Plan (WDFW 2015)
- Survival by Degrees—389 bird species on the brink (Wilsey et al. 2019)

Animal species are listed in the table below, grouped by animal type. The table provides state and federal status, habitat use in the State of Washington, vulnerability to climate change, and reason for inclusion in the list. Plant species of local importance are discussed in Section 6.1 (see Species and Habitats of Local Importance).

Acronyms for the table below are listed here.

Federal Status (United States 1983):

- FT – Federally listed Threatened Species under the Endangered Species Act
- FE – Federally listed Endangered Species under the Endangered Species Act

State Status, with state definitions (WDFW 2023a):

- SE – Endangered. Seriously threatened with extinction throughout all or a significant portion of its range.
- ST – Threatened. Likely to become endangered within the foreseeable future without cooperative removal of threats.
- SS – Sensitive. Vulnerable or declining and likely to become endangered or threatened in a significant portion of its range without cooperative management or removal of threats.
- SC – Species identified as a Candidate for listing under Washington Administrative Code 220-610-110.

Special Designations:

- PHS – Priority Habitats and Species (WDFW 2023b)
- SGCN – Species of Greatest Conservation Need (WDFW 2015; list updated 2018)

References

United States. 1983. The Endangered Species Act as amended by Public Law 97-304 (the Endangered Species Act amendments of 1982). Washington: U.S. G.P.O.

Washington Department of Fish and Wildlife (WDFW). 2015. *Washington's State Wildlife Action Plan: 2015 Update*. Washington Department of Fish and Wildlife, Olympia, Washington, USA.

Washington Department of Fish and Wildlife (WDFW). 2023a. State Listed Species and State Candidate Species. Updated May 2023. Olympia, WA. 2 pages.

Washington Department of Fish and Wildlife (WDFW). 2023b. *Washington State Priority Habitats and Species List 2008*, updated June 2023. Olympia, WA. 291 pages.

Wilsey, C., B. Bateman, L. Taylor, J. X. Wu, G. LeBaron, R. Shepherd, C. Koseff, S. Friedman, and R. Stone. 2019. Washington state brief, from: *Survival by Degrees: 389 Bird species on the Brink*. National Audubon Society: New York.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Common Loon, *Gavia immer*	Bird	Both	none	SS	PHS; SGCN	Breeds in mountain lakes; winters in marine nearshore.	Moderate	This species has a small breeding population in Washington. Its overall range has contracted northward. Due to life history and a small population in Washington, it is highly vulnerable to impacts if not monitored and managed where appropriate.
Marbled Murrelet*, *Brachyramphus marmoratus*	Bird	Both	FT	SE	PHS; SGCN	Breeds in old-growth forest; feeds in marine nearshore.	Moderate-high	Because of its breeding association with old forests, Marbled Murrelet populations have been severely affected by loss of mature and old forest habitat. Food resources in the marine environment may also influence population status. Audubon Washington bird of "immediate concern."
Western Grebe, *Aechmophorus occidentalis*	Bird	Marine	none	SC	PHS; SGCN	Large freshwater lakes, reservoirs, and marshes during the summer breeding season; primarily coastal marine areas with relatively sheltered waters are used in winter.	High	Fluctuating water levels at breeding sites, disruption of nesting activities, and reductions of prey at overwintering areas in the Salish Sea. Audubon Washington bird of "high concern."
Black Scoter, *Melanitta nigra*	Bird	Marine	none	none	SGCN	Winter in marine waters/shorelines.	Moderate-high	This species has undergone significant population declines in Puget Sound. Sources of impacts have not been clearly identified. Increasing development in the Puget Sound region has led to more disturbance, pollution, and degradation of foraging areas used by sea ducks.
Surf Scoter, *Melanitta perspicillata*	Bird	Marine	none	none	SGCN	Winter in marine waters/shorelines.	Moderate-high	This species has undergone significant population declines in Puget Sound. Sources of impacts have not been clearly identified. Increasing development in the Puget Sound region has led to more disturbance, pollution, and degradation of foraging areas used by sea ducks. Reduction of marine forage (primarily herring spawn) may be reducing populations in some areas.
White-winged Scoter, *Melanitta fusca*	Bird	Marine	none	none	SGCN	Winter in marine waters/shorelines.	Moderate-high	This species has undergone significant population declines in Puget Sound. Sources of impacts have not been clearly identified. Increasing development in the Puget Sound region has led to more disturbance, pollution, and degradation of foraging areas used by sea ducks. Reduction of marine forage (primarily herring spawn) may be reducing populations in some areas.
Western High Arctic Brant, *Branta bernicla*	Bird	Marine	none	none	PHS; SGCN	Winter in marine waters/shorelines; rely on eelgrass beds for foraging.	Moderate-high	Western High Arctic Brant include a small population that has experienced a long-term decline in numbers. Factors affecting population status and distribution are currently unknown.
Harlequin Duck, *Histrionicus histrionicus*	Bird	Both	none	none	PHS; SGCN	Breeding habitat is along fast moving, mountain streams, and wintering habitat is along rocky marine shorelines.	Moderate-high	Declines in wintering numbers of Harlequin Ducks have occurred on Puget Sound. Sources of impacts have not been clearly identified.
Cinnamon teal, *Anas cyanoptera*	Bird	Terrestrial	none	none	SGCN	Breeding areas typically contain dense upland vegetation near freshwater ponds and lakes, usually with dense aquatic vegetation.	Moderate	A once fairly common breeding species in Washington that has declined significantly in the past 40 years.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Bufflehead, *Bucephala albeola*	Bird	Both	none	none	PHS	In the winter, most often found in coastal areas in shallow bays and inlets.	High	Non-breeding concentrations.
Barrow's Goldeneye, *Bucephala islandica*	Bird	Both	none	none	PHS; SGCN	This species is a cavity nester, the female placing its nest in mature and late successional forests and riparian areas adjacent to low gradient rivers, sloughs, lakes, and beaver ponds.	High	Cavity nesting habitat; non-breeding concentrations.
Common Goldeneye, *Bucephala clangula*	Bird	Marine	none	none	PHS	Winter primarily in marine areas, in shallow protected bays, estuaries, and large lakes with a sandy, gravel, or rocky substrate.	High	Non-breeding concentrations.
Wood Duck, *Aix sponsa*	Bird	Terrestrial	none	none	PHS	Wooded wetlands and slow-moving, tree-lined rivers, with a preference for deciduous-tree habitats. Requires either a natural cavity or nest box to raise its young.	Low	Loss of cavity nesting habitat.
Hooded merganser, *Lophodytes cucullatus*	Bird	Terrestrial	none	none	PHS	Small, forested, freshwater wetlands with emergent vegetation.	Low	Loss of cavity nesting habitat.
Trumpeter Swan, *Cygnus buccinator*	Bird	Both	none	none	PHS	Inhabit lakes, ponds, large rivers, and coastal bays. Their most important habitat requirements are open water, access to food, and protection from disturbance.	Moderate	Habitat loss and lead poisoning from ingestion of lead shot.
Tundra Swan, *Cygnus columbianus*	Bird	Both	none	none	PHS	During migration and through the winter, inhabit shallow lakes, slow-moving rivers, flooded fields, and coastal estuaries.	Unknown	Vulnerable aggregations.
Pelagic Cormorant, *Phalacrocorax pelagicus*	Bird	Marine	none	none	PHS	Exclusively marine, can be found in bays and sounds.	Unknown	Vulnerable aggregations.
Pigeon Guillemot, *Cepphus columba*	Bird	Marine	none	none	PHS	Exclusively marine, along rocky shores and inshore waters.	Unknown	Vulnerable aggregations. Conservation status is not well understood.
Caspian Tern, *Hydroprogne caspia*	Bird	Both	none	none	PHS	Fresh- and saltwater wetlands, especially estuaries, coastal bays, and beaches. Nesting sites are often human made.	Unknown	Vulnerable aggregations: highly susceptible to disturbance at nesting sites. Audubon Washington bird of "high concern."
Waterfowl Concentrations (Anatidae, excluding Canada Geese in urban areas)	Bird	Both	none	none	PHS	Varies, but includes significant breeding areas during breeding season and regular concentrations in winter.	Unknown	Vulnerable aggregations.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Western Washington nonbreeding concentrations of plovers (Charadriidae) and sandpipers (Scolopacidae)	Bird	Both	none	none	PHS	Varies, but includes any concentrations during migration periods and winter.	Unknown	Vulnerable aggregations.
Northern Spotted Owl*, *Strix occidentalis*	Bird	Terrestrial	FT	SE	PHS; SGCN	Old-growth forest.	High	Impacts from habitat loss are now exacerbated by effects of competition with Barred Owls for prey and habitat. Audubon Washington bird of "Immediate Concern."
Western Screech Owl, *Otus kennicotii macfarlanei*	Bird	Terrestrial	none	none	SGCN	Found in many forest types, from urban to rural and including riparian zones and forests dominated by Douglas-fir, western hemlock, Sitka spruce, and grand fir.	Moderate	This species appears to have been impacted by the presence of Barred Owls in western Washington.
Bald Eagle*, *Haliaeetus leucocephalus*	Bird	Both	none	none	SGCN	Shorelines (marine and freshwater) and riparian areas.	Low-Moderate	Population is currently robust.
Golden Eagle, *Aquila chrysaetos*	Bird	Terrestrial	none	SC	PHS; SGCN	Open areas with large, rocky cliffs or large trees. Often found in alpine parkland and mid-elevation clear-cuts, as well as in shrub-steppe areas and open forests.	Moderate-High	Harassment by humans; loss of prey base. Audubon Washington bird of "High Concern."
Osprey*, *Pandion haliaetus*	Bird	Both	none	none	none	Nest near rivers, estuaries, salt marshes, lakes, reservoirs, and other large bodies of water.	Stable	Stable and potentially growing population.
Northern Goshawk*, *Accipiter gentilis*	Bird	Terrestrial	none	SC	PHS	Nest almost exclusively in coniferous forest, mostly late-seral stage.	High	Availability of nesting habitat and suitable prey, especially post-fledging. Although the effects of timber harvesting on goshawks are not fully understood, evidence suggests that harvest impacts nest site selection and potentially impacts nesting rates. Audubon Washington bird of "Immediate Concern."
Peregrine Falcon*, *Falco peregrinus*	Bird	Terrestrial	none	none	SGCN	Nest on cliffs near water.	Low-Moderate	Stable and growing population.
American bittern, *Botaurus lentiginosus*	Bird	Terrestrial	none	none	none	Found in dense freshwater marshes and extensive wet meadows. They prefer wetlands with thick cattail and bulrush, mixed with areas of open water. In the winter, can be found in a wider range of habitats, including flooded willow and salt marshes.	Low	Audubon Washington bird of "Immediate Concern."
Great Blue Heron*, *Ardea herodias*	Bird	Both	none	none	PHS	Typically feeds in slow-moving or calm salt, fresh, or brackish water. Inhabit sheltered, shallow bays and inlets, sloughs, marshes, wet meadows, shores of lakes, and rivers. Nesting colonies are typically found in mature forests, on islands, or near mudflats.	Stable	Bald Eagle predation on nests; loud noise near nests.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Hairy Woodpecker, *Picoides villosus*	Bird	Terrestrial	none	none	none	Mature coniferous forest.	Low	They require areas with heavier, more mature tree cover than Downy Woodpeckers and are more dependent on the presence of large trees.
Pileated Woodpecker, *Dryocopus pileatus*	Bird	Terrestrial	none	none	none	Inhabit mature and old-growth forests, and second-growth forests with snags and fallen trees. They need big nesting trees, which are the limiting factor.	Stable	The removal of large snags, large decaying live trees, and large downed wood of the appropriate species, size, and decay class eliminates nest and roost sites and foraging habitat.
Black-Backed Woodpecker, *Picoides arcticus*	Bird	Terrestrial	none	SC	PHS	Suitable mature, old-growth and recently dead lodgepole pine, ponderosa pine, and pine-dominated mixed coniferous forest stands that have experienced recent pine beetle infestation, large blowdowns, or fire.	High	Forest management policies that reduce occurrence of large, high-intensity wildfires that create woodpecker habitat.
American three-toed woodpecker, *Picoides tridactylus*	Bird	Terrestrial	none	none	none	Nest in mature or old-growth boreal conifer forests, especially spruce, larch, fir, and pine. They can be found at elevations from about 4,000 feet up to the tree line. Will come down lower to burned and flooded areas with standing dead trees and to other areas undergoing heavy infestations of wood-boring beetles.	High	Quantity and distribution of mature and old-growth forests probably limit their numbers. Past timber management and current mega fires have not left the diseased and dying timber that hosts their main food source.
Belted kingfisher, *Ceryle alcyon*	Bird	Both	none	none	none	Nest along marine and freshwater shorelines. They require sandy vertical banks for nest burrows and clear water so they can see their aquatic prey.	Stable	Availability of suitable banks for nesting is a limiting factor in distribution and abundance.
Pacific coast band-tailed pigeon, *Columba fasciata*	Bird	Terrestrial	none	none	PHS; SGCN	Relies on upland forests with mineral sources.	Low-Moderate	Timber harvest and management of clearcuts that reduce food resources. Audubon Washington bird of "High Concern."
Oregon Vesper Sparrow, *Pooecetes gramineus affinis*	Bird	Terrestrial	Petitioned for listing	SE	PHS	Open habitats (grassland, shrub-steppe, and agriculture).	Moderate	Loss and degradation of habitat; this subspecies is now in danger of extirpation in Washington. Audubon Washington bird of "Immediate Concern."
Yellow-Billed Cuckoo, *Coccyzus americanus*	Bird	Terrestrial	FT	SE	PHS; SGCN	Large, continuous riparian zones with cottonwoods and willows. Cottonwoods and willows that form open woodlands with dense, low vegetation are particularly preferred.	Low-Moderate	Reasons for decline are not well understood but include habitat loss.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Vaux's Swift*, *Chaetura vauxi*	Bird	Terrestrial	none	none	PHS	Nesting habitat is forest, either coniferous or mixed, but primarily old growth with snags for nesting and roosting. Nests are in natural cavities with vertical entranceways, such as hollow trees.	High	Old-growth snags.
Western Meadowlark, *Sturnella neglecta*	Bird	Terrestrial	none	none	none	In King County, inhabit grasslands/prairie areas and agricultural areas.	Low	Conversion of grassland/prairie habitat. Also, Western Meadowlarks are extremely sensitive to human disturbance during the breeding season and will abort nesting attempts if they are flushed while incubating eggs.
Olive-sided Flycatcher, *Contopus cooperi*	Bird	Terrestrial	none	none	none	Used burned areas and logged areas.	High	Audubon Washington bird of "Immediate Concern."
Red-eyed Vireo, *Vireo olivaceus*	Bird	Terrestrial	none	none	none	In Washington, confined to stream and lakeside woodlands and cottonwood stands.	Unknown	Decline in population most likely resulting from Brown-headed Cowbird parasitism and the degradation and loss of streamside habitat.
Purple Finch, *Carpodacus purpureus*	Bird	Terrestrial	none	none	none	Moist coniferous and mixed-forest lowlands, especially those with many openings and edges, and an abundant understory. They are often found in revegetating clear-cuts, on farmland, and in rural residential areas.	Moderate	House Finches have replaced Purple Finches in many developed areas of Washington.
Purple Martin, *Progne subis*	Bird	Terrestrial	none	none	SGCN	Natural and manmade cavities in marine and freshwater nearshore habitats.	Low-Moderate	The population of Purple Martins in Washington is small and largely dependent on humans to provide nest structures. Consequently, persistence of the population likely requires ongoing human intervention of erecting and maintaining nest structures. Audubon Washington bird of "High Concern."
Sooty Grouse, *Dendragapus fuliginosus*	Bird	Terrestrial	none	none	PHS	Wet conifer forest from sea level to the subalpine and alpine zones at openings and edges that provide a well-developed understory vegetation of grasses, herbs, and shrubs. Winter in dense conifer stands, often at a higher elevation than their breeding habitat.	Unknown	Sooty Grouse are more productive in old-growth forest than even-aged forest. Deforestation for development and agriculture has eliminated habitat for Sooty Grouse in this area.
Chinook Salmon (Puget Sound), *Oncorhynchus tshawytscha*	Fish	Both	FT	none	PHS; SGCN	Spawners use pool and riffle areas in channels that have adequate depth, velocity, gravel substrate, and temperature. Young juveniles use lower velocity and shallower areas, including stream margins and non-mainstem channels such as those found in natural floodplains. Suitable or optimal freshwater temperatures vary by life stage but generally range between 41 and 59°F. Estuaries serve as important rearing habitats, and juveniles use shallow nearshore areas as they migrate through Puget Sound. Sub-adults use deeper, more offshore Puget Sound areas for foraging.	Moderate-High	Riverine, riparian, floodplain, estuarine, and nearshore-marine habitats lost, modified, or heavily degraded by agricultural, urban, and residential development. Habitat loss and degradation due to dams, transportation crossings, culverts, water diversions, and shoreline industrial uses. Dam operations that modify natural hydrological cycle and flows and restrict or eliminate fish passage. River scour and excessive sedimentation from high flows and bank/hillside erosion.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Steelhead (Puget Sound), *Oncorhynchus mykiss*	Fish	Both	FT	SC	PHS; SGCN	Spawn in river mainstems and large and small tributaries, some relatively far upstream compared to other salmonids. Redds constructed in riffles and downstream margins of pools in streambeds where gravel sizes are optimal. Instream woody debris, boulders, and stream bank structure provide important cover. Newly emerged juveniles use shallow gravel bed areas in riffles, among boulders, or near stream banks. As juveniles grow, they move to higher water velocity areas.	Moderate-High	Riverine, riparian, floodplain, estuarine, and nearshore-marine habitats lost, modified, or heavily degraded by agricultural, urban, and residential development. Habitat loss and degradation due to dams, transportation crossings, culverts, water diversions, and shoreline industrial uses. Dam operations that modify natural hydrological cycle and flows and restrict or eliminate fish passage. River scour and excessive sedimentation are threats from high flows and bank/hillside erosion.
Rainbow Trout, *Oncorhynchus mykiss*	Fish	Terrestrial	none	none	PHS	Generally prefer fast water in small to large mainstem rivers, and medium to large tributaries.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Bull Trout, *Salvelinus confluentus*	Fish	Terrestrial	FT	SC	PHS; SGCN	Deep pools in cold rivers and large tributary streams, often in moderate to fast currents, and large, cold lakes and reservoirs.	Moderate-High	Spawning and resident habitat has been destroyed or is threatened by urbanization, fisheries management activities, agriculture practices, mining, residential development, livestock grazing, dams, and logging practices. Increased water temperatures, which may have negative temporal and spatial impacts.
Dolly Varden, *Salvelinus malma*	Fish	Both	none	none	PHS	Streams and lakes.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Chum Salmon, *Oncorhynchus keta*	Fish	Both	none	none	PHS	Small coastal streams and the lower reaches of larger rivers. Fry do not rear in freshwater for more than a few days. Shortly after they emerge, chum fry move downstream to the estuary and rear there for several months before heading out to the open ocean.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Coastal Resident/Sea-run Cutthroat Trout, *Oncorhynchus clarki clarki*	Fish	Both	none	none	PHS	Small to moderately large, clear, well-oxygenated, shallow rivers with gravel bottoms. Marine nearshore.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Coho/Silver Salmon, *Oncorhynchus kisutch*	Fish	Both	none	none	PHS	Spawn in small coastal streams and the tributaries of larger rivers. They prefer areas of mid-velocity water with small- to medium-sized gravels. Because they use small streams with limited space, they must use many such streams to successfully reproduce, which is why coho can be found in virtually every small coastal stream with a year-round flow.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Pink Salmon, *Oncorhynchus gorbuscha*	Fish	Both	none	none	PHS	Mainstems of large rivers and some tributaries, often very close to saltwater.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Sockeye/Red Salmon, *Oncorhynchus nerka*	Fish	Both	none	none	PHS	Streams and rivers connected to lakes.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Kokanee Salmon, *Oncorhynchus nerka*	Fish	Terrestrial	none	none	PHS	Lake and their tributaries.	Unknown	Altered stormwater flows, past hatchery practices, predation, fishing, passage barriers, and lake temperature and dissolved oxygen levels.
Bocaccio Rockfish, *Sebastes paucispinis*	Fish	Marine	FE	none	PHS	Deep marine water.	Moderate-High	By-catch in other fisheries, injuries from barotrauma can be fatal. Anglers can't identify species.
Brown Rockfish, *Sebastes auriculatus*	Fish	Marine	none	none	PHS	Marine nearshore to depths of approximately 400 feet.	Moderate-High	Habitat loss or degradation; toxins in water.
Canary Rockfish, *Sebastes pinniger*	Fish	Marine	FT	none	PHS	High current areas and deeper water.	Moderate-High	By-catch in other fisheries, injuries from barotrauma can be fatal. Anglers can't identify species.
Copper Rockfish, *Sebastes caurinus*	Fish	Marine	none	none	PHS	Depths less than 200 feet and associated with high-relief rocky habitats throughout Puget Sound.	Moderate-High	By-catch in other fisheries, injuries from barotrauma can be fatal. Anglers can't identify species.
Quillback Rockfish, *Sebastes maliger*	Fish	Marine	none	none	PHS	Nearshore and deep waters to 700 feet in Puget Sound. Prefer high-relief rocky habitat; however, can also be found on mud/sand bottoms near rock outcrops or at the base of drop-offs.	Moderate-High	By-catch in other fisheries, injuries from barotrauma can be fatal. Anglers can't identify species.
Yelloweye Rockfish, *Sebastes ruberrimus*	Fish	Marine	FT	none	PHS	Deep waters of Puget Sound. High-relief rocky habitats and often near steep slopes.	Moderate-High	By-catch in other fisheries, injuries from barotrauma can be fatal. Anglers can't identify species.
Southern Rock Sole, *Pleuronectes bilineatus*	Fish	Marine	none	none	PHS	The only flatfish in Puget Sound that are known to spawn in very shallow water, even intertidally, and their eggs have been found on exposed beaches in some locations.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Pacific Cod, *Gadus macrocephalus*	Fish	Marine	none	none	PHS	Found at most depths, most commonly associated with soft bottom and low-relief habitats, including mud, sand, and gravel, but larger individuals may occasionally inhabit rock and boulder habitats.	High	Increases in sea surface temperature. By-catch in other fisheries, injuries from barotrauma can be fatal. Anglers can't identify species.
Lingcod, *Ophiodon elongatus*	Fish	Marine	none	none	PHS	Found on the bottom, with most individuals occupying rocky areas at depths of 10 to 100 meters (32 to 328 feet).	Unknown	Highly susceptible to overfishing.
Pacific Herring, *Clupea pallasi*	Fish	Marine	none	none	PHS; SGCN	Marine nearshore and estuarine. Juveniles congregate in bays, inlets, and channels in summer, and typically spend at least their first year in Puget Sound/Strait of Georgia.	Moderate-High	Maintaining viable spawning grounds and water quality in Puget Sound is a challenge to herring management in Washington. Water temperature, salinity changes, and vegetation under climate change are a risk.
Pacific Sand Lance, *Ammodytes hexapterus*	Fish	Marine	none	none	PHS; SGCN	Upper intertidal sand and sand/gravel spawning sites on Puget Sound beaches are documented as important breeding areas throughout Puget Sound.	Moderate-High	Lack of erosional sediment inputs due to shoreline armoring. Water temperature, oxygen availability, and prey species availability under climate change are a risk.
Surf Smelt, *Hypomesus pretiosus*	Fish	Marine	none	none	PHS	Spawning occurs around high tides on mixed sand-gravel substrates in the upper intertidal	Moderate-High	Widespread shoreline armoring practices on Surf Smelt spawning beaches.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
						zone in a wide variety of wave-exposure regimes, from very sheltered beaches to fully exposed pebble beaches.		
Longfin Smelt, *Spirinchus thaleichthys*	Fish	Both	none	none	PHS	Wide range of temperature and salinity conditions in coastal waters near shore, bays, estuaries, and rivers. Some populations are landlocked in lakes, including Lake Washington.	Unknown	Potential threats include pesticide runoff from agricultural areas and invasions by exotic species, both plant and animal, that may displace or predate on adult or larval Longfin Smelt.
White Sturgeon, *Acipenser transmontanus*	Fish	Both	none	none	PHS; SGCN	Marine nearshore estuarine; rivers.	Moderate	Species of Recreational, Commercial, and/or Tribal Importance.
Pacific Lamprey, *Entosphenus tridentatus*	Fish	Both	none	none	PHS; SGCN	Medium- and large-sized, low-gradient rivers and streams.	Moderate-High	Species of Recreational, Commercial, and/or Tribal Importance. Adults spawn in gravel nests in stream riffles and then die. Eggs hatch into larvae (ammocoetes) and drift downstream to slow velocity areas. Ammocoetes live in silt/sand substrates and filter feed for 3 to 7 years. They no longer exist above dams and other impassable barriers in west coast streams.
Western River Lamprey, *Lampetra ayresii*	Fish	Both	none	SC	PHS; SGCN	Larval lamprey burrow into soft sediment of slow-moving freshwater streams and rivers that lead to the ocean.	Moderate-High	Habitat above artificial barriers.
Pygmy Whitefish, *Prosopium coulteri*	Fish	Terrestrial	none	SS	PHS; SGCN	Deep, unproductive lakes where the water temperatures are 50°F or lower.	Low to Moderate	Decline in numbers possibly from non-native fish.
Fisher, *Pekania pennanti*	Mammal	Terrestrial	none	SE	PHS; SGCN	Inhabit coniferous and mixed coniferous-deciduous forests and tend to avoid areas with significant human activity and developed areas. Forests that provide moderate to high canopy closure and the presence of large woody structures such as cavity trees, snags, and logs.	Moderate-High	Fisher was extinct in Washington. There are now reintroduction efforts. Incidental trapping capture, highway mortality, and other mortality sources pose a risk for the reintroduced population.
Pacific Marten, *Martes caurina*	Mammal	Terrestrial	none	none	PHS; SGCN	Older coniferous forests and riparian forest habitats.	Moderate-High	Risk of loss to trapping, and the loss and fragmentation of habitat from road building and logging.
Gray Wolf, *Canis lupus*	Mammal	Terrestrial	FE	SE	PHS elsewhere in WA, not KC; SGCN	Habitat generalists. Generally found in forests and nearby open habitats characterized by lower elevations and gentle terrain, especially during winter.	Low-Moderate	Illegal killing and persecution. Human-wolf conflict resulting from livestock depredations.
Wolverine, *Gulo gulo*	Mammal	Terrestrial	FT	SC	PHS; SGCN	Alpine and subalpine forest habitats.	Moderate-High	Loss of denning habitat and foraging habitat due to climate change. Barriers or impediments to movement across Interstate 90.
Cascade Red Fox, *Vulpes vulpes cascadensis*	Mammal	Terrestrial	none	SE	PHS; SGCN	A subspecies of Red Fox that occurs only in the montane environments of the Cascade Range in Washington. Subalpine meadows, parklands, and open forests.	High	Climate change may represent a threat from loss of higher elevation meadows and parklands.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Townsend's Big-Eared Bat*, *Corynorhinus townsendii*	Mammal	Terrestrial	none	SC	PHS; SGCN	In western Washington, inhabits lowland conifer and deciduous forests, montane conifer forest, riparian forest, and open fields. Use caves, mines, hollow trees, and built structures for roosting. Snags and large trees may be important roosts for this species.	Moderate-High	Human disturbance of roosts during breeding and wintering periods. Reclamation or vandalism of mines. Loss of snag habitat. Pesticides in agricultural areas.
Big Brown Bat, *Eptesicus fuscus*	Mammal	Terrestrial	none	none	PHS	Trees, snags, caves, mines, crevices in cliffs, bridges, and buildings (e.g., inside attics and walls).	Unknown	Protection of maternity roosts and sizeable hibernacula is a priority for conservation.
Pallid Bat, *Antrozous pallidus*	Mammal	Terrestrial	none	none	PHS	Rock crevices, holes in rock overhangs, large snags and decadent trees, caves, mines, bridges, and other open human-made structures.	Unknown	Known hibernacula and maternity roosts should be protected from human activity.
Myotis spp., *Myotis* spp.	Mammal	Terrestrial	none	none	PHS	Varies by species; many rely on large snags.	Unknown	Varies by species but loss of large decadent trees and snags is likely an important threat. White-nose syndrome.
Douglas Squirrel, *Tamiasciurus douglasii*	Mammal	Terrestrial	none	none	Protected under WAC 220-200-100	Stands of fir, pine, cedar, and other conifers.	Unknown	Locally impacted by loss of forest.
Roosevelt Elk, *Cervus canadensis roosevelti*	Mammal	Terrestrial	none	none	PHS	Productive grasslands, meadows, or clearcuts, interspersed with closed-canopy forests.	Unknown	Species of Recreational, Commercial, and/or Tribal Importance.
Mountain Goat, *Oreamnos americanus*	Mammal	Terrestrial	none	none	PHS	Alpine and subalpine environments.	High	Population in decline.
Pika, *Ochotona princeps*	Mammal	Terrestrial	none	none	Protected under WAC 220-200-100; SGCN	Live year-round in talus fields that are surrounded by meadows or forests, usually located above 8200 feet.	High	Sensitive to temperatures above 78°F and relies on winter snow pack to insulate them from extreme cold conditions.
Northern Flying Squirrel, *Glaucomys sabrinus*	Mammal	Terrestrial	none	none	Protected under WAC 220-200-100	Deciduous and coniferous forests. Make their homes in snags, woodpecker holes, nest boxes, and abandoned nests of birds and other squirrels.	Unknown	Loss of snags.
Hoary Marmot, *Marmota caligata*	Mammal	Terrestrial	none	none	Protected under WAC 220-200-100	High elevations above timberline in the sub-alpine and alpine zones where rock slides or loose boulder piles occur next to moist meadows or other lush herbaceous vegetation.	High	Reduced snow cover (snow droughts). Extreme heat events.
Townsend's Chipmunk, *Tamias townsendii*	Mammal	Terrestrial	none	none	Protected under WAC 220-200-100	Inhabit dense forests and brush thickets, and live in underground burrows.	Unknown	Old-growth stands appear to provide better habitat than young (30–60 year old) second-growth stands. Population trend unknown.
Killer (Orca) Whale, *Orcinus orca*	Mammal	Marine	FE	SE	PHS; SGCN	All marine waters.	Southern residents: Moderate-High	Declining populations linked to a variety of factors, including depleted populations of Chinook salmon, noise and disturbance from marine vessels, and chemical contaminants in water and food supply.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
							Transient/ offshore: Low-Moderate	
Gray Whale, *Eschrichtius robustus*	Mammal	Marine	FE	SS	PHS; SGCN	Marine nearshore and deeper water during migration.	Low-Moderate	Oil spills.
Harbor Porpoise, *Phocoena phocoena*	Mammal	Marine	none	SC	PHS	Marine waters throughout Puget Sound.	Low-Moderate	Entanglement in fisheries gear (netting, pots, and traps).
Dall's Porpoise, *Phocoenoides dalli*	Mammal	Marine	none	none	PHS	Marine, including nearshore.	Unknown	Vulnerable aggregations.
Harbor Seal, *Phoca vitulina*	Mammal	Marine	none	none	PHS	Marine, including nearshore.	Unknown	Vulnerable aggregations.
California Sea Lion (haul-outs), *Zalophus californianus*	Mammal	Marine	none	none	PHS	Marine, including nearshore.	Unknown	Vulnerable aggregations.
Steller Sea Lion, *Eumetopias jubatus*	Mammal	Marine	none	none	PHS	Marine, including nearshore.	Moderate	Alteration of marine food webs through changes in coastal upwelling patterns, warmer water temperatures, ocean acidification, changes in prey availability (including species range shifts), and changes in other ecological processes.
Larch Mountain Salamander, *Plethodon larselli*	Amphibian	Terrestrial	none	SS	PHS; SGCN	Associated with talus, scree, gravelly soils, and other areas of accumulated rock where spaces exist between the rock and soil. Steep slopes are also an important habitat feature. Occupied rocky substrates in non-forested areas are usually north facing and nonvascular plants, especially mosses, dominate the ground cover. In some areas of the Cascade Mountains, inhabit old-growth coniferous forests without significant exposed rocky areas. In all of these habitats, important microhabitats include woody debris, leaf litter, and rocks.	High	Status is based on the small global range, narrow environmental specificity, and concern that there is not adequate protection for this species' specialized habitat of rocky accumulations and talus. Any ground-disturbing activity or land use that changes the moisture regimes and permeability of inhabited rocky substrates, such as overstory tree removal and gravel removal, may threaten populations. In addition, sedentary habits and specific habitat requirements likely hinder dispersal and colonization to new areas as well as limiting gene flow between populations.
Oregon Spotted Frog, *Rana pretiosa*	Amphibian	Terrestrial	FT	SE	PHS; SGCN	This species is highly aquatic and rarely found away from water. Extant populations occur in large, shallow wetland systems associated with a stream or stream network. Breeding habitat is in seasonally flooded margins of wetlands and areas of extensive shallows (approximately 6 to 8 inches deep). Egg masses are placed in areas where they receive little or no shading from vegetation. Beaver-impounded systems appear to provide many of the habitat requirements of this species.	Moderate-High	Human-caused stressors include wetland loss and alteration, loss of disturbance processes that set back succession, introduction of non-native/invasive flora and fauna, and alteration of creek and river channels. Only six watersheds are currently known to be occupied in Washington. Within a watershed, most breeding populations are small and many are isolated from other breeding populations. Require breeding sites in shallow water with short vegetation and full sun exposure. This habitat type is rapidly lost to invasive grasses without management or restoration to native flora.
Northern Red-legged Frog, *Rana aurora*	Amphibian	Terrestrial	none	none	none	Found in lowland (mostly below 3000 feet in Washington) moist forested habitats with access to suitable breeding sites, which include still-	Unknown	Although widespread throughout its historical habitat in western Washington, declines in British Columbia, Oregon, and California cause concern.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
						water bodies that persist until at least July at low elevations, later at high elevations.		
Western Toad, *Bufo boreas*	Amphibian	Terrestrial	none	SC	PHS; SGCN	Occurs in a variety of terrestrial habitats, including forests. Breeding waters are usually permanent and include wetlands, ponds, lakes, reservoir coves, and the still-water off-channel habitats of rivers, as well as river edges.	Moderate	Road mortality. Loss of upland habitat through the development on shorelines and around waterbodies used for breeding. Habitat alteration and degradation.
Northwestern Pond Turtle, *Actinemys marmorata*	Reptile	Terrestrial	Petitioned for listing	SE	PHS; SGCN	Ponds and lakes. Nest in grasslands and open woodland around ponds.	Moderate	American Bullfrogs and introduced warm-water fish. Habitat loss, degradation, and fragmentation. Lack of suitable habitat for reintroduction sites. Invasive tall vegetation overgrowing nesting habitats and uplands.
Western Fence Lizard, *Sceloporus occidentalis*	Reptile	Terrestrial	none	none	none	Habitats include grassland, woodland, coniferous forest, upper beach driftwood along Puget Sound, and farmland. Tend to avoid dense moist forests.	Unknown	Beach driftwood at risk from bulkheading.
Western Pearlshell Mussel, *Margaritifera falcata*	Mollusk: freshwater mussel	Terrestrial	none	none	SGCN	Inhabits cold creeks and rivers with clear, cold water with low velocities and stable substrates, and are frequently found in eddies and with sea-run salmon or native trout. Tend to congregate in areas with boulders and gravel substrate with some sand, silt, and clay. This species appears to be intolerant of sedimentation.	Moderate	Degraded water quality resulting from development and unsustainable agriculture. Many historical sites no longer support mussels, and many local populations no longer successfully reproduce.
Western Ridged Mussel, *Gonidea angulata*	Mollusk: freshwater mussel	Terrestrial	none	none	SGCN	Inhabits cold creeks, rivers, and lakes from low to mid-elevations with substrates that vary from gravel to firm mud, and include at least some sand, silt, or clay. Generally associated with constant flow, shallow water (less than 10 feet in depth), and well-oxygenated substrates.	Moderate	Degraded water quality resulting from development and unsustainable agriculture. Many historical sites no longer support mussels, and many local populations no longer successfully reproduce.
Oregon Floater, *Anodonta oregonensis*	Mollusk: freshwater mussel	Terrestrial	none	none	none	Found more commonly in ponds, lakes, and reservoirs but can also occur in low gradient reaches of streams. They can be found in silty substrates and sandbars at stream confluences.	Unknown	The Oregon Floater is likely affected by the same factors that affect other western Anodonta, including water diversion, dams, pollution, and invasive species.
Blue-gray taildropper, *Prophysaon coeruleum*	Mollusk: slug	Terrestrial	none	SC	PHS; SGCN	Moist, coniferous or mixed-wood forests of varying age classes. Associated with moist forest floor conditions and abundant coarse woody debris, particularly of bigleaf maple.	Unknown	Often associated with older forests and required microhabitat features, including abundant coarse woody debris or other cover, a deep forest litter layer, and shaded, moist forest floor conditions.
Olympia Oyster, *Ostrea lurida*	Mollusk: clams, mussels, and oysters	Marine	none	none	PHS; SGCN	Marine: water depths up to 230 feet and water temperature range of 43 to 68°F.	High	Likely sensitive to a number of climate factors, including declines in salinity, oxygen, and pH. Species of Recreational, Commercial, and/or Tribal Importance.
Butter Clam, *Saxidomus giganteus*	Mollusk: clams, mussels, and oysters	Marine	none	none	PHS	Marine shorelines: sand, gravel, or cobble. Occur from the mid-intertidal to subtidal zones.	Unknown	Vulnerable aggregations. Species of Recreational, Commercial, and/or Tribal Importance.

Common and Scientific Name	Animal Type	Marine or Terrestrial Use in King Co.	Federal Status	State Status	Special Designations	Habitat	Risk from Climate Change	Justification and/or Limiting Factors
Native Littleneck Clam, *Leukoma staminea*	Mollusk: clams, mussels, and oysters	Marine	none	none	PHS	Marine shorelines: buried 4 to 6 inches deep in cobble, gravel, sand, or mud substrate. Normally occur in the mid-intertidal zone.	Unknown	Vulnerable aggregations. Species of Recreational, Commercial, and/or Tribal Importance.
Dungeness Crab, *Cancer magister*	Shellfish	Marine	none	none	PHS	Marine shorelines: eelgrass beds and prefers sandy or muddy substrates.	Unknown	Vulnerable aggregations. Species of Recreational, Commercial, and/or Tribal Importance.
Pandalid Shrimp, *Pandalus* species	Shellfish	Marine	none	none	PHS	Marine: varied.	Unknown	Vulnerable aggregations. Species of Recreational, Commercial, and/or Tribal Importance.
Beller's Ground Beetle, *Agonum belleri*	Arthropod: beetle	Terrestrial	none	SC	PHS; SGCN	Occurs only in low to mid-elevation (less than 3280 feet) Puget Lowland Sphagnum bogs.	Moderate-High	Occurs only in low to mid-elevation (less than 3280 feet) Puget Lowlands Sphagnum bogs. Small number of isolated populations, highly limited distribution and range, and dependence on specialized, restricted, and threatened habitats.
Hatch's Click Beetle, *Eanus hatchii*	Arthropod: beetle	Terrestrial	none	SC	PHS; SGCN	Sphagnum bogs between 0 and 1640 feet in elevation.	Moderate-High	Sphagnum bogs between 0 and 1640 feet in elevation. Small number of isolated populations, highly limited distribution and range, and use of specialized, highly restricted, and threatened Sphagnum moss bog habitat.
Pacific Clubtail, *Phanogomphus kurilis*	Arthropod: dragonfly	Terrestrial	none	SC	PHS; SGCN	Large ponds and lakes in western Washington.	Moderate-High	Riparian vegetation; cool water temperatures. Small number of isolated populations and continued threats to aquatic habitats.
Western Bumble Bee, *Bombus occidentalis*	Arthropod: bee	Terrestrial	Under review	SC	PHS; SGCN	Depend on habitats with rich floral resources throughout the nesting season. Bumble bees require above and below-ground micro-sites for overwintering and nesting, including logs, stumps, and abandoned rodent and ground-nesting bird nests.	Moderate-High	Facing high or extremely high risk of extinction. Requires habitat free of pathogens and insecticides.
Johnson's Hairstreak, *Mitoura johnsoni*	Arthropod: butterfly/moth	Terrestrial	none	SC	PHS; SGCN	Old-growth forests from 100 to 2500 feet in elevation that contain western hemlock and western dwarf mistletoe.	Moderate-High	Western dwarf mistletoe (*Arceuthobium campylopodum*), a plant that parasitizes old-growth western hemlock trees.
Valley Silverspot, *Speyeria zerene bremnerii*	Arthropod: butterfly/moth	Terrestrial	none	SC	PHS; SGCN	Westside prairie: native grasslands.	Low-Moderate	In the south Puget Sound region: low-elevation, short-stature grasslands.

Appendix B: Critical Areas Screening Trends and Housing Development

King County's Department of Local Services (DLS) processes housing development permit applications and enforces King County Code (K.C.C.) in unincorporated King County (UKC). The Growth Management Act (GMA) requires that King County protect critical areas. The GMA also requires that the County plan for and accommodate a variety of housing types and that permit applications be processed in a fair and timely manner (see Section 1.1). King County permitting processes must also allow for reasonable use of private property (Section 3.2.3).

While preparing updates to critical areas protections, King County reviewed 3 years of DLS permit data to determine what percentage of processed permits include a critical areas condition. Further analysis was completed to determine what percentage of these critical areas conditions were related to riparian areas (see Section 5) or wetland buffers (see Section 4). Table B.1 summarizes results of this analysis.

Table B.1 Critical Areas screening trends and housing development.

	Count	Percent
Processed Housing Permits (2019-2021)	933	100%
Any Critical Area Condition on Permit	370	40%
Riparian Area *or* Wetland Buffer Condition	270	29%
Wetland Buffer Condition	197	21%
Riparian Area Condition	158	17%
Riparian Area *and* Wetland	85	9%