



Climate Change and the Puget Sound: Building the Legal Framework for Adaptation

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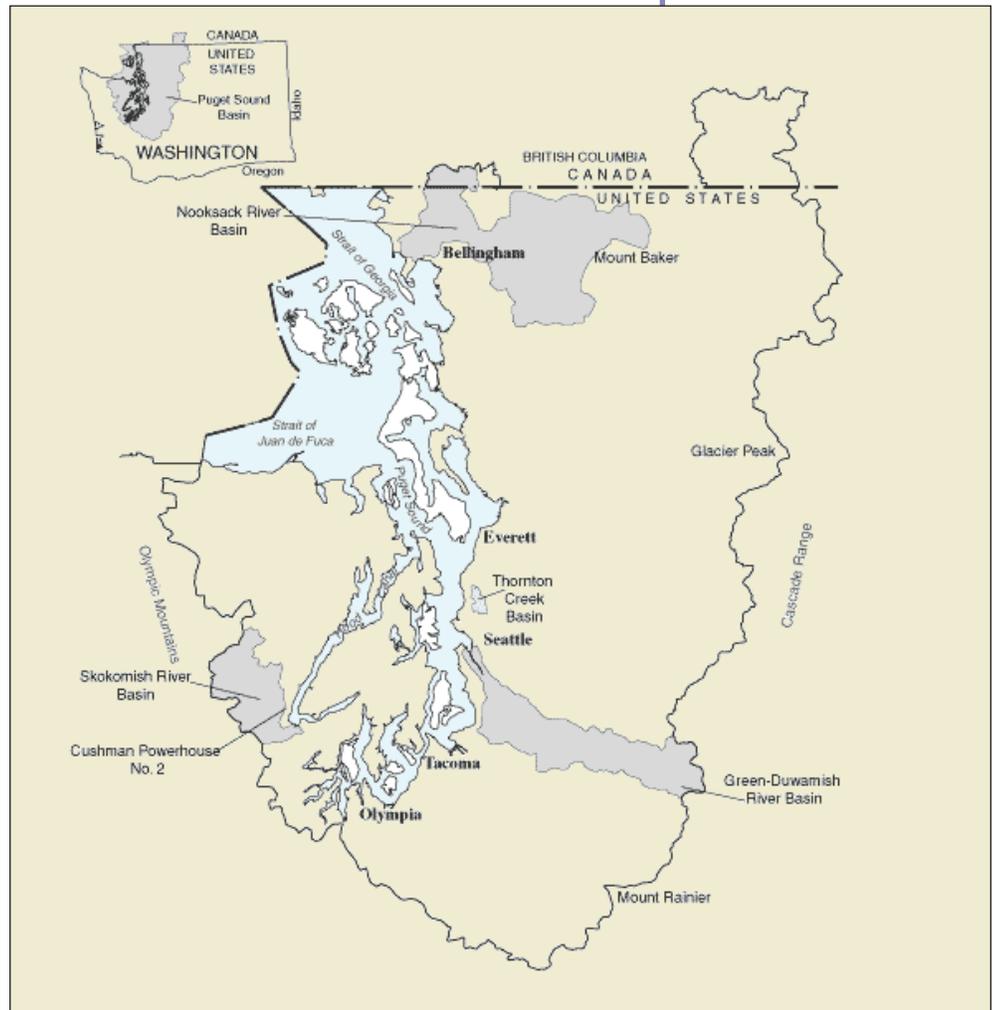
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I. Executive Summary

The scope of climate change impacts is expected to be extraordinary, touching every ecosystem on the planet and affecting human interactions with the natural and built environment. From increased surface and water temperatures to sea level rise, climate change promises vast and profound alterations to our world. Indeed, scientists predict continued climate change impacts regardless of any present or future mitigation efforts due to the long-lived nature of greenhouse gases emitted over the last century. Thus, the need to adapt to this new future is crucial. Adaptation may take a variety of forms, from implementing certain natural resources management strategies to applying principles of water law to mimic the natural water cycle. The goal of adaptation efforts is to lessen the magnitude of these impacts on humans and the natural environment through proactive and planned actions. The longer we wait to adopt a framework and laws for adapting to climate change, the more costly and painful the process will become.

Washington State is already a leader in addressing climate change effects, recognizing the need both to assess the likely impacts of climate change and to identify and implement adaptation strategies. In 2009, the Climate Impacts Group (CIG) released a detailed report on the impacts of climate change across the state. The purpose of this manual is to construct from CIG's scientific findings a legal framework to enable policymakers in the Puget Sound Basin to identify and adopt environmentally protective and socially equitable adaptation strategies.



This manual first examines the overarching procedural strategies that apply to every climate change impact and every sector. In identifying adaptation strategies, lawmakers and policymakers should decide whether the proposed strategy meets certain criteria. The questions below should guide the selection of strategies:

Does the proposed adaptation strategy:

- Acknowledge uncertainty in the models or projections of the climate change impact?
- Increase the resilience of natural systems and human communities?
- Rely as much as possible on natural infrastructure to buffer the impacts of climate change?
- Incorporate principles of fairness and reduce personal and community risk?
- Lead to proactive and precautionary actions?
- Have multiple benefits for other sectors or benefit climate change mitigation efforts?
- Consider the long-term timeframe?
- Avoid maladaptive outcomes or strategies that focus only on the short-term or foreclose future options?
- Maximize the use of existing legislation or legal tools?

Unlike mitigation efforts, which have a single goal of reducing the concentration of greenhouse gases in the atmosphere, adaptation efforts will take various forms that necessarily reflect the localized impacts of climate change. Washington and communities and Tribes within the Puget Sound Basin must also act in the face of uncertainty. Although climate scientists agree on many of the likely effects of climate change, regional climate models are unable to predict specific extreme flooding events or in which year the sea level will reach a specific height. Thus, the legal framework must incorporate *principled flexibility*, meaning that state agencies and local governments should be given flexibility in preparing for a changing climate, yet be held accountable for implementing adaptation actions by the public. Flexibility should not translate into open-ended discretion to delay, do nothing, or deviate materially from the overarching regulatory and management goals.

As lawmakers and advocates consider using existing laws to address adaptation or propose new legislation or interpretations, they should integrate features of this principled flexibility identified in this manual:

Planning

Planning for available options before a disaster or emergency situation occurs will likely reduce the chaos of post-disaster recovery, when the rush to provide assistance may ignore crucial needs or prevent public participation.

Scenario Planning

Scenario planning is a tool to integrate scientific considerations into the policymaking process. Using quantitative and qualitative models, scenario planning can help policymakers visualize future outcomes based on various decisions, policies, or societal pathways. The scenarios should include a worst-case outcome and not focus exclusively on the most likely outcome.

Triggering Mechanisms or Benchmarks

One mechanism for creating principled flexibility is to establish thresholds or benchmarks that, if reached, trigger a certain course of action. Unbounded flexibility creates a risk that agencies will abuse their discretion by failing to act when necessary.

Periodic Review and Revision of Strategies

Flexibility in the adaptation context will require the ability to review and adjust strategies as climate change impacts occur. Introducing follow-up mechanisms or requiring periodic review and revision of decisions to incorporate new information or data will unshackle environmental laws from this front-loaded process, allowing management adjustments to tailor decisionmaking to changing and realistic conditions.

Redundancy

Climate change strategies should include a certain amount of redundancy or backstop measures in case primary actions are inadequate or overwhelmed.

Building principled flexibility into the existing law is a necessity, and transforming the governance space into a fluid, dynamic web will help communities better respond to climate change.

This manual then identifies some of most relevant strategies to address the major impacts of climate change in the Puget Sound Basin, identifies overarching themes for addressing major impacts, and lays the foundation for the future discussion, exploration, and implementation of new ideas. This manual is in no way a comprehensive look at all anticipated climate change impacts and all of the legal tools needed to address them. Instead, it focuses on key principles for selecting adaptation strategies, selected examples of how existing law enables or foils adaptation, and new proposals to enable adaptation to a climate-altered world. The following tables summarize these strategies and recommendations:

Recommendations: Changes to the Hydrologic Cycle

For the Puget Sound Basin, climate change will alter the timing and flow of spring snowmelt and winter runoff. Climate models indicate that over the next century the spring snowmelt will decline and eventually disappear, replaced by an elevated winter runoff peak.

Overarching Principles

- Strictly implement and vigorously enforce the Clean Water Act
- Quantify water resources
- Integrate science into water law by adopting a watershed approach to water resources management
- Recognize the tension between adaptation strategies for human water use and ecosystem water use

Specific Adaptation Strategies & Selected Examples

Reform prior appropriation	Bolster the public interest review	The Department of Ecology should establish criteria or guidance to determine what proposed uses are “not detrimental to the public interest” in light of climate change impacts on the hydrologic cycle.
	Enforce relinquishment for abandonment or failure to beneficially use water	The Department of Ecology should enforce the “beneficial use” component of prior appropriation and, in developing a water budget, identify abandoned water uses.
	Establish incentives for conservation	Public water utilities should establish tiered, seasonal pricing of water that reflects its full cost or other financial incentives for users who achieve a stated level of conservation.
	Facilitate the ability to transfer water or change uses	The Washington Legislature and the Department of Ecology should continue developing water banks and other incentives or rules to make water available when and where it is needed.

Specific Adaptation Strategies & Selected Examples		
Enhance instream flows	Enforce instream flow rules and trust water rights for ecosystems and aquatic resources	The Washington Legislature should pass legislation to guarantee a minimum volume or percentage of flow for environmental purposes that must be fulfilled prior to non-domestic uses and to prioritize instream, environmental uses of water.
	Establish incentives to encourage more permanent transfers of water rights	The Washington Legislature should establish tax or other benefits to encourage the permanent retirement of water rights, particularly those with senior priority dates.
	Establish water quality criteria for flow	The Department of Ecology and delegated Tribes should establish seasonal, dynamic flow levels using numeric standards in section 303 of the Clean Water Act. Ultimately the U.S. Environmental Protection Agency should develop guidance to encourage states to adopt numeric flow standards.
	Establish adequate flows below impoundments	The Department of Ecology and delegated Tribes should use its authority under the Clean Water Act to ensure that flow regimes below impoundments meet water quality standards.
Improve water quality under the Clean Water Act	Reduce or remove as many existing stressors as possible to increase aquatic ecosystem resilience	The Department of Ecology and delegated Tribes should ensure that pollutant discharge permits are clearly written, should ensure that permit holders comply with the permit terms, and should bring enforcement actions if necessary.
	Administer the Total Maximum Daily Load program on a watershed basis	The Department of Ecology, delegated Tribes, and the U.S. EPA should establish TMDLs to both restore the individual impaired water and contribute to the overall restoration of the watershed.
	Reduce pollution from nonpoint sources	The Washington Legislature should authorize the Department of Ecology to regulate pollution from nonpoint sources if voluntary programs are inadequate.
Use the Endangered Species Act to assist with species adaptation	Use the critical habitat designation to enable migration	Environmental advocates should push the U.S. Fish and Wildlife Service to designate habitat that may be critical for species to use as migration corridors or future habitat.
	Use recovery plans as a source of information to promote adaptation plans for species	The Department of Natural Resources should use information in a species' recovery plans to establish more protective regulations if federal protections are inadequate.
	Maximize consultation requirement to prevent further harm to species	Federal agencies in the Puget Sound Basin should ensure that their responses to climate change impacts do not further jeopardize endangered or threatened species.

Recommendations: Sea Level Rise

Climate change will cause both the gradual, landward encroachment of the high water mark and sudden, episodic changes to shorelines and coastlines.

Overarching Principles

- Institute coastal planning and scenario building based on different projections of sea level rise
- Rely on natural features of the shoreline or other “green infrastructure”
- Identify critical impacts on other sectors such as public health and transportation

Specific Adaptation Strategies & Selected Examples

Adopt a statewide definition of a coastal hazard area		A county or city with a comprehensive plan should consider the impacts of sea level rise in the definition of a geologically hazardous area or as part of a new element, the coastal hazard area. Alternatively, the Washington Legislature should amend the Growth Management Act to include a coastal hazard element.
Use the Shoreline Management Act to consider sea level rise	Consider the impact of sea level rise on existing and projected shoreline uses in the shoreline use analysis	The Department of Ecology should require consideration of sea level rise in the shoreline use analysis of shoreline master programs through guidance or new regulations.
	Consider how to redefine the “no net loss” policy in light of sea level rise	The Department of Ecology should begin considering how sea level rise will affect the “no net loss” policy for shorelines by soliciting public input.
	Require applications of conditional use permits to demonstrate how a proposed use will adapt to sea level rise	The Department of Ecology should establish guidance or new regulations to ensure that an applicant describes how a proposed conditional use will adapt to sea level rise.
Adopt coastal resilience plans		Coastal communities and Tribes around the Puget Sound should adopt coastal resilience plans that identify how to enhance the resiliency of shorelines, prioritizing where possible the restoration of natural features to serve as buffers.
Apply rolling easements and selected retreat from certain shorelines		Environmental advocates should promote the movement of structures away from shorelines through rolling easements and selected retreat, working with local communities and governments to identify and negotiate appropriate areas.
Enforce and broaden the scope of the public trust doctrine	Protect and maintain natural features of trust lands and resources	Environmental advocates should push the Department of Ecology to actively fulfill the public trust duties of protecting shoreline uses, public access, and the shoreline itself in the face of sea level rise.
	Defend against takings claims for government actions to protect trust resources	Local governments should rely on the public trust doctrine among other authorities to defend trust resources.
	Support other common law remedies to protect shorelines	Local governments should use a variety of common law remedies to fill in gaps in statutory protection of shorelines and other trust resources.

Recommendations: Increased Average Temperature and Extreme Weather Events

Climate change is projected to increase the average surface temperature in Washington and is likely to increase the frequency of extreme heat and precipitation events.

Overarching Principles

- Adopt an integrated, holistic approach to increase community and individual resilience
- Adopt adaptation strategies that have co-benefits for other sectors or that link to other sectors
- Consider underlying disparities or differences that affect a community’s ability to adopt to or recover from an extreme weather event

Specific Adaptation Strategies & Selected Examples

Plan for disasters and other extreme weather events		Tribes and local governments should adopt disaster management plans that are “adaptation aware,” including a projection of future climate change-induced risks, basic information about the community structure, a post-disaster vision for a resilient community; a description of post-disaster goals and policies; and clear designation of public and private organizations’ roles and responsibilities
Use the Clean Air Act to improve air quality	Ensure achievement of current air quality standards	The Department of Ecology and delegated Tribes should ensure that, at a minimum, all sources of air pollution are meeting current air quality standards through careful permit oversight and increased enforcement efforts, if necessary.
	Revise guidance on determination of attainment status	At the federal level, the U.S. EPA should revise guidance that relies on historical data to demonstrate achievement of attainment status.
	Revise guidance on determination of future achievement of attainment status	At the federal level, the U.S. EPA should revise guidance on demonstration of future achievement of attainment status to reflect background air quality conditions that are likely to be worsened by climate change impacts.



Adapting to climate change impacts in the Puget Sound Basin will require an innovative and sustained approach that recognizes the many connections between and among human interactions and ecosystems. Broad swaths of natural resources and communities will be affected, and the response must be integrated, holistic, and multi-disciplinary. Climate change will challenge the legal status quo, forcing policymakers to rethink existing tools and how they may apply to previously unknown problems.

Facing tough policy questions now and laying the foundation for responding to climate impacts, both gradual and catastrophic, are among the best adaptation strategies that Washington and communities in the Puget Sound Basin can take to ensure environmentally protective and socially equitable adaptation to climate change.

II. Introduction & Purpose of the Manual

It is tempting to imagine that the discernible impacts of climate change will be felt only in certain areas most vulnerable to certain anticipated impacts, such as low-lying areas and coastal areas. Such thinking is fanciful. The scope of climate change impacts is extraordinary, reaching every ecosystem on the planet and affecting human interactions with the natural and built environment. From increased surface and water temperatures to sea level rise, climate change promises vast and profound alterations to our world. Yet the daunting scope and unpredictability of these impacts cannot become an excuse for paralysis and inaction. Although the focus has long been on mitigation—that is to say, efforts to reduce greenhouse gas (GHG) concentrations in the atmosphere—past and ongoing emissions guarantee certain changes, regardless of future reductions. Moreover, these changes are likely to last for at least a century or two, and probably more. Thus, the need to adapt to this new future is crucial. The longer we wait to adopt a framework and laws for adapting to climate change, the more costly and painful the process will be.

The purpose of this manual is to provide policymakers, advocates, and the public with some approaches to adapting to the impacts of climate change in the Puget Sound Basin by using the existing legal framework and by offering ideas for new legislation. State agencies, public and private organizations, and grassroots advocates in Washington have an opportunity to strengthen their leadership in climate change science and policy by adopting and promoting adaptation strategies that are environmentally protective and socially equitable. This manual identifies some of these strategies, identifies overarching themes for addressing major impacts, and lays the foundation for the future discussion, exploration, and implementation of new ideas. This manual is in no way a comprehensive look at all anticipated climate change impacts or at all of the legal tools needed to address them. Instead, it focuses on key principles for selecting adaptation strategies, selected examples of how existing law enables or foils adaptation, and new proposals to enable adaptation to a climate-altered world.

III. Climate Change Initiatives in Washington

Washington is a leader in addressing climate change action, recognizing the need both to assess the likely impacts of climate change and to identify and implement adaptation strategies. Various state agencies, tribal governments, counties, and municipalities have already undertaken important adaptation initiatives. The state has conducted extensive studies on the impacts of climate change in the region and has assessed the vulnerabilities and basic capacity of the state to adapt to these impacts. Using this information, Washington is in the early stages of identifying and assessing adaptation options to respond to the changes that have already begun and are expected to result from climate change.

The state has begun to create a legal framework for climate change adaptation. In 2007, Gov. Christine Gregoire issued Executive Order 07-02, which focused on mitigation and overall reductions in greenhouse gas emissions. The Order set reduction goals relative to levels of emissions in the 1990s, seeking by 2020 to reduce emissions to 1990 levels and by 2025 to reduce emissions to 50 percent below 1990 levels, the equivalent of an absolute reduction by 50 million metric tons below 2004 levels.² This Order also established the Washington Climate Change Challenge to address the specific steps that the state should take to decrease the magnitude of climate change. The Climate Advisory Team (CAT), supported by five Technical Working Groups (TWGs) and five Preparation and Adaptation Working Groups (PAWGs), issued its final report and recommendations in February 2008. The recommendations for adaptation focused on improving data-sharing and public awareness of climate change impacts; incorporating climate change impacts into planning; and improving water supply management.³

Two years later, Executive Order 09-05 specifically addressed adaptation by, among other things, directing the Department of Ecology (Ecology) to “evaluate the potential impacts of sea level rise... and develop recommendations for addressing these impacts.” The Order also directed Ecology and the Department of Health to “develop specific guidelines, tools, and recommendations to assist the state and its water users to meet the anticipated changes in water resources due to climate change impacts.”⁴

Under Washington law, the integrated climate change response strategy directs adaptation and preparation efforts. Among other provisions, the strategy:

- Directs state agencies to develop “an integrated climate change response strategy to better enable state and local agencies, public and private businesses, nongovernmental organizations, and individuals to prepare for, address, and adapt to the impacts of climate change” by December 2011.⁵

- Requires the integrated climate change response strategy to address “the impact of and adaptation to climate change, as well as the regional capacity to undertake actions, existing ecosystem and resource management concerns, and health and economic risks.”⁶
- Requires state agencies to “strive to incorporate adaptation plans of action as priority activities when planning or designing agency policies and programs. Agencies shall consider: The integrated climate change response strategy when designing, planning and funding infrastructure projects; and incorporating natural resource adaptation actions and alternative energy sources when designing and planning infrastructure projects.”⁷

Within the Puget Sound Basin, King County has been on the front lines of taking climate change adaptation actions and preparing the county for future adaptation efforts. The 2007 King County Climate Plan laid the foundation for focusing adaptation efforts on collecting more scientific data on the potential impacts on public health, safety, and emergency preparedness; water supply and quality issues; the built environment; the economy; and the natural environment.⁸ To date, King County has acquired repetitive-loss properties and other at-risk properties in the floodplain and has invested in maintenance and repair of flood-control structures.⁹ In addition, the county has begun to assess climate impacts on the built infrastructure and on public health.

Case Study: Swinomish Indian Tribal Community’s Climate Adaptation Action Plan¹⁰

Around the world, some of the communities that are most affected by climate change are indigenous communities, for whom the impacts of climate change may alter not only the natural environment but also their sense of identity. Because of the acute cultural impacts climate change is expected to produce, indigenous communities are also among the leaders of preparedness and adaptation. In 2010, the Swinomish Indian Tribal Community released its *Climate Adaptation Action Plan*, which identifies specific and unique impacts on the tribal members and resources and lays the

foundation for addressing these impacts. The Plan grew out of a series of abnormal and severe extreme weather events in the past decade, including unusually strong storms, storm surges, heat waves, and high tides.

The Swinomish Reservation is located north of Seattle on the southeastern peninsula of Fidalgo Island. The reservation comprises approximately 10,350 acres and includes more than 3,000 tribal members. The Tribe depends heavily on the abundant salmon, shellfish, and other flora and fauna from both the land and the water. Tribal members maintain historical connections to the natural resources, land, and waters of their ancestral homeland, “connections



The Maiden of Deception Pass is a Samish story pole that represents Ko-Kwal-Alwoot, a young Samish girl who was transformed into a sea spirit. Overlooking the water, she protects the Samish Indian Tribe and provides plentiful fish, shellfish, and water resources for her people.

that go back generations and are deeply embedded in the cultural foundations of tribal life and community.”¹¹ The socioeconomic conditions for the Swinomish, characterized by low graduation rates, high unemployment, below average income levels, and high rates of violence and drug abuse, pose obstacles to adaptation by lowering overall community health.¹²

Native communities measure overall community health and resilience to climate change impacts using unique factors that link physical, mental, and spiritual aspects. Five primary indicators define overall community health: community cohesion, food security, ceremonial use, knowledge transmission, and self-determination.¹³ For example, a severe weather event that causes the community to disperse—affecting community cohesion and knowledge transmission—would have a negative impact on community health. Because place is so central to identity, communities are likely to resist relocation as a response to climate change impacts. Dwindling natural resources for food consumption and ceremonial uses would have a similarly negative effect on community health, and existing socioeconomic conditions hamper resiliency. Thus, climate change adaptation strategies must consider the vitality of each of these factors to ensure maximum community health and cultural resilience.

The Swinomish and other Native communities are also in a unique position

to contribute indigenous knowledge to the discussion of and solutions to climate change adaptation. *Indigenous knowledge* is the knowledge of and beliefs in the interconnections between humans and the environment in the web of life. This body of embedded knowledge is accumulated over time and is dynamic, moral, and spiritual. It is also place-based, in relation to the specific local culture from which the knowledge originates.¹⁴ As Washington and communities and tribes in the Puget Sound Basin collaborate to identify adaptation strategies, they should consider the depth of knowledge and wealth of anecdotal observations that Native communities offer. For example, tribal members may be able to provide insight into the necessary components of a healthy forest ecosystem based on historical observations and an intimate understanding of the interactions among species.

Adaptation strategies must also explore the implication for treaty rights and tribal sovereignty in light of climate change impacts. For example, “first foods” are traditional or cultural foods that tribes have relied on for centuries and are central to their culture. Treaty rights often provide for access to these foods, including salmon, deer, and berries. If climate change renders the waters of the Puget Sound uninhabitable for salmon, adaptation strategies must consider how to continue fulfilling this treaty right.

IV. Framework and Principles of Adaptation

A. What is Adaptation?

The mainstream discussion of climate change has long focused on mitigation—that is, what humans can do to reduce the sources of or increase the sinks for greenhouse gases.¹⁵

The ultimate goal of mitigation strategies is to reduce the ambient concentration of greenhouse gases in the atmosphere, thereby attenuating adverse climate related impacts. Proposals to limit carbon dioxide emissions from power plants, to switch to renewable sources of energy, or to increase fuel efficiency in cars all address mitigation. Examples of increasing carbon dioxide sinks include extending rotation ages in working forests, halting deforestation, restoring riparian vegetation along stream banks, and modifying agriculture practices.

More recently, however, discussion of adaptation has been added to the policy mix. Adaptation is defined by the Intergovernmental Panel on Climate Change (IPCC) as “the adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects.” Underlying adaptation efforts is an acceptance that certain climate change impacts will inevitably occur. The goal of adaptation efforts is to lessen the magnitude of these impacts on humans and the natural environment through proactive or previously planned reactive actions. As the IPCC said, “[M]itigation will always be required to avoid ‘dangerous’ and irreversible changes to the climate system. Irrespective of the scale of mitigation measures that are implemented in the next 10-20 years, adaptation measures will still be required due to inertia in the climate system.”¹⁷

Despite the overwhelming consensus on certain effects from climate change, the process of climate change adaptation is daunting and presents a number of difficult challenges. From a scientific and technical perspective, some of the specific, local impacts of climate change can be extremely uncertain. For example, climate models generally agree that climate change will impact the water cycle, but the exact impacts may be very different in western and eastern Washington. Models, moreover, cannot precisely predict specific events, such as floods or droughts. Climate change also undermines the reliability of historical data in predicting future phenomena such as extreme weather events. Incorporating this uncertainty into adaptation planning is crucial but inherently difficult because the extent and timing of these impacts are unknown.

Irrespective of the scale of mitigation measures that are implemented in the next 10 to 20 years, adaptation measures will still be required due to inertia in the climate system.

- Intergovernmental Panel on Climate Change

Institutionally, the existing fragmentation of authority to manage natural resources may preclude a holistic approach to climate change adaptation.¹⁸ For example, water resources management may involve federal agencies like the Environmental Protection Agency, the Fish and Wildlife Service, and the Army Corps of Engineers, state agencies like the Department of Ecology, and local governments that design comprehensive land use plans. In addition, there is a concern that adaptation efforts, much like mitigation efforts, will suffer from a lack of long-term funding and, at times, a lack of political will to support the necessary changes. Thus, successful climate change adaptation will depend upon public education and outreach and strong advocacy efforts by grassroots organizations, which must be independent of and yet occur simultaneously with the increased use of legal tools.

Despite these obstacles, focusing on adaptation is imperative because of what scientists call the “inertia” of the climate. Past and current emissions have set into motion a series of changes that will very likely occur regardless of future reductions in emissions because of the long-lived nature of greenhouse gases (especially carbon dioxide) and the absorption of heat by the oceans.¹⁹ Mitigating emissions to lessen additional impacts remains a priority, but communities must also prepare to address the changes that will result regardless of future mitigation efforts.

Existing environmental and natural resource management laws tend to equip agencies with the tools to address only the variations that fall into a mostly predictable and limited range based on historical records. Climate change upends this legal paradigm of reasonable predictability because of the unprecedented nature of the changes it has begun to induce, leading scientists and scholars to look for a new policymaking paradigm.²⁰ In addition, non-climatic factors such as demographic changes and population growth, invasive species, and habitat degradation may further exacerbate the impacts of climate change or create feedback loops and vice versa.

B. Foundations of the Adaptation Framework

The recommendations for legal reform to prepare the Puget Sound region to adapt to climate change are guided by a set of principles with this overarching goal: to adopt and employ the most environmentally protective and socially equitable policies. These principles include:

- **Acknowledge uncertainty.** The strength of climate models is their ability to predict general trends in average surface temperature, sea level rise, or other global impacts. However, regional or local models are unable to predict the precise extent of these impacts at localized scales that are more useful for planning. Although the ability to downscale climate impacts is improving, uncertainty surrounding the precise impacts should be acknowledged and accommodated through scenario-based planning and other tools discussed in section VIII.B, rather

than used as an excuse for inaction. The corollary of acknowledging uncertainty is to collect as much information and data as possible and to conduct vulnerability assessments and mapping.

- **Increase resilience of natural systems and human communities.** The IPCC defines “resilience” as the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change.²¹ For natural systems, increasing resilience means in part to remove to the extent possible existing stressors such as invasive species and air and water pollution. For human communities, increasing resilience may include improving public health or socio-economic conditions prior to a disturbance and ensuring access to re-building resources after a disturbance.
- **Rely on natural infrastructure as much as possible.** Natural systems have evolved to adapt to changing climates, and this natural or green infrastructure should be incorporated into the overall climate change adaptation strategy. Green infrastructure prolongs the natural ecosystem, whereas grey and other manmade infrastructure often eliminate natural buffers. In many places, however, human development and encroachment have permanently eliminated this capacity or rendered the ecosystem much less resilient. Where possible, climate change adaptation strategies should use the natural buffering capacity of forests, shorelines, and wetlands to absorb the impacts of climate change, whether by designating protected areas, restoring natural features, or increasing resilience.²²
- **Incorporate fairness and reduce personal and community vulnerability.** Climate change impacts, like natural disasters, are likely to highlight social and economic fractures by disproportionately affecting vulnerable groups such as low-income populations or racial minorities. Adaptive reforms should protect public health, safety, and environment in ways that “promote distributional fairness and that do not increase... vulnerabilities.”²³
- **Adopt proactive and precautionary strategies.** Adaptation strategies can be either *proactive* or *reactive*. Proactive strategies are designed to reduce future harms before those harms occur or to maximize benefits. In contrast, reactive strategies are contemporaneous responses to observed climate change impacts, typically through emergency and disaster response.²⁴ This wait-and-see approach is generally perceived as inefficient and unsuccessful in addressing irreversible damage, though it may be appropriate for some climate-related impacts that are highly uncertain and difficult to anticipate.²⁵ While designing proactive strategies may be information-limited, these strategies allow decisionmakers to assess baseline capacities, fill gaps, and plan for major impacts before they occur.

- **Select strategies that provide multiple benefits for other sectors and for climate change mitigation.** Adaptation approaches have been described as “low regrets,” “no regrets,” or “win-win.”²⁶ “Low regrets” actions result from moderate additional investments to increase the ability to adapt to climate change impacts.²⁷ “No regrets” actions provide benefits regardless of whether or not a projected climate change impact occurs. These actions, for example, address non-climatic driven changes but, if climate impacts occur, provide additional adaptation benefits. Finally, “win-win” strategies reduce the magnitude of a particular impact and also provide additional environmental, social, or economic benefits.²⁸ Restoring or preserving coastal wetlands would buffer inland areas from sea level rise while also generating environmental and economic benefits through recreation and tourism. Some adaptation strategies, such as reforestation, may also benefit mitigation efforts.
- **Consider longer-term temporal scales for adaptation planning.** Because the impacts of climate change are likely to occur over several decades, if not centuries, adaptation planning must extend over a commensurate timeframe. The exact timeframe will vary from sector to sector but should generally encompass the lifespan of a proposed action.
- **Avoid maladaptive actions.** The IPCC defines “maladaptation” as an action that increases vulnerability to the impacts of climate change.²⁹ These actions tend to deliver short-term gains or economic benefits but lead to increased vulnerability in the medium- to long-term and may foreclose future adaptation options or have negative impacts on mitigation efforts. Sea walls may provide temporary protection for coastal development but they lead to complete erosion of the shoreline and thus foreclose the ability to restore the shoreline as a natural buffer. Policymakers should identify and avoid these maladaptive strategies.
- **Maximize the use of existing legislation and legal tools.** Recognizing that the current and future political and economic situation may not be amenable to passing new legislation or financing new programs, this manual emphasizes the use of existing legislation and legal tools to achieve adaptation goals where possible. Some existing laws simply need better, stronger, and more consistent enforcement, whereas others require some reinterpretation or emphasis on overlooked provisions. Where these laws do not adequately address adaptation, this manual proposes new solutions.

By using these principles to adopt and implement climate change adaptation strategies, policymakers and advocates can maximize the chance that adaptation actions will be both effective and equitable. Building on this basic framework, the remainder of this manual focuses first on the procedural strategies to address climate change adaptation and then discusses some specific impacts of climate change, the sectors that will be affected by each such set of impacts, and substantive adaptation strategies.

Social Equity and Environmental Justice in Climate Change Adaptation

Climate change impacts that manifest as disasters will, as law professor and CPR Member Scholar Robert R.M. Verchick notes, heighten and accentuate bad habits—fear, bigotry, and malign neglect—that already exist in society. The real tragedy may not be the environmental destruction but instead the human actions, or inactions, executed by humans against other humans. Although disasters appear to be “social equalizers” that are blind to race, creed, and color, long-term recovery efforts are nearly always accompanied by patterns of unfair social distribution.³⁰ Thus, some communities will be subject to more danger and hardship than others, creating obvious social injustice and less obvious social wedges that inhibit recovery efforts.³¹ A first step in promoting social equity, therefore, is to dispel this notion. As Professor Verchick notes, “Catastrophe is bad for everyone. But it is especially bad for the weak and disenfranchised.”

The environmental justice movement is premised on the notion that every person should have equal access to some minimum level of resources to enable the pursuit of a safe, purposeful, and dignified existence.³² However, geographic inequalities, inequalities

arising from over- and under-inclusive health standards, and inequalities in the legal and political processes all stand in the way of this equal access. For example, a growing body of research demonstrates that the poor and marginalized racial communities are disproportionately subjected to hazardous waste facilities, air pollutants, contaminated fish, and pesticides.³³ These communities are at greater risk because their **exposure**, or the physical aspects of a disaster that place people in harm’s way, and their **vulnerability**, or their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard, are high.

As communities select adaptation strategies and Washington revises its laws, both must ensure that these strategies and laws pay special attention to the poor and marginalized during both disaster and recovery.³⁴ Broad improvements to underlying socio-economic conditions are required, as is deliberate protection from bias and bigotry, whether intentional, unconscious, or structural.

For a more detailed discussion of social equity amidst disaster, see Robert R.M. Verchick, *FACING CATASTROPHE: ENVIRONMENTAL ACTION FOR A POST-KATRINA WORLD* (Harvard Univ. Press 2010).

V. Overarching Considerations for the Legal Framework

The impact of climate change presents a fundamentally new problem for the United States, falling outside the relatively tame levels of historical rates of change currently reflected in federal and state environmental laws. The projected scope of climate change impacts will erode the natural resiliency of many ecosystems and make them more vulnerable to both anthropogenic and natural disturbances. These impacts are expected to occur on an accelerated, unpredictable timeline that will make accommodation to the impacts extremely difficult, if not impossible, for many ecosystems and species. Although global and regional downscaled climate models are able to predict trends, they cannot predict precise storm events, exact increases in sea level rise, or definite temperature increases. The uncertainty in predicting the timing, scale, and location of adverse climate change impacts arises from the complex and nonlinear interactions among the factors that influence climate.

[T]he global scale of the problem, the limited study of effects, the variety and complex interaction of variables, and the particular difficulties for localized ecosystem modeling combine to raise uncertainty to a level humans have never encountered and governments have never attempted to manage.

- Law Professor and CPR Member
Scholar Alex Camacho

How can governments act in the face of such great uncertainty, and what overarching features of law might be useful in accommodating and managing uncertainty? Law professor and CPR Member Scholar Alejandro Camacho and other scholars suggest using *procedural* strategies to allow governments to simultaneously deal with uncertainty and move forward on necessary adaptation measures.³⁶ Substantive strategies, addressed in the other sections of this manual, respond directly to the effects of climate change by, for example, using building codes to address sea level rise or water law to ensure adequate water supplies for the environment.³⁷ The procedural strategies discussed in this section focus on the decisionmaking process and can both help manage the uncertainty surrounding the effects of climate change and maximize the efficacy of substantive adaptation responses. For example, an adaptive approach to managing a species affected by climate change would allow resource managers to make immediate management decisions and then reevaluate those decisions as climate change impacts occur. Procedural strategies that disseminate information and encourage widespread participation may also increase the willingness to act in the face of uncertainty.³⁸

This section first will discuss the impact of climate change on the legal infrastructure and propose features that build flexibility and resilience into the legal process to better address uncertainties. This section then touches on new decisionmaking strategies that will facilitate responses to climate change despite uncertainty. It concludes with a discussion of the strengths and limitations of using Washington's State Environmental Policy Act to adapt to climate change. Ultimately, in light of the inevitable uncertainty climate change presents, developing and implementing adaptive procedural strategies may be the best precautionary actions that Washington and Puget Sound communities can take right now.

A. Establishing Principled Flexibility

In the face of climate change, many existing environmental laws premised on a stable environment will crumble. If natural systems become more dynamic and baseline conditions change, the Endangered Species Act will be unable to protect species, existing water rights will be unable to allocate water effectively, the Clean Air Act will not protect air quality, and more. The law itself will need to become more flexible and adaptive in the face of climate change. Although other areas of law, such as energy, national security, or immigration, may become increasingly pressing drivers of climate change adaptation, the existing environmental laws and legal structures are likely to remain in the spotlight.³⁹ To maximize responsiveness to climate change impacts, it is important to consider how these laws can incorporate flexibility and thus manage uncertainty.

1. Features of Principled Flexibility

Traditional environmental laws are based on concepts of preservation and restoration and tend to assume stationarity—that natural systems fluctuate but within a bounded, predictable range.⁴⁰ These laws seek to restore natural systems to a selected baseline, usually by reference to historical data or levels.⁴¹ For example, the Clean Water Act contains an anti-degradation provision that requires states to maintain existing water quality, but that goal may become unachievable in the future due to the impacts from climate change. The projected impacts from climate change will upend environmental laws premised on the concept of stationarity, increasing the discrepancy between the overwhelming need to respond to climate change impacts and the limited ability of environmental law to respond to this need.

The flexibility needed in climate change adaptation laws must, as law professor and CPR Member Scholar Robin Kundis Craig proposes, involve *principled flexibility*, meaning that flexibility should not translate into open-ended discretion to do nothing or to deviate materially from the overarching regulatory and management goals.⁴² Rather, flexibility needs to be accompanied by measures to hold policymakers accountable for acting. Communities should be required to develop adaptation strategies, but communities should have the flexibility to decide how to select and tailor these strategies to local circumstances.

Incorporating this principled flexibility into particular laws could include certain features, such as:

- **Planning.** As discussed later in section VIII.B, planning is a key tool in responding to climate change impacts. Planning for available options before a disaster or emergency situation occurs will likely reduce the chaos of post-disaster recovery, when the rush to provide assistance may ignore crucial needs or prevent public participation. Washington law requires local governments to plan under both the Growth Management Act and the Shoreline Management Act, and communities should fully consider pre- and post-disaster adaptation strategies in these plans.

- **Scenario Planning.** Scenario planning is a tool to integrate scientific considerations into the policymaking process. It can capture uncertainties by establishing the likelihood or probability of a given impact. Using quantitative and qualitative models, scenario planning can help policymakers visualize future outcomes based on various decisions, policies, or societal pathways.⁴³ The scenarios should include a worst-case outcome and not focus exclusively on the most likely outcome.⁴⁴ Like adaptive management, scenario planning identifies key uncertainties and allows decisionmakers to explore those uncertainties, understand their implications, act, and monitor the outcomes.⁴⁵ Under Washington law, state agencies are already required to include a “range of scenarios for the purposes of planning ... to assess project vulnerability and, to the extent feasible, reduce expected risks and increase resiliency to the impacts of climate change.”⁴⁶
- **Triggering Mechanisms or Benchmarks.** One mechanism for creating principled flexibility is to establish thresholds or benchmarks that, if reached, trigger a certain course of action. Unbounded flexibility creates a risk that agencies will abuse their discretion by failing to act when necessary. Triggers promote accountability by forcing agency action at specific times or occurrences. For example, property severely damaged or destroyed by flooding in a certain number of years could trigger a no-rebuild provision, or disqualify the property owner from participating in publicly subsidized flood insurance. These benchmarks could also trigger a different decisionmaking scheme that is detailed in advance. This element is particularly relevant in the adaptive management context, discussed below.
- **Periodic review and revision of strategies.** Flexibility in the adaptation context will require the ability to review and adjust strategies as climate change impacts occur. Current environmental laws, such as the National Environmental Policy Act (NEPA) and the Clean Air Act (CAA), depend heavily on predictions and standards made as a part of an initial determination, such as the environmental assessment required by NEPA, or based on historical data, such as attainment status under the CAA. Introducing follow-up mechanisms or requiring periodic review and revision of decisions to incorporate new information or data will unshackle environmental laws from this front-loaded process, allowing management adjustments to tailor decisionmaking to changing and realistic conditions.⁴⁷
- **Redundancy.** Climate change strategies should include a certain amount of redundancy or back-up options in case primary strategies are ultimately ineffective or overwhelmed by the scope of the impact.

The uncertainty of climate change impacts can provide a seemingly plausible excuse for delaying action, particularly when policymakers face tough political situations or economic constraints. Because these features of law provide workable mechanisms for managing uncertainty, however, “uncertainty” will become a less compelling justification for inaction.

2. Adaptive Management

The concept of adaptive management illustrates many of the features discussed above. In the climate change adaptation context, adaptive management is appealing because it specifically recognizes the uncertainty of climate change impacts but provides a structured approach to addressing and attempting to reduce this uncertainty. By applying the process of scientific inquiry to a natural resources management problem, adaptive management can reduce uncertainty and generate new knowledge and information. It requires resource managers to design management actions as scientific experiments, monitor the outcomes, and adjust the management actions depending on the outcomes produced by the experiments. When designed and implemented correctly, adaptive management can provide the principled flexibility necessary to accompany adaptation strategies for managing natural resources.

Although the definitions of adaptive management differ, it generally includes these elements:

- Articulation of clear goals and measurable indicators of progress toward achieving those goals;
- An iterative approach to decisionmaking and the opportunity to adjust strategies;
- The continual monitoring of outcomes and impacts; and
- Explicit acknowledgement and characterization of risks and uncertainties.⁴⁸

Adaptive management is well suited for natural resource management problems affected by climate change because they are inherently dynamic and likely not well understood. These problems will benefit most from the deliberate learning generated by adaptive management.

However, the widespread application of adaptive management may reflect optimistic hopes rather than reality. Law professor and CPR Member Scholar Holly Doremus notes that documented instances of successful adaptive management are rare, and in practice natural resources managers have not exhibited sufficient adherence to the principles of this approach.⁴⁹ Agency cultures and funding structures often pose barriers to the learning component. In addition, adaptive management can provide cover for agencies to avoid politically controversial limits on economic activity through the promise of future action after more knowledge is accumulated.⁵⁰ Thus, resource managers should keep in mind these best practices:

- **Tailor the strategy to the problem.** Adaptive management is not a panacea for all resource management problems, such as those limited to a single decision point. At the outset, resource managers should carefully assess whether a particular problem has the requisite elements and can benefit from this approach: (1) information gaps



exist, leading to (2) good prospects for learning and (3) opportunities for adjusting the management strategy after new information is acquired.⁵¹ For natural resources impacted by climate change, these prerequisites are likely to be met.

- **Ensure accountability and enforceability for acting on the new knowledge generated through the adaptive management process.** As noted earlier, adaptive management can provide cover for delayed agency action or even inaction, particularly in high profile or controversial situations. Thus, agencies should set clear benchmarks or trigger points—such as the sea level reaching a given point—for further action or incorporation of new information. Mandatory actions under the management plan should also be enforceable by interested citizens.⁵²
- **Promote directed learning.** The management plan should be designed to elicit new information about the natural resource. At the outset, resource managers should identify the needed data and the ways that the data, once collected, will be useful and used.⁵³ For example, forest managers could design experiments to test the effects of climate-induced increased temperatures or burning frequency on forest regeneration and apply the results to forestry management.
- **Ensure sufficient and dedicated funding.** Properly implemented, adaptive management requires more resources than conventional management strategies, particularly when used to address the long-term impacts of climate change. It involves technical and scientific resources to conduct monitoring and personnel resources to analyze the results and can thus be quite expensive to implement.⁵⁴ Policymakers committed to adaptive management should provide sufficient resources to give the approach an opportunity to work as intended.

Adaptive management is not a panacea, nor is it applicable to every natural resources management problem that will be affected by climate change. Designed properly and adequately supported, however, adaptive management provides the principled flexibility necessary to move forward with climate change adaptation actions.

B. Transforming Decisionmaking

Climate change also will require flexibility and fluidity in the decisionmaking processes within and among agencies that manage natural resources. The boundaries of traditional jurisdiction will be stretched, if not wholly reconfigured, by climate change impacts, requiring discussions now about how governments and agencies will operate and how to allocate authority in a new climate. Climate change adaptation requires a fluid decisionmaking process that incorporates public participation, collaboration among differing interests, decentralization of governance structures, and integration of policy across different sectors.⁵⁵

1. Recalibrate the Allocation of Traditional Authority

Because the acute impacts of climate change will manifest as localized impacts, states and local governments should naturally exercise significant control over developing and implementing adaptation strategies. **Yet in many of the areas that are key to adaptation—water policy and land use planning, for example—federal, state, tribal, and local governments have traditionally had distinct and largely separate jurisdiction.** As communities in the Puget Sound and Washington—and the federal government—consider climate change adaptation strategies, it is important to reexamine the allocation of authority in a way that does not rely solely on traditional, sector-by-sector divisions of power and jurisdiction. Different levels of government should exercise their authority to best meet adaptation needs without ignoring the wider public interest of neighboring counties or states or of the United States as a collective. Under this framework, attempts to ignore this broad public interest may invite displacement of authority by the federal or state government, regardless of traditional spheres of jurisdiction.

Governments operate on both vertical and horizontal planes. The vertical planes represent the hierarchical nature of government, from the federal, tribal, and state levels down to the municipal level. The horizontal plane represents the network of agencies that work at the same level of government, like distinct state environmental and natural resources agencies.

For example, if a local government's response or adaptation strategy adequately addresses the relevant climate change impact and does not cause negative impacts to a neighboring municipality or tribal reservation, state government involvement should be secondary, perhaps limited to gathering and distributing information and financial resources. Similarly, the federal government may harmonize adaptation responses to prevent states from acting in conflict with other states' or tribes' interests or to establish processes that facilitate inter-jurisdictional communication and planning.

State or local adaptation strategies that ignore or harm the public interest may require more involvement by higher levels of government.⁵⁶ For example, an upstream region in an interstate watershed may decide against enacting water conservation measures despite climate-induced changes to the water supply, reducing the water quantity available to downstream regions. Here, uniform statewide standards for conservation may be appropriate to prevent this harm. Such a uniform "floor" can also help counter the free-rider effect—that is, the risk that some counties or cities will fail to act, relying instead on being the beneficiary of adaptation strategies adopted by others.

The strongest role for the federal or state government—complete displacement of lower government regulations—is appropriate only when individual, overzealous state or local regulations are unlikely to produce the optimal result from a collective perspective due to divergent incentives and interests, thereby harming the public interest.⁵⁷ For example, a state could decide to construct canals to block salt water intrusion from sea level rise even though the canals fragment important habitat or drain wetlands. The federal government may step in to prevent these negative environmental consequences. A stronger role would also be appropriate if local adaptation strategies created either too much variation or unequal

footing among states. Law professor and CPR Member Scholar Robert L. Glicksman suggests that this situation may justify uniform rules for interstate water transfers to prevent states from adopting laws to hoard scarce water supplies.⁵⁸

**Case Study:
Adaptation Initiatives
& the Bottom-Up Approach**

Early on, Seattle Public Utilities (SPU) recognized the importance of climate change adaptation to its mission of providing water for Seattle and the greater metropolitan area. The utility has done a lot of work on adaptation with respect to water supply issues, sea level rise, and to some degree urban drainage, and has been recognized by the U.S. Environmental Protection Agency for its sophisticated work. SPU has conducted

vulnerability analyses for the water supply, has created sea level rise scenarios, and has mapped areas vulnerable to flooding. SPU is also forging ahead with capacity-building across the public utility sector and is working to incorporate adaptation into the institutional culture.

Collectively, these initiatives demonstrate the role of quasi-governmental and private organizations in a bottom-up approach and in the absence of state or federal mandates.

2. Integrate Decisionmaking Vertically and Horizontally Among Agencies and Institutions

State and local governments have a significant role to play in implementing and supplementing federally established policies. In addition, responsibility to address particular environmental problems is often dispersed among multiple agencies at the same governmental level. This kind of dispersed decisionmaking authority has many benefits, including enhancing public participation and facilitating experimentation by different government actors. To maximize synergies and avoid the risk of uncoordinated decisions and conflicting policies and authority, however, relevant government agencies and nongovernmental organizations should engage in coordinated and, where appropriate, collaborative adaptation planning efforts.

3. Build Transgovernmental Networks among Agency Personnel

Strengthening the relationships among individuals at various government agencies will help promote the flow of information among agencies. This information exchange will produce decisions that are better informed and consider a range of multi-sector impacts and influences.⁵⁹ While these interpersonal networks do not have the authority to pass legislation or dictate policy, they can more adeptly transfer information, confer about trends, and identify potential obstacles to adaptation strategies.⁶⁰ For example, public health officials could discuss transportation and siting-decisions with transportation and land-use officials to coordinate health response in an emergency situation and to consider new joint initiatives across their respective agencies or institutions.

C. Washington's State Environmental Policy Act

The State Environmental Policy Act (SEPA) in Washington demonstrates both the potential of existing law to incorporate climate change adaptation and the significant limitations in existing environmental law. Using some of the principles and features described above, this section will take a closer look at SEPA and its federal counterpart, the National Environmental Policy Act (NEPA). Environmental assessment under SEPA and its federal counterpart NEPA is an appealing legal tool to consider adaptation elements in government actions because of its capacity to promote informed, realistic decisionmaking. However, the assessment mechanism at both levels of government appears to be limited to an evaluation of the impact of a proposed action *on the environment*, rather than the impact of climate change and the environment *on the proposed action*. In other words, the assessment of the action does not contemplate the changes that climate change and an altered environment inevitably will bring to it.

The federal Council on Environmental Quality (CEQ) has carefully navigated around this potential obstacle to effective preparation for the adverse consequences of climate change. In draft guidance issued in February 2010, the CEQ noted that relevant environmental effects include not only how a proposed action would impact the environment, but also how climate change could impact the proposed action or alternatives.⁶¹ The guidance directs agencies to assess how climate change impacts may exacerbate or contribute to the impacts, sustainability, vulnerability, and design of the proposed action.⁶² As such, “[a]gencies should use the scoping process to set reasonable spatial and temporal boundaries for this assessment and focus on the aspects of climate change that may lead to changes in the impacts, sustainability, vulnerability, and design of the proposed action and alternative courses of action.”⁶³ In light of climate change, agencies should consider how the proposed action will affect the environment, public health and safety, and vulnerable populations.

This guidance provides a helpful start but does not go far enough in integrating adaptation concerns. At best, it appears to be an indirect method for incorporating climate change adaptation into the NEPA assessment. For example, climate change-induced storm surges may threaten proposed transportation infrastructure, which means that the project would result in greater environmental impacts than if the proposed project itself were not at risk from climate-induced changes. CEQ advises agencies to “consider the specific effects of the proposed action (including the proposed action’s effect on the vulnerability

Action Items: Climate Change Adaptation & SEPA

1. **In the SEPA environmental checklist, consider whether the project over its lifetime is resilient in the face of potential climate change impacts.**
2. **Reclassify categorically exempt activities that occur in coastal hazard areas to require environmental assessment.**
3. **In both environmental assessments and environmental impact statements, consider both the impact of climate change on the proposed action and how that action may need to adapt to those impacts.**
4. **Require follow-up monitoring and verification of proposal information and analysis and of mitigation measures.**

of affected ecosystems), the nexus of those effects with projected climate change effects on the same aspects of [the] environment, and the implications for the environment to adapt to the projected effects of climate change.” Here again, the focus is not squarely on how the proposed action should adapt, although that question may be answered by proposed alternatives.

The purpose of SEPA and NEPA is to ensure that government agencies act only after considering potential environmental consequences. As an information-gathering mechanism and planning tool for major actions, these laws seem like natural fits for considering the impacts of climate change on those very actions so that policymakers better understand the relationship between the proposal and its effects on the environment in light of the anticipated consequences of climate change. CEQ guidance has decidedly pointed NEPA in this direction. However, in order for these laws to effectively address climate change impacts, they must also be adjusted or otherwise reinterpreted to include follow-up monitoring and explicit consideration of climate change impacts on the proposed action.⁶⁴

How SEPA Works

Washington’s State Environmental Policy Act (SEPA) is modeled on the National Environmental Policy Act (NEPA). SEPA requires a detailed environmental statement for legislative recommendations or proposals or “other major actions significantly affecting the quality of the environment.”⁶⁵ The first question is whether the action is “significant,” and the law provides an environmental checklist to help the state agency proposing the action to determine the nature of the action. The agency can make one of three determinations concerning the significance of an action: a determination of non-significance, meaning no further review is required; a mitigated determination of non-significance, meaning that mitigation measures must be taken to avoid significant impacts; or a

determination of significant impact, which requires a detailed environmental impact statement. SEPA also provides categorical exemptions from environmental review, which allow the proposing agency to bypass more comprehensive environmental impact assessment.⁶⁶

If an action has a significant impact, the state agency must then prepare an environmental impact statement, including: the environmental impact of the proposed action; any adverse environmental effects that are unavoidable if the proposal is implemented; alternatives to the proposed action; the relationship between local short-term uses of the environment and long-term productivity; and any irreversible and irretrievable commitment of resources that the proposal involves.⁶⁷

D. Conclusion

The impacts of climate change are not limited to the human and natural environment. Climate change will test the resilience and flexibility of the law itself, raising serious questions about the current legal framework and governance structure to address the profound changes in natural resources management and response. Deliberately incorporating processes such as adaptive management can address the inherent uncertainties associated with climate impacts and will improve the resiliency of both the law and the human and natural environments under its protection. **Building principled flexibility into the existing law is a necessity, and transforming the governance space into a fluid, dynamic web will help communities better respond to climate change.**

The remaining sections focus on selected major climate change impacts that will bring some of the most perceptible changes to the Puget Sound Basin and some of the substantive strategies to address these changes.

VI. Changes to the Hydrologic Cycle

The Pacific Northwest and the Puget Sound Basin are famous for their verdant, lush landscape, courtesy of ample precipitation throughout much of the year. Because water plays such a central role in shaping human communities and ecosystems across the Sound, the impacts of climate change on the hydrologic cycle will be significant. **The most perceptible and dramatic long-term impact will likely be a shift in the timing of the hydrologic cycle.** While this shift in the hydrologic cycle may not significantly affect water supplies for human uses, it may be disastrous for salmon and other aquatic ecosystems. Because humans interact with these resources, they, too, will be affected. This section identifies the major impacts to the hydrologic cycle on water availability and aquatic habitat and discusses general principles for adaptation strategies. This section also identifies specific legal tools for climate change adaptation.

Quic Look: Altered Hydrologic Cycle

Primary Impact

- Climate change will likely cause a pronounced shift in the timing of water available for all uses, including human and ecosystem uses.

Who and/or What Sectors are Affected?

- Public utilities and municipal water suppliers
- Salmon and aquatic ecosystems and species

Who are the Primary Actors?

- Departments of Ecology and Natural Resources
- U.S. Fish and Wildlife Service

The Puget Sound basin drains nearly 11,600 square miles of land, ranging from sea level to the Cascade Mountains in the east and to the Olympic Mountains in the west. The basin is home to nearly 70 percent of Washington's population. Historically, precipitation patterns range from 24 to 118 inches annually, most of which falls between October and March. Many of the major rivers in Washington drain into the Sound, including rivers that are the primary sources of drinking water for residents in the metropolitan areas of Seattle, Tacoma, and Everett: the Cedar, Green, Tolt, and Sultan.⁶⁸

The Puget Sound area is a transient basin, meaning that the drainage is a mix of rain and snow with a characteristic biannual peak runoff for both snowmelt and precipitation. Snow accumulation acts as a natural reservoir, releasing water as the seasons change. According to the Climate Impacts Group (CIG), modeling shows a consistent shift in the hydrograph toward higher runoff during the cool season and lower runoff during the warm season. This shift could ultimately lead to a single peak runoff as a result of precipitation increasingly falling as rain rather than snow. Snowmelt may also occur earlier and faster.

The 2009 CIG report concludes that for Puget Sound, the “primary hydrological manifestation of climate change... will be the decline and eventual disappearance on average of the springtime snowmelt hydrograph peak, and its replacement with an elevated winter runoff peak, and its replacement with an elevated winter runoff peak.”⁶⁹ The graphs below show a gradual shift in water runoff for the Cedar River between 2000 and 2075. Most notably, the peak flow rate changes from two peaks in December and May in 2000 to a single peak in January 2075. Analysis of water security for human consumption in light of this climate change-induced impact indicates that water availability remains relatively stable for the major metropolitan areas in Puget Sound basin, which have in the past benefitted from strong conservation measures and an overall decrease in demand despite population growth.⁷⁰

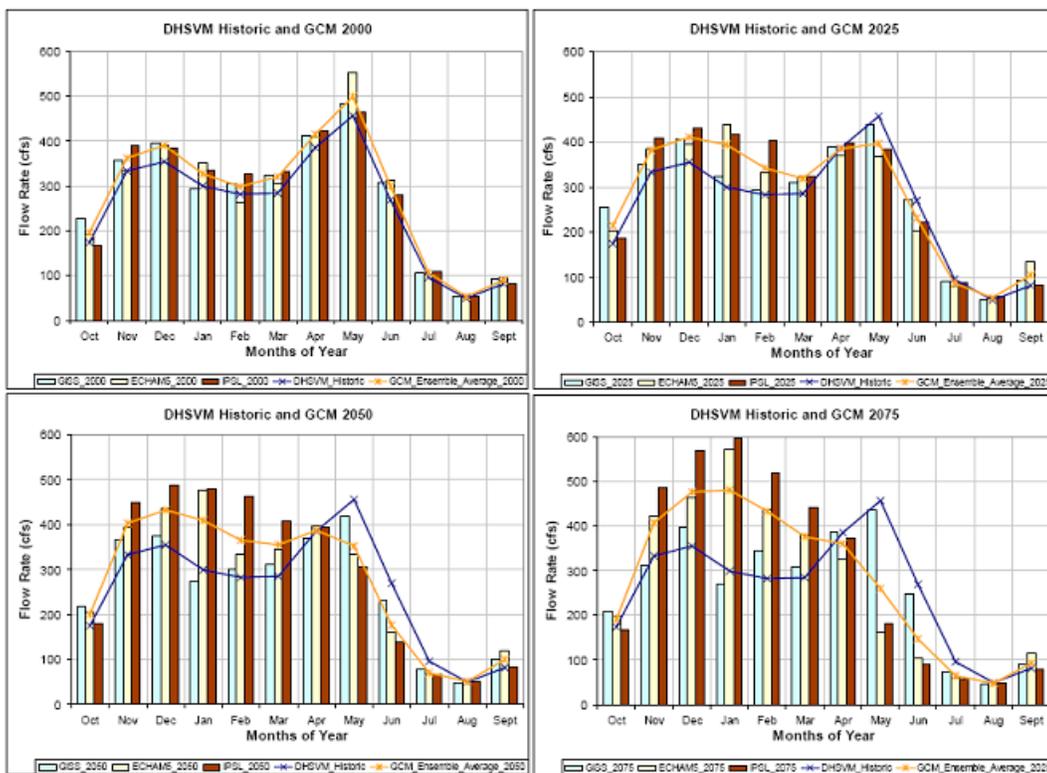
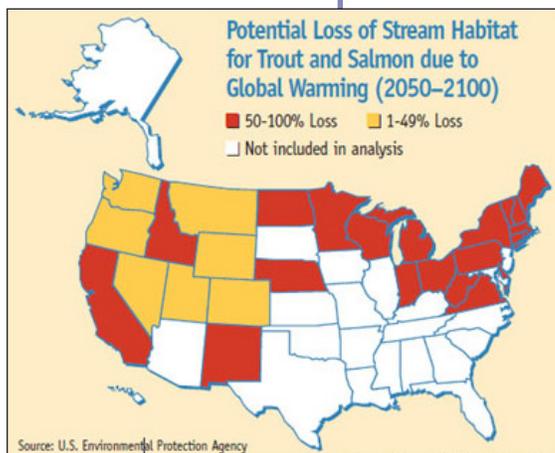


Figure 51 – Simulated 2000, 2025, 2050, and 2075 Projected Annual Average Streamflow at Cedar 1

For the iconic but dwindling salmon populations, however, the changes in timing could be devastating, with ripple effects for the many Native American tribes that depend on salmon and have rights to take salmon according to treaties with the United States. The waters in and around Puget Sound provide migration routes and breeding grounds for many species of salmon and trout, which spend parts of their lives in both fresh and marine waters. Already the destruction of wetlands and estuaries by human activities has jeopardized the habitats and breeding grounds of these fish. Evidence of climate change impacts on the marine environment, such as marine current patterns and ocean acidification, will likely further harm anadromous fish species.⁷¹

Flow rates are themselves critically important to the timing of salmon runs, during which smolts migrate out to sea and adults return to freshwater to spawn. In addition, flow rates are intimately connected to water temperature, and water temperature affects salmon at every stage of development, although the specific sensitivities depend on the species and stock-specific adaptations to local conditions. Cold-water fish species in Montana, for example, are already feeling these temperature impacts.⁷² For species classified as “of concern” or those already listed as threatened, the impacts of climate change may compound existing stressors such as habitat destruction, requiring additional protections under the Endangered Species Act. For example, in 2010 the National Marine Fisheries Service established a recovery plan for the Puget Sound Chinook salmon that recognizes the connected impacts of habitat degradation, historical over-harvesting, and climate change.⁷³



Climate models and research from the CIG project habitat loss for salmonids of between 5 and 22 percent by 2090, the result of temperature increases that affect their distribution, migration, health, and reproductive capacity. Research has shown, for example, that salmonids have increased vulnerability to predation and displacement when average water temperatures exceed 59 degrees Fahrenheit. In addition, higher water temperatures increase their vulnerability to disease and infection. Water temperatures that exceed 72 degrees Fahrenheit can prevent migration altogether. Communities in the Puget Sound must confront the worst-case scenario possibility that, in a world so altered by climate and continuing human impacts, salmon or other species will not be able to adapt on an accelerated timescale.⁷⁴ Given this possibility, improved projections of climate impacts, adaptive management, and scenario-building are critical to salmonid-related policy and management.

Conflict and controversy over water management is likely to intensify in the Pacific Northwest as climate change advances. The overarching goal of a prudent adaptation strategy, therefore, is to ensure adequate water supplies and flows when and where it is needed for both human consumption and ecosystem use.

A. General Considerations and Principles for Adaptation to Changes in the Water Cycle

In a 2008 *Science* article, a group of scientists and natural resource managers declared, “Stationarity is dead.” The concept of stationarity is the idea that natural systems fluctuate within an unchanging envelope of variability and is a foundational concept that underlies water resource management and water law.⁷⁵ The authors of the article argued that stationarity no longer applies to water resources management because the substantial anthropogenic change of the Earth’s climate is altering the means and extremes of the hydrologic cycle, sea level, and glacial melt. If stationarity is no longer applicable, significant implications for state-level water law and the federal Clean Water Act arise.

Current water law, involving the allocation of water at the state level, is designed to promote stability and predictability rather than to respond to change.⁷⁶ The “first in time, first in right” mantra of prior appropriation regimes demonstrates this underlying guarantee of stability, at least for the most senior users. Prior appropriation thus preserves water uses that may no longer reflect current social values. For example, the value of water for aquatic ecosystems has become increasingly important, but often constitutes a junior use. Under prior appropriation, no junior user gets water until senior appropriators receive the full allocation of their water rights.

Another obstacle to adaptation is the disjointed nature of both water law and environmental law, which creates unscientific and confounding divisions between surface water and groundwater, water quantity and water quality, and intrastate and interstate jurisdiction.⁷⁷ This lack of coherence impedes the ability to reallocate or redistribute water supplies to the most desirable or valuable uses as an adaptation strategy. For example, in times of drought, a state may allocate water to sustain existing out-of-stream human uses at the expense of instream uses and compliance with the Clean Water Act. The ability of water to serve multiple masters—hydropower uses, drinking water supplies, recreational uses, aquatic ecosystems, riparian habitats, and others—in the face of climate change may test traditional jurisdictional boundaries and raise tough questions. What happens if the rivers in the Puget Sound Basin can no longer sustain salmon or other coldwater fish or aquatic species because of uncontrollable changes to the environment to which species cannot adapt? Policymakers and society at large may face this dilemma, and it is important to begin exploring the legal options and policy responses before these impacts occur.

Climate change will also strain the traditional boundaries between federal and state jurisdiction of water. The artificial division between water quality and water quantity will become even more apparent, as decreased flows result in higher in-stream pollutant concentrations and temperatures and put endangered and threatened species in greater jeopardy. In the future, the availability of water may determine land use and the growth of urban areas, causing water law, land-use law, and environmental law to become increasingly intertwined rather than remaining separate areas of law.

The goal of adaptation to a changing hydrologic cycle is to ensure that water can be used where it is most needed, however society determines that need. Overall, several underlying principles apply to the water sector in order to achieve this goal:

- **Strictly implement and vigorously enforce the Clean Water Act.** Ecosystems that are coping with other problems—pollution, destruction of wetlands, and the loss of biodiversity—are less resilient and more vulnerable to the impacts of climate change than healthy systems. Stronger implementation and enforcement of the CWA and other traditional environmental laws is imperative. Throughout the country, EPA, states, and tribes can strengthen regulation of stormwater and enforcement of National Pollutant Discharge Elimination System permits. Maximizing pollutant controls will enhance the resiliency of aquatic ecosystems.⁷⁸
- **Quantify water resources.** Calculating the total amount of water in the Puget Sound basin will facilitate improved water resources management and can be used to develop a water budget. Models can be used to calculate significant inflows, outflows, and storage capacity under alternative climate change scenarios and to build various climate change scenarios as well. To effectively prioritize uses and conservation goals, the Department of Ecology and other water users must have a clearer understanding of the entire picture of water uses in the Puget Sound basin. From the information gained in this quantification, the Department of Ecology can better target conservation measures, enforce instream flows and the beneficial use of water, and plan for an altered hydrologic cycle.
- **Integrate science into law by adopting a watershed approach to water resources management.** Water science has long established the interconnections between waters located within the same watershed, both surface waters and groundwater, and between water quantity and water quality. However, existing water laws tend to artificially separate these connections and thus fail to manage water in a holistic way. As climate change impacts on water highlight these connections, laws should be implemented to reflect the cumulative impacts of climate change on a watershed and to better integrate science and hydrologic data.
- **Recognize the tension between adaptation strategies for human use of water and ecosystem use of water.** Climate change adaptation strategies for human use of water and ecosystem use of water may come into conflict as a result of changes to the hydrologic cycle. Policymakers should ensure that strategies to protect supplies for human use cause as little impact as possible to the flows needed to maintain a healthy, functioning ecosystem.

Keeping these principles and considerations in mind, the following section discusses specific reforms in water law, the Clean Water Act, and the Endangered Species Act to address the impact of climate change on the hydrologic cycle.

B. Specific Adaptation Strategies

1. Reform Prior Appropriation

Water law in the United States is largely a matter of geography. In the eastern states, where water has been plentiful historically, a doctrine known as riparian rights took hold. Under riparianism, water is viewed as a common property to be shared by riparian landowners. Because all riparian landowners have an equal right of reasonable use, the amount and use of water is a matter of individual judgment, barring any court resolution.⁷⁹

Washington, like most states west of the 100th meridian where water is generally a scarce resource, has adopted the system of prior appropriation as its dominant state water law (with some holdovers from riparian law as well). Prior appropriation is codified at RCW 90.03.010, which provides that waters of the state belong to the public but a right of use “may be acquired only by appropriation for beneficial use and in the manner provided. . . [and] as between appropriations, the first in time shall be the first in right.” The heavy emphasis on the notion of “first in time, first in right”—or the priority aspect of prior appropriation—displaces other ingredients of prior appropriation law, such as beneficial use, the rule against waste, and the doctrines of relinquishment or abandonment.

In light of climate change adaptation and potential water shortages, law professor and CPR Member Scholar Robert Adler suggests that prior appropriation is in theory better than other forms of water allocation law because, in times of shortages, it guarantees senior appropriators their full allotment of water and thus a measure of certainty, albeit at the expense of junior appropriators. However, Professor Adler notes that these protections have not been truly tested in reality because the extensive network of dams and water infrastructure have largely averted water shortages and thus avoided any harsh outcomes for junior appropriators.

Prior appropriation may be beneficial because it renders water rights as concrete property rights, which facilitates water transfer and the overall ability to move water to where it is needed.⁸¹ However, critics of western water law point out that this system freezes certain uses, such as outdated and inefficient irrigation techniques, leaving little water for new uses that may be more efficient or highly valued. While Washington and other western states are highly unlikely to abandon prior appropriation as a system of water law, placing equal importance on elements other than priority is a crucial adaptation strategy to both identify wasteful and inefficient uses and to conserve existing water supplies.

Action Items: Climate Change Adaptation & the Hydrologic Cycle

1. Enforce co-equal elements of prior appropriation—beneficial use, waste, abandonment, and relinquishment of water rights.
2. Enforce and expand water conservation laws, such as tiered pricing for water use.
3. Consider climate change impacts on water quality in administering programs under the Clean Water Act.
4. Strengthen the instream flow and trust water rights programs by enforcing existing instream rules, by establishing better incentives for participation, and by prioritizing instream use.

- **Bolster the public interest review.** The public interest review in prior appropriation recognizes that water is a public resource that should be used in the overall public interest. To obtain a water right, an applicant must demonstrate that the proposed use is “not detrimental to the public interest.”⁸² When authorizing new uses or even use transfers or changes, Washington should consider what constitutes a use that is “detrimental to the public interest” in light of climate change impacts on water timing and availability for both human and ecosystem uses. Uses that decrease ecosystem resilience might be regarded as contrary to the public interest.
- **Enforcement of relinquishment provisions for abandonment or failure to beneficially use water.** Prior appropriation water use rights may revert to the State of Washington if the holder of those rights abandons or voluntarily fails without sufficient cause to beneficially use or withdraw water for any period of five successive years after July 1, 1967.⁸³ Beneficial use encompasses the idea that uses should not be wasteful and should be efficient. To ensure adequate quantities of water, Washington should consider establishing priorities among beneficial uses, establish criteria for waste, and enforce relinquishment provisions for abandoned prior appropriation rights and failure to use water beneficially.
- **Establish incentives for conservation.** Water conservation may prove to be one of the most effective ways of ensuring adequate water supplies for human consumption during dry periods. Incentives could range from tiered, seasonal pricing of water for increasing volumes of water usage, such as the scheme used by Seattle Public Utilities, to other financial or regulatory benefits for users who achieve a stated level of conservation.
- **Facilitate the ability to transfer water or change uses.** A prior appropriation water right is granted for a specific point of diversion, a specific use, and a specific time and place for that use. To ensure greater flexibility in supplying water where needed, Washington should continue to develop water banks to create a reservoir of water supplies that are available to improve stream flows and instream uses during critical drought periods; to offset future development; or to efficiently reallocate water among beneficial uses.

The doctrine of prior appropriation is deeply rooted in western states and in the mindsets of many western water users. Faced with potentially catastrophic changes to aquatic ecosystems, however, countries and regions around the world have reformed their water laws. For Washington, the impact of climate change on the hydrologic cycle may provide this impetus.

Across the Pacific: Water Law Reform in Australia

Although reforming water law and the doctrine of prior appropriation seems daunting, innovative reform is possible and imperative when facing the dire combination of environmental devastation and increased human demand.

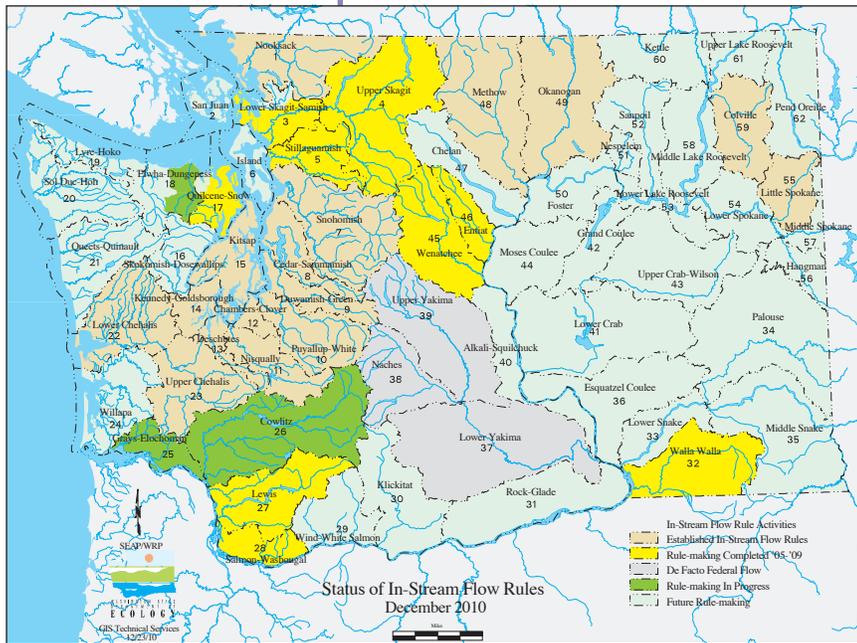
In Australia, the colonies transitioned from the doctrine of riparian rights to a more regulated system in the late 19th century, in recognition of the continent's dry conditions. They explicitly rejected the doctrine of prior appropriation, instead choosing a system in which the rights of the community were elevated above those of the individual. During most of the 20th century, Australians relied on government administration for the fair allocation of water. This system worked well for many years because there was generally enough water to go around and no one really worried about the environment. By the 1980s, however, many Australian waters were over-allocated, producing intense competition among water users and a severely degraded aquatic habitat. Calls for reform came not only from environmentalists and those who realized that water use must be based upon a sustainable resource, but also from water users who, amid droughts and chronic shortages, wanted security of entitlement.⁸⁴

New South Wales, the most populous state in Australia, reformed its water law most recently in 2000. Under this water management statute, water licenses on regulated rivers provide a right for an annual volumetric amount of water, but only to the extent that water is available. Thus, a typical allocation announcement might say: "[I]rrigators are advised that 65 percent of

allocations are currently available. There is a 60 percent change this will rise to 75 percent by December and a 45 percent chance of 100 percent allocations by the same date."⁸⁵ The government regularly determines what percentage of an allocation is available by adding the amount of water in storage to expected inflows, and then deducting environmental requirements and system losses. During times of shortage, the law also prioritizes environmental needs, second only to domestic water uses. In order to meet the required environmental flows, dams release water in such a way that the downstream river flow will mimic natural variations. Of course, the establishment of these environmental flows, which reduces the amount of water available to license holders on over-allocated rivers, has prompted questions about adjustment assistance and the purchase of water entitlements from willing sellers.⁸⁷

By basing allocations on percentages of available flow rather than volumetric allocations and prioritizing the environmental uses of water, New South Wales has developed an equitable tool for managing water in times of shortage that may prove extremely useful as a changed climate alters the water cycle.

For more information about Australia's water law reform, see Brian Haisman, "Impacts of Water Rights Reform in Australia," in [WATER RIGHTS REFORM: LESSONS FOR INSTITUTIONAL DESIGN](#) 113 (Bryan Randolph Bruns et al. eds. 2005); William L. Andreen, "Water Law and the Search for Sustainability: A Comparative Analysis," in [WATER RESOURCES PLANNING AND MANAGEMENT](#) (R. Quentin Grafton and Karen Hussey eds. 2011).



2. Augment Instream Flows

Among the most significant impacts to the hydrologic cycle is the disruption of the timing and volume of flows to which salmon and other aquatic species have adapted. Washington has two primary programs to ensure the continued flow of instream water. In 1967, the state legislature adopted the Minimum Water Flows and Levels Act to give the Department of Ecology the authority to promulgate rules that set flow levels for the state’s rivers to protect fish and other aquatic resources, as well as recreational and aesthetic values. Setting flow levels is crucial to determining the amount of water available for out-of-stream allocation, establishing salmon and other aquatic resource recovery plans, and determining overall watershed and water resources management.⁸⁸

To assist salmon and other aquatic species to adapt to climate change, the Department of Ecology should administer water law and instream flows to mimic the natural hydrograph to allow species to survive disruptions of the hydrologic cycle.

The second instream program is the Trust Water Rights program, whereby the state may acquire water rights through sale, donation, or lease and hold it in trust for instream flow or other beneficial uses.⁸⁹ The trust water right retains the same date of priority as the original water right.

To strengthen the protections for instream water flows, Washington should:

- **Enforce instream flow rights and trust water rights for ecosystem and natural resources purposes.** The Department of Ecology must ensure that instream flows are set at environmentally protective levels and strictly enforced as intended. Under current law, enforcement of an instream flow is limited by its priority date, which tends to be more recent compared to existing water rights and thus fulfilled only after all prior water rights are fulfilled. The Washington legislature should further protect water for environmental use by passing legislation to guarantee a certain minimum volume or percentage of flow for instream use that must be fulfilled before water is appropriated for non-domestic uses.⁹⁰ The legislature should prioritize instream or environmental use of water.
- **Establish incentives to encourage more permanent transfers of water rights.** The Trust Water Rights program allows the acquisition of water rights by lease, which allows the water rights holder to recover the right at the expiration of the lease. This provision is helpful in encouraging the donation of rights to the state. However, the state legislature should consider establishing tax or other benefits that encourage the permanent retirement of water rights.
- **Establish water quality criteria for flow.** One of the biggest problems with the instream flow program in many states, including Washington, is the low priority date for these flows. Thus, while the Department of Ecology may set minimum flow levels to protect certain species or aquatic ecosystems, the flows typically remain unfulfilled. To enhance these flows, the Department of Ecology should establish seasonal, dynamic flows using numeric water quality criteria under section 303 of the Clean Water Act.⁹¹ At the federal level, EPA could also encourage and eventually require states to adopt numeric flow standards under its authority in section 303(c).
- **Establish adequate flows below impoundments.** Many private hydroelectric dams are currently undergoing or will in the near future undergo relicensing from the Federal Energy Regulatory Commission. Washington should use its authority under the Clean Water Act to ensure that flow regimes below these impoundments meet water quality standards for flow regimes to offset the changes to the water cycle.

**Case Study:
Incentives for Participation
in the Walla Walla Basin**

The Walla Walla River Basin, located in southeastern Washington, has adopted a series of promising pilot projects to augment stream flows for endangered and threatened species. The basin is over-appropriated and has limited stream flows. One goal of these pilot projects is to create a flexible system to make water available when and where it is needed for both water users' and fish and aquatic ecosystems. For example, irrigators may switch between surface water and groundwater sources depending on how much instream water is required for fish, or they may switch the point of diversion to maintain upstream flows. Another proposal is the establishment of the Walla Walla Water Bank to facilitate the reallocation of water among beneficial uses, including environmental uses, and to offset impacts from future development.

To encourage participation in these pilot projects and the Water Bank, the Walla Walla Watershed Management Partnership provides assurance that participation will not jeopardize users' water rights and will be transparent. Some incentives include:

- Suspending the clock for relinquishment for participation in good faith in these projects;
- Ensuring pre-participation status after completing participation or agreeing on any changes in status prior to participation;
- Preventing the Department of Ecology or other state agencies from using information gained through participation in a regulatory hearing against a good-faith participant;
- Providing regulatory assurances for participants who achieve stated levels of conservation; and
- Establishing monetary incentives for participation.

The success of water management in the Walla Walla Basin may provide valuable lessons for the Puget Sound Basin and watersheds across the western United States.

For more information, see Washington Department of Ecology, *Walla Walla Watershed Management Partnership: A Proposal for a Pilot Local Water Management Program in the Walla Walla Basin*, Pub. No. 08-11-061 (2008).

3. Improve Water Quality under the Clean Water Act

The Clean Water Act (CWA) is the primary legal mechanism for protecting the quality of the waters in the United States. The heart of the CWA's implementation and enforcement strategy is the National Pollution Discharge Elimination System (NPDES) program. All point sources—discernible conveyances such as pipes or ditches—through which pollutants are added to waters of the United States must obtain a NPDES permit and comply with the conditions set forth in the permit. Among those conditions are uniform technology-based effluent limitations by industrial category, which are generally set by the U.S. EPA. Additional, more stringent permit limits are established when necessary to meet state water quality standards. EPA has delegated authority to Washington and some Tribes to administer the NPDES permit program.

Whereas state water law focuses on the quantity and allocation of water, the CWA has generally focused on the quality of water. Climate change impacts will highlight the relationship between water quantity and water quality because the maintenance of a healthy ecosystem depends upon both clean water and a natural flow of water. Nevertheless, as Washington has already established in the U.S. Supreme Court, the CWA itself provides mechanisms for linking water quality and water quantity considerations in pursuit of protection of aquatic ecosystem health.⁹²

To improve upon these existing linkages, EPA, Washington, and the Tribes should:

- **Use the Clean Water Act to remove or reduce as many existing stressors as possible to increase aquatic ecosystem resilience.** Assuming that climate change will exacerbate existing stressors and alter water quality by causing an increase in water temperatures, changing the timing and flow of water, and lowering the pH of marine environments, EPA, Washington, and the Tribes should use the water quality standards to reduce existing stressors. For example, they could establish water quality standards for flow, incorporate more stringent thermal effluent discharge limits in NPDES permits for any waters projected to be impaired by climate-induced warmer waters, or adopt marine water pH criteria to address ocean acidification.⁹⁴
- **Administer the Clean Water Act's TMDL program on a watershed-wide basis.** According to the 2002 assessment of Washington's waters, more than 50 percent of the streams in the Puget Lowlands ecoregion failed to meet their designated use.⁹⁵ For these impaired waters, the CWA contains a powerful but relatively little used tool to limit the discharge of pollutants into water, the Total Maximum Daily Load (TMDL). A TMDL represents the total amount of a pollutant that all sources may add to a water body without exceeding the water quality standards for that pollutant. This pollutant cap may be used to establish limits in NPDES permits for point sources that are more stringent than EPA's technology-based effluent limitations. For nonpoint sources, which are not required to have NPDES permits, the TMDL

may serve as a basis for inducing the use of voluntary best management practices or increased mandatory regulation of these sources pursuant to state law. Restoration of a watershed cannot be achieved on a piecemeal basis. When establishing TMDLs, a state should ensure that a TMDL not only helps to restore the individual impaired water but also contributes to the overall restoration of the watershed.

- **Reduce pollution from nonpoint sources.** Nonpoint source pollution remains the largest source of water pollution across the United States. While the CWA does not regulate nonpoint sources, it provides funding for state programs that encourage voluntary practices. EPA should encourage states to adopt implementation plans for TMDLs, as it has done in the Chesapeake Bay. States may also enact legislation to regulate these sources and require pollution reduction controls and practices. Reducing water pollution from these sources is an important adaptation strategy because it provides a way to increase the resiliency of aquatic ecosystems to the likely consequences of climate change, such as lower summer flows, increased water temperatures, and increased levels of sedimentation arising from erosion linked to more frequent and severe wet weather events.

4. Use the Endangered Species Act to Assist Adaptation of Species

A changed hydrologic cycle, combined with changed marine currents in the northeastern Pacific Ocean, will severely stress Pacific Northwest salmon and other aquatic species if they are unable to adapt. In addition to the legal tools discussed earlier in this section, another tool for specifically protecting anadromous fish species is the Endangered Species Act. The critical habitat, recovery plan, and consultation provisions of sections 4 and 7, respectively, are well-suited to assist species in adapting to climate change and thus ensure their survival.

The Washington Department of Natural Resources and the U.S. Fish and Wildlife Service should:

- **Use critical habitat designation to enable migration.** The ESA authorizes the federal wildlife agencies to designate critical habitat outside of a species' current habitat if it is essential for the conservation of the species. As climate change alters habitat, it may be necessary either to make landscapes more permeable so that species can respond by moving through them or to physically move species.
- **Use recovery plans as a source of information to promote protection of species.** Recovery plans are intended to guide conservation actions necessary for the recovery of listed species. Although the plan is not enforceable, its primary value may be in providing a wealth of information about a species that can help inform other adaptation measures.⁹⁶ State and local policymakers can enact legislation or regulations that are more protective of species than federal actions and should therefore craft effective adaptation measures by making the most they can of the information provided in the plans.

- **Maximize consultation requirement to prevent further harm to species.** The consultation requirement in section 7 also will apply to a federal agency’s response to climate change if its actions might affect the species. The response cannot jeopardize “the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of [the critical] habitat of such species.” At the federal level, this consultation requirement and the no-jeopardy prohibition provide concrete tools for adaptation efforts to protect salmon and other endangered or threatened species.

Assisted Migration

Climate change will require many species to move as their habitat shifts. One proposal to ameliorate the problem is through assisted migration. The term has been applied to actions that range from increasing the permeability of landscapes to the intentional transfer of species to a new region.⁹⁷ Although it is gaining some currency among natural resource managers, the more active approach concept is quite controversial because it represents a dramatic departure from traditional natural resources management and raises ethical, practical, and legal questions.

Section 10 of the ESA may provide the legal basis for this intentional translocation of listed species either as an experimental

population⁹⁸ or for other general scientific purposes.

More important is the basic question of how to select species for assisted migration. One set of criteria could be (1) conclusive evidence of a threat of extinction, (2) a quantitative model showing the likelihood of success once transferred with minimal impact on other species, and (3) dedicated resources for long-term monitoring and adaptive management.⁹⁹ Once selected and transferred, however, the species could become invasive in its new environment. At its core, assisted migration exemplifies how climate change may fundamentally alter the traditional tenets of natural resources management.

C. Conclusion

Overall, the climate-induced changes to the hydrologic cycle portend serious environmental implications for salmon and other aquatic species. While the direct impacts to human uses of water are relatively manageable, aquatic ecosystems are likely to change—perhaps substantially—in response to previously unknown fluctuations in water supply and increases in water temperature. These effects on aquatic ecosystems will have indirect impacts to humans, particularly for Tribes that depend on and have treaty-secured rights to salmon and for others who look to fish for food or for their livelihoods. Communities in Puget Sound and across Washington must consider implementing existing water laws in new, dynamic ways to enhance the resiliency of these aquatic systems and to reflect the profound impacts caused by climate change.

VII. Sea Level Rise

Picturesque shorelines and productive estuaries and wetlands are among the major attractions in Puget Sound. Like thousands of coastal communities around the world, however, Puget Sound faces significant challenges as a result of sea level rise caused by climate change. Stronger storm surges and coastal erosion have motivated these communities to plan for adaptation to the encroaching water. This section will describe the impacts of sea level rise and identify specific tools for addressing it. Some of the cross-cutting issues related to sea level rise are part of section IX.

Quick Look: Sea Level Rise

Primary Impact

- Climate change will cause both gradual landward migration of the ordinary mean high water mark and sudden, episodic changes to the shoreline and coastline.

Who and/or What Sectors are Affected?

- Coastal communities
- Marine ecosystems, estuaries, coastal wetlands, and other natural space along the coast
- Ports

Who are the Primary Actors?

- Coastal communities and local and tribal governments
- Private landowners

The coastline along Puget Sound spans close to 1500 miles and is densely inhabited, with 90 percent of the coastline lined with single-family housing or available for development. Even though the predominant land use is low-density housing, much of the development has permanently altered or even destroyed natural ecosystems that could help buffer the impact of sea level rise. Hard-armorings of the shoreline with sea walls, bulkheads, and riprap inevitably lead to encroachment of the ocean and elimination of the naturally dynamic near-shore habitat.¹⁰⁰ Around the Puget Sound, retention of shallow water habitat and beaches are important for juvenile fish, shellfish, and shorebirds.

Sea level rise causes not only the landward migration of the shoreline along open beaches, but also coastal bluff erosion. The erosion of the base of bluffs causes large slabs to break off, weakening the bluff structure on which houses or other human infrastructure may

be built. Sea level rise may also cause saltwater to seep into coastal freshwater aquifers, but the 2009 CIG report concluded that saltwater intrusion is not a major risk for most of Washington.¹⁰¹ Coastal communities may experience stronger storm surges and other extreme weather events as the most immediate impacts of sea level rise. For example, energy and waste facilities located on the coast are vulnerable to strong storm surges, which may cause both infrastructure damage and public health problems if a storm surge breaches waste containment structures.

The CIG Report concluded that relative sea level rise in Washington will be greatest in south Puget Sound and the least on the northwest tip of the Olympic Peninsula.¹⁰² The climate-induced sea level rise is augmented by natural land subsidence. Whereas the Olympic Peninsula is rising at seven-hundredths of an inch (2 millimeters) per year, South Puget Sound is subsiding by an equal amount.

A. General Considerations and Principles for Adaptation to Sea Level Rise

Adaptation to sea level rise will require planning and action over a long-term timeframe. Because of the uncertainty associated with specific local impacts, local governments should rely on the following principles:

- **Approaches to adaptation.** In considering actions to adapt to sea level rise, three general approaches exist: accommodation, protection, and retreat.¹⁰³ *Accommodation* involves maintaining existing land uses with actions to protect structures or land from flooding by seawater. For example, a coastal community may elevate buildings onto piles but does not actively attempt to prevent dry land from flooding onto existing dry land.

Protection involves maintaining existing land uses by preventing flooding with hard or soft structures. Hard structures, such as seawalls, concrete jetties or bulkheads, or riprap, are generally considered maladaptive because they halt the natural migration of the shoreline such that erosion eventually eliminates the shallow water area and the beach.¹⁰⁴ Soft structures, or “green armoring,” using rocks, vegetation, and sand or gravel, prolong the natural ecosystem and provide habitat, but require maintenance and generally are not permanent.¹⁰⁵

Retreat is arguably the most effective (even if it appears to be the most difficult to implement) and the most likely to generate political opposition of the three approaches. Retreat involves eliminating existing land uses by moving development inward and returning the coastal zone to natural ecosystems that can then shift and migrate as sea levels rise.

- **Institute coastal planning and scenario-building based on climate change projections.** Climate change adaptation is a continuous process that will span decades, if not centuries. In permitting new structures and renewing permits to modify existing structures, coastal communities in Washington should consider the likely lifespan of the new structure and the range of sea-level rise scenarios over that lifespan. This long-term approach may help minimize future problems. Coastal planning should also include decommissioning requirements or benchmarks for major infrastructure or facilities that handle toxic or hazardous materials and are vulnerable to sea level rise and storm surges.
- **Rely on natural features of the shoreline or other “green infrastructure.”** The goal of adapting to sea level rise is to rely, as much as possible, on the natural features of the shoreline to protect ecosystems and human communities. This approach entails a combination of active and passive activities, such as removing infrastructure and designating existing natural areas as “no development zones.”

Case Study: New York’s Sea Level Rise Task Force

Earlier this year, New York issued a report on the impact of sea level rise across the state. The report includes recommendations for an action plan to protect coastal communities and natural resources from sea level rise. Among the key findings and recommendations issued by the New York Sea Level Rise Task Force:

- Natural coastal ecosystems and features, such as wetlands, beaches, and aquatic vegetation, provide significant environmental and adaptation benefits that would be “prohibitively expensive to replicate with human-built systems.” Building hard-armoring structures, such as seawalls and dikes, may prove to be poor investments and less effective than relying on natural features.
- The report urges New York to adopt a statewide definition for a “coastal risk management zone,” which includes high hazard areas and areas with certain existing wave action. Defining and mapping this zone can be used as the

basis to determine which areas are most vulnerable to sea level rise and to determine how to reform local building ordinances and implement other programs to address climate change impacts.

- In New York, serious funding and information gaps exist that create significant obstacles for implementation of adaptation strategies. One strategy is to make funding for plan implementation contingent on adequate consideration of sea level rise. The state must also undertake detailed mapping and other data collection to provide more information on localized or downscaled climate change impacts.

Despite the geographic distance between New York and Washington, these two states and other coastal states can learn from each other in developing sea level rise adaptation strategies. Novel approaches, such as the establishment of certain coastal zones, could apply uniformly to all coastal communities.

Adaptation to sea level rise requires a fundamental change in the way local governments approach shoreline development, including designating vulnerable areas as “no development” zones and providing incentives or compensation to prevent future development in critical areas. Washington and coastal communities in the Puget Sound should also identify areas where reliance on green infrastructure is not an option—such as ports or high-density coastal developments—and begin identifying feasible accommodation or protection strategies.

- **Identify critical impacts on other sectors such as public health and transportation.** Sea level rise poses a threat not only to coastal ecosystems and coastal structures but also to public health, transportation, and disaster management planning. The impact on these sectors may become apparent only with episodic but severe weather events and may take precedence over adaptation to the more gradual encroachment of water. Identifying and adopting plans for these multiple impacts are key to adapting to sea level rise.

Among the important tools that Washington and communities in Puget Sound should use to adapt to sea level rise are relying on the existing Growth Management Act and Shoreline Management Act to identify vulnerable areas and plan for future coastal land use, refining local building codes to increase the resilience of built infrastructure, and robustly applying the public trust doctrine to protect natural coastlines. In addition, using laws to recognize natural migration and rolling easements would give communities in the Puget Sound a well-stocked toolbox to address this inevitable impact.

B. Specific Recommendations

1. Adopt a Statewide Definition of Coastal Hazard Area

The Growth Management Act requires a county or city to identify critical areas, including “geologically hazardous areas” that “because of their susceptibility to erosion, sliding, earthquake, or other geological events, are not suited to the siting of commercial, residential, or industrial development consistent with public health or safety concerns.”¹⁰⁶ Sea level rise reasonably fits among these events. **Thus, a county or city with a comprehensive plan should consider the impacts of sea level rise in the definition of a hazardous area, either by adopting a new category specific to the shorelines or as a subarea plan¹⁰⁷ : the coastal hazard area.** Alternatively, the **Washington Legislature should amend the Growth Management Act to require a coastal hazard element.**

The scope of this area could be a combination of the geologically hazardous area—areas susceptible to gradual sea level rise or episodic storm surges and other extreme weather events—and the definition proposed by the New York Sea Level Rise Task Force: zones designated by FEMA to include coastal high hazard areas and any areas defined by FEMA as “areas of moderate wave action,” or subject to wave action of 1.5 to 3 feet. Areas designated coastal hazard areas would then trigger specific mandatory adaptation strategies to address sea level rise, such as increased setback lines or other building requirements, as proposed in the Swinomish Climate Action Plan.

Action Items: Climate Change Adaptation & Sea Level Rise

1. **Adopt a statewide definition of coastal hazard areas that are most vulnerable to sea level rise and increase adaptation planning for these areas.**
2. **Incorporate sea level rise impacts into Shoreline Master Programs by prohibiting development in existing natural areas and adopting building codes that account for sea level rise.**
3. **Consider the application of rolling easements or selective retreat from the coast.**
4. **Fulfill trustee duties under the Public Trust Doctrine to preserve natural areas and existing green infrastructure.**

2. Adopt Coastal Resilience Plans

Coastal communities around the Puget Sound should adopt coastal resilience plans, as proposed in the New York Sea Level Risk Task Force report. The purpose of such a plan is to assess in advance the resiliency of the coast or shoreline by identifying the protection, accommodation, or retreat options for coastal infrastructure and features. The plans should:

- Identify hard-armoring alternatives to reduce vulnerability in coastal risk areas;
- Identify areas where structural protection is needed to protect significant public investment, water-dependent uses, and critical infrastructure;
- Identify opportunities to further reduce vulnerability through non-structural measures in the recovery and restoration process following coastal damage or storms;¹⁰⁹
- Identify adaptation strategies to be implemented after extreme storm events, such as land use controls, infrastructure relocation or abandonment; and restoration of natural features;
- Include laws or mechanisms that make the plans enforceable; and
- Encourage public participation in identifying and prioritizing strategies to bolster coastal resilience.

The impacts from sea level rise demonstrate the localized effects of climate change, and coastal communities should tailor their plans to reflect unique, local circumstances.

3. Use the Washington's Shoreline Management Act to Protect against Sea Level Rise

Washington's Shoreline Management Act (SMA) is intended in part to protect the natural character of the shoreline and public access for recreational opportunities. Adverse impacts to the shoreline from preferred or allowed uses are supposed to be mitigated to the maximum extent feasible. In addition, local governments that administer the SMA are required to provide for public access to publicly owned shoreline areas and the preservation and enlargement of recreational opportunities.

At the local level, the SMA is implemented through shoreline master programs (SMPs), which are essentially a combination of shoreline-specific comprehensive plans, a permit system for shoreline development, and zoning ordinances that are tailored to the specific geographic, economic, and environmental needs of the shoreline community. Local governments are responsible for administering the SMPs and are required to review them every seven years. The Department of Ecology reviews and approves of the plans, as well as provides funding and assistance for plan implementation.

Although the regulations for SMPs do not specifically include consideration of sea level rise, they encompass a handful of policies that should be used to authorize actions that protect against the adverse consequences of sea level rise:

- **Consider the impact of sea level rise on existing and projected shoreline uses in the shoreline use analysis.**¹¹⁰ Washington regulations specify certain elements that must be included in SMPs, including economic development, public access, recreation, circulation, conservation, and historic and cultural elements. Impacts from sea level rise can be easily incorporated into the plans as it obviously has the potential to affect each of these elements. For example, the shoreline use analysis could consider the impact of sea level rise on existing and projected uses.¹¹¹ The conservation element also provides a good opportunity to consider adaptation to sea level rise by identifying projects to restore natural processes or features such as erosion and sediment transport or vegetated dunes.
- **Consider how to redefine the “no net loss” policy in light of sea level rise.** Washington regulations establish the “no net loss” policy for shorelines, meaning that the “existing condition of shoreline ecological functions should remain the same as when the SMP is implemented.” The purpose of the policy is to prevent harm to the ecological functions of shorelines that result from new development. Shoreline functions should be improved where possible, but at a minimum, adverse impacts to shorelines should be avoided or minimized or the shoreline should be restored where damage has already occurred. Over time, however, sea level rise and other changes resulting from climate change will likely prompt the Department of Ecology to examine the feasibility of this policy as rising sea levels erode shorelines to the edge of bluffs or hard-armoring structures and to decide how the policy should be redefined to ensure resilience in the face of climate change.
- **Require applicants for conditional use permits to demonstrate how a proposed use will adapt to sea level rise.** SMPs establish regulations for development and define what uses are “conditional uses” that are not preferred but may be permitted under certain conditions. Conditional Use Permits (CUPs) are approved or disapproved by the Department of Ecology depending on whether the use meets certain criteria, including “no significant adverse effects to the shoreline” and “no substantial detrimental effect to the public interest.” These criteria provide an opportunity for the Department of Ecology to require an applicant to show, for example, how a proposed use will adapt to changing conditions over the lifespan of the use.

Ultimately the Department of Ecology should pass regulations to explicitly consider sea level rise in shoreline master programs.



About the Shoreline Management Act

Enacted in 1971, the Shoreline Management Act emphasizes three basic policies: preferred uses of shorelines, environmental protection of shorelines, and public access to shorelines. Combined, these policies strive to protect against adverse effects to the public health, the land, and its vegetation and wildlife, and the waters and aquatic life of the state, while generally protecting public rights of navigation and related rights. The SMA recognizes that the shorelines are among Washington's greatest and most fragile natural resources and declares that "the public's opportunity to enjoy the physical and aesthetic qualities of natural shorelines of the state shall be preserved to the greatest extent feasible consistent with the overall best interest of the state and the people generally."¹¹²

The SMA applies to all 39 counties in Washington and more than 200 towns and cities that contain "shorelines of the state," including all marine waters; streams and rivers above a certain flow; lakes above a certain acreage; upland shorelands extending landward from these waters; and wetlands and floodplains associated with these waters. In addition, the SMA classifies certain shorelines as "shorelines of statewide significance," which include among others certain Puget Sound shorelines and all waters of Puget Sound.

For these significant shorelines, a preferred use may be a long-term, statewide interest that preserves the ecology and natural features of the shoreline and promotes public access and recreation.¹¹³

4. Apply Rolling Easements and Selected Retreat

Part of adapting to climate change may entail simply letting natural systems move and adjust as they would without hard, human-built infrastructure. Much has been written about the concept of rolling easements, where private property rights yield to a naturally migrating shoreline and the public use on that shoreline. The most prominent state with rolling easements is Texas, which adopted the Texas Open Beaches Act.¹¹⁴ The purpose of the Act was to guarantee public access to the beach rather than to guarantee the dynamism of the shoreline, but many advocates have since proposed a shift in the fundamental purpose. Under the Act, the public has the right of access to the state-owned beaches along the Gulf of Mexico. The Act further states that the public can, through continual use, easement, or dedication, acquire a right of access up to the landward line of vegetation.¹¹⁵ Thus, if a party can first establish that the public has a right to use the contested area, the Act authorizes the removal of barriers and other obstructions, even if they exist on private land.¹¹⁶

Washington could adopt a similar act because the legal foundations, in part, already exist. For example, the definition of the ordinary high water mark (OHWM) recognizes that the mark migrates:

"[T]hat mark that will be found by examining the bed and banks and ascertaining where the presence and action of waters are so common and usual, and so long continued in all ordinary years, as to mark upon the soil a char-

acter distinct from that of the abutting upland ... *as it may naturally change thereafter*, or as it may change thereafter in accordance with permits issued by a local government of the Department of Ecology...”¹¹⁷

In addition, the Washington Supreme Court has clarified under what circumstances the OHWM shifts in a river or a stream: if the shift “is slow and imperceptible so that it may be classified as accretion or reliction,” the OHWM shifts. However, if the shift is avulsive and therefore marks a sudden change, the original line remains. *Parker v. Farrell*, 445 P.2d 620, 622 (Wash. 1968). Although no cases that address avulsion of shorelines have been brought in Washington, it is likely that a court would extend this reasoning to coastal avulsion.

With this framework, Washington should implement rolling easements through different methods and levels of restrictions and state actions. First, local governments could simply prohibit the construction of hard structures that block the natural migration of the shoreline. Washington should also pass legislation to specify that rolling easements apply to all shorelines and require this disclosure in property deeds. In addition, states could negotiate an option to purchase private property along the shoreline if sea level rises to a certain point.¹¹⁸

Case Study: Managed Retreat in California

In California, sea levels are projected to rise as much as 55 inches by 2100 and inundate up to 41 square-miles of coastal land. As a result, the city of Ventura has embarked on a managed retreat effort for Surfer’s Point, relocating a bike path and parking lot 65 feet inland and extending the life of the point by 50 years. At a cost of \$4.5 million, the project is the first of its kind in California.

Private landowners with property adjacent to the Point, agreed to give up some land in order to allow the beach to migrate landward. This project marks a significant departure from the ubiquitous concrete sea walls and other hard-armoring structures favored to keep the ocean at bay, which provide only short-term relief and creating long-term hazards such as further erosion of coastal shorelines.¹¹⁹

5. Enforce and Broaden the Scope of the Public Trust Doctrine

This public trust doctrine reflects the idea that certain natural resources belong to the public because of their immense value to the public as a whole, and no private entity can ever acquire the right to monopolize or deprive the public of the right to use and enjoy these resources.¹²⁰ Although it originally focused heavily on water and shorelines used for navigation, states like Washington have increasingly applied the public trust doctrine to protection of environmental values in water.¹²¹

In Washington, the public trust doctrine is part of both the state constitution and the Shoreline Management Act.¹²² Article XVII of the state constitution declares that the state of Washington owns “the beds and shores of all navigable waters in the state up to and including the line or ordinary high tide, in waters where the tide ebbs and flows, and up to and including the line of ordinary high water within the banks of all navigable rivers and lakes.” Washington law also defines aquatic lands as “all state owned tidelands, shorelands, harbor areas, and the bends of navigable waters” and requires the state to manage these lands to encourage public use and access and to ensure environmental protection.¹²³ Prior to leasing land or allowing changes of use, the Department of Natural Resources must consider “the value of state-owned aquatic lands as wildlife habitat, natural area preserve, representative ecosystem, or spawning area.”



The public trust doctrine, like trust theories generally, includes three primary components: the trustee, the trust principal, and the beneficiaries of the trust. In the public trust framework, the *state* is the trustee, which manages *specific natural resources*¹²⁴—the trust principal—for the benefit of the *current and future generations*—the beneficiaries. These components allow the doctrine to play a key role in adapting to sea level rise by dictating that land uses affecting the shoreline be controlled using a forward-looking perspective. Although the doctrine does not give the state any *additional* regulatory authority, it can be used to support and protect natural features of the trust lands, to defend against takings claims that may arise from application of laws and regulations to protect the shoreline, and to protect vulnerable areas in combination with other common law remedies.¹²⁵ However, lawmakers and

advocates should be mindful of concurrent trust obligations to tribes in the Puget Sound region and should avoid encroaching on these obligations or other treaty rights.¹²⁶

As a tool for adapting to sea level rise, Washington should use the public trust doctrine to:

- **Protect and maintain natural features of trust lands.** Using the public trust doctrine, advocates should push for Washington to actively fulfill its public trust duty by protecting shoreline uses, including public access, and protecting the shoreline itself. In the adaptation context, the goal would be to maintain or improve the buffering capacity of shorelines to provide natural defenses to sea level rise and reduce the need for hard-armoring.
- **Defend against takings claims.** The public trust doctrine may provide a defense for state action taken to protect public trust lands or resources but affecting private property. Where Washington is obligated by the public trust doctrine to act, a court may find that the state does not have to compensate a private landowner.¹²⁷
- **Support other common law remedies.** Other common law remedies such as dedication or prescription may also be used to protect shorelines and other public trust resources. For example, public rights to a beach may be established by open and continuous public use for a statutory period of time. In addition, a private adaptation action that harms trust resources or endangers public health may constitute a public nuisance. Public trust resources therefore benefit from a variety of common law doctrines that all promote and preserve the greater public good.

C. Conclusion

In Puget Sound, the impacts from sea level rise will likely manifest as incremental migration of the ordinary mean high water mark as well as episodic but forceful storm surges and other extreme weather events. Adapting to these impacts requires advance planning and mapping of vulnerable areas, identifying priority actions for existing structures, and designating natural areas subject to development restrictions. Advocates could also consider legal tools such as rolling easements and the public trust doctrine to protect natural areas. As many coastal communities around the country and the world are faced with sea level rise, communities in Puget Sound can learn from and contribute to the adaptation conversation.

VIII. Increased Average Temperature and Extreme Weather Events

Increased average temperature and extreme weather events will be some of the most disruptive impacts from climate change. Increases in average temperature are likely to occur gradually and less perceptibly, but increased frequency of extreme weather events is likely to take the form of episodic but severe temperature or precipitation events. These changes will directly affect human health by exacerbating existing public health problems and introducing new problems. This section first describes the impact of climate change on human health and then identifies general principles for selecting and identifying adaptation strategies. It emphasizes the importance of pre-disaster planning to protect the public health and the need for strategies to address poor air quality.

Quick Look: Increased Average Temperature & Increased Frequency of Extreme Heat Events

Primary Impact

- Climate change is expected to increase the average surface temperature in Washington by 3.2° F by the 2040s and to increase the frequency of extreme heat and precipitation events.

Who and/or What are the Primary Sectors Affected?

- Human health, particularly vulnerable populations such as children, day laborers, the elderly, the poor and socially marginalized, and those with existing health conditions
- Forests
- Stormwater infrastructure and public and private infrastructure in floodplains

Who are the Primary Actors?

- State and Local Governments
- Local non-governmental organizations (such as community or religious groups)

The relationship of climate change to human health is multi-faceted. For example, the severity of climate impacts on health is strongly influenced by underlying vulnerabilities, such as poor baseline health and poverty. Failing to address these underlying vulnerabilities will reduce the effectiveness of any climate-specific adaptation efforts. Climate impacts are also likely to widen existing disparities because vulnerable populations are less likely to be able to obtain health care or to access other resources for recovery. As a result, these vulnerable populations will bear the most severe impacts of climate change, triggering a negative feedback loop that often results in long-term poverty.

The Puget Sound Basin benefits from a mild climate, with average temperatures ranging from 30 to 80 degrees Fahrenheit throughout the year. Thus, some of the most dramatic impacts of climate change on human health will not result from increased average temperature but instead from extreme weather events, in the form of both precipitation and periods of unusual heat. Indeed, in the United States, extreme heat events cause more deaths each year than all other extreme weather events combined.¹²⁸ These periods of heat in normally temperate regions, such as Puget Sound, can be more lethal than in regions accustomed to high temperatures because fewer buildings are designed to provide protection from heat.

The CIG conducted modeling of heat-related morbidity and mortality under three warming scenarios, low, middle, and high, in 2025, 2045, and 2085.¹²⁹ In the Puget Sound region, the increase of deaths ranged from 68 to 211 in 2025 under the three scenarios, from 89 to 401 in 2045, and 107 to 988 in 2085.¹³⁰ The most vulnerable populations are children; the elderly; the poor; those with existing mental illnesses or chronic diseases; and day laborers.

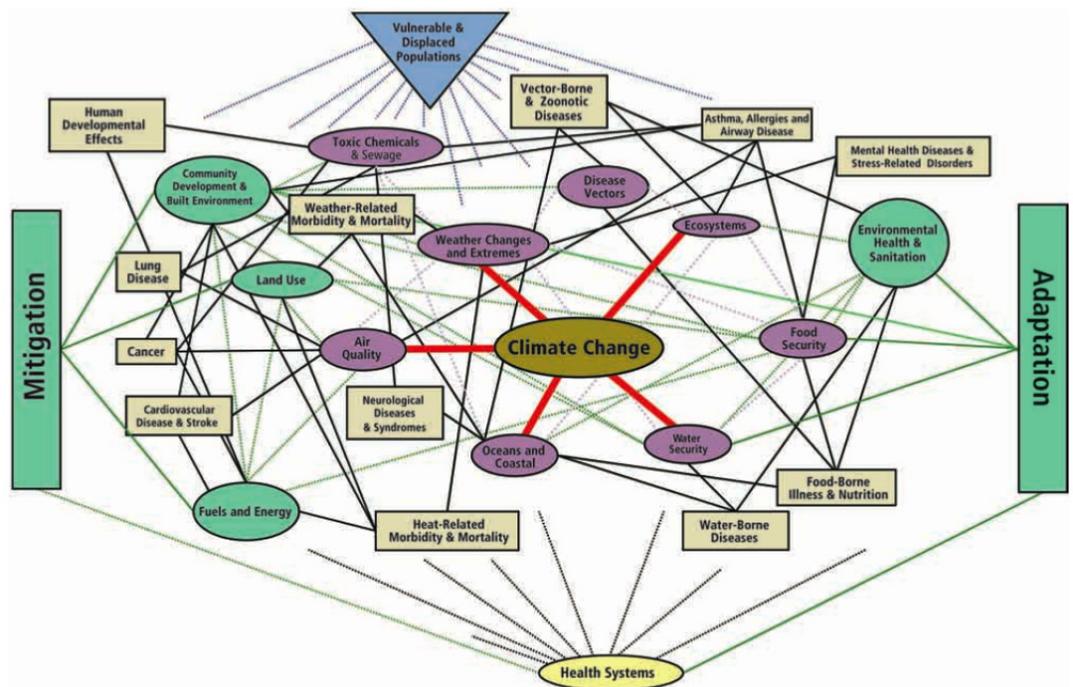
More broadly, the Centers for Disease Control (CDC) identified a range of potential climate impacts on human health,¹³¹ which include increased incidences of:

- *Asthma and respiratory allergies or diseases*, caused by increased exposure to pollen from extended growing seasons or to mold after heavy precipitation;
- *Cancer*, potentially caused by increased exposure to chemicals and toxins from hazardous facilities damaged as a result of extreme weather events;
- *Cardiovascular disease and stroke*, as a result of increased stress from exposure to airborne particulates and air pollutants;
- *Food-borne diseases and nutritional deficiencies*, from contaminated agriculture and fish and potential food shortages related to weather-related crop damage or impacts to transportation and storage of food supplies;
- *Heat-related morbidity and mortality*, resulting from increased heat stress;
- *Human development effects*, such as birth defects, early onset puberty, and abnormal gene expression, resulting from increased exposure to toxins and chemicals in the air and water;
- *Mental health and stress-related disorders*, resulting from the trauma of the extreme weather events, geographic displacement, and death of loved ones;
- *Vector-borne and zoonotic diseases* that transfer to humans from animals, as a result of geographic expansion of host and disease ranges, shortened pathogen incubation periods, and relocation of human populations;
- *Waterborne diseases and illnesses*, caused by human contact with contaminated water; and
- *Weather-related morbidity and mortality*, as a result of increased frequency of extreme weather events such as flooding, hurricanes, droughts, and heat waves.¹³²

Many of these impacts require further study because the direct causal links are uncertain despite the high correlative links. However, the need for further study does not preclude action. Populations in the Puget Sound region could potentially experience increased risk of most of these impacts, and public health officials should be aware of how these health impacts are related to climate change and how they present. For example, shellfish and shellfish aquaculture are vital to the health and well-being of the region's Native American tribes and are important to the economy of Puget Sound.¹³³ However, the toxins in shellfish, which cause a range of effects from mild gastrointestinal illness to paralysis after shellfish consumption, are present in higher concentrations in warmer waters.¹³⁴ Climate change may therefore lead to the increased risk of food-borne illness for human populations. In addition, the historically mild climate in Puget Sound means that relatively few buildings

and homes are equipped with air conditioning, increasing vulnerability to morbidity and mortality from extreme heat events.

The figure below illustrates the complex relationships among human health, climate change impacts, and mitigation and adaptation effects. Climate change has direct impacts on five aspects (red lines, purple circles) of the human environment that in turn impact other environmental factors (purple circles). These environmental factors alter aspects of human health (tan boxes), which include subpopulations that are particularly vulnerable to human health impacts. Mitigation and adaptation efforts themselves alter the human health landscape, and health systems play an integral role in addressing the impacts of climate change on human health.¹³⁵



A. Principles for Adapting to Climate Change in the Human Health Sector

The determinants of individual health are a complex interaction of genetics, community, socioeconomic status, environment, and education and are often difficult to isolate. The increased average temperatures and increased frequency of extreme weather events that are driven by climate change will seldom be the sole drivers for negative impacts to human health but instead will exacerbate underlying conditions.

To begin adaptation efforts in the human health sector, policymakers and advocates should consider the following principles:

- **Adopt an integrated, holistic approach to increase resilience.** Human health is complex, dependent on many environmental, social, and economic factors. Addressing any one factor may not result in improvement in health outcomes or remove barriers to good public health posed by other factors. For example, building cooling centers as an adaptation strategy may help, but only if those who may need the centers are able to access them during a heat wave. This strategy must be paired with transportation solutions for those who cannot afford cars or public transportation. Thus, climate change adaptation strategies and laws should consider these multiple factors, including profound economic disparities, to increase a community's overall resilience.
- **Consider underlying disparities or differences that affect a community's ability to adapt to or recover from an extreme weather event.** The impacts of climate change on human health will manifest differently for discrete populations within the same area. For example, immigrant communities that speak little to no English or communities that view the police or government with suspicion will need appropriate public service or emergency announcements, such as announcements in different languages or disseminated by non-governmental organizations. For prolonged increases in temperature, access to and the ability to afford air conditioning is correlated with income. While air conditioning is critical to reducing the health impacts of elevated temperatures, individuals with limited income may forego obtaining or using air conditioning without financial assistance. For climate change adaptation to be both effective and equitable, these differences and disparities must be acknowledged and accounted for as part of any adaptation strategy.
- **Adopt adaptation strategies that have co-benefits for other sectors or that link to other disciplines.** Because of the interconnectedness of factors that impact human health, this area presents a particularly ripe opportunity to promote strategies and laws that provide benefits to other sectors. For example, improving underlying air quality (discussed below) to lessen the existing impacts of heat-induced ozone pollution would have important co-benefits for human health and the environment more generally. At the same time, decisionmakers should also consider any negative spillover effects caused by adaptation strategies in the public health sector, such as introducing air conditioning that will lead to higher rates of energy consumption and greenhouse gas emissions.

B. Disaster Planning: Preparation is Key

**Three Phases of Disaster Planning:
Some Considerations**

Pre-Disaster Planning

- Evaluate vulnerabilities of critical infrastructure (such as health care facilities and major evacuation routes)
- Designate responsibility, including overlap of major areas of concern
- Identify vulnerable communities
- Ensure adequate, culturally suitable, pre-disaster warning system

Response During a Disaster

- Ensure timely and accessible public announcements
- Ensure ability to evacuate
- Ensure access to safe areas or shelters

Post-Disaster Rebuilding and Recovery

- Describe process or schema for deciding recovery priorities
- Identify areas for relocation, redevelopment, or abandonment in rebuilding phase that meet the needs of all communities

Overarching Elements

- Communication and dissemination of information
- Public participation and input in decision making
- Designate roles and responsibilities, including NGOs as appropriate

One of the key adaptation strategies to address the episodic but severe weather impacts from climate change is pre-disaster planning. Starting the adaptation conversation early, prior to the chaos of a disaster, creates an opportunity for broad community participation in planning for post-disaster recovery. Communities in the Puget Sound region should ensure that they are undertaking thorough review of the existing ability to respond to and recover from disasters.

In Washington, county governments are responsible for disaster mitigation, preparedness, response, and recovery within unincorporated areas, while tribes and municipalities are responsible for planning within their jurisdictions. The mandatory Washington Comprehensive Emergency Plan (WCEP)¹³⁶ constitutes “a comprehensive, all-hazard emergency plan for the state” that includes an analysis of the natural, technological, or human-caused hazards that could affect the state. Washington defines “emergency” or “disaster” as a situation that either demands immediate action to preserve public health, to protect public property, or to provide relief to any stricken community; or reaches proportions of destructiveness that warrant the governor declaring a state of emergency. The plan also describes the procedures to be used during emergencies, such as the process for administering emergency assistance to victims of disasters.

In the adaptation context, disaster management planning is crucial because the impacts from episodic but extreme weather events will likely manifest as events that qualify as disasters. As Washington and local communities in Puget Sound review their disaster management plans, they should revise their plans with adaptation in mind. Making disaster management plans “adaptation aware” should include:

- **Projection of future risk.** A disaster management plan should consider how climate change impacts will exacerbate existing risks and should project these new risks. For example, the boundaries of flood plains may expand with more severe storms. The plan should project risks associated with a range of scenarios.
- **Basic information about structure of the community.** A disaster management plan should include basic information about the community, including the economic and demographic landscape. The plan should focus on identifying vulnerable populations.

- **Post-disaster vision for resilient communities.** A disaster management plan should define “recovery” or include an overarching post-disaster vision that transitions toward a more adaptive environment. This element should also distinguish between areas that should be rebuilt and areas that are unsuitable for rebuilding because of repeated or future risk. The community priorities should be developed through extensive outreach to and public participation by all groups, including traditionally marginalized populations.
- **Description of post-disaster goals and policies.** The disaster management plan should include goals that lead toward achieving the overarching post-disaster vision and incorporating climate change adaptation strategies as part of any disaster recovery strategy. Ideally, the plan should include goals related to improving resilience, improving equity and social justice in implementing recovery strategies; protecting health and safety, and enhancing economic recovery.¹³⁷ The plan should also include policies to achieve these goals, including an overview of available financial, personnel, and technical resources and existing or needed legal tools.
- **Designation of roles and responsibility.** Much as the WCEP describes the role of state agencies in a disaster or emergency, local disaster management plans should identify the roles of local government agencies, quasi-governmental organizations, and nonprofit or nongovernmental organizations. The plan should also identify the administrative, technical, and financial resources available to these actors.¹³⁸ Plans should also identify the roles of state and federal government agencies and catalogue available resources.

C. The Clean Air Act: Increased Temperatures and Air Quality

Climate change is projected to cause a gradual increase in average surface temperature, which will cause long-term impacts on human health through deteriorated air quality.¹³⁹ Two of the air pollutants that will most significantly impact human health are ground-level ozone and particulate matter.

Ground-level ozone is not directly emitted by pollution sources. Instead, it occurs naturally and through photochemical reactions between primary air pollutants (known as ozone precursors). These reactions are facilitated by a variety of factors, including temperature. The higher the temperature, the higher the level of ozone resulting from a given level of emissions of ozone precursors. Ozone concentrations tend to be highest during summer months, when sunlight is the most intense.¹⁴⁰ Ground-level ozone pollution is associated with serious health impacts, such as increased incidence of pneumonia, asthma, allergies, and other chronic respiratory diseases, and increased mortality.¹⁴¹

Similarly, concentrations of air-borne particulate matter (PM) may increase as average surface temperatures increase because PM formation depends partly on temperature and humidity.¹⁴² Studies link exposure to increased PM concentrations to increased morbidity and mortality.¹⁴³

[F]uture climate change may cause significant air quality degradation by changing the dispersion rate of pollutants; the chemical environment for ozone and particle pollution generation; and the strength of emissions from the biosphere, fires, and dust.

- Intergovernmental Panel on Climate Change,
The Physical Science Basis (2007).

At the federal level, the Clean Air Act (CAA) is the primary vehicle for addressing the air quality impacts of climate change. It has been credited with achieving a 50 percent reduction in the most common air pollutants and with reducing industrial pollutant emissions by more than 70 percent.¹⁴⁴ More recently, it has become a vehicle by which EPA can regulate the emissions of greenhouse gases.¹⁴⁵

While many have considered how the CAA can be used to reduce GHG emissions, less attention has been focused on the Act's potential role in adaptation. EPA regulates ground-level ozone and particulate matter concentrations by establishing national ambient air quality standards (NAAQS), and oversees state plans designed to achieve the NAAQS. In the ozone context, neither EPA nor the states can rely exclusively on current temperature data to determine the emission levels of ozone precursors that will be needed to ensure future compliance with the ozone NAAQS. Controls on emissions of ozone precursors that would have achieved air quality standards if temperatures remained constant could fail to achieve the standards if temperatures—and, consequently the ozone levels associated with a given level of emissions of ozone precursors—increase.

EPA and Washington should adjust their implementation of the Clean Air Act to better assure continued and future attainment of the ozone and particulate NAAQS in the following ways:

- **Ensure achievement of current air quality standards.** Knowing that climate change will likely worsen background air quality, the Department of Ecology should strive to ensure that, at a minimum, all sources are meeting applicable source-specific emission limitations through increased enforcement efforts and permit oversight.
- **Revise guidance on determination of attainment status.** Currently, EPA generally recommends that states and tribes use historical air quality data to determine attainment status. For example, EPA guidance on 8-hour ozone and particulate matter attainment demonstrations relies on a historical 3-year average.¹⁴⁶ This reliance on historical data assumes that future conditions will remain relatively

static, a false assumption given projected temperature increases and their impact on pollution levels. While this method may be viable within the stationarity framework of environmental law, the increased frequency of extreme heat events may upend the usefulness of past data in projecting how much emission control is needed to meet the NAAQS and protect public health from air pollution. At the federal level, EPA should require states to assess not only whether they are in attainment based upon past emissions, but whether they are likely to remain in attainment based on the increased pollutant concentrations that higher temperatures are likely to trigger.

- **Revise guidance on demonstration of future achievement of attainment status.** States with nonattainment areas must develop state implementation plans that show how they will, by deadlines specified in the CAA, attain the NAAQS. For demonstrating future attainment for ozone and particulate matter, for example, EPA again recommends in part that states use historical data as a baseline.¹⁴⁷ In light of climate change, states should model future pollution scenarios based on the concentrations likely to arise as a result of higher temperatures or include worst-case scenario planning in the contingency measures. States should then be required to alter their implementation plans and individual source permits to achieve attainment in light of the increased ozone and particulate concentrations likely to result from higher temperatures.

D. Other Legal Tools & Considerations

In considering adaptation to increased temperatures and increased frequency of extreme weather events, federal, state, tribal, and local governments should also consider revising building codes and land use regulations to ensure that they are flexible and respond to adaptation needs. For example, low impact development requirements could not only enhance water catchment, but also require design features that maximize cooling such as vented ceilings, site selection, and structure orientation. Hazardous waste treatment or disposal facilities could be subject to additional building codes or stormwater prevention plans to prevent leakage during flooding events. Major disasters in the past decade, including Hurricane Katrina in the United States and the 2011 tsunami in Japan, demonstrate the importance of such measures.

Ultimately, adaptation in the public health sector involves significant collaboration among local governments, health care providers, and the public. Socially equitable adaptation strategies require public participation in disaster management planning. To avoid unanticipated surges in air pollution, Washington should begin implementing the Clean Air Act to control emissions to levels that will protect the public from pollution when temperatures increase.

IX. Cross-Cutting Impacts

As noted throughout this manual, climate change impacts will not fall neatly into clear, defined boundaries. Instead, the impacts will crisscross traditional lines of jurisdiction and affect a variety of sectors in countless and unknown combinations. Other important sectors, such as agriculture and hydropower, are primarily concentrated outside the scope of the Puget Sound Basin and thus were not addressed in this manual. The overarching principles discussed in section IV are nonetheless applicable. This section will briefly highlight particular areas of overlap.

A. The Marine Environment

The impact of greenhouse gas emissions affects both the atmosphere and the oceans. In the ocean, climate change produces twin evils: the warming of the ocean surface and depths and increasing acidification of the ocean.¹⁴⁸ Studies show that the oceans have absorbed the vast majority of the heat generated since the 1950s, causing deep convective changes in at least one of the world's oceans.¹⁴⁹ The heat and carbon dioxide sequestered by the oceans is cycled into the depths of the large ocean basins; turnover occurs on millennial timescales.¹⁵⁰ The oceans and the Puget Sound are becoming increasingly acidic—a vast change from their natural, alkaline state. The ocean is normally saturated with carbonate and bicarbonate ions, which many marine organisms take up to form their shells and skeletons. However, the oceans are becoming saturated with carbon dioxide, which reduces the availability of these carbonate ions.

Case Study: The Mountains-to-Sound Approach

One integrated approach to thinking about climate change adaptation is a mountains-to-sound approach, adopted by the Tulalip Tribes. Because most of the river systems in the Puget Sound Basin begin in the Cascades or the Olympics and flow into the Sound, this approach looks holistically at the many connections between upstream and downstream ecosystems and actions. For example, restoring upland forest ground cover is an adaptation strategy with

downstream benefits. It will absorb the earlier snowmelt expected from climate change and prevent rushing waters from scouring side channels where juvenile salmon rest before migrating to saltwater.

As Terry Williams, the commissioner of fish and wildlife for the Tulalip Tribes, says, "Climate change in marine waters can't be looked at in isolation. We're looking at what happens to carbon levels in the places where air meets fresh water and where fresh water meets the sea."¹⁵¹

These changes will have broad impacts on sea level rise, marine ecosystems and species, and Washington's aquaculture industry. Changes to the marine environment will impact Washington's 106 commercial shellfish aquaculture areas, which lead the country in commercially farmed bivalve shellfish. The annual economic value of Washington's shellfish industry is valued at roughly \$75 million.¹⁵² Adapting to these changes poses a particular problem because the impact is global and the sources of greenhouse gases are dispersed, falling outside the jurisdiction of Washington and even the United States.

B. Impacts on Flora and Fauna

The combined impacts of increased surface temperatures and changed hydrologic conditions will threaten almost all species in every habitat in the Puget Sound basin. Adaptation efforts should strive to maintain whole ecosystems, recognizing the complex interactions and relationships among species.

C. Forests

The overall increase in average surface temperature is likely to have significant impacts on forest composition, productivity, and health in Puget Sound. Both temperature and water availability will impact the distribution of certain species, such as the Douglas fir, and will affect the composition of forests in the inland areas of the Puget Sound Basin. Projected increases in mountain pine beetle outbreaks and forest fires will cause significant disturbances to forest ecosystems. The pine beetle outbreaks are likely to worsen at higher altitudes, due to warmer conditions that are favorable to the insects. The CIG also estimates that the burn area will double or triple by the end of the 2040s, and total burned acres may reach up to 2 million acres in the 2080s. For all forests across the state, the combination of higher temperatures, decreased water availability as a result of less snowpack and higher rates of evaporation from soil in summer months, and associated ecosystem disturbances suggest that few forests will be immune to adverse changes.



D. Stormwater & Flooding

Flooding poses significant risks both for aquatic ecosystems, by scouring habitat and introducing contaminants, and human-built infrastructure. Projections for extreme precipitation and flooding events are uncertain, but regional climate models generally indicate an increase in extreme rainfall events. The CIG report notes that few statistically significant changes in extreme rainfall have been observed in Washington, except for the

Puget Sound. More recent flood events suggest that current infrastructure, using 20th century data, may be insufficient for the future climate. For example, the CIG Report noted that the 50-year storm between 1956 and 1980 became an 8.4-year storm between 1981 and 2005 in the Puget Sound region. Flooding can jeopardize property and human health, for example, by leading to sewage overruns that cause widespread water contamination.

For an excellent guide to adopting local stormwater ordinances, see [Local Water Policy Innovation: A Road Map for Community Based Stormwater Solutions](#) by American Rivers.



E. Ports

The major ports of Seattle and Tacoma have begun accommodation actions—elevating piers and docks, designing floating terminals—to adapt to projected sea level rise. These ports are part of a vast transportation hub in the Puget Sound basin, and climate change impacts on them will have reverberating effects on infrastructure, food supplies, public health, and other sectors. Relying on green infrastructure is not feasible for most ports, which are heavily developed.



X. Future Research & Conclusions

Adapting to climate change impacts in the Puget Sound Basin will require an innovative and sustained approach that recognizes the many connections between and among human interactions and ecosystems. Much as the impacts will affect broad swaths of natural resources and communities, so too must the response be integrated, holistic, and multi-disciplinary. Climate change will challenge the legal status quo, forcing policymakers to rethink existing tools and how they may apply to previously unknown problems.

This manual is intended to guide the climate change adaptation discussion in the Puget Sound Basin toward an environmentally protective and socially equitable approach. Although the impacts will be overwhelming, that fact cannot be an excuse for delay, half-hearted attempts, or inaction. Future adaptation research could examine what lessons Washington can learn from other regions, states, and countries. Future research could also focus on developing a set of model regulations for individual sectors that provide a template for local governments and states that are serious about adapting themselves to a new climate future.

Facing tough policy questions now and laying the foundation for responding to climate impacts, both gradual and catastrophic, is one of the best adaptation strategies that Washington and communities in the Puget Sound Basin can take to ensure environmentally protective and socially equitable adaptation to climate change.

XI. Glossary of Selected Terms

Adaptation	The adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects
Adaptive Management	A natural resources management approach where managers design management actions as scientific experiments, monitor the outcomes, and adjust the management actions depending on the outcomes produced by the experiments
Environmental Justice	Concept that every person should have equal access to some minimum level of resources to allow the pursuit of a safe, purposeful, and dignified existence; emphasizes a broad interpretation of “environment,” protection from harm, and public participation
Exposure	The physical aspects of a disaster that place people or natural resources in harm’s way
Indigenous Knowledge	The knowledge of and beliefs in the interconnections between humans and the environment in the web of life
Maladaptation	Adaptation action that increases vulnerability to the impacts of climate change, such as actions that deliver short-term gains or economic benefits but lead to increased vulnerability in the medium- to long-term and may foreclose future adaptation actions
Mitigation	Human actions taken to reduce the sources of or increasing the sinks for greenhouse gases, thereby reducing their ambient concentration in the atmosphere
Principled Flexibility	Ability to act with bounded discretion to achieve stated goals and accountability for not acting, delaying action, or substantially deviating from the overarching regulatory and management goals
Public Trust Doctrine	A common law doctrine holding that the state holds certain natural resources in trust for the benefit of current and future generations
Resilience	The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning; the capacity for self-organization, and the capacity to adapt to stress and change
Stationarity	The concept that natural systems fluctuate within an unchanging envelope of variability
Vulnerability	The capacity of an individual or community to anticipate, cope with, resist, and recover from the impact of a natural hazard

XII. Selected List of Climate Change Adaptation Resources

A. Climate Change Science

Climate Impacts Group 2009. [The Washington Climate Change Impacts Assessment](#) (M. McGuire Elsner, J. Littell, and L. Whitely Binder eds.).

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Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: The Physical Science Basis* (Cambridge University Press 2007).

—*Climate Change 2007: Mitigation of Climate Change* (Cambridge University Press 2007).

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B. Adaptation Resources in Washington

[Swinomish Climate Adaptation Action Plan](#) (2010).

Washington Department of Ecology, Pub. No. [08-11-061](#). Walla Walla Watershed Management Partnership: A Proposal for a Pilot Local Water Management Program in the Walla Walla Basin (2008).

—[Appendix A: Addressing Sea Level Rise in Shoreline Master Programs](#) in SHORELINE MANAGEMENT PROGRAM HANDBOOK.

—[Greenhouse Gas Emissions and SEPA](#) (Working Paper, Oct. 19, 2010).

—[State Environmental Policy Act Handbook](#) (2003).

Washington Department of Natural Resources, “[Chapter 4 No Net Loss of Ecological Functions](#)” in SHORELINE MANAGEMENT PROGRAM HANDBOOK (June 22, 2010).

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City of Chicago, [Chicago Climate Action Plan](#) (2008),

California Natural Resources Agency, [2009 California Climate Adaptation Strategy](#) (2009).

New York State Sea Level Rise Task Force, [Report to the Legislature](#) (November 2010).

Florida Atlantic University, [Florida's Resilient Coasts: A State Policy Framework for Adaptation to Climate Change](#).

National Academy of Sciences, "Chapter 3: What are America's Options for Adaptation?" in ADAPTING TO THE IMPACTS OF CLIMATE CHANGE (National Academies Press 2010).

United Kingdom, Department of Environment and Rural Affairs, [Climate Change: Taking Action](#) (2010).

—[Adapting to Climate Change in England: A Framework for Action](#) (2008).

D. Adaptation Overview & Guidance

Pew Center on Global Climate Change, [Climate Change Adaptation: What Federal Agencies are Doing](#) (Nov. 2010).

White House Council on Environmental Quality, [Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy](#) (Oct. 5, 2010).

Government Accountability Office, GAO-10-113, [Climate Change Adaptation: Strategic Federal Planning Could Help Government Officials Make More Informed Decisions](#) (Oct. 7, 2009).

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E. Other

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Interagency Working Group on Climate Change and Health, [A Human Health Perspective on Climate Change](#).

F. Law Review Articles

Alejandro Camacho, *Adapting Governance to Climate Change: Managing Uncertainty through a Learning Infrastructure*, 59 EMORY LAW JOURNAL 1 (2009).

—*Assisted Migration: Redefining Nature and Natural Resource Law Under Climate Change*, 27 YALE JOURNAL ON REGULATION 171 (2010).

Robin Kundis Craig, *A Comparative Guide to the Western States' Public Trust Doctrines: Public Values, Private Rights, and the Evolution Toward an Ecological Public Trust*, 37 ECOLOGY LAW QUARTERLY 53 (2010).

—*Stationarity is Dead! Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARVARD ENVIRONMENTAL LAW REVIEW 1 (2010).

—*Climate Change Comes to the Clean Water Act: Now What?*, 1 WASHINGTON & LEE JOURNAL OF ENERGY, CLIMATE, & THE ENVIRONMENT 7 (2010).

Holly Doremus, *Adaptive Management as an Information Problem*, 89 NORTH CAROLINA LAW REVIEW 101 (2011).

—*New Directions in Environmental Law: The Endangered Species Act: Static Law Meets Dynamic World*, 32 WASHINGTON UNIVERSITY JOURNAL OF LAW & POLICY 175 (2010).

Daniel A. Farber, *Adaptation Planning and Climate Impact Assessments: Learning From NEPA's Flaws*, 39 ENVIRONMENTAL LAW REPORTER 10605 (2009).

Robert L. Glicksman, *Climate Change Adaptation: A Collective Action Perspective on Federalism Considerations*, 40 ENVIRONMENTAL LAW 1159 (2010) (with Richard E. Levy).

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—*General Design Principles for Resilience and Adaptive Capacity in Legal Systems: Applications to Climate Change Adaptation Law*, 89 NORTH CAROLINA LAW REVIEW __ (2011).

—*Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 BOSTON UNIVERSITY LAW REVIEW 1 (2008)

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XIV. Endnotes

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- ⁴ [Executive Order 09-05](#) (May 21, 2009).
- ⁵ Wash. Rev. Code § 43.21M.010.
- ⁶ Wash. Rev. Code § 43.21M.020.
- ⁷ Wash. Rev. Code § 43.21M.040.
- ⁸ King County, Washington, [2007 Climate Action Plan](#) (Feb. 2007).
- ⁹ King County, Washington, [2009 Climate Report](#) (Feb. 1, 2010).
- ¹⁰ Swinomish Indian Tribal Community, Office of Planning and Community Development, [Swinomish Climate Change Initiative: Climate Adaptation Action Plan](#) (Oct. 2010) [hereinafter *Swinomish Action Plan*].
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- ¹³ *Id.* at 20.
- ¹⁴ *Id.* at 15.
- ¹⁵ Intergovernmental Panel on Climate Change (IPCC), CLIMATE CHANGE 2007: MITIGATION OF CLIMATE CHANGE [818](#) (B. Metz et al., eds., Cambridge University Press 2007) [hereinafter *IPCC Mitigation Report*].
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- ¹⁷ *IPCC Mitigation Report*, *supra* note 15, at [101](#).
- ¹⁸ Alejandro Camacho, *Adapting Governance to Climate Change: Managing Uncertainty through a Learning Infrastructure*, 59 EMORY L.J. 1, 26-27 (2009).
- ¹⁹ White House Council on Environmental Quality, [Progress Report of the Interagency Climate Change Adaptation Task Force: Recommended Actions in Support of a National Climate Change Adaptation Strategy](#) 15 (Oct. 5, 2010).
- ²⁰ See Robin Kundis Craig, *Stationarity is Dead! Long Live Transformation: Five Principles for Climate Change Adaptation Law*, 34 HARV. ENVTL. L. REV. 1 (2010).
- ²¹ *IPCC Mitigation Report*, *supra* note 15, at [818](#).
- ²² See Craig, *supra* note 20, at 39.
- ²³ Robert R.M. Verchick, FACING CATASTROPHE: ENVIRONMENTAL ACTION FOR A POST-KATRINA WORLD 3 (Harvard Univ. Press 2010).
- ²⁴ J.B. Ruhl, *Climate Change Adaptation and the Structural Transformation of Environmental Law*, 40 ENVTL. L. 363, 383 (2010).
- ²⁵ *Id.*
- ²⁶ Climate Impacts Group, M. McGuire Elsner et al. (eds.), [The Washington Climate Change Impacts Assessment](#) 393 (2009) [hereinafter *CIG Report*].
- ²⁷ *Id.*
- ²⁸ *Id.*
- ²⁹ IPCC, *Climate Change 2001: Impacts, Adaptation and Vulnerability* [990](#) (James M. McCarthy et al. eds., Cambridge University Press 2001).
- ³⁰ *Id.* at 107.
- ³¹ *Id.*
- ³² *Id.* at 118.
- ³³ *Id.* at 117.
- ³⁴ *Id.* at 117.
- ³⁵ *Id.* at 156.
- ³⁶ Camacho, *supra* note 18, at 25.
- ³⁷ *Id.* at 21-22.
- ³⁸ *Id.*
- ³⁹ See Ruhl, *supra* note 24.
- ⁴⁰ Craig, *supra* note 20, at 9.
- ⁴¹ See J.B. Ruhl and James Salzman, *Gaming the Past: The Theory and Practice of Historic Baselines in the Administrative State*, 64 VAND. L. REV. 1 (2011).
- ⁴² Craig, *supra* note 20, at 17.
- ⁴³ Leigh Welling, National Park Service Climate Change Response Program, “[A Tool for Decision-Making in an Era of Uncertainty](#)” (Dec. 2010).
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- ⁴⁵ *Id.*

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- ⁴⁷ J.B. Ruhl, *General Design Principles for Resilience and Adaptive Capacity in Legal Systems: Applications to Climate Change Adaptation Law*, 89 N.C.L. REV. __, *20, 21 (forthcoming 2011). See also Robert L. Glicksman and Sidney A. Shapiro, *Improving Regulation Through Incremental Adjustment*, 52 KAN. L. REV. 1179 (2004).
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- ⁵¹ Doremus, supra note 49, at *12.
- ⁵² *Adaptive Management*, supra note 48, at 11.
- ⁵³ *Id.* at 12.
- ⁵⁴ *Id.* at 13.
- ⁵⁵ Ruhl, supra note 47, at *22.
- ⁵⁶ Robert L. Glicksman, *Climate Change Adaptation: A Collective Action Perspective on Federalism Considerations*, 40 ENVTL. L. 1159, 1183 (2010).
- ⁵⁷ *Id.* at 1191.
- ⁵⁸ *Id.* at 1189.
- ⁵⁹ Ruhl, *Resilience* at 107-8, and *Climate Change, Dead Zones, and Massive Problems in the Administrative State: A Guide for Whittling Away*, 98 Calif. L. Rev. 59 (2010).
- ⁶⁰ Ruhl, *Massive Problems*, supra note 59, at 108.
- ⁶¹ Memorandum for Heads of Federal Departments and Agencies from Nancy H. Sutley, Chair, Council on Environmental Quality, on [Draft NEPA Guidance on Consideration of the Effects of Climate Change and Greenhouse Gas Emissions](#) (Feb. 18, 2010) [hereinafter *CEQ Guidance*].
- ⁶² *Id.* The Guidance somewhat circuitously states that federal agencies should consider “the ways in which climate change is affecting or could affect the environmental effects of the proposed action.” The Washington Department of Ecology has drafted a working paper on using SEPA to address climate change mitigation, including the SEPA checklist to identify project-related emissions and measures to avoid, minimize, or mitigate those emissions. Washington Department of Ecology, “[Greenhouse Gas Emissions and SEPA Working Paper](#)” (Draft, Oct. 2010).
- ⁶³ *Id.*
- ⁶⁴ CPR Member Scholar and law professor Daniel Farber has proposed a National Adaptation Planning Act, which would require each agency to prepare a list of critical adaptation needs for major existing projects or lands under its jurisdiction that will be significantly affected by climate change. Agencies would prepare adaptation planning statements and address uncertainties, including disagreements between models, areas of scientific disagreement, and gaps in necessary data. Daniel Farber, [A Legal Framework for Climate Adaptation Assessment](#), Resources for the Future Issue Brief 09-14 (Dec. 2009).
- ⁶⁵ Wash. Rev. Code § 43.21C.030(c).
- ⁶⁶ Wash. Admin. Code 197-11-800.
- ⁶⁷ Wash. Rev. Code § 41.21C.030.
- ⁶⁸ Some of these major rivers include: the Nooksack, Samish, Skagit, Stillaguamish, Snohomish, Cedar, Green/Duwamish, Puyallup, Nisqually, Deschutes, Skykomish, Dosewallips, Dungeness, and Elwha Rivers.
- ⁶⁹ CIG Report, supra note 26, at 128.
- ⁷⁰ *Id.* at 120.
- ⁷¹ For more on the impact of ocean-atmosphere climate on salmon, see N.J. Mantua et al., *A Pacific Interdecadal Climate Oscillation with Impacts on Salmon Production*, 78 Bulletin of the Am. Meteorological Soc’y 1069 (1997); U.S. Fish and Wildlife Service, “[Salmon Research and Climate Change](#)” (last visited April 12, 2011).
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- ⁷⁶ Robert W. Adler, *Climate Change and the Hegemony of State Water Law*, 29 STAN. ENVTL. L.J. 1 (2010).
- ⁷⁷ *Id.* at 18. See also Christine A. Klein, *On Integrity: Some Considerations for Water Law*, 56 ALA. L. REV. 1009 (2005).
- ⁷⁸ Craig, supra note 20, at 45.
- ⁷⁹ For an overview of state water law and the Clean Water Act, see William L. Andreen, *Developing a More Holistic Approach to Water Management in the United States*, 36 ENVTL. L. REP. 10277 (2006).
- ⁸⁰ Adler, supra note 76, at 24.
- ⁸¹ *Id.* at 25.
- ⁸² Wash. Rev. Code § 90.30.290.

- ⁸³ Wash. Rev. Code § 90.14.160. A water right holder can avoid relinquishment only by showing sufficient cause or by demonstrating that an exception applies. For example, nonuse due to drought, military service, or legal proceedings constitutes sufficient cause. In addition, certain water rights are never subject to relinquishment, including trust water rights, municipal supplies, or standby supplies for drought conditions. *See* City of Union Gap v. Ecology, 195 P.3d 580 (Wash. App. 2008), *rehearing denied* (2009).
- ⁸⁴ William L. Andreen, “Water Law and the Search for Sustainability: A Comparative Analysis,” in WATER RESOURCES PLANNING AND MANAGEMENT 164-65 (R. Quentin Grafton and Karen Hussey eds. 2011).
- ⁸⁵ Brian Haisman, “Impacts of Water Rights Reform in Australia,” in [WATER RIGHTS REFORM: LESSONS FOR INSTITUTIONAL DESIGN](#) 113 (Bryan Randolph Bruns et al. eds. 2005)
- ⁸⁶ *Id.* at 132.
- ⁸⁷ Andreen, *supra* note 84, at 167-68.
- ⁸⁸ Department of Ecology, Pub. No. 03-11-007, [A Guide to Instream Flow Setting in Washington State](#) (March 2003).
- ⁸⁹ Wash. Rev. Code § 90.42.040.
- ⁹⁰ Wash. Dep’t of Ecology, [Map of Instream Flow Rules](#) (last visited April 13, 2011).
- ⁹¹ 33 U.S.C. § 1313.
- ⁹² PUD No. 1 of Jefferson County v. Wash. Dep’t of Ecology, 511 U.S. 700 (1994).
- ⁹³ Robin Kundis Craig, *Climate Change Comes to the Clean Water Act: What Now?*, 1 WASH. & LEE J. CLIMATE, ENERGY, & ENVT. 7 (2010).
- ⁹⁴ As a result of a settlement with environmental groups in 2010, EPA began grappling with the question of how to address ocean acidification under the CWA. This question is particularly difficult to answer because the dischargers that ultimately cause ocean acidification are emitters of carbon dioxide and are regional, if not global. Nonetheless, EPA concluded in a November 2010 memorandum that states should list waters not meeting marine pH water quality criteria on their 2012 impaired waters list. Memorandum to Water Division Directors, Regions 1-10, from Denise Keehner, Director, Office of Wetlands, Oceans and Watershed, on [Integrated Reporting and Listing Decisions Related to Ocean Acidification](#) (Nov. 15, 2010).
- ⁹⁵ Washington Department of Ecology, Pub. No. 02-03-026, [Washington State Water Quality Assessment, Year 2002 Section 305\(b\) Report](#) (June 2002).
- ⁹⁶ One recent district court appears to treat the recovery plans as mandatory, *Friends of Blackwater v. Salazar*, 2011 WL 1098964, at *8-11 (D.D.C. Mar. 25, 2011).
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- ⁹⁸ 16 U.S.C. § 1539 (j) & (a)(1)(A).
- ⁹⁹ J.B. Ruhl, *Climate Change and the Endangered Species Act: Building Bridges to the No-Analog Future*, 88 BOSTON UNIV. L. REV. 1, 60 (2008).
- ¹⁰⁰ CIG Report, *supra* note 26, at 291.
- ¹⁰¹ *Id.* at 299.
- ¹⁰² *Id.* at 288.
- ¹⁰³ U.S. Env’tl Protection Agency, [“Strategies for Adaptation to Sea Level Rise”](#) (last visited April 14, 2011).
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- ¹⁰⁷ Wash. Rev. Code § 36.70A.080.
- ¹⁰⁸ *See* Swinomish Action Plan, *supra* note 10, at 46.
- ¹⁰⁹ *Task Force Report*, *supra* note 104, at 56.
- ¹¹⁰ Wash. Dep’t of Ecology, [“Appendix A: Addressing Sea Level Rise in Shoreline Master Programs”](#) in SHORELINE MASTER PROGRAM (SMP) HANDBOOK.
- ¹¹¹ *Id.*
- ¹¹² Wash. Rev. Code § 90.58.020.
- ¹¹³ Wash. Rev. Code § 90.58.020.
- ¹¹⁴ Other states, including California and North Carolina, have rolling easements as well.
- ¹¹⁵ Tex. Nat. Res. Code § 61.011. However, the Texas Supreme Court recently limited the Act to the gradual, landward migration of the line of vegetation. *Severance v. Peterson*, 54 Tex. Sup. Ct. J. 172 (2010), *rehearing granted* (April 19, 2011). The court held that the Act does not apply to a sudden, avulsive event that causes the line of vegetation to move landward.
- ¹¹⁶ *Severance v. Patterson* 54 Tex. Sup. Ct. J. 172 (2010).
- ¹¹⁷ Wash. Rev. Code § 90.58.030 (emphasis added).
- ¹¹⁸ James L. Titus, *Rising Seas, Coastal Erosion, and the Takings Clause: How to Save Wetlands and Beaches Without Hurting Property Owners*, 57 MD. L. REV. 1279 (1998).
- ¹¹⁹ Tony Barboza, [In Ventura, a retreat in the face of a rising sea](#), L.A. TIMES (Jan. 16, 2011). It is unclear whether the landowners, the Ventura County Fairgrounds, received compensation.
- ¹²⁰ Joseph L. Sax, *The Public Trust Doctrine in Natural Resource Law: Effective Judicial Intervention*, 68 MICH. L. REV. 471, 484 (1970).

- ¹²¹ See Alexandra B. Klass and Yee Huang, *Restoring the Trust: Water Resources and the Public Trust Doctrine*, CPR White Paper No. 908 (Sept. 2009) [hereinafter *Restoring the Trust*]; Robin Kundis Craig, *A Comparative Guide to Western States' Public Trust Doctrines: Public Values, Private Rights, and the Evolution Toward an Ecological Public Trust*, 37 *ECOL. L.Q.* 53 (2010); and Alexandra B. Klass, *Modern Public Trust Principles: Recognizing Rights and Integrating Standards*, 82 *NOTRE DAME L. REV.* 699 (2006).
- ¹²² The Ninth Circuit Court of Appeals noted that “it is beyond cavil that the [doctrine] has always existed in Washington.” *Esplanade Props., LLC v. City of Seattle*, 307 F.3d 978, 985 (internal citations omitted).
- ¹²³ Wash. Rev. Code §§ 70.01.101(1) & 79.105.001
- ¹²⁴ Historically, the natural resources comprising the trust principal were limited to navigable waters and the submerged lands beneath them. The legal definition of “navigable” comes from an early Supreme Court case: a waterway is navigable when it is or could be used in its natural state as a highway for commerce in the customary ways commerce is conducted. *The Daniel Ball*, 77 U.S. 557 (1870). At that time, commerce was dominated by river and other water-dependent transportation.
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- ¹²⁸ U.S. Centers for Disease Control, [A Human Health Perspective on Climate Change](#) 40 (2010) [hereinafter *CDC Perspective*].
- ¹²⁹ *CIG Report*, *supra* note 26.
- ¹³⁰ *CIG Report*, *supra* note 26, at 360.
- ¹³¹ *CDC Perspective*, *supra* note 128, at 7.
- ¹³² See generally *CDC Perspective*, *supra* note 128.
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- ¹³⁵ *CDC Perspective*, *supra* note 128, at 5.
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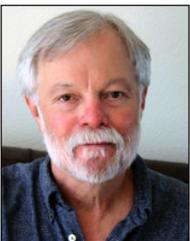
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