THURSTON CLIMATE ADAPTATION PLAN

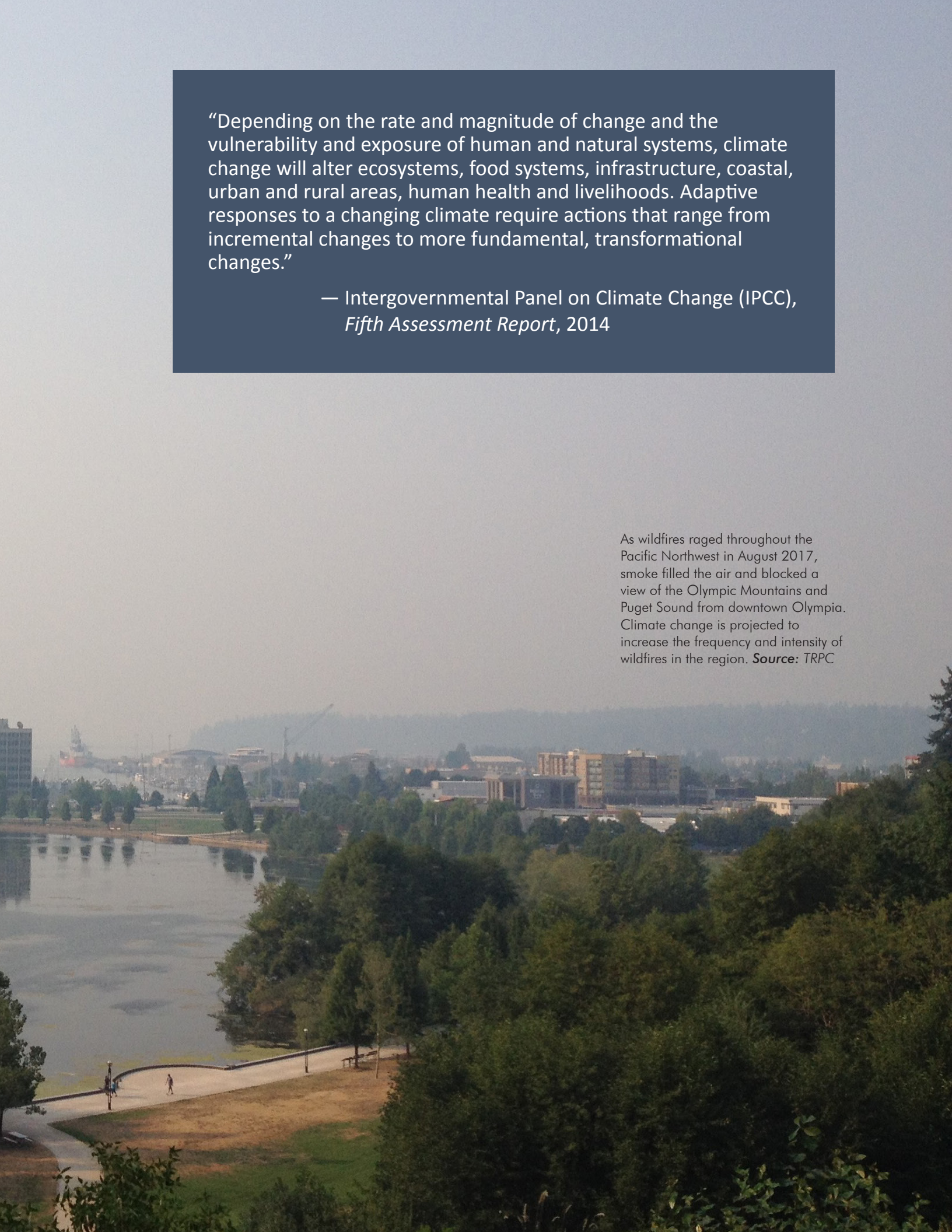
Climate Resilience Actions for Thurston County and South Puget Sound

2018

thurston regional planning council

"Depending on the rate and magnitude of change and the vulnerability and exposure of human and natural systems, climate change will alter ecosystems, food systems, infrastructure, coastal, urban and rural areas, human health and livelihoods. Adaptive responses to a changing climate require actions that range from incremental changes to more fundamental, transformational changes."

— Intergovernmental Panel on Climate Change (IPCC), *Fifth Assessment Report*, 2014



As wildfires raged throughout the Pacific Northwest in August 2017, smoke filled the air and blocked a view of the Olympic Mountains and Puget Sound from downtown Olympia. Climate change is projected to increase the frequency and intensity of wildfires in the region. ***Source:*** *TRPC*

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Acknowledgments

The Thurston Regional Planning Council (TRPC) prepared the Thurston Climate Adaptation Plan — which recommends actions to help Thurston County and the broader South Puget Sound region prepare for and adjust to adverse climate change impacts (adaptation) and bolster resilience. The U.S. Environmental Protection Agency (EPA) provided a National Estuary Program grant for the project. The Washington Department of Commerce administered the funding, and TRPC hired Thurston County and Earth Economics as subcontractors. TRPC is grateful for the support of these organizations and the thousands of area residents who served on the project's advisory committees, attended meetings, and otherwise contributed to the plan's development. For more information, please visit www.trpc.org/climate.

Thurston Regional Planning Council (TRPC) is a 22-member intergovernmental board made up of local governmental jurisdictions within Thurston County, plus the Confederated Tribes of the Chehalis Reservation and the Nisqually Indian Tribe. The Council was established in 1967 under RCW 36.70.060, which authorized creation of regional planning councils.

TRPC's mission is to "Provide Visionary Leadership on Regional Plans, Policies, and Issues."

To Support this Mission:

A. Support regional transportation planning consistent with state and federal funding requirements.
B. Address growth management, environmental quality, economic opportunity, and other topics determined by the Council.
C. Assemble and analyze data that support local and regional decision making
D. Act as a "convener" to build regional consensus on issues through information and citizen involvement.
E. Build intergovernmental consensus on regional plans, policies, and issues, and advocate local implementation.

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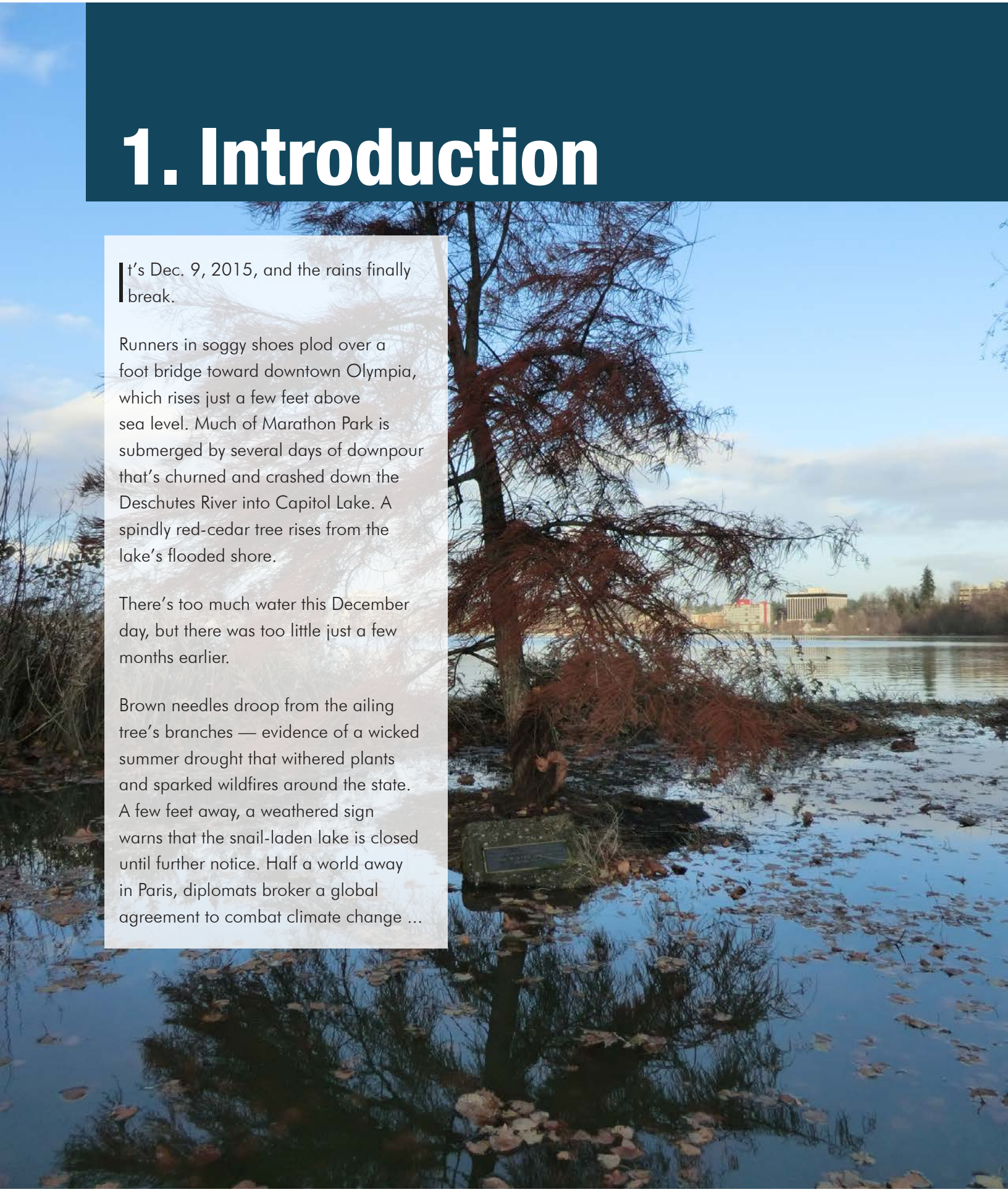
1. Introduction



It's Dec. 9, 2015, and the rains finally break.

Runners in soggy shoes plod over a foot bridge toward downtown Olympia, which rises just a few feet above sea level. Much of Marathon Park is submerged by several days of downpour that's churned and crashed down the Deschutes River into Capitol Lake. A spindly red-cedar tree rises from the lake's flooded shore.

There's too much water this December day, but there was too little just a few months earlier.

Brown needles droop from the ailing tree's branches — evidence of a wicked summer drought that withered plants and sparked wildfires around the state. A few feet away, a weathered sign warns that the snail-laden lake is closed until further notice. Half a world away in Paris, diplomats broker a global agreement to combat climate change ...

It’s a scene rich with symbolism, a scene set in the context of extremes: 2015 marked Washington’s most severe wildfire year in modern history — with more than 1 million acres burned by summer’s end — but December’s deluge still made the year one of wettest on record (USDA, 2015).

Such seasonal extremes are perhaps a preview of our future.

Burning fossil fuels in automobiles and other human activities are increasing emissions of carbon dioxide and other gases that trap heat in the atmosphere like a greenhouse. Even as we strive to slow our emissions, adaptation is essential to address unavoidable warming due to past emissions. Our temperate region of snowy peaks, rocky shores, and evergreen forests is not immune to change.

Climate models project progressively warmer, wetter winters and hotter, drier summers for the Puget Sound region through the end of the 21st century. The warming is projected to shift the timing, type, and intensity of precipitation — all of which have a trickle-down effect on snowpack, runoff, streamflow, groundwater, and other crucial components of the hydrologic cycle: Picture winters in the 2050s with less snow across our highlands and more flooding along our rivers. And while our summers might feel more Californian, such warmer and drier days will raise the risk of algal blooms, wildfires, disease outbreaks, heat illnesses, and other hazards.

The takeaway: Climate change will continue to affect our human and natural systems in myriad ways tomorrow, so we must begin adapting today. It's the socially, economically, and environmentally responsible thing to do.

The plan you're reading includes a menu of actions to help the Thurston County, Washington region (Thurston Region) and broader South Puget Sound prepare for and adjust to climate impacts — the very definition of adaptation. Many actions are new to the region, while other actions build on work we're already doing. Please read on to learn what you can do personally and what your community can do collectively to become more resilient.

We have one planet but many climate solutions, so let's get to work.

Low-lying buildings and roads where McLane Creek meets Eld Inlet are among built assets vulnerable to sea-level rise. ***Source:*** *Washington State Department of Ecology*

Fresh snow blankets the forest surrounding the Alder Dam, in southeastern Thurston County. ***Source:*** *TRPC*

2. Executive Summary

2.1 Plan Overview

Climate change adaptation entails "efforts by society or ecosystems to prepare for or adjust to future climate change."

— U.S. Environmental Protection Agency

Storms. Floods. Droughts. Wildfires. ... We face these natural hazards today, and climate change is projected to worsen them tomorrow. Fortunately, we can reduce our risks, respond to impacts, and remain resilient.

This is a guiding principle of the *Thurston Climate Adaptation Plan* — a concerted effort to help Thurston County and the broader South Puget Sound region prepare for and adjust to climate change. The Thurston Regional Planning Council (TRPC) crafted this important document with a $250,000 National Estuary Program (NEP) grant from the U.S. Environmental Protection Agency (EPA) and significant in-kind support from the community.

Partners included representatives from tribes, municipalities, universities, nonprofits, businesses, and other entities within the project area: three geographically diverse watersheds (Nisqually, Deschutes and Kennedy-Goldsborough) within Thurston County that drain into Puget Sound [*See Figure 01*]. The watersheds are dynamic — encompassing beaches, rivers, lakes, wetlands, highlands, forests, farms, ranches, cities, towns, and tribal reservations.

The Chehalis River Basin covers southwestern Thurston County and drains into the Pacific Ocean, so this area is outside of the NEP grant's estuary boundary. That said, many of this adaptation plan's actions may be applied effectively across Thurston County's entire 774-square-mile area. Indeed, it is TRPC's hope that other communities throughout the Puget Sound region, state, and nation will replicate this project's science-based assessments, innovative public-engagement efforts, collaborative planning processes, economic analyses, and comprehensive actions.

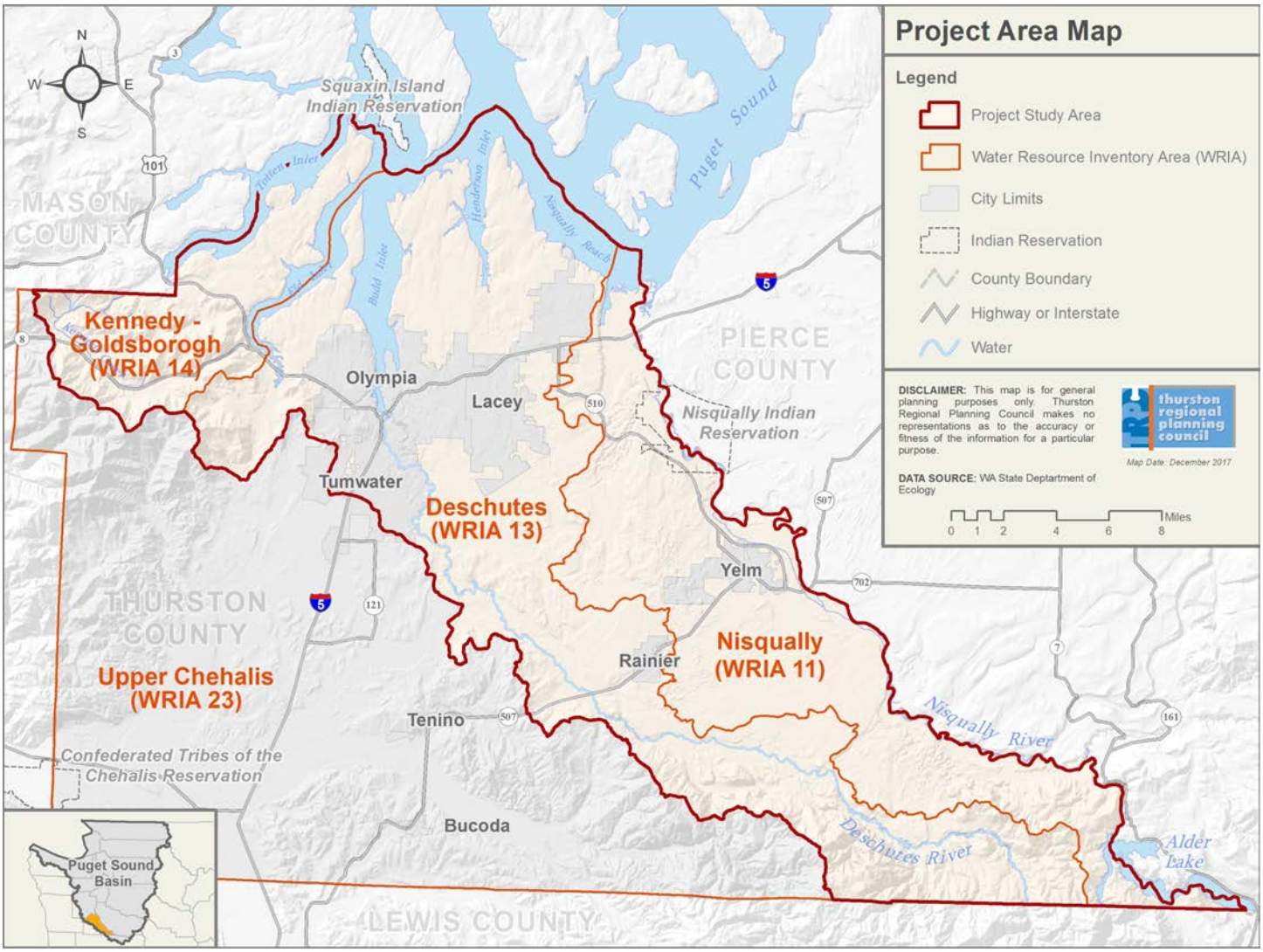


Figure 01: The *Thurston Climate Adaptation Plan* project area included parts of the Puget Sound-draining Nisqually (WRIA 11), Deschutes (WRIA 13) and Kennedy-Goldsborough (WRIA 14) watersheds that are within Thurston County. The full Nisqually Watershed straddles Thurston, Pierce and Lewis counties and begins on the flanks of Mount Rainier; the Deschutes Watershed straddles Lewis and Thurston Counties and begins in the Mount Baker-Snoqualmie National Forest, southwest of Alder Lake; the Kennedy-Goldsborough Watershed (WRIA 14) straddles Mason and Thurston counties and includes Kennedy and Goldsborough creeks, as well as Totten, Hammersley and Little Skookum inlets. The Upper Chehalis Watershed (WRIA23) is not within the project area, so climate modeling for southwestern Thurston County is limited to streamflow (Mauger et al., 2016). ***Source:*** *TRPC*

2.2 Plan Components

The *Thurston Climate Adaptation Plan* is the sum of many parts completed over a more than two-year period. Below is a project timeline and summary of these components, which are featured in this plan's body and appendices.

Science Summary

In spring 2016, the project team — composed of TRPC and Thurston County staff members — completed a science summary of observed and projected climate change impacts at the global, national, and regional scales [*See Section 4.1 and Appendix A*]. The document also explored the emissions scenarios and computer models used in Intergovernmental Panel on Climate Change (IPCC) and University of Washington Climate Impacts Group (CIG) reports that provided the scientific foundation for this project's vulnerability and risk assessments.

Plan Goals & Advisors

In summer 2016, the project team formed the Stakeholder Advisory Committee — a group composed of more than 20 public- and private-sector people with technical expertise and policy influence [*See pg. 5*]. The Stakeholder Advisory Committee, which met 13 times through fall 2017, began its work by choosing a vision statement, 12 goals, and nine guiding principles for the adaptation plan [*See Section 3*]. Members of TRPC's ad hoc Science Advisory Committee also reviewed project materials, as needed, to ensure technical accuracy.

Vulnerability Assessment

In fall 2016, the project team completed work on a 100-page vulnerability assessment [*See Section 4.2 and Appendix B*], which used maps and other tools to explain how the region's climate has changed historically, how it is projected to change during the 21st century, and how such changes affect the vulnerability of our human and natural systems. Building on the science summary, the vulnerability assessment describes how human health and welfare, as well as highways, municipal water systems, estuaries, and other built and natural "assets" within the project area are vulnerable to the collective impacts of natural hazards (e.g., wildfires, landslides, floods) and human-caused stressors (e.g., water pollution) exacerbated by climate change.

Risk Assessment

In winter 2017, the project team and Stakeholder Advisory Committee used a U.S. EPA methodology to evaluate how 85 risks identified in the vulnerability assessment affect the region's ability to achieve the 12 project goals. The Stakeholder Advisory Committee selected a strategy for each risk — either Take Action or Accept — based on the risk's likelihood and consequence of occurrence [*See Section 4.3 and Appendix C*].

Public Engagement

In early spring 2017, the project team began executing a public-engagement strategy to communicate the region's climate risks and elicit adaptation action ideas from the community [*See Section 4.4 and Appendix D*]. Members of the project team met with more than 20 local organizations, hosted a community forum, and administered an online survey. TRPC promoted the project via an online video, newspaper editorial, social media, and other multimedia tools that reached more than 50,000 community members.

Action Evaluation & Prioritization

In late spring 2017, the project team drafted actions to respond to the region's most severe climate risks. The Stakeholder Advisory Committee then modified the actions, as needed, and prioritized them using common criteria (effectiveness, durability, equity, etc.) [*See Section 5.1*]. This collaborative exercise yielded a list of 91 adaptation actions, including 25 priority actions, across six thematic categories: General; Drought & Water Quality; Flood & Erosion; Plants & Animals; Transportation & Energy; and, Wildfire & Extreme Heat. Priority actions in this plan include:

General:

G-01: Direct government staff members to develop their technical expertise and skills to prepare for and respond to climate change impacts.

G-02: Create hazard recovery plans and prioritize the restoration of vital public safety facilities and other essential community assets (e.g., hospitals and major bridges).

G-03: Pursue funding to implement highest-priority actions identified in the adopted Hazards Mitigation Plan for the Thurston Region.

G-04: Factor climate impacts into the planning of operations and the coordination of disaster response and recovery activities among first-responders, including public health, law enforcement, fire, and emergency medical services personnel.

Drought & Water Quality:

D-01: Develop and implement a comprehensive drought-response strategy that sets action levels for different drought stages.

D-02: Evaluate and secure sustained funding to support long-term monitoring of ground and surface water quality and quantity.

D-03: Increase reuse of reclaimed water for irrigating plants, supplementing low streamflow, and other purposes.

D-04: Conduct benefit-cost analyses of adaptation actions that conserve water resources.

Flood & Erosion:

F-01: Evaluate and secure sustained funding to restore and protect riparian vegetation along freshwater and marine shorelines.

F-02: Incorporate projected sea-level rise and flooding information into the designation of regulatory hazard areas.

F-03: Design new and replacement stream culverts and other drainage infrastructure to accommodate projected higher peak flows associated with more frequent and intense heavy precipitation events.

F-04: Install flood gates and pumps on stormwater outfalls connected to Puget Sound to mitigate back-ups during high tides and heavy rains exacerbated by rising seas.

F-05: Build floodwalls or other protective structures around critical facilities located in areas vulnerable to flooding as a result of sea-level rise and heavy precipitation.

F-06: Require that new or renovated buildings utilize flood-protection measures (such as raised finished-floor levels and temporary flood barriers) to accommodate projected sea-level rise over the structures' lifespan.

Plants & Animals:

P-01: Increase funding, education, and incentives for private landowners to manage lands in ways that enhance ecological and economic resilience (e.g., protecting and restoring forests, prairies, and shoreline/riparian areas).

P-02: Use best-management practices, such as installing large woody debris in rivers, to improve water temperature, streamflow, and channel conditions.

P-03: Create/Update basin plans that integrate climate impacts, and include goals and targets for protecting natural resources and habitat.

Transportation & Energy:

T-01: Expand and retrofit the region's energy distribution, monitoring, and storage infrastructure to support more on-site renewable energy generation.

T-02: Provide additional utility incentives to support energy efficiency and renewable energy investments in buildings.

T-03: Offer additional utility rebates or bill credits to induce residents to buy and install energy-efficient appliances and other equipment.

T-04: Evaluate strategies to protect important electrical equipment that is within critical areas at risk of flooding and/or landslides.

T-05: Map transportation infrastructure that is vulnerable to repeated floods and/or landslides, and designate alternative travel routes for critical transportation corridors when roads must be closed because of natural hazards.

Wildfire & Extreme Heat

W-01: Create and maintain a map of the region's high-risk Wildland Urban Interface (WUI) communities and locations of wildfires.

W-02: Require new developments in high-risk wildfire areas to submit a fire-protection plan during site plan review.

W-03: Provide private forestland owners and residents living in Wildland-Urban Interface (WUI) areas information about fire prevention/Firewise practices, and encourage application of such practices.

Tables with all 91 actions, as well as recommended leads and partners, conclude Section 5.2.

Benefit-Cost Analyses

The Tacoma-based consulting firm Earth Economics conducted benefit-cost analyses (BCAs) of plan actions that call for protecting and expanding vegetative buffers along shorelines and incentivizing infill development in urban areas [*See Section 5.3 and Appendix F*]. The economic analyses, which incorporate the value of local ecosystem services (e.g., forests, grasslands, and riparian shorelines), include data that are applicable to a wide range of climate adaptation and mitigation actions and can aid decision-making efforts.

Next Steps

Effective plans don't sit on shelves and collect dust, so this document's first action and final section underscore that TRPC and its partners should consult the *Thurston Climate Adaptation Plan* frequently and update it periodically. This work should include evaluating the plan's climate modeling and implementation progress, taking and amending actions where necessary, and enhancing the community's understanding of climate change causes, impacts, and responses.

To this end, the final section [*See Section 6*] directs readers to TRPC's online climate "Resilience Toolkit" and points to innovative ways TRPC and its partners are working to increase the community's climate literacy. Such efforts include a climate change board game, pop-up library, and public art.

Climate change mitigation is just as important as adaptation, so the plan concludes by explaining how TRPC and its partners will continue working to reduce the region's carbon footprint. Such efforts include commissioning an "energy map" of Thurston County's energy sources and end uses, and commissioning "carbon wedge" analyses that show pathways to hit the region's 2050 emissions-reduction target.

TRPC developed the "Resilience Road" board game to encourage residents to learn about climate stressors and response actions in this plan. Visit trpc.org/climate to download and play the game.

The sun begins to set over the Nisqually estuary during summer 2017. The low-lying marshes and woodlands are vulnerable to sea-level rise.
Source: *TRPC*

3. Vision, Goals, & Guiding Principles

"In addition to doing its part to reduce greenhouse gas emissions, the Thurston County region will remain resilient in the face of climate change impacts during the 21st century and beyond."

— VISION STATEMENT
Thurston Climate Adaptation Plan

The Stakeholder Advisory Committee's first official action was to help the project team draft a vision statement, goals, and guiding principles for the adaptation plan. Such policy language recognizes that adaptation and mitigation are equally important and builds upon work the Thurston Region is already doing to reduce and respond to climate change impacts.

3.1 Vision Statement

This plan's vision statement recognizes that our region must do its part to shrink its carbon footprint [*Also see Section 6.2*] while adapting to climate impacts in the years ahead.

The award-winning Sustainable Thurston plan, which TRPC policymakers adopted in late 2013 and subsequently integrated into local policies, set the following targets for reducing the Thurston Region's greenhouse gas emissions:

- Achieve 25 percent reduction of 1990 levels by 2020;
- Achieve 45 percent reduction of 1990 levels by 2035; and,
- Achieve 80 percent reduction of 1990 levels by 2050

The 2050 emissions target — which also has been adopted by California, King County, and many other state and local governments — provides a medium chance of preventing the global average temperature from rising more than 2° Celsius (3.6° Fahrenheit) above pre-industrial levels (Luers et al., 2007). The United Nations Framework Convention on Climate Change's "Paris Agreement," which was brokered by more than 150 nations in late 2015, includes the 2°C target but also stresses the importance of pursuing a more aggressive 1.5°C (2.7°F) target to mitigate the most dangerous climate change risks (Figueres, 2015).

3.2 Project Goals

The Stakeholder Advisory Committee selected Sustainable Thurston's 12 priority goals, which are regional in scope and comprehensive in nature, as the adaptation plan's regional goals [*right*]. The subsequent risk assessment [*See Section 4.3*] considered how climate change risks compromise the Thurston Region's ability to achieve these goals.

REGIONAL GOALS

1. Create vibrant centers, corridors and neighborhoods while accommodating growth;
2. Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands, and develop compact urban areas;
3. Create a robust economy;
4. Protect and improve water quality, including groundwater, rivers, streams, lakes and Puget Sound;
5. Plan and act toward zero waste in the region;
6. Ensure that residents have the resources to meet their daily needs;
7. Support a local food system to increase community resilience, health and economic prosperity;
8. Ensure that the region's water supply sustains people in perpetuity while protecting the environment;
9. Move toward a carbon-neutral community;
10. Maintain air quality standards;
11. Provide opportunities for everyone in the Thurston Region to learn about and practice sustainability;
12. Make strategic investments to advance sustainability regionally.

3.3 Guiding Principles

Lastly, the Stakeholder Advisory Committee crafted nine guiding principles to shape the adaptation plan's development and outcomes. These principles are reflected throughout the plan's components [*See Section 4*] and actions [*See Section 5*].

GUIDING PRINCIPLES

1. Think in terms of multiple generations and connected built and natural systems, as well as view local and regional decisions through the lens of social, economic, and environmental sustainability;
2. Increase resiliency through achievable, flexible — and, where possible, measurable and replicable — adaptation strategies and actions that will help the region prepare for and cope with climate change impacts;
3. Be responsive to immediate and long-term climate impacts — both emergencies and opportunities;
4. Identify and leverage climate change adaptation strategies and actions with mitigation co-benefits, such as reducing, capturing, and storing greenhouse gas emissions;
5. Utilize sound scientific research, scenarios modeling, economic analysis, and other tools to analyze regional and local climate change vulnerabilities, risks, and solutions;
6. Incorporate and complement work produced by others, including the Natural Hazards Mitigation Plan for the Thurston Region, Sustainable Thurston, Thurston Thrives, and Olympia sea-level rise analyses;
7. Consider the impacts of climate change adaptation recommendations on the region's economy, environment, and society; this includes all urban and rural communities — especially vulnerable residents — and the ecosystem benefits provided by natural systems;
8. Recognize and strive to protect local indigenous tribes' community health and well-being, including natural resources security and self-determination;
9. Seek broad community input, as well as educate residents about climate change and inspire them to take action.

Downtown Olympia's 4th Avenue bridge rises above lower Budd Inlet during high tide in spring 2016. ***Source:*** *TRPC*

4. Plan Development

"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased."

— IPCC, 2014

The following section includes excerpts from the science summary, vulnerability assessment, and other plan components. A full, annotated copy of each document is appended.

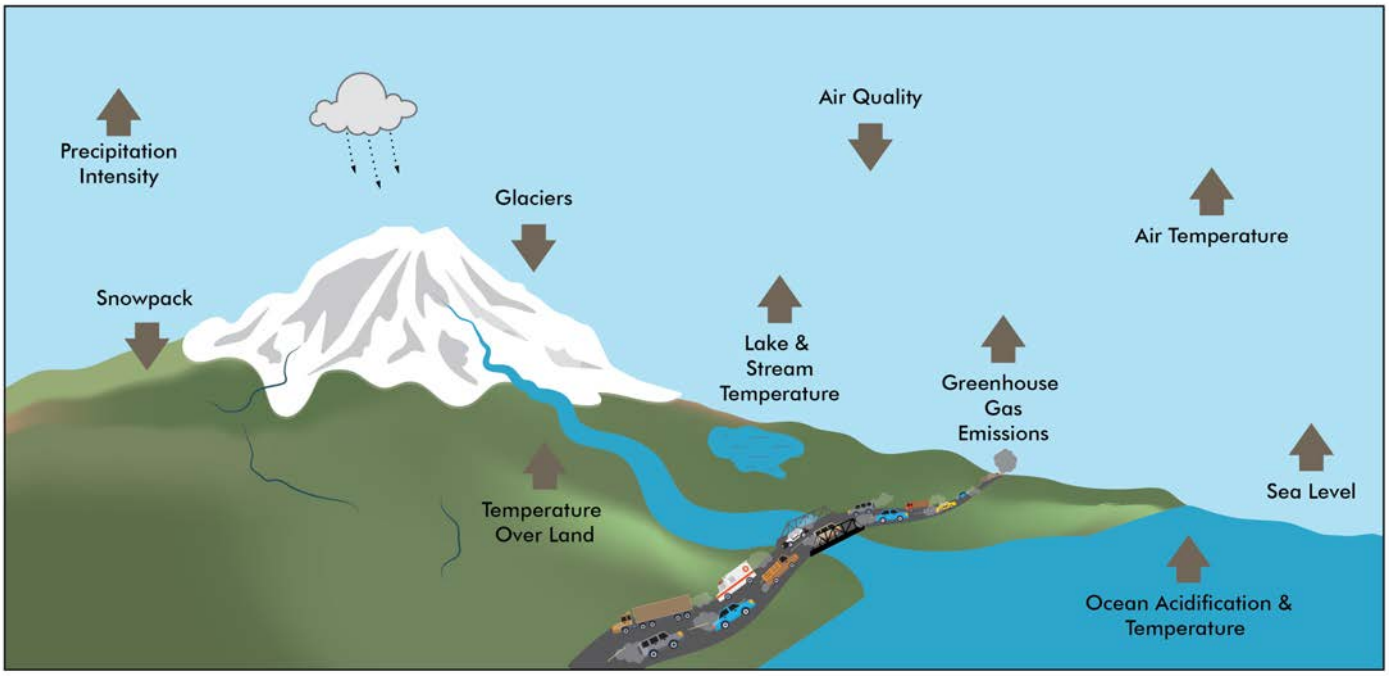


Figure 02: Pictured above are key indicators of the region's changing climate. Arrows show increasing or decreasing trends, based on empirical data and modeling. ***Source:*** *TRPC, adapted from image in U.S. Global Change Research Program's (USGCRP) 2014 National Climate Assessment*

4.1 Science Summary

Our individual actions affect our collective carbon footprint — whether we drive a car, charge a cellphone, or catch a plane. Emissions from burning all those gallons of fuel and generating all those watts of electricity are adding up and changing the climate in significant ways.

Consider the science: The IPCC concluded in a recent global climate change synthesis report, it is "extremely likely" that human influence was the "dominant cause" of observed planetary warming between 1951 and 2010 (IPCC, 2013). Such warming of the air, land, and water has caused a reduction in snow and ice, rise in sea level, and other changes [*See Figure 02*] (USGCRP, 2014).

Shortly after calendars flipped to 2017, scientists reported that 2016 was the warmest year since modern record-keeping began in 1880: The global average temperature was 58.69°F — more than 1.8°F (1°C) warmer than it was in pre-industrial times (NOAA, 2017). Just as noteworthy, 2016 marked the fifth new record annual temperature this century and the 40th consecutive year that the annual temperature was above the 20th century average (57°F).

There's no crystal ball that shows what the future holds, so scientists run plausible scenarios of future greenhouse gas emissions — also known as Representative Concentration Pathways (RCPs) — through models that simulate global climate. Local researchers can then downscale these scenarios to project changes in temperature, precipitation, and other climate indicators for the Pacific Northwest, Puget Sound region, and individual watersheds.

The IPCC's 2013 report included an "extremely low" scenario (RCP 2.6), involving aggressive emissions reductions, all the way up to a "high" scenario (RCP 8.5), involving continued substantial greenhouse gas emissions through 2100 [*See Figure 03*]. The UW Climate Impacts Group's 2015 *State of Knowledge* report (Mauger et al., 2015) — the primary source of watershed-scale modeling for TRPC's vulnerability assessment — included the low and high scenarios in its projections for the Puget Sound region.

Weather vs. Climate

Weather is atmospheric conditions over the short term (e.g., minutes to days). Climate is the average of weather over longer periods of time and space (e.g., years and decades). … A good way to remember the difference is that climate is what you expect — like a long and hot summer; weather is what you get — like a dry and sunny day.

— NASA, 2015

Science isn't static, of course. The climate scenarios reflect the scientific community's current understanding of complex and dynamic natural systems, coupled with informed assumptions about future human behaviors, economies, and technologies. Understanding of these various components will continue to evolve over time, as will the climate projections developed on the basis of these components. Additionally, natural variability (e.g., El Niño) has and will continue to play a role in shaping the Pacific Northwest's climate. Some weather events and seasons may deviate temporarily from long-term climate trends.

All of this to say, the Thurston Region should monitor how modeled projections track with actual climate impacts in the years ahead. To this end, the Thurston Climate Adaptation Plan's first action (A-01) recommends that TRPC update the document periodically with new information, evaluate implementation efforts, and amend strategies and actions as necessary.

A May 2017 microburst caused heavy rain and overflowing gutters in Lacey.
Source: *Mollie Selstrom*

Greenhouse gas scenarios	Scenario characteristics	Amount of carbon dioxide in the atmosphere, 2100	Qualitative description, as used by UW CIG
RCP 2.6	A very low emissions scenario that assumes ambitious greenhouse gas emissions reductions (50% reduction in global emissions by 2050 relative to 1990 levels, and near or below zero net emissions in the final decades of the 21st century)	400 parts per million (ppm)	"Very Low"
RCP 4.5	A low scenario in which greenhouse gas emissions stabilize by mid-century and fall sharply thereafter	538 ppm	"Low"
RCP 6.0	A medium scenario in which greenhouse gas emissions increase gradually until stabilizing in the final decades of the 21st century	670 ppm	"Medium"
RCP 8.5	A high scenario that assumes continued increases in greenhouse gas emissions until the end of the 21st century	936 ppm	"High"

Figure 03: This table shows the greenhouse gas emissions scenarios (RCPs) used in the IPCC's 2014 synthesis report.

Source: *UW Climate Impacts Group (Mauger et al., 2015)*

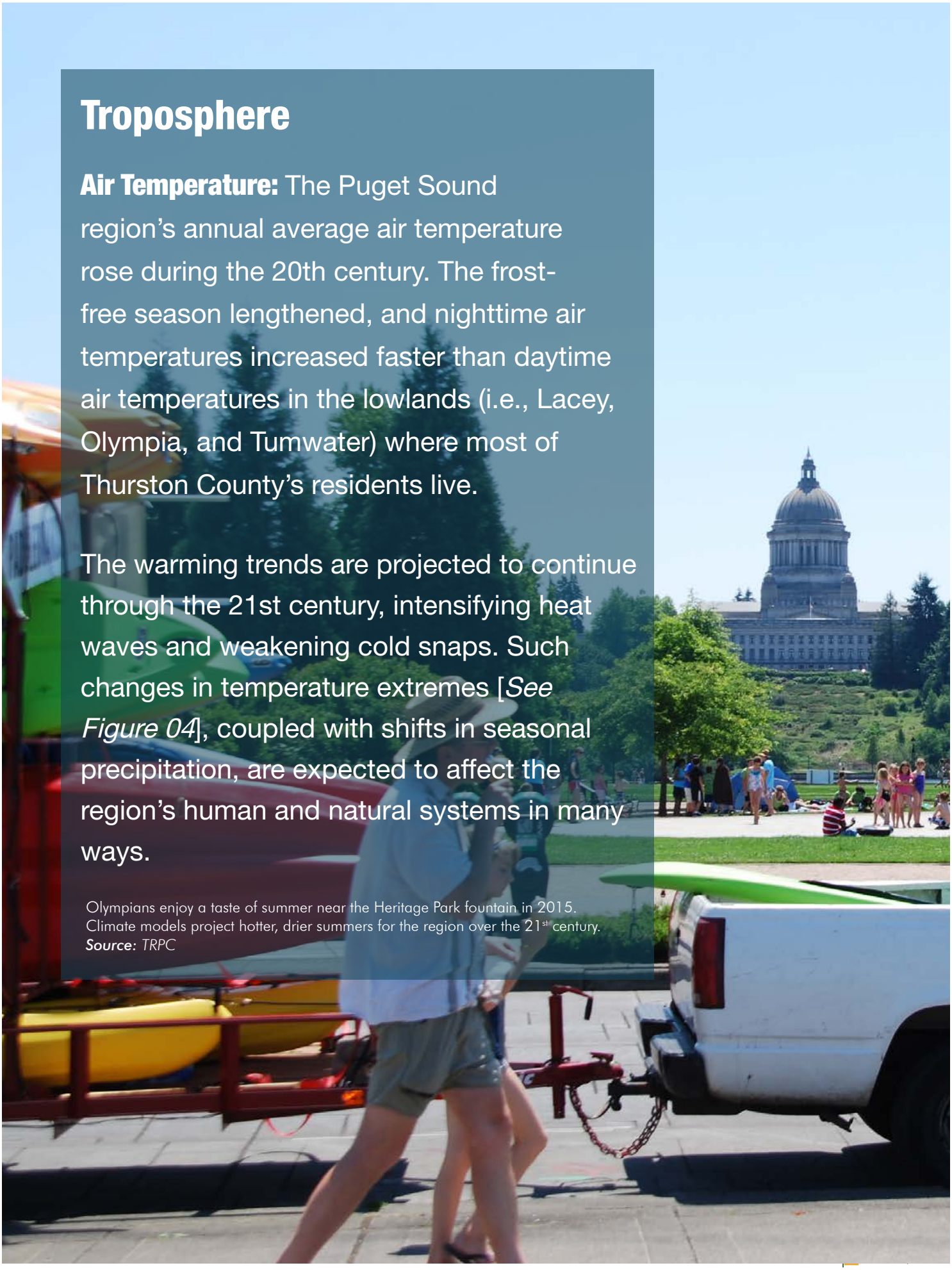
4.2 Vulnerability Assessment

Building on the science summary [See Appendix A], the vulnerability assessment [See Appendix B] uses empirical data and modeling to produce text, tables, and maps that explain how the South Puget Sound region's climate has changed historically, how it is projected to change during the 21st century, and how such changes affect the vulnerability of our human and natural systems. The 100-page document (TRPC, 2016) is organized into five sections — Troposphere, Freshwater Ecosystems, Marine Ecosystems, Terrestrial Ecosystems, and Human Health & Welfare — each of which is summarized on the following pages.

Troposphere

Air Temperature: The Puget Sound region's annual average air temperature rose during the 20th century. The frost-free season lengthened, and nighttime air temperatures increased faster than daytime air temperatures in the lowlands (i.e., Lacey, Olympia, and Tumwater) where most of Thurston County's residents live.

The warming trends are projected to continue through the 21st century, intensifying heat waves and weakening cold snaps. Such changes in temperature extremes [*See Figure 04*], coupled with shifts in seasonal precipitation, are expected to affect the region's human and natural systems in many ways.



Olympians enjoy a taste of summer near the Heritage Park fountain in 2015. Climate models project hotter, drier summers for the region over the 21st century.
Source: *TRPC*

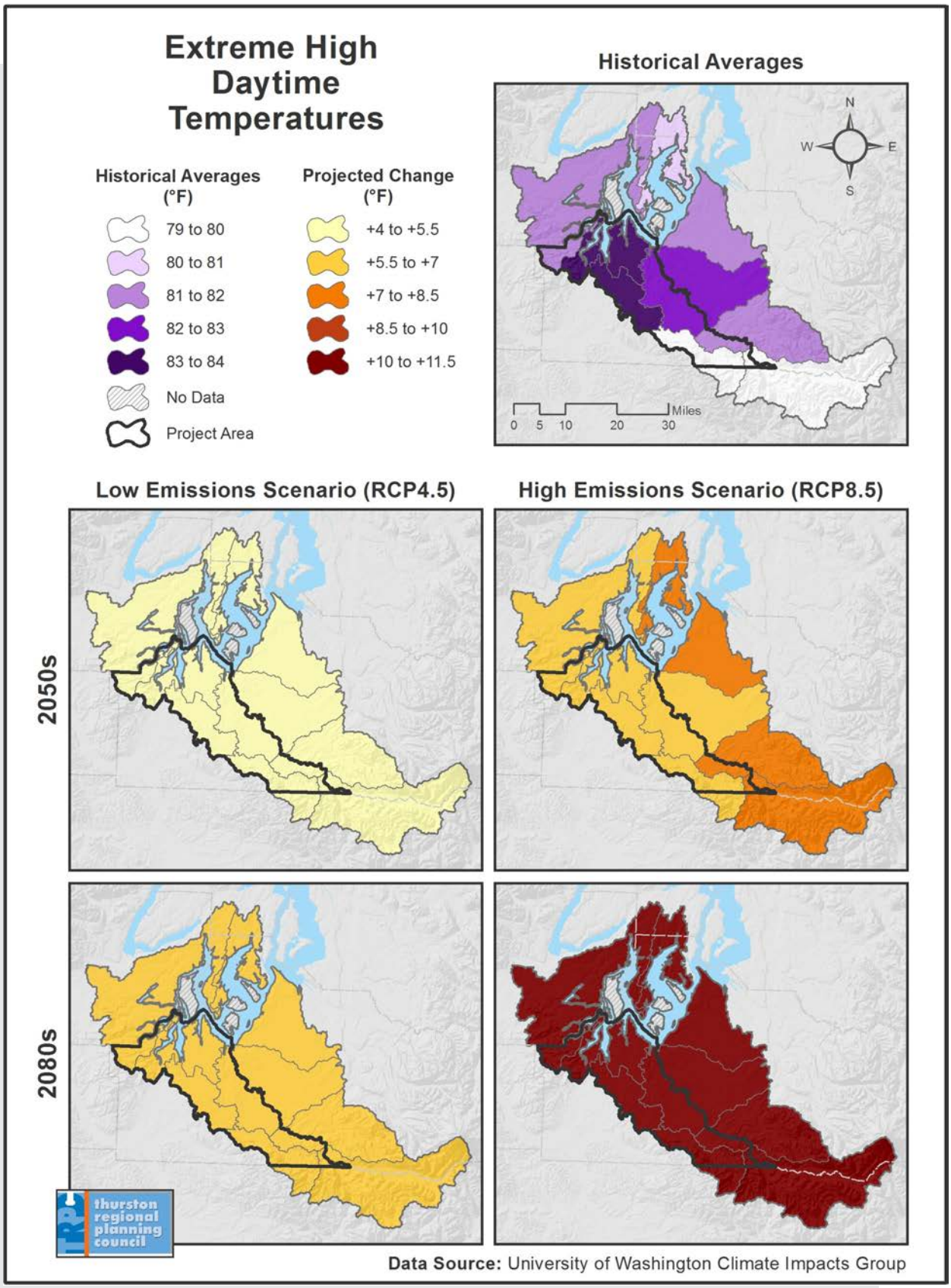
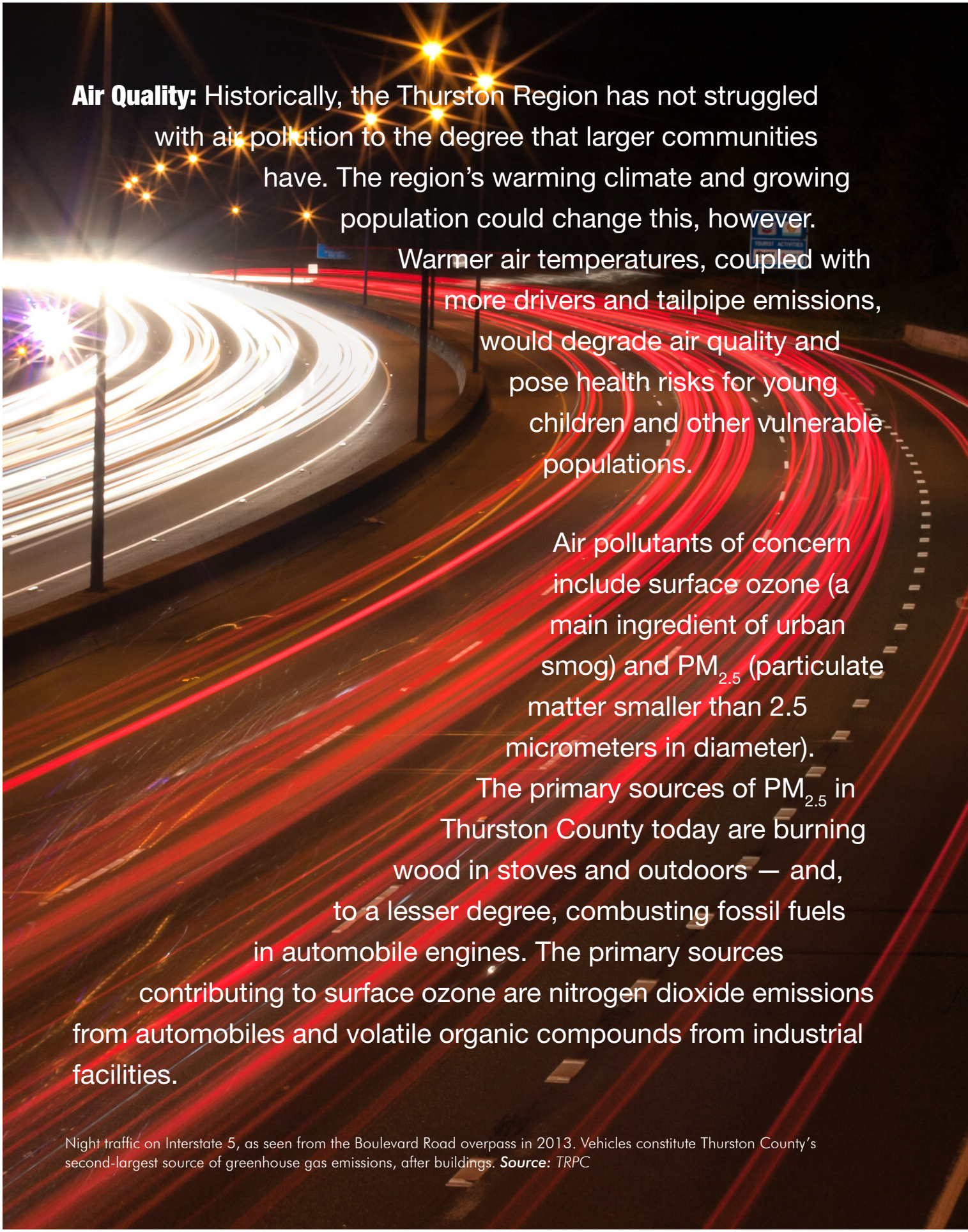


Figure 04: This series of maps, which utilizes UW Climate Impacts Group data, shows observed and projected extreme high daytime temperatures for the Nisqually, Deschutes, and Kennedy-Goldsborough watersheds. The full vulnerability assessment [*See Appendix B*] includes dozens more South Puget Sound watershed maps of climate change indicators, including precipitation, snowpack, and runoff.

Source: *Adapted from Figure 4b in Appendix B of Mauger et al., 2015.*



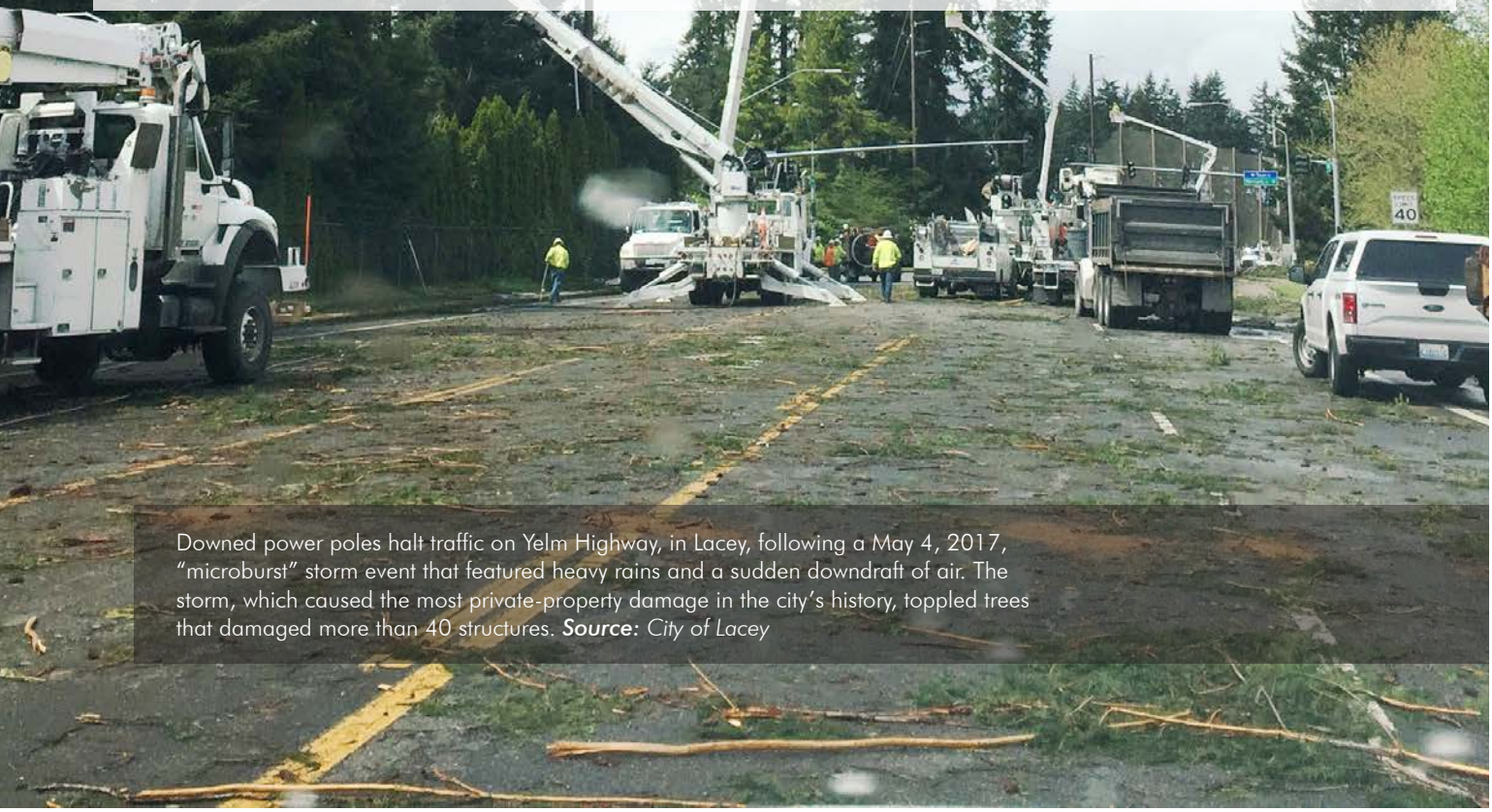
Air Quality: Historically, the Thurston Region has not struggled with air pollution to the degree that larger communities have. The region's warming climate and growing population could change this, however. Warmer air temperatures, coupled with more drivers and tailpipe emissions, would degrade air quality and pose health risks for young children and other vulnerable populations.

Air pollutants of concern include surface ozone (a main ingredient of urban smog) and $PM_{2.5}$ (particulate matter smaller than 2.5 micrometers in diameter). The primary sources of $PM_{2.5}$ in Thurston County today are burning wood in stoves and outdoors — and, to a lesser degree, combusting fossil fuels in automobile engines. The primary sources contributing to surface ozone are nitrogen dioxide emissions from automobiles and volatile organic compounds from industrial facilities.

Night traffic on Interstate 5, as seen from the Boulevard Road overpass in 2013. Vehicles constitute Thurston County's second-largest source of greenhouse gas emissions, after buildings. ***Source:*** *TRPC*

Precipitation: There is no discernable historical trend in precipitation across the Puget Sound region, which averaged about 78 inches annually during the latter half of the 20th century. The region's annual precipitation volume is not projected to change significantly this century. Seasonal precipitation volumes are projected to change considerably, however: Models indicate generally hotter and drier summers and warmer and wetter winters. Highland forest areas of the Deschutes and Nisqually watersheds would see the biggest shifts in precipitation timing, type, and volume.

The frequency of the region's heaviest 24-hour rain events (top 1 percent) is projected to increase — occurring about seven days a year by late century, compared to two days a year historically. The intensity of such events is projected to increase as well, making communities more vulnerable to downed trees and power poles, floods, landslides, and water-borne pollution [*See Figure 05, opposite*].



Downed power poles halt traffic on Yelm Highway, in Lacey, following a May 4, 2017, "microburst" storm event that featured heavy rains and a sudden downdraft of air. The storm, which caused the most private-property damage in the city's history, toppled trees that damaged more than 40 structures. ***Source:*** *City of Lacey*

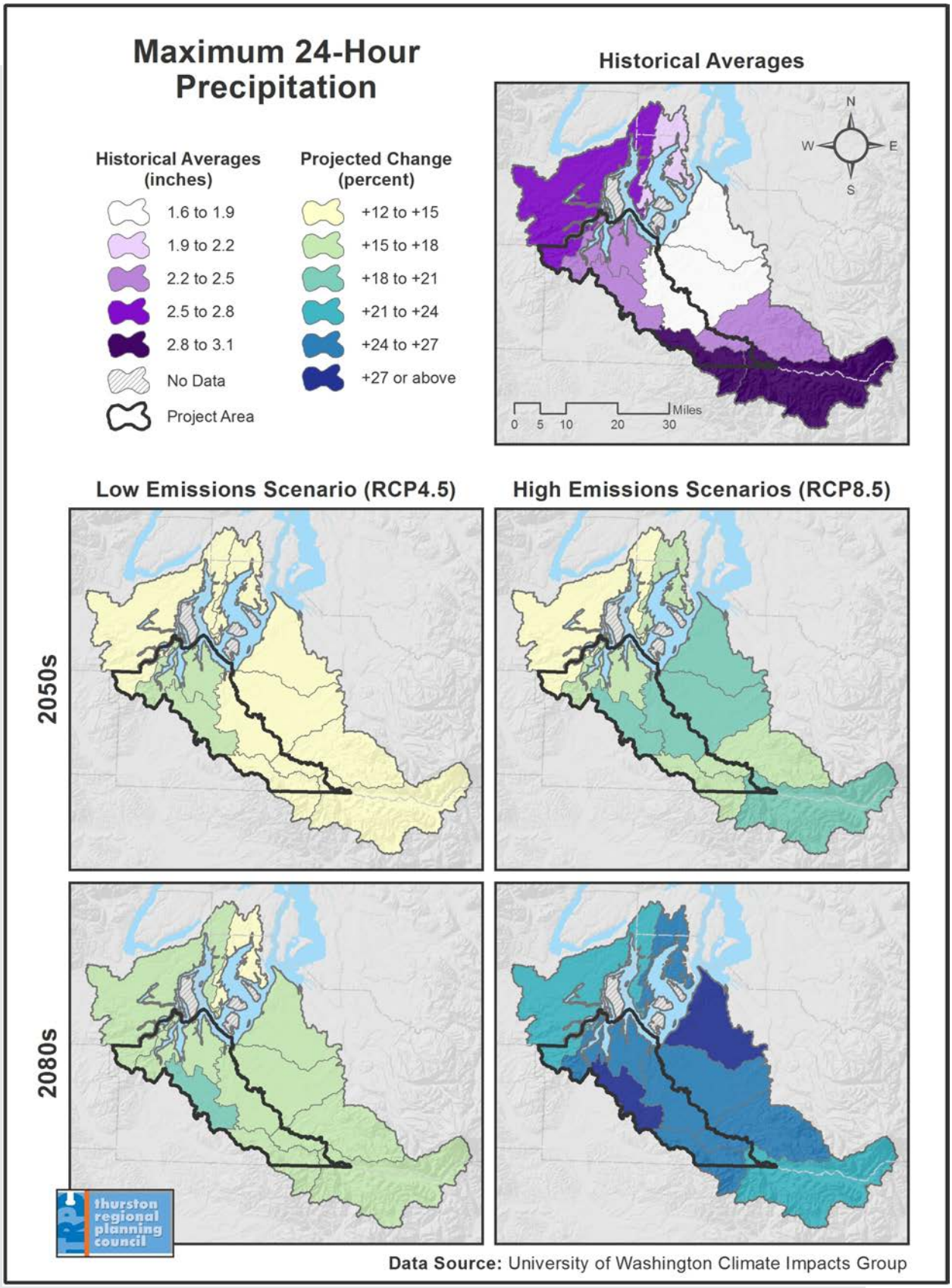
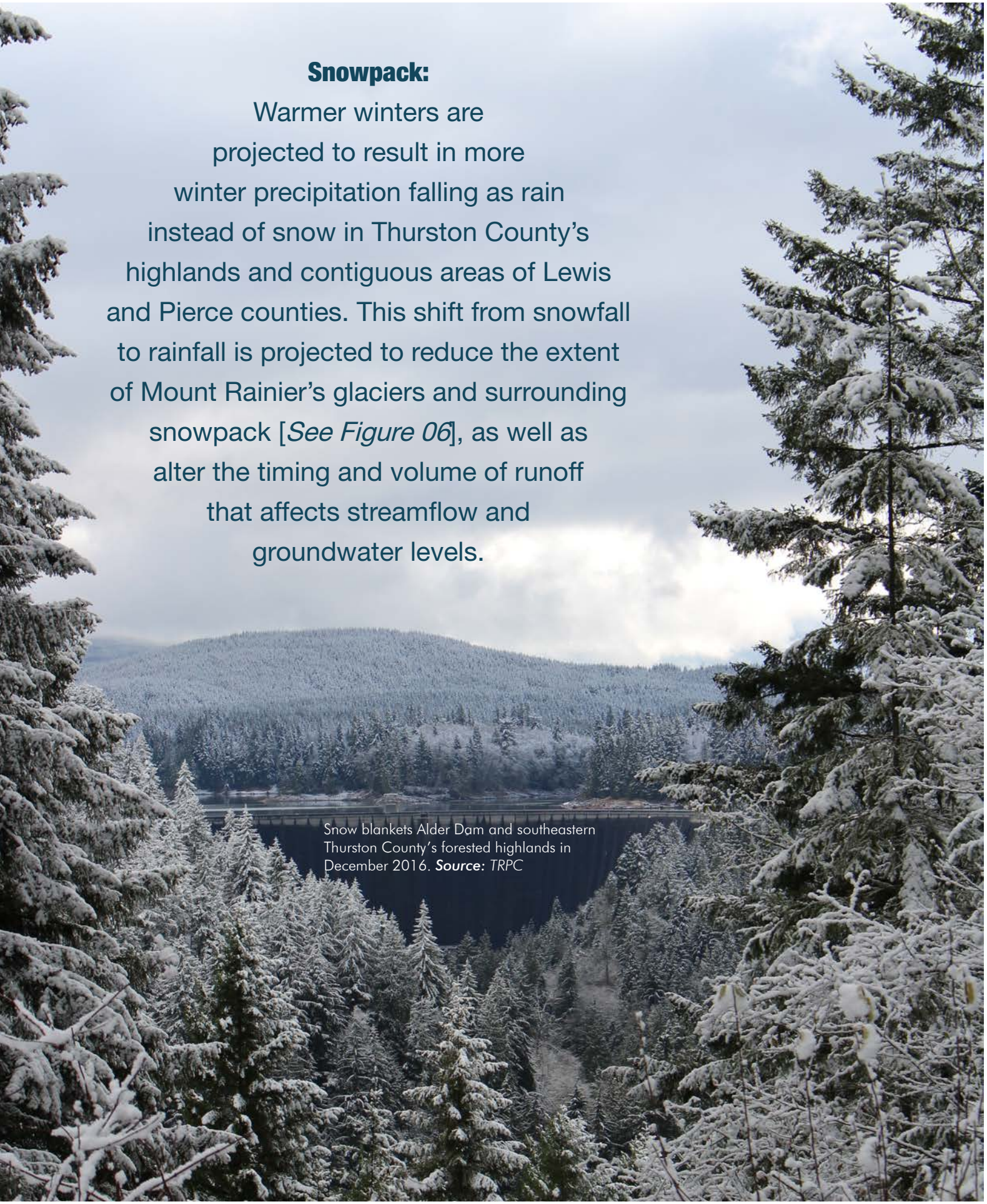


Figure 05: The intensity of the heaviest 24-hour rain events (top 1 percent) — as measured in inches of precipitation — is projected to increase amid the project area. ***Source:*** *Adapted from Figure 8b in Appendix B of Mauger et al., 2015.*

Snowpack:

Warmer winters are projected to result in more winter precipitation falling as rain instead of snow in Thurston County's highlands and contiguous areas of Lewis and Pierce counties. This shift from snowfall to rainfall is projected to reduce the extent of Mount Rainier's glaciers and surrounding snowpack [*See Figure 06*], as well as alter the timing and volume of runoff that affects streamflow and groundwater levels.



Snow blankets Alder Dam and southeastern Thurston County's forested highlands in December 2016. ***Source:*** *TRPC*

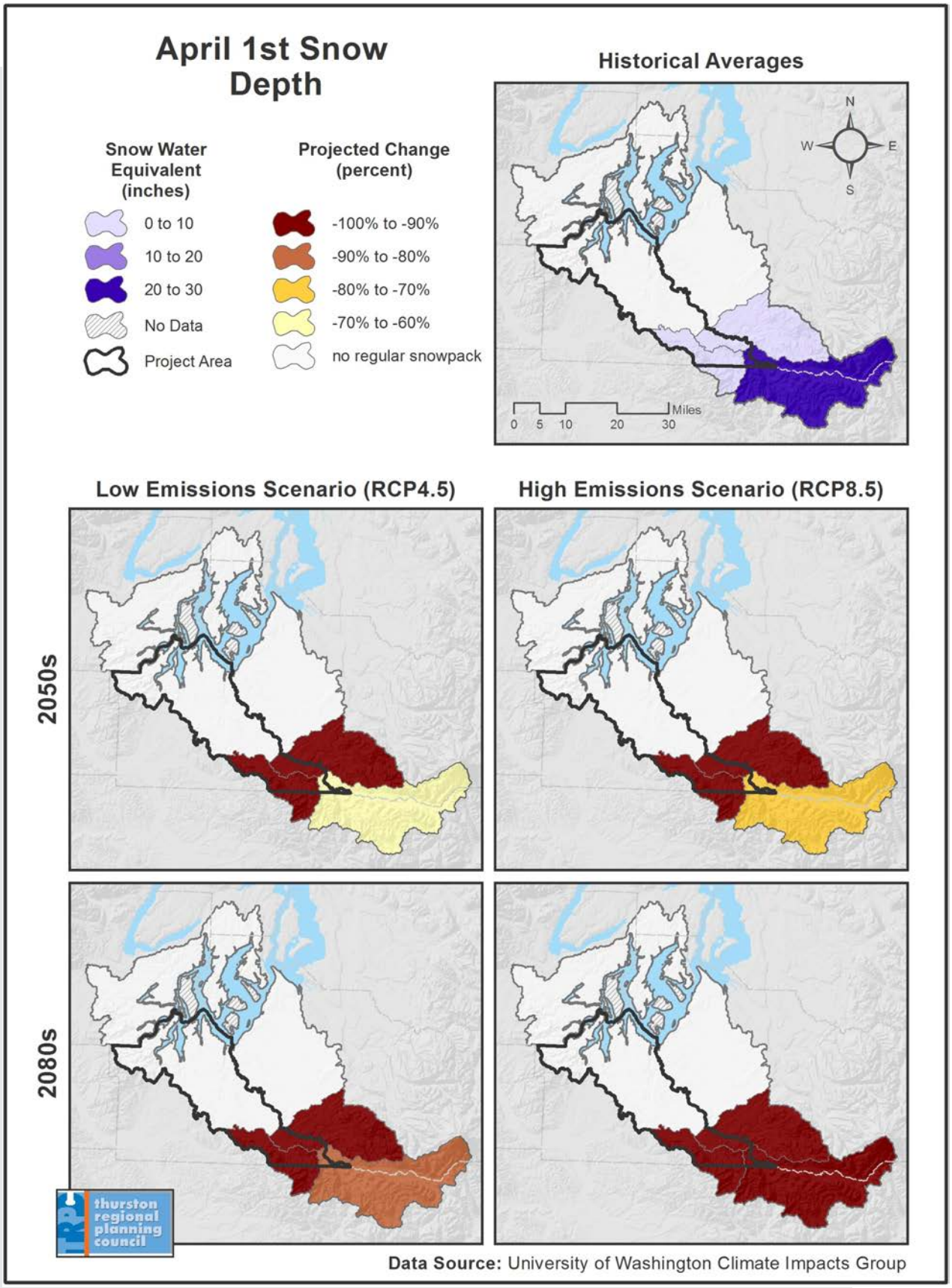


Figure 06. Projected changes in April 1st peak snowpack, expressed as snow water equivalent (measure of the total amount of water contained in snowpack) amid South Puget Sound watersheds. ***Source:*** *Adapted from Figure 11b in Appendix B of Mauger et al., 2015.*

Freshwater Ecosystems

Streamflow: A shift to more rain-dominant conditions across Thurston County watersheds is projected to result in higher runoff and streamflow during cooler months but the opposite during warmer months.

Within the Nisqually and Deschutes watersheds, the higher-elevation headwater areas are projected to experience the biggest changes in snowpack and runoff [*See Figure 07*], which affect streamflow timing and volume. Fish and other species that have evolved around predictable peak flows would be vulnerable to die-offs and degraded habitat.

The Deschutes River overtops its banks at Tumwater Falls Park after a record-breaking storm in December 2015. ***Source:*** *TRPC*

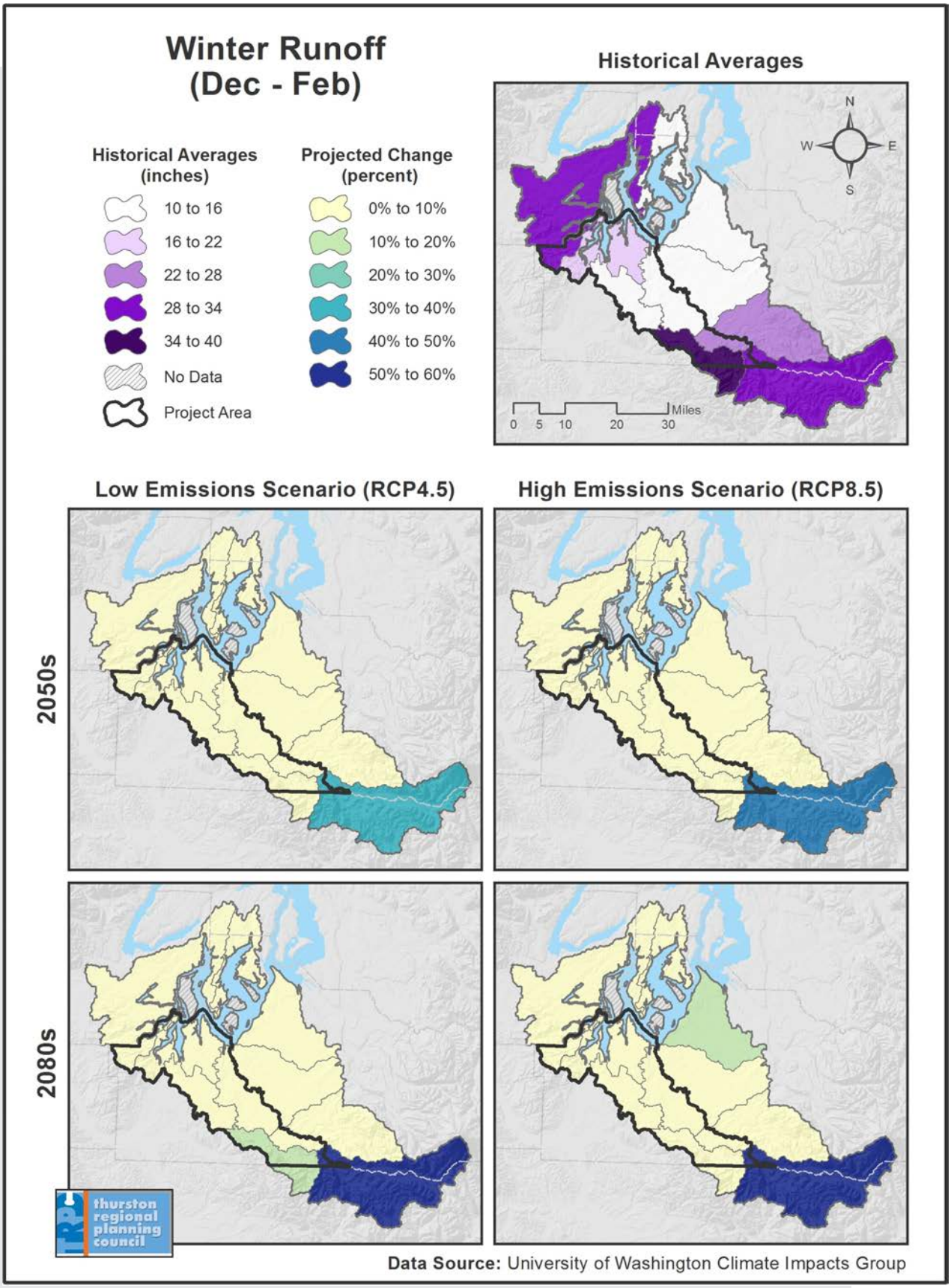
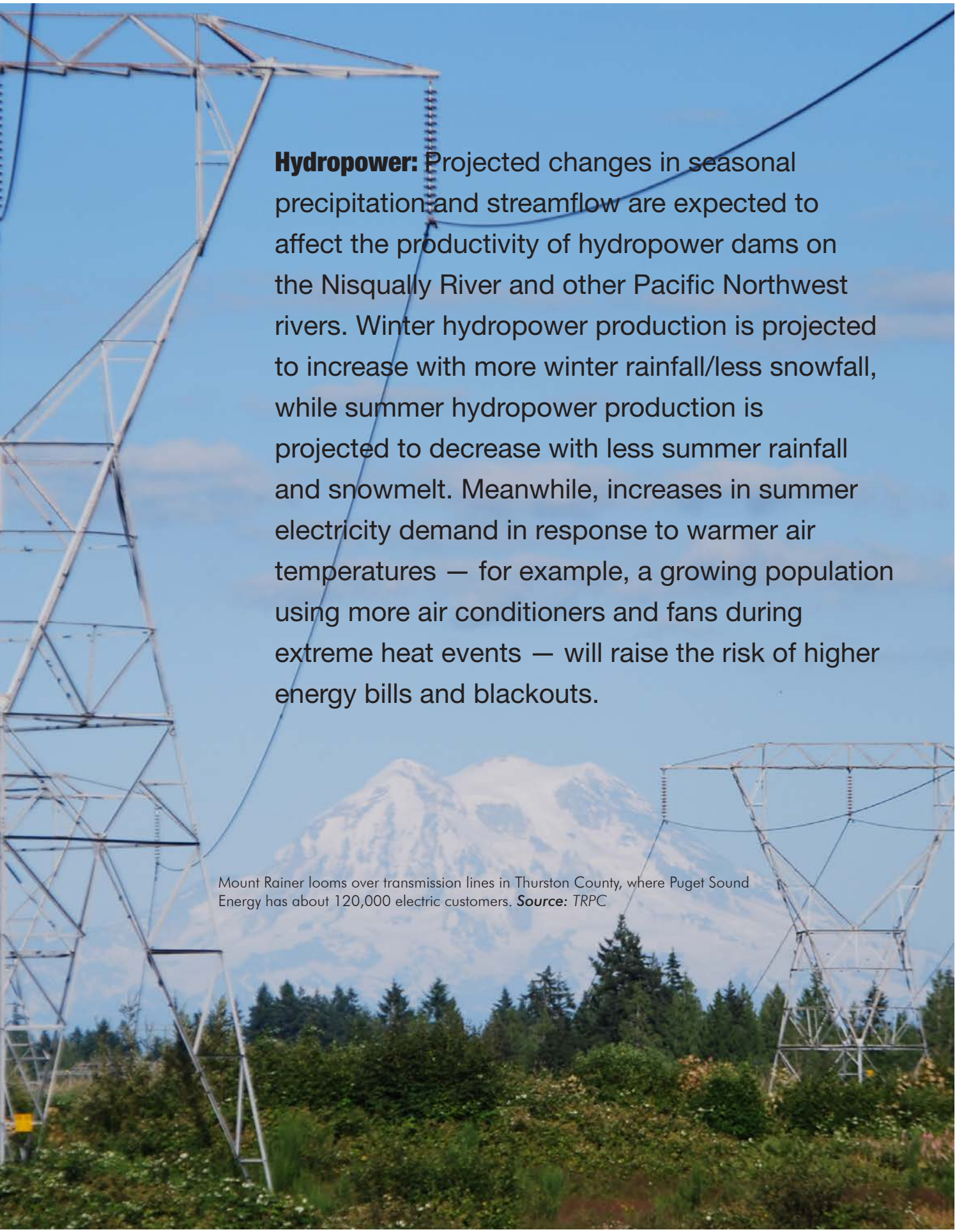
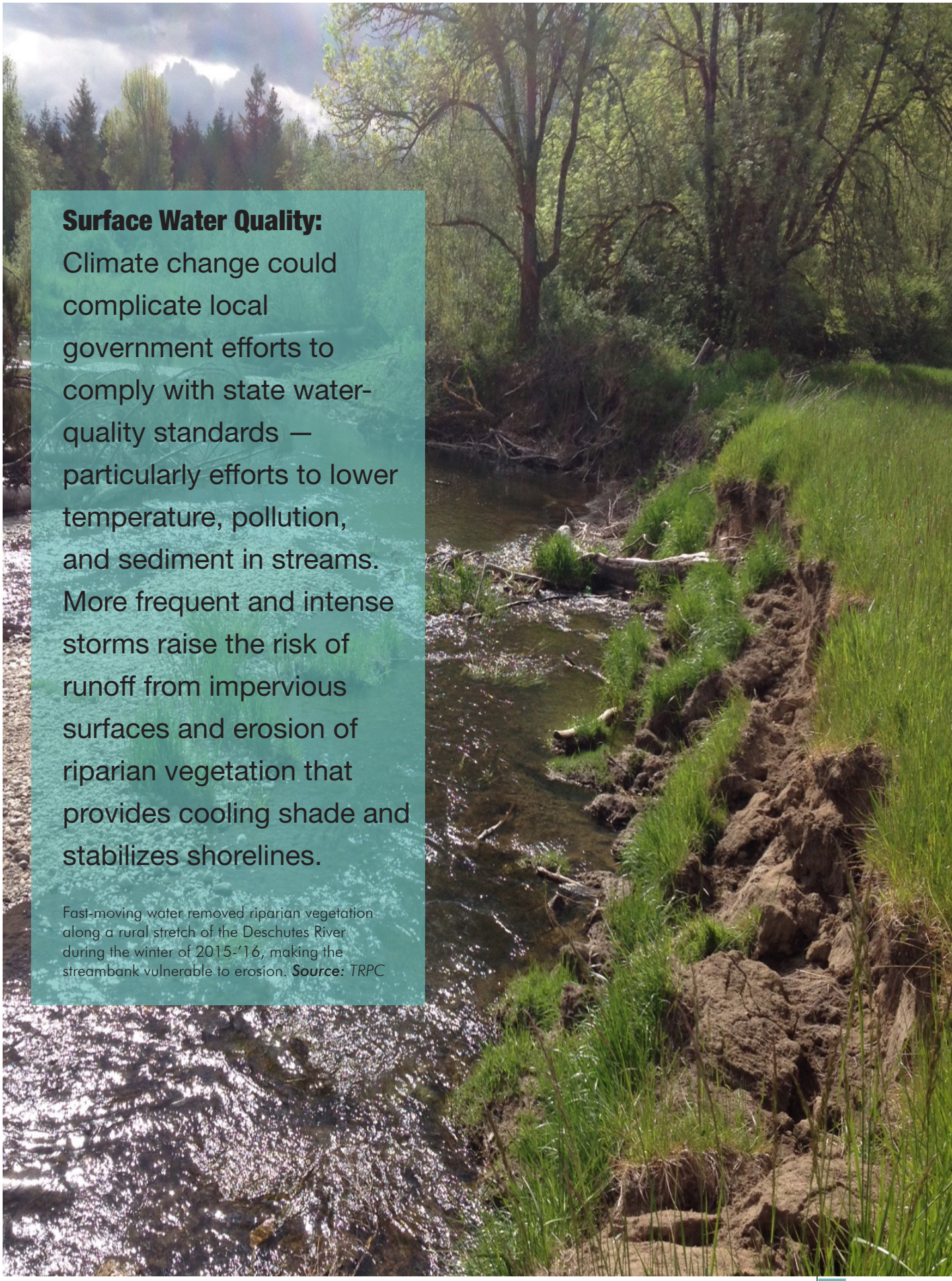


Figure 07. Projected changes winter runoff amid South Puget Sound watersheds per emissions scenarios. Source: Adapted from Figure 14b in Appendix B of Mauger et al., 2015.



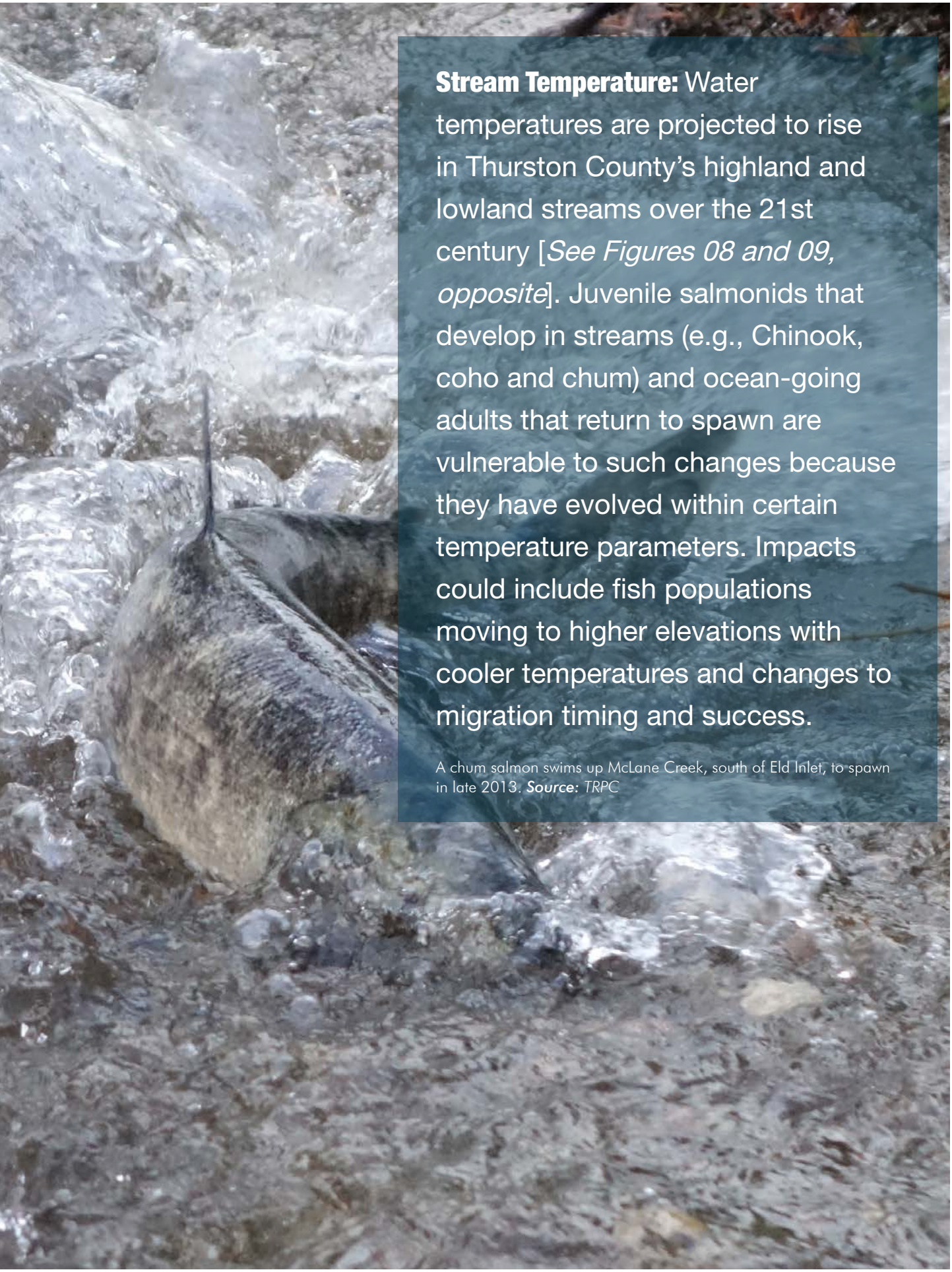
Hydropower: Projected changes in seasonal precipitation and streamflow are expected to affect the productivity of hydropower dams on the Nisqually River and other Pacific Northwest rivers. Winter hydropower production is projected to increase with more winter rainfall/less snowfall, while summer hydropower production is projected to decrease with less summer rainfall and snowmelt. Meanwhile, increases in summer electricity demand in response to warmer air temperatures — for example, a growing population using more air conditioners and fans during extreme heat events — will raise the risk of higher energy bills and blackouts.

Mount Rainer looms over transmission lines in Thurston County, where Puget Sound Energy has about 120,000 electric customers. ***Source:*** *TRPC*



Surface Water Quality: Climate change could complicate local government efforts to comply with state water-quality standards — particularly efforts to lower temperature, pollution, and sediment in streams. More frequent and intense storms raise the risk of runoff from impervious surfaces and erosion of riparian vegetation that provides cooling shade and stabilizes shorelines.

Fast-moving water removed riparian vegetation along a rural stretch of the Deschutes River during the winter of 2015-'16, making the streambank vulnerable to erosion. ***Source:*** *TRPC*



Stream Temperature: Water temperatures are projected to rise in Thurston County's highland and lowland streams over the 21st century [*See Figures 08 and 09, opposite*]. Juvenile salmonids that develop in streams (e.g., Chinook, coho and chum) and ocean-going adults that return to spawn are vulnerable to such changes because they have evolved within certain temperature parameters. Impacts could include fish populations moving to higher elevations with cooler temperatures and changes to migration timing and success.

A chum salmon swims up McLane Creek, south of Eld Inlet, to spawn in late 2013. ***Source:*** *TRPC*

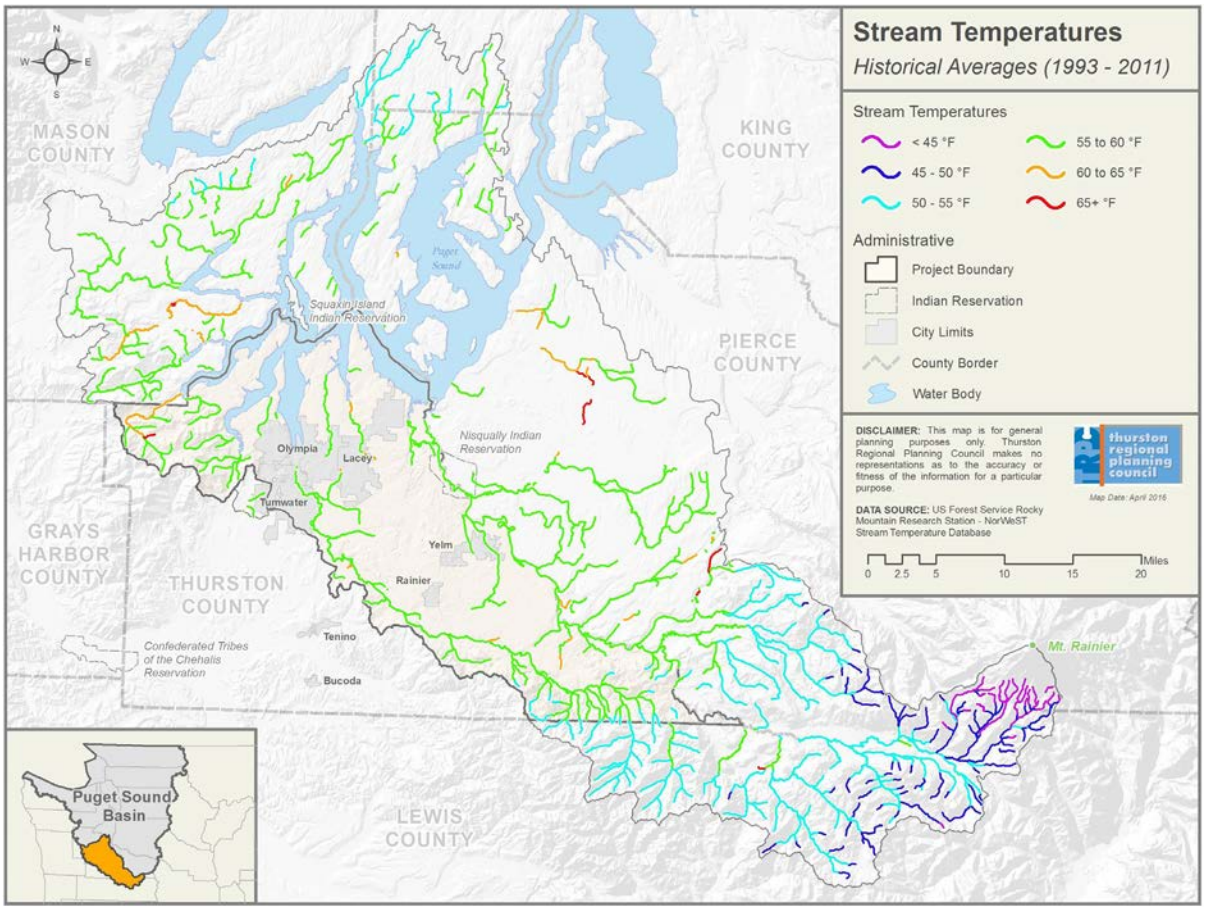
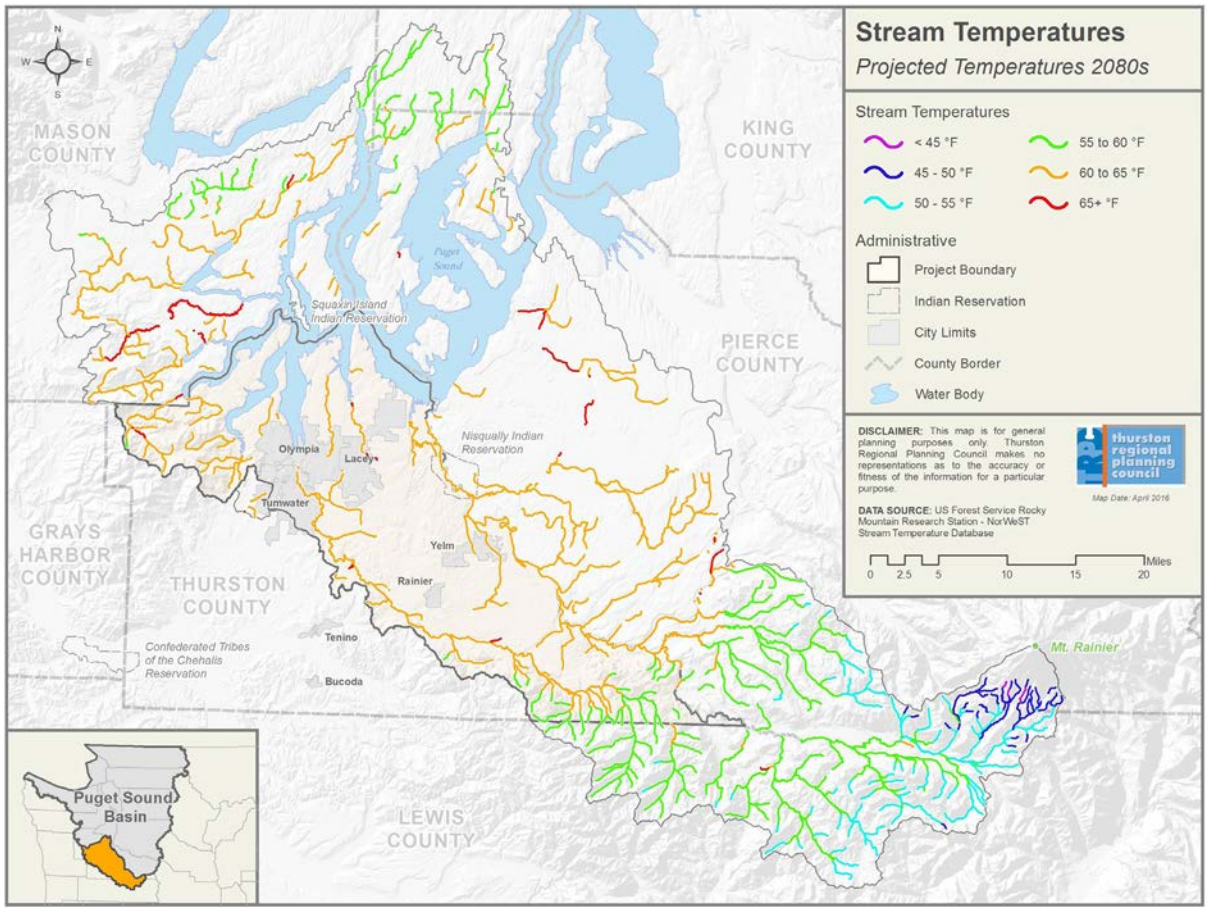
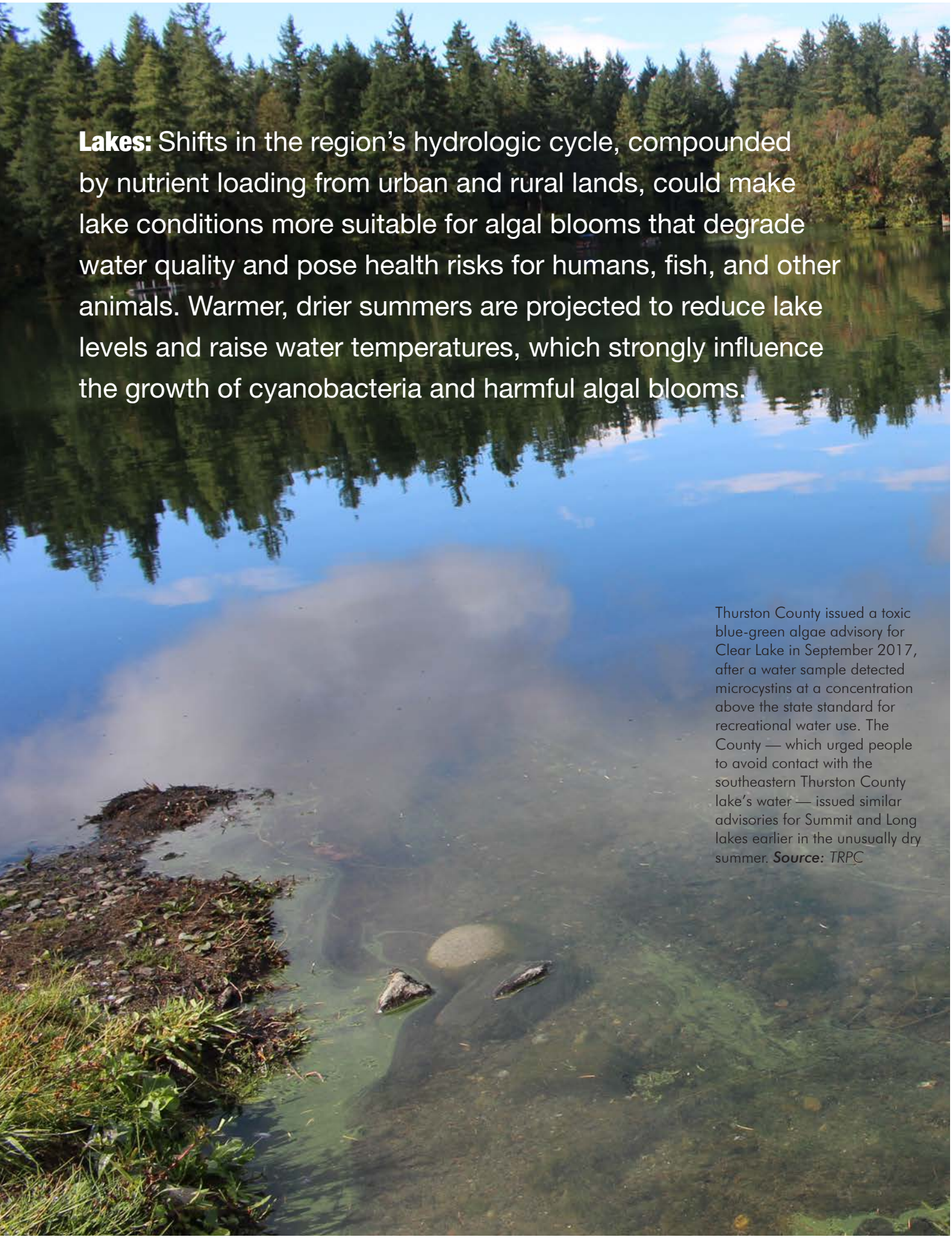


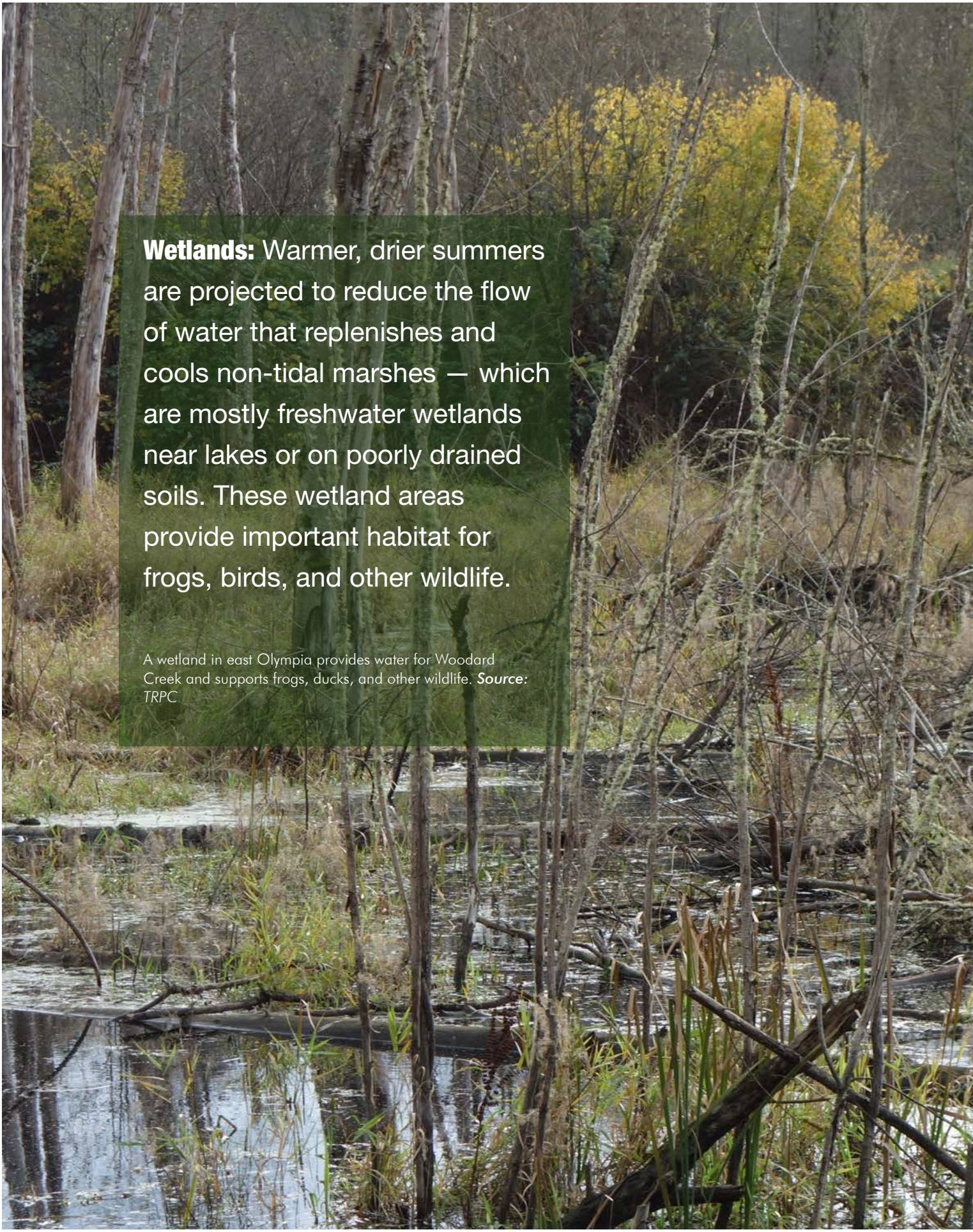
Figure 08 (above) shows historical stream temperature averages, from 1993 - 2011, while **Figure 09** (below) shows projected temperatures for the 2080s.





Lakes: Shifts in the region's hydrologic cycle, compounded by nutrient loading from urban and rural lands, could make lake conditions more suitable for algal blooms that degrade water quality and pose health risks for humans, fish, and other animals. Warmer, drier summers are projected to reduce lake levels and raise water temperatures, which strongly influence the growth of cyanobacteria and harmful algal blooms.

Thurston County issued a toxic blue-green algae advisory for Clear Lake in September 2017, after a water sample detected microcystins at a concentration above the state standard for recreational water use. The County — which urged people to avoid contact with the southeastern Thurston County lake's water — issued similar advisories for Summit and Long lakes earlier in the unusually dry summer. ***Source:*** *TRPC*



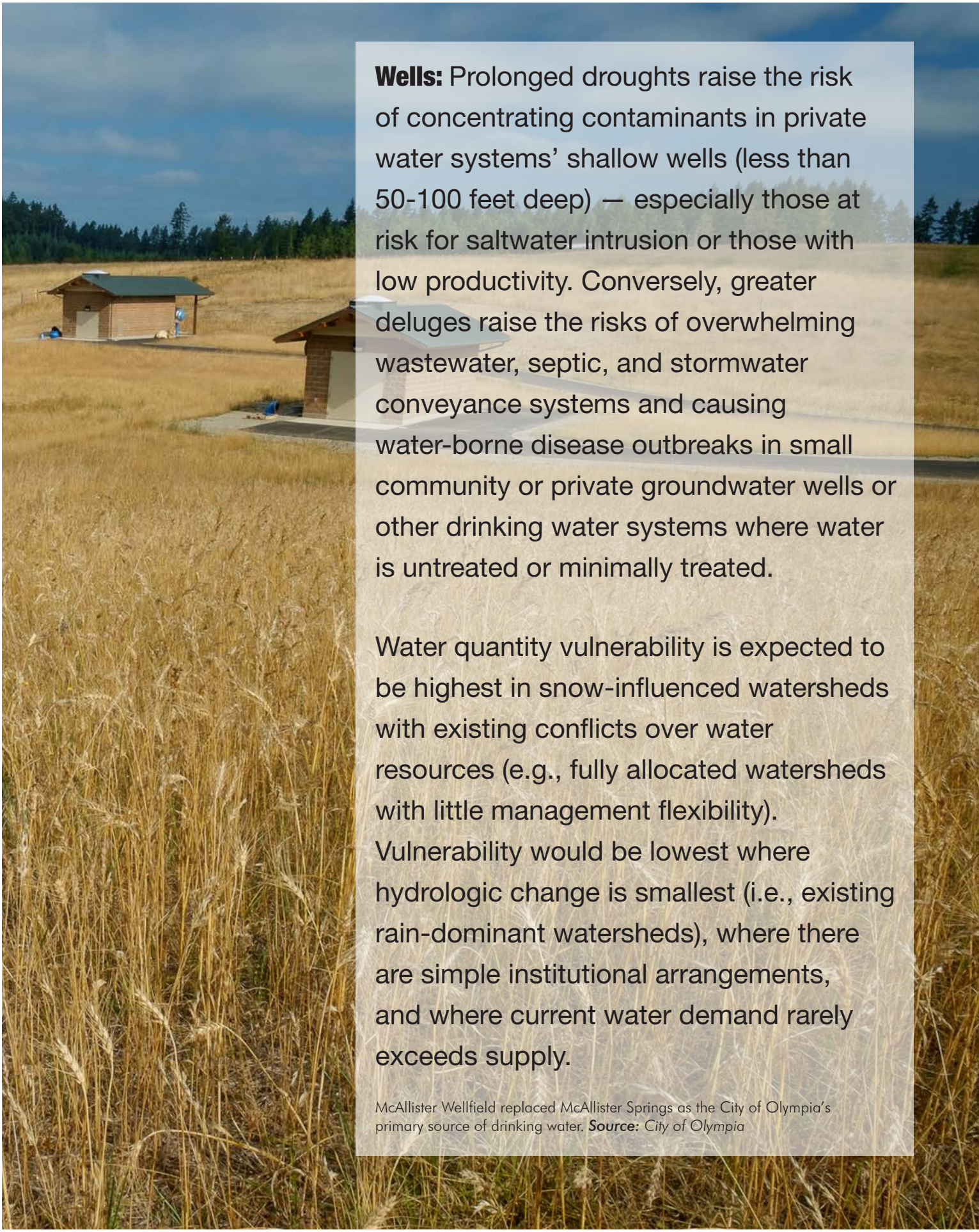
Wetlands: Warmer, drier summers are projected to reduce the flow of water that replenishes and cools non-tidal marshes — which are mostly freshwater wetlands near lakes or on poorly drained soils. These wetland areas provide important habitat for frogs, birds, and other wildlife.

A wetland in east Olympia provides water for Woodard Creek and supports frogs, ducks, and other wildlife. ***Source:*** *TRPC*

Groundwater: Bigger winter storms could result in high groundwater flooding, less infiltration into the saturated soil, and more runoff into streams and Puget Sound. Summer droughts, in turn, could spur more groundwater pumping when surface water is scarce. Such direct and indirect climate impacts, coupled with sea-level rise, could make Thurston County's coastal freshwater aquifers more vulnerable to water quality and quantity risks.

The direct impacts of saltwater intrusion and inundation on groundwater are likely to be greatest in places with low topographic relief and very low hydraulic gradients between freshwater and saltwater (e.g., downtown Olympia and Nisqually Valley).

In 1995, the City of Olympia applied to the state Department of Ecology to transfer its municipal water rights from McAllister Springs (pictured this page) to a new McAllister Wellfield (pictured next page), upslope of the springs. Engineers had deemed McAllister Springs — Olympia's primary water source at the time — susceptible to saltwater intrusion from nearby Puget Sound, as well as vulnerable to hazardous transportation spills and microbial contamination. ***Source:*** *City of Olympia*



Wells: Prolonged droughts raise the risk of concentrating contaminants in private water systems' shallow wells (less than 50-100 feet deep) — especially those at risk for saltwater intrusion or those with low productivity. Conversely, greater deluges raise the risks of overwhelming wastewater, septic, and stormwater conveyance systems and causing water-borne disease outbreaks in small community or private groundwater wells or other drinking water systems where water is untreated or minimally treated.

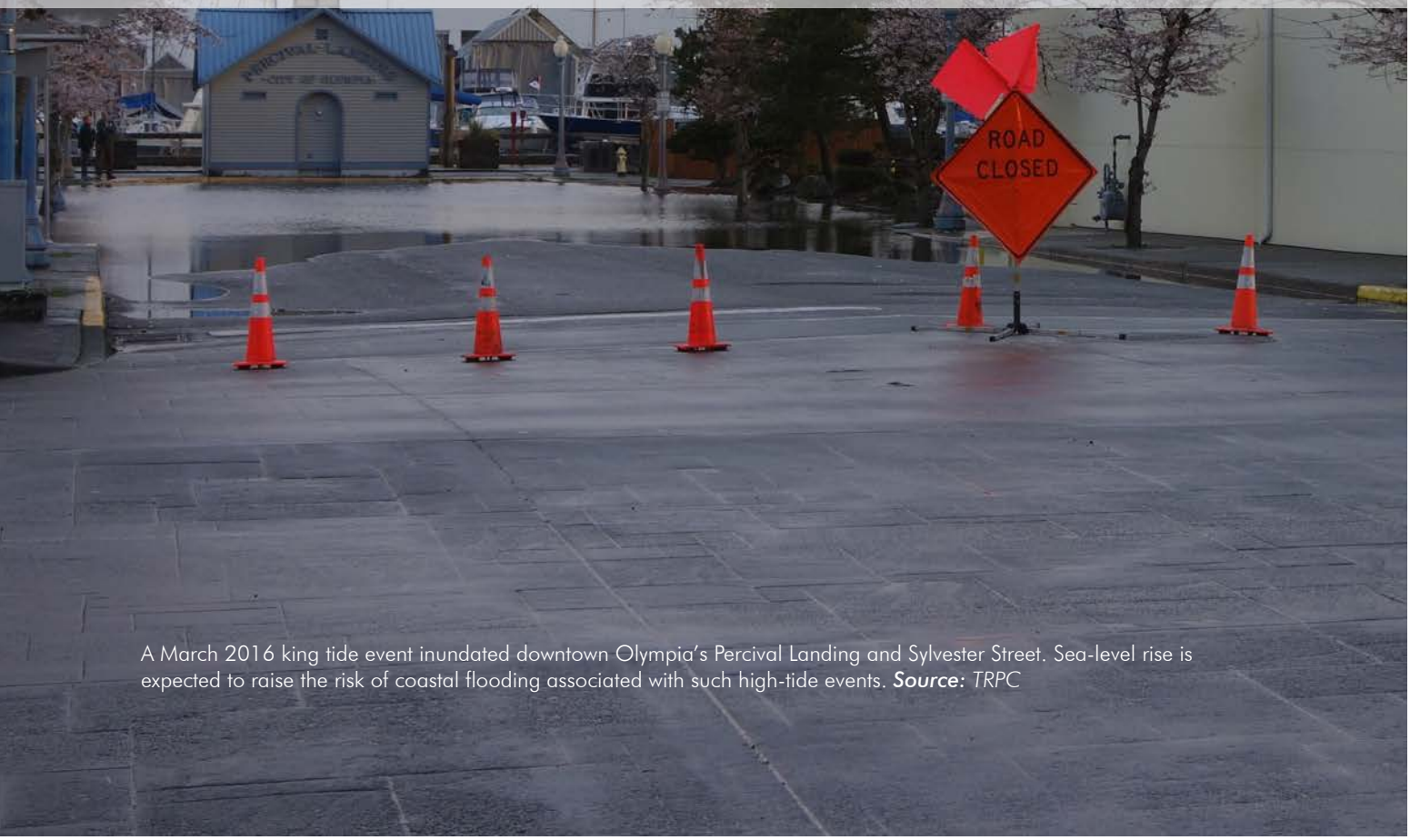
Water quantity vulnerability is expected to be highest in snow-influenced watersheds with existing conflicts over water resources (e.g., fully allocated watersheds with little management flexibility). Vulnerability would be lowest where hydrologic change is smallest (i.e., existing rain-dominant watersheds), where there are simple institutional arrangements, and where current water demand rarely exceeds supply.

McAllister Wellfield replaced McAllister Springs as the City of Olympia's primary source of drinking water. ***Source:*** *City of Olympia*

Marine Ecosystems

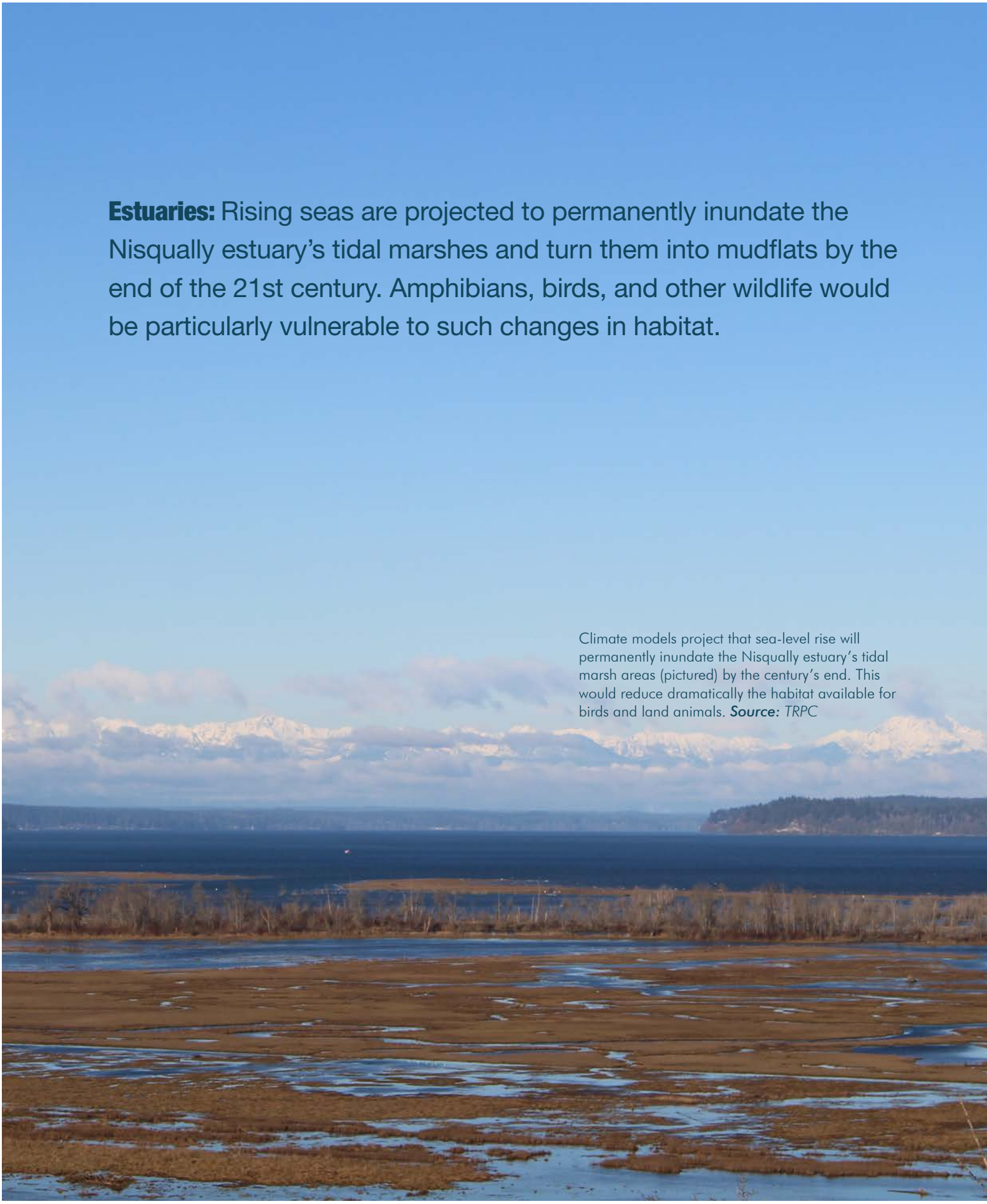
Sea-level Rise: The Puget Sound region is projected to experience continued, and possibly accelerated, sea-level rise in coming decades as a result of melting ice sheets and warmer oceans. This may result in permanent inundation of some low-lying areas, and increased frequency, depth, and duration of coastal flooding due to greater reach of tides and storm surges.

Downtown Olympia, part of which is built atop fill, floods today during high tides. Rising sea levels are projected to exacerbate this problem and increase the vulnerability of key roads, LOTT's Budd Inlet Treatment Plant, and other important assets. Vulnerable infrastructure along other parts of Thurston County's Puget Sound shoreline include low-lying homes, seawalls, and sections of Interstate 5 and U.S. Highway 101.

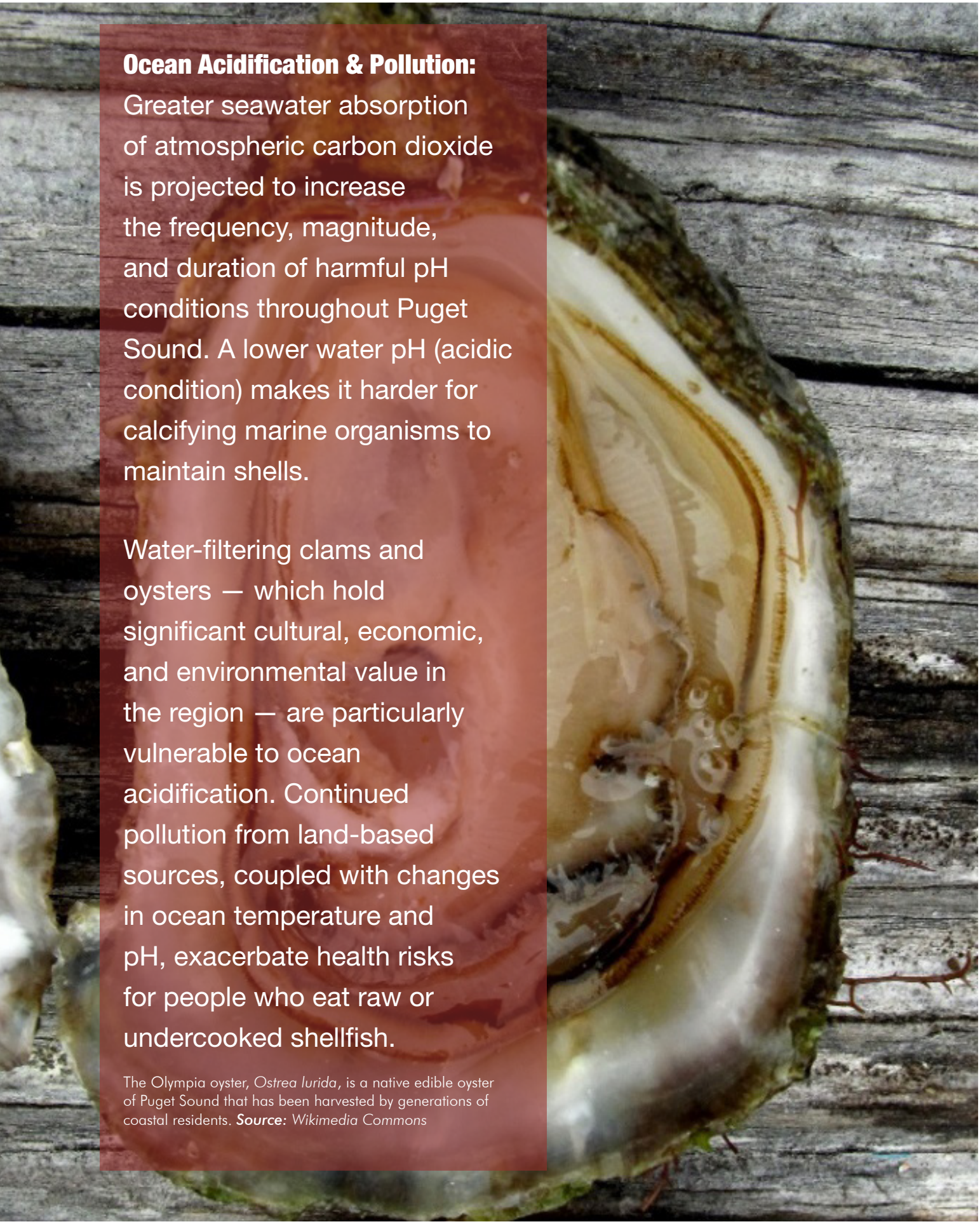


A March 2016 king tide event inundated downtown Olympia's Percival Landing and Sylvester Street. Sea-level rise is expected to raise the risk of coastal flooding associated with such high-tide events. ***Source:*** *TRPC*

Estuaries: Rising seas are projected to permanently inundate the Nisqually estuary's tidal marshes and turn them into mudflats by the end of the 21st century. Amphibians, birds, and other wildlife would be particularly vulnerable to such changes in habitat.



Climate models project that sea-level rise will permanently inundate the Nisqually estuary's tidal marsh areas (pictured) by the century's end. This would reduce dramatically the habitat available for birds and land animals. ***Source:*** *TRPC*



Ocean Acidification & Pollution: Greater seawater absorption of atmospheric carbon dioxide is projected to increase the frequency, magnitude, and duration of harmful pH conditions throughout Puget Sound. A lower water pH (acidic condition) makes it harder for calcifying marine organisms to maintain shells.

Water-filtering clams and oysters — which hold significant cultural, economic, and environmental value in the region — are particularly vulnerable to ocean acidification. Continued pollution from land-based sources, coupled with changes in ocean temperature and pH, exacerbate health risks for people who eat raw or undercooked shellfish.

The Olympia oyster, *Ostrea lurida*, is a native edible oyster of Puget Sound that has been harvested by generations of coastal residents. ***Source:*** *Wikimedia Commons*

Terrestrial Ecosystems

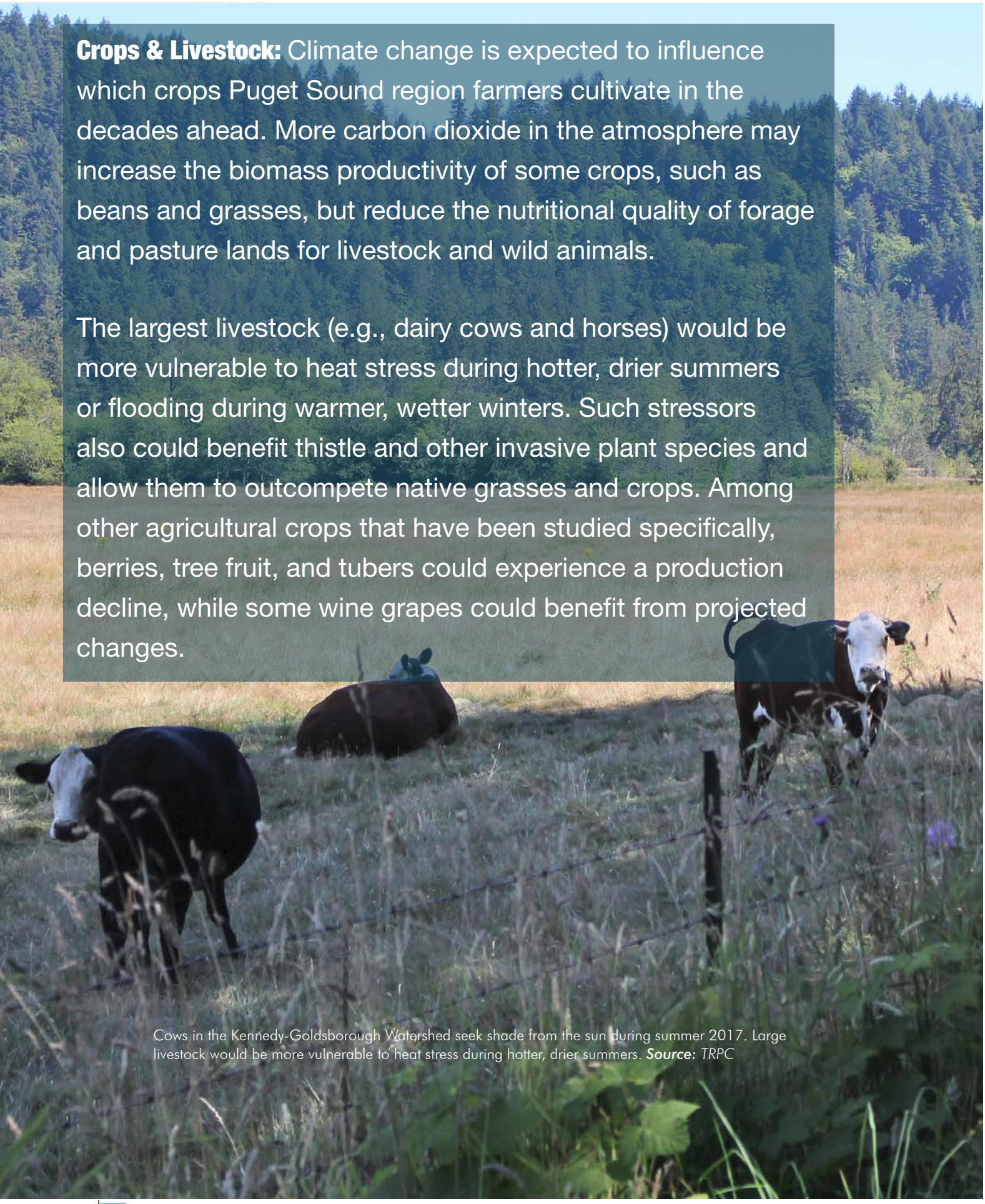
Farms & Ranches: Puget Sound's agricultural sector is expected to be relatively resilient to climate change — and some crops may even benefit from a longer growing season and more atmospheric carbon dioxide. However, periodic drought and flood events, as well as invasive pests and plants, still pose risks for local farms and ranches.

Sustained periods of low or no precipitation could make surface water supplies scarce, forcing farmers and ranchers to rely more heavily on groundwater for irrigating agricultural crops and watering livestock. Conversely, sustained periods of heavy rain, coupled with sea-level rise, could reduce the ability of drainage ditches and other infrastructure to handle flood events in near-coastal agricultural lands.

Young tomatos grow in a Lacey garden during summer 2013. ***Source:*** *TRPC*

Crops & Livestock: Climate change is expected to influence which crops Puget Sound region farmers cultivate in the decades ahead. More carbon dioxide in the atmosphere may increase the biomass productivity of some crops, such as beans and grasses, but reduce the nutritional quality of forage and pasture lands for livestock and wild animals.

The largest livestock (e.g., dairy cows and horses) would be more vulnerable to heat stress during hotter, drier summers or flooding during warmer, wetter winters. Such stressors also could benefit thistle and other invasive plant species and allow them to outcompete native grasses and crops. Among other agricultural crops that have been studied specifically, berries, tree fruit, and tubers could experience a production decline, while some wine grapes could benefit from projected changes.



Cows in the Kennedy-Goldsborough Watershed seek shade from the sun during summer 2017. Large livestock would be more vulnerable to heat stress during hotter, drier summers. ***Source:*** *TRPC*

Forests & Prairies: Climate change is projected to affect the region's forest and prairie vegetation growth, productivity, and range, as well as the prevalence and location of diseases, insects, and invasive species.

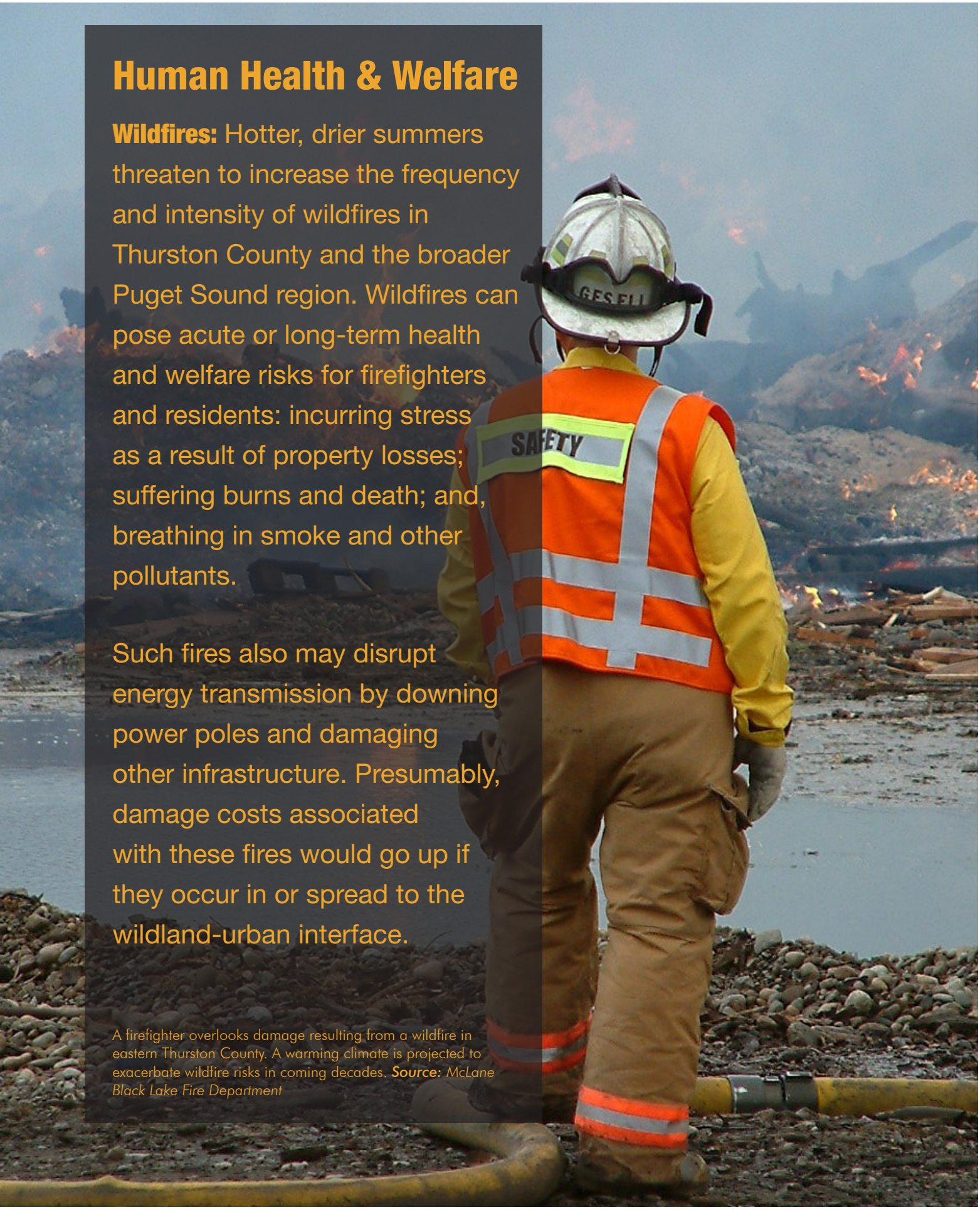
Shifts in seasonal temperature and precipitation threaten to alter the timing of flowering and the abundance of insect pollinators amid prairies, which could reduce some plant species. Such shifts also threaten to alter the range of Garry oak, Douglas-fir and other important tree species, as well as threaten their survival due to pest and disease outbreaks.

South Thurston County, as seen from Tumwater during summer 2013, appears as a sea of rolling blue ridges and towering green trees. Douglas-fir, which have thrived in the region's temperate climate, provide abundant natural capital. ***Source:*** *TRPC*

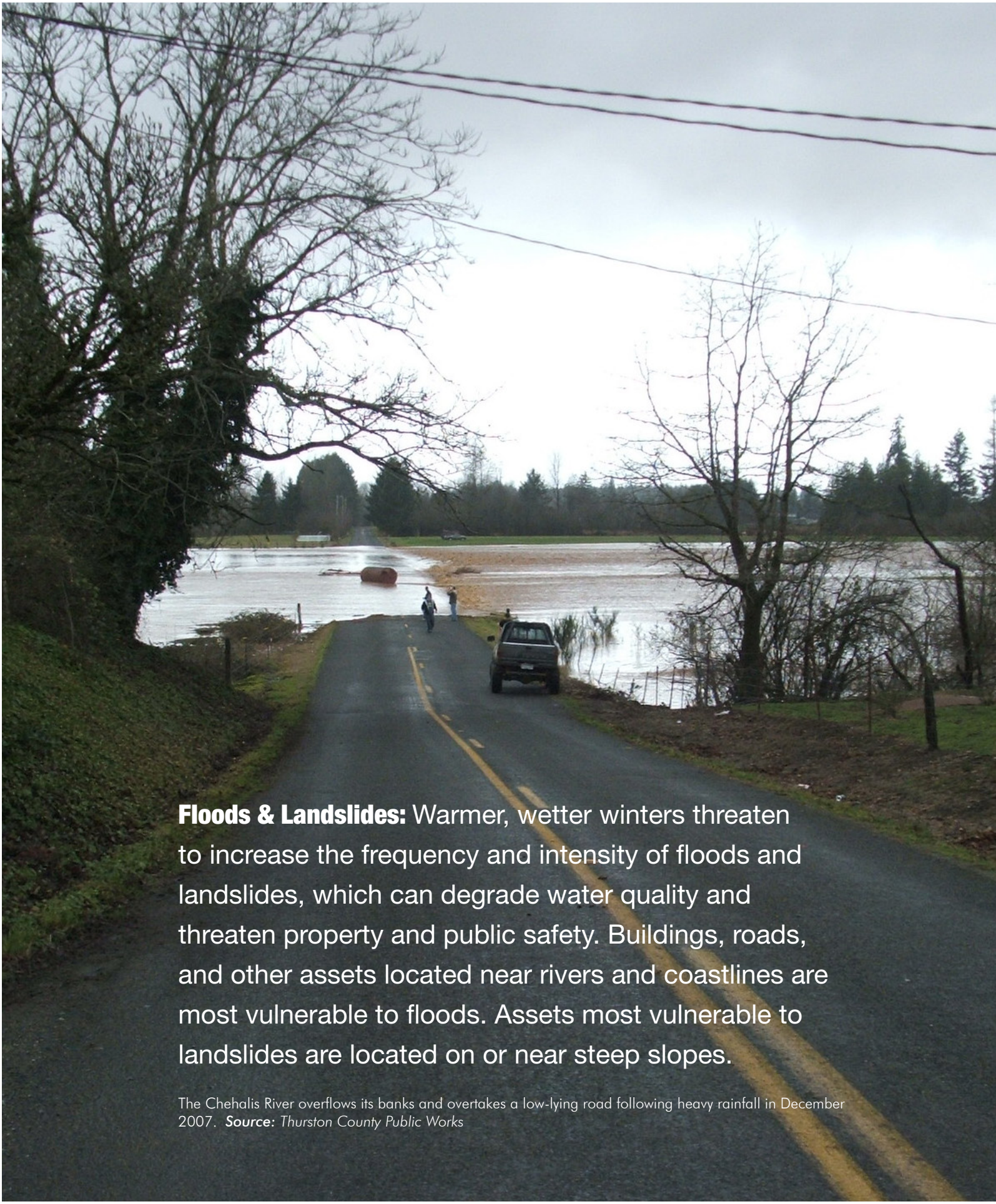
Human Health & Welfare

Wildfires: Hotter, drier summers threaten to increase the frequency and intensity of wildfires in Thurston County and the broader Puget Sound region. Wildfires can pose acute or long-term health and welfare risks for firefighters and residents: incurring stress as a result of property losses; suffering burns and death; and, breathing in smoke and other pollutants.

Such fires also may disrupt energy transmission by downing power poles and damaging other infrastructure. Presumably, damage costs associated with these fires would go up if they occur in or spread to the wildland-urban interface.



A firefighter overlooks damage resulting from a wildfire in eastern Thurston County. A warming climate is projected to exacerbate wildfire risks in coming decades. ***Source:*** *McLane Black Lake Fire Department*

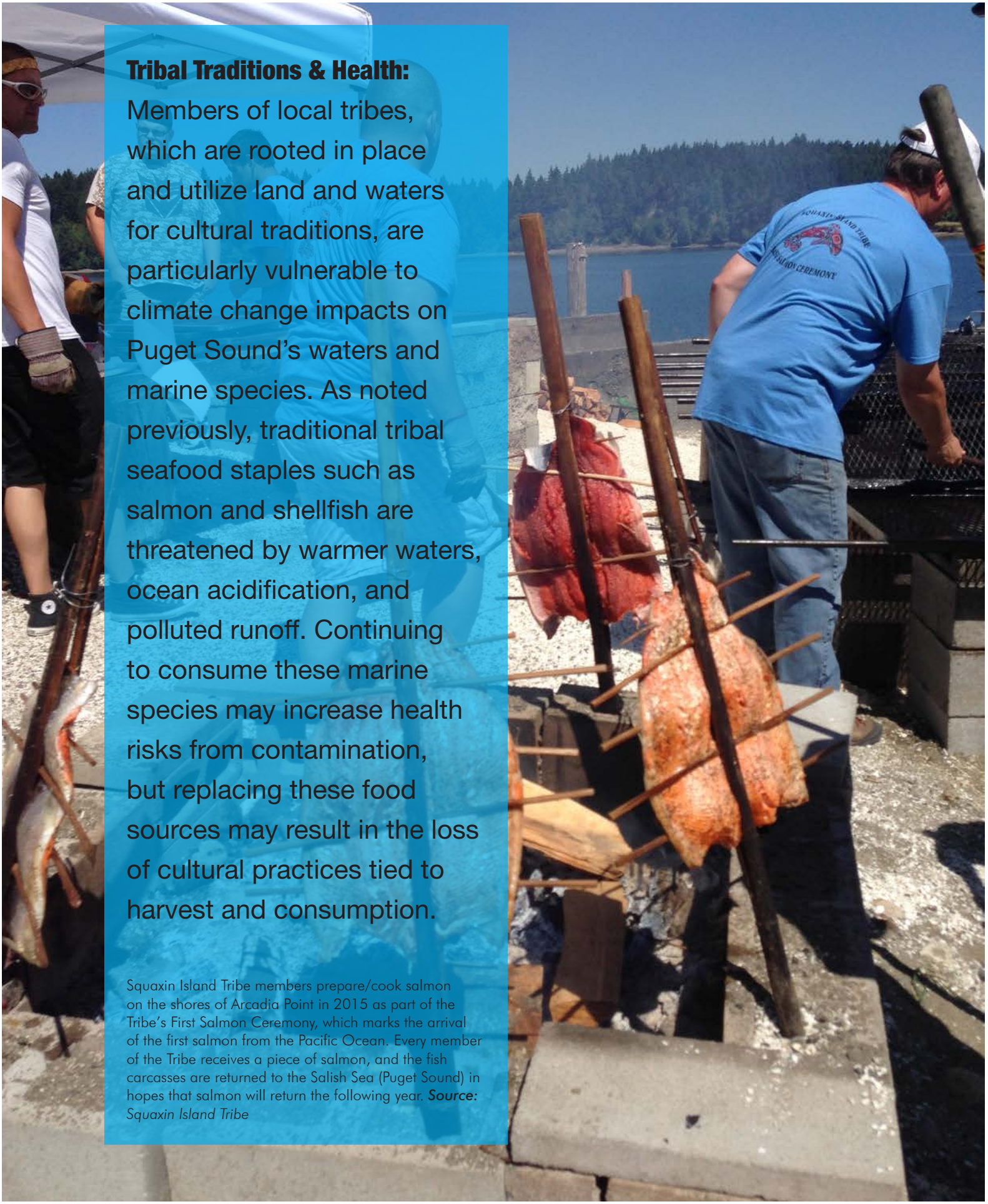


Floods & Landslides: Warmer, wetter winters threaten to increase the frequency and intensity of floods and landslides, which can degrade water quality and threaten property and public safety. Buildings, roads, and other assets located near rivers and coastlines are most vulnerable to floods. Assets most vulnerable to landslides are located on or near steep slopes.

The Chehalis River overflows its banks and overtakes a low-lying road following heavy rainfall in December 2007. ***Source:*** *Thurston County Public Works*

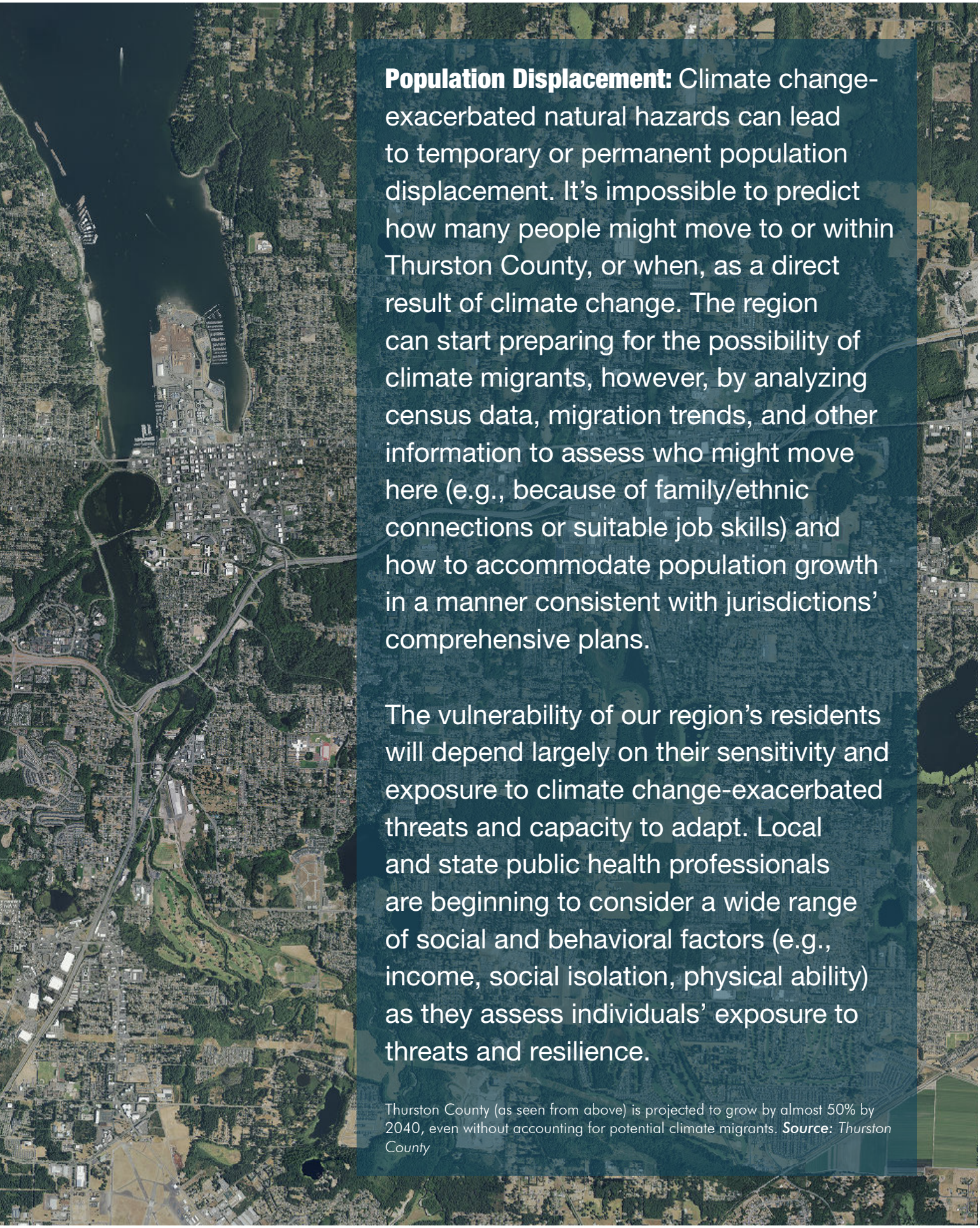
Disease Vectors: The shifts in temperature and precipitation noted previously are projected to exacerbate or introduce a wide range of threats, including infectious diseases from exposure to viruses and bacteria, which would affect human health outcomes. Exposure pathways include food, water, air, soil, trees, insects, and other animals.

A warming climate is expected to make western Washington more hospitable for mosquitos that carry West Nile Virus, which can cause a fatal neurological disease in humans. ***Source:*** *Thurston County Public Health & Social Services*



Tribal Traditions & Health: Members of local tribes, which are rooted in place and utilize land and waters for cultural traditions, are particularly vulnerable to climate change impacts on Puget Sound's waters and marine species. As noted previously, traditional tribal seafood staples such as salmon and shellfish are threatened by warmer waters, ocean acidification, and polluted runoff. Continuing to consume these marine species may increase health risks from contamination, but replacing these food sources may result in the loss of cultural practices tied to harvest and consumption.

Squaxin Island Tribe members prepare/cook salmon on the shores of Arcadia Point in 2015 as part of the Tribe's First Salmon Ceremony, which marks the arrival of the first salmon from the Pacific Ocean. Every member of the Tribe receives a piece of salmon, and the fish carcasses are returned to the Salish Sea (Puget Sound) in hopes that salmon will return the following year. ***Source:*** *Squaxin Island Tribe*



Population Displacement: Climate change-exacerbated natural hazards can lead to temporary or permanent population displacement. It's impossible to predict how many people might move to or within Thurston County, or when, as a direct result of climate change. The region can start preparing for the possibility of climate migrants, however, by analyzing census data, migration trends, and other information to assess who might move here (e.g., because of family/ethnic connections or suitable job skills) and how to accommodate population growth in a manner consistent with jurisdictions' comprehensive plans.

The vulnerability of our region's residents will depend largely on their sensitivity and exposure to climate change-exacerbated threats and capacity to adapt. Local and state public health professionals are beginning to consider a wide range of social and behavioral factors (e.g., income, social isolation, physical ability) as they assess individuals' exposure to threats and resilience.

Thurston County (as seen from above) is projected to grow by almost 50% by 2040, even without accounting for potential climate migrants. ***Source:*** *Thurston County*

4.3 Risk Assessment

TRPC's project team and Stakeholder Advisory Committee used U.S. EPA's *Being Prepared for Climate Change* workbook (EPA, 2014) to evaluate how risks identified by the vulnerability assessment [*See Section 4.2*] would affect the region's ability to achieve the 12 project goals [*See Section 3*]. The assessment, which resulted in a strategy for each risk, took about four months to complete.

Members of the Stakeholder Advisory Committee identify connections between climate risks and project goals during a fall 2016 meeting. ***Source:*** *TRPC*

Risk Identification

In October 2016, the project team and Stakeholder Advisory Committee identified how 85 risks intersect with the 12 project goals and eight climate stressors: Warmer Summer; Warmer Winter; Warmer Water; Increasing Drought; Intensifying Precipitation; Sea-Level Rise; Ocean Acidification; and, Population Change [*See Figure 10*].

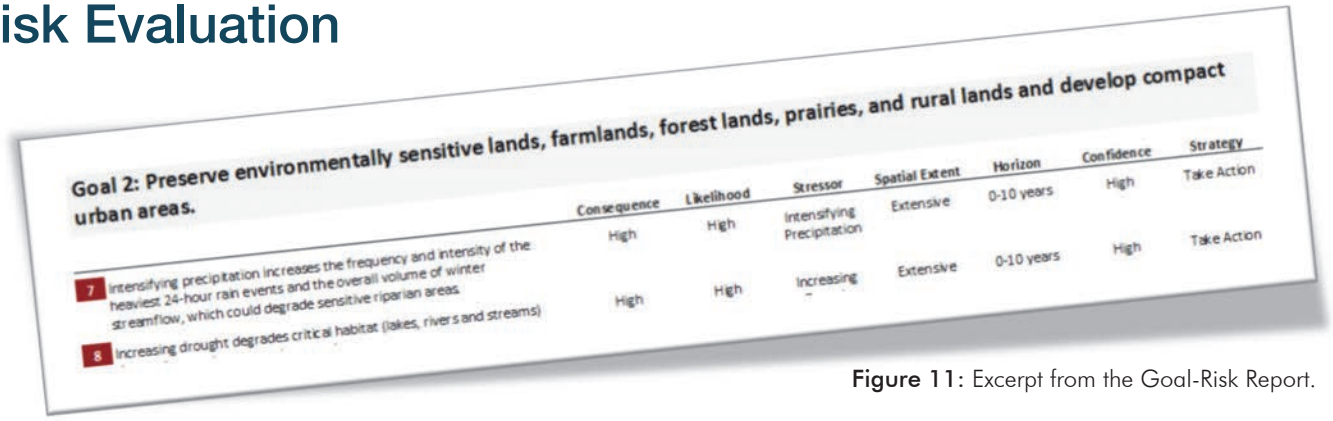
STRESSOR	DESCRIPTION
Warmer Summer	Encompasses the risks of the region's warm months (April-September) being warmer than they have been historically
Warmer Winter	Encompasses the risks of the region's cool months (October-March) being warmer than they have been historically
Warmer Water	Encompasses the risks of warming affecting the chemical, biological and/or physical characteristics of the region's freshwater and marine waterbodies during any season
Increasing Drought	Encompasses the risks of drought — a deficiency in precipitation over an extended period — increasing in frequency and intensity
Intensifying Precipitation	Encompasses the risks of rain events increasing in frequency and intensity
Sea-Level Rise	Encompasses the risks of Puget Sound's water levels rising
Ocean Acidification	Encompasses the risks of Puget Sound absorbing more atmospheric carbon dioxide
Population Change	Encompasses the risks that climate change will cause temporary or permanent population displacement

Figure 10: This table describes the eight climate stressors the project's Stakeholder Advisory Committee considered in its risk assessment.

Risk Analysis

In November 2016, the project team and its Stakeholder Advisory Committee used the vulnerability assessment's scientific research and modeling to analyze each risk's likelihood, consequence, spatial extent, and time horizon [*See Goal-Risk Report, Appendix C*].

Risk Evaluation



Goal 2: Preserve environmentally sensitive lands, farmlands, forest lands, prairies, and rural lands and develop compact urban areas.

	Consequence	Likelihood	Stressor	Spatial Extent	Horizon	Confidence	Strategy
7 Intensifying precipitation increases the frequency and intensity of the heaviest 24-hour rain events and the overall volume of winter streamflow, which could degrade sensitive riparian areas	High	High	Intensifying Precipitation	Extensive	0-10 years	High	Take Action
8 Increasing drought degrades critical habitat (lakes, rivers and streams)	High	High	Increasing	Extensive	0-10 years	High	Take Action

Figure 11: Excerpt from the Goal-Risk Report.

In January 2017, the project team placed each of the 85 risks in a matrix [*See Figure 12*] to show their consequence and likelihood.

Likelihood expressed the probability of impacts, given the climate modeling and research. Consequence expressed the severity of impacts, given local assets' risk exposure.

Thirty-nine risks of greatest impact fell in the matrix's upper-right third (red); 23 risks of lesser impact fell in the middle third (yellow); and, 23 risks of least impact fell in the lower-left third (green).

In February 2017, the Stakeholder Advisory Committee used the matrix to select a broad strategy — either *Take Action* or *Accept* — for each climate change risk.

- **Take Action** — means choosing to reduce the risk's impacts by recommending actions (new or continuing) and determining leads, partners, and timeframe. The Stakeholder Advisory Committee selected this strategy for all "red" risks and many "yellow" risks of high consequence or likelihood.
- **Accept** — means choosing to continue business as usual, monitor, and reassess the risk if impacts occur. The Stakeholder Advisory Committee selected this strategy for "green" and "yellow" risks of lesser consequence and/or likelihood.

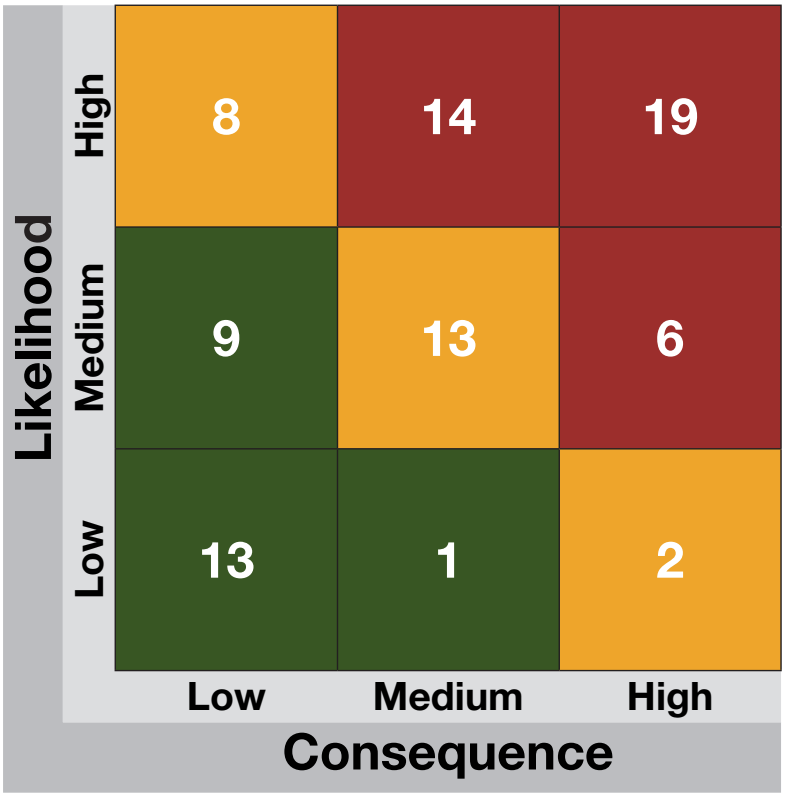
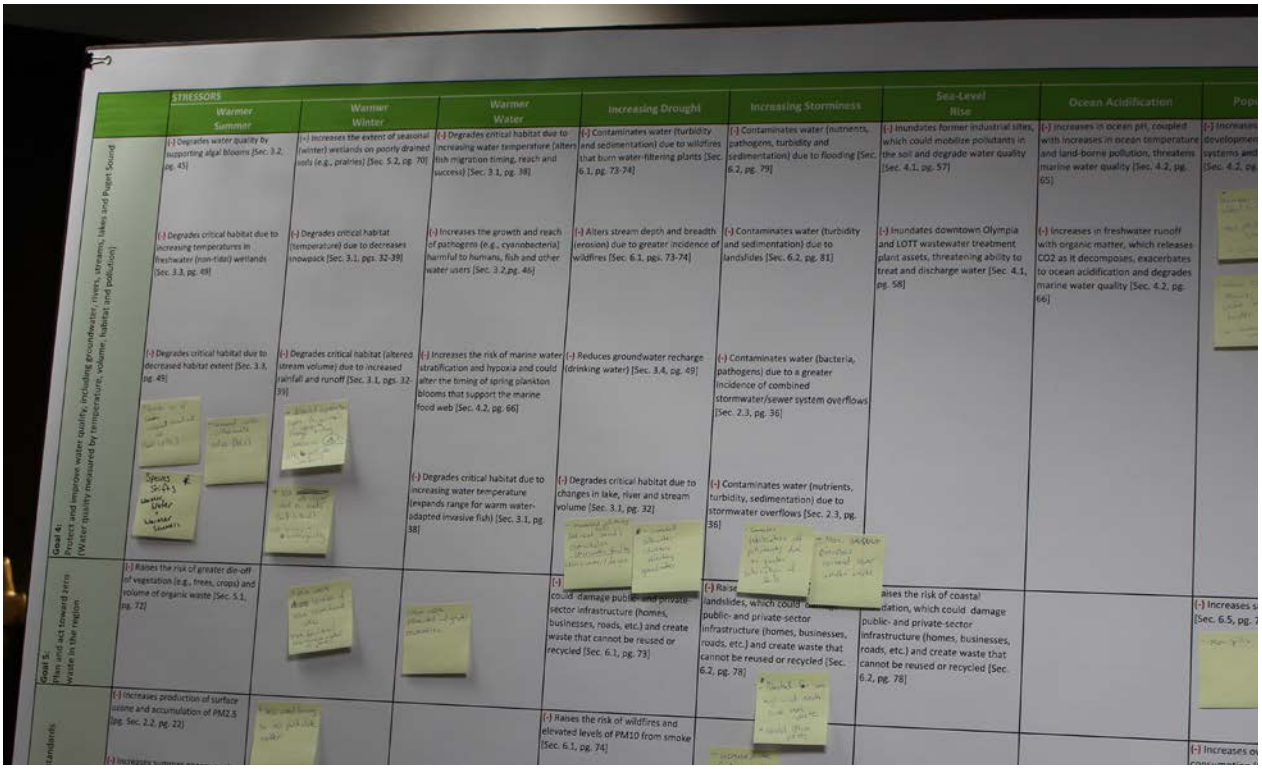


Figure 12: The Consequence/Likelihood Matrix enabled stakeholders to show the relative impact — low, medium, or high — of 85 climate risks. ***Source:*** *TRPC*



The project team created a grid (pictured) that enabled the Stakholder Advisory Committee to identify risks that intersect with project goals and climate stressors. ***Source:*** *TRPC*

4.4 Public Engagement

In early spring 2017, the project team began executing a public-engagement strategy [*See Appendix D*] to communicate the region's climate risks widely and elicit adaptation action ideas.

The project team met with more than 20 diverse organizations — ranging from the Black Hills Audubon Society and the South Thurston Economic Development Initiative, to the Nisqually River Council and the Thurston County Fire Chiefs Association. The project team also hosted a community forum and administered online surveys. TRPC promoted these events via an online video, newspaper editorial, social media, word-of-mouth, and other methods that reached more than 50,000 people.

The community forum and online survey enabled participants to learn about the region's climate risks and recommend adaptation and mitigation actions.

Figure 13: The project team used posters, including those pictured, at the April 2017 community forum to help communicate what climate risks the Thurston Region faces and what actions it could take to prepare for and adjust to climate impacts. ***Source:*** *TRPC*

PLANTS & ANIMALS

Changes in temperature and precipitation threaten the health and resilience of our region's plants and animals.

WHAT IS AT RISK:

- **Shellfish:** As the ocean becomes more acidic, shellfish have a difficult time developing shells.
- **Agriculture:** Crop yields and harvests can decrease or fail because summers are drier and hotter for longer periods of time.
- **Habitat:** Warmer summers stress sensitive plants and habitat. This can leave them more vulnerable to damage and disease caused by pests and pathogens.

WHAT WE CAN DO:

- **Marine Habitat:** Enhance marine vegetation (e.g., eelgrass) and reduce polluted runoff to help sustain local fisheries.
- **Freshwater Habitat:** Enhance streambank vegetation to slow erosion, provide shade and cool water for salmon.
- **Agriculture:** Increase options for urban farming, permaculture, and aquaponics. Provide incentives, education, and other resources for farmers to use more water-wise irrigation methods. Grow crops that are better adapted to warmer, drier summers.
- **Control Invasive Species:** Actively monitor, remove, and control the spread of invasive plants and insects. This means expanding existing programs.

TELL US YOUR IDEAS:

What additional actions can individuals and their communities take to reduce these risks and enhance resiliency? Please fill out a card at tonight's meeting or complete an online survey (www.trpc.org/climate).

TRANSPORTATION & ENERGY

Extreme storms can cause landslides, floods, and other hazards that damage roads, bridges and power lines, endanger lives, and cut off access to vital goods and services.

WHAT IS AT RISK:

- **Public Safety:** Collapsed hillsides, downed trees, and other hazards can hinder police and other emergency responders' access to residents.
- **Power Substations:** Extreme rain events, coupled with sea-level rise, can flood coastal power substations and cut off electricity to homes and businesses.
- **Bridges and Culverts:** Extreme rain events and stormwater runoff can scour streams, damage bridges, and block culverts with debris.
- **Energy Security:** Longer, hotter summers can reduce hydropower production and increase electricity demand to cool buildings. This raises the risk of power outages and increases the overall cost of energy.

WHAT WE CAN DO:

- **Emergency Preparedness:** Train residents to become more self-reliant and able to provide local assistance during emergencies when hazards cut off power and access for emergency responders.
- **Relocate Infrastructure:** Relocate or retrofit low-lying roads and energy infrastructure vulnerable to flooding.
- **Road Design:** Design and build stream culverts to accommodate higher peak streamflow.
- **Energy Efficiency:** Make new and existing buildings more energy efficient and generate renewable energy on site (e.g., rooftop solar).
- **Renewable Energy:** Build large renewable energy projects (e.g., wind farms) locally, and expand energy storage and transmission infrastructure to meet growing electricity demand.

TELL US YOUR IDEAS:

What additional actions can individuals and their communities take to reduce these risks and enhance resiliency? Please fill out a card at tonight's meeting or complete an online survey (www.trpc.org/climate).

WILDFIRES & EXTREME HEAT

Longer, hotter and drier summers can increase the number and severity of wildfire and extreme heat events. These risks have social, economic, and environmental costs.

WHAT IS AT RISK:

- **Infrastructure:** Wildfires can damage or destroy homes, power poles, forests, and other important buildings and infrastructure.
- **Human Health:** Extreme heat events make cities hotter, especially in densely developed areas. Hospitalizations and emergency service calls for heat-related illnesses place greater demands on the region's emergency medical services. The elderly and homeless are especially vulnerable.
- **Agriculture:** Extreme heat events can damage or kill crops and livestock.

WHAT WE CAN DO:

- **Extend Burn Ban:** Most wildfires are caused by people. Extend and enforce the rural burn ban during periods of drought and/or extreme heat.
- **Expand Wildfire Response:** Enhance training and financial support for wildfire response efforts.
- **Outreach and Education:** Increase public outreach and education efforts about how extreme heat and other climate impacts affect human health and welfare. Awareness can influence behavior.
- **Public Safety:** Increase the availability and community awareness of cooling shelters (e.g., schools and community centers) than can serve vulnerable and special-needs populations during the hottest days of the year.
- **Increase Tree Canopy:** Plant drought-tolerant trees and other landscaping that provide cooling shade. This also helps reduce the urban heat island effect, absorb stormwater, improve air quality, and reduce maintenance costs.
- **Agriculture:** Grow crops that are better suited to drier, warmer conditions.

FLOODING & EROSION

Rising sea levels and heavier rain events raise the risk of flooding, erosion, and landslides that threaten people, plants, and animals.

WHAT IS AT RISK:

- **Stormwater:** Heavier rainfall and runoff can overwhelm stormwater systems (e.g., roadside swales, drains, and pipes), especially in urban communities.
- **Wildlife Habitat:** Heavier rainfall and runoff can erode streambeds and streambanks and degrade sensitive habitat for fish and wildlife.
- **Roads and Homes:** Heavier rainfall and saturated soil can trigger landslides that endanger homes, roads, and lives near steep slopes. Sea-level rise and wave exposure raises such risks for coastal bluffs.
- **Marshes and Estuaries:** Sea-level rise can cause low-lying coastal areas to be under water more frequently and for longer periods of time. This can turn our region's coastal marshes and forests into mudflats and alter habitat for birds and other animals.

WHAT WE CAN DO:

- **Stormwater:** Design, install, and maintain stormwater infrastructure that can manage larger rain events, as well as capture and filter runoff on site (e.g., porous pavement, bioswales, rain gardens). Retrofit existing stormwater infrastructure.
- **Habitat Restoration:** Restore native trees, bushes, and other vegetation along freshwater and marine shorelines to help control flooding, stabilize banks, and filter out pollutants.
- **Stabilize Slopes:** Locate new homes and roads farther from steep slopes near lakes, rivers, streams, and Puget Sound. Maintaining trees and other vegetation helps slow the erosion of these areas.
- **Coastal Transition:** Remove or retrofit roads and other barriers to support the inland migration of coastal estuaries as sea levels rise.

TELL US YOUR IDEAS:

What additional actions can individuals and their communities take to reduce these risks and enhance resiliency? Please fill out a card at tonight's meeting or complete an online survey (www.trpc.org/climate).

People who attended the April 17 community forum at Lacey's South Sound Community College campus wrote what a resilient community means to them. ***Source:*** *TRPC*

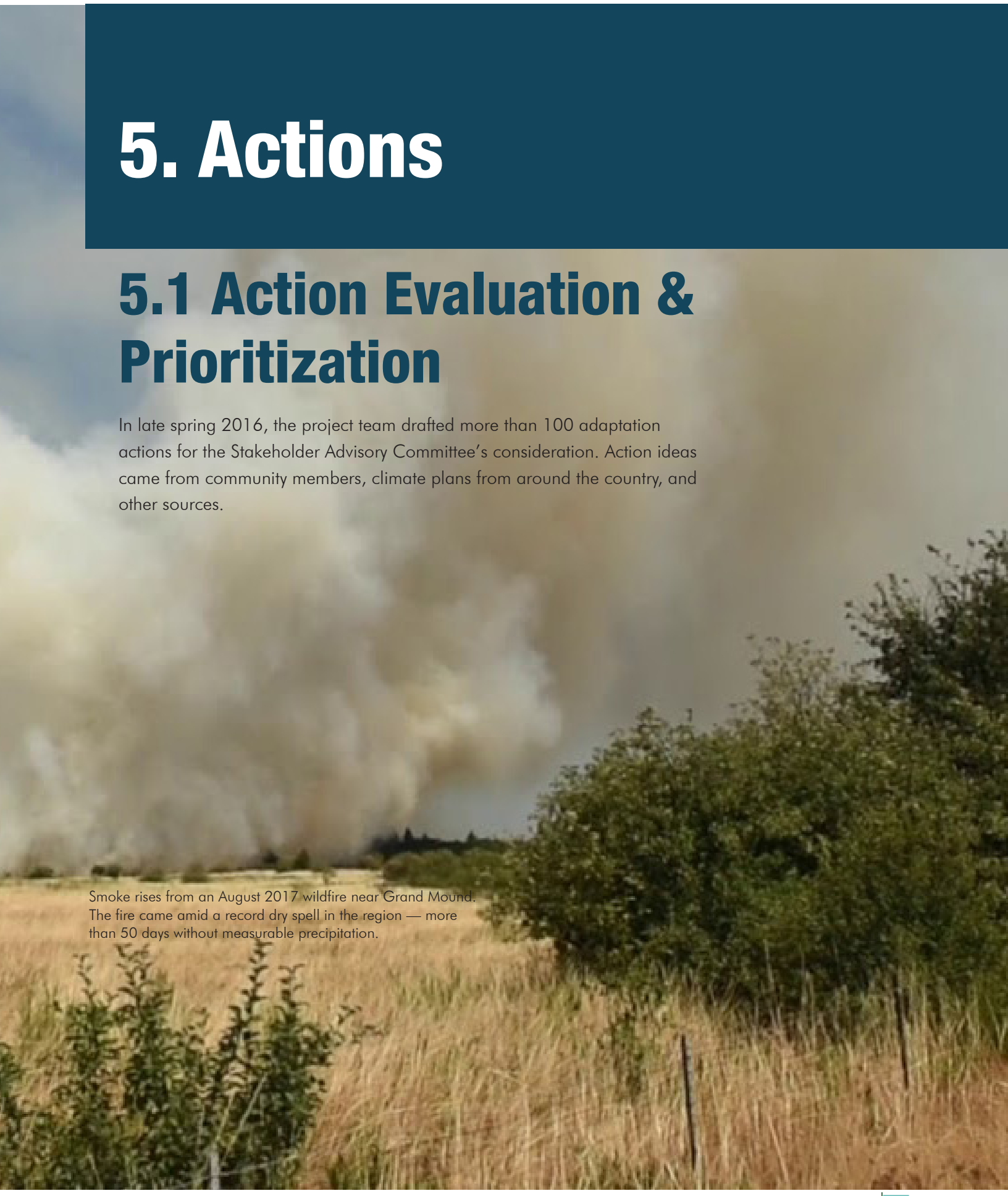
Figure 14: The comments above were collected during TRPC's April 2017 public forum in Lacey. The project team considered these and other comments for plan actions.


Provide young trees and bushes to homeowners by watershed creek/ river/etc.
Re-evaluate our landscaping designs and specs for low water use plants and retain trees.
Be prepared to relocate move intra-regionally or inter regionally.
Continue planting shade trees for riparian zones to help control summer water temps in streams and rivers to help protect fisheries.
Wildfire - fire safety regulations/ teaching. Extreme heat- Make this a "fun" and engaging concept.
Be wise - reduce driving! And stay home - flexible workplaces and schools.
Build with greater resilience in mind in how you site buildings and structures.
Business perspective. Intergrading community solar and workforce development. Non profit - group purchase of vehicles. Work force transitioning - new jobs.
Restore estuaries. Preserve mature woodlands and wildlife corridors.
More P.R. so more people really get this. Support local food supply and local reliant economics to inter regional transportation is not the only things we're relying on.
Teach youth/ people to withstand temps! Reserve energy systems for elderly and disabled. Encourage innovation by creating personalized community cooling and fire suppression systems.
Help neighborhoods maintain woods while also being safe.

5. Actions

5.1 Action Evaluation & Prioritization

In late spring 2016, the project team drafted more than 100 adaptation actions for the Stakeholder Advisory Committee's consideration. Action ideas came from community members, climate plans from around the country, and other sources.



Smoke rises from an August 2017 wildfire near Grand Mound. The fire came amid a record dry spell in the region — more than 50 days without measurable precipitation.

The Stakeholder Advisory Committee added, removed and revised actions. Next, the committee used common criteria [*See Figure 15*] to evaluate the actions and an online survey to prioritize them. This collaborative exercise yielded a final list of 91 adaptation actions, including 25 priority actions.

Criteria		Answer Range
Magnitude:	How many risks does this action address?	One, Few, or Many
Effectiveness:	Is this action a long-term solution (i.e., durable)?	Yes or No
	To what degree would this action reduce the risk(s)?	Low, Medium, High
	Is this action already being taken?	Yes or No
Side-effects:	Would this action have negative effects on other goals?	Yes or No
	Would this action have positive effects on other goals?	Yes or No
Equity:	Would the costs and benefits of this action be shared equally?	Yes or No

Figure 15: The project team assigned a positive or negative numeric value to each criterion, which resulted in a net score for each action. This exercise helped the stakeholder committee prioritize the actions. ***Source:*** *TRPC*

5.2 Action Tables

The action tables that follow include steps individuals, neighborhoods, cities, and the broader community can take to prepare for and adjust to adverse climate impacts — the very definition of "adaptation." The project's 22-member Stakeholder Advisory Committee drafted and prioritized the actions, incorporating the science-based vulnerability and risk assessments and community members' ideas.

The tables' "Lead" and "Partner" rows recommend community stakeholders who should take the action. The "Timeframe" row recommends when the community stakeholders should take the action. The "Stressor" row lists stressors (e.g., increasing drought) to which the action responds. See the actions legend at the end of this section [*page 89*] for a description of the lead, partner, timeframe, and stressor terms. See the Action-Risk Report (*Appendix E*) for the full list of the actions and the specific stressors and risks to which they respond.

The *Thurston Climate Adaptation Plan's* first and foremost action (*A-01, below*) calls for updating the plan periodically to ensure it remains a relevant reference tool for our region. In short, the adaptation plan must be adaptive.

A-01

Update the regional climate adaptation plan periodically with new information, evaluate implementation efforts and effectiveness, amend strategies and actions as necessary, and enhance community climate literacy (e.g., by working with schools, libraries, and other partners to enhance the public's understanding of climate change causes, impacts, and responses).

TRPC should update the plan every five years with new climate data (observed and projected) and community input to ensure that the plan remains a relevant reference tool for local policy makers and residents. As part of its adaptive management process, TRPC should track which actions the community takes and consider steps to overcome barriers to implementation and coordination.

LEAD: TRPC

PARTNER: All

TIMEFRAME: Short

STRESSOR: All

The remaining 90 actions are grouped into six thematic categories:

- General
- Drought & Water Quality
- Flood & Erosion
- Plants & Animals
- Transportation & Energy
- Wildfire & Extreme Heat

Actions marked with a star are "Priority Actions," as identified by the Stakeholder Advisory Committee. These are the most important actions the region should take to remain resilient.

While all actions are advisory recommendations, municipalities and other policymaking organizations may choose to adopt and integrate the actions into their respective codes and other regulations.

General Actions

The general actions that follow address a range of climate risks across several thematic categories. Such actions improve adaptation broadly by incorporating climate science into local planning and decision-making processes.

G-01

Direct government staff members to develop their technical expertise and skills to prepare for and respond to climate change impacts.

With clear policy direction from local and tribal government policymakers, staff members could invest in professional development that enhances their understanding of projected changes in the region's climate (e.g., air temperature and precipitation) and their impacts on municipal services and infrastructure. Staff members could use the skills and knowledge to protect human health and welfare, as well as adequately plan, design, build and maintain roads, culverts, and other assets.

LEAD: Cities/Towns, County, Tribes

PARTNER: State, Federal, TRPC

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought, Population Change, Warmer Winter

G-02

Create hazard recovery plans and prioritize the restoration of vital public safety facilities and other essential community assets (e.g., hospitals and major bridges).

As part of this action, ensure that all appropriate personnel — including municipal public works, planning, and public health workers — have adequate training and gear (e.g., reflective vests, hard hats, and agency vehicles) to respond to emergencies.

LEAD: Cities/Towns, County, Tribes

PARTNER: State, Residents, Fire Districts, LOTT, PSE, Port, Water Providers, Transit, Business Community, K-12, TRPC

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Warmer Summer, Increasing Drought

G-03

Pursue funding to implement highest-priority actions identified in the adopted Hazards Mitigation Plan for the Thurston Region.

This action would improve the region's resilience, its ability to recover more quickly and fully from hazards. Visit www.trpc.org/hazards to view a list of countywide and local partner actions.

LEAD: Cities/Towns, County, Federal, Fire Districts, Port

PARTNER: State, TRPC

TIMEFRAME: Underway (extensive)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought, Warmer Summer

G-04

Factor climate impacts into the planning of operations and the coordination of disaster response and recovery activities among first-responders, including public health, law enforcement, fire, and emergency medical services personnel.

Examples of activities include: updating emergency services communications equipment; enhancing training of emergency personnel and other responders; taking regular inventory of emergency facility needs (e.g., cooling centers and temporary shelters); assessing and improving the adaptive capacity of people who are most vulnerable to climate change-exacerbated hazards (e.g., people who are homeless, elderly, socially isolated, and/or live in high-risk areas).

LEAD: Cities/Towns, County, State, Federal, Fire Districts, Port, Water Providers, Transit, Tribes, K-12

PARTNER: TRPC

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Warmer Summer, Increasing Drought

G-05

Assess potential climate change-induced population migration within and to the Thurston Region, and evaluate response strategies.

This action could entail assessing who in the region is most vulnerable to temporary or permanent displacement (e.g., low-income or socially isolated residents who may be forced to move because of climate-exacerbated hazards) and what resources they might need. This action also could entail assessing who is most likely to move to the region and how to accommodate them in ways consistent with community values. For example, this could be done by studying "chain migration" (the tendency of migrants to follow those of similar ethnicity, language or job skillset), as well as by evaluating such migrants' needs and where/how much growth should occur so that it's consistent with local comprehensive plans. TRPC could integrate such analysis into its periodic population and employment forecasts. For more information, visit: http://www.trpc.org/236/Population-Employment-Forecasting.

LEAD: TRPC

PARTNER: Cities/Towns, County, Development Community

TIMEFRAME: Long

STRESSOR: Increasing Drought, Population Change

G-06

Create a household preparedness plan and store of food, water, and other supplies (lanterns, bicycles, etc.) to use in case a flood or other hazard cuts off access to goods, services, and emergency responders.

Municipalities, neighborhood associations, and their partners (e.g., the American Red Cross) can encourage these household preparedness practices by enhancing outreach and incentives. See TRPC's online Resilience Toolkit (www.trpc.org/climate/resiliencetoolkit) for links to preparedness resources.

LEAD: Residents

PARTNER: Cities/Towns, County, State, Nonprofits, Neighborhoods

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought

G-07

Identify a neighborhood site (e.g., a school, house of worship, or other location that's safe, accessible, and well-known) to serve as a temporary coordination center for local hazard response and recovery efforts, and publicize the hub's location widely.

This action could help increase household and neighborhood resilience, in the event that police and fire personnel cannot provide immediate assistance. Households and their broader neighborhoods could work with municipal agencies (e.g., through neighborhood and sub-area plans) and nonprofits (e.g., the American Red Cross) to plan, select, and publicize emergency coordination sites.

LEAD: Neighborhoods, Residents

PARTNER: Cities/Towns, County, Nonprofits, Tribes, Fire Districts

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Warmer Summer, Increasing Drought

G-08

Encourage neighborhoods to become familiar with residents who have skills and tools to assist others with special needs (e.g., elderly or disabled), should residents need to provide emergency response in the event that police and fire personnel cannot provide immediate assistance.

Programs such as "Map Your Neighborhood" are effective ways to develop maps and inventories/directories of neighborhood assets. [Thurston County Emergency Management Map Your Neighborhood: http://www.co.thurston.wa.us/em/MYN/MYN.htm]

LEAD: Cities/Towns, County, Fire Districts, Tribes

PARTNER: Neighborhoods, Residents

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Warmer Summer, Increasing Drought

G-09

Encourage residents to organize or participate in regular emergency preparedness, response, and recovery planning and training events.

Such events can include neighborhood potlucks with disaster drills, skills sharing, and discussions about hazards (extreme heat, wildfires, etc.) with local emergency responders.

LEAD: Cities/Towns, County, Fire Districts, Tribes

PARTNER: Residents

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Population Change, Warmer Summer

G-10

Increase the number of residents who receive Community Emergency Response Team (CERT) training to improve local hazard preparedness, response, and recovery efforts. Ensure such efforts are ongoing.

This action would help increase household and neighborhood resilience, in the event that police and fire personnel cannot provide immediate assistance.

LEAD: Cities/Towns, County, Tribes

PARTNER: State, Residents, Fire Districts

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Warmer Summers, Increasing Drought

G-11

Factor climate impacts into the full life-cycle costs of roads, buildings, parks, and other assets — from their initial siting and design to their ongoing operations and maintenance.

The Thurston Climate Adaptation Plan, which should be updated periodically by TRPC [See Action A-01], will serve as a regional reference guide for understanding local climate impacts and asset risks. By considering such impacts (e.g., projected sea levels), public- and private-sector property owners will be better able to protect their assets and reduce operations and maintenance costs.

LEAD: All

PARTNER: --

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Population Change, Increasing Drought

G-12

Increase incentives to make urban infill and redevelopment projects more viable financially.

Incentives could include, but are not limited to, tax credits and fee waivers for infill and redevelopment projects, as well as stormwater control transfer programs (e.g., Redmond, Washington's stormwater mitigation banking program).

Infill and redevelopment projects within urban centers and corridors inside of the urban growth areas enhance residents' resilience by providing better access to transportation options and services (e.g., food stores, hospitals, and emergency responders). Such projects also have potential climate mitigation benefits, enabling residents to drive fewer miles and reduce their greenhouse gas emissions.

LEAD: Cities/Towns, State, Federal, Tribes

PARTNER: County, Nonprofits, Residents, Higher Education, Port, Transit, Business Community, K-12, TRPC, Development Community

TIMEFRAME: Long

STRESSOR: Increasing Drought, Intensifying Precipitation, Population Change

G-13

Align land use, hazard mitigation, transportation, capital improvement, and other plans so that they take into account climate change and work toward the same goals.

This action, in which TRPC could take the lead as a coordinating body, would help ensure consistent interjurisdictional and interagency planning and policymaking with regard to climate change mitigation and adaptation.

LEAD: Cities/Towns, State, TRPC, Federal, Tribes, County

PARTNER: Nonprofits, Residents, Higher Education, Port, Transit, Business Community, K-12, Development Community

TIMEFRAME: Short

STRESSOR: Increasing Drought, Intensifying Precipitation, Population Change

G-14

Expand ability to predict drought and flood events by tracking soil moisture, streamflow, precipitation, groundwater levels, tide levels, well levels, reservoir levels, and weather forecasts.

The City of Olympia proposes working with the Port of Olympia and the U.S. Geological Survey (USGS) to establish a tide gauge in Olympia.

Additionally, the National Oceanic & Atmospheric Administration (NOAA) hosts the online Water Resources Dashboard — which includes maps and data that can help local resource managers monitor for the potential for extreme precipitation and drought events: https://toolkit.climate.gov/topics/water-resources/water-resources-dashboard.

LEAD: County, Cities/Towns

PARTNER: State, Federal, Higher Education, Tribes, TRPC, Water Providers

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Increasing Drought, Intensifying Precipitation, Warmer Summer, Warmer Winter

G-15

Create a website that details health risks exacerbated by climate change and provides information that helps residents prepare for and respond to drought, poor air quality, extreme heat, disease vectors, and other threats.

This action would improve the region's climate literacy and resilience.

LEAD: County

PARTNER: Cities/Towns, State, Federal, Higher Education, Tribes, TRPC

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Increasing Drought, Intensifying Precipitation, Warmer Summer, Warmer Winter

G-16

Develop a countywide disaster debris management plan with actions to dispose of or recycle materials (organic and artificial) efficiently after a disaster.

This action would improve the region's resilience, its ability to recovery quickly and fully from hazards.

LEAD: County

PARTNER: Cities/Towns, PSE, State, Federal, Tribes, Residents, Business Community, Agricultural Community

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought, Population Change

G-17

Advocate for expanding the eligibility of federal disaster-assistance funding to allow for the replacement or relocation of aging or vulnerable infrastructure before it fails.

This includes facilities such as water infrastructure, fire stations, transportation infrastructure, emergency coordination shelters, and buildings that are used as emergency shelters.

LEAD: County, Cities/Towns

PARTNER: PSE, State, Federal, Tribes, Residents, Business Community, Agricultural Community

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought, Population Change

G-18

Limit access to parks, lakes, and other outdoor recreation areas when natural hazards (e.g., algal blooms, wildfires, floods) pose risks to public safety.

This action would help protect public health and welfare.

LEAD: Cities/Towns, County

PARTNER: Residents

TIMEFRAME: Underway (extensive)

STRESSOR: Sea-Level Rise, Increasing Drought, Intensifying Precipitation, Warmer Water, Warmer Winter

Drought & Water Quality Actions

Projected shifts in seasonal precipitation and temperature (e.g., warmer, wetter winters and hotter, drier summers) threaten the region's water quality and quantity. Impacts include:

- **Groundwater:** Bigger winter storms can result in more runoff and less infiltration into aquifers. Summer droughts, in turn, could spur more groundwater pumping. Such direct and indirect climate impacts, coupled with sea-level rise, make Thurston County's water resources more vulnerable to water quality and quantity risks.
- **Surface water:** Changes in water volume and temperature threaten to scour streams and spur algal blooms that can degrade critical habitat for fish and wildlife, including salmon.

The following actions can help the region reduce and respond to these and other climate impacts identified through the project's vulnerability and risk assessments.

D-01

Develop and implement a comprehensive drought-response strategy that sets action levels for different drought stages.

Thurston County experienced moderate or more extreme drought conditions in the summer months nine out of the last sixteen years, including the last three consecutive years. Climate change and population growth will exacerbate these water shortages. A possible funding source for this action is the Washington Department of Ecology's Watershed Planning Implementation and Flow Achievement grant; the next funding cycle is 2019-2021.

LEAD: Cities/Towns, County

PARTNER: State, Federal, Neighborhoods, Fire Districts, LOTT, Water Providers, Business Community, Tribes, TRPC

TIMEFRAME: Short

STRESSOR: Increasing Drought

D-02

Evaluate and secure sustained funding to support long-term monitoring of ground and surface water quality and quantity.

This action includes enhancing monitoring of water volume, temperature, and pollution in streams, lakes, and Puget Sound. Existing resources include:

The state Department of Ecology measures changes in the Puget Sound lowland streams and urban shoreline areas as a result of stormwater management: www.ecy.wa.gov/programs/wq/stormwater/municipal/rsmp/status.html.

Thurston County conducts data analysis and regular monitoring of specific lakes, rivers, and streams: www.co.thurston.wa.us/health/ehswat/swater.html.

LEAD: Cities/Towns, County, Water Providers, Tribes

PARTNER: Federal, State, TRPC

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Warmer Summer, Increasing Drought

D-03

Increase reuse of reclaimed water for irrigating plants, supplementing low streamflow, and other purposes.

In the north Thurston County area, the LOTT Clean Water Alliance produces reclaimed water. LOTT's partner cities — Lacey, Olympia, and Tumwater — operate reclaimed water utilities and purvey the water to customers for reuse.

LOTT develops reclaimed water production capacity based primarily on the need for additional treatment capacity in the wastewater system. Other community needs, such as climate resilience, can influence planning for additional reclaimed water.

Because reclaimed water must be conveyed in a separate purple pipe network, distribution and reuse is generally limited to areas within close proximity to existing reclaimed water pipelines. Decisions about the expansion of the distribution line network are generally made by the partner cities' utilities. Significant cost is involved in adding reclaimed water production capacity and expanding the distribution system. Local and outside funding committments may be necessary.

LEAD: Cities/Towns, LOTT

PARTNER: County, Neighborhoods, Residents, Higher Education, Business Community

TIMEFRAME: Long

STRESSOR: Increasing Drought, Population Change

D-04

Conduct benefit-cost analyses of adaptation actions that conserve water resources.

Benefit-cost analyses (BCAs), also commonly called cost-benefit analyses, would provide Thurston Region policymakers an important economic tool for evaluating water-conservation actions, including those in this plan [See Drought & Water Quality actions].

LEAD: TRPC

PARTNER: All

TIMEFRAME: Short

STRESSOR: Increasing Drought, Population Change

D-05

Increase the number of water rights that are transferred to a trust, temporarily or permanently.

This action would be measurable and could involve a variety of leads and partners. Washington's Trust Water Rights Program provides a way for the State to legally hold water rights for future uses without the water right relinquishing. Water rights holders may sell, lease, or donate their unused capacity to the program. The Department of Ecology, guided by RCW 90.42.40, holds the water rights in a trust to support instream flows and other beneficial uses. Water rights that are donated or leased temporarily to Ecology retain their original priority date while held in the trust. Water rights that are sold permanently to Ecology are retired. For more information, visit ecy.wa.gov/programs/wr/market/waterbank.html.

LEAD: County, State, Tribes

PARTNER: Nonprofits, Residents, Agricultural Community, Property Owners

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Population Change

D-06

Set up a water bank in Thurston County's watersheds to enable water rights trading that supports conservation.

Thurston County does not currently have an active water bank for its watersheds. Under RCW 90.42.40, however, communities in the Yakima River, Columbia River, Dungeness River, and Walla Walla River watersheds have set up water banks for buying and selling water rights. In Walla Walla's water bank, for example, the Walla Walla Watershed Management Partnership buys water rights and then divides them into exempt well mitigation credits for sale to prospective water users. Thurston County could explore creating a similar partnership.

LEAD: County

PARTNER: Cities/Towns, State, Nonprofits, Residents, Development Community, Agricultural Community

TIMEFRAME: Medium

STRESSOR: Increasing Drought, Population Change

D-07

Implement tiered water pricing.

This action, in which municipal water customers pay more per gallon as they use more, would provide a clear price signal and support conservation.

LEAD: Cities/Towns

PARTNER: Business Community

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Population Change

D-08

Increase incentives for water conservation during dry months.

This action would investigate and implement additional incentives that could be offered, including for outdoor use and for properties on private water systems or wells.

LEAD: Cities/Towns, County, Water Providers

PARTNER: Residents, Business Community, Agricultural Community

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Population Change

D-09

Incentivize new commercial construction to include on-site rainwater harvesting facilities.

This action would reduce runoff and provide a source of water for irrigating plants and flushing toilets.

LEAD: Cities/Towns, County

PARTNER: Water Providers, Business Community, K-12

TIMEFRAME: Long

STRESSOR: Increasing Drought, Intensifying Precipitation, Population Change

D-10

Install efficient plumbing fixtures and equipment in buildings so as to conserve water.

The Uniform Plumbing Code, part of the Washington State Building Code, sets maximum water consumption levels for new faucets, toilets, showerheads, and other plumbing fixtures in buildings.

The LOTT Clean Water Alliance provides free water-saving kits (showerheads, leak-detection kits, etc.) to rate-payers within its Lacey, Olympia and Tumwater service area. LOTT also provides rebates to residential, commercial, industrial, and institutional rate-payers who install water-saving toilets, appliances, and other equipment. For more information, visit http://lottcleanwater.org/programs.

LEAD: Residents, Higher Education, Business Community, Development Community, Property Owners

PARTNER: LOTT, Cities/Towns, County

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Population Change

D-11

Evaluate and offer new incentives for residents to install rain gardens on well-draining soils and plant drought-tolerant landscaping (e.g. xeriscaping) to adapt to changes in seasonal precipitation.

Incentives can include utility rebates or credits. [U.S. EPA has published a handbook with "Water-Smart" landscaping tips for rain gardens and other parts of the yard: https://www3.epa.gov/watersense/docs/water-efficient_landscaping_508.pdf]

LEAD: Cities/Towns, County, Nonprofits

PARTNER: State, Higher Education

TIMEFRAME: Long

STRESSOR: Warmer Summer, Intensifying Precipitation, Increasing Drought

D-12

Construct new water-storage systems (e.g., large cisterns, water towers, and reservoirs) to provide back-up water supplies during droughts.

Per state law (RCW Title 90), a municipality or other party would need state approval to store and withdraw water that exceeds its allocated water rights.

LEAD: Cities/Towns, County, Water Providers, Tribes

PARTNER: State, Federal, Nonprofits, Residents, Agricultural Community

TIMEFRAME: Short

STRESSOR: Increasing Drought, Population Change

D-13

Expand Thurston County's septic system operation and maintenance education and outreach programs.

Climate models project more frequent and intense rain storms, which could oversaturate drain fields around septic tanks and cause them to flood, overflow, and release pollutants into surface waters. A 2016 report by Thurston County and TRPC — Deschutes Watershed Land Use Analysis: Scenario Development Report — estimated that it would cost about $43,000 annually to administer a voluntary septic system operation and maintenance program in the Deschutes Watershed alone.

LEAD: County

PARTNER: Cities/Towns, Nonprofits, Neighborhoods, Residents

TIMEFRAME: Short

STRESSOR: Warmer Water, Population Change, Intensifying Precipitation

D-14

Reduce zoning density (i.e., "downzone") and lower limits for impervious surfaces on parcels near streams and lakes with nutrient-loading problems.

When considering whether to take this action, which would mitigate the combined impacts of water pollution and warming, government agencies should consider whether it would result in more impervious surfaces elsewhere.

LEAD: Cities/Towns, County, Tribes

PARTNER: Neighborhoods, Residents, Development Community, Agricultural Community, Property Owners

TIMEFRAME: Underway (extensive)

STRESSOR: Increasing Drought, Warmer Water, Population Change, Intensifying Precipitation, Warmer Winter

D-15

Facilitate new residential water connections to municipal sources, where feasible.

This action would help protect water quality and quantity.

LEAD: Cities/Towns, County

PARTNER: Residents, Development Community, LOTT

TIMEFRAME: Short

STRESSOR: Increasing Drought, Population Change

D-16

Incentivize water metering for all wells.

Metering all wells, either through voluntary or regulatory means, would help fill water usage data gaps and provide water managers with information they can use to ensure there is sufficient supply to meet demand (water for people, fish, and other users).

Every municipal water supplier in Washington — i.e., Group A water systems with at least 15 service connections — must install a source meter that shows total system production, as well as install service meters that show authorized consumption for each connection (e.g., a single-family home). All new Group B water systems — those with multiple, but fewer than 15 connections, often in less-urbanized areas — must install a source meter as well.

Most of Thurston County's Group B systems have source meters, in compliance with state law, but such systems are not required to report their production data to state and local governments. Few of Thurston County's Group B systems have individual service meters, which are not required by state law.

About a quarter of Thurston County's wells are considered "permit-exempt" and are not in a Group A or B water system. Washington's groundwater permit exemption (RCW 90.44.050) allows for single or group domestic well water use up to 5,000 gallons per day without first obtaining water right permits.

LEAD: County, Water Providers

PARTNER: State, Residents, Agricultural Community

TIMEFRAME: Short

STRESSOR: Increasing Drought, Population Change

D-17

Establish a local non-regulatory entity to provide technical assistance to private well owners regarding conserving water and detecting leaks and pollution.

This action would help protect water quality and quantity.

LEAD: Cities/Towns, County, Water Providers, TRPC

PARTNER: State, Nonprofits, Neighborhoods, Residents, Agricultural Community

TIMEFRAME: Short

STRESSOR: Increasing Drought, Sea-Level Rise, Population Change

Flood & Erosion Actions

Projected rising sea levels and heavier rain events increase the risk of flooding, erosion, and landslides that threaten people, plants, and animals. Impacts include:

- **Stormwater:** Heavier rainfall and runoff can overwhelm stormwater systems (e.g., roadside swales, drains, and pipes), especially in urban communities.
- **Wildlife Habitat:** Heavier rainfall and runoff can erode streambeds and streambanks and degrade sensitive habitat for fish and wildlife.
- **Roads and Homes:** Heavier rainfall and saturated soil can trigger landslides that endanger homes, roads, and lives near steep slopes. Sea-level rise and wave exposure magnify risks for coastal bluffs.
- **Marshes and Estuaries:** Sea-level rise can cause low-lying coastal areas to be under water more frequently and for longer periods of time. This can turn our region's coastal marshes and forests into mudflats and alter habitat for birds and land animals.

The following actions can help the region reduce and respond to these and other climate impacts identified through the project's vulnerability and risk assessments.

F-01

Evaluate and secure sustained funding to restore and protect riparian vegetation along freshwater and marine shorelines.

Plant buffers stabilize banks, provide shade and flood storage, slow and filter polluted runoff, store carbon emissions, and enhance air quality. A local government, for example, could add a vegetation surcharge to its stormwater utility rate to fund restoration of these riparian areas.

LEAD: Cities/Towns, County, Nonprofits, Tribes, TCD

PARTNER: State, Federal, Residents, Development Community, Agricultural Community

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought, Warmer Winter, Warmer Water

F-02

Incorporate projected sea-level rise and flooding information into the designation of regulatory hazard areas.

Development and activities typically are required to be set back and/or buffered from regulated hazard areas, such as floodplains, marine shorelines, and high groundwater areas, which are determined by historic water level information. This action could involve updating regulations to better reflect projections about how water levels may change (e.g., the Ordinary High Water Mark [OHWM], the 100-year floodplain or channel migration area) in order to ensure new homes and other development are located and/or designed appropriately for future conditions.

LEAD: Cities/Towns, County, Tribes

PARTNER: Residents, Development Community, Property Owners

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise

F-03

Design new and replacement stream culverts and other drainage infrastructure to accommodate projected higher peak flows associated with more frequent and intense heavy precipitation events.

This action would improve fish passage and reduce flooding that occurs when debris blocks culverts. Additional funding could help Thurston County address problematic culverts more quickly.

LEAD: Cities/Towns, County, State

PARTNER: Nonprofits, K-12 Neighborhoods, TCD, Tribes, Development Community

TIMEFRAME: Short

STRESSOR: Intensifying Precipitation

F-04

Install flood gates and pumps on stormwater outfalls connected to Puget Sound to mitigate back-ups during high tides and heavy rains exacerbated by rising seas.

This action, to be considered as part of the City of Olympia's sea-level rise response strategy for downtown (2018), would help reduce flooding and its impacts on public budgets and mobility.

LEAD: Cities/Towns, County, State

PARTNER: --

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation

F-05

Build floodwalls or other protective structures around critical facilities located in areas vulnerable to flooding as a result of sea-level rise and heavy precipitation.

This action will be considered as part of the City of Olympia's sea-level rise response strategy for downtown (2018). Local policymakers could utilize best available science to evaluate site-specific responses, which could include walls, berms, or other "hard" or "soft" structures. As a follow-up to this action, policymakers could identify and set aside areas to receive critical facilities that could be moved at the end of their useful lifespan.

LEAD: Cities/Towns, County, LOTT, Port, Tribes

PARTNER: Development Community

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation

F-06

Require that new or renovated buildings utilize flood-protection measures (such as raised finished-floor levels and temporary flood barriers) to accommodate projected sea-level rise over the structures' lifespan.

Chapter 16.80 of the Olympia Municipal Code, which focuses on reducing damage from sea-level rise, requires that all new buildings have the lowest floor (including basement) protected from flooding or elevated to 16 feet or greater. Other parts of the county could replicate this requirement.

LEAD: Cities/Towns, County, Tribes

PARTNER: Development Community, State

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation

F-07

Increase education and enforcement efforts to ensure that commercial and residential building owners properly maintain low-impact development (LID) facilities that treat stormwater runoff on site.

Washington's municipal stormwater permit directs recipients to make LID the "preferred and commonly used approach to site development," where feasible. Such facilities, even those on private property, must be maintained properly to reduce stormwater runoff, flooding, and water pollution.

LEAD: Cities/Towns, County, Tribes

PARTNER: Nonprofits, Neighborhoods, Residents, Higher Education, K-12

TIMEFRAME: Short

STRESSOR: Intensifying Precipitation, Increasing Drought, Population Change

F-08

Assess drinking water wells' vulnerability to saltwater intrusion and inundation from rising sea levels, and develop adaptation measures (e.g., relocating wells).

This action would help ensure drinking water supplies are sustainable.

LEAD: Cities/Towns, County, Water Providers, Tribes

PARTNER: State

TIMEFRAME: Long

STRESSOR: Sea-Level Rise

F-09

For sites where elevating or relocating a building is not a viable option in response to flood risks, acquire the property, use the land for appropriate uses (e.g., flood storage or agriculture), and help the occupants resettle in the community.

This action would help protect public welfare and physical assets while mitigating flood risks.

LEAD: Cities/Towns, County

PARTNER: State, Federal, Residents, Business Community, Agricultural Community

TIMEFRAME: Medium

STRESSOR: Sea-Level Rise, Intensifying Precipitation

F-10

Implement brownfield clean-up strategies/planned actions for low-lying sites that are most vulnerable to sea-level rise.

This action would reduce the risk of water contamination from polluted coastal sites that become inundated with seawater.

LEAD: Cities/Towns, State

PARTNER: County, Business Community

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise

F-11

Protect important historical or cultural sites that are at risk of coastal or inland flooding, erosion, and wildfires.

Options can include allowing inundation of the site, relocating the structure, or stabilizing the site's shoreline with vegetation, rip-rap or other materials.

LEAD: Cities/Towns, County, State, Tribes

PARTNER: Residents

TIMEFRAME: Long

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought

F-12

Limit construction of buildings and roads in areas where flood and landslide risks are highest.

This action would reduce the risk of infrastructure damage from floods and landslides exacerbated by changes in precipitation timing, type and volume.

LEAD: Cities/Towns, County, Tribes

PARTNER: State, Federal

TIMEFRAME: Underway (extensive)

STRESSOR: Sea-Level Rise, Intensifying Precipitation

F-13

Identify where and how the region could support the natural inland transition of coastal lowlands to estuaries as sea levels rise.

Supportive actions can include modifying artificial barriers such as roads, as well as purchasing vulnerable properties (e.g., low-lying agricultural lands) that could transition to estuaries over time.

LEAD: State, Federal, Tribes

PARTNER: Nonprofits, Residents, Agricultural Community, Property Owners, County, Cities/Towns

TIMEFRAME: Long

STRESSOR: Sea-Level Rise

F-14

Construct flood-storage facilities (e.g., wetlands or artificial ponds) upstream of concentrated development areas that are at risk of flooding.

This action would reduce the risk of flooding and protect downstream built and natural assets.

LEAD: Cities/Towns, County, Tribes

PARTNER: Nonprofits, Agricultural Community

TIMEFRAME: Long

STRESSOR: Intensifying Precipitation

F-15

Minimize development, disturbance, and vegetation removal on or near steep slopes (>25% gradient) adjacent to waterbodies.

This action would reduce the risks of landslides and sediment runoff.

LEAD: Cities/Towns, County, State, Tribes

PARTNER: Federal, Residents, TRPC, Development Community

TIMEFRAME: Short

STRESSOR: Sea-Level Rise Intensifying Precipitation

F-16

Retrofit or reroute pedestrian/bicycle trails and bridges in areas that are subject to repetitive flooding and/or landslides.

This action would help protect public welfare.

LEAD: Cities/Towns, County

PARTNER: State

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation

F-17

Decouple remaining combined storm and sewer systems, where cost-effective, so as to add capacity and mitigate back-ups and water-borne disease outbreaks.

This action would help protect the LOTT Clean Water Alliance's downtown Olympia treatment plant from marine water inundation during coastal flood events exacerbated by rising seas and heavy rains. Marine water would kill the plant's biological water-treatment process.

LEAD: Cities/Towns, LOTT

PARTNER: --

TIMEFRAME: Long

STRESSOR: Sea-Level Rise, Intensifying Precipitation

Plants & Animals Actions

Projected changes in temperature and precipitation threaten the health and resilience of our region's plants and animals. Impacts include:

- **Shellfish:** As the ocean becomes warmer and more acidic, shellfish have a harder time developing shells. Land-borne pollution can exacerbate such threats and make shellfish toxic and dangerous to consume.
- **Agriculture:** Crop yields and harvests can decrease or fail when summers are drier and hotter for longer periods of time. Extreme heat and flooding also threatens cattle, horses, and other large livestock.
- **Vegetation:** Warmer, drier summers can stress sensitive plants and habitat, including riparian vegetation and urban landscaping. This can leave them more vulnerable to extreme heat, pests, and pathogens.
- **Salmon:** Changes in stream temperature and volume can threaten critical habitat for juvenile salmonids that develop in streams and ocean-going adults that return to spawn.

The following actions can help the region reduce and respond to these and other climate impacts identified through the project's vulnerability and risk assessments.

P-01

Increase funding, education, and incentives for private landowners to manage lands in ways that enhance ecological and economic resilience (e.g., protecting and restoring forests, prairies, and shoreline/riparian areas).

Incentives can include expanding Thurston County's Transfer of Development Rights (TDR) program, conservation easement funding, as well as expanding market-based approaches for ecosystem service payments or credits (e.g., for water quality, carbon sequestration and flood management).

LEAD: Cities/Towns, County, State, Higher Education, Tribes, TCD

PARTNER: Nonprofits, Neighborhoods, Residents, Agricultural Community

TIMEFRAME: Long

STRESSOR: Warmer Water, Warmer Winter, Increasing Drought, Intensifying Precipitation, Warmer Summer, Population Change, Ocean Acidification

P-02

Use best-management practices, such as installing large woody debris in rivers, to improve water temperature, streamflow, and channel conditions.

Placing large woody debris in rivers alters the flow of water, digs out cooler pools for fish to rest, and creates sediment-free riffles for fish to spawn. It will be necessary to choose proper sites and structures that do not cause flooding.

LEAD: State, Nonprofits

PARTNER: County, Residents, Tribes, Agricultural Community, TCD

TIMEFRAME: Underway (limited)

STRESSOR: Intensifying Precipitation, Increasing Drought, Warmer Winter

P-03

Create/Update basin plans that integrate climate impacts, and include goals and targets for protecting natural resources and habitat.

This action would ensure that region continues to assess how climate change affects watersheds and takes measurable steps to protect the water, plants (e.g., riparian areas), and animals within.

LEAD: Cities/Towns, County, Tribes, TRPC

PARTNER: State, Residents, Development Community, Agricultural Community

TIMEFRAME: Short

STRESSOR: Increasing Drought, Warmer Winter, Warmer Summer, Sea-Level Rise, Ocean Acidification, Population Change, Warmer Water, Intensifying Precipitation

P-04

Implement monitoring practices that provide early detection of invasive species on land and in water, and expand biological control and manual removal of such plants and insects.

This action would help halt the spread of invasive plant and insect species that thrive in a warmer climate.

LEAD: Cities/Towns, County, State, Federal, Higher Education

PARTNER: Nonprofits, Neighborhoods, Agricultural Community

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Winter, Warmer Water

P-05

Evaluate additional assisted migration of vulnerable plant and animal species to suitable habitat.

This action would help ensure species survival as changes in temperature and precipitation shift the location of suitable habitat.

LEAD: County, State, Federal, Higher Education, Tribes

PARTNER: Nonprofits, Residents, Development Community

TIMEFRAME: Underway (limited)

STRESSOR: Intensifying Precipitation, Increasing Drought, Warmer Summer, Warmer Winter

P-06

Expand efforts to monitor the cause and extent of changes in native and invasive plant distribution.

This action would help land managers select and implement effective actions to ensure the survival of native plants.

LEAD: County, State, Higher Education

PARTNER: Residents

TIMEFRAME: Short

STRESSOR: Increasing Drought, Warmer Summer, Warmer Winter, Warmer Water

P-07

Increase organic matter content and water retention in soils within urban and agricultural settings.

Integrating perennials into cropping systems such as grass forages, cover cropping, compost application and conservation tillage help improve water infiltration and storage, as well as increase soil organic matter content and carbon sequestration.

LEAD: Residents, Agricultural Community

PARTNER: Higher Education, TCD

TIMEFRAME: Short

STRESSOR: Increasing Drought, Warmer Summer, Intensifying Precipitation

P-08

Increase urban agriculture and biointensive farming methods to maximize crop yields and ecosystem services.

Municipalities and their partners can encourage such practices by providing technical support and incentives.

LEAD: Agricultural Community

PARTNER: Cities/Towns, County, Nonprofits, Neighborhoods, K-12, Higher Education

TIMEFRAME: Short

STRESSOR: Increasing Drought, Warmer Summer, Intensifying Precipitation, Warmer Winter, Population Change

P-09

Protect and enhance marine vegetation, such as eelgrass, so as to help clean water, sequester carbon dioxide, and improve fish habitat and survival.

The Nisqually estuary has Thurston County's only significant eelgrass beds.

LEAD: County, State, Federal, Port, Tribes

PARTNER: Nonprofits, Neighborhoods, Residents, Agricultural Community, Property Owners

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Ocean Acidification

P-10

Educate waterfront property owners about the benefits of voluntary oyster seeding and other shellfish production, and encourage such practices.

This action would help improve water quality and sustain the region's shellfishery, which are threatened by ocean acidification and land-borne pollution.

LEAD: State, Tribes, Business Community

PARTNER: Federal, Nonprofits, Higher Education, County

TIMEFRAME: Long

STRESSOR: Warmer Water, Increasing Drought, Sea-Level Rise, Ocean Acidification

P-11

Support Voluntary Stewardship Program (VSP) implementation to encourage conservation of agricultural lands and critical areas (e.g., riparian stream buffers) that provide ecosystem services.

Under the VSP program, which was created via state law, Thurston County works with landowners to develop voluntary, site-specific plans to protect critical areas on agricultural lands.

LEAD: County, TCD

PARTNER: Residents, Higher Education, Agricultural Community

TIMEFRAME: Underway (limited)

STRESSOR: Intensifying Precipitation, Increasing Drought, Warmer Winter

P-12

Grow woody perennial crops that help conserve water, store carbon, and provide other ecosystem services.

This action — which includes planting fruit trees and other crops whose woody stems and branches don't die off each winter — has both climate adaptation and mitigation co-benefits.

LEAD: Residents, Agricultural Community

PARTNER: --

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Summer, Warmer Winter

Transportation & Energy Actions

Projected extreme precipitation events threaten to increase the frequency and intensity of floods, landslides, and other hazards that damage roadways and power lines, endanger lives, and cut off access to vital goods and services. Impacts include:

- **Public Safety:** Collapsed hillsides, downed trees, and other hazards can hinder police and other emergency responders' access to residents.
- **Power Substations:** Extreme rain events, coupled with sea-level rise, can flood coastal power substations and cut off electricity to homes and businesses.
- **Bridges and Culverts:** Extreme rain events and stormwater runoff can scour streams, damage bridges, and block culverts with debris.
- **Energy Security:** Longer, hotter summers can reduce hydropower production and increase electricity demand to cool buildings. This raises the risk of power outages and increases the overall cost of energy.

The following actions can help the region reduce and respond to these and other climate impacts identified through the project's vulnerability and risk assessments.

T-01

Expand and retrofit the region's energy distribution, monitoring, and storage infrastructure to support more on-site renewable energy generation.

Bolstering the region's electricity distribution, monitoring, and storage infrastructure to handle more on-site renewable energy generation (e.g., solar panels on residential rooftops) would provide a hedge against the risk of service disruptions as a result of storms and blackouts.

LEAD: PSE, State

PARTNER: Federal

TIMEFRAME: Short

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought, Warmer Summer

T-02

Provide additional utility incentives to support energy efficiency and renewable energy investments in buildings.

Thurston County's electric utility, Puget Sound Energy, could offer new incentives to help building owners cover the cost of investing in energy efficiency (e.g., installing new windows and insulation) and installing solar panels, small-scale wind turbines, and other equipment that generates electricity on site from clean, renewable resources.

Washington state law allows "on-bill" financing, for example, in which an electric utility provides a loan to the owner of a commercial or residential building to invest in on-site renewable energy generation and efficiency upgrades. The borrower, which pays back the loan on its electric bill, saves money over time as it reduces its need for utility-provided electricity. This, in turn, reduces pressure on the utility to invest in generation from new sources (e.g., coal and natural gas power plants).

LEAD: PSE, State. Federal

PARTNER: Business Community, Property Owners

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Summer

T-03

Offer additional utility rebates or bill credits to induce residents to buy and install energy-efficient appliances and other equipment.

Thurston County's electric utility, Puget Sound Energy, could provide residential rate-payers additional financial incentives to buy and install energy-efficient light bulbs, clothes dryers, air conditioners, and other equipment that saves energy and lowers bills. To enhance equity, PSE could increase incentives for low-income renters and homeowners.

LEAD: PSE, State, Federal

PARTNER: Property Owners, Business Community

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Summer

T-04

Evaluate strategies to protect important electrical equipment that is within critical areas at risk of flooding and/or landslides.

Examples of such critical electrical equipment include underground power lines and low-elevation substations near the Puget Sound shoreline. Strategies could include elevating, reinforcing, or relocating such equipment.

LEAD: PSE

PARTNER: --

TIMEFRAME: Long

STRESSOR: Sea-Level Rise, Intensifying Precipitation

T-05

Map transportation infrastructure that is vulnerable to repeated floods and/or landslides, and designate alternative travel routes for critical transportation corridors when roads must be closed because of natural hazards.

Integrate this lifeline transportation route map's data into the Thurston County Emergency Operations Plan and other local planning efforts.

LEAD: TRPC

PARTNER: Cities/Towns, County, State, Fire Districts, Tribes

TIMEFRAME: Underway (extensive)

STRESSOR: Sea-Level Rise, Intensifying Precipitation

T-06

Relocate or retrofit low-lying roads vulnerable to coastal or inland flooding.

This action, for example, could include relocating or raising Interstate 5 at the Nisqually estuary and U.S. Highway 101 at Mud Bay (e.g., building taller, longer bridges). Such near-shore areas are vulnerable to coastal flooding exacerbated by sea-level rise and heavy precipitation.

LEAD: Cities/Towns, County, State

PARTNER: Federal

TIMEFRAME: Long

STRESSOR: Sea-Level Rise, Intensifying Precipitation

T-07

Increase the energy efficiency of the region's water infrastructure.

This action includes replacing pumps and other drinking water, wastewater, and stormwater systems that consume large amounts of energy.

LEAD: Cities/Towns, County, LOTT, Water Providers

PARTNER: PSE

TIMEFRAME: Underway (limited)

STRESSOR: Sea-Level Rise, Intensifying Precipitation, Increasing Drought

T-08

Build additional large-scale renewable energy projects (e.g., utility-scale solar arrays and wind farms) in Thurston County.

Such clean-energy projects offset demand for electricity from polluting fossil fuels (coal and natural gas) and hydropower — which is vulnerable to less summer precipitation/lower streamflow.

LEAD: PSE, Business Community

PARTNER: State

TIMEFRAME: Long

STRESSOR: Increasing Drought, Warmer Summer

T-09

Establish energy goals/benchmarks (e.g., LEED) for new buildings, and adopt permitting practices and building code and/or design guidelines that support clean and efficient energy practices and technologies (e.g., passive design, rooftop solar panels, electric vehicle charging stations).

This action, which could be taken by tribal, state or local governments, would reduce building electricity consumption and demand/costs for utility-provided power.

LEAD: Cities/Towns, County, State, Tribes

PARTNER: PSE, Business Community, Development Community

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Summer, Intensifying Precipitation

T-10

Expand utility outreach to and education of commercial and residential power customers about the benefits of clean and efficient energy technologies and practices.

Generating electricity from clean, renewable resources (e.g., the wind and sun) — and using electricity more efficiently — helps reduce the region's greenhouse gas emissions that contribute to global climate change. Such actions also offset demand for electricity Puget Sound Energy gets from polluting fossil fuels (coal and natural gas) and hydropower — which is vulnerable to less summer precipitation/lower streamflow.

LEAD: PSE

PARTNER: Cities/Towns, County, State

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Summer

T-11

Develop and adopt policies that require residential and commercial properties to undertake an energy audit at the time of sale or during a substantial remodel.

Tribes or local governments could require such energy audits. If the energy audits identify deficiencies, regulators could recommend energy retrofits to upgrade properties to a specified level.

LEAD: Cities/Towns, County, Tribes

PARTNER: Residents, PSE, Business Community, Development Community

TIMEFRAME: Long

STRESSOR: Increasing Drought, Warmer Summer

T-12

Generate additional energy from waste products (e.g., woody biomass and sewage) in Thurston County.

LOTT's wastewater-treatment plant, located in downtown Olympia, already captures methane to generate heat and electricity on site. Such projects offset demand for electricity from polluting fossil fuels (coal and natural gas) and hydropower — which is vulnerable to less summer precipitation/lower streamflow.

LEAD: Cities/Towns, LOTT, PSE

PARTNER: State, Business Community, Development Community, Agricultural Community, Property Owners

TIMEFRAME: Long

STRESSOR: Increasing Drought, Warmer Summer

T-13

Increase resources to monitor air quality, and enforce regulations to reduce the health risks of air pollution (e.g., surface ozone and particulate matter) exacerbated by warmer temperatures and automobile emissions.

This action would help reduce air pollution that threatens the region's residents.

LEAD: Federal, ORCAA

PARTNER: Cities/Towns, County, State

TIMEFRAME: Long

STRESSOR: Warmer Summer, Population Change, Increasing Drought

T-14

Retrofit neighborhood power lines that are subject to repeated damge from storm impacts, including fallen trees and branches.

Strategies could include burying or rerouting overhead power lines, replacing them with stronger materials, or building in transmission redundancies. The electric utility and its partners could investigate new funding mechanisms to pay for such work, which could reduce the risks of outages and injuries from downed power lines.

LEAD: Cities/Towns, County, PSE

PARTNER: --

TIMEFRAME: Underway (limited)

STRESSOR: Intensifying Precipitation

Wildfire & Extreme Heat

Projected hotter and drier summers threaten to increase the number and severity of wildfire and extreme heat events that carry significant social, economic, and environmental costs. Impacts include:

- **Infrastructure:** Wildfires can damage or destroy homes, power poles, forests, and other important buildings and infrastructure.
- **Urban Heat Islands:** Extreme heat events make cities hotter, especially in densely developed areas. Hospitalizations and emergency service calls for heat-related illnesses can place increasing demands on the region's emergency medical services. The elderly and homeless are especially vulnerable.
- **Air Quality:** Increasing drought raises the risk of wildfires and elevated levels of PM_{10} (coarse particulate matter) from smoke, which degrades air quality and threatens human health.

The following actions can help the region reduce and respond to these and other climate impacts identified through the project's vulnerability and risk assessments.

W-01

Create and maintain a map of the region's high-risk Wildland Urban Interface (WUI) communities and locations of wildfires.

Such a map can be used to regulate Firewise development practices (e.g., requiring building fire-suppression sprinklers and setbacks), as well as to educate property owners about wildfire risks.

LEAD: County, TRPC

PARTNER: Cities/Towns, State, Federal, Residents, Fire Districts, Tribes, Development Community

TIMEFRAME: Underway (extensive)

STRESSOR: Increasing Drought

W-02

Require new developments in high-risk wildfire areas to submit a fire-protection plan during site plan review.

This action would help reduce the risk of wildfire spreading to and damaging buildings.

LEAD: Cities/Towns, County

PARTNER: Development Community, Property Owners

TIMEFRAME: Short

STRESSOR: Increasing Drought

W-03

Provide private forestland owners and residents living in Wildland-Urban Interface (WUI) areas information about fire prevention/Firewise practices, and encourage application of such practices.

Firewise is a program of the National Fire Protection Association (NFPA) and co-sponsored by the USDA Forest Service, the US Department of the Interior and the National Association of State Foresters. Firewise practices include limiting vegetation near homes and building such structures with flame-resistant materials.

LEAD: Cities/Towns, County, Fire Districts

PARTNER: Neighborhoods, Residents

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought

W-04

Plant drought- and pest-resistant trees, shrubs, and grasses in parks, landscaping strips, and other urban areas.

Such vegetation reduces the need for watering, provides cooling shade, improves air and water quality, and supports flood storage/infiltration.

LEAD: Cities/Towns, County, Neighborhoods, Residents, Business Community

PARTNER: Nonprofits, K-12

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought, Warmer Summer, Population Change, Intensifying Precipitation

W-05

Adopt wildfire hazard overlay districts with development regulations (for new structures) based on factors such as slope, structure, and fuel hazards.

This action would help reduce the risk of wildfire spreading to and damaging buildings.

LEAD: Cities/Towns, County

PARTNER: Development Community

TIMEFRAME: Short

STRESSOR: Increasing Drought

W-06

Lower the density of development allowed in areas with the highest risk of wildfire.

Downzoning rural, unincorporated areas within the region's Wildland-Urban Interface (WUI), the zone where natural areas and development meet, would decrease the number of homes and businesses at risk of fire damage. Downzoning areas within city and town urban growth areas, however, may be in conflict with state Growth Management Act and local density goals.

LEAD: Cities/Towns, County, Tribes

PARTNER: Residents, Development Community, Property Owners

TIMEFRAME: Short

STRESSOR: Increasing Drought

W-07

Extend and enforce the rural burn ban when wildfire risks are high.

This action would lower the risk of wildfires during periods of extreme heat and drought.

LEAD: County, Tribes

PARTNER: Neighborhoods, Residents, Agricultural Community, Property Owners

TIMEFRAME: Underway (limited)

STRESSOR: Increasing Drought

W-08

Modify building codes, where necessary, to require fire sprinkler systems and enable emergency access/egress in all new residential and commercial construction.

This action would help mitigate the risks of wildfires spreading.

LEAD: Cities/Towns, County

PARTNER: State, Development Community

TIMEFRAME: Underway (limited)

STRESSOR: Intensifying Precipitation, Population Change, Increasing Drought

W-09

Account for the inclusion of defensible spaces into future developments (e.g., designing roads, pathways, sidewalks, and landscaping to create firebreaks) in areas where there is high wildfire risk.

This action would reduce the risk of wildfires spreading to and damaging homes.

LEAD: Cities/Towns, County, Residents

PARTNER: Fire Districts, Development Community

TIMEFRAME: Short

STRESSOR: Increasing Drought

W-10

Enhance training and financial support for wildfire response.

This action would lower the risk of wildfires spreading during periods of extreme heat and drought.

LEAD: Cities/Towns, County, Fire Districts

PARTNER: State, Federal, Tribes

TIMEFRAME: Short

STRESSOR: Increasing Drought

W-11

Expand the region's urban tree canopy and manage forests responsibly.

Planting more native and drought-tolerant tree species in rights-of-way, parks, plazas, and other urbanized areas reduces the urban heat island effect and hyperthermia risks by providing cooling shade (Also see Action W-04). Such trees also conserve water (less irrigation needed), improve air quality (e.g., capturing and storing carbon dioxide) and support infiltration (stormwater).

LEAD: Cities/Towns, County, Port

PARTNER: Nonprofits, Neighborhoods, Residents, Property Owners, K-12

TIMEFRAME: Underway (limited)

STRESSOR: Warmer Summer, Increasing Drought

W-12

Install reflective and/or vegetated roofs to reduce building energy consumption and the urban heat island effect.

"Cool" roofs covered with light colors or reflective pigments help direct away the sun's heat, cooling buildings and surrounding areas. Similarly, "green" roofs covered with sedum and other low-maintenance vegetation help insulate buildings from solar heat. Such rooftops help reduce building cooling costs and heat-related illnesses and deaths.

LEAD: Development Community

PARTNER: All

TIMEFRAME: Underway (limited)

STRESSOR: Warmer Summer

ACTIONS LEGEND

TIMEFRAME	
Name	**Description**
Underway--Limited	A few community stakeholders are taking this action now
Underway--Extensive	Many community stakeholders are taking this action now
Short	Take action within the decade (0-10 years)
Long	Take action within the following decade (10-20 years)

LEADS & PARTNERS	
Name	**Description**
Agricultural Community	Farms, ranches, suppliers, processors, shippers, sellers
All	All community stakeholders
Business Community	Thurston Economic Development Council, chambers of commerce, private-sector companies
Cities/Towns	Olympia, Lacey, Tumwater, Yelm, Tenino, Rainier, Bucoda
County	Thurston County government
Development Community	Builders, surveyors, architects, lenders, real estate agents for all building types
Federal	U.S. government agencies and installations (e.g., Joint Base Lewis McChord)
Fire Districts	Fire districts that serve rural and urban Thurston County
Higher Education	Colleges and universities
K-12	Kindergarten-Grade 12 schools (public and private)
LOTT	LOTT Clean Water Alliance
Neighborhoods	Home owners' associations (HOAs), neighborhood associations and informal neighborhood groups
Nonprofits	Organizations that focus on land conservation/restoration (Sierra Club), emergency response (e.g., the American Red Cross), and other issue areas
ORCAA	Olympic Region Clean Air Agency
Port	Port of Olympia
Property Owners	People who own commercial, industrial, residential or resource lands but don't necessarily occupy them
PSE	Puget Sound Energy
Residents	People who live in Thurston County
State	Legislature, Governor, and state agencies
TCD	Thurston Conservation District
Transit	Intercity Transit, Rural & Tribal Transportation (R/T)
Tribes	Nisqually Indian Tribe, Squaxin Island Tribe, Confederated Tribes of the Chehalis Reservation
TRL	Timberland Regional Library
TRPC	Thurston Regional Planning Council
Water Providers	Thurston Public Utility District, municipal water systems, private systems

STRESSORS	
Name	**Description**
Warmer Summer	This stressor encompasses the risks of the region's warm months (April-September) being warmer than they have been historically.
Warmer Winter	This stressor encompasses the risks of the region's cool months (October-March) being warmer than they have been historically.
Warmer Water	This stressor encompasses the risks of warming affecting the chemical, biological and/or physical characteristics of the region's freshwater or marine waterbodies during any season.
Increasing Drought	This stressor encompasses the risks of drought — a deficiency in precipitation over an extended period — increasing in frequency and intensity.
Intensifying Precipitation	This stressor encompasses the risks of "heavy" 24-hour precipitation events (top 1 percent) — increasing in frequency and intensity.
Sea-Level Rise	This stressor encompasses the risks of Puget Sound being higher than it was historically and the effects on the region's shorelines and areas farther inland.
Ocean Acidification	This stressor encompasses the risks of Puget Sound absorbing more atmospheric carbon dioxide.
Population Change	This stressor encompasses the risks of climate change-induced displacement and migration (temporary or permanent) within, to and from our region.

5.3 Action Benefit-Cost Analyses

TRPC hired the Tacoma-based consulting firm Earth Economics to perform benefit-cost analyses (BCAs) of a pair of representative actions with climate adaptation and mitigation co-benefits:

- **Action F-01:** Evaluate and secure sustained funding to restore and protect riparian vegetation along freshwater and marine shorelines.
- **Action G-12:** Increase incentives to make urban infill and redevelopment projects more viable financially.

Earth Economics' analyses [*See Appendix F*] factored in the value of forests, grasslands, riparian shorelines, and other land cover types. Such areas have social, economic, and environmental benefits — "ecosystem services" such as providing wildlife habitat and filtering water — which the economists measured in real dollars.

After running the actions through planning scenarios that focused on specific areas of the region [*See Figure 16*], Earth Economics produced for each action a benefit-cost ratio that showed the dollar value of ecosystem service benefits produced by each dollar of related costs (i.e., the return on investment for every $1 in expenditures or forfeited revenue). The analyses show that both actions have positive benefit-cost ratios, or BCRs:

- The BCR for Action F-01 ranges from 1.73 (based on low estimates of the value of ecosystem services) to 9.34 (based on high estimates).
- The BCR for Action G-12 ranges from 14.78 (low estimates) to 18.15 (high estimates).
- Ecosystem services in restored riparian areas would produce between $2,644 and $8,311 per acre, every year.

Earth Economics did not include additional community benefits, such as expanded employment opportunities and associated income, in its analyses. Even without accounting for such benefits, however, the report concluded that investing in climate adaptation in Thurston County offers exceptionally good returns. Thus, it is TRPC's hope that municipalities, tribes and other stakeholders will consider the ecosystem service values calculated in the BCAs when evaluating whether to take these and other actions.

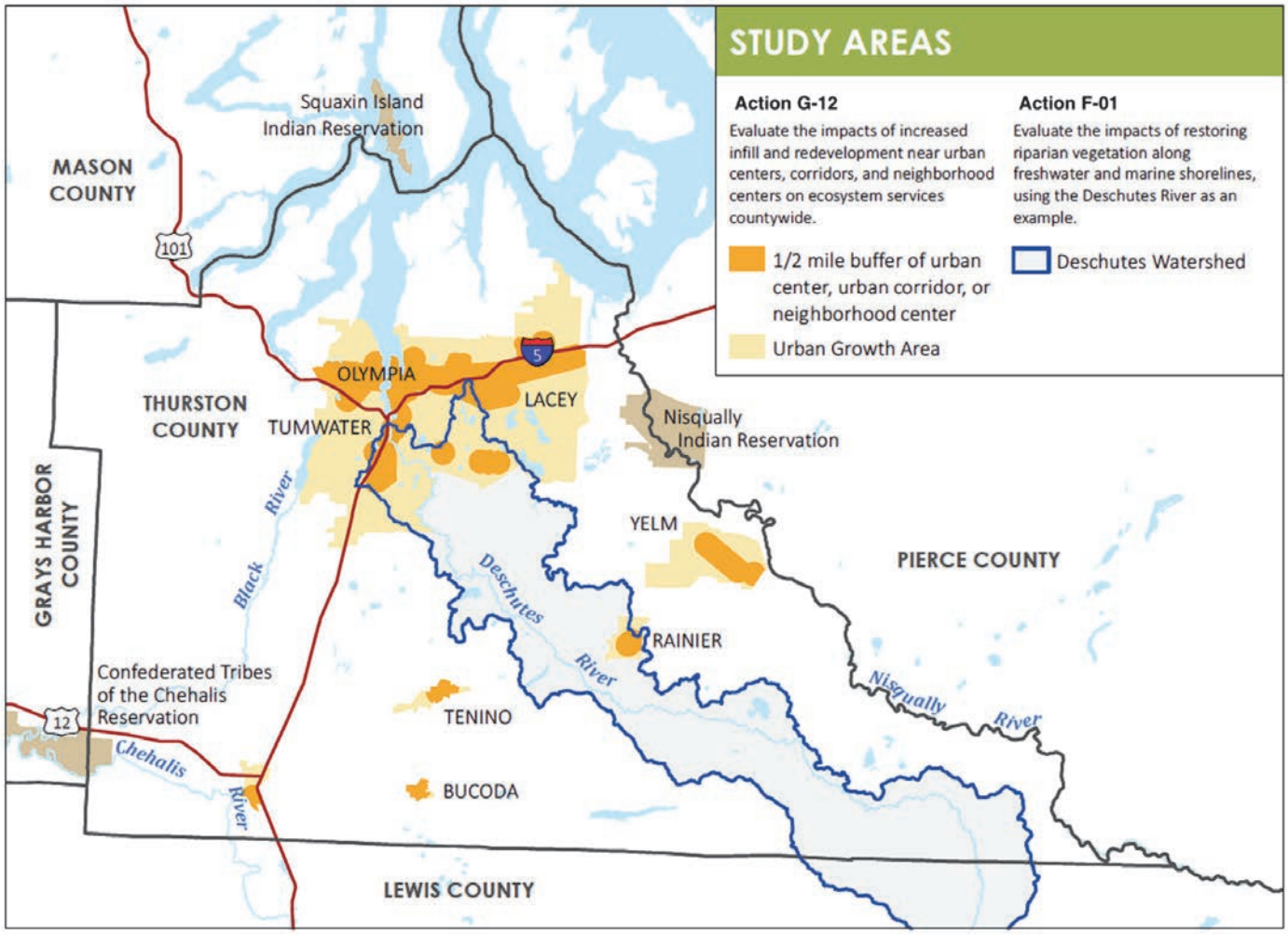
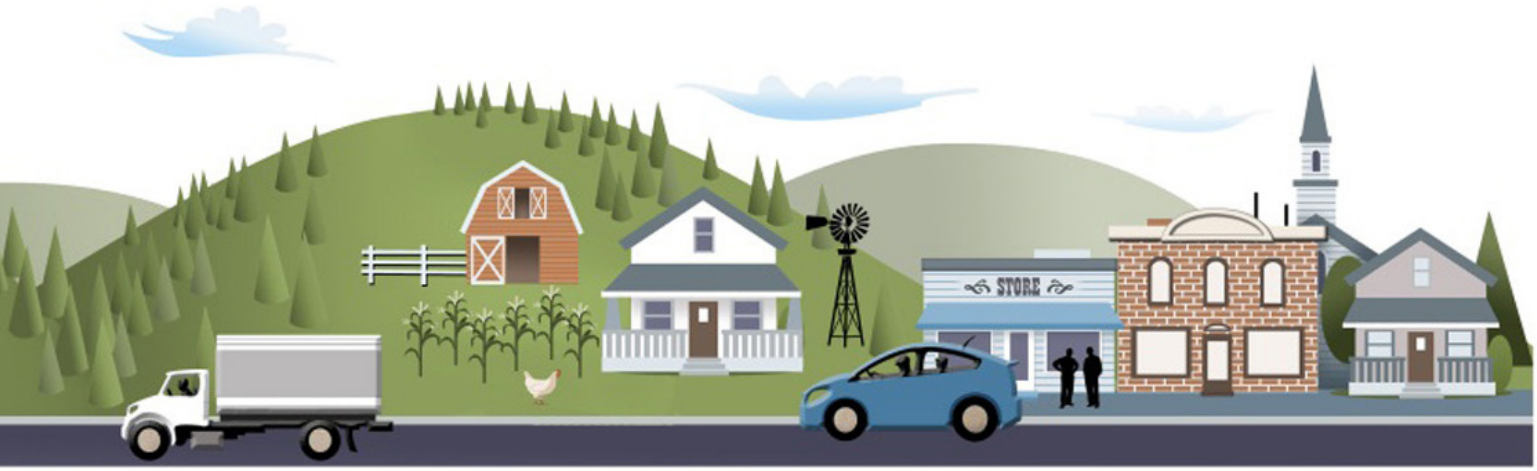
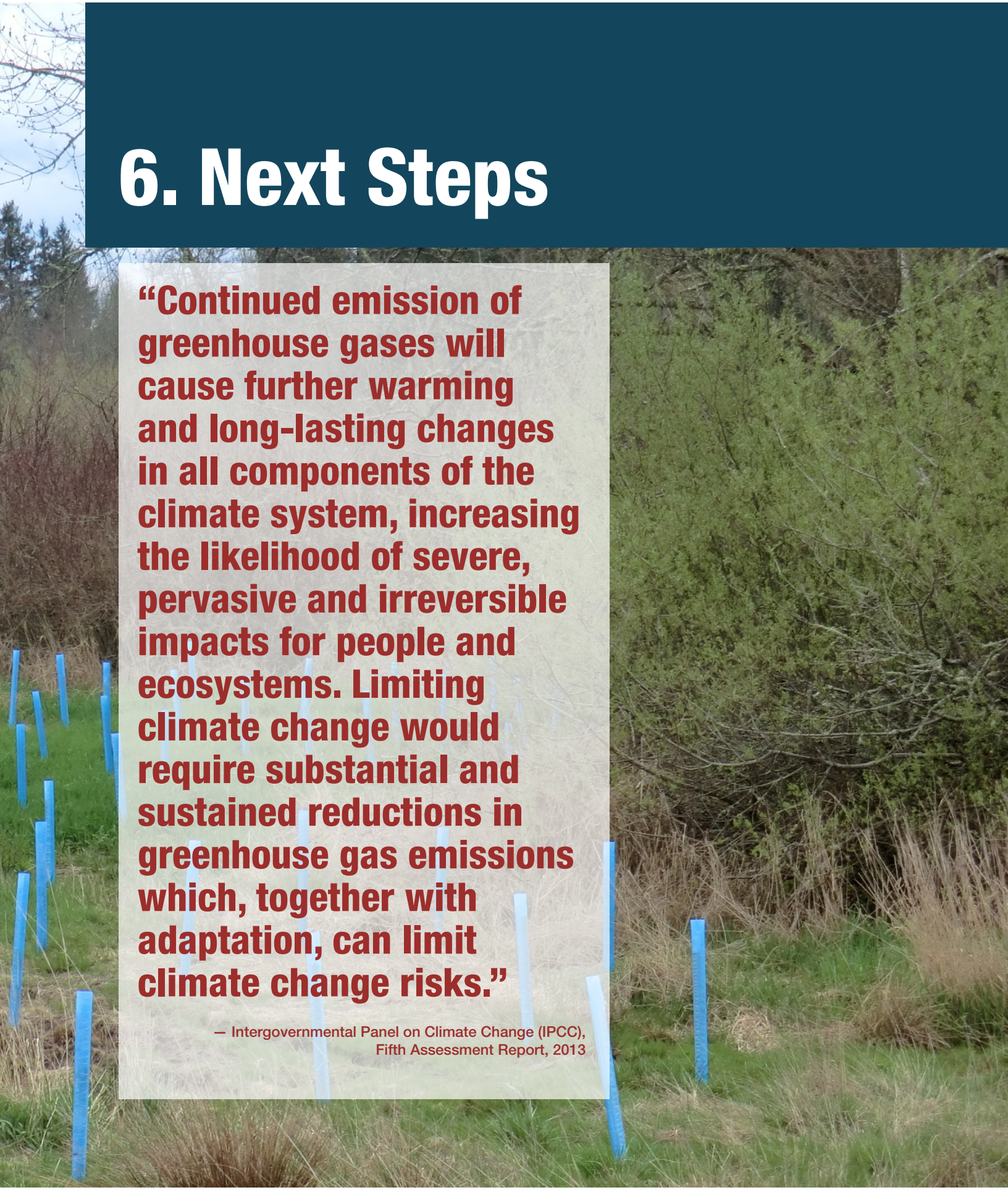


Figure 16: Earth Economics' planning scenarios for Action G-12 focused on Thurston County's urban corridors and centers; scenarios for Action F-01 focused on the Deschutes Watershed. Such scenarios provide quantitative inputs for holistic BCAs that can be adjusted or replicated as other implementation scenarios or actions are considered. ***Source:*** *TRPC*



6. Next Steps



"Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks."

— Intergovernmental Panel on Climate Change (IPCC), Fifth Assessment Report, 2013

6.1 Ongoing Implementation & Engagement

As noted previously, some actions in this plan are new to the region, while other actions are underway.

TRPC encourages all community stakeholders — from households and neighborhood associations to businesses and nonprofits — to consider how, when, and where to take actions. Tribal and local governments, for example, could consider ways to integrate adaptation actions into their major policy documents, including municipal and tribal codes and plans.

Some such efforts are already underway. In 2017, Thurston County staff members identified adaptation actions that could be integrated into the Thurston County Comprehensive Plan. The City of Olympia, LOTT, and Port of Olympia — which also had representatives on this project's Stakeholder Advisory Committee — began analyzing site-specific actions for protecting downtown Olympia assets from sea-level rise. This collaborative effort — which incorporates several of this plan's priority actions — will wrap up at the end of 2018 and identify decision-making thresholds, implementation schedules, and funding needs.

Local artist Carrie Zeigler painted a mural of plankton — a critical link in the marine food chain — on the exterior of downtown Olympia's Puget Sound Estuarium. Her hope is to raise awareness about marine organisms affected by climate change and inspire action. ***Source:*** *Carrie Ziegler*

For its part, TRPC will continue working with local artists, educators, and other diverse partners to increase the community's understanding of climate change causes, impacts, and responses.

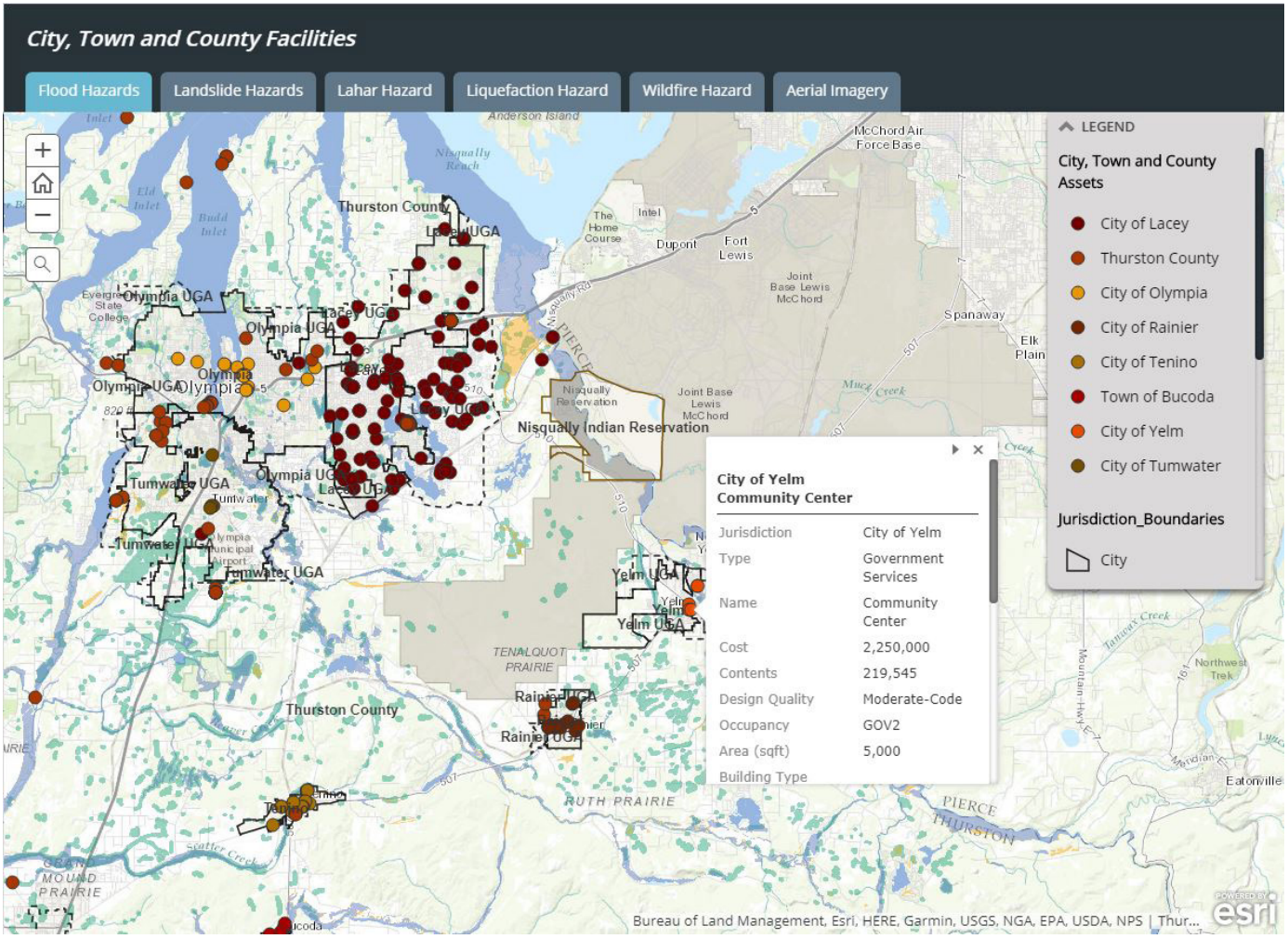
In October 2017, the Timberland Regional Library, TRPC, City of Olympia, and other partners hosted "Art of Change," a community event that merged climate literacy, art, science, and policy. Against the backdrop of an ocean acidification mural painted freshly on downtown's Puget Sound Estuarium building, Timberland staged a "pop-up library" during fall 2017 Arts Walk. Patrons signed up for a card and checked out books, films, and other resources focused on climate change.

City of Olympia and TRPC staff hosted an adjacent information station that featured print and online materials related to their climate planning work. Among the materials were a draft of this plan, a climate "Resilience Toolkit" brochure, and an adaptation board game that TRPC created as part of this project.

The "Art of Change" event during fall Arts Walk in downtown Olympia featured TRPC, City of Olympia, Timberland Regional Library, and other organizations working on climate issues. ***Source:*** *TRPC*

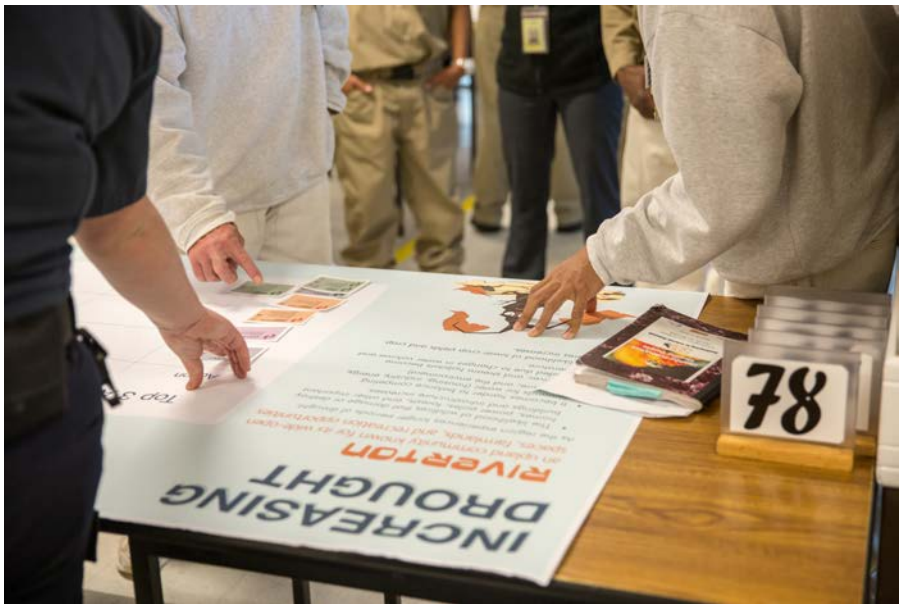
The Resilience Toolkit — also featured on TRPC's website (trpc.org/resiliencetoolkit) — includes links to information to enhance the community's climate resilience: tips for enhancing household and neighborhood emergency preparedness; data and maps showing climate change impacts at national, regional and local scales; economic analyses of potential adaptation policies; and, library books, films, and online courses about climate change. The toolkit also links to TRPC's Thurston Region Hazards Assessment Map — an interactive story map that enables users to view the locations of medical buildings, wells, fire stations, and other important assets and their exposure to floods, landslides, wildfires and other hazards.

TRPC encourages municipalities and other partners to link to the online toolkit from their website, as well as to place the brochure in their buildings (e.g., city halls, libraries, transit centers).



TRPC's interactive Thurston Region Hazards Assessment Map (*pictured*) enables users to explore the hazard vulnerability of medical buildings, wells, fire stations, and other important assets. ***Source:*** *TRPC*

The board game, *Resilience Road: A Game of Climate Change & Chance,* enables players to explore the climate stressors, risks, and actions featured in this plan. Players attempt to reach "Resilience Ridge" by traveling through Thurston County along "Resilience Road," drawing adaptation action cards and cooperating to respond to intensifying precipitation, drought, and other stressors along the way.



TRPC presented its climate adaptation plan to inmates at a local correctional facility in October 2017. Inmates then had an opportunity to discuss the implementers and effectiveness of actions in the plan. The presentation and group exercise were part of a Sustainability in Prisons Project symposium on climate change. ***Source:*** *Ricky Osborne*

Northwest Climate Conference attendees play TRPC's climate board game, "Resilience Road," in October 2017. The interactive game spurs players to take adaptation actions to respond to climate stressors. ***Source:*** *TRPC*

TRPC staff members presented the board game to other diverse audiences around the Puget Sound region — including to climate scientists and policy practitioners at the 2017 Northwest Climate Conference, in Tacoma, and to inmates at the Stafford Creek Corrections Center, in Aberdeen. The latter event was part of a Sustainability in Prisons Project symposium on climate change.

TRPC staff members will look for future opportunities to share and play the board game — for example, at neighborhood association, school, and municipal government meetings. The game is designed to be adaptable, so communities anywhere may play it using their own climate stressors and actions.

In summary, TRPC's multifaceted public-engagement strategy responds directly to this plan's guiding principle to "seek broad community input, as well as educate residents about climate change and inspire them to take action." What better way to do this than with a simple board game?

6.2 Mitigation Planning

Many of this plan's adaptation actions have mitigation co-benefits. For example, the same trees that stabilize slopes and cool urban areas also soak up carbon dioxide — the main greenhouse gas.

To be sure, the Thurston Region must do much more than planting trees to hit its emissions-reduction targets [*See Section 3*]. In mid-2017, TRPC hired a team of consultants to show just how far we have to go.

Seattle-based Clean Energy Transition and the Stockholm Environment Institute developed for TRPC an "energy map" that shows the carbon emissions associated with Thurston County's 2015 electricity generation sources (coal, natural gas, etc.) and end uses (buildings, vehicles, etc.) [*See Figure 16*].

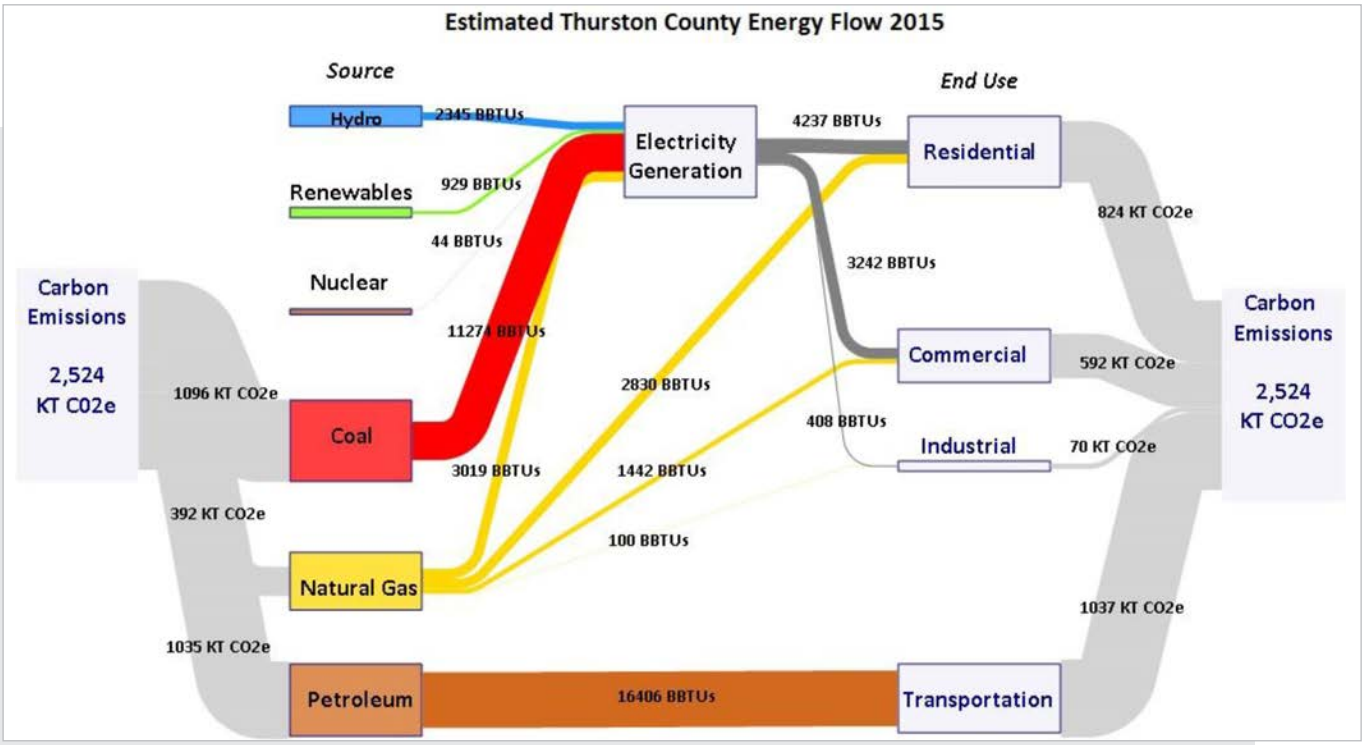


Figure 16: This graph shows the 2015 carbon emissions associated with electricity generation sources and end uses.
Source: *Clean Energy Transition and Stockholm Environment Institute*

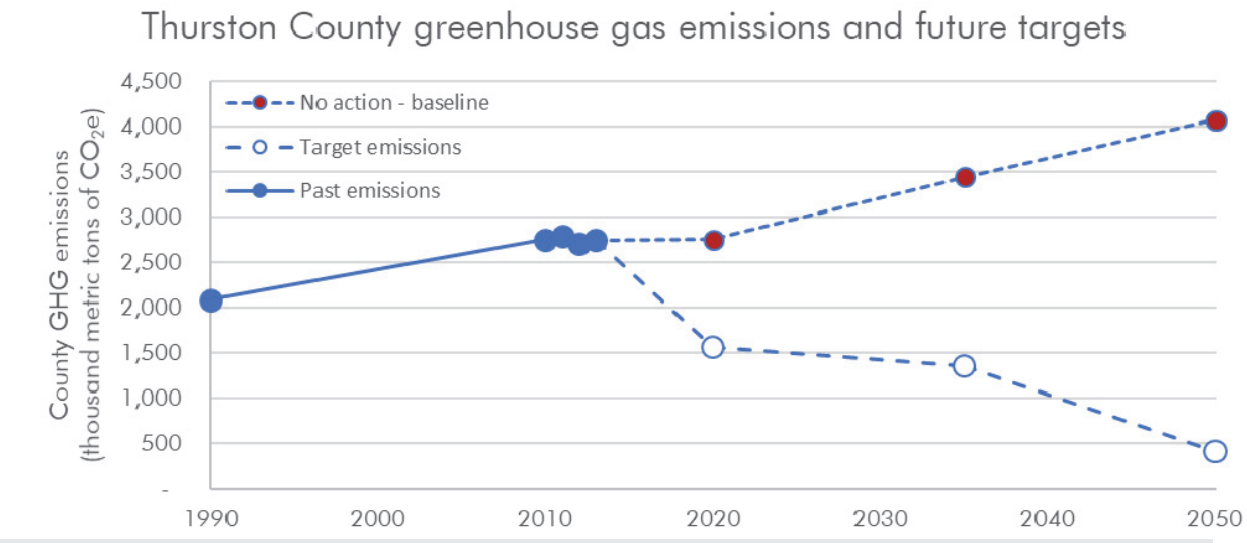


Figure 17: This graph shows Thurston County's past emissions through 2015 (solid blue line) and projected "business-as-usual" emissions through 2050 (dotted blue line with red circles). The region's 2020, 2035, and 2050 emissions targets are shown as hollow blue circles. ***Source:*** *Clean Energy Transition and Stockholm Environment Institute*

The consultants also graphed the Thurston Region's actual 1990 and 2015 emissions and its 2020, 2035, and 2050 emissions targets, which were adopted as part of the Sustainable Thurston plan [*See Figure 17*].

Using this information, the consultants produced several "carbon wedge" scenarios, which show the cumulative emissions reductions in Thurston County that are expected from existing and potential laws and policies. For each scenario, the effects of laws or policies are stacked as wedges to show their respective contribution toward hitting the 2020, 2035 and 2050 emissions-reduction targets [*See Figure 18*].

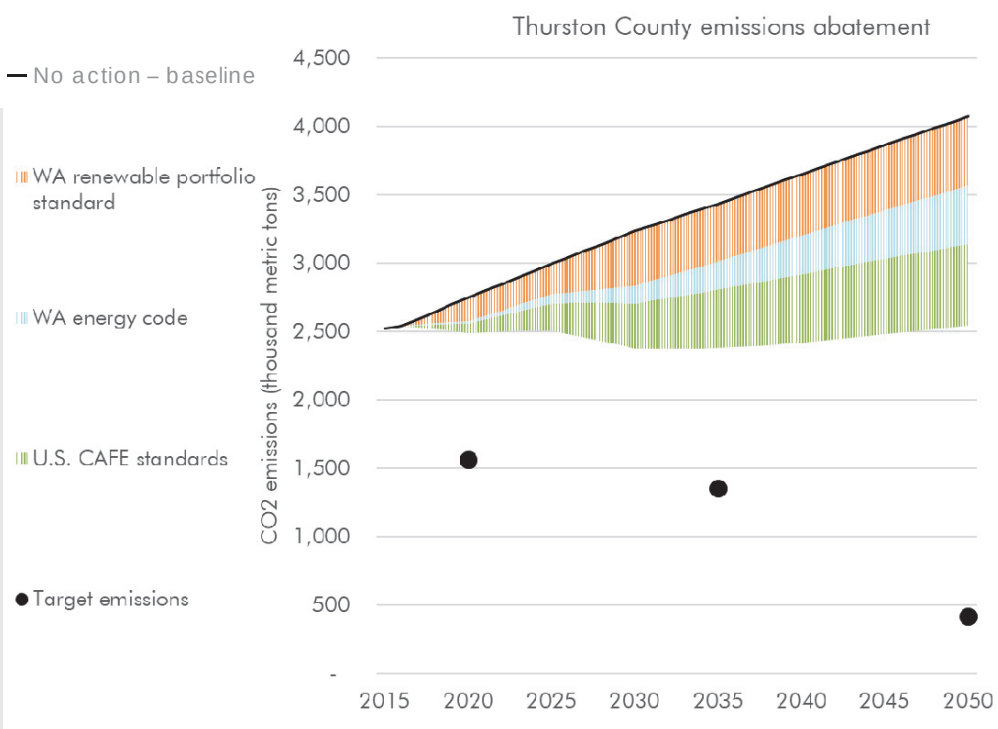


Figure 18: This graph shows emissions reductions from a baseline (2015) due to existing state and federal policies: Washington's renewable portfolio standard for electric utilities; the Washington Energy Code for buildings; and, the federal Corporate Average Fuel Economy (CAFE) standards for automobiles. ***Source:*** *Clean Energy Transition and Stockholm Environment Institute*

The consultants produced a summary memo that includes broad recommendations about where the Thurston Region should focus its mitigation efforts (vehicles, buildings, power plants, etc.) to hit the 2050 target. The memo and associated materials may be downloaded via TRPC's climate Resilience Toolkit (trpc.org/resiliencetoolkit).

Per the direction of local policymakers, TRPC staff will pursue funding and partners to develop a companion climate mitigation plan with actions sufficient to meet the regional emissions-reduction targets. TRPC's climate adaptation plan, as well as the energy map and carbon wedges, provide a solid foundation for such work. This multifaceted approach recognizes that many climate adaptation and mitigation actions — large and small — are needed to help our region and planet remain resilient. Success requires each of us to do our part.

Source: *NASA*

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8. Appendices

Appendix A: Science Summary

Appendix B: Vulnerability Assessment

Appendix C: Goal-Risk Report

Appendix D: Public-Engagement Strategy

Appendix E: Action-Risk Report

Appendix F: Action Benefit-Cost Analyses