State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Mailing Address: Post Office Box 43200 Olympia, WA 98504-3200 • (360) 902-2200 • TDD (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia, WA

December 1, 2022

The Honorable Christine Rolfes
Chair, Senate Ways and Means
303 John A. Cherberg Building
Post Office Box 40466
Olympia, WA 98504-0466

The Honorable Timm Ormsby
Chair, House Appropriations
315 John L. O'Brien Building
Post Office Box 40600
Olympia, WA 98504-0600

The Honorable Kevin Van De Wege
Chair, Senate Agriculture, Water
Natural Resources, and Parks
212 John A. Cherberg Building
Post Office Box 40424
Olympia, WA 98504

The Honorable Mike Chapman
Chair, House Rural Development,
Natural Resources, and Parks
132B Legislative Building
Post Office Box 40600
Olympia, WA 98504

Dear Chairs Rolfes, Ormsby, Van De Wege, and Chapman,

During the 2022 Legislative session—through the proviso contained within Engrossed Substitute Senate Bill 5092—the Washington State Legislature directed the Washington Department of Fish and Wildlife (WDFW) to investigate a pathway for incorporating a Net Ecological Gain (NEG) standard into state law with the goal of improving endangered species recovery and ecological health statewide.

WDFW assessed opportunities for incorporating NEG into existing state law through a mix of research and engagement, with support from consultants and review and scientific input from the Washington State Academy of Sciences (WSAS). I am pleased to share our findings in the following report.

In our work to preserve, protect, and perpetuate Washington's fish, wildlife, and ecosystems, we see firsthand the need for bold polices that promote the rapid restoration of watersheds, wetlands, and other natural environments if we are to have a chance to recover threatened species. And equally important, to prevent further declines and state or federal endangered species listings.

In the face of such challenges, consulted experts largely agree that adopting NEG standards has merit and is an important step forward in advancing environmental protection in Washington state. However, NEG must build from the foundation of existing environmental policy in the state.

Washington currently has a No Net Loss (NNL) policy for development involving shorelines, wetlands, and certain other critical habitats. Despite significant investments in the recovery of salmon and other fish and wildlife species, scientific evidence of continued ecosystem decline in Washington indicates that NNL polices are not working or are not going far enough to protect our state's rich natural heritage.

In advancing NEG standards, the state must simultaneously address these issues and others tied to NNL. The Legislature must also identify a clear scope of NEG application, namely whether standards will apply to both private and public properties. Public projects should contribute to a higher environmental standard when conducting the public's business. If we are serious about restoring species such as Chinook salmon, Southern Resident orca whales, and sharp-tailed grouse, we should be investing in ecosystem restoration through each public works project, big or small.

We must protect what we currently have and restore ecological and watershed functions—through increased investments and actions at a greater scale and pace—if salmon and other threatened species are to have a chance for recovery in Washington, especially in the face of climate change and continued human population growth.

To be successful, this will require cooperation, innovation, increased investments, and bold leadership from our elected leaders, tribes, stakeholders, and local communities.

We have not lost the battle yet, but time is not on our side if threatened fish and wildlife species are to have a chance for recovery. Recovery of Pacific Northwest icons requires restoration at scale, and as this report indicates, Net Ecological Gain is one powerful tool for doing so.

If you have any questions about this report or the Department's efforts in this area, please feel free to contact Tom McBride, WDFW's Legislative Director, at (360) 480-1472.

Sincerely,

Kelly Susewind

Director

cc: Jeff Davis, WDFW Director of Conservation Policy
Ruth Musgrave, Senior Policy Advisor to Governor Jay Inslee

Washington Department of FISH and WILDLIFE

NET ECOLOGICAL GAIN STANDARD PROVISO SUMMARY REPORT

Washington Department of Fish and Wildlife (WDFW)

December 2022

TABLE OF CONTENTS

PROJECT TEAM

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE

Jeff Davis
Chase Gunnell

CONSULTING TEAM

Cascadia Consulting Group

Addie Bash
Gretchen Muller
Nicole Gutierrez

The Watershed Company

Dan Nickel
Dawn Spilsbury

ECONorthwest

Mark Buckley

EXECUTIVE SUMMARY

During the 2021 Legislative session—through the proviso contained within Engrossed Substitute Senate Bill 5092—the Washington Legislature directed the Washington Department of Fish and Wildlife (WDFW) to **investigate a pathway for incorporating a Net Ecological Gain (NEG) standard into state law** with the goal of improving endangered species recovery and ecological health statewide. In summer and fall of 2022, WDFW assessed opportunities for incorporating NEG legislation into existing state law through a mix of secondary research and engagement, with support from consultants and review and scientific input from the Washington State Academy of Sciences (WSAS).

Key project initiatives included:

- **Review and expansion of the NEG definition and other key findings from the WSAS 2022 report**, "Report on Net Ecological Gain" (see full report in *Appendix D. WSAS Report on Net Ecological Gain*), which led to the following updated definition:

  Ecological functions and values, that support biodiversity and resiliency of native plant, animal and fungi species, water quality and quantity, air quality, and food security for all species, are improved over current conditions, at a cumulative scale that can be incrementally implemented through site-specific actions, with any short-term loss of those functions and values being more than offset by overall ecological gains.

- **Review and analysis of precedent** set by other communities based on national and international NEG research papers and legislation.

- **Analysis of existing Washington State environmental, development, or land use law or rule** where the existing standard—namely, No Net Loss (NNL)—is less protective of ecological integrity than the standard of Net Ecological Gain, to understand how these standards have operated within the state.

- **Robust engagement with local governments, state agencies, federally recognized tribes, and key stakeholder groups** across Washington State (henceforth referred to as "experts"). Engagement included a mix of one-on-one and small group interviews as well as large roundtable discussions.

Through these tasks, the project team identified several key themes for the legislature to consider when exploring the integration of NEG into Washington state policy. Key considerations, summarized throughout this report and detailed in Key Themes from Engagement below, include the following:

- Experts largely agree that adopting NEG standards has merit and is an important step forward in advancing environmental protection in Washington state. However, **NEG must build from the foundation of existing environmental policy** in the state.
- Evidence of ecosystem decline in Washington indicates that NNL is not working. However, **the true impact of existing NNL standards is largely unknown.** A pervasive lack of funding and resources available to state agencies and local jurisdictions has led to inconsistent implementation and enforcement of NNL standards and little to no monitoring and reporting of its impacts. Furthermore, there is not a consistent baseline of current conditions from which to monitor progress. In advancing NEG standards, the state must simultaneously address these issues and others tied to NNL.
- The legislature must **identify a clear scope of NEG application**, namely whether standards will apply to both private and public properties or just to public projects.[1]
- For NEG and NNL to succeed, the state needs to **significantly expand funding and resources** available to implementers. Stronger mandates, if insufficiently funded, will have little to no impact on rolling back ecological degradation and preserving the state's valuable natural resources.

The project culminated in the development of the following recommendations, detailed in Chapter 3: Recommendations.

NEG FRAMEWORK, METRICS, MONITORING, AND ENFORCEMENT

- Define policy frameworks that address NEG goals.
- Define scale and scope of NEG application (e.g., site specific or cumulative scale).
- Establish metrics that will be used for establishing targets and current conditions, and tracking progress.
- Establish the baseline conditions against which NNL and NEG can be quantitatively monitored.
- Identify existing information and gaps in monitoring data to ensure standardization across watersheds.
- Improve monitoring and compliance with existing and future environmental standards.

[1] This project primarily assessed NEG under the assumption that policy mandates would apply specifically to public projects and that private projects would continue to comply with a NNL standard. Experts both supported and disputed this stance through engagement and debate over the application of NEG persisted throughout the project. See Scope of Application of NEG legislation on Public and Private Projects for more details.

NEG & NNL IMPLEMENTATION

- Expand understanding of the successes and failures of NNL policies and improve implementation and oversight of NNL moving forward, to ensure that standards are upheld.
- Establish how to set up the tracking and reporting system and oversight for NEG.
- Convene an oversight body to develop an implementation framework for NEG to ensure cross-agency, cross-jurisdictional collaboration and assist with integration into local government planning.
- Ensure equitable and inclusive outcomes of a NEG standard.

NEG INCENTIVES & OTHER STRATEGIES

- Create NEG as a voluntary planning element under the Growth Management Act (GMA) and further incentivize local governments to participate in counties such as Whatcom, Snohomish, and King County.
- Strengthen and expand current incentives contributing to NEG for public projects and voluntary actions on private lands.
- Create new incentives to increase participation in programs and projects that benefit NEG.
- Understand opportunities and challenges in using incentives to achieve long-term benefits.
- Identify additional strategies for voluntarily achieving NEG on private property.

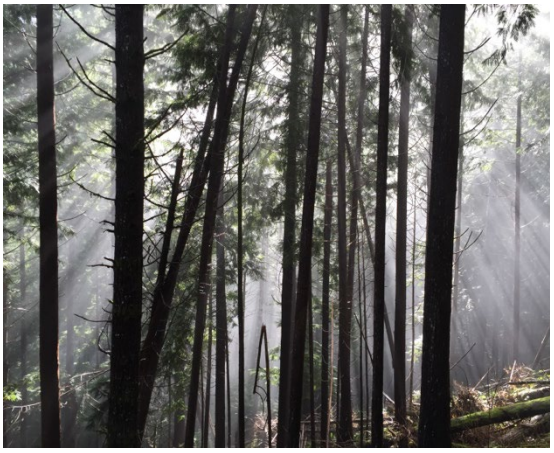
FUNDING NEG & NNL

- Ensure existing funding sources maximize ecological impact.
- Increase funding for implementing and monitoring NEG and NNL.
- Increase funding for local governments to increase staff capacity for long-range planning and compliance.
- Increase funding for local, state, and tribal monitoring programs.
- Provide funding for NEG and NNL multi-jurisdictional oversight.
- Maximize federal funding opportunities.
- Identify new funding opportunities.

EQUITABLE AND INCLUSIVE OUTCOMES AND COMMUNITY ENGAGEMENT

- Continue stakeholder and tribal engagement as early NEG elements move forward.
- Provide annual NEG status reports to the WA State Governor's Office and State Legislature.
- Enhance community engagement in developing an NEG program and continue to engage the community as standards are implemented.
- Review, utilize, or improve public engagement and education programs to support more extensive public awareness and engagement for NEG and NNL.

ACKNOWLEDGMENT OF TRIBAL ENGAGEMENT ON NET ECOLOGICAL GAIN REPORT



The Indigenous Peoples of the Pacific Northwest have resided throughout the lands known today as Washington state since time immemorial. For thousands of years, many generations of indigenous people have practiced stewardship and conservation. There are 29 federally recognized tribal governments that reside within Washington, of which 21 are treaty tribes and eight are executive order tribes (or recognized by Act of Congress). Further, three treaty tribes located outside of Washington have off-reservation treaty rights in the Columbia River and/or Blue Mountains regions in Washington.

The U.S. Constitution recognizes Native American tribes as distinct sovereign governments. Treaty tribes cooperatively manage fish in usual and accustomed areas reserved in their treaties. WDFW has a unique government-to-government relationship with Northwest tribes, with shared responsibilities in stewardship, conservation, and resource management. More information is available at: wdfw.wa.gov/about/state-tribal-coordination

In drafting this report to the Washington State Legislature on NEG policy considerations—and in accordance with the Legislature's direction—**WDFW sought to recognize the unique status of tribal nations and the standing of treaty tribes' roles in fish management**. WDFW invited federally recognized tribes as well as the Northwest Indian Fisheries Commission (NWIFC), Columbia River Inter-Tribal Fish Commission (CRITFC), and Upper Columbia United Tribes (UCUT) to provide input. WDFW engaged directly with leaders and staff of individual tribes and tribal commissions, including through one-on-one conversations, representative roundtables, and presentations to tribal commission meetings. WDFW provided opportunities to review the final report and recommendations prior to publication.

The following section was submitted by NWIFC. It was not written nor edited by WDFW.

NWIFC MEMBER TRIBES COMMENTS ON WASHINGTON DEPARTMENT OF FISH AND WILDLIFE'S REPORT TO THE WASHINGTON STATE LEGISLATURE ON NET ECOLOGICAL GAIN

DECEMBER 1ST, 2022

Since Washington State enacted the Shoreline Management Act (SMA) in 1971 and subsequently the Growth Management Act (GMA) in 1990 and implemented the mitigation standard of No Net Loss (NNL), there has been a steady decline in habitat and the associated ecosystem processes that are critical to sustaining salmon populations and supporting Endangered Species Act (ESA) listed salmon recovery efforts. It is the duty of Washington State to protect the treaty reserved rights of the 20 treaty tribes in western Washington. The tribes' treaty reserved rights are a property right which supersedes the property rights of the individual citizens of Washington State as the treaties were signed in 1855, 34 years before Washington became a member of the union and entered statehood. For Washington State to uphold the tribes' treaty reserved rights and resources guaranteed within the treaties, Washington State needs to protect and restore the habitat these resources depend on. It is imperative that Washington State act quickly and change its land use laws and regulations and the way that it manages growth and development to stave off ongoing and future impacts to the habitat necessary to sustain and recover salmon populations.

The SMA and GMA were intended to balance growth and development with its corresponding impacts to habitat in a way that results in a NNL of habitat function and the ecosystem processes that functional habitat provides. This is critically important as many ESA listed species, such as salmon and Orca, rely on this habitat and the inherent ecosystem processes that these habitats provide. However, due to the competing interests within the GMA and SMA and a deference to ensuring that private property owners can reasonably use their property, these two laws have failed to protect critical habitat for ESA listed species. The current laws and regulations give undue deference to private property owners right to use their property over habitat protection and conservation. This current system perpetuates declines in habitat function and the ecosystem processes that functional habitat provides, and in turn, salmon populations have and will continue to decline throughout Washington State.

The second chapter of the Washington State Academy of Science (WSAS) report, *Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring*, found that the current standard of NNL is not working. "When considering whether existing ecological standards, including NNL, have been sufficient in safeguarding ecological health and achieving endangered species recovery, the committee's consensus view is that NNL has not been an effective approach for ecosystem

or habitat management and protection nor for the maintenance of ecosystem services."[2] The report also states that there will continue to be a decline in habitat and ecosystem function if no changes are made to the State's land use laws and regulations. As a result of this continued loss of habitat and ecosystem function, the report concludes that species and habitat types will continue to go extinct in Washington State. Mitigation will never lead to recovery of ESA list species such as salmon, only the immediate protection and restoration of habitat critical for salmon such as riparian (freshwater & marine), wetlands, and estuaries, will enable ESA listed salmon to begin to recover.

For this report the Washington Department of Fish and Wildlife (WDFW) is proposing to only implement a Net Ecological Gain (NEG) standard for only publicly funded projects. While this is a good first step, it will not be sufficient to achieve the gains in habitat that are immediately needed to stop the continued decline of salmon populations and recover ESA listed salmon and the Orca that depend on them. Instead, a NEG standard with specific conservation metrics must established and applied to all public and private development projects in Washington State. Furthermore, the new standard of NEG will only apply to new development projects and does not address legacy impacts. Development that occurred before the adoption of GMA and SMA is exempt from mitigating the impacts to habitat that occurred from these projects. The ecological function that was lost from development that occurred before the GMA and SMA, also need to be recovered if Washington State is going to stop the decline of salmon populations and recover ESA listed species.

Tribes and salmon do not have the time to wait for WDFW to study how to implement a NEG standard and fix NNL to ensure that NNL is achieving its intended outcome on private development projects. Decades of evidence conclusively demonstrates that NNL is not working and as indicated by the WSAS report, will never work. Therefore, only the immediate protection and restoration of habitat critical for salmon will slow the decline of salmon populations and enable ESA listed species to begin to recover. The tribes constantly hear from organizations like the Washington Association of Counties and the Builders Industry Association of Washington that this will be too expensive and too difficult to achieve, but it will never be cheaper and more achievable than right now.

While the tribes commend the work that WDFW did for this report, their proposed recommendations do not go far enough and the lack the regulatory framework required to stop the decline of salmon populations and recover ESA listed species. The current system of laws and land use regulations in Washington State is failing to protect habitat, simply modifying the existing system will not be enough to lead to recovery of ESA listed species. Instead, the Washington State legislature must immediately enact stronger land use laws and regulations that require the immediate protection and restoration of habitat that is critical for salmon recovery, such as one Site Potential Tree Height riparian buffers, and require an enhanced standard that is more protective of habitat impacted by both public and private projects. This is the only way Washington State will be able to uphold its obligation to the tribes to protect the tribes' treaty-reserved rights and resources.

[2] Washington State Academy of Sciences. (2022). Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring. Seattle, WA: WSAS, 1-40.

LEGISLATIVE PROVISO

The proviso directed WDFW to assess how to improve statewide recovery of endangered and threatened species, species of concern, and ecological health by incorporating an NEG standard into state land use, development, and environmental laws and rules. The proviso required that this assessment include several specific actions. These requirements, and the process taken to address them, are detailed below.

Consult with the appropriate local governments, state agencies, federally recognized Indian tribes, and stakeholders with subject matter expertise on environmental, land use, and development laws.

Over the course of the project, the project team engaged with representatives from each of the groups outlined by the legislature. Engagement focused on gathering feedback on successes, failures, opportunities in the existing NNL standards, and challenges and opportunities in incorporating NEG. Engagement included one-on-one interviews and large roundtable discussions. The Engagement with Stakeholders and Tribes section of this report details these engagement activities.

Address each environmental, development, or land use law or rule where the existing standard is less protective of ecological integrity than the standard of net ecological gain.

The project team conducted a detailed regulatory review of how existing development and land use laws incorporate the current standards of NNL; findings are summarized in *Appendix B. Regulatory Review Memo.* These findings were then enhanced by engagement focused on understanding how laws are implemented and enforced to paint a more complete picture of how NNL operates within Washington.

The initial regulatory review focused on the following laws outlined by the legislature:

- Shoreline Management Act (chapter 90.58 RCW)
- Growth Management Act (chapter 36.70A RCW)
- Construction Projects in State Waters (chapter 77.55 RCW)
- Model Toxics Control Act (chapter 70A-305 RCW)

It also included the State Environmental Policy (chapter 43.21C RCW) and Forest Practices Act (chapter 76.09 RCW), identified as additional key pieces of legislation pertaining to NNL.

The analysis focused on how NNL standards operate within each of the state laws, regarding the following topics:

- How the law defines NNL (i.e., what metrics are used to determine whether NNL is achieved).
- How habitat prioritization/ranking systems are integrated in the law's mitigation requirements.
- Requirements for enforcement and oversight of NNL standards.
- How the law differentiates between on-site and compensatory mitigation approaches.

The Regulatory Review section provides the complete analysis of this legislative landscape.

Assess and compare opportunities and challenges, including legal issues and costs on state and local governments, to achievement of overall net ecological gain.

The project team conducted a detailed literature review of different planning documents, laws, and reports related to the development and application of NEG and NNL standards. Findings from this analysis, detailed in the Literature Review of NEG/NNL Legislative Precedent section, were presented, analyzed, and discussed through subsequent engagement to inform the final recommendations in this report.

The concerns over unconstitutional taking of private property that might arise from financial or other constraints imposed on private landowners as a result of NEG requirements are detailed in the Legal Considerations section.

Develop a definition, objectives, and goals for the standard of net ecological gain.

The WSAS 2022 report, "Report on Net Ecological Gain"—also developed in response to the same 2021 proviso within Senate Bill 5092—outlined a definition, objectives, and goals for the standard of NEG [1].

This project focused on assessing the WSAS conclusions through engagement and other analysis to identify any necessary revisions to the definitions, objectives, and goals outlined. Findings and subsequent recommendations are detailed in the Recommendations sections below.

The full WSAS report is included in *Appendix D. WSAS Report on Net Ecological Gain.*

Develop recommendations on funding, incentives, technical assistance, legal issues, monitoring, use of scientific data, and other applicable considerations to the integration of needs to assess progress made toward achieving net ecological gain into each environmental, development, and land use law or rule.

All project tasks, informed the final Recommendations outlined in this report. Ultimately, recommendations focused on key considerations, identified through engagement, for integrating NEG into existing state environmental, development, and land use laws as well as opportunities to improve the likelihood of meeting NNL standards.

Identify an enhanced approach to implementing and monitoring no net loss in existing environmental, development, and land use laws.

Through the literature review, detailed in the Literature Review of NEG/NNL Legislative Precedent section, the project team identified several consistent challenges that communities around the country and globe have faced in implementing and monitoring NNL standards. Engagement with policymakers, tribes, and subject matter experts, revealed that in its implementation of NNL standards to date, Washington state has faced several of these same challenges, including lack of resources, inconsistent data, fragmented enforcement, and lack of a baseline from which to monitor. The literature review and subsequent engagement also shed light on several opportunities and best practices to enhance the state's implementation and monitoring moving forward. More detailed findings and subsequent recommendations are detailed in the Recommendations section below.

Assess how applying a standard of net ecological gain in the context of each environmental, land use, or development law is likely to achieve substantial additional environmental or social co-benefits.

The literature review, detailed in the Literature Review of NEG/NNL Legislative Precedent section, provided a foundation for exploring the implications of NEG in achieving additional environmental and social co-benefits. These benefits include the cascading economic and social impacts of increased biodiversity and environmental resilience that NEG can achieve. Through engagement and additional secondary research, the project team built upon this foundation to identify the benefits most applicable to Washington state specifically. Additional findings and related recommendations are detailed in the Recommendations section below.

REPORT OVERVIEW

CHAPTER 1. INTRODUCTION

- **Background**—An overview of the NNL and NEG history in Washington policy.
- **Scope of NEG Legislation** —Details on the approach for assessing NEG standards on private projects.

CHAPTER 2. QUALITATIVE ANALYSIS

- **Engagement with stakeholders and tribes**—Overview of the project team's approach for assessing NEG and NNL through secondary research and engagement, and key findings from this engagement.
- **Secondary research**—Overview of secondary research conducted by the project team, including a literature review of NNL/NEG policy precedent set by other communities, and a comprehensive regulatory review of existing Washington state policies.

CHAPTER 3. RECOMMENDATIONS & NEXT STEPS

- **Revised NEG Definition**—The proposed updated NEG definition developed through engagement and secondary research.
- **Recommendations**—Final recommendations for the legislature to consider regarding integrating NEG standards into Washington policy and enhancing existing NNL standards.

APPENDICES

- **Appendix A. Literature Review Summary**—Detailed summary of the literature reviewed as part of the secondary research element of the project.
- **Appendix B. Regulatory Review Memo**—Detailed memo of the review of existing Washington state policies.
- **Appendix C. Interview Guide**—Complete interview guide and questions asked of experts as part of the one-on-one project interviews.
- **Appendix D. WSAS Report on Net Ecological Gain**—Full WSAS report developed in response the 2021 proviso within Senate Bill 5092.

CHAPTER 1: INTRODUCTION

BACKGROUND

Washington state has integrated NNL standards into environmental, development, and land use policy since 2013 with the adoption of the Shoreline Management Act, which outlined NNL requirements as part of the Shoreline Master Programs Guidelines [2]. At a high level, **NNL standards seek to limit the impacts from new development by adopting a mitigation hierarchy to avoid, minimize, remediate, and offset negative impacts on ecosystems** [3]. However, in the years since the introduction of NNL, Washington state has continued to face environmental degradation, indicating that the current NNL approach has been insufficient and that more rigorous standards, or more rigorous oversight of existing NNL requirements, are needed to adequately protect the state's many important species and habitats.

Fish, wildlife, and habitats are increasingly at risk in Washington. Population growth and climate change have been the driving factors for landscape changes affecting biodiversity. According to the State Wildlife Action Plan Washington is home to 268 Species of Greatest Conservation Need—from the wolverine, bull trout, and snowy plover to lynx, sharp-tailed grouse, and pinto abalone. Bold action is needed to avoid collapse of fish, wildlife, and ecosystems in Washington.

As our state's human population continues to grow, we must hold the line on habitat loss and vastly increase the scope and scale of recovery and restoration actions. Climate change is predicted to exacerbate these declines in Washington, with experts predicting dramatic impacts to biodiversity, including the erosion and loss of shoreline habitats from sea level rise, threats to salmon from warming streams and altered streamflow, and more frequent disruption to species and habitats from severe weather and wildfire [4].

One potential policy solution to addressing this ecological decline in Washington is implementing NEG standards into Washington land use, environmental, and development law. NEG exceeds NNL by not only requiring that impacts are avoided, but also requiring that projects improve the delivery of valued ecosystem functions by increasing biodiversity or resilience in the affected ecosystem [5]. However, according to many state representatives involved in NNL policy and other experts engaged in this project, there is evidence that the state has not successfully implemented, enforced, nor monitored existing NNL standards and that **in adopting new, more stringent standards, the state must simultaneously devote resources to improve NNL**.

This proviso summary report seeks to shed light on these and other pertinent questions related to NEG and NNL in Washington state. Engagement with experts with deep knowledge of the state's environmental, land use, and development laws informed the findings in this report as well as secondary research focused on the implementation of these environmental protection standards in Washington state and other communities around the country and globe. These findings are intended to guide the legislature's next steps in defining and implementing ecological preservation standards into the state's development and land use laws.

SCOPE OF NEG LEGISLATION

This project primarily assessed NEG assuming that policy mandates would apply specifically to public projects and that private projects would continue to comply with a NNL standard. Achieving NEG in private projects—at least in the short term—would continue to be achieved primarily through voluntary incentive programs promoted to private landowners.

This approach to assessing NEG aligns with the current legislative dialogue surrounding this policy in Washington. Considerations for applying NEG to private land have evolved since the legislature's original proviso in light of potential legal constraints (detailed in the Legal Considerations section below). The project team did not conduct a comprehensive legal analysis of NEG. However, many experts voiced concerns about imposing mandates on private projects. Experts asserted that imposing NEG mandates on private property was beyond the regulatory authority of state and federal agencies and that enforcement of NEG could, in some cases, amount to a regulatory taking (an unconstitutional acquisition of private property resulting from a government regulation). Experts also raised the concern that expanding mandates to private projects at this time could undermine the effort to successfully adopt any NEG standards in the state.

On the other hand, some experts voiced opposition to limiting the scope of NEG to public projects only, predicting that the state will not achieve NEG if mandates do not apply to both public and private projects. Some asserted that although public lands and projects could be held to a higher standard, there are not enough of those lands to address the current situation and low standards related to habitat impacts; therefore, limiting the scope of NEG to public lands will not result in enough recovery.

Given this feedback, this report's recommendations outline an approach for implementing a NEG standard on public projects, while still addressing ecosystem decline on private projects by incentivizing NEG and bolstering the implementation of NNL standards. Experts indicated that defining the scope of NEG implementation for private and public projects was a key first step in advancing the policy.

CHAPTER 2: QUALITATIVE ANALYSIS

This project interpreted its legislative charge as **outlining a roadmap for the future of Washington's ecological standards** by assessing the impact of the state's existing NNL standards, exploring opportunities for enhanced NEG standards and how these standards might interact with current laws, and understanding how various stakeholders, agencies, and tribes experience these policies.

To achieve these goals**, the project team took a multi-pronged qualitative approach** to information gathering through robust engagement with stakeholders and tribes, and secondary research. Findings from both are summarized below.

ENGAGEMENT WITH STAKEHOLDERS AND TRIBES

Per the proviso direction to **"Consult with the appropriate local governments, state agencies, federally recognized Indian tribes, and stakeholders with subject matter expertise on environmental, land use, and development laws,"** the project team engaged with these experts through interviews, roundtable discussions, and presentations at meetings focused on NEG.

Project engagement took place between September and November 2022. Engagement focused on gathering experts' unique perspectives and opinions based on their expertise in this subject matter to inform the final recommendations detailed it this report. **Engagement did not focus on coming to a single consensus on the final recommendations**.

ENGAGEMENT APPROACH

Engagement with experts included the following initiatives:

- **One-on-one interviews** related to NNL and NEG. Interviewers asked participants about current successes and challenges with NNL, opportunities and barriers related to NEG, and specific implementation questions for each of these policies. Interview questions are detailed in *Appendix C. Interview Guide.*

- **Roundtable discussions** focused on the same topics and questions discussed in the interviews, but with increased focus on understanding participants' specific recommendations for improving the implementation of existing NNL standards, whether and how to integrate NEG into state law, and other key considerations for the legislature.

  - The roundtables were attended by tribal representatives, representatives from state agencies and local governments, as well as stakeholders from the real estate and building industries, agricultural and forestry sectors, and state environmental groups.

- **Participation in external meetings** related to NEG policy hosted by the Northwest Indian Fisheries Commission and the Puget Sound Partnership.

KEY THEMES FROM ENGAGEMENT

Feedback from engagement was the driving force for developing the Recommendations presented in this report. While all feedback was considered and used to inform recommendations, several key themes emerged that ultimately directed the final set of recommendations.

- As indicated by the WSAS in its 2022 report, overall ecosystem loss in the state indicates that NNL is not working [1]. However, according to experts, there is also evidence that **lack of funding and oversight have barred NNL from being properly implemented and monitored**, and therefore the true impacts (or potential impacts) of NNL policy on mitigating ecological impacts from developments are largely unknown. Additionally, variances and exceptions in permitting requirements, as well as the approach of implementing NNL at a site-specific rather than cumulative scale, have limited the effectiveness of NNL and led to overall ecosystem decline.
- **Issues with the implementation of NNL may carry over to NEG unless they are identified and addressed**. Experts consistently shared that to successfully implement NEG, the state must complete a more robust assessment of NNL to identify and address the current issues with NNL standard implementation.
- **NEG policy must clearly define the scope and scale of the implementation of NEG standards.** Experts expressed that NEG policy must clearly define which projects are required to comply with NEG and at what scale NEG will be measured (e.g., whether implementation will be at the site-specific and/or cumulative scale or if NEG will eventually apply to private properties and projects).
- **NEG policy should include a robust decision-making framework and clearly defined goals.** The framework should outline how NEG implementers will achieve the defined goals and clearly define the implementation responsibilities and roles of state agencies and local governments.
- Currently, there is insufficient technical capacity and funding to implement, monitor, and enforce NNL and future NEG standards. Experts shared that **investment in the development of technical parameters and methodologies to measure ecological health** will be key to successfully implementing NEG. This investment should include developing a monitoring plan, defining baseline conditions, and establishing metrics to measure ecological health.
- Experts expressed frustration with underfunded government mandates, highlighting the need for NEG policy to also outline a plan for allocating **sufficient resources and funding for NEG**

implementation in projects, particularly to local jurisdictions to support planning, monitoring, and enforcement.

- **NEG and NNL policy must also outline an enforcement protocol** that ensures compliance with NNL and NEG standards. Experts also expressed that compliance could be achieved through offering incentives for NEG implementation.
- In order to ensure community buy-in, **there is a need for consistent and broad community engagement** as NEG policy is developed and executed.

SECONDARY RESEARCH

Secondary research included a **regulatory review** of existing Washington state environmental, development, and land use law, as well as a comprehensive **literature review** of policies, existing research, and evidence from other communities that have implemented NEG and NNL.

REGULATORY REVIEW

In response to the proviso direction to ***"Address each environmental, development, or land use law or rule where the existing standard is less protective of ecological integrity than the standard of net ecological gain,"*** secondary research included a regulatory review of existing environmental and land use laws with NNL standards.

The regulatory review analyzed existing Washington State environmental, development, or land use laws or rules where the existing standard, namely NNL or a similar standard, is mentioned to understand how these standards have operated within the state. The laws and rules assessed were those named within the proviso as well as two additional laws identified by the project team.

The analysis focused on the four primary laws outlined in the proviso—the Shoreline Management Act (SMA) (chapter 90.58 RCW), the Growth Management Act (GMA) (chapter 36.70A RCW), Construction Projects in State Waters (CPSW) (chapter 77.55 RCW), and the Model Toxics Control Act (MTCA) (chapter 70A-305 RCW)—as well as two additional statutes identified as key pieces of Washington legislation pertaining to NNL by the project team: the State Environmental Policy Act (SEPA) (chapter 43.21C RCW) and Forest Practices Act (FPA) (chapter 76.09 RCW).

REGULATORY REVIEW - KEY FINDINGS

The legislative review was bolstered by engagement with representatives from state agencies and local governments whose day-to-day work interacts with NNL implementation or oversight and others with

intricate knowledge of how NNL standards operate within the state. **The review of these regulations and subsequent engagement revealed several key themes in how NNL has operated in Washington** that ultimately informed the subsequent recommendations for how to enhance NNL standards moving forward. These themes are summarized below. For a more detailed synopsis of these regulations, see *Appendix B. Regulatory Review Memo.*

NNL DEFINITION AND INTEGRATION IN WASHINGTON STATE

The state uses a variety of terms to refer to NNL, including "no adverse impacts," "conservation," and "protection," and terminology varies across legislation. This **inconsistency in language, experts indicated through engagement, may create confusion** around what NNL encompasses, leading to inconsistent application of standards. Furthermore, uncertainty has been exacerbated by the introduction of an entire new set of potential standards under NEG.

Through engagement, **experts also highlighted a general lack of data and technical capacity to properly implement NNL standards**, including a lack of technical understanding of the ecosystem impacts that NNL seeks to mitigate. Experts also voiced concern that NNL standards have been defined and integrated into the state largely based around political and social needs (e.g., related to development), rather than maintaining ecosystem functions and biodiversity.

On the other hand, **experts also indicated that in other respects NNL has been defined and integrated successfully into Washington legislation**. In particular, some experts noted that the standards are written in a manner that allow for flexibility for growth and development while also providing a framework for mitigating impacts from development, and that the standards are within the scope of regulatory authority and adhere to federal and state law. However, according to other experts, these characteristics—namely, the flexibility of existing standards—have been a primary reason why the state has not successfully achieved NNL.

ENFORCEMENT, TRACKING, AND MONITORING

In the regulations analyzed, **requirements for monitoring the cumulative impacts of NNL** and/or documenting that regulations with NNL standards are achieving NNL **were inconsistent and minimal**, or in some cases nonexistent. Similarly, while each rule or act did include some details on enforcement of NNL standards, requirements were similarly inconsistent, with few or no specifics on penalties for violations.

Experts also expressed concern over enforcement, oversight, and monitoring of NNL in Washington throughout engagement, noting that local government and state agencies tasked with the enforcement and monitoring lacked financial support and other resources needed to adequately carry out these responsibilities and that enforcement of permit conditions left to the jurisdiction of local governments results in checkered enforcement processes and varying standards, which exacerbate lack of compliance.

Additional gaps related to enforcement, tracking, and monitoring identified in the regulatory review included the following:

- No requirement was found to require compensatory mitigation for temporal loss of ecological function after violations or inadvertent impacts are discovered.
- Mitigation required by local and state agencies does not have a long-term requirement beyond the initial monitoring period, meaning that when properties are sold, the new owners can degrade the mitigation.
- Permitting and SEPA exemptions, which most of the reviewed laws and rules allowed for in some capacity, complicate NNL tracking because the impacts of these exemptions are not always thoroughly accounted for in NNL assessments.
- Within the FPA, there is a need for measuring the cumulative impact of forest practices on ecological functions and values for all critical areas, not just the listed fish or riparian-dependent species that are the focus of the act.
- There is a lack of oversight of emergency permitting actions, which are often held to different ecological function standards. No requirement was found requiring compensatory mitigation for ecological function loss, including temporal loss, should it have occurred as a result of the emergency action(s), and there was no system for measuring the impacts of emergency permitted activities.

Experts echoed these same gaps through engagement. The decline in ecosystem function and biodiversity in the state indicates that **NNL is not being achieved**, experts said. However, **this failure is tied to a lack of proper implementation of the standards and other key gaps in the policy, including:**

- The baseline for which impacts are measured against is undefined or inconsistent, and there are not clear metrics for monitoring success or failure through time.
- There is not enough scientific understanding around site specific ecosystem function degradation and whether offsite (and especially out-of-kind) mitigation is equal to or outperforms the site-specific degradation.
- Overall, there is insufficient monitoring of NNL standards.
- There has been a persistent lack of accountability and enforcement, which exacerbates noncompliance.
- The state has not properly monitored the cumulative impacts of legacy development, variances and exceptions, and illegal development.

LITERATURE REVIEW OF NEG/NNL LEGISLATIVE PRECEDENT

In response to the proviso direction to ***"Assess and compare opportunities and challenges, including legal issues and costs on state and local governments, to achievement of overall net ecological gain,"*** the project team conducted a comprehensive literature review of policy documents, laws, and other research and reports related to NEG and NNL policy and implementation.

The literature review focused on key considerations identified by WDFW staff, as well as requirements outlined in the proviso. The review focused primarily on benefits achieved through NEG implementation, implementation strategies, economic implications, and barriers or challenges of implementing NEG policy.

The review included documents that focused primarily on the implementation of NEG, but also included details related to NNL. Sources represented different geographic scales, including global, national (United Kingdom), regional (Lake Tahoe), and statewide (Washington state). Findings from the review guided subsequent engagement with Washington experts and ultimately informed many of the final recommendations detailed in this report. The section below provides a summary of the key findings from the literature review. See *Appendix A. Literature Review Summary* for a more comprehensive summary of findings.

LITERATURE REVIEW - KEY FINDINGS

TRANSITIONING TO NEG AND IMPROVING NNL

The assessment of NNL and NEG implementation and policy standards found that NNL has not always been effective in producing successful outcomes and protecting ecosystem services and habitats [6], indicating a potential opportunity for implementing NEG and improving outcomes. However, **there are challenges that hinder progress in achieving NNL that the state must address to build from these standards to achieve NEG**. These challenges include establishing appropriate current baseline conditions, identifying appropriate targets and metrics, coordinating regionally between multiple levels of government, and securing funding for successfully implementing, enforcing, and monitoring NNL policy [1] [7] [8] [9]. After addressing these issues with NNL, experts indicated that the state must then

determine what level of gain is required in each geographic area to achieve NEG, and then apply NEG to all public projects within that area.

Despite these challenges, NEG is becoming increasingly more established in international policy and corporate practice [10].

POLICY DEVELOPMENT

The assessment revealed **key principles for successful design and development of NEG policies and plans**, including the following:

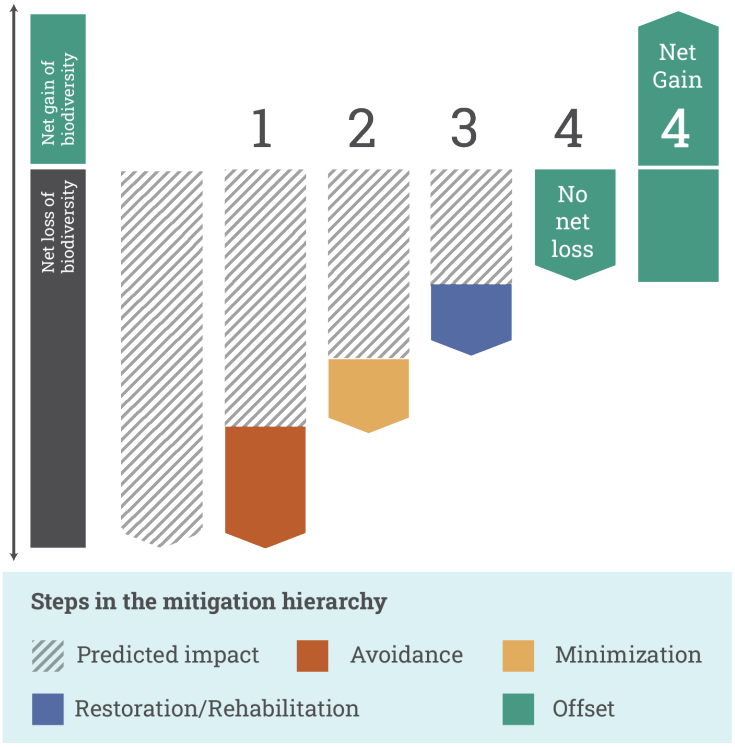
- **Address risk and uncertainty related to NEG, ensure additionality of ecosystem offsets** (i.e., ensure that NEG offsets are unique and not undermined through potential double counting of existing habitat restoration or conservation obligations) that exceed existing obligations.
- **Identify and classify baselines and metrics**, and ensure NEG generates long-term benefits [7] [8] [11] [12] [13] [14].

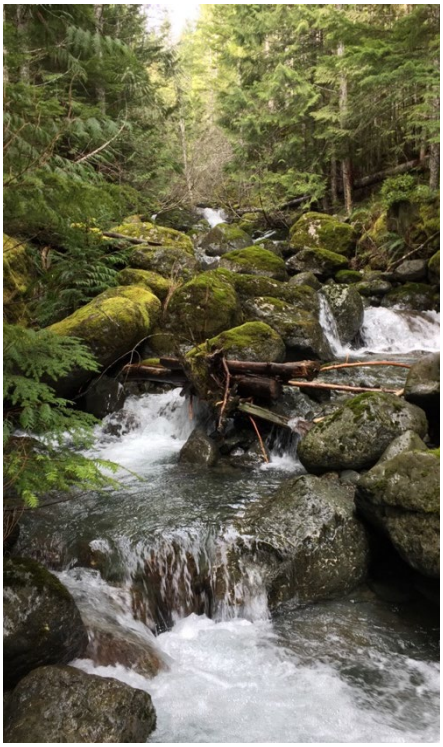
Interviewees also discussed these principles and established the importance of studies and assessments as important solutions to NEG policy barriers.

Successful design of NEG policies and plans also depend on adherence to the mitigation hierarchy (Figure 1) to avoid, minimize, remediate, and offset [12] [13]. Offsets must focus on providing benefit above and beyond avoided loss, and policies should adopt a no down-trading policy that states mitigation offsets in lower quality habitats cannot be applied to higher quality habitat impacts [8] [14]. Sources mainly described achieving NNL and NEG within this mitigation hierarchy via developers directly offsetting their project impact on site or off site, without relying on third parties. Other mitigation strategies that were mentioned for achieving mitigation offsets included:

- **Habitat banking** - A market mechanism where credits from actions with beneficial biodiversity outcomes can be purchased to offset the debit from environmental damage [11].
- **In-lieu fee program/compensation fund** - Accept payments in exchange for credits. Habitat creation and restoration projects are carried out once enough funds have been collected [11, 13].

Figure 1. Mitigation hierarchy for net gains [11].





Source: Adapted from Bennet et al., 2017

OVERSIGHT, MONITORING, AND METRICS

Robust monitoring, assessment, and accountability are critical to successful implementation of both the existing NNL and a new NEG policy. Monitoring strategies include enabling and incentivizing cross-agency and cross-disciplinary communication and collaboration and providing funding for long-term monitoring and maintenance of NEG outcomes.

It is also critical to manage a database of monitoring data to establish a baseline to measure gains or declines in ecosystem function and biodiversity from NEG. Proper data management and an established and justified baseline are key factors in successfully implementing and measuring NEG [13].

COST AND FUNDING CONSIDERATIONS

It is important for authorities to allocate sufficient funds to implement NNL and NEG long term. **Policymakers should plan for a range of costs**, including capital investment, management contingency costs, legal fees, administrative costs, ongoing costs for monitoring and reporting, risk mitigation, insurance, and inflation. Policymakers should also account for potential negative financial impacts to income that result from NEG requirements [8], as well as the positive economic implications of restoring ecosystem services from clean air and water, reduced heat island effects, improved native pollination, recovered salmon stocks, and reduced flood damages.

LEGAL CONSIDERATIONS

NEG policy mandates could constitute a regulatory taking due to the property constraints and/or financial burdens imposed on landowners. Specifically, a regulatory action such as NEG will amount to a taking if it deprives the property of all value or depreciates the value of the land to an extent that it meaningfully alters the expected future uses of the property. The character of the government's actions is also considered, namely whether there is substantial public interest at stake and whether the government could achieve the same objective through less intrusive means**. To ensure that a taking of private property is constitutional, the government must prove that the burden imposed on the landowner is reasonable and proportionable to the identified problem**. In the case of NEG, the government must demonstrate that the burden imposed on private landowners and developers mitigates the adverse impacts of the proposed development [15].

INCLUSIVITY AND EQUITY

Policymakers must intentionally consider inclusivity and equity in the design, implementation, monitoring, and evaluation approach of NEG policy to avoid inequitable outcomes. Policymakers should involve stakeholders and partners early in the process, balance on-site and off-site benefit delivery, and more explicitly incorporate social considerations into NEG initiatives [13] [16]. Experts proposed related solutions of ensuring broad engagement and input related to developing a potential NEG policy and integrating tribal sovereignty and climate equity into NEG policy and endpoint.

NEG IMPLEMENTATION IN OTHER COMMUNITIES

The project team also reviewed examples of NEG implementation in other communities, including Lake Tahoe and the United Kingdom. Findings from this review are detailed below.

LAKE TAHOE CASE STUDY

The Lake Tahoe Basin in the southwest United States is located in portions of both California and Nevada. As part of a regional and national effort to protect and enhance environmental conditions throughout the basin, a Bi-State Compact was developed in 1980 to **set environmental thresholds focused on establishing shared goals for restoration and environmental quality in the region**. These thresholds include a variety of environmental conditions, such as water clarity, water quality, air quality, vegetative cover, and habitat availability. Some of the thresholds are aimed at maintaining current environmental conditions, whereas others (e.g., water clarity) target improvements and restoration over time. Regional policymakers also developed a Tahoe Regional Plan to implement goals, policies, and regulations focused on meeting the threshold standards and balancing the natural and built environment [17]. There are **several components of the Regional Plan that could inform NEG in Washington**:

- The Plan leverages **private-public partnerships and creates incentives for property owners** to make improvements to their land and developments.

- The Plan promotes **environmentally friendly redevelopment** of aging built environment.
- Continued **monitoring and reporting of environmental conditions** helps track progress in meeting the thresholds.
- An **environmental evaluation report is prepared every four years** and assessed to determine if the Regional Plan needs to adapt to changing needs, circumstances, and emerging threats.

UNITED KINGDOM CASE STUDY

In the United Kingdom (UK), current NEG policy (referred to as biodiversity net gain or BNG) includes **explicit requirements to minimize impacts on biodiversity and provide net gains in biodiversity** as part of the government's commitment to halt biodiversity decline. The policy framework also includes "a presumption in favor of sustainable development" to emphasize support for and encourage sustainable development. This standard incentivizes developers by expediting or favoring sustainable development plans [18].

In the UK, NEG policy is on track to become mandatory by November 2023 and will require a minimum 10% gain of direct footprint losses from development, with gains maintained over a minimum of 30 years [19].

There are several **aspects of the UK policy development and implementation that could inform policy development in Washington**:

- The UK identified a need for **expanded funding to support local authorities** to enforce, monitor, and administer an NEG standard [19].
- The UK identified a need for **expanded funding to support local authorities** to enforce, monitor, and administer an NEG standard [19]. To measure the impact of NEG, the UK developed **a consistent biodiversity metric** to provide ecologists, developers, planners, and other interested parties in the UK with a means of assessing changes in biodiversity value (losses or gains) brought about by development or changes in land management [7].
- The UK has also partnered with local environmental record centers (LERCs) to **manage and retain data on changes to the natural environment**. These databases have been key to establishing the baseline ecological conditions to compare against and generally track NEG impacts over time [12].

CHAPTER 3: RECOMMENDATIONS

REVISED NEG DEFINITION

In response to the proviso direction to **"*Develop definition, objectives, and goals for the standard of net ecological gain,"*** the project team used findings from engagement and secondary research to develop the following updated definition of NEG.

> *Ecological functions and values, that support biodiversity and resiliency of native plant, animal and fungi species, water quality and quantity, air quality, and food security for all species, are improved over current conditions, at a cumulative scale that can be incrementally implemented through site-specific actions, with any short-term loss of those functions and values being more than offset by overall ecological gains.*

RECOMMENDATIONS

Ultimately, all project tasks focused on responding to the proviso direction to **"*Develop recommendations on funding, incentives, technical assistance, legal issues, monitoring, use of scientific data, and other applicable considerations to the integration of needs to assess progress made toward achieving net ecological gain into each environmental, development, and land use law or rule."***

Considerations related to the proviso direction to ***"Identify an enhanced approach to implementing and monitoring no net loss in existing environmental, development, and land use laws,"*** are also woven throughout the recommendations.

The regulatory review of existing environmental and land use laws, comprehensive literature review of policies, and engagement with experts culminated in the following set of 15 recommendations across six categories, each with a series of supporting actions needed to achieve that goal. **Recommendations relate to both NNL and NEG,** and, as noted above, were developed with the assumption that NEG will be required for public projects and that any net gain on private lands would be achieved through voluntary incentive program participation.

Throughout this section we have indicated where actions are recommended for **Near Term Action** ( ) as well as where actions **Require Legislative Action to Complete** ( ).

Action	Recommended for Near Term Action	Legislative Action Needed
Confirm that NEG would be required for public projects and voluntary for private projects/land.	✓	✓
Establish the metrics that will be used for establishing targets and current conditions and to track progress.	✓	
Clearly define what additional gains are needed beyond the existing NNL standards and scope, with appropriate sequencing.	✓	
Establish the baseline conditions against which NNL and NEG can be quantitatively monitored.	✓	
Fund and prioritize compliance with local jurisdictional environmental standards that are designed to achieve NNL.	✓	
Create a robust and cooperative monitoring program that tracks NEG and NNL implementation and enforces compliance.	✓	
Develop an oversight program that will work with local jurisdictions to set a protocol for compliance enforcement and penalties.	✓	
Establish how to set up the tracking and reporting system and oversight for NEG.	✓	
Convene an oversight body to develop an implementation framework for NEG to ensure cross-agency, cross-jurisdictional collaboration and assist with integration into local government planning.	✓	✓
Convey understanding of the current problem with the implementation of NNL, focusing on ecosystem function decline and why NNL is not working.	✓	
Clearly define performance metrics, such as quantifiable habitat functions, connectivity, refugia, downstream metrics.	✓	
Significantly increase investment in incentive programs on private property with measurable NEG. Consider funding incentives through fees imposed on activities that generate net ecological losses, thereby disincentivizing activities counter to NEG.	✓	
Increase funding for local governments to increase staff capacity for long-range planning and compliance.	✓	✓
Maximize state-level matching of federal funding sources (e.g., CREP) to ensure Washington is maximizing returns.	✓	
Incorporate inclusivity and equity in the design, implementation, monitoring, and evaluation approach of NEG policy by integrating input from communities that are disproportionately impacted by ecologically degraded environments.	✓	

NEG FRAMEWORK, METRICS, MONITORING, AND ENFORCEMENT

Define policy frameworks that address NEG goals.

- Confirm that NEG would be required for public projects and voluntary for private projects/land.
- Identify opportunities to address NEG through existing state, federal, and local laws and policies that improve habitat or decrease impacts of existing and future development.
- Identify challenges and limitations in existing laws that would need to be addressed for a more robust policy framework to achieve NEG.
- Identify opportunities to further NEG on public lands and use public funds to achieve NEG at relevant ecosystem scales.
- Identify existing information and gaps in the monitoring data to ensure standardization across watersheds.

Define scale and scope of NEG application (e.g., site specific or cumulative scale) and the metrics that will be used to track progress and establish a baseline.

- Establish the metrics that will be used for establishing targets and current conditions and to track progress.
- Clearly define what additional gains are needed beyond the existing NNL standards and scope, with appropriate sequencing.
- Establish the baseline conditions against which NNL and NEG can be quantitatively monitored.3
- Identify existing information and gaps in monitoring data to ensure standardization across watersheds.[4]
- Launch multi-scale NEG pilot projects to inform goals, baseline, and metrics that build upon findings from case studies focused on the implementation of NEG in other communities.
- Explore opportunities for developing and implementing coordinated monitoring requirements at the state level to reduce the burden on local jurisdictions and increase compliance with permit requirements.

3 For guidance on establishing this baseline, see the Time Scale and Baseline Measurements section on page 8 of the WSAS "Net Ecological Gain, Definition, Goals, and Objectives" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*.
4 WSAS has outlined guidance on how to navigate the process of selecting metrics/indicators and tracking progress toward NEG on page 15-16 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*. Additional guidance related to choosing and ranking indictors is also detailed on page 20 of this chapter.

- Conduct a comprehensive cost/benefit analysis of local jurisdictions currently tracking and monitoring NNL standards to inform the funding approach for NEG.

Improve monitoring and enforcement of existing and future environmental standards.

- Fund and prioritize compliance with local jurisdictional environmental standards that are designed to achieve NNL.
- Create a robust and cooperative monitoring program that tracks NEG and NNL implementation and enforces compliance.5
- Develop an oversight program that will work with local jurisdictions to set a protocol for compliance enforcement and penalties.
  - Allocate significant funding toward enforcement, oversight, long-range planning, monitoring, and compliance to ensure local governments have capacity to monitor post-permitting outcomes.
  - Address existing barriers to voluntary implementation and monitoring, such as limitations in using Conservation Reserve Enhancement Program (CREP) data because of privacy concerns for private landowners.

- Create and manage central repositories for data and information to monitor NNL and NEG. NNL databases should include data related to specific actions implemented as well as violations and emergency actions, and any variances that don't achieve NNL—including temporally. NEG databases should include data that track metrics and indicators signaling NEG in the environment.[6]
  - Fund a database to monitor successful implementation milestones tied to funding incentives and adaptively manage when metrics/indicators show inadequate progress. Funding should cover database creation, long-term maintenance, analysis, and reporting.[7]

- Consult with existing successful programs that utilize a suite of approaches for monitoring and complying with requirements—such as municipal stormwater permit structural controls under the Clean Water Act and local development regulations that trigger improvements on public

[5] WSAS has proposed a potential NEG monitoring system on pages 20-21 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain.*

[6] WSAS has outlined an approach for data collection and monitoring on pages 26-27 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*.

[7] For guidance on using scientific tools such as modeling or decision-making structures to reduce uncertainty, see pages 6-7 of the WSAS report chapter "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" in *Appendix D. WSAS 2022 Report on Net Ecological Gain*. According to WSAS, these tools can inform understanding of how an action could impact ecological functions, the kind of indicators necessary to monitor the impact, and how long it might take to see a response.

rights-of-way to meet transportation requirements—when developing the NEG and NNL monitoring framework.[8]

NEG & NNL IMPLEMENTATION

Expand understanding of the successes and failures of NNL policies and improve oversight of NNL moving forward to ensure that standards are upheld.[9]

- Establish how to set up the tracking and reporting system and oversight for NEG.
- Convene an oversight body to develop an implementation framework for NEG to ensure cross-agency, cross-jurisdictional collaboration and assist with integration into local government planning.
- Conduct a NNL assessment within a representative sample of counties to analyze the performance outcomes of implementing NNL policies, what programs counties currently use to implement NNL, and how standards for NNL were implemented within these communities.
- Convey understanding of the current problem with the implementation of NNL, focusing on ecosystem function decline and why NNL is not working.
- Identify and evaluate other agencies' programs and actions that may result in NNL and/or NEG through implementation of those specific programs (such as capping or reducing water use, chemical/pesticide use, pollution from stormwater treatment, etc.). Cross-jurisdictional coordination has been employed successfully in the Puget Sound region, which uses a suite of Vital Sign indicators for identification and tracking of implementation.
  - Identify existing programs that contribute to NEG and/or NNL and identify what initiatives are making the greatest impact. The goal of this assessment is to account for existing programs that already work toward NNL and/or NEG, and synergize efforts to increase the pace of recovery.
  - Address gaps in existing programs where NNL and/or NEG are known to fail currently, including:
    - Impacts of legacy development properties and practices in sensitive areas (e.g., development that would not be allowed under current regs or that would require changes in approaches)
    - Legal constructs that preclude future restoration options (e.g., development behind a levee that makes future removal more costly)

[8] WSAS has outlined additional examples of monitoring programs on pages 22-26 and page 27 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*.The chapter also details a process for monitoring NEG, including considerations for community engagement, on pages 27-28.

[9] To review the WSAS assessment of NNL, see pages 4-5 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*.

  - Cumulative permitted development outside of urban growth areas (UGAs) that eventually hits a threshold where it impacts hydrology through stormwater, impervious area, etc.

- Assess the cost of not achieving NNL. Evaluate the cost of ecological decline of function/loss/services compared to what could be achieved through successful NNL or NEG implementation.

Develop the implementation framework for NEG.[10]

- Clearly define performance metrics, such as quantifiable habitat functions, connectivity, refugia, downstream metrics.
- Develop a funding strategy for NEG implementation.
- Audit use of funding allocated to protect investments in NEG.
- Define responsibilities and roles between agencies with a focus on who has authority; establish interagency coordination, shared timelines, and standards.
- Identify opportunities to advance NNL, and barriers that conflict with NNL, within existing or developing state legislation.
- Develop accountability and enforcement metrics and monitoring requirements for NEG.
- Ensure equitable and inclusive outcomes of a NEG standard.

NEG INCENTIVES & OTHER STRATEGIES[11]

Strengthen and expand current incentives contributing to NEG.

- Create NEG as a voluntary planning element under the Growth Management Act (GMA) and further incentivize local governments.
- Conduct case studies that represent different geographic scales to understand what incentive programs have been implemented and how they have performed.
  - Determine the effectiveness of incentives and key design considerations—including non-financial incentives, such as streamlined permitting—for different types of redevelopment and development (i.e., those motivated to adhere to NEG early on versus those that require additional incentives to comply).
  - Analyze what co-benefits/tangential financial benefits developers gained from NEG (e.g., competitive advantages, increased financial property value, secured efficiencies) and how

[10] WSAS has outlined a planning and implementation framework for NEG in sections III and IV of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*. The framework includes implementation considerations and approaches for developing criteria and indicators for NEG.
[11] WSAS noted that incentive programs must be based on social science research and need substantial strategic planning; the WSAS Committee recommends defining a more inclusive NEG process.

those benefits can be highlighted and maximized to improve participation and private investment in NEG.

- Ensure equitable access to incentive programs, particularly with respect to local businesses and low-income, minority, overburdened, and other historically marginalized groups.
- Integrate performance incentives into projects tied to monitoring requirements at the start of projects (e.g., performance-based payments where managers are paid once biodiversity NNL/NEG and the associated social outcomes can be demonstrated).

Create new incentives to increase participation in programs that benefit NEG.

- Significantly increase investment in incentive programs on private property with measurable NEG. Consider funding incentives through fees imposed on activities that generate net ecological losses, thereby disincentivizing activities counter to NEG.
- Create and/or maximize incentives to avoid development on the most biodiverse sites.
- Certify projects that meet NEG standards as nature positive, and support advertising and publication of certification for market premium benefits.
- Develop expedited permitting pathways for projects that meet or exceed NEG standards.
- Plan for and conduct a strategic social marketing study to aid in targeting incentives.
- Provide incentives for early adopters/pilots to provide demonstration to other potential investors, and reduce outcome uncertainty.

Understand opportunities and challenges in using incentives to achieve long-term benefits.

- Apply incentives beyond the implementation minimum and pair incentives with strong monitoring.
- Consider how gains earned from status quo are accounted for, and whether credits are counted toward NEG.
  - Consider accounting for gains using a structure similar to NOAA's nearshore conservation calculator.
- Design incentives to complement existing incentives such as marketing benefits to developers and ecosystem service benefits, to close the cost gap and nudge as many NEG projects forward at the lowest cost possible.

Identify additional strategies for achieving NEG on private property.

- Adjust acquisition fund application to permit the use of market values as opposed to assessed values in particularly ecologically sensitive areas to avoid further development. Ensure acquisition program is nimble and able to respond to urgent acquisitions of key sensitive areas.

- Explore alternative mitigation strategies for achieving gains on private lands; ensure that impacts from these alternatives are adequately tracked in future monitoring systems to ensure that they are achieving the intended gains.
- Investigate the potential implications of NEG on affordability issues for private properties—particularly with respect to housing—or onerous permitting.
- Study how NEG implementation can coexist with the current local and federal permitting systems with an emphasis on private property rights.

FUNDING NEG & NNL

Ensure existing funding sources maximize positive ecological impact.

- Compile existing funding programs that relate to NNL and/or NEG, including restoration grant funds.
- Develop a framework for comparing ecological benefits and costs across existing restoration grant programs, with specific measurement that compare a range of activities such as:
  - Preserving current habitat such as through land acquisition.
  - Restoring degraded habitat.
  - Regulating new developments.
  - Regulating legacy developments that do not comply with current standards.

Increase funding for implementing and monitoring NEG and NNL.

- Increase funding for local governments to increase staff capacity for long-range planning and compliance.

- Increase funding for local, state, and tribal monitoring programs.
- Provide funding for NEG and NNL multi-jurisdictional oversight.
- Assess the adequacy of existing funding for implementation, monitoring, and enforcement for NNL and identify additional funding if implementing NEG.
- Assess and fully fund existing programs that contribute to NEG outcomes.
  - Determine requirements for securing ongoing fundings. If requirements are conditional, consider whether they might deter participation.
  - Allocate resources toward local code enforcement programs.
  - Support organizational capacity to access matching funds, educational resources, and technical assistance.

- Identify state-level funding sources that could require a fixed amount of funds to go toward ecological restoration projects.
- Allocate funding to local jurisdictions and agencies to assist with NEG planning and implementation by updating guidance documents (e.g., Ecology Shoreline Planner handbook, Comprehensive Plan updates) and increase capacity for local implementers.
  - Target funding for greatest benefit per dollar spent, potentially through coordination with incentive design.

Maximize federal funding opportunities.

- Maximize state-level matching of federal funding sources (e.g., CREP) to ensure Washington is maximizing returns.
- Increase resources to promote federal funding opportunities to local jurisdictions and state agencies, and support jurisdictions and agencies in securing funding.

Identify new funding sources.

- Assess opportunities for new funding for projects that achieve ecological gains at a regional, watershed, or connectivity scales.
- Identify funding sources targeting co-benefits of NEG that can be stacked.
- Explore options for integrating a conservation impact fee, similar to school and transportation impact fees, into NNL requirements to support/offset some costs for NNL implementation.

EQUITABLE AND INCLUSIVE OUTCOMES AND COMMUNITY ENGAGEMENT

Ensure equitable and inclusive outcomes of a NEG standard.

- Continue stakeholder and tribal engagement as early NEG elements move forward.
- Provide annual NEG status reports to the WA State Governor's Office and State Legislature.
- Enhance community engagement in developing an NEG program and continue to engage the community as standards are implemented.
- Review, utilize, or improve public engagement and education programs to support more extensive public awareness and engagement for NEG and NNL.
- Incorporate inclusivity and equity in the design, implementation, monitoring, and evaluation approach of NEG policy by integrating input from communities that are disproportionately impacted by ecologically degraded environments.

- Incorporate social considerations in NEG initiatives by including a human and health well-being element to the mitigation hierarchy that will aid in efforts to reduce negative local impacts [12].
- Develop engagement dashboard to track ongoing community engagement efforts related to NEG to help identify and address inequities.

Enhance community engagement in developing an NEG standard and continue to engage the community as standards are implemented.

- Ensure broad engagement and input related to developing potential NEG policy, especially with regards to communities disproportionately impacted by degraded ecological conditions.
- Collaborate with experts in the development process of an NEG standard to better understand how existing policies can better protect and restore ecological function.[13]

ANTICIPATED CO-BENEFITS

In response to the proviso direction to ***"Assess how applying a standard of net ecological gain in the context of each environmental, land use, or development law is likely to achieve substantial additional environmental or social co-benefits,"*** the project team analyzed the anticipated co-benefits of advancing NEG legislation.

Projects that generate NEG will likely generate other direct and indirect ecological co-benefits, as well as social and economic impacts through improved public health, quality of life, economic growth, and climate resiliency.

Direct ecological benefits include aesthetic and recreational improvements and positive impacts to various ecosystem services, such as stormwater management and net reduction of greenhouse gas emissions from increased carbon sequestration and storage capacity [20]. **Indirect ecological benefits** include reduced erosion, pollination and natural pest predation, reduced threatened and endangered species listings and the regulatory complexity that such listings create, and increased fish and wildlife for fishing, hunting, and wildlife viewing.

The ecological improvements under NEG policy can produce a range of additional positive social and economic impacts [21] [22] [23]. Companies and individuals can benefit financially in the form of

[12] WSAS incorporated human and health elements into its report and recommendations, which can be found in *Appendix D. WSAS 2022 Report on Net Ecological Gain*. The WSAS Committee discusses the importance of the human dimension to the success of NEG throughout report, including pages 9-10 of the "Definition, Goals, and Objectives" chapter and pages 27-28 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter. WSAS suggested that this set of recommendations emphasize the socio-economic and ecological dimensions of NEG.

[13] WSAS recommended that this collaboration include establishing an ongoing process to ensure that existing and emerging scientific knowledge is a core part of NEG implementation. A more detailed explanation on WSAS's recommendations related to collaboration with experts can be found on pages 28-29 of the "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring" chapter in *Appendix D. WSAS 2022 Report on Net Ecological Gain*.

increased property value and reductions in other expenses (i.e., avoided costs). Communities benefit through enhanced well-being, enhanced climate resiliency, improved public health, and efforts to foster equity in communities through public services. For example, NEG in coastal ecosystems can create climate resiliency benefits by protecting against flooding and rising sea levels [24]. These benefits can, in turn, reduce the cost of restoration from climate change impacts.

Existing literature and methods provide a basis for categorization, measurement, and valuation of co-benefits that arise from NEG. Several tools are also available for measuring and valuing ecological improvements across geographies, including through the Millennium Ecosystem Assessment, a comprehensive assessment of the consequences of ecosystem change for human well-being [25].

These co-benefits are important drivers and motivators for advancing funding and incentives to provide NEG. Accounting for co-benefits allows for a more accurate valuation of NEG, thus better aligning costs and benefits of ecological improvement. Co-benefits can also serve as the basis for identifying partnering opportunities by stacking benefits to draw in more organizations and identify financial sources of support. For example, NEG projects might access secondary funding sources by simultaneously providing water quality/stormwater, habitat, air quality, recreation, carbon sequestration, emissions reduction, and wildfire risk reduction benefits.

NEXT STEPS

Through this proviso summary report the project team aimed to shed light on the most pertinent considerations for the legislature in defining and implementing the next phase of ecological preservation standards in Washington state. This report is one of several critical steps in developing and implementing NEG policy as well as enhancing the implementation and oversight of existing NNL standards. Currently, WDFW is exploring the following immediate next steps in advancing NEG:

1. Create an oversight body to develop metrics, monitoring, and reporting for future standards.
2. Create NEG as a "voluntary planning element" under GMA to encourage a few counties to partner with the organizing body to develop and implement the initial NEG program along with NNL improvements.
3. Confirm that NEG applies to public projects only, while encouraging voluntary gains on private properties.
4. Increase funding incentives for participating local governments (staff capacity, planning funding, and public project funding).
5. Develop a reporting framework for the oversight body to report progress to the governor and legislature.

Considering the ecological decline already documented in Washington and the expected advancement of this decline in the face of climate change, expediently advancing these protection standards is now more important than ever.

Washington Department of FISH and WILDLIFE

APPENDICES

APPENDIX A. LITERATURE REVIEW SUMMARY

METHODOLOGY

In September 2022, Cascadia Consulting Group conducted a literature review regarding key considerations related to net ecological gain (NEG) and no net loss (NNL) policy and implementation. The review focused on several key considerations identified by Washington Department of Fish and Wildlife (WDFW) staff, as well as requirements outlined in the state legislature's 2021 proviso contained within Engrossed Substitute Senate Bill 5092. Specifically, this review focused on benefits achieved through NEG implementation, implementation strategies, economic implications, and barriers or challenges of implementing NEG policy.

To conduct the literature review, the project team collected resources provided by WDFW. To ensure we captured the most relevant literature in our review, WDFW prioritized each document as low, medium, and high. A total of 13 documents were identified as a high priority. We also identified six additional source materials during the literature review research and added these to our review.

Overall, the sources reviewed represent a variety of document types relating to the policy standard of NNL and NEG and are representative of implementation at different geographic scales, including global, national (United Kingdom), regional (Lake Tahoe), and statewide (Washington state) policy implementation.

This review and assessment step will be important to ensure we are building upon existing foundational knowledge, both in Washington and other regions, and identifying potential middle ground options worth discussing. This step will also inform how we engage stakeholders and tribal representatives, especially those experiencing frustration or fatigue around these topics.

KEY FINDINGS FROM LITERATURE REVIEW

The following summarizes key themes identified related to the concept and implementation of a NEG policy that were emphasized in one or more documents. The numbers list in brackets following findings refer to the numbered items in the bibliography.

NO NET LOSS (NNL) AND NET ECOLOGICAL GAIN (NEG) DEFINITIONS

NNL policy is a tool that has been implemented by governments around the world in response to ecosystem function decline driven by built infrastructure development [6]. In concept, **NNL seeks to neutralize impacts of human infrastructure on the environment**, typically by applying some form of the mitigation hierarchy criteria—sequentially avoid, minimize, remediate, and offset biodiversity impacts from new development [26] [10].

Where NNL policy seeks to neutralize development impact to ecosystem function, NEG policy seeks to result in an **increase** in biodiversity or resilience that improves the delivery of valued ecosystem functions in the affected ecosystem following development [1]. NEG implementation also follows the

mitigation hierarchy to avoid, minimize, remediate, and/or offset negative impacts on ecosystems **and the net benefits they provide**.

TRANSITIONING FROM A NNL TO NEG POLICY PRESENTS OPPORTUNITIES AND CHALLENGES

NNL and NEG are key principles in conservation policy that seek to address the ongoing decline in ecosystem function and biodiversity loss caused by the impact of built infrastructure [10]. While NNL is well established in international policy, NEG is gaining popularity as a superior goal that will achieve better outcomes for the environment [10]. Additionally, there is scientific consensus that "NNL has not been an effective approach for ecosystem or habitat management and protection nor for the maintenance of ecosystem services" [26]. In a global review of NNL outcomes, researchers found that successful NNL outcomes were limited, and a key reason cited for success appeared to be due to the implementation of high offset ratios, i.e., large offsets relative to the impacted area [6].

If NNL policy is not working currently, **shifting from a NNL policy in favor of a NEG policy could be a solution** to reduce ecosystem decline; however, transitioning between these two policies can be difficult due to persisting barriers affecting both policy frameworks.

Challenges identified in NNL that will persist in NEG include the following:

- Establishing appropriate baseline conditions [26].
- Uneven distribution of impact and mitigation. On average, assessments of habitat quality tended to find that the quality of offset sites was lower than that at impact sites [6, 26].
- Identification of appropriate targets, indicators, and metrics, as well as the determination of the appropriate spatial and temporal scales for monitoring [10, 1, 7, 8].
- Funding and infrastructure, incorporation of climate change science, monitoring, assessment accuracy, and community buy in [10, 1, 7, 8].
- Regional coordination between multiple levels of government with the potential for conflicting internal rules and policies (compliance and enforcement) [9].

  "Ecological uncertainties make it difficult to know where the threshold between no net loss and net gain lies and to specify how large gains should be." [7]

- Transitioning from NNL to NEG policy will therefore need to address these challenges in addition to determining what constitutes sufficient gain [1, 7]. Because NNL success often requires overcompensating for losses, **determining how large gains should be to achieve NEG goals is not straightforward** [10].

INSIGHTS FROM ESTABLISHED NEG POLICY: IMPLEMENTATION GUIDELINES AND SUPPORT

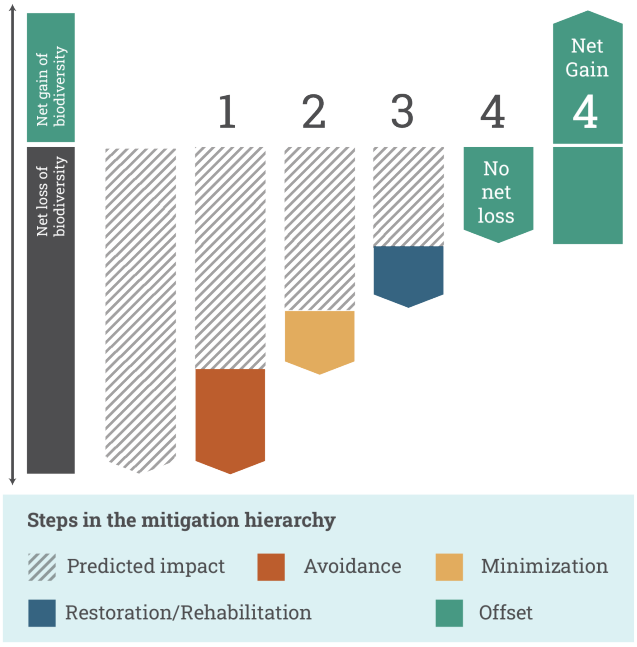
Despite the challenges successful implementation may present, **NEG is increasingly well established in international policy and corporate practice** [10]. In the United Kingdom (UK) current NEG policy (referred to as biodiversity net gain or BNG) includes explicit requirements to minimize impacts on biodiversity and provide net gains in biodiversity as part of the government's commitment to halt biodiversity decline [18]. The policy framework also includes "a presumption in favor of sustainable development" to emphasize support and encouragement of sustainable development [18]. This favor creates an incentive for developers by expediting or favoring sustainable development plans.

In the UK, NEG policy is on track to become mandatory by November 2023 and will require a minimum of 10% gain related to direct footprint losses due to development to be secured for at least 30 years [11]. Due to the mandatory implementation of NEG, the UK has produced resources providing insight and guidance on best practices when implementing NEG policies. In addition, implementation of NNL policy from Lake Tahoe, CA and Washington state provide **insights on how successful implementation of an NEG policy could look**. We summarize the main takeaways of these policies below.

DEVELOPING NEG POLICY AND PLANS

Key principles identified for the **successful design of NEG policies and plans** include the following:

Adhere to the mitigation hierarchy (Figure 1) to avoid, minimize, remediate, and offset [12, 13]. Offsets must focus on providing benefit above and beyond avoided loss [14]. Additionally, policies should adopt a no down-trading policy that states mitigation offsets in lower quality habitats cannot be applied to higher quality habitat impacts [8].



Source: Adapted from Bennet et al., 2017

The first and most important step of the mitigation hierarchy is to avoid adverse impacts, including the consideration of project alternatives. The second step consists of measures to reduce impacts that cannot be avoided, followed by work to restore, or rehabilitate damaged ecosystems or species populations on the site of the development (Step 3). Offsets (Step 4) can be used as a measure of the last resort if and when it can be demonstrated that appropriate efforts have been made, through other steps in the mitigation hierarchy, to minimize residual impacts. Offsets can either be on site or off site. They can be used to achieve either a no net loss objective or a net gain in biodiversity following the development.

Figure 2. Mitigation hierarchy for net gains [11].

- **Identify and classify baselines and metrics** needed to measure ecological impact [7, 11, 14].
- **Be inclusive and equitable in policy/program development.** Engage stakeholders early, and involve them in designing, implementing, monitoring, and evaluating the approach to Net Gain. Achieve NEG in partnership with stakeholders where possible and share the benefits fairly among stakeholders [12].
- **Ensure additionality of ecosystem offsets** that exceed existing obligations [12, 14].
- **Use robust, credible evidence and local knowledge** to make clearly justified choices when considering the following policy elements [12]:
  - Delivering compensation that is ecologically equivalent in type, amount and condition, and that accounts for the location and timing of biodiversity losses.
  - Compensating for losses of one type of biodiversity by providing a different type that delivers greater benefits for nature conservation.
  - Achieving NEG locally to the development while also contributing towards nature conservation priorities at local, regional, and national levels.
  - Enhancing existing or creating new habitat.
  - Enhancing ecological connectivity by creating more, bigger, better, and joined areas for biodiversity.
- **Ensure NEG generates long-term benefits** (benefits delivered in perpetuity) by planning for adaptive management, securing and dedicating funding for monitoring, incorporating resiliency

to external factors such as climate change and other land uses, and supporting local level management of NEG activities [8, 12, 13, 14].

- **Address risk and uncertainty** related to achieving NEG [12].

NEG IMPLEMENTATION STRATEGIES TO ADDRESS UNCERTAINTY

It is critical to evaluative uncertainties that exist in NEG policy to implement it successfully and determine the best path forward for developing robust plans that will lead to long term ecological gains [26]. There are risks to delivering NEG by creating or enhancing habitat, and climate change poses a significant level of uncertainty for all ecosystems [26]. However, there are suggested strategies that can be incorporated into program design that are important for NEG success, including the following:

Incorporate an adaptive management process. For example, in Lake Tahoe, CA an adaptive management system is used to ensure the region is meeting threshold standard goals related to environmental conditions such as water quality. The adaptive management system is described as a systematic approach for improving resource management by learning from management outcomes [9]. Figure 2 provides a visual for adaptive management flow. In terms of Lake Tahoe's adaptive management system, "the threshold standards and the Regional Plan represent the 'plan' function. The long-term goals (threshold standards) are set and kept up to date through periodic review and amendment as needed. Completion of public and private projects, programs, and proposals corresponds to the 'do' function. The 'check' function is carried-out through monitoring and reporting which is then used on an ongoing basis to 'adjust' by making changes to the 'plan." [9]

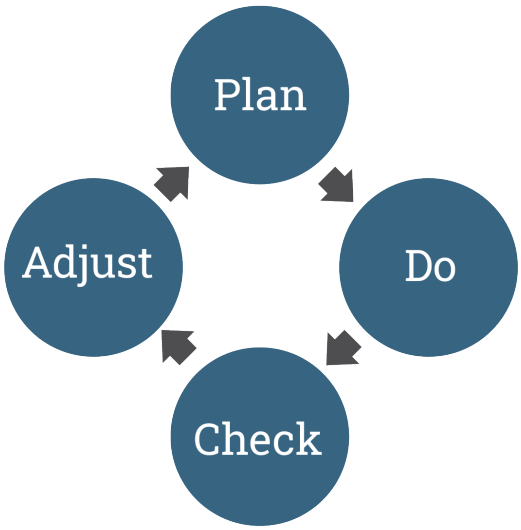


Figure 3. The adaptive management or continuous improvement "plan-do-check-adjust" approach used by Lake Tahoe's threshold and Regional Plan system [9].

- **Establish consistent biodiversity metrics.** Provide data on anticipated losses and gains related to ecosystem function or biodiversity in a standardized format that can be easily collected [7]. In the UK, the Department for Environment, Food & Rural Affairs (Defra) proposed a "Defra Biodiversity Metric" designed to provide ecologists, developers, planners, and other

interested parties with a means of assessing changes in biodiversity value (losses or gains) brought about by development or changes in land management. The metric is a habitat-based approach to determining a proxy biodiversity value. This metric will be used to measure Biodiversity Net Gain under the UK's mandatory policy [19, 27].

- **Establish consistent biodiversity metrics.** Provide data on anticipated losses and gains related to ecosystem function or biodiversity in a standardized format that can be easily collected [7]. In the UK, the Department for Environment, Food & Rural Affairs (Defra) proposed a "Defra Biodiversity Metric" designed to provide ecologists, developers, planners, and other interested parties with a means of assessing changes in biodiversity value (losses or gains) brought about by development or changes in land management. The metric is a habitat-based approach to determining a proxy biodiversity value. This metric will be used to measure Biodiversity Net Gain under the UK's mandatory policy [19, 27].
- **Manage a database of monitoring data.** Authorities can partner with organizations that manage data on the natural environment. In the UK, local environmental record centers (LERCs) are an important partner in establishing NEG within local planning associations. LERCs have the expertise to manage and retain databases and can aid in creating robust datasets that are available to others [13].
  - Monitoring data collection can be used to **establish a baseline** to which environmental improvement will be referenced.
  - Proper data management addresses the issue of double counting.
- **Make NEG mandatory** for all new developments. Making NEG mandatory will provide private investor confidence in the approach and in offsetting. This is vital to creating a 'Restoration Economy' through habitat banking, net gain, and corporate natural capital accounting [14]. In the US, regulatory certainty surrounding NNL policies led to significant economies of scale leading to the start of large, multisite habitat banking entities that can buffer risks [11].

MEASURING NEG

Achieving measurable net gains in biodiversity and ecosystem function is essential to the success of NEG. A 2019 guidance document out of the UK summarized the key points on measuring NEG as follows [13]:

- Justify the methods used to measure NEG.
- Use the same methods consistently throughout a project's life cycle (quantify outcomes from avoidance, minimization, and compensation measures that show additional gains).
- Establish and justify a baseline.
- Be transparent on metrics used and how NEG outcomes were determined.
- Use qualitative and quantitative assessments to be used in design, implementation, and maintenance/monitoring of NEG to capture all aspect of biodiversity/ecosystem function.
- Incorporate uncertainties into calculations by adding contingency to increase the amount of ecosystem function or biodiversity needed to achieve net gain. Contingency should account for the time-lag between losses occurring and the gains being realized.

- Do not aggregate all features together into a single summed number for a project.
- Carefully consider what constitutes net gain; it is important to consider metric accuracy compared to the goal of net gains.
- Present quantifiable evidence that demonstrates measurable net gains. This will typically mean monitoring data over a timeframe that is commensurate with the specific feature of the net gain design.

MONITORING IS ESSENTIAL FOR COMPLIANCE AND ENFORCEMENT OF NEG POLICY

- **Robust monitoring, assessment, and accountability are critical to successful implementation of NEG policy** [26]. Without monitoring and reporting plans in place, compliance could lapse, and enforcement or accountability triggers would fail. However, funding, authority, scale of mitigation, and the establishment of universal metrics all present challenges for creating monitoring plans related to NEG [28]. This section provides insights on key factors to consider when designing a monitoring program related to NEG and highlights legal considerations specific to Washington state.
- **Enable and incentivize cross-agency and cross-disciplinary communication and collaboration** on NEG-related issues [26]. This would decrease the potential for conflicting internal rules and policies between multiple levels of government [9].
  - If NNL or NEG are only applied to a subsection of impacts, then even if project-scale mitigation is achieved, the policy will inevitably oversee landscape-scale declines in biodiversity. "There are two main sources of unmitigated infrastructural impacts: (1) deliberate policy choices that leave particular sets of impacts either entirely unaddressed or granted special exemptions from regulation and (2) illegal, noncompliant, or unreported impacts." [13]
- **Funding for long-term monitoring and maintenance of NEG outcomes.** In the UK, additional funding to support local authorities to enforce, monitor, and administer a NEG standard has been identified as a need [28]. Overall, it is important for authorities to ensure sufficient funds have been allocated to deliver management long-term, anticipating costs such as capital works, negative impacts to income, potential need for management cost contingency, legal, administration, monitoring, reporting, foreseeable risks, insurance, and inflation [8].

LEGAL ISSUES IN WASHINGTON STATE

There is concern that mandatory enforcement of NEG policy could lead to a regulatory taking on private lands [15]. A taking is described as a "regulatory action that deprives property of all value […]. Where there is less than a complete deprivation of all value, a court will evaluate whether a taking has occurred by considering the economic impact in relation to at least two other factors: (1) the extent to which the government's action impacts legitimate and long-standing expectations about the use of the property; and (2) the character of the government's actions—is there an important interest at stake and has the government tended to use the least intrusive means to achieve that objective?" [15].

In an advisory memorandum related to actions to avoid unconstitutional takings of private property [15], the Office of the Attorney General stated that when a regulation requires a private property owner to dedicate land to public use, the dedication or financial obligation that is required from the landowner must be reasonable and proportional- i.e., specifically designed to mitigate adverse impacts of a proposed development. Ultimately, the government must demonstrate that it acted reasonably, and that its actions are proportionate to an identifiable problem.

ALTERNATIVE MITIGATION STRATEGIES

Sources mainly described achieving NNL and NEG within the mitigation hierarchy via developers directly offsetting their project impact on site or off site, without relying on third parties. Other mitigation strategies that were mentioned for achieving mitigation offsets included:

- **Habitat banking** - A market mechanism where credits from actions with beneficial biodiversity outcomes can be purchased to offset the debit from environmental damage [11].
- **In-lieu fee program/compensation fund** - Accept payments in exchange for credits. Habitat creation and restoration projects are carried out once enough funds have been collected [11, 13].

EQUITABLE AND INCLUSIVE OUTCOMES OF NEG POLICY ARE NOT A GUARANTEE AND SHOULD BE INTENTIONAL IN PLANNING

There is an opportunity to ensure NEG policy is more equitable and inclusive in its outcomes compared to NNL policy. Currently, social issues are often not well considered by those designing and implementing strategies to mitigate biodiversity loss and social impacts of changes in biodiversity are often overlooked [7, 16]. As a result, there is evidence that underserved groups are most affected by ecological loss, while wealthier members of the same community disproportionately benefit through mitigation actions [1].

> *"NNL is not equitable and NEG processes must learn from NNL's downfalls and create more equitable stakeholder engagement practices." [26]*

To address these inequities, **policymakers must consider inclusivity and equity in the design, implementation, monitoring, and evaluation approach of NEG policy**. Engaging and involving stakeholders and other partners early in the process will support successful NEG outcomes and promote community trust and buy-in [26, 13, 16]. Previous NNL and NEG implementation have also demonstrated the importance of balancing on-site and off-site benefit delivery. Although operating under the mitigation hierarchy first seeks to avoid significant adverse impacts and encourages on-site mitigation, there are often local constraints such as disturbance and lack of available space that make it a challenge to deliver social benefits where the impacts are observed [7, 14]. In the UK, it is typical for 80% of NEG to be delivered off-site which has raised concerns that some communities will experience most of the adverse impacts of development while others will receive the benefits [14].

Moving forward, **NEG initiatives can incorporate social considerations more explicitly**. Ecosystem services are often tied to community well-being, and as such, policies to mitigate ecosystem decline

should incorporate local values and impact [16]. In practice, incorporating these considerations is challenging because NEG is most effectively achieved at scale [14]. However, including a well-being framework to the mitigation hierarchy will aid in efforts to reduce negative local impacts [16].

ENVIRONMENTAL AND SOCIAL CO-BENEFITS

Successful implementation of NEG will increase biodiversity or resilience that improves the delivery of valued ecosystem functions in the affected ecosystem following development [1]. Strengthening ecosystem function and health has a cascading effect of positive environmental and social outcomes. In addition to providing increased climate resiliency, NEG environmental and social co-benefits include:

Protection of critical ecosystem function while ensuring sustainable development. Global development will continue to meet residential population and commercial enterprise demand [6, 26]. NEG will be an essential component of supporting this growth to continue in a sustainable way that leads to positive ecological outcomes.

Increased human health and well-being. Promoting sustainable development results in economic, social, and environmental benefits. By increasing biodiversity and ecosystem function through development, homes, and the people who live in them can benefit from clean water and air. Sustainable development has also been cited as increasing the value of a new home [13] and flood protection [7].

POTENTIAL INCENTIVES TO PROMOTE NEG

Incentivizing NEG for developers and private landowners will be a key component of moving the needle on NEG implementation. We summarize incentives included in the literature below.

- **Performance Incentives**. Monitoring requirements should be budgeted for at the start of the project. Where feasible, these requirements should link to financial incentives at the project level—such as withholding of project finance until monitoring data are submitted—or the individual level—such as performance-based payments where managers are paid once biodiversity NNL/NEG and the associated social outcomes can be demonstrated [29].
- **Create incentives for on-site mitigation** or off-set close to the mitigation site [11].
  - Incentivize the use of local habitat compensation schemes and encourage on-site enhancement [28].
- **Incentivize environmental principles within the development itself.** This would mean that built developments which were designed sustainably, utilizing sustainable building materials, or incorporating renewable energy, would score positively in a NEG approach [28].
- **Create incentives to avoid the most biodiverse sites for development** by recognizing biodiversity costs and benefits [28].

In addition to regulatory incentives, sources state that developers can gain a competitive advantage, increase financial value, and secure efficiencies by adopting good practice principles for NEG [13]. These advantages include the following:

- **Competitive advantage**—developers that implement NEG ensure a smooth transition when aligning project and operations with requirements to deliver NEG; help companies improve site selection; improve stakeholder relations by providing a collaborative basis to work from; demonstrate sustainability leadership, which can benefit company reputation.
- **Increased financial value**—developers that implement NEG can create more desirable areas due to the creation of sustainable building, public parks and other spaces that enhance people's wellbeing and quality of life. This can create increased investment and demand in the area.
- **Secured efficiencies**—applying the mitigation hierarchy can minimize the risk of delay and costs related to potential effects on the environment earlier in the process.

APPENDIX B. REGULATORY REVIEW MEMO

During the 2021 Legislative session, the Washington legislature directed Washington Department of Fish and Wildlife (WDFW) to investigate a pathway for incorporating a Net Ecological Gain (NEG) standard into state law with the goal of improving endangered species recovery and ecological health statewide.

One of the key project initiatives required by the legislative proviso includes an analysis of existing Washington State environmental, development, or land use laws or rules where the existing standard—namely NNL or a similar standard—is mentioned to understand how these standards have operated within the state. These include the Shoreline Management Act (SMA) (chapter 90.58 RCW), the Growth Management Act (GMA) (chapter 36.70A RCW), Construction Projects in State Waters (CPSW) (chapter 77.55 RCW), and the Model Toxics Control Act (MTCA) (chapter 70A.305 RCW).

This memo summarizes the NNL standards, mitigation, and enforcement requirements within the laws and associated rules named by the proviso above as well as within the State Environmental Policy Act (SEPA) (chapter 43.21C RCW) and the Forest Practices Act (FPA) (chapter 76.09 RCW)—identified as other key pieces of Washington legislation pertaining to NNL. Throughout this memo, laws and rules are linked when first referenced.

Table 1 summarizes the key legislative details outlined in this memo.

METHODOLOGY

The laws and rules assessed were those named within the proviso. SEPA was also included because of the law's requirements to review governmental decision making regarding environmental impacts and mitigation sequencing.

This memo is limited to review of the Revised Code of Washington (RCW) and Washington Administrative Code (WAC) language and relevant guidance documents produced by the Washington Department of Commerce (Commerce), Washington Department of Ecology (Ecology) and WDFW. Table 1 summarizes the key legislative details outlined in this memo.

This memo is not a literature review nor assessment of regulatory effectiveness of these laws, regulations, or guidelines. These details were gathered primarily through engagement with experts.

SUMMARY OF LEGISLATION REVIEWED

SHORELINE MANAGEMENT ACT (CHAPTER 90.58 RCW)

The SMA rules were the first rules to include NNL explicitly. The rules require local jurisdictions to develop and implement Shoreline Master Programs that protect shorelines of the state from NNL through land use zoning designations, with associated permitted uses and development standards, such as buffers and setbacks. Mitigation sequencing is applied to all projects with "avoidance" of impacts to ecological functions and values being the highest priority. Compensatory mitigation is an option if impacts cannot be avoided, minimized, rectified, reduced, or eliminated. Local governments oversee permit implementation and enforcement [30].

GROWTH MANAGEMENT ACT (CHAPTER 36.70A RCW)

The intent of GMA is to provide for growth while protecting natural resource lands and critical areas. Counties and cities are required to designate agricultural lands, forest lands, mineral resource lands, and critical areas where appropriate and develop protective regulations. The implementing guidance for protection of critical areas states that if development regulations allow harm to critical areas, that cannot be mitigated otherwise through appropriate mitigation sequencing, compensatory mitigation is required to avoid a net loss of critical areas. Local governments are responsible for permit implementation and enforcement [31].

CONSTRUCTION PROJECTS IN STATE WATERS (CHAPTER 77.55 RCW)

This regulation defines when a hydraulic project approval (HPA) is required for projects that might contribute to the decline of aquatic ecosystem function in or near state waters. HPAs are issued by WDFW and are designed to protect fish and their aquatic habitats. The law outlines the application requirement, review and approval procedures, and remediation actions required. WDFW may only deny or provision a HPA on the grounds of fish life protection, including habitat impacts. WDFW is responsible for enforcement of permit implementation and monitoring of violations [32].

MODEL TOXICS CONTROL ACT (CHAPTER 70A-305 RCW)

The Model Toxics Control Act (MTCA) directs the investigation, cleanup, and prevention of future contamination of sites that are contaminated by hazardous substances. The law directs the Department of Ecology to investigate any releases or threatened releases of hazardous substances, including but not limited to inspecting, sampling, or testing to determine the nature or extent of any release or threatened release of a hazardous material. The MTCA includes MTCA Cleanup Regulations, Sediment Management Standards and Remedial Action Grants and Loans. The law adopts the standard of "no adverse effects", which is defined as "no acute or chronic adverse effects to biological resources as measured by a statistically and biologically significant response relative to reference or control." Ecology is responsible for the enforcement of monitoring plan and mitigation standards [33].

STATE ENVIRONMENTAL POLICY ACT (CHAPTER 43.21C RCW)

The State Environmental Policy Act (SEPA) is intended to ensure that state and local agencies consider environmental values during decision making for proposed planning documents (non-project) or project actions. A threshold determination is made based on the standard of whether the project will result in "adverse environmental impacts," which then triggers further actions based on the level of impact expected, including the need for mitigation and or advanced review with an Environmental Impact Statement. The threshold determination is subjective and based, in part, on the physical setting, including, but not limited to, the sensitivity and value of the location as well as the magnitude and duration of the impact. The determination also considers proposed mitigation activities and input from stakeholders and other permit requirements. SEPA is a required planning tool used in conjunction with many environmental decisions to arrive at a determination of significance which then triggers mitigation sequencing and other planning actions. SEPA processes are led by lead agencies determined by the nature, intent, or location of the project on a project-by-project basis. SEPA standards are enforced by the state or local agency that issued the original permit for the project in question [34].

FOREST PRACTICES ACT (CHAPTER 76.09 RCW)

The Forest Practices Act (FPA) regulates forest practice activities on state-owned and public forest lands. FPA rules ensure the protection of federally listed fish and riparian-dependent species while maintaining commercial forest management as an economically viable use of forestlands. Forest practice rules focus on riparian and instream habitats by regulating activities such as timber harvesting, road construction, and road maintenance plans. Protection standards extend to protecting associated lands that affect habitat, such as operations on or around steep and unstable slopes and wetlands, as well as water quality. Incidental take of focus species and habitat impacts are monitored through regular assessments, monitoring and adaptive management programs. Washington Department of Natural Resources implement and enforce forest practice permits [35].

THEMES IDENTIFIED ACROSS LEGISLATION

THE DEFINITION OF NNL VARIES ACROSS WASHINGTON LEGISLATION

NNL is clearly defined as a requirement in the SMA guidance (chapter 173-26 WAC) and as a requirement for HPA (chapter 77.55 RCW) approval. It is defined as a goal in guidance for implementation of the GMA but not defined explicitly in the GMA (chapter 36.70A RCW).

SEPA (chapter 43.21C RCW) is widely used to assess environmental impacts of projects and determine if impacts will occur that require mitigation, but is not required for all land-use projects and decisions.

The MTCA cleanup regulations (chapter 173-340 WAC) and Sediment Management Standards (chapter 173-204 WAC) use the standard of "no adverse effects" which is defined as "no acute or chronic adverse effects to biological resources."

MITIGATION REQUIREMENTS VARY ACROSS LEGISLATION

Mitigation sequencing is explicitly stated in the SMA, SMA guidelines, and GMA guidelines. Mitigation for actions approved by CPSW is less well-defined but is suggested. Compensatory mitigation is consistently the least favored action. Commerce's 2018 Critical Area Handbook recommends local governments direct mitigation, including compensatory and compensatory mitigation, towards salmon recovery priorities in the basin when developing regulations for critical areas [31].

Mitigation plans (chapter 90.74 RCW) are an alternative process to standard on-site mitigation; in-kind mitigation can be approved by Ecology or WDFW and are initiated by the project proponent seeking a permit. Neither Ecology nor WDFW can limit the scope of options within a mitigation plan on, or adjacent to, site of impact, or to habitat types of the same type that will be impacted. They are not required to approve mitigation plans that do not provide equal or better ecological functions and values within the watershed or bay (chapter 90.74.020 RCW).

The MTCA does not appear to involve mitigation sequencing or procedures. If violations are found and "adverse impacts" are discovered then a cleanup process is initiated and permits revised.

THERE ARE CONSISTENT GAPS OR NEEDS ACROSS LEGISLATION WHERE THERE IS NOT STRONG GUIDANCE NOR STANDARDS

The following is a very high-level assessment of potential gaps and needs that were identified during this summary effort but is in no way comprehensive nor is this assessment vetted by legal staff or policy implementers. It is possible that these gaps and needs are addressed by different laws and rules not reviewed for this memo.

NEEDS

A consistent application of a standard would provide clarity of intent regarding goals to not lose any ecological function or values as a result of land use decisions and actions. The variety of terms used to address NNL ("no adverse impacts," "conservation," "protection") may be leading to confusion and inconsistent protections.

Fiscal and capacity support for local governmental enforcement and monitoring would enable comprehensive monitoring of permit implementation and violation investigations. Enforcement of permit conditions left to the jurisdiction of local governments results in a variety of enforcement processes and varying standards. Without enforcement and permit implementation review being required, NNL may be occurring, which in turn impacts the current conditions inventory during periodic updates. The baseline of NNL that is determined by inventories is negatively impacted, leading to incremental loss.

Forest practice actions should be included in any NNL assessment. Not achieving a NNL standard, when the entire forest ecology is considered, should not be considered a failure of forest practices. The FPA law and rules were designed to prevent impacts to, and incidental take of, a limited number of endangered species and federal and state water quality standards, while maintaining a viable timber industry. The law and rules were not designed to achieve NNL across the broad watershed landscape for all ecological functions and values. While the management practices required by the FPA have resulted in habitat improvements over historical forest practices, any assessment of NNL should also include forest lands under the FPA given the focus on fish and riparian-dependent species to ensure a cumulative picture of the amount of NNL across the state.

GAPS

- Most of the reviewed laws and rules include permitting and SEPA exemptions for different types of proposals. The impact of these exemptions may be considered during cumulative impacts analyses and NNL assessments conducted by local governments or state agencies, when required for periodic updates. However, any proposal action exempt from permit review, or held to different review standards under programs that do not undergo periodic updates, may not be accounted for in NNL assessments.
- Guidance for completing periodic updates does not include an assessment of ecological functions that may have been lost due to unpermitted activities or permitted activities with unexpected impacts. Nor is an assessment of potential ecological functions gained due to voluntary measures required during periodic updates. The current requirements of the cumulative impacts analysis are forward looking in time and only account for existing

conditions and proposed actions. SMPs are required to have Restoration Plans but not required to implement the proposed actions or assess any progress during periodic updates.

- During periodic updates under GMA and SMA, local governments are not required to "show their work" as to how they are achieving NNL or if they are achieving the standard. Monitoring and tracking are not required.
- During SMA periodic updates, local governments are not required to document progress made on implementing actions recommended in restoration plans. Restoration plan actions are voluntary. However, restoration is recognized as necessary in conjunction with protective regulations to achieve NNL. Therefore, an assessment of implementation progress of restoration plans would inform the overall state of NNL.
- No requirement was found to require compensatory mitigation for temporal loss of ecological function after violations or inadvertent impacts are discovered. Restoring lost habitat does not account for the temporal loss of ecological function.
- Emergency permitting actions are often held to different ecological function standards. No requirement was found requiring compensatory mitigation for ecological function loss, including temporal loss, should it have occurred as a result of the emergency action(s).

DETAILED LEGISLATION SUMMARIES

SHORELINE MANAGEMENT ACT (CHAPTER 90.58 RCW)

BRIEF DESCRIPTION

Washington State adopted the Shoreline Management Act (SMA) to prevent the inherent harm that results from uncoordinated development of the state's shorelines. SMA's broad policies are translated into regulatory standards for shoreline use by local governments in their Shoreline Master Programs (SMP). The development of SMPs is governed under WAC 173-26, which was the first rule to incorporate a NNL standard requirement within its governing regulations. Specifically, WAC 173-26-201(2)(c) states:

> "These guidelines are designed to assure, at minimum, no net loss of ecological functions necessary to sustain shoreline natural resources and to plan for restoration of ecological functions where they have been impaired."

The NNL standard is intended to halt the introduction of new impacts to shoreline ecological functions resulting from new development. Local governments are expected to achieve this standard through both the SMP planning process and by regulating individual developments. It is recognized that to achieve NNL, it is necessary that both restoration and protection occur [36].

The SMA regulatory jurisdiction lies with Ecology.

CURRENT STANDARDS GOVERNING THE DETERMINATION OF NNL (I.E., METRICS USED TO DETERMINE NNL)

For determining NNL at a project permit level, local governments use SEPA (Chapter 43.21C RCW) to review proposed projects and determine the anticipated environmental impacts. Following this review, a determination of significance is issued, which determines next steps for project implementation.

For determining if NNL is achieved through local government planning efforts, SMP plans and updates are reviewed and approved by Ecology's director, who must formally conclude that the proposed SMP will result in NNL over a 20-year planning horizon. Local governments also apply SEPA to these planning and program-level decisions.

Local governments are expected to demonstrate NNL through:

1. A comprehensive SMP update planning process, and
2. Project review and permitting processes, over time.

Local governments are also encouraged to utilize the following practices to meet the NNL standard:

- Locate, design, and mitigate development within a watershed context (utilizing watershed characterization to identify areas for development, restoration and on or compensatory investigation,
- Prohibit uses that are not preferred for shoreline uses or are not-water dependent,
- Require future shoreline development be carried out so that it limits further degradation,
- Require buffers and setbacks,
- Use watershed inventory and characterization to create environment designations,
- Establish strong policies and regulations through permit review, mitigation measures and restoration requirements,
- Recommend actions for properties that are outside shoreline jurisdiction but may impact shorelands, and
- Require mitigation sequencing for all development (avoid, minimize, rectify, reduce, compensate as well as monitor and take corrective actions) [36].

During their periodic SMP Updates, which are required every eight years, local jurisdictions produce a watershed characterization, use analysis, management recommendations, and a restoration plan. A cumulative impacts analysis and NNL summary—which are meant to provide a record of the jurisdiction's decisions on SMP policies and regulations—are also required. Chapter 17 of Ecology's SMP Handbook provides guidance on the Cumulative Impacts Analysis component of a local government's SMP update. The analysis must include (1) a current circumstances assessment, (2) consideration of foreseeable future development, and (3) consideration of beneficial effects of any existing regulatory programs beyond the SMP. The analysis is not required to analyze historic trends to assess if the current SMP is achieving NNL as intended. Chapter 4 of the SMP Handbook provides guidance to local governments on how to ensure they are meeting the NNL standard [37].

Shoreline inventories are used to set the baseline against which indicators measure change. Inventories are completed during the watershed characterization process during initial SMP planning process and/or during SMP updates.

A list of potential metrics/NNL indicators have been developed by Ecology but their use by local governments is voluntary and local governments may develop their own indicators.

SMP HABITAT PRIORITIZATION/RANKING SYSTEM FOR MITIGATION

Mitigation sequencing is defined in WAC 173-26-201(2)(e) as:

> *"To ass*ure no net loss of shoreline ecological functions, master programs shall include provisions that require proposed individual uses and developments to analyze environmental impacts of the proposal and include measures to mitigate environmental impacts not otherwise avoided or mitigated by compliance with the master program and other applicable regulations."

SMP regulations must state that mitigation measures shall follow a sequence of steps, in priority of avoiding, minimizing, rectifying, reducing, or eliminating, and finally compensating. Monitoring and taking corrective measures are also listed as requirements.

SMP restoration plans should help identify priority sites for restoration and compensatory mitigation but do not suggest priority criteria (WAC 173-26-201(2)(iii)(c)). Restoration is a noted requirement to achieve NNL. While a Restoration Plan is a required element of SMPs, the implementation of proposed restoration actions is not required nor is it always evaluated during the update process.

ENFORCEMENT OF SMA

Enforcement of the NNL standard can occur during the approval process of SMPs by Ecology or through permit compliance either by the local government or through Ecology. The Shorelines Hearings Board also has an enforcement role at the SMP planning level.

Ecology may not approve a local government's SMP if the proposed SMP does not provide an adequate level of protection for shoreline ecological functions, including proving NNL of those functions through the planning process or permitting review. WAC 173-26-070(b) states:

> *"Pursua*nt to RCW 90.58.090(4), when the department determines that those parts of a master program relating to shorelines of state-wide significance do not provide for optimum implementation of the policy of chapter 90.58 RCW to satisfy the statewide interest, the department may develop and adopt by rule an alternative to the local government's master program proposal."

Ecology has adopted an alternative Master Program should Ecology not approve the local government's proposed SMP until the local government can propose a SMP that does.

The Shorelines Hearings Board hears and decides appeals challenging local governments' comprehensive plans and critical areas ordinances by those that feel that protections and standards required by the SMA, including the NNL standard, are not being upheld or if the shoreline is inadequately protected.

Local governments are expected to identify a process for periodically evaluating the cumulative effects of authorized development on shoreline conditions Chapter 4 of the SMP Handbook suggests, but does not require, that local governments use a suite of indicators to evaluate effects of development. Local governments are only required to show how a development project will achieve NNL. Chapter 4 briefly mentions that local governments are expected to implement a compliance strategy that should include a mechanism to document project review actions and a method to periodically evaluate cumulative effects of authorized shoreline development. The compliance strategy should include development project reviews and identification of enforcement priorities. This development of enforcement and resulting mitigation or restoration of impacts is the local government's responsibility [37].

ON-SITE VERSUS COMPENSATORY MITIGATION APPROACHES

The SMA does differentiate between on-site and compensatory mitigation, stating that on-site mitigation is preferred to compensatory mitigation in WAC 173-26-201(2)(e)(ii)(B):

> *"When compensatory measures are appropriate pursuant to the mitigation priority sequence above,* ***preferential consideration shall be given to measures that replace the impacted functions directly and in the immediate vicinity*** *of the impact. However, alternative compensatory mitigation within the watershed that addresses limiting factors or identified critical needs for shoreline resource conservation based on watershed or comprehensive resource management plans applicable to the area of impact may be authorized. Authorization of compensatory mitigation measures may require appropriate safeguards, terms or conditions as necessary to ensure no net loss of ecological functions" (emphasis added).*

GROWTH MANAGEMENT ACT (CHAPTER 36.70A RCW)

BRIEF DESCRIPTION

The purpose of the Growth Management Act (GMA) (chapter 36.70A RCW) is to provide for growth while protecting natural resource lands and critical areas.

Chapter 36.70A.170 WAC directs counties and cities to designate agricultural lands, forest lands, mineral resource lands and critical areas where appropriate. It also directs counties and cities to consider the guidelines adopted by the Department of Commerce (Commerce) when developing protective regulations. These guidelines are considered the minimum requirements for protecting natural resource lands and critical areas.

Commerce released an updated Critical Areas Handbook guidance in 2018 (approved in 2022) to assist local governments in reviewing and potentially revising their locally adopted programs that designate and protect critical areas [31]. Local governments have the discretion to tailor the comprehensive plans

and development regulations to their local circumstances, within the goals and requirements of the GMA.

CURRENT STANDARDS GOVERNING THE DETERMINATION OF NNL (I.E., METRICS USED TO DETERMINE NNL)

Chapter RCW 36.70A.020 (Planning Goals) does not mention "no net loss," specifically. The planning goal in RCW is stated as requiring the "conservation" of habitat, the environment, productive forest, and agricultural lands, along with conserving natural resource-based industries. Protection of water quality and availability is stated as important in supporting the state's high quality of life. There is no mention of protecting the function of habitat in the Planning Goals.

The implementing guidance for protection of critical areas does reference NNL. WAC 365-196-830(4) states that if development regulations allow harm to critical areas, compensatory mitigation is required to avoid a net loss of critical areas. The WAC states that local governments must adopt regulations to "protect" critical areas. Protection is defined in this context as preservation of the functions and values of the natural environment, or to safeguard the public from hazards to health and safety.

Local governments may develop and implement alternative means of protecting critical areas if those means provide NNL of functions and values and are developed based on best available science (WAC 365-196-830(8)).

The critical areas guidance does encourage local policymakers to take an ecosystem approach to developing regulations. The Growth Management Hearings Boards have found that "development regulations may not allow a net loss of the functions and values of the ecosystem that includes the impacted or lost critical areas" [38] [39].

WAC 365-195-925 states that, in addition to including best available science, cities and counties must also give "special consideration" for the protection and enhancement of anadromous fisheries when developing regulations and protective measures. The Supreme Court found that while "enhancement" of anadromous habitat should be given "special consideration," cities and counties are not required to adopt measures to require enhancement. The Court concluded that the "no harm" standard protected critical areas by maintaining existing conditions [40].

GMA HABITAT PRIORITIZATION/RANKING SYSTEM FOR MITIGATION

WAC 365-196-830(4) states that:

> *"Although counties and cities may protect critical areas in different ways or may allow some localized impacts to critical areas, or even the potential loss of some critical areas, development regulations must preserve the existing functions and values of critical areas. If development regulations allow harm to critical areas, they must require compensatory mitigation of the harm. Development regulations may not allow a net loss of the functions and values of the ecosystem that includes the impacted or lost critical areas."*

SEPA rules (WAC 197-11-768) and Section 404 of the federal Clean Water Act (CWA) both require that a sequence of actions be taken for proposed projects that will impact wetlands. SEPA is used to assess impacts and determine whether mitigation should be required. SEPA cannot substitute for critical area regulations because of the many exemptions in SEPA and the lack of specific standards [31].

Commerce's Critical Area Handbook discusses mitigation sequencing, stating that if a project will result in an impact to a critical area, the project proponent should, but is not necessarily required to, show how impacts were attempted to be avoided or minimized wherever practicable. The handbook further recommends directing mitigation, including compensatory mitigation towards salmon recovery priorities in the basin [31].

ENFORCEMENT OF GMA

The cumulative impact of development on habitat is assessed during the required periodic reviews outlined in comprehensive plans and critical area ordinances. These assessments focus on determining if existing regulations were achieving NNL.

Commerce can deny approval of the local government's proposed comprehensive plan if the plan would result in significant adverse impacts if losses are not mitigated.

Project action enforcement is delegated to local governments who are authorized to create their own enforcement processes to ensure the intent of the law and the requirements outlined in approved comprehensive plans followed.

The Growth Management Hearings Board hears and decides appeals challenging local governments' comprehensive plans and critical areas ordinances by those that feel that protections and standards required by the Growth Management Act, including the NNL standard, are not being upheld or habitats are inadequately protected.

ON-SITE VERSUS COMPENSATORY MITIGATION APPROACHES

The current version of the critical areas guidance [31] states that compensatory compensation or compensatory mitigation should only be utilized if avoidance and on-site mitigation are not possible. The guidance also states that if compensatory mitigation is not possible, then harm to the critical area must be avoided.

> *"Given the requirement to protect the functions and values of critical areas, compensatory mitigation should only be used after mitigation sequencing and it should be allowed with caution. Before allowing compensatory mitigation, a local government will need to determine that there is the ability to replace the functions and values through compensatory mitigation. Compensatory mitigation is specifically called out in the Minimum Guidelines as it applies to wetlands, and to geologically hazardous areas. The WAC is silent with respect to the three other types of critical areas. For some types of critical areas or for some types of impacts, compensation may not be possible. When compensatory mitigation is not possible, harm to the critical area from development activity must be avoided" [31].*

CONSTRUCTION PROJECTS IN STATE WATERS (CHAPTER 77.55 RCW)

BRIEF DESCRIPTION

Chapter 77.55 RCW is the law that defines when a hydraulic project approval (HPA) is required or exempt. HPAs are issued by WDFW and are designed to protect fish and their aquatic habitats in or near state waters. The law outlines the application contents, review and approval procedures, and violation remediation actions.

WAC 220-660-050(9)(c)(iii)(D) states:

> *"A complete applicati*on package for HPA must contain…a description of the measures that will be implemented for the protection of fish life, including any reports assessing impacts from the hydraulic project to fish life and their habitat, and plans to mitigate those impacts to ensure the project results in no net loss."

WDFW may only deny or provision an HPA on the grounds of fish life protection [32]. Forest practices that require a forest practice application and involve aquatic habitat are exempt from HPA requirements. Both the Forest Practices Act (chapter 76.09 RCW) and the hydraulic code statutes in chapter 77.55 RCW were amended in 2012 to integrate fish protection standards into forest practice rules. WDFW is required to review forest practice applications (FPA) when the FPA involves work in fish-bearing waters or shorelines of the state.

CURRENT STANDARDS GOVERNING THE DETERMINATION OF NNL (I.E., METRICS USED TO DETERMINE NNL)

As regulated in WAC 220-660-080, WDFW will determine if a proposed project will mitigate impacts to fish life and habitat based on available information. Impacts are evaluated by comparing the conditions of the habitat before project construction to the anticipated condition after project completion.

WDFW evaluates mitigation credits (i.e., positive impacts to fish life and habitat) and debits (i.e., negative impacts to fish life and habitat) based on a scientifically valid measure of habitat function, value, and quantity by habitat type. Compensatory mitigation must also compensate for temporal losses, uncertainty of performance, loss of habitat quantity by habitat type, and differences in habitat functions and value.

Mitigation plans, if required, must provide equal or better biological functions and values, compared to existing conditions, based on the following conditions:

- Relative value of the mitigation in terms of quality and quantity of biological functions and values,
- Compatibility with other existing management plans, regulations, and protection programs,
- Ability to address scarce functions and values in the watershed,
- Benefits to landscape and connectivity functions,
- Benefits of early implementation of mitigation measures, if applicable, and
- Significance of any negative impacts to non-target species.

HABITAT PRIORITIZATION/RANKING SYSTEM FOR MITIGATION

WAC 220-660-080 defines the mitigation requirements for HPAs and states that mitigation must achieve NNL. The guidance defines mitigation as "sequentially avoiding impacts, minimizing and rectifying unavoidable impacts, and compensating for remaining impacts."

If an experimental mitigation technique is proposed, WDFW may require advanced mitigation whereby the mitigation actions are fully functional prior to the project impacts.

ENFORCEMENT OF CONSTRUCTION PROJECTS IN STATE WATER

WDFW enforces compliance with Chapter 77.55 RCW. Compliance biologists visit sites during and after construction to assess compliance with HPA requirements. Correction requests are issued if WDFW determined that there is opportunity for landowners or contractors to correct the violating action(s). If voluntary compliance doesn't occur, WDFW may take further action, including notices to comply, stop work orders, notice of penalty, and referment to WDFW's Enforcement Program for criminal prosecution. Civil or criminal enforcement actions may include fines up to $10,000 per violation and/or 364 days in jail, as well as denial of future HPAs. There is also a system in place to report potential violation to WDFW.

ON-SITE VERSUS COMPENSATORY MITIGATION APPROACHES

RCW 77.55.241 gives WDFW permission to permit compensatory mitigation for hydraulic projects that require mitigation for the protection of fish life, where the mitigation may be most cost-effective and provide the most benefit to the fish resource if located compensatory.

WAC 220-660-080(4)(b) states that when compensatory mitigation is necessary to offset impacts, on-site mitigation, or mitigation immediately adjacent to the impact site is preferred. If on-site or adjacent mitigation is not possible, then WDFW prefers actions benefiting the same fish populations, habitat types and functions as those impacted by the project.

Under WAC 220-660-080, opponents of a project are permitted to request that a compensatory mitigation plan is adopted within a watershed that, pursuant to RCW 90.74.020, is not necessarily limited to the areas of on or near the project site.

MODEL TOXICS CONTROL ACT (CHAPTER 70A-305 RCW)

BRIEF DESCRIPTION

The Model Toxics Control Act (chapter 70A-305 RCW) directs the investigation, cleanup, and prevention of future contamination of sites that are contaminated by hazardous substances. The law directs Ecology to investigate any releases or threatened releases of hazardous substances, including but not limited to inspecting, sampling, or testing to determine the nature or extent of any release or threatened release of a hazardous materials. This law directs Ecology to act once a discharge of hazardous materials has happened or is threatened to happen if a reasonable basis to believe the report has been established. The MTCA is made up of three chapters that fall under Ecology's jurisdiction:

- The MTCA Cleanup Regulations (chapter 173-340 WAC) apply to all cleanup, including upland and groundwater.

- The Sediment Management Standards (chapter 173-204 WAC) apply only to cleanups in freshwater and marine environments.
- The Remedial Action Grants and Loans (RAG) (Chapter 173-322A WAC) establishes the requirements for grants and loans to local governments for remedial hazardous and toxic cleanup actions.

The regulations mentioned above use the standard of "no adverse effects" which is defined as "no acute or chronic adverse effects to biological resources as measured by a statistically and biologically significant response relative to reference or control."

CURRENT STANDARDS GOVERNING THE DETERMINATION OF NNL (I.E., METRICS USED TO DETERMINE NNL)

WAC 173-340-7490(3) sets procedures for conducting terrestrial ecological evaluations. The goal of this process is:

> *"The protection of terrestrial ecological receptors from exposure to contaminated soil with the potential to cause significant adverse effects. For species protected under the Endangered Species Act or other applicable laws that extend protection to individuals of a species, a significant adverse effect means an impact that would significantly disrupt normal behavior patterns that include, but are not limited to, breeding, feeding, or sheltering. For all other species, significant adverse effects are effects that impair reproduction, growth or survival."*

The MTCA Cleanup Regulations (WAC 173-204-320) set sediment quality standards for marine waters. Standards are measured against chemical composition and biological effects criteria. Biological effects criteria are based on growth, abundance, and mortality tolerance levels for different categories of biota (i.e., amphipods, benthic biota, microtox, larval and juvenile polycheate). Marine finfish rearing facilities are exempt from these sediment standards, as per WAC 173-204-412, and instead are addressed through the National Pollutant Discharge Elimination System or other permits issued by Ecology for facility operations.

The Cleanup Regulations and Sediment Management Standards (WAC 173-204) states that Ecology will determine the criteria, methods, and procedures necessary to meet the sediment standards rules on a case-by-case basis for low-salinity and freshwater standards, respectively.

The Sediment Management Standards (WAC 173-204) states that Ecology shall consider the following factors to determine if the potential discharge will violate marine, low salinity, and freshwater sediment standards:

- Discharge particle characteristics
- Discharge contaminant concentrations, flow and loading rate
- Sediment chemical concentration and biological effects levels
- Receiving water characteristics
- Geomorphology of sediments

- Cost mitigating factors
- Other factors deemed necessary by Ecology

The Sediment Management Standards do not, under any circumstances, relax the discharge permit requirements of other authorities, including the Water Pollution Control Act (chapter 90.48 RCW), the Water Resources Act (chapter 90.54 RCW) and the Federal Water Pollution Control Act.

MTCA HABITAT PRIORITIZATION/RANKING SYSTEM FOR MITIGATION

No ranking system identified within the MTCA or associated regulations.

ENFORCEMENT OF MTCA

WAC 173-340-310 details the investigation procedures once Ecology receives information that a release of a hazardous substance has occurred. WAC 173-204-400(8), in turn, allows Ecology to alter permit requirements in the event of a violation.

WAC 173-204-600 regulates sampling and plan standards and applies monitoring and clean up action plans authorized under the Sediment Management Standards regulations to sampling for sediment impact zones.

ON-SITE VERSUS COMPENSATORY MITIGATION APPROACHES

There were no details regarding on-site and compensatory mitigation approaches within the MTCA or associated regulations.

STATE ENVIRONMENTAL POLICY ACT (CHAPTER 43.21C RCW)

BRIEF DESCRIPTION

Washington established the State Environmental Policy Act (SEPA) under the premise that "each person has a fundamental and inalienable right to a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment." SEPA is intended to ensure that state and local agencies consider environmental values during decision making SEPA rules are contained in WAC Chapter 197-11. SEPA is enforced by the lead agency which is determined for each project or non-project action based on criteria listed in WAC 197-11-938.

CURRENT STANDARDS GOVERNING THE DETERMINATION OF NNL (I.E., METRICS USED TO DETERMINE NNL)

The standard used by SEPA is "adverse environmental impacts." A checklist is used to gather information on proposed planning documents (non-project) or project actions. The information gathered is examined as a whole and a threshold determination is made, which then triggers further actions based on the level of impact expected, including the need for mitigation and/or advanced review with an Environmental Impact Statement.

The threshold determination is subjective and based, in part, on the physical setting, including, but not limited to, the sensitivity and value of the location as well as the magnitude and duration of the impact.

The determination also considers proposed mitigation activities and input from stakeholders and other permit requirements.

SEPA HABITAT PRIORITIZATION/RANKING SYSTEM FOR MITIGATION

Mitigation is listed in SEPA (WAC 197-11-768) as avoidance, minimization, rectification, compensation, or elimination of adverse impacts, and may also involve monitoring and a contingency plan for correcting problems if they occur. Applying SEPA standards to a proposed project may or may not require mitigation actions but it does not automatically require that the applicant apply the mitigation sequence. However, if mitigation required under existing local, state and federal rules is not sufficient to avoid, minimize, or compensate for significant impacts, additional mitigation can be applied with the use of SEPA substantive authority.

ENFORCEMENT OF SEPA

A lead agency can condition or deny proposals if they would result in significant adverse environmental impacts and reasonable mitigation measures are not sufficient to mitigate the identified impact to a non-significant level.

If an approved proposal is violated, the regulatory authority that issued the associated permit is responsible for enforcement.

ON-SITE VERSUS COMPENSATORY MITIGATION APPROACHES

SEPA does not distinguish between on-site and compensatory mitigation.

FOREST PRACTICES ACT (CHAPTER 76.09 RCW)

BRIEF DESCRIPTION

The Forest Practices Act (FPA) regulates forest practices on 12 million acres of state-owned and public forest lands. The Forest Practice Board (title 222 WAC) developed forest practice rules based on the negotiated and science-backed forest management strategies that would ensure the protection of "covered aquatic species to the maximum extent practicable consistent with maintaining commercial forest management as an economically viable use of forestlands" [35].

The Forest Practice Habitat Conservation Plan (FPHCP) states how protection for Endangered Species Act (ESA) listed fish and riparian-dependent species will be achieved on the land regulated under the FPA. "Incidental Take Permits" were issued by the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS), which are responsible for the protection of the target species listed under the ESA, assuring the state that full implementation of the FPA would satisfy requirements of the ESA and protect those operating under the FPA from penalties as a result of "take of covered species" under the ESA.

Forest practice rules incorporate current fish protection standards in the rules adopted under chapter 77.55 RCW. Forest practice actions involving aquatic habitats are exempt from hydraulic permit requirements under the chapter 77.55 RCW.

CURRENT STANDARDS GOVERNING THE DETERMINATION OF NNL (I.E., METRICS USED TO DETERMINE NNL)

The standard of NNL is not mentioned in the FPA. The FPA was designed minimize the amount of take of covered species. The FPHCP requires the level of incidental take be estimated periodically. The FPHCP states:

> *"Estimating take for purposes of the FPHCP focuses on the number of habitat acres affected by the plan. The approach involves developing a hypothetical management strategy that it is assumed would have little if any measurable effects on species covered by the plan. This "minimal effects" strategy serves as a baseline for evaluating and comparing management under the FPHCP."*

Cumulative impacts of forest practices on the environment are reduced through a detailed adaptive management program, by utilizing SEPA reviews for forest practices which have a potential for a substantial impact on the environment, establishing minimum protection standards for all types of forest practice permits and alternative forest practice plans.

FPA HABITAT PRIORITIZATION/RANKING SYSTEM FOR MITIGATION

The FPA's focus on habitat protection for fish and riparian-dependent species, as well as water quality standards, results in a riparian and instream habitats being prioritized. Streams with fish habitat are provided more protections than non-habitat streams.

ENFORCEMENT OF FPA

WADNR enforces the forest practice rules under chapter 222-46 WAC. Compliance is the first tier of enforcement with stop work orders, notices to comply, and education. Enforcement actions escalate depending on success of compliance attempts up to and including a gross demeaner conviction, a fine between $100 and $1,000 or imprisonment for up to a year. Each violation and each day of the violation occurrence is constituted as a separate violation.

ON-SITE VERSUS COMPENSATORY MITIGATION APPROACHES

SEPA checklists and determinations are issued for forest practices that involve several specific conditions including unstable slopes, endangered species, forest practices meant for conversion rather than reforestation, and any watershed analysis. Chapter 222-10 WAC contains the determination standards for each category of forest practice subject to SEPA. Should proposed mitigation not adequately reduce the risk of significant adverse impacts identified in the final or supplemental environmental impact statement, then WADNR as the lead agency will disapprove the application or notification.

On-site or compensatory mitigation is not addressed within the FPA but may be inferred by reference to SEPA when certain application practices are proposed.

Table 1: Summary of NNL Legislation

Rule/Law						Enforcement/Monitoring/Metrics			Mitigation sequencing	
Law	**RCW/ WAC**	**Description**	**Jurisdiction**	**NNL Defined?**	**Standard**	**Methods**	**Metrics**	**Enforcement**	**Mitigation**	**Habitat prioritization/ ranking**
SMA	**90.58**	Prevents the inherent harm in an uncoordinated and piecemeal development of the state's shorelines	ECY	No	"Contemplates protecting adverse effects…while protecting rights of navigation and corollary rights incidental."	Planning at program level and permitting at project level.	Subjective assessment by Ecology of proposed planning regulations and processes protection of existing conditions during local government planning actions. Subjective assessment by local governments of project-level proposals based on assumptions presented by reports supplied by project proponent.	In rules only, not law.	In rules only, not law.	None mentioned.
SMP	**173-26**	Translates the broad policies of the SMA into standards for regulating shoreline uses	ECY	Yes	"Assure, at minimum, no net loss of ecological functions."	Mitigation sequencing for all development Buffers/ setbacks Restoration Plan.	Must consider, at a minimum, habitat, water quality, and water quantity. Additional indicators of changes in function are suggested but not required.	Local governments are expected to have a compliance strategy and to periodically evaluate cumulative impacts of NNL, but no particular structure nor process is required. Restoration Plan implementation is not required.	Follows SEPA requirements: *Avoid* *Minimize* *Rectify* *Reduce or eliminate* *Compensate* *Monitor*	Suggested objective of Restoration Plan includes priority restoration sites for restoration or compensatory mitigation.
SEPA	**43.21**	Ensures that environmental values are considered during decision making by state and local agencies	Lead Agency	No	43.21C.010(2): "to promote efforts which will prevent or eliminate damage to the environment and biosphere…"	Require assessment of "significant impact" and a threshold determination for gov't decisions	43.21C.240 Determined by local government. …"considers the specific probable adverse environmental impacts of the proposed actions and determines that these specific impacts are adequately addressed by the development regulations or other applicable requirements of [comprehensive plans and other regulations]"	Agency can deny government planning action if the action or proposal would result in significant adverse impacts and cannot be mitigated. Project action enforcement is delegated to local governments. Local governments have ability to create their own enforcement processes to ensure intent of the law	See Rule below.	None mentioned.
SEPA Rules	**197-11**	SEPA implementation rules	Lead Agency	No	"Adverse environmental impacts."	See law above.	See law above.	See law above.	197-11-768: *Avoid* *Minimize* *Rectify* *Reduce or eliminate* *Compensate* *Monitor*	None mentioned.
GMA	**36.70A**	Provides for growth while protecting natural resource lands and critical areas	Commerce	No	"Conservation" of habitat, the environment, productive forest, and agricultural lands, along with conserving natural resource-based industries.	Planning at program level and permitting at project level.	Undefined.	Growth Management Hearings Board.	See Rule below.	None mentioned.

Rule/Law						Enforcement/Monitoring/Metrics			Mitigation sequencing	
Law	**RCW/ WAC**	**Description**	**Jurisdiction**	**NNL Defined?**	**Standard**	**Methods**	**Metrics**	**Enforcement**	**Mitigation**	**Habitat prioritization/ ranking**
Comprehensive Plans and Development Regulations	**365-196**	GMA implementation rules	Commerce	Yes	WAC 365-196-830(4): "Development regulations may not allow a net loss of the functions and values of the ecosystem that includes the impacted or lost critical areas." WAC 365-196-830(8)(a): "When developing alternative means of protection, counties and cities must assure no net loss of functions and values and must include the best available science."	Planning at program level and permitting at project level.	Undefined.	Agency can deny government planning action if the action or proposal would result in significant adverse impacts and cannot be mitigated. Project action enforcement is delegated to local governments. Local governments have ability to create their own enforcement processes to ensure intent of the law.	Follows SEPA requirements: *Avoid* *Minimize* *Rectify* *Reduce or eliminate* *Compensate* *Monitor*	"Special Consideration" for protection and enhancement of anadromous fish habitat when developing regulations, protective measures, or requiring compensatory mitigation.
Construction Projects in State Waters **Hydraulic Code Rules**	**77.55** **220-660**	Hydraulic Code and Hydraulic Permit Applications	WDFW	No Yes	Protection of fish life. No net loss to fish life and their habitat.	Project level permitting, enforcement.	Conditions of habitat before project construction to anticipated condition after project completion. If found to result in temporal loss, uncertainty of performance, loss of habitat quantity, or difference in habitat function/value found, then mitigation required via sequence.	Well defined sequence from education to criminal violation; enforced by WDFW.	WAC 220-660-080: defines mitigation as “sequentially avoiding impacts, minimizing and rectifying unavoidable impacts, and compensating for remaining impacts"	None mentioned.
Model Toxics Control Act	**70A-305**	Directs the investigation, cleanup, and prevention of sites that are contaminated by hazardous substances	Ecology	No	"No adverse effects" to biological resources.				None mentioned.	None mentioned.
MTCA Cleanup Regulations	**173-340**	Guides upland and groundwater cleanup	Ecology	No	Protection from "significant adverse effects" that impair reproduction, growth, and survival of species.	Compliance monitoring.	173-340-410: Chemical constituents, biological testing, physical parameters.	Ecology enforces based when monitoring plan standards being exceeded. Cleanup plans are initiated, and permit requirements are adjusted.	Mitigation sequencing not mentioned. Cleanup plans are initiated to restore conditions.	None mentioned.
Sediment Management Standards	**173-204**	Guides fresh and marine water cleanup	Ecology	No	Not to exceed chemical composition and biological effects criteria	Compliance monitoring.	173-204-400: Water discharge characteristics compared to receiving water composition.	Ecology enforces based when monitoring plan standards being exceeded. Cleanup plans are initiated, and permit requirements are adjusted.	Mitigation sequencing not mentioned. Cleanup plans are initiated to restore conditions.	None mentioned.

APPENDIX C. INTERVIEW GUIDE

Interviewee Name (Affiliation):	
Interviewer Name:	
Date:	

INTRODUCTION

Thank you for meeting with us today. As you may know, the Washington Department of Fish and Wildlife has been tasked by the Legislature with assessing how to incorporate a Net Ecological Gain standard into state land use, development, and environmental laws and rules to achieve a goal of better statewide performance on endangered species recovery and ecological health.

As part of this process, we are here as part of a consulting team soliciting input from local governments, tribes, ports, and other subject matter experts throughout the report development process, and WDFW has identified you as a key partner in this conversation.

The 1-1 interviews are the first step in the stakeholder engagement process which will also include two roundtable discussions later this fall. Today's interview will be approximately 30 minutes and we have 8 questions to ask you during this time.

We will be taking detailed written notes to ensure we capture what you say and may occasionally pause to write things down or ask you to repeat something. I also want to note that your answers will be kept anonymous.

Thank you again for your willingness to share your perspective on the Net Ecological Gain standard.

Before we begin, are there any questions you want to ask related to the interview process or goal?

INTERVIEW QUESTIONS

NO NET LOSS – OUR EXISTING STANDARD

Before we dive into Net Ecological Gain, we'd like to discuss No Net Loss (NNL) which is the existing standard that is embedded in WA land use, development, and environmental laws and rules.

1. What is working with NNL? What isn't working with NNL?

ESTABLISHING A BASELINE UNDERSTANDING OF NEG

Now we are shifting to the topic of Net Ecological Gain. We've got two sets of questions related to NEG. The first set of questions focus on your overall understanding of NEG either as a policy framework or a concept. The second set of questions focus on implementation of NEG.

2. What is your current understanding of Net Ecological Gain? *This can be within the policy framework context or the concept behind Net Ecological Gain.*

IMPLEMENTATION OF NEG POLICY

Seeking to achieve Net Ecological Gain presents opportunities and challenges in terms of its implementation. The next few questions will focus on gaining your perspective on implementation of Net Ecological Gain policies related to land use, development, or environmental rules and laws.

3. What are the biggest near-term opportunities to implement a NEG policy?

4. What are the biggest barriers to implement a NEG policy?

5. Do you see a role in integrating salmon recovery and land use planning to achieve net ecological gain?

6. What are some components of the policy that you would need to see to support a policy on Net Ecological Gain?

7. Do you think there should be different standards in implementing NEG policies for private and public lands/projects? If so, what?

CLOSING

Thank you so much for your time and insights into the concept of Net Ecological Gain. Before we end,

8. Is there something you'd like to add that we haven't asked yet?

Please do not hesitate to reach out with follow-up questions or comments you have about any of the topics we covered today.

APPENDIX D. WSAS 2022 REPORT ON NET ECOLOGICAL GAIN

WASHINGTON STATE
Academy of Sciences
Science in the Service of Washington State

Report on Net Ecological Gain

Prepared for the Washington State Department of Fish and Wildlife

July 2022

WSAS Committee on Net Ecological Gain

Seattle, WA

About the Washington State Academy of Sciences

The Washington State Academy of Sciences (WSAS) was requested by Governor Christine Gregoire and authorized by the Washington State Legislature in 2005. WSAS is a not-for-profit organization of Washington State's leading scientists and engineers dedicated to serving the state. Members are elected by their peers for outstanding contributions to research. Dr. Roger Myers is the President.

Formed as a working academy, not an honorary society, WSAS is modeled on the National Academies of Sciences, Engineering, and Medicine. WSAS provides independent, objective analysis and advice to the State and conducts other activities to solve complex problems and inform public policy decisions. WSAS also encourages education and research, recognizes outstanding contributions to knowledge, and increases public understanding in matters of science and engineering.

Learn more at www.washacad.org

This activity was supported by Contract No. 21-18220 from the Washington Department of Fish and Wildlife. Any opinions, findings, conclusions, or recommendations expressed in this publication do not necessarily reflect the views of the organization or agency that provided support for the project.

Committee on Net Ecological Gain:

Ronald Thom, *Chair*, Pacific Northwest National Laboratory (emeritus), WSAS President (2018-2020)
Heather Burpee, University of Washington
Ken Currens, Northwest Indian Fisheries Commission
Heida Diefenderfer, Pacific Northwest National Laboratory and University of Washington
Tim Essington, University of Washington
Anand Jayakaran, Washington State University
Mary Ruckelshaus, Stanford University
Katharine Wellman, Northern Economics, Inc. (retired)

WSAS Staff:

Donna Gerardi Riordan, Executive Director
Yasmeen Hussain, Program Officer
Amanda Koltz, Program Officer
Katie Terra, Science Writer

Washington State Academy of Sciences
901 5th Avenue, Suite 2900
Seattle, WA 98164
wsas.programs@washacad.org
www.washacad.org
206.219.2401

This document contains two reports in their entirety, which should be cited separately.

Suggested citation for introduction only: Washington State Academy of Sciences. (2022). Report on Net Ecological Gain. Seattle, WA: WSAS, pp. 1-63.

Suggested citation for Chapter 1: Washington State Academy of Sciences. (2022). Net Ecological Gain Definition, Goals, and Objectives. Seattle, WA: WSAS, pp. 1-15.

Suggested citation for Chapter 2: Washington State Academy of Sciences. (2022). Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring. Seattle, WA: WSAS, pp. 1-37.

Contents

INTRODUCTION

The Washington Department of Fish and Wildlife (WDFW) requested that the Washington State Academy of Sciences (WSAS) inform its work on the development of a net ecological gain (NEG) standard for public projects as part of the response to a proviso contained within Engrossed Substitute Senate Bill 5092 (2021).

WSAS convened a committee of scientific and technical experts to conduct this work. The scope of work for the committee was to develop a definition, goals, objectives, and performance metrics for the net ecological gain standard, assess how sufficient existing standards have been in achieving endangered species recovery, and make recommendations about monitoring and indicators for no net loss and net ecological gain. The scope of work was divided into two report chapters.

The committee completed two separate report chapters and transmitted them to WDFW. This document contains the two reports in their entirety; the content of the chapters should still be cited separately.

The first report chapter synthesizes the committee's perspectives on a proposed definition for net ecological gain, considerations for defining net ecological gain, and goals and objectives for achieving net ecological gain. The committee interpreted the charge as producing a definition of net ecological gain that would be relevant to Washington State, as well as providing examples of specific goals and objectives for how the definition should be applied to ecosystems or projects.

The second report chapter focuses on (1) assessing whether and why existing standards of ecological protectiveness, such as no net loss (NNL) standards, have been sufficient or insufficient to protect ecological health and achieve endangered species recovery and (2) providing recommendations for developing: performance metrics for the NEG standard, indicators to assess NNL and NEG, establishment of a monitoring system, and incorporation of climate science predictions into NNL and NEG standards. The committee also presents suggestions for subsequent activities that may facilitate next steps toward successful implementation of NEG in Washington State.

The committee hopes that this report serves as a useful reference for Washington State agencies, tribes, and legislators.

WSAS COMMITTEE ON NET ECOLOGICAL GAIN

Ronald Thom (*Chair*)

Dr. Ron Thom is Staff Scientist Emeritus in the Coastal Sciences Division of the Pacific Northwest National Laboratory, where he led the Coastal Ecosystem technical group at the Marine Sciences Laboratory until retirement. His research is focused on ecosystem restoration and adaptive management in coastal and estuarine ecosystems. Dr. Thom has directed approximately 200 multidisciplinary ecological studies and authored five book chapters, around 100 peer reviewed papers, and hundreds of reports. He also served on numerous professional committees and panels; including chairing the Technical Advisory Committee of the EPA's Puget Sound Estuary Program, serving on the Expert Regional Technical Group to restore ecosystem health and salmon in the Columbia River Estuary Ecosystem Restoration Program, being a member of an EPA Science Advisory Board panel to review the Great Lakes Restoration Program, and serving on a National Academy of Science, Engineering, and Medicine panel on recovery of the Gulf of Mexico coastal ecosystem following the 2010 Deepwater Horizon oil spill. Dr. Thom was appointed by the Washington Governor to the Northwest Straits Commission and serves as a Senior Science Advisor to the Puget Sound Partnership. Dr. Thom is an elected Fellow in the American Association for the Advancement of Science. He was elected to the Washington State Academy of Sciences and was on the Board of Directors for several years before serving as president of the Academy from 2018-2020. Dr. Thom has a PhD from the University of Washington School of Aquatic and Fishery Sciences.

Heather Burpee

Heather Burpee is a Research Associate Professor and the Director of Education and Outreach at the University of Washington's Integrated Design Lab. She is an expert in high-performance buildings that reduce energy and promote healthy indoor environments. Her research includes tracking health impacts and synergies between environmental quality, natural systems, sensory environments and energy efficiency. Some of her efforts in this area include creating roadmaps and protocols for performance-based design, tracking, and auditing for hospitals, higher education, and commercial buildings. Ms. Burpee consults regularly with design teams to implement high-performance buildings and she also develops curriculum and other educational opportunities for various groups on this topic. Ms. Burpee has a Master of Architecture degree from the University of Washington College of Built Environments.

Ken Currens

Dr. Ken Currens is the manager of the Conservation Planning Program for the Northwest Indian Fisheries Commission. He has expertise in population genetics, ecology, phylogeography, conservation strategy and planning, risk assessment, and endangered species. In his current role, Dr. Currens coordinates and develops annual and long-term research and conservation plans for Western Washington Indian Tribes

and serves as the technical liaison for the tribes with the federal government, state agencies, and non-governmental organizations on conservation issues. He also contributes to endangered species and ecosystem recovery planning and manages a research program to provide support for recovery planning of fish species listed under the Endangered Species Act. Dr. Currens previously served as the Science Director for the Puget Sound Partnership. He has a PhD in population genetics, fishery science, and statistics from Oregon State University.

Heida Diefenderfer

Dr. Heida Diefenderfer is an Earth Scientist with the Energy and Environment Directorate of the Pacific Northwest National Laboratory, at PNNL's Marine and Coastal Research Lab in Sequim, WA. A restoration ecologist, Dr. Diefenderfer conducts long-term and large-scale ecological and geomorphological research across a variety of terrestrial and aquatic ecosystems with a focus on wetlands, forests, marshes, and submerged vegetation. This work spans several areas of applied research, including spatial planning, resilience, climate adaptation, endangered species recovery, and blue-carbon experimentation and field data development for Earth systems modeling. Dr. Diefenderfer's ongoing work includes research and adaptive management for the recovery of Endangered Species Act-listed fish as mitigation for energy infrastructure, and evidence-based assessment of large-scale ecosystem restoration. She also serves as chair of the Washington Natural Heritage Advisory Council. Dr. Diefenderfer received her PhD in Forest Resources and Ecosystem Analysis from the University of Washington and is a Faculty Fellow at the UW College of the Environment.

Tim Essington

Dr. Tim Essington is a Professor at the School of Aquatic and Fishery Sciences and former Director of the Center for Quantitative Sciences and the Interdisciplinary Quantitative Ecology & Resource Management Graduate Program at the University of Washington. His research uses quantitative approaches to understanding predator-prey and food web interactions among fish and other organisms in marine, estuarine, and freshwater habitats. He also investigates the conservation benefits of fisheries policy tools and how to apply risk-based approaches to decision making. Dr. Essington has served as an Editor for several scientific journals and as a member of multiple scientific advisory boards and panels, including for the Marine Stewardship Council, Puget Sound Partnership, Washington Marine Spatial Planning, the Ecosystem Science and Management Working Group with NOAA, and the National Center for Ecological Analysis. He was a Pew Marine Conservation Fellow in 2011, was awarded the Oscar Sette Award by the American Fisheries Society in 2017 for Outstanding Marine Fishery Biologist, and was appointed as an American Fisheries Society Fellow in 2021. He was awarded the UW College of the Environment Outstanding Research and Outstanding Teaching awards in 2018 and 2021, respectively. He held the Wakefield Endowed Professorship in Ocean and Fishery Sciences between 2008-2013 and again from 2021-2026. Dr. Essington has a PhD in Zoology from the University of Wisconsin-Madison.

Anand Jayakaran

Dr. Anand Jayakaran is a Professor with Washington State University based at the Puyallup Research and Extension Center. His role is to meet education and research needs in a region experiencing the impacts of rapid urbanization, a changing climate, and increasingly diverse communities. He develops strategies to manage water resources using Green Stormwater Infrastructure and ecological engineering principles. Ani's program aims to positively influence stormwater management decisions that impact traditionally underserved Black, and Indigenous communities, people of color, and lower-income groups. He holds bachelor's and master's degrees in Civil Engineering, a doctoral degree in Agricultural & Biological Engineering, and is a professionally licensed civil engineer in Washington.

Mary Ruckelshaus

Dr. Mary Ruckelshaus is the Managing Director of the Natural Capital Project and a consulting professor at Stanford University. Prior to her current position, she led the Ecosystem Services Program at NOAA's Northwest Fisheries Science Center and was an assistant professor of biological sciences at Florida State University. Her recent work focuses on developing ecological models to estimate the flow of ecosystem services and human wellbeing under variable management regimes. Dr. Ruckelshaus serves on the science council of The Nature Conservancy, the Board of Directors for the Wild Salmon Center, and on the Council of Advisers for Salish Sea Expeditions. She is also a member of the United Nations' High Level Panel on Building a Sustainable Ocean Economy and the U.S. Ocean Research Advisory Panel. Dr. Ruckelshaus is a past chair of the Science Advisory Board of the National Center for Ecological Analysis and Synthesis (NCEAS) and was previously Chief Scientist for the Puget Sound Partnership. Dr. Ruckelshaus has a PhD in Botany from the University of Washington.

Katharine Wellman

Dr. Katharine Wellman recently retired from Northern Economics, Inc., where she was a Senior Economist conducting applied research on a variety of topics related to the valuation of marine ecosystem goods and services and the economics of marine ecosystem restoration. Her work also considered the human dimension of ecosystem service recovery and associated indicators of human well-being. Dr. Wellman has served on the Puget Sound Partnership Science Panel and the Task Force on Southern Resident Killer Whale Recovery. She is currently a member of The SeaDoc Society Science Advisory Board and on the Board of Directors of the Schoodic Institute at Acadia National Park. She currently serves on the Board of the Northwest Maritime Center, and was previously the President of the Board of the Salish Sea Expedition. Dr. Wellman holds a PhD in Natural Resource Economics and a Masters of Marine Affairs from the University of Washington.

WASHINGTON STATE
Academy of Sciences
Science in the Service of Washington State

Net Ecological Gain Definition, Goals, and Objectives

Prepared for the Washington State Department of Fish and Wildlife

April 2022

Net Ecological Gain Definition, Goals, and Objectives

Table of Contents

I. INTERPRETATION OF CHARGE

The Washington Department of Fish and Wildlife (WDFW) requested that the Washington State Academy of Sciences (WSAS) inform its work on the development of a net ecological gain (NEG) standard for public projects as part of the response to a proviso contained within Engrossed Substitute Senate Bill 5092 (2021). WSAS convened a committee of scientific and technical experts (referred to in this document as "the committee") to conduct this scope of work. The full scope of work for the committee was to develop a definition, goals, objectives, and performance metrics for the net ecological gain standard, assess how sufficient existing standards have been in achieving endangered species recovery, and make recommendations about monitoring and indicators for no net loss and net ecological gain.

The committee interpreted the charge as producing a definition of net ecological gain relevant to Washington State, as well as providing examples of specific goals and objectives for how the definition would be applied to ecosystems or projects. The committee was informed that watersheds are of particular interest to WDFW, which has a goal of achieving resilient, self-perpetuating, viable ecosystems and biodiversity across the state. Similarly, the committee interpreted the charge as identifying performance metrics that are relevant across the state, although it is expected that these may vary according to ecological community types. The committee aimed to maintain the level of detail and rigor allowed by the science while meeting the task set out by WDFW by developing a report comprising two chapters.

This first report chapter synthesizes the committee's preliminary perspectives—developed since its first meeting on November 15, 2021—on a proposed definition for net ecological gain, considerations for defining net ecological gain, and goals and objectives for achieving net ecological gain. The subsequent chapter focuses on recommendations for metrics, monitoring, and indicators for net ecological gain standards and provides an assessment of no net loss.

II. DEFINITION OF NET ECOLOGICAL GAIN

Preamble

Earth's natural systems have been profoundly affected by human activities, particularly over the past century when human population growth and industrialization (Figure 1) have transformed terrestrial and aquatic ecosystems. These transformations have often led to habitat loss and degradation for species that have cultural or economic roles recognized by humans. The balance between population and economic growth and management of ecosystem health is complex and dynamic. Specifically, as a key part of coupled human-natural systems, people are agents of change who affect the biophysical condition of ecosystems but also simultaneously (1) require functional ecosystems to provide life-supporting services that affect our well-being and (2) alter our behavior in response to ecosystem dynamics.

Net ecological gain (NEG) must be viewed in this larger context. In many cases, applications of NEG may occur in ecosystems that are already highly impacted and degraded by prior human activity. Thus, it may not always be feasible to return these ecosystems to states that resemble those of a century ago. Additionally, the effects of atmospheric greenhouse gases on climate, hydrologic patterns, and ocean chemistry will continue to grow, even under the most optimistic scenarios (Pörtner et al., 2022), meaning that ecosystems require the capacity to absorb or adapt to those effects without undergoing irreversible or deleterious transformation.

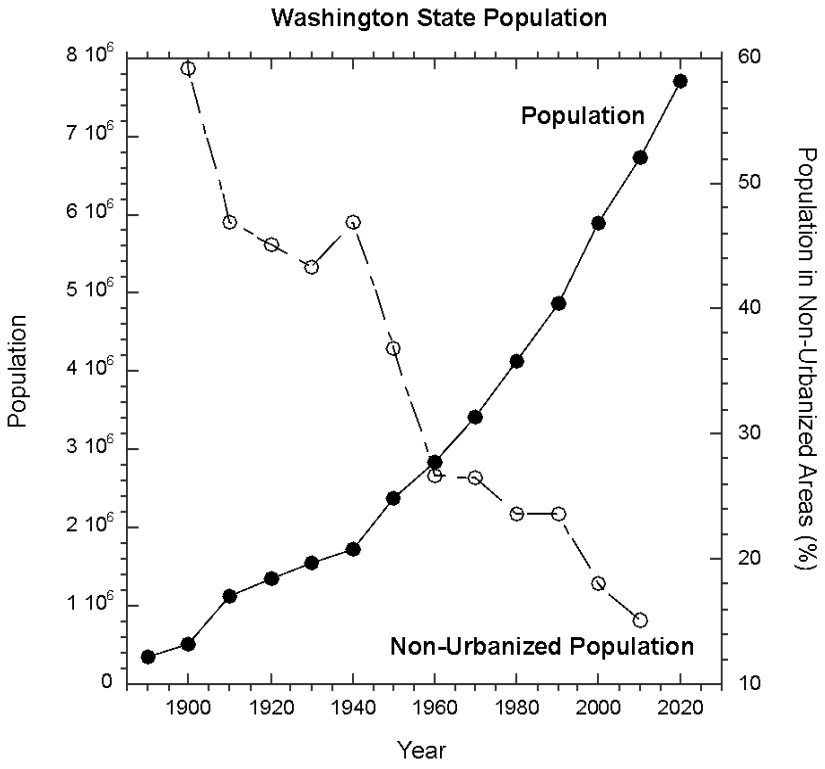


Figure 1. *Between 1890 and 2020, the population of Washington State grew from approximately 360,000 to 7.7 million people, of whom more than 84% (about 6.6 million) now live in urban areas (Iowa Community Indicators Program, 2022; U.S. Census Bureau, 2010). The population is expected to continue growing over the next decade. With continued urbanization, suburbanization, and sprawl come associated loss and degradation of natural habitats in those areas and the ecosystem services they provide. Net ecological gain is intended to buffer these changes.*

Conceptually, one can view NEG in the context illustrated in Figure 2. Although the health of many ecosystems is degraded compared to historic baselines, thoughtful infrastructure design and other development in terrestrial and aquatic systems can still lead to improvements in ecosystem status. Moreover, we judge these improvements based on a comparison to a theoretical future in which such developments and designs are not implemented.

While conceptually simple, deriving practical and specific guidelines for implementing net ecological gain is difficult in practice. This is because social-ecological systems are inherently complex and affected

by a variety of human activities and sociopolitical drivers. These complexities have led to frequent reformulations within the scientific community regarding how terms like ecosystem health and ecosystem integrity are defined.

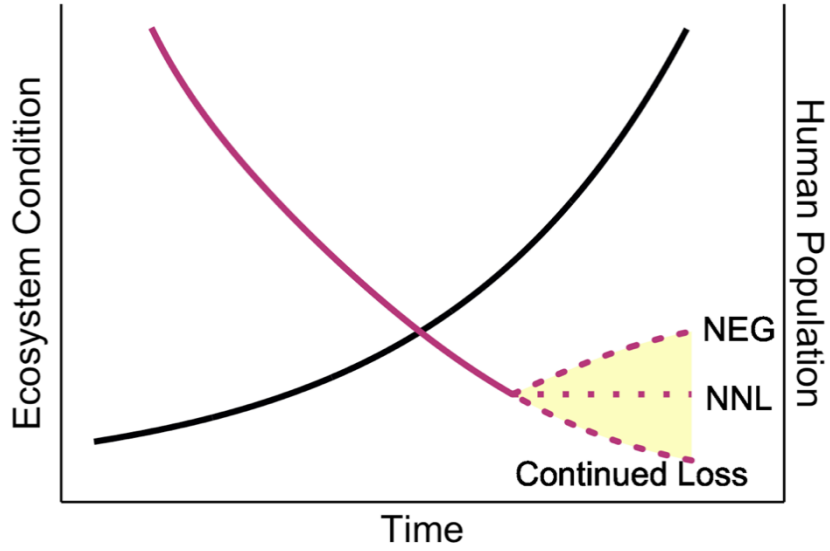


Figure 2. *Conceptual relationship between changes in population and ecosystem condition and the corresponding effects of implementing NEG or no net loss (NNL) vs. continued degradation of the ecosystem condition under current scenarios. Human population is depicted in black; ecosystem condition is in purple. This conceptual figure is based on population and ecosystem trends identified by the Washington Biodiversity Council (2007). Note that the human population is no longer increasing exponentially in the U.S. but shifting consumption choices may have similarly negative ecosystem impacts.*

Three key characteristics or elements of ecosystems must be recognized to frame definitions of net ecological gain:

- **Ecosystem**: The collection of fauna and flora and the key physical, biological, and chemical drivers that influence them in a specific location
- **Ecosystem Structure**: The biological, physical, and chemical constituents, how these constituents are organized and linked to one another, and the size of the ecosystem
- **Ecosystem Processes**: Feedbacks among ecosystem structure and composition occur through a series of processes, such as nutrient or water cycling, many of which benefit people through the production of goods and services.

The combined dynamic interaction of ecosystem components, structure, and processes creates the emergent properties of ecosystems that are relevant for ecosystem protection and restoration and that can maintain benefits to people. Some common emergent properties include:

- Biodiversity, defined as "the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part" (National Infrastructure Commission, 2021; Wilson, 1988)
- Resilience and adaptive capacity—the ability to cope with and adapt to changing conditions (e.g., climate change, sea level rise, wildfire, flooding, water quality)
- Productive habitat for culturally or economically valuable species
- Ecological regulation of air, soil, and water quality

Due to the variety of situations under which NEG could be considered or implemented in the future, any definition of net ecological gain that attempts to be applicable in all situations would risk being cumbersome, overly general, and not necessarily appropriate to guide decision-making. For that reason, the committee chose to define net ecological gain in terms that are specifically applicable to Washington State.

Definition

WSAS convened a committee of scientific experts to review the existing science and develop a definition of net ecological gain. The committee constructed this definition primarily from two existing definitions of NEG (Apex Goal Task Force, 2020; National Infrastructure Commission, 2021), also articulating additional components and considerations.

The proposed definition for NEG in the state of Washington is as follows:

> **Net ecological gain means that after development, there is an increase in biodiversity or resilience that improves the delivery of valued ecosystem functions in the affected ecosystem.**

Applying this definition of NEG will be contextual in nature and depend on the characteristics of the given social-ecological system. External considerations, such as the type of ecosystem (e.g., marine, nearshore, freshwater, prairie, shrub steppe—see Rocchio & Crawford, 2011), biogeographic region, and legacy conditions from human development and natural catastrophes shape both the biophysical and human conditions of the ecosystem. For any given intervention, the priority ecosystem objectives, attributes, and current and likely future stressors (e.g., climate impacts) will also vary. For example, ecosystem composition, structure, processes, and functions will vary depending on the type of ecosystem. These elements will, in turn, produce different kinds of goods and services that affect human well-being. There is also a wide variety of attributes that may be enhanced as part of NEG. Table 1 lists examples of such attributes, categorized by ecosystem element or property. Depending on values and the institutions where development is proposed, different individual and collective choices need to be considered for NEG to succeed. Likewise, explicit consideration of the spatial and temporal extent of post-construction restoration, maintenance, and monitoring will be necessary.

Several assumptions are also implicit within this proposed definition of NEG. First, some level of ecosystem degradation is coincident with meeting the demands created by humanity, such as the needs

for sustenance and materials (Locke et al., 2021). However, ecosystem degradation ultimately results in reduced ecosystem services, thereby harming the people who rely on them. Ecosystem stewardship that aims to minimize degradation and increase key ecosystem attributes through recovery planning, conservation efforts, and restoration activities will facilitate the realization of NEG as defined in this report.

Table 1. *Examples of some key components or attributes of socio-ecological systems within Washington State that may be enhanced under NEG*

Ecosystem element or property	**Attributes that may be enhanced**
Ecosystem structure	● area/spatial extent ● spatial structure (e.g., continuity, connectivity) ● temporal structure ● habitat heterogeneity and complexity ● composition (e.g., native species abundance and distribution)
Biodiversity	● the number and relative abundance of viable species ● population status and trends for native flora, fauna, and fungi relative to historical conditions ● genetic diversity (including varieties) ● diversity of communities and ecosystems ● conservation and/or prevention of local extinction of native species
Ecosystem processes	● hydrology and water cycles ● nutrient cycling ● fluxes of mineral and organic materials ● primary and secondary productivity ● decomposition ● habitat formation ● species interactions ● species movements ● disturbance regimes
Ecosystem functions and services	● recreation ● flood and erosion regulation ● water provision and regulation ● distributed stormwater and runoff management, especially via green stormwater infrastructure ● elimination, reduction, or mitigation of environmental stressors, such as toxins, pollutants, or non-native species, including pollution filtration processes that reduce pollutants to downstream water bodies ● food and fiber production and sovereignty ● pollination ● soil health ● regulation of infectious agents and pests ● climate regulation through carbon storage and sequestration ● cultural and spiritual interactions and benefits ● treaty rights ● added green space or urban greening that provides physical and mental health benefits, especially for under-resourced communities and other vulnerable groups

	● promotion of equity and protection of human well-being through livelihoods, economic returns, community diversity, and sense of place ● other ecosystem processes that provide goods and services that contribute to economies, satisfaction of human needs, and health, either directly or indirectly
Ecosystem resilience	● ability of the ecosystem, including urban ecosystems, to absorb disturbances and reorganize to maintain critical functions ● ability of the ecosystem, including urban ecosystems, to withstand shocks and stresses and recover from them so that the system does not surpass irreversible thresholds

Net Ecological Gain and the Mitigation Hierarchy

The goal of net ecological gain falls within a hierarchy of action steps—known internationally as the mitigation hierarchy—that is intended to limit the impacts of development on biodiversity and ecosystem functions relative to a predetermined reference condition (Business and Biodiversity Offsets Programme, 2018; Maron et al., 2018). Understanding the theoretical and practical challenges learned from use of the mitigation hierarchy over the last 15 years is critical for developing a net ecological gain standard for Washington State.

Sequentially, the action steps of the mitigation hierarchy are applied to evaluate a proposed activity or intervention and relocate or redesign the intervention so that it can: 1) avoid, 2) minimize, 3) remediate, and/or 4) offset negative impacts on ecosystems and the net benefits they provide (Figure 3; Arlidge et al., 2018; Wende et al., 2018). Although there is often more interest from developers in focusing on the latter steps, the conservation benefits from the first steps are expected to be greater than those associated with the subsequent steps because uncertainty of success increases as the steps progress (Arlidge et al., 2018).

The first of the four steps of the mitigation hierarchy—avoid—focuses on assessing impacts prior to project design and development and selecting an alternative site for the development with fewer potential impacts (Phalan et al., 2018). Impacts to biological, ecological, or social elements that are deemed irreplaceable or that will require long restoration times (e.g., to endangered endemic species, iconic wilderness, unique archaeological sites, fragile coral systems) by definition cannot be offset to provide net gain because gains somewhere else are not comparable in type or amount (Arlidge et al., 2018; however, see discussion on comparability in Pope et al., 2021). The second step—minimize—involves using the most environmentally friendly design or construction practices available. The third step—remediate—emphasizes replacing or remedying the loss of biodiversity and ecosystem functions at the same location of the development or project. Finally, the fourth step—offset—involves improvement in biodiversity and ecosystem functions in another location that creates positive impacts that are equal to or greater than the residual impacts not addressed by the first three steps. Without offsets, net gain is generally impossible because not all impacts can be addressed by the first three steps. Offsets are accomplished either by protecting against an anticipated loss at another location through the removal of threats or by enhancing and restoring an already degraded location (Maron et al., 2012). Offsets are the most uncertain and controversial step because they require the assumption that impacts at a site can be accurately measured and appropriately balanced by actions elsewhere (Maron et al., 2016).

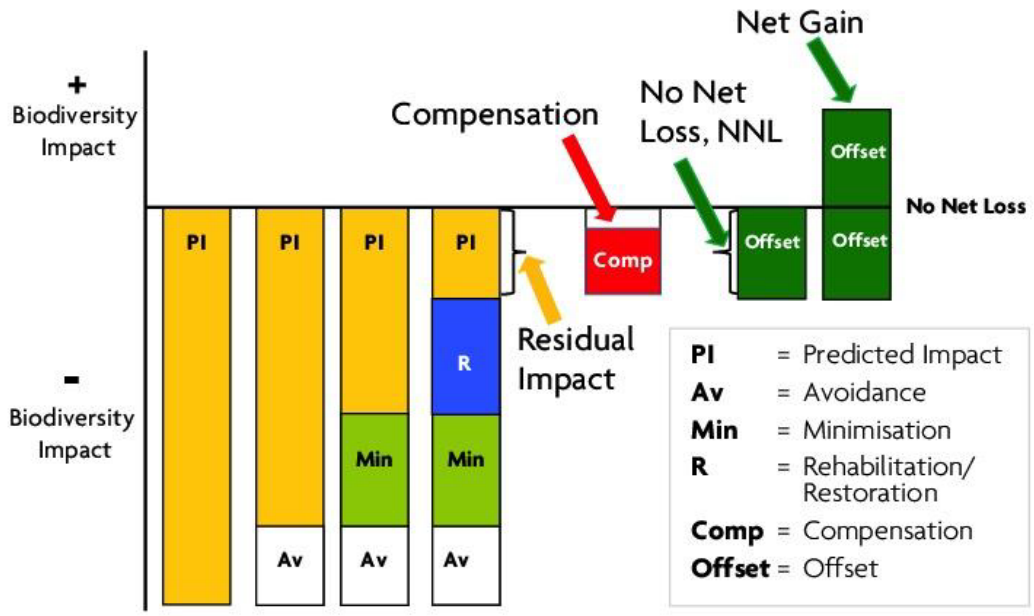


Figure 3. *Steps of the mitigation hierarchy for biodiversity impacts leading to net gain (Business and Biodiversity Offsets Programme, 2018, adapted from Rio Tinto and Govt. of Australia)*

The theoretical and practical challenges to successfully implementing the mitigation hierarchy have been well described elsewhere (e.g., Arlidge et al., 2018; Bull et al., 2014; Moilanen & Kotiaho, 2018; Tallis et al., 2015). Many of these challenges are associated with failure to resolve conceptual issues, inappropriate implementation of the hierarchy, inadequate monitoring, inequitable distribution of impact and offset, and lack of compliance. Two key issues deserve emphasis in a discussion of the mitigation hierarchy and its relevance to net ecological gain. One is the choice of reference scenarios for evaluating success because the concept of net gain is meaningless unless it is specified relative to alternative possible scenarios. Developing and agreeing on these scenarios is challenging, however, due to uncertainties associated with making projections and opportunities for gaming outcomes (Ruhl & Salzman, 2011). The other key issue is the importance of setting targets and monitoring outcomes. In this case, choosing appropriate metrics to ensure net gain is achieved is a critical and context-specific step. Metrics need to be 1) sensitive and predictably responsive to anticipated development impacts, 2) informative at different spatial scales, 3) feasible to monitor, and 4) cost effective. These topics will be addressed in more detail in the subsequent chapter by the committee.

III. CONSIDERATIONS FOR IMPLEMENTING NET ECOLOGICAL GAIN

The implementation of the proposed NEG definition requires an expanded operational definition to specify the attributes of the system that will be improved. The committee recommends considering the following factors to promote clarity and successful implementation of NEG.

Level of Specificity

The definition must be specific enough to readily address unique individual ecosystems, yet broad enough to be operationalizable for a wide range of diverse ecosystems and contexts across the state. Implementation of the definition must also encompass the built environment and address various aspects of human health and well-being, including economic and cultural consequences, physical and mental health, environmental justice, and intergenerational equity (Díaz et al., 2020).

Geographical Scale

The committee recommends a focus on NEG at the project level but urges that potential changes in the ecosystem attributes and services outlined in Table 1 also be considered within the context of the broader system (e.g., the watershed within which a site occurs and the body of water into which it discharges), which is likely subject to larger-scale processes affecting long-term NEG outcomes (Griffiths et al., 2019). Impacts to a particular site can affect other locations. Thus, implementation of a net ecological gain standard must include an integrated assessment of how individual sites fit into overarching ecosystems and landscapes, including how impacts of different projects could potentially interact with one another (Diefenderfer et al., 2021; National Academies of Science, Engineering, and Medicine, 2022).

Time Scale and Baseline Measurements

Effects of development or other interventions on a site may occur immediately or manifest well after the conclusion of a project. For this reason, monitoring by taking consistent measurements over time, including beyond the timespan of the project, is necessary to ensure that long-term gains result from implementation of the NEG standard. Implementing the NEG framework therefore requires identification of and accounting for potential prolonged human intervention and external resources to ensure key ecosystem processes are maintained. Further, the consideration of cumulative effects across time, including anticipated future effects–whether beneficial or detrimental–is crucial for ensuring successful NEG (Diefenderfer et al., 2021).

Based on findings from past practice (National Research Council, 2001) and the understanding of ecosystem response times (Carpenter & Turner, 2001), mitigation timeframes that are restricted to the duration of the activity will typically fail to advance ecosystem resilience. Rather, NEG requires that indicators be measured regularly against a baseline measurement from a specific point in time (Maron et al., 2021), ideally against the aforementioned reference condition. However, ecosystems are dynamic, so even some baseline measurements will have already been influenced by the widespread and historical impacts of human activity.

Notably, based on extensive documentation of impacts to date, researchers anticipate that climate change and the projected growth and consumption patterns of the human population will continue to accelerate impacts to ecosystems. These factors must be accounted for, and goals must be adjusted accordingly in instances where the aim is to restore a system (Centers for Disease Control and Prevention, 2021; Locke et al., 2021).

IV. GOALS AND OBJECTIVES FOR NET ECOLOGICAL GAIN

The committee articulated the following general goals for net ecological gain, each with corresponding objective(s) for desired outcomes. These intended outcomes would achieve improvements to the natural environment and fortify ecosystem resilience.

Sustain and Recover Biodiversity

Biodiversity is a key measure of an ecosystem's overall condition. To promote net ecological gain for biodiversity through the lens of enhancing ecosystem integrity, (1) the species diversity and genetic diversity of the biological community must be preserved or enhanced, (2) vulnerable species must be protected, and (3) viable populations must be maintained (Díaz et al., 2020; Stange et al., 2021). Washington contains an extensive array of ecosystems (Washington State Department of Natural Resources, 2022). Previous work has established methods to measure the ecological integrity of these ecosystems (Rocchio & Crawford, 2011; Rocchio et al., 2020a, 2020b). Some of these methods can also be applied to measure the progress of NEG during and after projects to ensure the protection and/or recovery of native species associated with impacted ecosystems.

Objective: Protect, conserve, restore, and enhance ecosystems to sustain biodiversity. Safeguarding biodiversity requires acknowledgement of the strong interconnections of life at all hierarchical levels of an ecosystem. It also calls for the articulation of required net outcomes and related methods of measurement pertaining to species populations, habitat ranges, and functions that are key to adaptation and persistence (Maron et al., 2021).

Protect and Enhance Natural Capital, Ecosystem Services, and Human Well-Being

Society relies on the natural environment for a variety of benefits essential to human survival, such as the provision of food, breathable air, and clean water. Species, habitats, and other ecosystem attributes constitute natural capital assets (Díaz et al., 2020). The flow of benefits from ecosystem structures and processes can be quantified by accounting for beneficiaries; some examples of this process may include identifying the number and demographic characteristics of people affected or calculating monetary values (e.g., avoided damages, livelihood support, food prices). Collectively, these ecosystem assets and flows are referred to as ecosystem services (National Infrastructure Commission, 2021).

Given the multifaceted relationship between humans and their natural surroundings, the well-being of humanity is intimately tied to ecosystem health. Thus, the concept of NEG extends beyond purely ecological implications to also include socioeconomic and human health considerations (Breslow et al., 2017; Griffiths et al., 2019). Economies from the global to local scale depend upon a wide variety of renewable and non-renewable resources that stem from natural capital (Locke et al., 2021). Additionally, two critical aspects of human well-being relate directly to ecological management: the ability to benefit from natural resources through both use and non-use values and the capability to thrive in one's surroundings (Breslow et al., 2017). For example, human physical health is affected by provision of air and water quality amid development projects, and mental health is affected by the amount of green space experienced. Both physical and mental health are key components of one's capacity to thrive in one's surroundings (Centers for Disease Control and Prevention, 2021).

Griffiths et al. (2019) proposed a "no worse-off principle" regarding the human health aspect of no net loss. According to this principle, the well-being of those affected by development projects must be prioritized as a component of NEG, with the outcome being equal to or better than their level of well-being prior to the project (Griffiths et al., 2019). Typically, underserved or impoverished groups are most affected by ecological loss, with wealthier members of the same community disproportionately benefiting through mitigation actions. It is important that those impacted by a project perceive that their well-being matches or exceeds what it was prior to the project. Further, special attention must be given to ensuring that vulnerable communities who may be disproportionately impacted are treated equitably and that effects on future generations are considered to promote intergenerational equity (Griffiths et al., 2019).

Objective: Maintain natural capital assets, which include components of the ecosystem composition such as habitat and species, so that they retain their ability to provide current or improved levels of ecosystem services and the resulting flows of benefits to people into the future.

Objective: Apply the mitigation hierarchy (which could include social compensation, for example) to ensure that affected communities emerge from the project "no worse-off" than they were before. Environmental justice and intergenerational equity are key considerations in determining fairness in social impacts (Griffiths et al., 2019).

Strengthen Ecosystem Resilience

By definition, a landscape may be composed of more than one ecosystem type. Activities at the project or site level that are incongruent with the overarching landscape can destabilize natural landscape-scale processes; therefore, it is critical to strengthen the resilience of ecosystem composition, structure, and processes at the ecosystem level. For example, increased resilience to natural disasters and human impacts can occur through ecosystem-based management and integrated landscape-scale planning.

Anthropogenic greenhouse gas emissions are another factor affecting resilience, with notable outcomes including dramatic increases in air and water temperatures, increased frequency of wildfires and floods, acidification of state waters, and loss of glacier and snowpack water reserves (Shukla et al., 2022). Revegetation and restricted degradation of ecosystems aid in reducing carbon emissions and thus support the mitigation of climate change impacts (Locke et al., 2021). Intact and restored ecosystems also can confer significant climate adaptation benefits through provision of ecosystem services, as described above. Because it affects all aspects of ecological integrity, from performance measurements to ecosystem and landscape resilience, climate change is an essential consideration in implementing the NEG standard. Urban ecosystems also have related resilience components within their own contexts (e.g., McPhearson et al., 2015).

Objective: Contextualize NEG efforts to the project site and larger scales to consider effects and the actions that are needed to confer resilience through larger-scale processes.

Objective: Foster greater ecosystem resilience by anticipating uncertainty around climate change impacts and incorporating expected impacts on the ecosystem into the design of mitigation and adaptation actions, including protection and restoration.

Objective: Protect against negative ecological impacts that result from safeguards against natural processes that are considered hazardous, such as flooding, wildfires, and landslides. Rather than attempts to prevent these natural processes, these occurrences must be accommodated and managed.

Objective: Protect and restore ecosystem-forming and maintaining processes (e.g., hydrology, sediment dynamics) that are impaired as a result of development projects.

Monitor and Record Best Practices

To continually improve the implementation of NEG, lessons learned must be captured and publicly disseminated according to best practices, such as the FAIR principles: Findability, Accessibility, Interoperability, and Reuse of digital assets (Wilkinson et al., 2016). This aspect of ecological management will significantly advance the ability of scientists and communities to contribute to increasing the success of future actions related to NEG. Such documentation requires a strong public commitment to structured approaches to compile and track project outcomes and findings, as well as a commitment to ongoing process improvement through continual implementation of best practices (Biber, 2011; Conservation Measures Partnership, 2020).

Objective: Compile and track the baseline measurements, subsequent periodic measurements, and observations or implications for future actions that emerge from these measurements.

Summary of Goals and Objectives

Table 2. *Summary of goals and corresponding objectives for net ecological gain*

Goal	Objectives
Sustain and Recover Biodiversity	● Protect, recover, and sustain native species biodiversity to enhance ecological integrity
Protect and Enhance Natural Capital, Ecosystem Services, and Human Well-Being	● Maintain and improve natural capital assets (e.g., habitats, species) so that they retain their ability to provide current or improved levels of ecosystem services and the resulting flows of benefits to people into the future ● Apply the mitigation hierarchy to ensure that affected communities emerge from the project “no worse-off” than they were before
Strengthen Ecosystem Resilience	● Contextualize NEG efforts to the project site and larger scales to consider effects and the actions that are needed to confer resilience through larger-scale processes ● Foster greater ecosystem resilience by anticipating uncertainty around climate change impacts and incorporating expected impacts on the ecosystem into the design of mitigation and adaptation actions ● Protect against negative ecological impacts that result from safeguards against natural processes that are considered hazardous, such as flooding, wildfires, and landslides ● Protect and restore ecosystem-forming and maintaining processes that are impaired due to development projects

Monitor and Record Best Practices for NEG	● Compile and track the baseline measurements, subsequent periodic measurements, and observations or implications for future actions that emerge from these measurements in a manner that is publicly accessible and usable for the long term

V. CONCLUSION

Net ecological gain is an approach aimed at reversing the human-associated degradation and loss of natural ecosystems and the species and services of those ecosystems. It recognizes that substantial human disturbance of ecosystems has occurred and will continue, while providing an approach that takes advantage of redesign and redevelopment to improve ecological functions, services, biodiversity, and resilience. Along with improving environmental conditions, realized NEG can improve human health and well-being. NEG is a simple concept but presents scientific, engineering, and human-based challenges. Having clear goals and objectives will guide implementation of an NEG standard. There are project examples of NEG in Washington State and internationally that demonstrate what can be achieved by creating strong operational definitions and following clearly outlined goals. The following chapter from the committee will focus on recommendations for metrics, monitoring, and indicators for a net ecological gain standard and provide an assessment of no net loss.

VI. REFERENCES

Apex Goal Task Force. (2020). *Apex Goal Task force on Target 1 "no net loss/net gain" meaning and principles*. A Global Goal for Nature. https://www.naturepositive.org/en/resources

Arlidge, W. N., Bull, J. W., Addison, P. F., Burgass, M. J., Gianunca, D., Gorham, T. M., Jacob, C., Shumway, N., Sinclair, S. P., & Watson, J. E. (2018). A global mitigation hierarchy for nature conservation. *BioScience, 68*, 336–347.

Biber, E. (2011). The problem of environmental monitoring. *University of Colorado Law Review, 83,* 1.

Breslow, S. J., Allen, M., Holstein, D., Sojka, B., Barnea, R., Basurto, X., Carothers, C., Charnley, S., Coulthard, S., Dolšak, N., Donatuto, J., García-Quijano, C., Hicks, C. C., Levine, A., Mascia, M. B., Norman, K., Poe, M., Satterfield, T., St. Martin, K., & Levin, P. S. (2017). Evaluating indicators of human well-being for ecosystem-based management. *Ecosystem Health and Sustainability, 3*(12), 1–18.

Bull, J. W., Gordon, A., Law, E. A., Suttle, K. B., & Milner-Gulland, E. J. (2014). Importance of baseline specification in evaluating conservation interventions and achieving no net loss of biodiversity. *Conservation Biology, 28*(3)*,* 799–809.

Business and Biodiversity Offsets Programme. (2018). *Working for biodiversity net gain: An overview of the Business and Biodiversity Offsets Programme (BBOP) 2004–2018*. https://www.forest-trends.org/bbop_pubs/overview2018

Carpenter, S. R., & Turner, M. G. (2001). Hares and tortoises: Interactions of fast and slow variables in ecosystems. *Ecosystems*, 495–497.

Centers for Disease Control and Prevention. (2021). *Climate and health: Regional health effects*. https://www.cdc.gov/climateandhealth/effects/default.htm

Conservation Measures Partnership. (2020). *Open standards for the practice of conservation (Version 4).* http://conservationstandards.org/wp-content/uploads/sites/3/2020/12/CMP-Open-Standards-for-the-Practice-of-Conservation-v4.0-English.pdf

Díaz, S., Zafra-Calvo, N., Purvis, A., Verburg, P. H., Obura, D., Leadley, P., Chaplin-Kramer, R., De Meester, L., Dulloo, E., Martín-López, B., Shaw, M. R., Visconti, P., Broadgate, W., Bruford, M. W., Burgess, N. D., Bares, J. C., DeClerck, F., Fernández-Palacios, J. M., Garibaldi, L. A., … Zanne, A. E. (2020). Set ambitious goals for biodiversity and sustainability. *Science, 370*(6515), 411–413.

Diefenderfer, H. L., Steyer, G. D., Harwell, M. C., LoSchiavo, A. J., Neckles, H. A., Burdick, D. M., Johnson, G. E., Buenau, K. E., Trujillo, E., Callaway, J. C., Thom, R. M., Ganju, N. K., & Twilley, R. R. (2021). Applying cumulative effects to strategically advance large-scale ecosystem restoration. *Frontiers in Ecology and the Environment, 19*(2), 108–117.

Griffiths, V. F., Bull, J. W., Baker, J., & Milner-Gulland, E. J. (2019). No net loss for people and biodiversity. *Conservation Biology, 33*(1), 76–87.

Iowa Community Indicators Program. (2022). *Urban percentage of the population for states, historical*. Iowa State University. https://www.icip.iastate.edu/tables/population/urban-pct-states

Locke, H., Rockström, J., Bakker, P., Bapna, M., Gough, M., Hilty, J., Lambertini, M., Morris, J., Polman, P., Rodriguez, C. M., Samper, C., Sanjayan, M., Zabey, E., & Zurita, P. (2021). *A nature-positive world: The global goal for nature*. https://www.naturepositive.org/en/resources

Maron, M., Brownlie, S., Bull, J. W., Evans, M. C., von Hase, A., Quétier, F., Watson, J. E., & Gordon, A. (2018). The many meanings of no net loss in environmental policy. *Nature Sustainability, 1*(1), 19–27.

Maron, M., Hobbs, R. J., Moilanen, A., Matthews, J. W., Christie, K., Gardner, T. A., Keith, D. A., Lindenmayer, D. B., & McAlpine, C. A. (2012). Faustian bargains? Restoration realities in the context of biodiversity offset policies. *Biological Conservation, 155,* 141–148.

Maron, M., Ives, C. D., Kujala, H., Bull, J. W., Maseyk, F. J., Bekessy, S., Gordon, A., Watson, J. E., Lentini, P. E., & Gibbons, P. (2016). Taming a wicked problem: Resolving controversies in biodiversity offsetting. *BioScience, 66*(6), 489–498.

Maron, M., Juffe-Bignoli, D., Krueger, L., Kiesecker, J., Kümpel, N. F., Kate, K. T., Milner-Gulland, E. J., Arlidge, W. N. S., Booth, H., Bull, J. W., Starkey, M., Ekstrom, J. M., Strassburg, B., Verburg, P. H., & Watson, J. E. M. (2021). Setting robust biodiversity goals. *Conservation Letters*, 14.

McPhearson, T., Andersson, E., Elmqvist, T., & Frantzeskaki, N. (2015). Resilience of and through urban ecosystem services. *Ecosystem Services, 12*, 152–156.

Moilanen, A., & Kotiaho, J. S. (2018). Fifteen operationally important decisions in the planning of biodiversity offsets. *Biological Conservation, 227,* 112–120.

National Academies of Sciences, Engineering, and Medicine. (2022). *An approach for assessing U.S. Gulf Coast ecosystem restoration: A Gulf Research Program environmental monitoring report*. National Academies Press. https://doi.org/10.17226/26335

National Infrastructure Commission. (2021). *Natural capital and environmental net gain.* https://nic.org.uk/studies-reports/natural-capital-environmental-net-gain/

National Research Council. (2001). *Compensating for wetland losses under the Clean Water Act*. National Academies Press.

Phalan, B., Hayes, G., Brooks, S., Marsh, D., Howard, P., Costelloe, B., Vira, B., Kowalska, A., & Whitaker, S. (2018). Avoiding impacts on biodiversity through strengthening the first stage of the mitigation hierarchy. *Oryx, 52*(2), 316–324.

Pope, J., Morrison-Saunders, A., Bond, A., & Retief, F. (2021). When is an offset not an offset? A framework of necessary conditions for biodiversity offsets. *Environmental Management, 67*(2), 424–435.

Pörtner, H. O., Roberts, D. C., Adams, H., Adler, C., Aldunce, P., Ali, E., Begum, R. A., Betts, R., Kerr, R. B., & Biesbroek, R. (2022). *Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the sixth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Rocchio, F. J., & Crawford, R. C. (2011). *Applying NatureServe's ecological integrity assessment methodology to Washington's ecological systems*. Washington Natural Heritage Program, Washington State Department of Natural Resources.

Rocchio, F. J., Crawford, R. C., & Ramm-Granberg, T. (2020a). *Field manual for applying rapid ecological integrity assessments in wetlands and riparian areas in Washington State (Version 1.2)*. Washington State Department of Natural Resources. https://doi.org/ 10.13140/RG.2.2.30936.52486

Rocchio, F. J., Ramm-Granberg, T., & Crawford, R. C. (2020b). *Field manual for applying rapid ecological integrity assessments in upland plant communities of Washington State (Version 1.3)*. Washington State Department of Natural Resources. https://doi.org/ 10.13140/RG.2.2.36389.12004

Ruhl, J. B., & Salzman, J. (2011). Gaming the past: The theory and practice of historic baselines in the administrative state. *Vand. L. Rev., 64*, 1.

Shukla, P. R., Skea, J., Slade, R., Al Khourdajie, A., van Diemen, R., McCollum, D., Pathak, M., Some, S., Vyas, P., Fradera, R., Belkacemi, M., Hasija, A., Lisboa, G., Luz, S., & Malley, J. (Eds.). (2022). *Climate change 2022: Mitigation of climate Change. Contribution of Working Group III to the sixth assessment report of the*

Intergovernmental Panel on Climate Change. Cambridge University Press. https://doi.org/10.1017/9781009157926

Stange, M., Barrett, R. D., & Hendry, A. P. (2021). The importance of genomic variation for biodiversity, ecosystems and people. *Nature Reviews Genetics, 22*(2), 89–105.

Tallis, H., Kennedy, C. M., Ruckelshaus, M., Goldstein, J., & Kiesecker, J. M. (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.

U.S. Census Bureau. (2010). *Dicennial census of population and housing data*. https://www.census.gov/programs-surveys/decennial-census/data.html.

Washington Biodiversity Council. (2007). *Washington's biodiversity: Status and threats*. Washington State Recreation and Conservation Office.

Washington State Department of Natural Resources. (2022). *Natural Heritage Program*. https://www.dnr.wa.gov/natural-heritage-program.

Wende, W., Tucker, G., Quétier, F., Rayment, M., & Darbi, M. (2018). *Biodiversity offsets—the European perspective on no net loss of biodiversity and ecosystem services*. Springer.

Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.W., Santos, da Silva Santos, L.B., Bourne, P. E., & Bouwman, J. (2016) The FAIR Guiding Principles for scientific data management and stewardship. *Scientific data, 3*(1), 1-9.

Wilson, E. O. (1988). The current state of biological diversity. *Biodiversity, 521*(1), 3-18.

WASHINGTON STATE
Academy of Sciences
Science in the Service of Washington State

Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring

Prepared for the Washington State Department of Fish and Wildlife

June 2022

Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring

Table of Contents

I. INTERPRETATION OF CHARGE

The Washington Department of Fish and Wildlife (WDFW) requested that the Washington State Academy of Sciences (WSAS) inform its work on the development of a net ecological gain (NEG) standard for public projects as part of the response to a proviso contained within Engrossed Substitute Senate Bill 5092 (2021). WSAS convened a committee of scientific and technical experts (referred to in this document as "the committee") to conduct this scope of work. The full scope of work for the committee was to develop a definition, goals, objectives, and performance metrics for the net ecological gain standard; assess the sufficiency of existing standards in achieving endangered species recovery; and make recommendations about monitoring and indicators for no net loss and net ecological gain.

The committee's first chapter on the NEG definition, goals, and objectives was previously shared with WDFW (Washington State Academy of Sciences, 2022). The committee interpreted their charge for this subsequent chapter, as outlined in the scope of work with WDFW, as (1) assessing whether and why existing standards of ecological protectiveness, such as no net loss (NNL) standards, have been sufficient or insufficient to protect ecological health and achieve endangered species recovery and (2) providing recommendations for:

- Performance metrics for the NEG standard
- Indicators to assess NNL and NEG
- Establishment of a monitoring system
- Incorporation of climate science predictions into NNL and NEG standards

This report chapter synthesizes the committee's perspectives on the effectiveness of existing ecological protection standards and focuses on recommendations regarding NEG metrics, monitoring, and indicators. The primary intended audiences for this document are Washington State agencies, tribes, and legislators.

To operationalize the concepts reviewed in this chapter, several additional steps are necessary, including educating agency staff and the public on NEG, developing inter-agency partnerships, building a workforce trained in interdisciplinary and transdisciplinary approaches to addressing socio-ecological challenges relevant to NEG, and helping to provide the scientific basis for any necessary legislation. In the concluding section of this chapter, the committee presents suggestions for some follow-on activities that may facilitate these next steps toward successful implementation of NEG in Washington State.

II. ASSESSMENT OF NO NET LOSS

The concept of no net loss (NNL) seeks to minimize impacts of human infrastructure on the environment, typically by applying some form of the mitigation hierarchy to sequentially avoid, minimize, remediate, and offset biodiversity impacts from new development (Bennett et al., 2017; also see the committee's first chapter on the NEG definition, goals, and objectives, Washington State

Academy of Sciences, 2022). NNL was first introduced through the 1970 National Environmental Policy Act. Upon issuance of the Clean Water Act in 1972, the Army Corps of Engineers applied NNL to manage dredge materials and mitigate the disposal of contaminants into water. The George H. W. Bush Administration further promulgated the concept, implementing a no net loss standard for wetlands in the early 1990s.

Yet, many natural ecosystems continue to be converted to residential and commercial development under existing standards. When considering whether existing ecological standards, including NNL, have been sufficient in safeguarding ecological health and achieving endangered species recovery, **the committee's consensus view is that NNL has not been an effective approach for ecosystem or habitat management and protection nor for the maintenance of ecosystem services**. Within the larger scientific community, shortcomings of the NNL approach were articulated as long as 30 years ago. For example, two National Academies reports (National Research Council, 1992, 2001) on compensatory mitigation for wetland loss through development were highly critical of NNL. Other global studies have found little to no documented evidence of NNL success and high regional variability in such success (e.g., Bull & Strange, 2018; zu Ermgassen et al., 2019).

The failure of NNL is directly relevant to Washington State ecosystems and the health and well-being of its residents. In Washington, there are 33 known extirpated plants and 6 known extirpated animals—one freshwater bivalve, two species of butterfly, one beetle, and two bird species (Washington Department of Natural Resources, 2022). An entire extirpated ecosystem has been identified by the Washington Natural Heritage Program to date: the noble fir-redwood sorrel forest of the Willapa Hills. There are another 179 endangered ecosystems in the state, including forest types associated with Oregon white oak woodlands, red alder-bigleaf maple-Douglas fir rainforests, Douglas fir-Western hemlock rainforests, silver fir-Western hemlock rainforests, Western hemlock-Sitka spruce rainforests, Douglas fir-madrone woodland, paper birch and quaking aspen swamp forests, 20 riparian forest types, and four maritime swamp forest types. The Western juniper ecosystem is also endangered, as are numerous grassland, shrubland, bog, fen, marsh, vernal pool, and wet meadow ecosystem types.

Additionally, an assessment process for the intensive climate change vulnerability index (Dawson et al., 2011; Young et al., 2012), which is currently being implemented in Washington, has already identified many plant species that are highly or extremely vulnerable (Fertig, 2020, 2022). There are widespread threats to game species habitats as well. Some of these are a result of negative impacts of wind and solar energy development on mule deer in Eastern Washington. Band-tailed pigeon harvest opportunities have also been reduced despite a hunting closure that was implemented from 1991 to 2001 (Washington Department of Fish and Wildlife, 2021).

Clearly, there have been net losses of species and habitats in Washington. The committee is reasonably confident that without policy changes, these types of losses will continue and will contribute to the disappearance of distinct habitats and ecosystem types from Washington's terrestrial and aquatic landscapes.

Application of NNL has been unsuccessful in most instances for a variety of reasons. First, there are challenges associated with establishing appropriate baseline conditions. For sites that have experienced

significant loss of habitat, biodiversity, or ecological functions, using the current condition as a baseline falls short of promoting adequate management and protection. For such sites, NEG is often a better approach because it necessitates an improvement in ecosystem biodiversity or resilience without requiring that the site revert to pristine conditions.

A second challenge of NNL lies in uneven distribution of impact and mitigation. Often, compensatory mitigation occurs offsite and fails to provide in-kind compensation for the loss. For example, a forest may be established offsite to compensate for wetland habitat loss, which does not truly offset the impacts of this loss. Poor implementation of NNL has been another common obstacle. For example, many wetland restorations have been inadequate. Limited funding and insufficient institutional structure for implementation often result in inadequate monitoring and enforcement before, during, and after a project. In addition, accurate assessment of the success of a standard's implementation can be difficult because this process requires the identification of appropriate targets, indicators, and metrics, as well as the determination of the appropriate spatial and temporal scales for monitoring. Finally, community buy-in for NNL has grown more difficult due to disproportionate impacts to low-income communities, as well as a pattern of compensatory actions under NNL failing to benefit the people most heavily impacted by a project.

Examining the reasons NNL has failed is imperative to designing and implementing a successful NEG standard. Many of the same challenges will persist under NEG without intentional action to improve the current approach to implementing ecological protection standards and overcome challenges related to funding and infrastructure limitations, incorporation of climate change science, monitoring, assessment, and community buy-in.

Beyond No Net Loss to Net Ecological Gain

In the committee's first chapter to WDFW (Washington State Academy of Sciences, 2022), the committee provided a definition, goals, and objectives for NEG in Washington State. The committee's proposed definition for NEG is:

> **Net ecological gain means that after development, there is an increase in biodiversity or resilience that improves the delivery of valued ecosystem functions in the affected ecosystem.**

NEG aims to achieve improvements to ecosystem health in comparison to a theoretical future in which the developments or projects did not occur, rather than using current conditions as a baseline. This approach seeks to go beyond simply offsetting loss to stopping and even reversing it.

The state of Washington has been considering NEG as an approach to preserve and restore ecological systems. The case studies provided in this chapter aim to demonstrate how the committee's broad definition, goals, objectives, and performance metrics for net ecological gain can be applied to various public projects in Washington State. The committee acknowledges that the case studies do not encompass all possible ecosystems and development situations in Washington State; they instead serve as examples to put these abstract concepts into perspective.

Future successful implementation of NEG in Washington will necessarily include the processes of defining targets, indicators, and metrics; building community support for the approach; establishing monitoring, assessment, and accountability systems; factoring in impacts of climate change; and assessing outcomes. These processes can be informed by existing ecologically relevant conceptual frameworks across various fields of study, as discussed throughout this chapter.

III. IMPLEMENTING AND ASSESSING A NET ECOLOGICAL GAIN STANDARD

Structured Decision Making and Ecosystem Planning

To progress toward the NEG goals and objectives outlined in committee's first chapter on the NEG definition, goals, and objectives, the committee recommends employing a conceptual framework that can effectively measure ecological function, structure, and processes. The field of ecological assessment includes several accepted frameworks for determining an ecosystem's condition by comparing its composition, structure, and function to baseline measurements. For instance, steps for measuring ecological integrity include identifying ecological attributes; determining metrics to measure degradation against baseline levels; assessing the attributes using remote sensing, rapid ground-based, and intensive ground-based metrics; and presenting the resulting measurements in a matrix that illustrates the interconnectedness of the attributes, metrics, and findings (Karr et al., 2021; Rocchio & Crawford, 2011; Rohwer & Marris, 2021; Wurtzebach & Schultz, 2016).

A well-accepted framework that is applicable to implementation of NEG is 'Structured Decision Making & Ecosystem Planning' (Gregory et al., 2012; Levin et al., 2018), which has been successfully applied to questions of fish and avian ecosystem management and restoration (Buenau et al., 2014; Neckles et al., 2015). This generic planning framework can be repurposed and adapted to a variety of scenarios.

Box 1. Fundamental Recommendations to Enhance the Probability of Successful NEG include:

- Understand controlling factors and linkages in the ecosystem
- Understand the role and mode of the actions of stressors and disturbances
- Apply science-based understanding to project design and development
- Apply simple yet effective technological solutions where appropriate
- Apply appropriate restoration and monitoring strategies
- Admit uncertainties and overcompensate in the design of projects for unavoidable damages

(modified from Thom et al., 2005b)

In the context of NEG and how it fits into a broader ecosystem planning process, this framework includes activities that aim to accomplish the following:

1. Describe the current state of the ecosystem (e.g., through state indicators and by creating an inventory of threats) and use conceptual models (e.g., Bayesian belief networks, qualitative models, Driver-Pressure-State-Impact-Response framework) to represent the way the ecosystem elements are thought to interact with each other, how they will respond to threats, and the potential pathways of human benefits
2. Articulate a set of desired futures, potentially including but not limited to a vision, strategic objectives, risk analysis, prioritization, and operational objectives
3. Create a plan to address top-priority threats and operational objectives, including:
    - Setting performance measures (which may or may not be the same as the previously described state indicators or threat indicators)
    - Identifying potential management strategies
    - Evaluating the range of outcomes for each objective
4. Implement the plan (in the context of NEG, this involves creating a built environment that seeks to achieve NEG) and establish time-bound measures of success and resources to monitor outcomes

Indicators developed using a structured decision making framework serve a variety of purposes and are selected based specifically on these purposes. Performance indicators need to be SMART: Specific, Measurable, Attainable, Relevant, and Time-bound.

Structured decision making is meant to provide a logic model that captures the pieces that need to be considered when evaluating NEG. **Structured decision making is a systematic and transparent process to evaluate a potential project and its impacts.** The process can be applied at different scales with varying intensity, but importantly, it must be as objective and transparent as possible, with conclusions drawn from available scientific evidence.

From a process standpoint, structured decision making also includes facilitating stakeholder identification of and consensus on the main threats and prioritizing multiple objectives. Involvement of diverse stakeholders and the affected community as early as practically possible helps generate buy-in and establish a forum for identifying goals, objectives, approaches, and solutions.

Ideally, the structured decision making process should be stakeholder-based and incorporate multiple objectives and values to determine how to best achieve NEG. Generally, the sooner stakeholders are brought into the process, the more successful the outcome will be (Gregory et al., 2012). There are various ways to do this, such as using a structured decision-making model that focuses on the science and engages stakeholders separately or by building stakeholder engagement into the process throughout (e.g., Environmental Protection Agency, 2022). Different approaches may also be required for different groups of stakeholders. Although such a process can be time-intensive, this engagement is critical for achieving long-term NEG (see the section on Human Well-Being, Stakeholder Engagement, and Community Buy-In below).

Overall, applying recognized and widely used frameworks such as structured decision making will help to maximize the efficiency, transparency, and replicability of NEG implementation.

Box 2. Case Study: Clinton Ferry Terminal Rebuild

The Clinton Ferry Terminal was redeveloped to address traffic concerns and needed repairs. The initial proposal was projected to remove approximately 3,000 square meters of eelgrass and create wide, shaded areas near the shore that would inhibit juvenile salmon migration. Terminal design engineers and scientists worked together to redesign the dock. The redesign included a narrower but longer dock, fewer pilings, reorientation of ferry slips to minimize bottom disturbances and turbidity, and addition of glass blocks in the walkway to allow light to pass. The net effect of this redesign was a reduction in projected loss of eelgrass to about 300 square meters.

Prior to the outset of the project, eelgrass shoots from the site were harvested and grown in culture, where they multiplied. Prior to completing the terminal rebuild, the cultured eelgrass was transplanted into previously disturbed areas, which resulted in an approximate 4:1 increase in eelgrass near the terminal over baseline conditions. While the eelgrass beneath the dock did not appear to respond to the additional light enabled by the glass blocks, it did show resilience and overall expansion over a 10-year period. The placement of the glass blocks also appeared to aid with the movement of salmon around the dock. Salmon primarily passed under the dock when there was minimal shadow. Overall, due to the redesign, the project resulted in a net gain in eelgrass and generally improved conditions for young salmon (Thom et al., 2005a, 2005b, 2012). Natural resource agencies met annually for 10 years with scientists and Washington State Ferry staff to review the monitoring results.

This project was rooted in a conceptual framework for measuring the goals and outcomes, which was in place prior to project initiation, thereby allowing review and mitigation of projected impacts in advance of the project's start. The Federal Highway Administration recognized this project with the 1997 National Environmental Excellence Award.

Tenets of the NEG definition articulated in the committee's first chapter on the NEG definition, goals, and objectives can be seen within this case study. For example, measurable net improvement to the ecosystem's structure and resilience can be seen in the expansion and resilience of eelgrass. Parallels can also be drawn between the goals and metrics presented in this chapter and the implementation of the Clinton Ferry Terminal rebuild (see below). Some of the project metrics that reflect the concepts presented in this document and the committee's first chapter (Washington State Academy of Sciences, 2022) include measurements of strengthened ecosystem resilience through the persistence of ecosystem structure and measurements of sustained biodiversity through improvements in populations of native species.

IV. ADDITIONAL CONSIDERATIONS FOR NEG IMPLEMENTATION

There are considerations specific to implementing NEG that have the potential to extend beyond a generic decision-making framework. Some of these considerations include the following.

- **Scale**. Potential impacts of any development project should be considered with careful attention to spatial, functional, and temporal scales because these considerations have the capacity to tip net outcomes from gain to loss.
    - Spatial scale may comprise an area as small as a building or property or may be most appropriately considered at the site, ecosystem or habitat, or landscape scale at which processes occur.
    - Functional scale pertains to the reach of impacts, including the location and demographics of the people affected.
    - Temporal scale refers to time-related considerations, such as the duration and anticipated peak of project outcomes. Evaluating temporal scale can be challenging because measurements typically occur after the conclusion of the project.

- **Distribution of impact**. It is important to consider the scale at which measurements are made versus the scale at which impacts accumulate. For example, a case study by the National Academies of Science, Engineering and Medicine (2022) details the relatively minor improvements in farmland management in the Mississippi River Basin relative to the size of the recurring hypoxic zone in the Gulf of Mexico. Conducting projections of what future conditions would be without the project is one method of adjusting project outcome measurements to potential changes in background environmental conditions that could occur for other reasons.

- **Distributional effects of restoration actions.** In addition to considering the distribution of impact, it is also critical to assess outcomes within the context of how a specific site contributes to critical ecosystem processes of the overall region in which it is situated. Individual sites vary in terms of their functional importance, their components or attributes, and the extent to which they contribute to human well-being (see Table 1 in the committee's first chapter on the NEG definition, goals, and objectives, Washington State Academy of Sciences, 2022). The determination of whether to move forward with a project, as well as the NEG considerations for that site, should take into account whether a site has high functional importance relative to the surrounding landscape.

- **Multiple objectives**. Often, impact assessments only examine a single objective, while NEG is a whole-system approach that takes place within the broad context of the complex, dynamic relationships between population and economic growth and the management of ecosystem health. Consideration of multiple objectives is important for situating NEG efforts within the larger context. As an example, the Puget Sound Partnership uses a structured decision analytic model developed by EPA (Yeardley et al., 2011) that enables the inclusion of multiple objectives and evolving scenarios. The flexibility of this model supports specific inquiry regarding outcomes. NEG efforts for impacts to the Columbia estuary followed a similar approach

(Diefenderfer et al., 2016), which is currently being adapted to the Whidbey Basin of Puget Sound (Whidbey Cumulative Effects Group, 2022).

- **Evaluation of uncertainties.** It is crucial to assess which pathways to NEG will be robust and able to accommodate uncertainties in the long-term. There are often critical uncertainties associated with development and ecological restoration projects relative to achieving the stated goals for the project outcomes. In addition, climate change poses a significant level of uncertainty for all ecosystems. Designing and employing an adaptive management process (e.g., Levin et al., 2018) is therefore important for NEG projects.

The committee's proposed definition of NEG emphasizes that the preferred approach is to first avoid or limit ecological losses that occur through development, thereby curtailing degradation that would require restoration efforts with less certain outcomes. Consistent with the hierarchy of mitigation, it is also assumed that development resulting in adverse effects is not allowable for ecosystems that are especially fragile or that play a central role in biodiversity or in the functioning of ecosystems and landscapes and the benefits they provide to humans (Díaz et al., 2020; Locke et al., 2021; Maron et al., 2021). **For critical ecosystems such as these, there are limits that will preclude achieving NEG from development**. Some of the critical ecosystems in Washington include those which have been systematically identified and classified statewide by the Washington Natural Heritage Program through implementation of the Natural Area Preserves Act (RCW 79.70.070) (Washington Natural Heritage Program, 2022). When projects move forward regardless of the environmental impacts to critical ecosystems, determining how to attain NEG can pose significant or even insurmountable challenges.

The concept of NEG is meaningless unless the proposed outcome is specified relative to alternative possible scenarios. Considering alternative scenarios is important for describing the anticipated outcomes if a particular project or action is not carried out. For example, impact-specific policies for no net loss and net ecological gain generally use counterfactual scenarios that describe what would be expected to happen in the absence of development and present associated mitigation actions as the basis for scenarios (Bull et al., 2014; Maron et al., 2018). Developing and agreeing on appropriate counterfactual scenarios can be challenging due to prediction-making uncertainties that are further exacerbated by climate change effects and potential opportunities for gaming outcomes (Salzman & Ruhl, 2010). Moreover, where a project impacts different biota and ecological processes, expected rates of change may vary spatially and temporally. The process of developing these counterfactual scenarios is important for the understanding of relevant ecological processes and the application of the chosen reference scenario for setting targets for NEG (i.e., desired outcomes of NEG-based activities).

To effectively promote net gain by addressing all variable factors, impact-specific scenarios should also be developed that go beyond counterfactual scenarios. Impact-specific scenarios consider the additional and cumulative impacts of ecosystem pressures attributable to threats that are unrelated to proposed development.

Broad, overarching policies for no net loss or net gain of biodiversity across a jurisdiction (e.g., state-wide goals by 2040 to achieve no net loss of biodiversity or a net increase in riparian habitat) often imply alternative reference scenarios in which all potential sources of loss need to be considered. However,

although counterfactual scenarios can describe an assessment of potential impacts that can be translated into a no net loss threshold, they do not identify targets for net gain. Quantitative targets and metrics must be defined and monitored to demonstrate success in offsetting negative impacts (Arlidge et al., 2018; Wende et al., 2018). This process of setting targets is similar to the objective-setting process defined in EPA's Decision Analysis for a Sustainable Environment, Economy & Society (DASEES; Yeardley et al., 2011).

For context, Washington State is an area identified by the Intergovernmental Panel on Climate Change (IPCC) as having high conservation importance based on the high number of freshwater and terrestrial species and high projected habitat losses, with a 20% loss of marine fish and benthic animal biomass expected even under the lower-risk scenario (IPCC, 2022). The IPCC's Working Group II had high confidence that the migration, distribution, and abundance of key fish resources have been impacted in the Northeast Pacific (Pörtner et al., in press). Climate change will further impact these ecosystem attributes in a variety of ways. Some of the implications of climate change include larger, longer-burning, more frequent, and more severe fires; increased stream temperatures; and glacial recession and reduced snowpack impacting summer streamflow (Frans et al., 2018; Halofsky et al., 2020; Koontz et al., 2018). Even without further land conversion to accommodate the expansion of residential populations and commercial enterprises, widespread climate change effects detrimental to Pacific Northwest ecosystems are expected to continue.

Targets and eventual outcomes must meet three conditions (Gardner et al., 2013). First, losses and gains of biodiversity and ecosystem functions must be *comparable* in type and magnitude. This condition is often challenged by policy makers who want more flexibility and by some conservation biologists who advocate for "trading up" by exchanging offset areas with like-for-like potential for other areas that they view as having higher conservation value (Moilanen & Kotiaho, 2018).

Second, the desired gains through offsets must be *in addition* to those that would have occurred if the development did not take place. Projections of gains should extend beyond the site scale and explicitly take into consideration the cumulative effects of impacts at the landscape scale (Figure 1; Diefenderfer et al., 2021; Hood et al., 2022; National Academies of Science, Engineering and Medicine, 2022). For example, different sites within a watershed may have varying innate functions, meaning that the expectations for each site should also vary. Sites must be accounted for within the context of what that site provides to the function of the overall landscape. A challenge for both NNL and NEG is deciding what constitutes sufficient gain. Multiplier and mitigation ratios based on expected loss are one approach for simplifying the process of setting targets; these ratios should be informed by available science.

Third, desired gains must be *lasting*, exceeding or at least equaling the duration of the residual impacts of the development in the face of climate change. When identifying quantitative outcomes for offset gains, the timing of when outcomes are achieved must also be considered. Unless offset targets are achieved before development, delays usually at least temporarily cause losses of biodiversity or ecosystem functions (Gann et al., 2018); further, targets not achieved before the project onset may fail to address ecological losses that occur at offset locations during the delay. The impacts of such time lags

are often addressed through multiplier or mitigation ratios that expand the offset target in proportion to expected delays, although this approach does not guarantee a net gain (Pope et al., 2021).

Choosing metrics to ensure net gain is achieved is a critical and context-specific step. Metrics need to be 1) sensitive and predictably responsive to anticipated development impacts, 2) informative at different spatial scales, and 3) feasible to monitor at the appropriate timescales to assess short- and long-term project outcomes.

Prioritization of NEG also requires that there be an "exit ramp" in the project development process, with one option being that the proposed project does not move forward as planned. Ideally, an initial step in project planning should entail an assessment of whether a location can reasonably withstand the proposed project. If implementation of NEG is infeasible because of too much risk or uncertainty, the project should be reconsidered for an alternative site or canceled.

Cumulative Effects and a Need for Large-Scale Planning to Achieve NEG

In addition to the localized impacts of an individual project, the cumulative impacts to surrounding ecosystems must be considered in planning for NEG. Successful implementation of NEG requires a transdisciplinary approach that addresses diverse socio-ecological needs across multiple spatial scales. This process may require assessing project impacts within the context of other ongoing or future projects and the current condition of the surrounding landscape (Fig. 1).

To assess and predict the cumulative ecosystem impacts of development, overarching goals should be set at the landscape scale in partnership with interdisciplinary experts, including scientists at state agencies, communities, and interested stakeholders. Examples of landscape-scale prioritization approaches include the WDFW strategies for nearshore protection and restoration in Puget Sound (Cereghino et al., 2012), the proposed use of landscape ecology principles in habitat restoration across the Columbia River Estuary (Hood et al., 2022), and prioritization of shoreline habitats for restoration under the Shoreline Master Program in Jefferson County (Diefenderfer et al., 2009).

In some cases, scientifically established and vetted goals set by state agencies can serve as these overarching goals; however, **Washington State currently lacks a systematic, state-wide landscape approach for evaluating the ecological processes that connect and sustain each of its ecosystem types and their natural factors of scale**, such as watershed or estuary size, gradients, and hydrology (see the section on Establishing a Monitoring System for NEG below).

In addition to setting overarching goals, **approaches that prioritize NEG should consider the cumulative impacts of individual projects toward larger landscape-scale targets**. A major drawback of many mitigation frameworks is that they focus on a single component of an ecosystem, such as floodplains or salmon. Combining these frameworks into an integrated approach would aid in addressing cumulative effects. For example, an overarching framework that integrates salmon recovery strategies with watershed goals would enable the assessment of how individual activities fit into broad, science-based goals that were set at the landscape level. For urban watersheds, this framework might integrate needs related to runoff, salmon habitat, and the impact of flows along marine shorelines.

In some cases, NEG may succeed at the project scale but fall short of the broader targets. It is nevertheless important to continually consider NEG within the larger context of cumulative impacts and to refine and adapt the associated approaches to work toward NEG at the landscape scale.

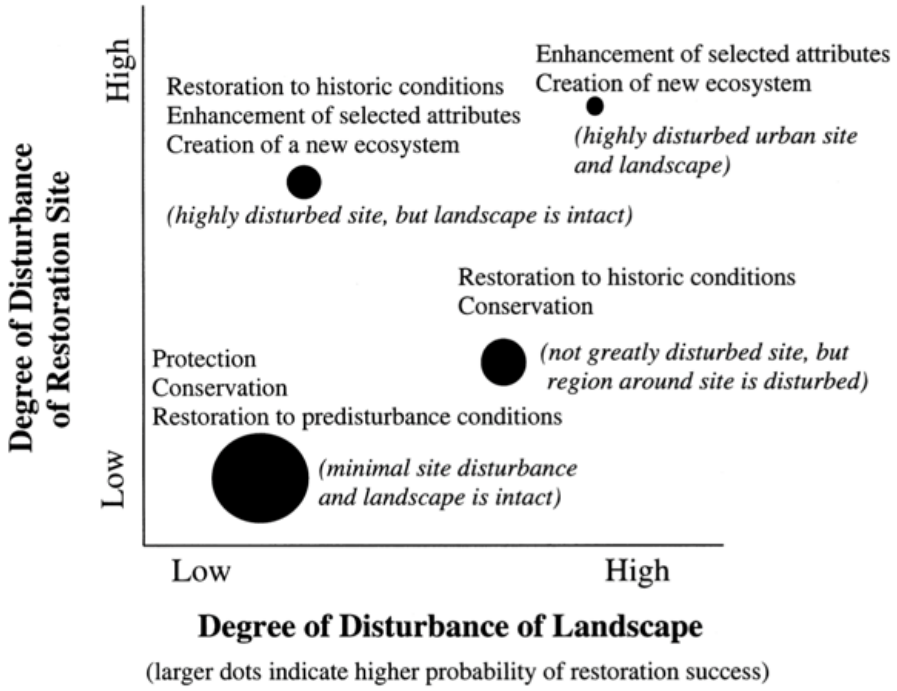


Figure 1*. This graphic illustrates the generalized relationship between the level of disturbance or degradation of the site and the landscape within which the site is located. The most appropriate restoration strategies, including ecological protection and the enhancement of selected attributes, are listed for four theoretical conditions. The larger the dot, the greater the chance that the site could be restored (Thom et al., 2005b).*

Human Well-Being, Stakeholder Engagement, and Community Buy-In

As noted in the committee's first chapter on the NEG definition, goals, and objectives (Washington State Academy of Sciences, 2022), there is an interdependent relationship between human well-being and ecosystem health. Communities depend on ecosystem goods and services, such as clean water and air, to sustain human well-being, and thus are profoundly affected by impacts to the ecosystems around them (Environmental Protection Agency, 2022).

Inclusively engaging communities in decision making is integral to ensuring policies, programs, and decisions themselves reflect the diverse interests, values, beliefs, and perspectives regarding a given area or issue. The value of engaging communities early and at all stages of decision making is well documented (e.g., IPBES, 2015). Early, continued engagement can help ensure decisions are more transparent, democratic, and equitable both in process and outcome.

Research increasingly demonstrates the importance of incorporating local community and Indigenous knowledge within environmental decision making and planning. By intentionally and inclusively

engaging communities, decision makers can become better informed or more able to fully understand the complexity of a given issue, its underlying causes or factors, and its potential impacts. This process helps to ensure longer-term stewardship and trust in governance around these issues. Activities associated with the new Healthy Environment for All (HEAL) Act (Washington State Legislature, 2021), which requires that agencies gather community input as part of environmental justice assessments, could help inform NEG efforts across Washington State.

The approach for obtaining community input varies depending upon the project scale and the composition and needs of the stakeholder group. However, a foundation of trust and community buy-in is critical to garner effective stakeholder engagement. Structured decision making is one way to involve stakeholders. A conceptual framework developed by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) presents another approach for leveraging community input to co-create an integrative knowledge base. This framework relies on a multidisciplinary, participatory approach to synthesize diverse stakeholder knowledge and create greater comparability across assessments (Díaz et al., 2015). Other forms of participatory research that are becoming increasingly popular, such as the use of crowdsourced environmental data sensing and/or volunteer community scientists, also offer promising ways to engage communities and generate buy-in.

Box 3. Case Study: Floodplains by Design

Floodplains by Design (https://www.floodplainsbydesign.org/) is a public-private partnership led by the Department of Ecology, The Nature Conservancy, the Bonneville Environmental Foundation, and Puget Sound Partnership which aims to reduce flood risks and restore habitat along Washington's major river corridors by restoring former agricultural lands located in habitats supporting salmon and other biodiversity. For example, to develop a solution that was satisfactory for all stakeholders, the project team gathered input on a land management solution from local landowners, neighboring property owners, land use commissioners, scientists, and watershed managers in Skagit County. The collaborative solution resulted in natural capital (restored land and salmon habitat), economic capital, and social capital (good will established between governing bodies and local landowners and a sense of stewardship over the land). The Floodplains by Design approach has been applied to projects across Washington State since 2013. This approach offers an excellent example of the value of stakeholder involvement in NEG initiatives. **Stakeholder involvement can support positive outcomes for all involved parties and build community trust and buy-in.**

V. PERFORMANCE METRICS AND INDICATORS

To measure and document the effects of restorative and protective actions, it is critical to use appropriate and well-developed measures of change. The committee defines a metric as anything one measures, while an indicator is specific to a particular decision and is assessed as part of an evaluation cycle that measures progress toward a specified objective. Indicators are more general than metrics. In other words, all indicators are metrics, but not all metrics are indicators. For example, when assessing

water quality, measurement of dissolved oxygen may be a metric, with an indicator for this assessment being the areal extent of water with quality that exceeds a predetermined oxygen level. Moreover, an indicator may comprise many metrics. Within the context of these definitions, many components of an ecosystem can be measured (metrics), but only a subset of those components are indicative of a particular ecosystem characteristic and directly useful for setting policy and making decisions (indicators). Some examples of recently published indicators include the use of growing-season sum exceedance value of hourly surface-water depth as a wetland inundation indicator within a proposed predictive framework for studies on estuarine–tidal river systems (Borde et al., 2020), as well as 7-day average daily maximum water depth as an indicator of marsh sediment accretion in a study on floodplain wetland morphology (Diefenderfer et al., 2021).

Process and Criteria for Setting NEG Indicators

This section describes approaches for developing criteria and indicators for net ecological gain. Rather than suggest specific indicators for net ecological gain across all habitat types and ecosystems represented in Washington, the committee aims to provide guidance on how to navigate the process of selecting indicators and tracking progress toward net ecological gain. The general process, criteria, and development of indicators discussed in this chapter build on the extensive work of the Business and Biodiversity Offset Programme (BBOP) and its technical documents (BBOP, 2012a, 2012b). Given that professionals throughout Washington are already working on ecological indicators for various plant and animal communities and ecosystems across the state, the committee also encourages inter-agency communication to develop appropriate indicators for Washington ecosystems based on existing data and information.

During the process of establishing indicators, it is important to consider (as described previously):

- Sites within their larger contexts, including their functions within the overall landscape and their contributions to cumulative impacts
- Geographical and temporal scale, because the scale at which a measurement is taken may differ from the scale at which the impacts accumulate
- An accepted and relevant conceptual framework
- Measurements that align with existing restoration strategies for the given region

To aid in identifying appropriate indicators, a baseline should be established prior to the beginning of a project. Creating a baseline can be challenging. Data from existing monitoring programs and ecosystem models can be helpful resources for compiling potential baseline or simulated data sets.

Indicators should be identified for both implementation and ecological outcomes. *Implementation indicators* measure the outputs of the planning and implementation processes for achieving net ecological gain. Implementation indicators are usually similar from case to case; a few examples of implementation indicators are summarized in Box 4 (also, see more in-depth examples in Appendix 1). In contrast, *ecological indicators*, which assess ecological outcomes, depend on the location (e.g., ecoregion and type of habitat), ecological and geographical scale (e.g., project size, dominant ecological

processes, and landscape context), and anticipated direct and indirect impacts of the project. Ecological indicators often differ across projects and systems.

Box 4. Example of principles (P), criteria (C), and implementation indicators (I) as part of the orientation and planning steps of a net ecological gain process

These examples are excerpted and adapted from the Business and Biodiversity Offsets Programme (BBOP 2012a, BBOP 2012b) to illustrate concepts. The full process includes tribal and stakeholder participation components, which, for brevity, are not outlined here.

P: Adherence to the mitigation hierarchy: A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimization, and onsite rehabilitation measures have been taken according to the mitigation hierarchy.

> C: The developer identifies, implements, and documents appropriate measures to avoid and minimize the direct, indirect, and cumulative negative impacts of the development project and to undertake onsite rehabilitation/restoration.
>
> I: An assessment of the development project's impacts on biodiversity (including direct, indirect, and cumulative impacts, as appropriate) is conducted with stakeholder participation

P: Net Ecological Gain: A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in net gain of biodiversity and resilience.

> C: The net gain goal for the development project is explicitly stated, and the offset design and conservation outcomes required to achieve this goal are clearly described.
>
> I: All residual biodiversity losses due to the project are quantified relative to the 'pre-project' condition of affected biodiversity, which is identified, characterized, and documented.
>
> C: An explicit calculation of loss and gain is undertaken as the basis for the offset design and demonstrates the manner in which a net gain of biodiversity can be achieved by the offset.
>
> I: A set of key biodiversity components at the species, habitat, and ecosystem levels, including landscape features and components related to use and cultural values, is identified. The rationale for selecting these key biodiversity components to represent all biodiversity affected by the project is explained and documented.

P: Limits to what can be offset: There are situations in which residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.

> C: The degree of risk that the project's residual impacts on biodiversity may not be capable of being offset ('non-offsetable') is assessed and measures are taken to minimize this risk.
>
> I: An assessment is undertaken to predict the level of risk that the project's residual impacts on biodiversity will or will not be capable of being offset, with special attention afforded to any highly irreplaceable and vulnerable biodiversity components.

Example: Indicators of Salmon Ecosystems

The following example describes the Puget Sound Recovery Implementation Technical Team's (PS RITT) application of the Open Standards for the Practice of Conservation framework to identify ecological indicators (PS RITT, 2015). The committee chose to highlight PS RITT's work because it is the result of a multi-decade process and is considered the "gold standard" for developing and selecting criteria for biophysical indicators. Notably, the salmon ecosystem for which these indicators were developed is one of the best studied ecosystems in Washington State. Not all successful projects that achieve NEG will necessarily have the capacity to follow such a comprehensive process.

The basic approach used by PS RITT to develop their extensive list of indicators was to first identify linkages among the major components of the salmon ecosystem and then characterize the key ecological attributes (KEAs), pressures, and indicators. Ecosystem components are the attributes we care about conserving and include biodiversity, species, habitat types, ecological processes, and particular ecosystems that encompass the full breadth of conservation objectives for a specific project. KEAs are the characteristics of an ecosystem component that, if present, would support a viable component but, if missing or altered, would lead to loss or degradation of the component over time. Pressures are the proximate human activities or processes that have caused, are causing, or may cause the destruction, degradation, or impairment of KEAs and ecosystem components.

Within this example, PS RITT sorted 14 major ecosystem components of Chinook salmon ecosystems into three different categories: freshwater habitats, estuarine and marine habitats, and biological communities (i.e., species and food webs). These categories and the corresponding ecosystem components are shown in Table 1.

Table 1. *Ecological components by category in PS RITT's identification of indicators, adapted from Puget Sound Recovery Implementation Technical Team (PS RITT, 2015)*

Category	**Components**
Freshwater habitats	• Uplands • channels >50 m bankfull width • Channels <50 m bankfull width • Side channels • Non-channel lakes and wetlands
Estuarine and marine habitats	• Large estuaries • Coastal landforms • Bluff-backed beaches • Pocket estuaries and embayments • Rocky pocket estuaries • Rocky beaches • Offshore marine systems
Biological communities	• Species and food webs

Key ecological processes associated with each of these components were then used to identify KEAs. For freshwater salmon habitats, for example, seven key ecological processes highlighted 15 KEAs (PS RITT, 2015; Table 2).

Table 2. *Key ecological attributes identified by ecological process in PS RITT's identification of indicators, adapted from Puget Sound Recovery Implementation Technical Team (from Table 8, PS RITT, 2015)*

Ecological Process	**KEAs**
Sediment processes	• Sediment delivery • Sediment transport and storage
Hydrological processes	• High flow hydrological regime • Low flow hydrological regime
Organic matter processes	• Organic matter inputs • Organic matter retention and processing
Riparian processes	• Spatial extent and continuity • Riparian community structure • Riparian function
Nutrient supply	• Nutrient concentration • Water quality • Nutrient flux and cycling
Floodplain-channel interactions	• Floodplain connectivity • Floodplain structure and function
Habitat connectivity	• Habitat connectivity

Each KEA was mapped to an associated ecosystem component. Next, KEA indicators and pressure indicators (Table 3) were identified based on review of the scientific literature for each KEA. This demonstrates how different types of indicators can be developed for a key ecosystem process. The same approach was used for marine/estuarine and species and food web components (PS RITT, 2015).

These tables provide a relevant example developed by PS RITT (2015) for salmon ecosystems. The process they used to identify and develop indicators could be applied to other types of habitats and biological communities, as well, such as shrubsteppe, prairie, or grassland ecosystems.

Table 3. *KEA and pressure indicators for hydrology across relevant spatial scales, as an example of how different types of indicators can be developed for a key ecosystem process. (adapted from Table 10, PS RITT, 2015).*

Scale	KEA	KEA Indicators	Pressure Indicators
Watershed	• High-flow hydrology regime • Low-flow hydrology regime	• Area/basin discharge, threshold discharge, point discharge, groundwater recharge/discharge • Land cover, including percentages of impervious surface area and vegetative cover • Hydrographic patterns unique to each watershed will determine specific measures and the seasonal patterns most affecting Chinook (e.g., 7-day low-flow and peak-flow frequency, magnitude, and duration) • Groundwater elevation/flows	• Regulated instream flow hydrograph • Volume of in-basin storage • Withdrawals and consumption • Volume of out-of-basin transfer • Volume and location of stormwater discharge and related alteration of natural hydrologic processes (e.g., infiltration, surface water and groundwater flow patterns)
Reach	• High-flow hydrology regime • Low-flow hydrology regime	Seasonal hydrological patterns: • Water depth and velocity • Area and type of habitat units, including seasonal variation • Residual pool depth • Stage/discharge/habitat relationships (e.g., low flow resulting in isolated habitats, high velocities resulting in redd scouring)	• Scour depth in incubation habitats • Area of redd stranding due to natural or regulated flows • Area and connectivity of floodplain channels leading to stranding of juveniles during low-flow time periods • Rapid decreases in flow stage (e.g., ramping of regulated flows) that isolate pools in floodplain channels and wetlands

Choosing Indicators

Effective indicators are those that not only reflect that state of socio-ecological systems, but also are meaningful to people and inform decision making and planning cycles. James et al. (2012) provided an example of useful selection criteria and a possible method for ranking indicators. In this example, the authors divided criteria for choosing indicators into three categories: scientific credibility and relevance, data issues, and communication and sustainability (Table 4). Criteria were weighted by importance based on the project's goals and a review of the scientific literature. Each criterion for every possible

indicator was then scored. Next, each indicator's score was calculated by totaling the products of each criterion evaluation by individual criterion weights.

To highlight ecological indicators for resilience, for example, ecological indicators such as those used by PS RITT (2015) can be weighted based on the review of resilience indicators in scientific literature (e.g., Grantham et al., 2019; Timpane-Padgham et al., 2017) and by how well they act as surrogates for resilience.

Table 4. *Criteria for choosing and ranking indicators, adapted from James et al. (2012).*

Category	Criteria
Scientific Credibility	• Theoretically sound, based on peer-reviewed findings, and capable of acting as a surrogate for a key ecosystem attribute • Relevant to management concerns, goals, and strategies • Responds predictably and is sufficiently sensitive to changes in a specific key ecosystem attribute • Responds predictably and sufficiently sensitive to a specific management action or pressure • Capable of being linked to defined reference points and/or progress targets to judge progress
Data Issues	• Directly measurable • Supported by historical data or information • Operationally simple so that sampling, measuring, processing, and analyzing the indicator is technically feasible • Quantitative measurements if possible • Spatial coverage available in all areas of interest • Time series available • Spatial and temporal variation understood • High signal-to-noise ratio to ensure that natural variability in indicator values does not prevent detection of significant changes
Communication & Sustainability	• Simple to interpret, easy to communicate, and supportive of public understanding that is consistent with technical definitions • Perceived as reliable and meaningful by a history of reporting • Cost-effective • Able to signal changes in key ecosystem attributes before they occur and, ideally, with sufficient lead time to allow for a management response • Comparable to those used in other geographic locations to contextualize ecosystem state and changes relative to other locations

VI. ESTABLISHING A MONITORING SYSTEM FOR NEG

NEG is most likely to succeed when accompanied by appropriate monitoring, assessment, and accountability systems. Individual projects that aim to achieve NEG require both targeted and long-term monitoring of relevant ecological processes at the regional or landscape scale. Monitoring at multiple scales is necessary because landscape-scale ecological conditions and dynamics are important benchmark metrics against which to measure the cumulative effects of individual projects. However, an

important tenet of adaptive management is to use existing streams of monitoring data whenever possible, only adding further monitoring as needed to address critical uncertainties that pose risks to the achievement of project outcomes or to stakeholder interests (Ebberts et al., 2018). Although maintaining or establishing new monitoring programs can be challenging due to infrastructure and funding needs (Biber, 2011; Lindenmayer, 2020; Lovett et al., 2007), **monitoring is a critical component of NEG implementation that must be budgeted for and incorporated into planning at the regional and project scales.**

Knowledge of the relevant ecological system and its stressors, as well as awareness of the broader context, are foundational for developing comprehensive monitoring systems. As mentioned above in the section on Additional Considerations, a key component of implementing NEG is being able to understand and account for multiple interacting pressures on a system. Monitoring for multiple goals, including overarching landscape-scale goals, is therefore very important. Moreover, detecting and identifying pressures on a system requires long-term data collection, especially for detecting responses by the biological community. In some cases it may be possible to focus on a system's specific stressors and whether those stressors have been alleviated; however, this approach requires substantial prior knowledge of the system, its stressors, and what the effects of the development will be, and this level of knowledge is rarely available.

Other key considerations include timescale and geographic scale. Ideally, monitoring should entail comparison of metrics over time and should be calibrated to the timescale of affected processes, especially those that may extend past the project timeline. For example, monitoring of sediment accumulations in a breached levy would require time for the sediment to amass before measurements can be taken for comparison. In this example, targets at the project scale might pertain to limiting runoff, while targets at the landscape scale might pertain to achieving a cleaner overall outflow despite cumulative effects. In addition to accommodating temporal and geographic considerations, priorities and indicators for monitoring should be aligned across agencies.

Considerations for Urbanized Systems

Urban systems confer similar considerations as larger natural ecological systems. Establishing baseline measures or benchmarking existing conditions helps teams to understand the context of the project, set actionable goals, and establish how projects fit into a larger context of improving current or past states. Quantitative metrics to measure progress toward goals aid in decision making throughout the design process and after implementation. Projects often cross jurisdictional and disciplinary boundaries, sometimes requiring challenging collaborations among separate yet interrelated agencies and disciplines. Through integrated design and decision making, stakeholders can help define project goals and decision-making frameworks and contribute to establishing measurement and monitoring approaches. This integrated approach enables better documentation and understanding of successes or shortcomings within the projects and the impacts to the site, larger neighborhood, and beyond.

As with best practices in adaptive monitoring, there is value in using existing monitoring and metrics systems in urban systems (e.g., building-level municipal systems for monitoring water and energy). Use of public data sources enables assessment of how much water or energy is being used, where it is used,

and whether that usage matches the design intent. Although this type of data collection and monitoring is often already in place to quantify usage within a site context, such data could be used more extensively across larger spatial scales for project-based evaluations.

Similar to the other fundamental considerations for monitoring outlined above, urban systems require effective interagency collaboration to reach better benchmarking goals and carry out sufficient monitoring. Prioritizing the monitoring of cumulative effects across multiple objectives is also critical as development projects are planned and executed. In addition, there is a need for clear communication with design teams about current or past states so that these teams can set appropriate goals relevant to design, operation, and use and better understand how their work contributes to larger NEG goals. For example, in the Aurora Swales project, described in Box 5, communicating the composition of stormwater runoff prior to and after project implementation aids the project team in assessing the impact of the work, helps the agencies with jurisdiction confirm the effectiveness of the project, and supports decision making for implementing similar solutions in other scenarios.

Box 5. Case Study: Aurora Bridge Swales

Background: Urban populations are growing and so are the number of cars on roadways and the amount of toxins entering the environment. Within the past 6 years, researchers in the Pacific Northwest have identified thousands of chemicals present in urban stormwater runoff, including toxins specifically responsible for the drastic decline of salmon populations in Puget Sound.

As an indicator species, salmon serve as a signal to the overall health of the marine environment. A dramatic decline in Pacific Northwest salmon populations spurred researchers to study the effects of stormwater runoff on the health of aquatic environments. The findings conclusively linked roadway runoff with salmon deaths (Chow et al., 2019), but surprisingly, the expected culprits—heavy metals and petroleum—were not responsible for salmon declines. While the specific source of the issue was unclear at the time, research findings did reveal that soil could be used to effectively filter the toxins (Spromberg et al., 2016), thereby reducing the negative effects of runoff on the salmon.

At the same time as the preliminary research was published, the project team of a new commercial office development project in the Fremont neighborhood of Seattle, WA, was assembling. Inspired by the recent research about stormwater effects on salmon mortality, the group wanted to see how they could apply the findings to their new building. The proposed building site was directly adjacent to and below the Aurora Bridge, a historic structure in Seattle under which all five of the region's salmon species swim to reach the network of rivers and streams for spawning.

Solution: The initial idea was simple: leverage the project's adjacency to the bridge to divert a downspout from the bridge and clean the water using a vegetated area before the water reached the salmon.

The solution was to locate a swale on a steep roadway instead of creating the settling pools used in more conventional green infrastructure. Embracing the steep grade of the roadway, the swales step and overflow through Corten steel weirs with every 2 feet of grade change. The use of steel is echoed in all phases, with custom details expressing the water story throughout. Native plants provide a robust forest

floor below the canopy simulated by the bridge structure and columns. Flowering plants were also chosen to attract and support multiple species of local pollinators.

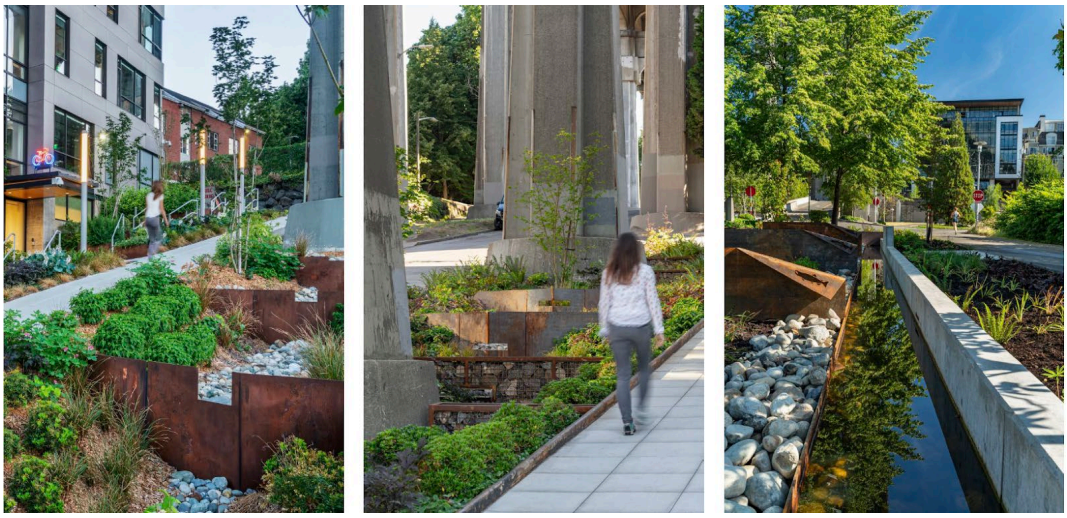


Figure 2. *The Aurora Bridge Swales phases I, II, and III is a first-of-its kind project that incorporates terraces of native plants and soils on three sites along the public right-of-way (Weber Thompson, 2022). These features function as a natural filter, and the project serves as a powerful example of the ability of private development to deploy a large-scale environmental response that can approach 100% effectiveness in reversing pollution's impacts through a replicable model.* ***This multi-faceted solution achieves NEG by beautifying the urban environment, improving biodiversity, mitigating heat-island impacts, and improving water quality while raising public awareness through community outreach and interactive educational elements.*** *Image credit: Meghan Montgomery, Built Work Photography.*

Challenges: Several barriers complicated the implementation of this vision. Among the most significant were the involvement of multiple municipal agencies and the lack of precedence for a private development to propose improvements that reach beyond the property boundary of the site. Specifically, the stormwater that falls on the Aurora Bridge changes jurisdiction many times before its outfall into Lake Union. Initially, rain falls onto the Washington State-owned bridge, where it flows into downspouts that are owned by the state but maintained by the Seattle Department of Transportation (SDOT). The downspouts end about 1 foot above the street below, where jurisdiction shifts solely to SDOT. From there, the stormwater enters a catch basin leading to a storm drain managed by Seattle Public Utilities, a subdivision of SDOT. When the storm drain crosses into a shoreline buffer within 200 feet of the water's edge of Lake Union, a set of Department of Ecology requirements and permits take effect, which include a below-grade outfall at the edge of the lake.

The simplicity of temporarily diverting stormwater was a critical factor in gaining support from the many review agencies. The approach avoided disputes over water rights or issues that might disenfranchise downstream users considering the water quality improvement.

Implementation: The second phase of the swales' construction occurred when the same design and development team proposed another office building on the opposite side of the bridge. With a clearer path for permitting and an established precedent, the project elected to divert two downspouts and take on the larger project goal of eliminating the use of potable water for non-potable uses within the building. The project installed a 20,000-gallon cistern to collect roof runoff and used the swale to slow and filter cistern overflow, which occurs for approximately 4 months out of the year.

A nearby property was also identified where five additional downspouts could be diverted into a grassy area. The third phase increased the volume of filtered bridge water to 2 million gallons, effectively treating the north half of the bridge deck above. **The goodwill and relationships built during the first and second phases helped to secure donations from other Fremont businesses for the third phase, as well as a matching grant from the state government.** As the third phase neared completion, researchers also successfully identified the chemical responsible for salmon deaths as 6PPD-quinone, a derivative of a preservative found in car tires (McIntyre et al., 2021; Tian et al., 2021).

Outcome: Tests of the water entering and leaving the swales confirmed measurable filtration of a large range of contaminants. The Aurora Bridge Swales project has won multiple awards for its successful design—most recently, the Honor Award in the General Design, Private Ownership category at the 2022 Washington Chapter American Society of Landscape Architects Awards (Weber Thompson, 2022).

Replicability: This project has high potential for replicability. Most urban bridges align with a roadway below; in these cases, green infrastructure is especially effective when the overflow at the end of the swale connects back to the existing storm pipe infrastructure that previously carried the unfiltered water to the lake or waterbody. **Reliance on green infrastructure can save municipalities from spending money to mechanically filter water at expensive treatment facilities.** Seattle Public Utilities has begun programs to incentivize similar improvements for private developments. A case study of the swales has also been included in a United Nations Guide for Sustainable Practices as a model to encourage professional designers to include green infrastructure as standard practice (Mossin et al., 2020).

Public communication and engagement: Public awareness of the transdisciplinary and innovative approach to this project is reinforced through many forms of public signage. Brass numbers embedded in the sidewalk illuminate the amount of water each swale cell mitigates. In addition, interactive brass plaques illustrate the many benefits of the strategies employed. Laser cutouts of the silhouettes of the five salmon species alert pedestrians to the greater story of how, **through smart development and design, we can help restore the aquatic environment.**

Figure 3. *The swales are built adjacent to the Aurora Bridge, a historic structure in Seattle where all five of the region's salmon species swim to reach the network of rivers and streams for spawning each year. Image credit: Weber Thompson.*

Box 6. Case Study: Seattle Waterfront

The current design of the Seattle waterfront is an excellent example of **how engineers and scientists used an interdisciplinary approach** to enhance the corridor that young salmon utilize along the waterfront as they out-migrate from the Duwamish River (Accola et al., 2022). This design was accomplished during the redevelopment of the Seattle waterfront for commercial and transportation operations.

The seawall and other structures of the highly developed Seattle waterfront suffered damage during an earthquake in 2001. A comprehensive effort to rebuild the waterfront included innovative measures to improve conditions for juvenile salmon migrating seaward from the adjacent Duwamish River. Scientists from the University of Washington and state agencies developed a plan to improve the migratory corridor used by salmon. This approach included texturizing the seawall, as well as enhancing light by incorporating glass blocks in the pedestrian walkway that borders the shoreline. The glass blocks allowed light to reach areas along the new seawall that supported algae growth. Algae form habitat for prey utilized by juvenile salmon. The light also enhanced the young salmon's ability to maintain their out-migration pattern. Research has demonstrated that the juveniles have benefited from these science-backed innovations (Accola et al., 2022). The combination of seawall enhancements and light transmittance through the walkway is considered a clear example of net ecological gain within the context of a highly active and developed shoreline redevelopment project.

Although the Seattle waterfront project includes elements from the Clinton Ferry Terminal Rebuild example, the Seattle project took advantage of a natural disaster to enhance a selected attribute (e.g., salmon feeding, rearing, and migration) in support of net ecological gain. The city of Seattle took the opportunity to highlight the positive benefits of the project and educate residents about salmon and how the community can use science to improve the environment.

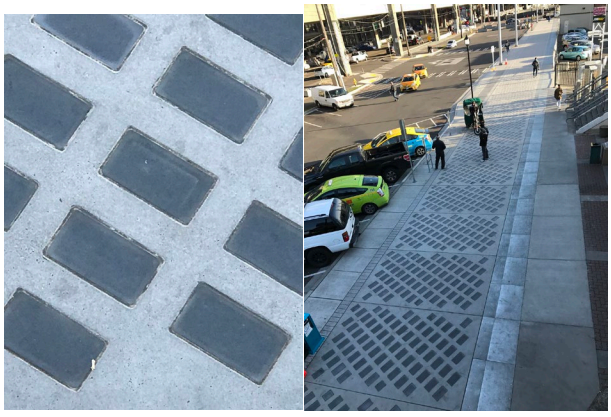


Figure 4. *View of glass blocks in Seattle waterfront walkway. These blocks allow light to stimulate growth of benthic algae that harbor prey for juvenile salmon. The blocks also provide a lighted corridor for migration of the juveniles as they exit Elliott Bay.*

VII. MONITORING IN WASHINGTON STATE

Several successful monitoring programs are found throughout the state. There are also newly developed tools and approaches for facilitating efficient monitoring across larger geographic areas (NASEM, 2022). However, not all of these resources are designed to assess indicators at the fine spatial or temporal scales that may be required at the project scale. Thus, **for individual projects, when there are critical uncertainties that would affect a system or community, there should be resources allocated for assessing variables and monitoring outcomes that go beyond data collection from previously existing regional monitoring programs**. There should also be contingency plans to repair and restore critical ecosystem elements if unexpected issues arise. This process is especially important for built infrastructure, which poses unique challenges to monitoring because development projects cannot typically be redone once they are completed.

At the landscape scale, there may also be potential for existing monitoring programs in the state to be strengthened and integrated with one another. Increased interagency collaboration and improved coordination of monitoring efforts across public and private entities could help expand spatial and temporal coverage and provide more comprehensive data on ecological trends across the state. This coordination and adequate funds to enable it are increasingly important as ecosystems and the species within them respond to climate change and land use change simultaneously.

Ecosystem types are classified by the Washington Natural Heritage Program (Washington State Department of Natural Resources, 2022), with data maintained through the international NatureServe network (http://www.natureserve.com) and summarized on an approximately 5-year cycle in State Natural Heritage Plans. Department of Natural Resources scientists have prioritized these ecosystems by conservation status ranks across each ecosystem's state (S) range and entire or global (G) range (Washington Natural Heritage Program, 2022).

A helpful step toward ecosystem process-based understanding would be the creation of a resource available to practitioners and stakeholders that is structured by the state's ecosystem types and includes the various monitoring programs that are or were implemented within each ecosystem's boundaries. The monitoring programs listed would include, for example, those for water quality and quantity, sediment transport, land cover type, geological evolution, and biota, with links to monitoring data and published reports, journal articles, and student theses and dissertations.

One demonstrated way of approaching the challenge of monitoring is to define Essential (or Potential) Conservation Areas. Several other states, including Colorado and Virginia, designate such areas as part of their natural heritage methodology. These areas are established by defining ecological boundaries around the occurrence of certain ecological elements that require long-term protection. Box 7 presents an example of how Colorado approaches this challenge.

Box 7. Potential Conservation Area (PCA):

"PCAs represent Colorado Natural Heritage's Program's best estimates of the primary areas supporting the long-term survival of targeted element occurrences and typically include adjacent suitable habitat and buffers from disturbance. PCA refers to the ability of a conservation area to maintain healthy, viable targets over the long term (100+ years), including the ability to respond to natural or human-caused environmental change. PCAs do not necessarily preclude human activities, but their ability to function naturally may be greatly influenced by them. PCAs at all scales may require ecological management or restoration to maintain their functionality. PCAs are assigned biodiversity significance ranks ranging from 1 (Outstanding Significance) to 5 (General Interest). Ranks are based on the rarity and quality of the element occurrences in the site.

Additionally, PCAs:

- Are often based on desk-top scientific references and need ground-truthing
- Focus on biological and physical factors and do not account for land ownership and political concerns
- Support land-use planning and conservation strategies but do not have legal meaning or in any way represent an attempt to regulate or limit the use of private property
- Do not automatically exclude specific activities, rather it is hypothesized that some activities will cause degradation to the elements or the processes on which they depend, while others will not."

(Colorado Natural Heritage Program, https://cnhp.colostate.edu/ourdata/help/)

VIII. NEXT STEPS FOR ADVANCING NEG IN WASHINGTON STATE

Within this report, the committee aimed to provide guidance on implementing NEG but recognizes that other critical steps must be taken prior to operationalizing this concept. Enabling NEG is a complicated process and a fairly new concept for which implementation practices will likely be learned and refined over time. Moreover, the successful implementation of NEG will vary by project scope and scale, with no single correct approach or solution.

The committee recommends the following initial steps to lay the groundwork for implementing and attaining NEG.

- Engage with the public throughout the project to increase trust, buy-in, and input around the NEG concept.
- Ensure adequate monitoring of ecosystems and habitats throughout the state to provide baselines and identify key indicators for NEG in future projects.
- Enable and incentivize cross-agency and cross-disciplinary communication and collaboration on NEG-related issues throughout the state.
- Create resources that provide information on all current monitoring systems to facilitate collaboration and access to relevant information.

- Invest in research, monitoring, and planning regarding climate change resilience to ensure ecosystem resilience and infrastructure sufficiency for addressing the impacts of future climate stressors.
- Provide funding and educational opportunities to develop a workforce trained in collaborative, interdisciplinary approaches to solving socio-ecological challenges in Washington State.

Overall, NEG provides an opportunity to take a transdisciplinary approach to promoting the health and well-being of Washington residents and the ecosystems they rely on. The precise approaches to NEG will vary by project and will depend upon available scientific evidence, engineering capabilities, and community needs. To help determine the appropriate approach for each situation, **the committee recommends the creation of a joint, interagency NEG council or committee comprising contributors from each state agency.** The Natural Areas Preserve Act of 1972—and the subsequently formed Natural Heritage Advisory Council and Natural Resources Conservation Areas—provide a possible template for cross-agency efforts to identify areas in need of protection and approaches for promoting NEG when such areas may be impacted. The committee urges that regional experts; natural, physical, and social scientists; engineers; and community leaders and partners be involved in assembling this council.

IX. CONCLUSION

In this chapter, the Committee addressed the present understanding of no net loss relative to net ecological gain and provided background information and recommendations on the process of developing metrics and indicators for net ecological gain.

Local, national, and global studies have shown that the NNL approach has been widely used but has been generally unsuccessful for several reasons. Reasons include the continued loss of habitat quality and area, inadequate implementation, offsite (as opposed to onsite) actions, and lack of enforcement. In contrast, NEG aims to achieve documented improvement in ecosystem health from the baseline ecosystem condition following redevelopment.

Successful implementation of NEG requires systematic assessment of (1) baseline conditions at a location and how the site contributes to ecological processes regionally and (2) what approaches can best be applied to maximize the probability of quantifiable gain following a redevelopment of the site. The first step should rely on available science, while the second requires input from natural and social scientists, engineers, and stakeholders to define the desired state, appropriate indicators, and steps that can be taken to achieve the desired state. The committee recognizes the complexity of these tasks and recommends employing the systematic process of structured decision making. The committee also advises applying a transdisciplinary approach that addresses social-ecological needs across multiple spatial scales.

Because of the wide array of physical and ecological conditions, as well as the diversity of potential development projects, the application of NEG is contextual. This diversity emphasizes the need to establish a process that is applicable across a range of conditions and situations. Project impacts must

also be assessed within the context of ongoing or future projects, the current condition of the surrounding landscape, and the human well-being aspects of the location, as well as projected climate change impacts.

Throughout the process of planning and quantifying NEG, there is a need for objective, science-based metrics and indicators. Within this chapter, the committee has provided a set of standard methods and guidance to develop metrics, set indicators, and establish a performance monitoring system. The committee has also included examples of recognized NEG projects in Washington State. Finally, the committee has recommended steps, including strong public involvement, to move forward in enabling and implementing NEG.

X. REFERENCES

Accola, K., Horne, J., Cordell, J., & Toft, J. (2022). Acoustic characterization of juvenile Pacific salmon distributions along an eco-engineered seawall. *Marine Ecology Progress Series*, *682*, 207–220. https://doi.org/10.3354/meps13917

Arlidge, W. N., Bull, J. W., Addison, P. F., Burgass, M. J., Gianuca, D., Gorham, T. M., Jacob, C., Shumway, N., Sinclair, S. P., & Watson, J. E. (2018). A global mitigation hierarchy for nature conservation. *BioScience*, *68*(5), 336–347.

Bennett, G., Gallant, M., & Ten Kate, K. (2017). State of biodiversity mitigation 2017: Markets and compensation for global infrastructure development. *Forest Trends' Ecosystem Marketplace, Washington, DC*.

Biber, E. (2011). The problem of environmental monitoring. *University of Colorado Law Review*, *83*(1).

Borde, A. B., Diefenderfer, H. L., Cullinan, V. I., Zimmerman, S. A., & Thom, R. M. (2020). Ecohydrology of wetland plant communities along an estuarine to tidal river gradient. *Ecosphere*, *11*(9), e03185.

Buenau, K. E., Hiller, T. L., & Tyre, A. J. (2014). Modelling the effects of river flow on population dynamics of piping plovers (Charadrius melodus) and least terns (Sternula antillarum) nesting on the Missouri River. *River Research and Applications*, *30*(8), 964–975.

Bull, J. W., Gordon, A., Law, E. A., Suttle, K. B., & Milner-Gulland, E. J. (2014). Importance of baseline specification in evaluating conservation interventions and achieving no net loss of biodiversity. *Conservation Biology*, *28*(3), 799–809.

Bull, J. W., & Strange, N. (2018). The global extent of biodiversity offset implementation under no net loss policies. *Nature Sustainability*, *1*(12), 790–798.

Business and Biodiversity Offsets Programme (BBOP). (2012a). *Guidance notes to the Standard on Biodiversity Offsets*. BBOP.

Business and Biodiversity Offsets Programme (BBOP). (2012b). *Standard on Biodiversity Offsets*. BBOP.

Cereghino, P., Toft, J. D., Simenstad, C. A., Iverson, E., & Burke, J. (2012). *Strategies for nearshore protection and restoration in Puget Sound*. U.S. Army Corps of Engineers, Seattle District.

Chow, M. I., Lundin, J. I., Mitchell, C. J., Davis, J. W., Young, G., Scholz, N. L., & McIntyre, J. K. (2019). An urban stormwater runoff mortality syndrome in juvenile Coho salmon. *Aquatic Toxicology*, *214*, 105231.

Colorado Natural Heritage Program (CNHP), Colorado State University. (2022). *Colorado Natural Heritage Program*. https://cnhp.colostate.edu/ourdata/help/

Dawson, T. P., Jackson, S. T., House, J. I., Prentice, I. C., & Mace, G. M. (2011). Beyond predictions: Biodiversity conservation in a changing climate. *Science*, *332*(6025), 53–58.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J. R., Arico, S., & Báldi, A. (2015). The IPBES Conceptual Framework—Connecting nature and people. *Current Opinion in Environmental Sustainability*, *14*, 1–16.

Díaz, S., Zafra-Calvo, N., Purvis, A., Verburg, P. H., Obura, D., Leadley, P., Chaplin-Kramer, R., De Meester, L., Dulloo, E., Martín-López, B., Shaw, M. R., Visconti, P., Broadgate, W., Bruford, M. W., Burgess, N. D., Cavender-Bares, J., DeClerck, F., Fernández-Palacios, J. M., Garibaldi, L. A., … Zanne, A. E. (2020). Set ambitious goals for biodiversity and sustainability. *Science*, *370*(6515), 411–413. https://doi.org/10.1126/science.abe1530

Diefenderfer, H. L., Borde, A. B., & Cullinan, V. I. (2021). Floodplain wetland channel planform, cross-sectional morphology, and sediment characteristics along an estuarine to tidal river gradient. *Journal of Geophysical Research: Earth Surface*, *126*(5), e2019JF005391.

Diefenderfer, H. L., Johnson, G. E., Thom, R. M., Buenau, K. E., Weitkamp, L. A., Woodley, C. M., Borde, A. B., & Kropp, R. K. (2016). Evidence-based evaluation of the cumulative effects of ecosystem restoration. *Ecosphere*, *7*(3), e012421. https://doi.org/10.1002/ecs2.1242

Diefenderfer, H. L., Sobocinski, K. L., Thom, R. M., May, C. W., Borde, A. B., Southard, S. L., Vavrinec, J., & Sather, N. K. (2009). Multiscale analysis of restoration priorities for marine shoreline planning. *Environmental Management*, *44*(4), 712–731. https://doi.org/10.1007/s00267-009-9298-4

Diefenderfer, H. L., Steyer, G. D., Harwell, M. C., LoSchiavo, A. J., Neckles, H. A., Burdick, D. M., Johnson, G. E., Buenau, K. E., Trujillo, E., Callaway, J. C., Thom, R. M., Ganju, N. K., & Twilley, R. R. (2020). Applying cumulative effects to strategically advance large-scale ecosystem restoration. *Frontiers in Ecology and the Environment*, *19*(2), 108–117. https://doi.org/10.1002/fee.2274

Ebberts, B. D., Zelinsky, B. D., Karnezis, J. P., Studebaker, C. A., Lopez-Johnston, S., Creason, A. M., Krasnow, L., Johnson, G. E., & Thom, R. M. (2018). Estuary ecosystem restoration: Implementing and institutionalizing adaptive management: Institutionalizing adaptive management. *Restoration Ecology*, *26*(2), 360–369. https://doi.org/10.1111/rec.12562

Fertig, W. (n.d.-a). *Climate Change Vulnerability Index reports for selected Washington State rare plant species. Natural heritage report 2020-04* (No. 2020–04). U.S. Forest Service.

Fertig, W. (n.d.-b). *Climate Change Vulnerability Index reports for selected Washington State rare plant species: Phase II. Natural heritage report 2022-01* (No. 2022–01). U.S. Forest Service.

Frans, C., Istanbulluoglu, E., Lettenmaier, D. P., Fountain, A. G., & Riedel, J. (2018). Glacier recession and the response of summer streamflow in the Pacific Northwest United States, 1960–2099. *Water Resources Research*, *54*(9), 6202–6225.

Gann, G. D., McDonald, T., Walder, B., Aronson, J., Nelson, C. R., Jonson, J., Hallett, J. G., Eisenberg, C., Guariguata, M. R., & Liu, J. (2019). International principles and standards for the practice of ecological restoration. *Restoration Ecology. 27 (S1): S1-S46.*, *27*(S1), S1–S46.

Gardner, T. A., Von Hase, A., Brownlie, S., Ekstrom, J. M. M., Pilgrim, J. D., Savy, C. E., Stephens, R. T. T., Treweek, J., Ussher, G. T., Ward, G., & Ten Kate, K. (2013). Biodiversity offsets and the challenge of achieving no net loss: Biodiversity offsets and no net loss. *Conservation Biology*, *27*(6), 1254–1264. https://doi.org/10.1111/cobi.12118

Grantham, T. E., Matthews, J. H., & Bledsoe, B. P. (2019). Shifting currents: Managing freshwater systems for ecological resilience in a changing climate. *Water Security*, *8*, 100049.

Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., & Ohlson, D. (2012). *Structured decision making: A practical guide to environmental management choices*. John Wiley & Sons.

Halofsky, J. E., Peterson, D. L., & Harvey, B. J. (2020). Changing wildfire, changing forests: The effects of climate change on fire regimes and vegetation in the Pacific Northwest, USA. *Fire Ecology*, *16*(1), 1–26.

Hood, W. G., Blauvelt, K., Bottom, D. L., Castro, J. M., Johnson, G. E., Jones, K. K., Krueger, K. L., Thom, R. M., & Wilson, A. (2022). Using landscape ecology principles to prioritize habitat restoration projects across the Columbia River Estuary. *Restoration Ecology*, *30*(3), e13519.

Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES). (2015). *IPBES/3/18—Report of the Plenary of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on the work of its third session, Decision IPBES-3/4: Communications, stakeholder engagement and strategic partnership*.

James, C. A., Kershner, J., Samhouri, J., O'Neill, S., & Levin, P. S. (2012). A methodology for evaluating and ranking water quantity indicators in support of ecosystem-based management. *Environmental Management*, *49*(3), 703–719.

Karr, J. R., Larson, E. R., & Chu, E. W. (2021). Ecological integrity is both real and valuable. *Conservation Science and Practice*. https://doi.org/10.1111/csp2.583

Koontz, E. D., Steel, E. A., & Olden, J. D. (2018). Stream thermal responses to wildfire in the Pacific Northwest. *Freshwater Science*, *37*(4), 731–746.

Levin, P. S., Essington, T. E., Marshall, K. N., Koehn, L. E., Anderson, L. G., Bundy, A., Carothers, C., Coleman, F., Gerber, L. R., & Grabowski, J. H. (2018). Building effective fishery ecosystem plans. *Marine Policy*, *92*, 48–57.

Lindenmayer, D. (2020). Improving restoration programs through greater connection with ecological theory and better monitoring. *Frontiers in Ecology and Evolution*, *8*, 50. https://doi.org/10.3389/fevo.2020.00050

Locke, H., Rockström, J., Bakker, P., Bapna, M., Gough, M., Lambertini, M., Morris, J., Polman, P., Samper, C., Sanjayan, M., Zabey, E., & Zurita, P. (2021). *A nature-positive world: The global goal for nature*.

Lovett, G. M., Burns, D. A., Driscoll, C. T., Jenkins, J. C., Mitchell, M. J., Rustad, L., Shanley, J. B., Likens, G. E., & Haeuber, R. (2007). Who needs environmental monitoring? *Frontiers in Ecology and the Environment*, *5*(5), 253–260. https://doi.org/10.1890/1540-9295(2007)5[253:WNEM]2.0.CO;2

Maron, M., Brownlie, S., Bull, J. W., Evans, M. C., von Hase, A., Quétier, F., Watson, J. E., & Gordon, A. (2018). The many meanings of no net loss in environmental policy. *Nature Sustainability*, *1*, 19–27.

Maron, M., Juffe-Bignoli, D., Krueger, L., Kiesecker, J., Kümpel, N. F., ten Kate, K., Milner-Gulland, E. J., Arlidge, W. N. S., Booth, H., Bull, J. W., Starkey, M., Ekstrom, J. M., Strassburg, B., Verburg, P. H., & Watson, J. E. M. (2021). Setting robust biodiversity goals. *Conservation Letters*, *14*(5). https://doi.org/10.1111/conl.12816

McIntyre, J. K., Prat, J., Cameron, J., Wetzel, J., Mudrock, E., Peter, K. T., Tian, Z., Mackenzie, C., Lundin, J., Stark, J. D., King, K., Davis, J. W., Kolodziej, E. P., & Scholz, N. L. (2021). Treading water: Tire wear particle leachate recreates an urban runoff mortality syndrome in Coho but not chum salmon. *Environmental Science & Technology*, *55*(17), 11767–11774. https://doi.org/10.1021/acs.est.1c03569

Moilanen, A., & Kotiaho, J. S. (2018). Fifteen operationally important decisions in the planning of biodiversity offsets. *Biological Conservation*, *227*, 112–120.

Mossin, N., Stilling, S., Bøjstrup, T. C., & Hau, I. (2020). *An architecture guide to the UN 17 sustainable development goals: Volume 2*.

National Academies of Sciences, Engineering, and Medicine. (2022). *An approach for assessing U.S. Gulf Coast ecosystem restoration: A Gulf Research Program environmental monitoring report*. The National Academies Press. https://doi.org/10.17226/26335

National Research Council. (1992). *Restoration of aquatic ecosystems: Science, technology, and public policy*. National Academies Press.

National Research Council. (2001). *Compensating for wetland losses under the Clean Water Act*. National Academies Press.

Neckles, H. A., Lyons, J. E., Guntenspergen, G. R., Shriver, W. G., & Adamowicz, S. C. (2015). Use of structured decision making to identify monitoring variables and management priorities for salt marsh ecosystems. *Estuaries and Coasts*, *38*(4), 1215–1232. https://doi.org/10.1007/s12237-014-9822-5

Pope, J., Morrison-Saunders, A., Bond, A., & Retief, F. (2021). When is an offset not an offset? A framework of necessary conditions for biodiversity offsets. *Environmental Management*, *67*(2), 424–435.

Pörtner, H. O., Alegría, A., Möller, V., Poloczanska, E. S., Mintenbeck, K., & Götze, S. (In press). IPCC, 2022: Annex I: Global to regional atlas. In H. O. Pörtner, D. C. Roberts, M. Tignor, E. S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, & B. Rama (Eds.), *Climate change 2022: Impacts, adaptation, and vulnerability. Contribution of Working Group II to the sixth assessment report of the Intergovernmental Panel on Climate Change*. Cambridge University Press.

Puget Sound Recovery Implementation Technical Team. (2015). *Puget Sound Chinook salmon recovery: A framework for the development of monitoring and adaptive management plans*. National Oceanic and Atmospheric Administration.

Rocchio, F. J., & Crawford, R. C. (2011). *Applying NatureServe's ecological integrity assessment methodology to Washington's ecological systems*. Washington Natural Heritage Program, Washington Department of Natural Resources. http://www1. dnr. wa. gov/nhp/refdesk/communities/pdf/eia/applying_eia. pdf

Rohwer, Y., & Marris, E. (2021). Ecosystem integrity is neither real nor valuable. *Conservation Science and Practice*, *3*(4). https://doi.org/10.1111/csp2.411

Ruhl, J. B., & Salzman, J. (2011). Gaming the past: The theory and practice of historic baselines in the administrative state. *Vand. L. Rev.*, *64*, 1.

Spromberg, J. A., Baldwin, D. H., Damm, S. E., McIntyre, J. K., Huff, M., Sloan, C. A., Anulacion, B. F., Davis, J. W., & Scholz, N. L. (2016). Coho salmon spawner mortality in western U.S. urban watersheds: Bioinfiltration prevents lethal storm water impacts. *Journal of Applied Ecology*, *53*(2), 398–407. https://doi.org/10.1111/1365-2664.12534

Thom, R. M., Diefenderfer, H. L., Vavrinec, J., & Borde, A. B. (2012). Restoring resiliency: Case studies from Pacific Northwest estuarine eelgrass (Zostera marina L.) ecosystems. *Estuaries and Coasts*, *35*(1), 78–91. https://doi.org/10.1007/s12237-011-9430-6

Thom, R. M., Williams, G., Borde, A., Southard, J., Sargeant, S., Woodruff, D., Laufle, J. C., & Glasoe, S. (2005a). Adaptively addressing uncertainty in estuarine and near coastal restoration projects. *Journal of Coastal Research*, 94–108. JSTOR.

Thom, R. M., Williams, G. W., & Diefenderfer, H. L. (2005b). Balancing the need to develop coastal areas with the desire for an ecologically functioning coastal environment: Is net ecosystem improvement possible? *Restoration Ecology*, *13*(1), 193–203. https://doi.org/10.1111/j.1526-100X.2005.00024.x

Tian, Z., Zhao, H., Peter, K. T., Gonzalez, M., Wetzel, J., Wu, C., Hu, X., Prat, J., Mudrock, E., Hettinger, R., Cortina, A. E., Biswas, R. G., Kock, F. V. C., Soong, R., Jenne, A., Du, B., Hou, F., He, H., Lundeen, R., … Kolodziej, E. P. (2021). A ubiquitous tire rubber-derived chemical induces acute mortality in Coho salmon. *Science*, *371*(6525), 185–189. https://doi.org/10.1126/science.abd6951

Timpane-Padgham, B. L., Beechie, T., & Klinger, T. (2017). A systematic review of ecological attributes that confer resilience to climate change in environmental restoration. *PLOS ONE*, *12*(3), e0173812. https://doi.org/10.1371/journal.pone.0173812

U.S. Environmental Protection Agency. (2022). *Ecosystem services*. https://www.epa.gov/eco-research/ecosystem-services

Washington Department of Fish and Wildlife. (2021). *2021 game status and trend report*. https://wdfw.wa.gov/sites/default/files/publications/02298/wdfw02298.pdf

Washington Department of Natural Resources. (2022). *State of Washington Natural Heritage Plan* (p. 92). Washington Department of Natural Resources.

Washington State Academy of Sciences. (2022). *Net ecological gain definition, goals, and objectives* (pp. 1–16). WSAS.

Washington State Department of Natural Resources. (2022). *Natural Heritage Program*. https://www.dnr.wa.gov/natural-heritage-program

Washington State Legislature. (2021). *SB 5141—2021-22: Implementing the recommendations of the environmental justice task force.* https://app.leg.wa.gov/billsummary?BillNumber=5141&Initiative=false&Year=2021

Weber Thompson. (2022). *Aurora Bridge Swales Project*.

Wende, W., Tucker, G., Quétier, F., Rayment, M., & Darbi, M. (2018). *Biodiversity offsets*. Springer.

Whidbey Cumulative Effects Group. (2022). *The cumulative effects of nearshore habitat recovery on juvenile salmonids in the Whidbey Basin: A study development report*. Puget Sound Partnership.

Wurtzebach, Z., & Schultz, C. (2016). Measuring ecological integrity: History, practical applications, and research opportunities. *BioScience*, *66*(6), 446–457. https://doi.org/10.1093/biosci/biw037

Yeardley, R. B. J., Dyson, B., & Tenbrink, M. (2011). *EPA growing DASEES (Decision Analysis for a Sustainable Environment, Economy & Society)—To aid in making decisions on complex environmental issues*. U.S. Environmental Protection Agency.

Young, B., Hall, K., Byers, E., Gravuer, K., Hammerson, G., Redder, A., & Szabo, K. (n.d.). Rapid assessment of plant and animal vulnerability to climate change. In J. F. Brodie, E. Post, & D. F. Doak (Eds.), *Wildlife conservation in a changing climate* (pp. 129–150). University of Chicago Press.

zu Ermgassen, S. O. S. E., Baker, J., Griffiths, R. A., Strange, N., Struebig, M. J., & Bull, J. W. (2019). The ecological outcomes of biodiversity offsets under “no net loss” policies: A global review. *Conservation Letters*, *12*(6). https://doi.org/10.1111/conl.12664

Appendix A.

Example of principles (P), criteria (C), and implementation indicators (I) to consider during the orientation and planning steps of a net ecological gain process. Table is divided into the four major stages of the process, and for each stage, the relevant Principles, Criteria, and Indicators are described in summary form. Although stages are organized sequentially, planning is usually iterative as some activities may call for refining earlier work. Excerpted and adapted from the Business and Biodiversity Offsets Programme (BBOP; 2012a, 2012b) to illustrate concepts.

Stage and Activity	Principles (P), Criteria (C) & Indicators
Review project scope & activities	P1: *Adherence to the mitigation hierarchy: A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimization and on-site rehabilitation measures have been taken according to the mitigation hierarchy.*
	C: The developer shall identify, implement, and document appropriate measures to avoid and minimize the direct, indirect and cumulative negative impacts of the development project and to undertake on-site rehabilitation/restoration.
	I: An assessment of the development project's impacts on biodiversity (including direct, indirect and cumulative impacts, as appropriate) is conducted with stakeholder participation
Review the legal framework and/or policy context for a biodiversity offset	P4: *Net Ecological Gain: A biodiversity offset should be designed and implemented to achieve in situ, measurable conservation outcomes that can reasonably be expected to result in net gain of biodiversity and resilience.*
	C: The net gain goal for the development project shall be explicitly stated, and the offset design and conservation outcomes required to achieve this goal clearly described.
	I: All residual biodiversity losses due to the project are quantified relative to the 'pre-project' condition of affected biodiversity, which is identified, characterized, and documented.
	C: An explicit calculation of loss and gain shall be undertaken as the basis for the offset design and shall demonstrate the manner in which a net gain of biodiversity can be achieved by the offset.
	I: A set of key biodiversity components at species, habitats, and ecosystem levels, including landscape features and components related to use and cultural values, is identified. The rationale for selecting these key biodiversity components to represent all the biodiversity affected by the project is explained and documented.
	P2: *Limits to what can be offset: There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.*
	C: The risk that the project's residual impacts on biodiversity may not be capable of being offset ('non-offsetable') shall be assessed and measures taken to minimize this risk.

	I: An assessment is undertaken to predict the level of risk that the project's residual impacts on biodiversity will be or not be capable of being offset, with special attention afforded to any highly irreplaceable and vulnerable biodiversity components.
Initiate a tribal participation process	*P6: Tribal participation: Tribes who depend on the land and its biodiversity to sustain their treaty rights will be included in the decision-making about biodiversity offsets, including their evaluation, selection, design, implementation, and monitoring.*
	C: Consultation and participation of tribes shall be integrated into the decision-making process for offset design and implementation and documented in the Biodiversity Offset Management Plan.
	I: For projects and/or offsets with adverse impacts on tribes, their free, prior and informed consent (FPIC) will be obtained and documented.
Initiate a stakeholder participation process	P6: *Stakeholder participation: In areas affected by the development project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation, and monitoring.*
	C: Consultation and participation of relevant stakeholders shall be integrated into the decision-making process for offset design and implementation and documented in the Biodiversity Offset Management Plan.
	I: Documentation of consultation and participation of stakeholders.
Apply mitigation hierarchy. Review significance of impact at regional and landscape level	P1: *Adherence to the mitigation hierarchy:*
	C: The developer shall identify, implement and document appropriate measures to avoid and minimise the direct, indirect and cumulative negative impacts of the development project and to undertake on-site rehabilitation/restoration.
	I: Measures to avoid and minimise biodiversity loss and to rehabilitate/restore biodiversity affected by the project are defined and documented, and these measures implemented, monitored and managed for the duration of the project's impacts.
	C: The biodiversity offset shall only address the residual impacts of the development project, namely those impacts left after all the appropriate avoidance, minimisation and rehabilitation/restoration actions have been identified.
	I: Any residual losses of biodiversity that may exist following avoidance, minimisation and rehabilitation/restoration are identified and described in the Biodiversity Offset Management Plan.
	P2: *Limits to what can be offset*
	C: The risk that the project's residual impacts on biodiversity may not be capable of being offset ('non-offsetable') shall be assessed and measures taken to minimise this risk.

	I: The risk assessment demonstrates how the project's residual impacts can and will be offset through specific measures and commitments, taking into account the level of risk and uncertainties regarding the delivery of the offset.
Determine the need for an offset based on residual adverse effects	*P6: Tribal participation*
	C: Consultation and participation of relevant tribes shall be integrated into the decision-making process for offset design and implementation, and documented in the Biodiversity Offset Management Plan.
	I: Relevant tribes are identified and informed of the desire to design and implement a biodiversity offset for the project.
	I: Records are maintained that document the results of informed consultation and participation of relevant tribes related to the design and implementation of the biodiversity offset.
	P6: *Stakeholder participation*
	C: Consultation and participation of relevant stakeholders shall be integrated into the decision-making process for offset design and implementation, and documented in the Biodiversity Offset Management Plan.
	I: Relevant stakeholders are identified and informed of the plan to design and implement a biodiversity offset for the project.
	I: Records are maintained that document the results of informed consultation and participation of relevant stakeholders related to the design and implementation of the biodiversity offset.
	P9: Transparency: The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner.
	C: The developer responsible for designing and implementing the biodiversity offset shall ensure that clear, up to date, and easily accessible information is provided to stakeholders and the public on the offset design and implementation, including outcomes to date.
	I: An independent mechanism (such as a steering committee, review panel, or system for peer review) is established to oversee the offset design and implementation process and report regularly to the public on their assessment of progress.
	I: Information on baseline findings, impact assessment as well as offset design and implementation is reported to stakeholders and the public in appropriate media during offset design and implementation

BIBLIOGRAPHY

Bibliography of Sources

[1] Washington State Academy of Science, "Report on Net Ecological Gain," Prepared for the Washington State Department of Fish and Wildlife, 2022.

[2] Department of Ecology, "SMP Handbook Chapter 4 No Net Loss of Shoreline Ecological Functions," 2009.

[3] G. Tucker, W. Wende, F. Quétier, M. Rayment and M. Darbi, "Biodiversity Offsets—The European Perspective on No Net Loss of Biodiversity and Ecosystem Services," 2018.

[4] Washington Biodiversity Council, "Washington Biodiversity Status and Threats," 2019.

[5] Washington State Academy of Sciences, "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring," Prepared for the Washington State Department of Fish and Wildlife, 2022.

[6] S. zu Ermgassen, J. Baker, R. Griffiths, N. Strange, M. Struebig and J. Bull, "The ecological outcomes of biodiversity offsets under “no net loss” policies: A global review," *Conservation Letters,* vol. 12, no. 6, 2019.

[7] POST (Parliamentary Office of Science and Technology), "POSTbrief 34: Net Gain," UK Parliament, 2019.

[8] The Environment Bank, "Accounting for Biodiversity in Planning. A toolkit for Local Planning Authorities in England.," 2018.

[9] Tahoe Regional Planning Agency, "Threshold Standards and Regional Plan," 2012.

[10] J. Bull and S. Brownlie, "The transition from No Net Loss to a Net Gain of biodiversity is far from trivial," *Oryx,* vol. 51, no. 1, pp. 53-59, 2015.

[11] S. Trémolet, I. Dickie, J. Treweek and T. Reisch, "Biodiversity Net Gain in England: Developing Effective Market Mechanisms. A Discussion Paper," The Nature Conservancy, London, 2021.

[12] J. Baker, "Biodiversity Net Gain: Good practice principles for development," 2016.

[13] J. Baker, R. Hoskin and T. Betterworth, "Biodiversity net gain. Good practice principles for development. A practical guide.," 2019.

[14] Chartered Institution of Water and Environmental Management, "Environmental Net Gain. Measurement, Devlivery, and Application.," Findings of the CIWEM conference, London, 2018.

[15] State of Washington Office of the Attorney General Bob Ferguson, "Advisory Memorandum and Recommended Process for Evaluating Proposed Regulatory or Administrative Actions to Avoid Unconstitutional Takings of Private Property," 2018.

[16] J. P. G. Jones, J. W. Bull, D. Roe, J. Baker, V. F. Griffiths, M. Starkey, L. J. Sonter and E. Milner-Gulland, "Net Gain: Seeking Better Outcomes for Local People when Mitigating Biodiversity Loss from Development," *One Earth,* vol. 1, no. 2, pp. 195-201, 2019.

[17] Tahoe Regional Planning Council, "Threshold Standards and Regional Plan," 1987.

[18] Ministry of Housing, Communities & Local Government, "National Planning Policy Framework," London, 2021.

[19] Department for Environment Food and Rural Affairs, "Biodiversity Offsetting Pilots. Technical Paper: the metric for the biodiversity offsetting pilot in England," 2012.

[20] U.S. Environmental Protection Agency, "Ecosystems and Climate Change Research," 2022.

[21] H. &. Jackson, "Synthesis of Two Decades of US EPA's Ecosystem Services Research to Inform Environmental, Community, and Sustainability Decision Making," *Sustainability 13, no. 15: 8249.,* 2009.

[22] B. &. Banzhaf, ""Valuing the Protection of Ecological Systems and Services: A Report of the EPA Science Advisory Board," 2007.

[23] "What are ecosystem services? The need for standardized environmental accounting units," *Ecological economics, 63(2-3),* pp. pp.616-626..

[24] P. L. I. T.-O. S. e. a. Menéndez, "The Global Flood Protection Benefits of Mangroves," *Sci Rep 10, 4404 ,* 2020.

[25] U.S. Environmental Protection Agency, "Ecosystem Services Research".

[26] Washington State Academy of Sciences, "Assessment of No Net Loss and Recommendations for Net Ecological Gain Metrics, Indicators, and Monitoring," Prepared for the Washington State Department of Fish and Wildlife, 2022.

[27] Planning Advisory Service, "Biodiversity Net Gain FAQs - Frequently Asked Questions," 2022. [Online]. Available: https://www.local.gov.uk/pas/topics/environment/biodiversity-net-gain-local-authorities/biodiversity-net-gain-faqs. [Accessed 20 September 2022].

[28] Department for Environment Food & Rural Affairs, "Net Gain. Summary of responses and government response," 2019.

[29] J. Bull, J. Baker, V. Griffiths, J. Jones and E. Milner-Gulland, "Ensuring No Net Loss for people and biodiversity: good practice principles.," Oxford, 2018.

[30] Washington State Legislature, "WAC 173-26-201(2)(c)," 2004.

[31] Commerce, "Critical Areas Handbook," Washington Department of Commerce, Olympia, WA, 2018.

[32] Washington State Legislature, "WAC 220-660-050 (13)".

[33] Washington State Legislature, "WAC 173-204".

[34] Washington State Legislature, "State Environmental Policy Act (chapter 43.21C RCW)," 1983.

[35] WADNR, "Forest Practices Habitat Conservation Plan," Washington Department of Natural Resources, Olympia, WA, 2005.

[36] Washington Department of Ecology, "Shoreline Master Programs Handbook," Olympia, WA, 2017.

[37] Washington Department of Ecology, "Shoreline Master Programs Handbook," 2017.

[38] *Whidbey Environmental Action Network v. Island County,* 2015.

[39] *Ann Aagaard, Judy Fisher, Bob Fisher, Glen Conley, and Save a Valuable Environment (SAVE)v. City of Bothell,* 2015.

[40] *Swinomish Indian Tribal Community v. Western Washington Growth Management Hearings Board,* 2007.

[41] *Whidbey Environmental Action Network v. Island County,* 2015.

[42] U.S. Environmental Protection Agency, "Ecosystem Services - EnviroAtlas Overview. Accessed," 2022.

[43] U.S. Environmental Protection Agency, Office of the Administrator, Science Advisory Board , 2009.