



**CITY COUNCIL WORKSESSION
MEETING AGENDA**

**Online via Zoom and In Person at
Tumwater Fire Department
Headquarters, EOC, 311 Israel Rd. SW,
Tumwater, WA 98501**

**Tuesday, May 23, 2023
6:00 PM**

1. Call to Order
2. Roll Call
- [3.](#) Carbon Sequestration White Paper Update (Alyssa Jones Wood)
4. Mayor/City Administrator's Report
 - Council Facebook Page
5. Adjourn

Meeting Information

All Councilmembers will be attending remotely. The public are welcome to attend in person, by telephone or online via Zoom.

Watch Online

<https://us02web.zoom.us/j/83440084349?pwd=RGkxbkJiVlhTdZlZWmVlaFRJSnJrZz09>

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Call (253) 215-8782, listen for the prompts and enter the Webinar ID 834 4008 4349 and Passcode 885737.

Public Comment

The public may submit comments by sending an email to council@ci.tumwater.wa.us, no later than 4:00 p.m. the day of the meeting. Comments are submitted directly to the Councilmembers and will not be read individually into the record of the meeting.

Post Meeting

Video recording of this meeting will be available within 24 hours of the meeting.

<https://tcmedia.org/channels.php>

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TO: City Council
FROM: Alyssa Jones Wood, Sustainability Coordinator
DATE: May 23, 2023
SUBJECT: Carbon Sequestration White Paper Update

1) Recommended Action:

No action is recommended. This item is for information only.

2) Background:

Part of the Thurston Climate Mitigation Plan Phase Three Interlocal Agreement (ILA) was a Work Program item "Regional Program for Carbon Sequestration." This item was intended to explore options for certifying, tracking, and administering a regional carbon sequestration program. This Work Program item was not completed by April 2022 and was carried over into Phase Four of the ILA as a Work Program item "Carbon Sequestration Program Design". The Thurston Regional Planning Council provided this white paper to the Climate Action Steering Committee in their February 2023 meeting.

3) Policy Support:

2023-2024 Strategic Priority: Be a Leader in Environmental Sustainability.

- Continue to update and advance the Climate Action Plan.
-

4) Alternatives:

☐ No alternatives are suggested.

5) Fiscal Notes:

None.

6) Attachments:

- A. Carbon Sequestration as a Climate Mitigation Strategy for the Thurston Region
- B. Appendices

FEBRUARY 2023

The logo for the Thurston Climate Mitigation Plan is located in the upper right quadrant. It consists of four stacked rectangular boxes, each containing a word in white, sans-serif, uppercase letters. The top box is teal and contains the word 'THURSTON'. The second box is dark red and contains the word 'CLIMATE'. The third box is dark blue and contains the word 'MITIGATION'. The bottom box is orange and contains the word 'PLAN'. To the right of these boxes is a thin, vertical green line.

**THURSTON
CLIMATE
MITIGATION
PLAN**

CARBON SEQUESTRATION AS A CLIMATE MITIGATION STRATEGY FOR THE THURSTON REGION

Developed for the Climate Action Steering Committee

THURSTON REGIONAL PLANNING COUNCIL

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American with Disabilities Act (ADA) Information

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Acknowledgements

This report was funded by Thurston County, Lacey, Olympia, and Tumwater through an interlocal agreement to support implementation of the Thurston Climate Mitigation Plan.

The authors wish to gratefully acknowledge the many individuals who made valuable contributions to this report at various stages, including those who lent their time and expertise in interviews: Anne-Gigi Chan and Kathleen Farley Wolf (King County); Allan Warren (Pierce County Conservation District); Stephanie Bishop, Sarah Moorehead, and Karin Strelloff (Thurston Conservation District); Loretta Seppanen; Laurence Reeves (Capitol Land Trust); Joe Kane (Nisqually land Trust); Patrick Shultz and Stephen Bramwell (WSU Extension); Lynn Fitz-Hugh and members of the Thurston Climate Action Team Tree Group. Staff from Thurston County, Lacey, Olympia, and Tumwater reviewed early drafts and provided significant feedback on the report structure and content. At Thurston Regional Planning Council, Michael Ambrogi contributed data analysis of land cover, and Jennifer Bass conducted interviews and research while serving as an intern for TRPC in 2021.

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1. Overview

The Thurston Climate Mitigation Plan (TCMP) includes carbon sequestration among the strategies and actions identified to meet the region's goal of reducing locally generated greenhouse gas emissions 85 percent from 2015 levels by 2050. This report outlines existing information and resources for policymakers and staff to inform next steps for increasing carbon sequestration in the Thurston region.

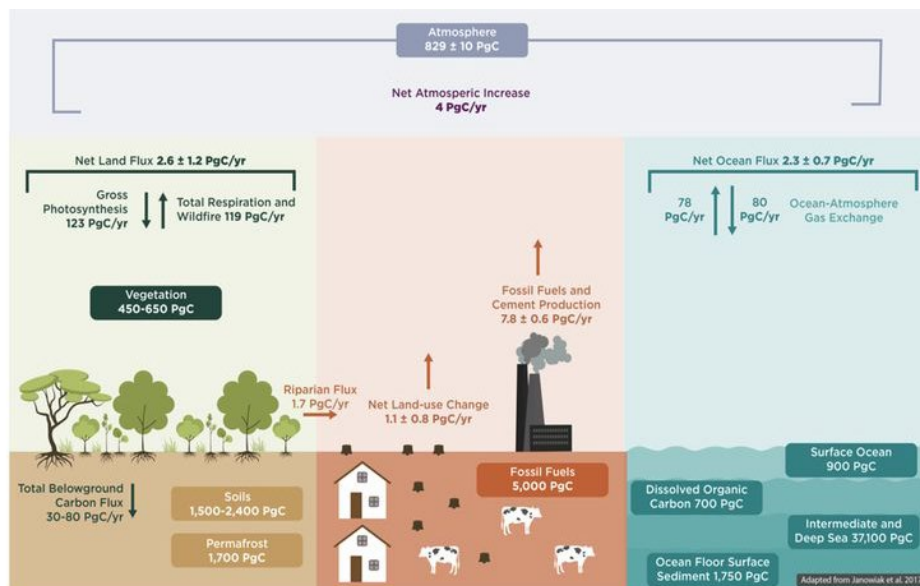
Findings from this report include:

- **Existing forests and trees in Thurston County sequester approximately 927,000 MTCO₂e/year.** This estimate provides a preliminary baseline that TCMP partners can use to monitor progress toward the carbon sequestration targets listed in the plan. Additional information is needed to estimate baseline sequestration provided by other land types, including agriculture and prairies.
- **The sequestration target set in the TCMP is highly ambitious, and likely infeasible with actions currently included in the plan.** Sequestration actions, including expanding regenerative agriculture, reforestation, prairie preservation, extended timber harvest, and tidal wetland restoration have the potential to increase sequestration by 122,411-314,290 MTCO₂e/year. This falls below the TCMP sequestration target of an additional 380,000 MTCO₂e/year over the baseline rate by 2050. This target may be harder to achieve as forested areas are developed and converted to other land uses—avoiding forest conversion does not increase sequestration potential, but can help maintain the existing sequestration provided by these areas.
- **TCMP partners can choose from a range of policies and programs to increase sequestration in the region.** Potential areas for initial focus include actions that preserve and increase sequestration in rural forests, align existing programs with sequestration goals, fill priority data gaps, and build relationships among community partners.

2. What is Carbon Sequestration?

Carbon sequestration is a process that removes carbon dioxide from the atmosphere and stores it in natural or artificial sinks, such as soil, vegetation, and the ocean. Other terms used to describe this process include carbon dioxide removal (CDR) and negative emissions technologies (NETs).

Figure 1. The global carbon cycle. Source: Michigan State University Forest Carbon and Climate Program.



“The carbon cycle is nature’s way of reusing carbon atoms, which travel from the atmosphere into organisms in the Earth and then back into the atmosphere over and over again. Most carbon is stored in rocks and sediments, while the rest is stored in the ocean, atmosphere, and living organisms.”

- NOAA

Carbon sequestration is both a naturally occurring process and a potential strategy for mitigating climate change. In theory, actions taken to increase rates of carbon sequestration can offset greenhouse gas emissions from other sources. All pathways modeled by the IPCC that limit global warming to 1.5°C require carbon dioxide removal, and this modeling indicates that the longer it takes for countries to reduce emissions towards zero, the more sequestration will be needed to meet that target (IPCC, 2018).

Carbon sequestration is sometimes criticized as “band-aid” for the climate crisis that enables emitters to avoid making changes that reduce sources of emissions. Some opponents argue that a focus on carbon sequestration distracts and diverts limited resources that would be better invested in proven technologies that need to be rapidly scaled up to meet climate targets, such as renewable energy infrastructure and energy efficiency improvements (Palmgren et al., 2004, Garcia Freitas and Jones, 2020). While carbon sequestration is a natural process, it can be challenging to determine the true effectiveness of actions intended to increase sequestration, and separate their benefit from what might have occurred without intervention (Badgley, et al, 2021).

3. Sequestration Strategies and Targets

The analysis completed for the Thurston Climate Mitigation Plan (TCMP) found that local actions identified to reduce emissions from sources like energy use and transportation will likely be sufficient to meet the region's 2030 goal, but fall short of the region's target for 2050 (Hammerschlag, 2020). The TCMP proposed using carbon sequestration to offset the gap with a target that the Thurston region sequester an additional 380,000 MTCO₂e/year by 2050 to offset continued emissions from other sectors and meet its emission reduction goal.

While carbon sequestration can take many forms,¹ the TCMP focuses on the role of terrestrial sequestration—processes by which trees and other types of plants capture carbon dioxide from the atmosphere through photosynthesis and store it in vegetation and soil. The TCMP focused on three strategies to reach its targets: regenerative agriculture, afforestation and reforestation, and conservation and restoration of native prairies.

Regenerative Agriculture is an approach to food production that employs a variety of practices with a holistic aim to improve soil and ecosystem health, increase biodiversity, and store carbon.² Practices like double cropping, using cover crops, planting perennials, or adding organic matter to the soil can increase carbon input, while practices that limit the amount and intensity of tillage, burning, and erosion can reduce the amount of carbon lost from the soil (Giller et al., 2021).

TCMP SEQUESTRATION ACTIONS & TARGETS: AGRICULTURE

STRATEGY & ACTIONS

Strategy A2. Support agricultural practices that sequester carbon.

- **Action A2.1 – regenerative agriculture.** Expand regenerative agricultural practices among farmers that aim for a “whole farm” approach. Provide education on how to increase organic matter content and water retention in soils within urban and agricultural settings.

TARGET

Manage 6,600 acres of agricultural land to store carbon through regenerative agriculture practices by 2050. This was estimated to increase carbon sequestration by 3,300 MTCO₂e/year.

Afforestation and Reforestation. Trees sequester carbon by capturing carbon dioxide from the atmosphere during photosynthesis and transforming it into biomass or storing it in deadwood and the soil. **Afforestation** is defined as planting trees in areas that have not historically been covered by forests and may involve land use transformation. **Reforestation** is defined as replacing trees in areas that have

¹ Other forms of carbon sequestration, including storing carbon through oceanic (blue carbon) and geologic processes were not included in the list of actions assessed to reach the TCMP's goals, but could be part of an overall carbon sequestration strategy.

² Despite widespread interest in regenerative agriculture, no legal or regulatory definition of the term “regenerative agriculture” exists nor has a widely accepted definition emerged in common usage. A survey of the term's use in journal articles and by practitioners found definitions often include a combination of process and outcomes (Newton et al., 2020). The authors recommend users of the term define it for their own purpose and context.

historically been covered by forests. The sequestration potential of trees can vary widely based on species, location, and age. The carbon density of coastal forests in the Pacific Northwest is up to twice that calculated for forests in the Midwest. Large individual trees can store significantly more carbon than small trees, so older, larger trees are important carbon stocks, though younger stands of smaller trees accumulate more carbon by area on an annual basis (carbon flux) (Case et al., 2021; Nowak & Crane, 2002; Gray et al., 2016).

TCMP SEQUESTRATION ACTIONS & TARGETS: FORESTS

STRATEGY & ACTIONS

Strategy A5: Manage forests to sequester carbon.

- **Action A5.1 – reforestation & afforestation program.** Develop a coordinated reforestation/afforestation program. Begin by identifying priority areas where reforestation and afforestation may have carbon reduction benefits.

Strategy A6: Reduce emissions from the urban landscape.

- **Action A6.5 – municipal canopy.** Maximize tree canopy on jurisdiction owned or managed land, where appropriate, in balance with other jurisdictional goals.
- **Action 6.9 – tree canopy preservation.** Develop a tree canopy ordinance that establishes a baseline for current urban canopy and sets goals for future canopy to increase resilience. Combine direct cooling value (urban heat island mitigation) with carbon sequestration value when evaluating urban tree management.

TARGET

Manage sufficient forestland and prairies to sequester 375,000 tons of CO₂ annually by 2050.

Prairie Preservation and Restoration. Prairies have perennial grasses with deep fibrous root systems that can make up 60-80 percent of biomass in surrounding soil. Prairies in Thurston County and the South Puget Sound have native bunch grasses with roots that extend up to two feet deep, and some of the native forbs, including lupine and balsamroot, can have taproots that extend up to ten feet deep (Hamman 2020, pers comm.). This subterranean biomass creates sequestration potential, with some estimates that prairies hold approximately 20 percent of the world's soil carbon stock (Janowiak et al., 2017). Quantifying soil carbon sequestration is highly complex and varies based on climate, soil, and vegetation, though soil carbon stocks in prairies and grasslands tend to be the greatest in regions with

TCMP SEQUESTRATION ACTIONS & TARGETS: PRAIRIES

STRATEGY & ACTIONS

Strategy A7: Increase carbon sequestration in marine and prairie ecosystems.

- **Action A7.3 – prairie preservation.** Support aggressive implementation of habitat conservation plans that provide for preservation and restoration of prairie habitat for endangered and threatened prairie species.

TARGET

Included in forests target.

the greatest rainfall, like Thurston County, and decrease with increasing annual temperature (Case et al, 2021).

The targets developed for the plan provide a rough calculation of how much TCMP partners would need to increase sequestration to meet the region's overall emissions reduction targets. The plan's analysis did not consider whether those targets are reasonable or feasible for local jurisdictions to achieve given practical constraints—such an assessment went beyond the scope and timeframe of the TCMP's development. The analysis also lacked data for several other strategies discussed in the plan that could contribute to a more complete estimate of sequestration potential:

- Baseline sequestration provided by existing land cover and land practices
- Change in emissions from anticipated development and changes to land uses between 2015 and 2050 (future baseline), and the sequestration potential of land conservation actions
- Sequestration rate of alternative forest, tree canopy, and agriculture management practices, including in urban areas
- Sequestration rate of restored prairie areas

These data gaps mean that while the TCMP recognizes the climate mitigation potential of conserving existing trees, forested areas, and prairies, these benefits were not quantified to set targets for the plan. Similarly, the potential benefits of restoring prairies and marine areas are discussed in the plan, but were not included in the sequestration target. Many other potential ways to increase carbon sequestration (such as climate-smart aquaculture practices like kelp farming) were not considered in developing the TCMP. For all these reasons, the quantitative targets developed for the plan should be viewed as a starting place to help frame regional discussions about the role of sequestration in climate mitigation. This report is a first step toward filling some of those data gaps.

4. Baseline Sequestration

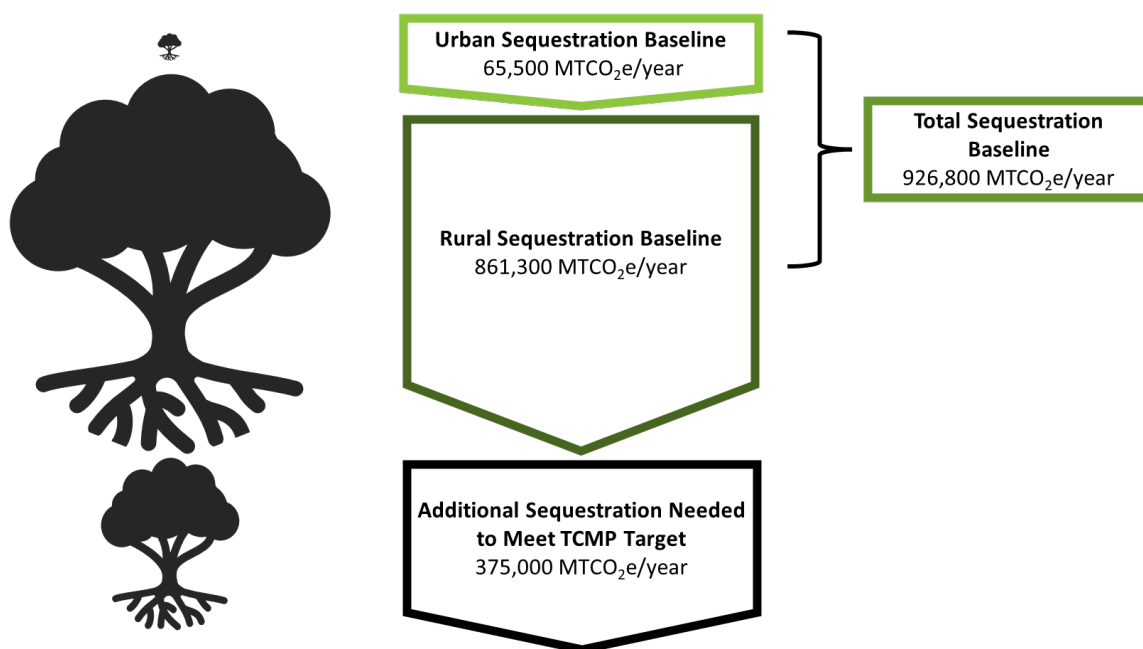
How much carbon does land in Thurston County sequester each year?³

The Intergovernmental Panel on Climate Change (IPCC) recommends that greenhouse gases from land uses be reported in six categories: Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land. To aid in this assessment, ICLEI⁴ developed the Land Emissions and Removals Navigator (LEARN) tool. As of 2022, the tool estimates local greenhouse gas impacts of forests and trees, but does not estimate emissions and sinks from other types of land uses, such as croplands and grasslands.

From 2006-2016, the LEARN tool estimates forests and trees in Thurston County sequestered 926,800 MTCO₂e/year.⁵ The bulk of that sequestration (93 percent) takes place in rural portions of the county; trees in urban areas contribute a relatively small proportion of sequestration countywide (7 percent).

Figure 2. Baseline carbon sequestration from forests and trees in Thurston County and sequestration targets.

Source: ICLEI LEARN tool, 2006-2016. Note this figure does not include estimated sequestration from agriculture.



This estimate provides a preliminary baseline that TCMP partners can use to monitor progress toward the carbon sequestration targets listed in the plan. To meet those targets, sequestration from forests and trees will need to increase to 1.3 million MTCO₂e/year, equivalent to the baseline figure plus an additional 375,000 MTCO₂e/year. Future analyses could improve on this data by developing baseline estimates for emissions from other land use categories, including agricultural lands and prairies.

³ See Appendix B for more in-depth review of existing, available methodologies and data sources to inform baseline and potential carbon sequestration in Thurston County.

⁴ ICLEI - United States chapter of the International Council for Local Environmental Initiatives

⁵ ICLEI LEARN tool estimates were re-run December 7, 2022, using current jurisdictional boundaries, and reflect updates made to the tool through that date. For more information, see Appendix B.

5. Carbon Sequestration Potential

How much more carbon could certain land covers (forest, agriculture lands, prairies) potentially sequester in the future under different climate mitigation strategies?

TRPC reviewed a variety of methodologies, data sources, and tools to estimate the carbon sequestration potential of different actions. This review suggests the sequestration target set in the TCMP is highly ambitious, and likely infeasible with actions currently included in the plan. Approaching the target will require a substantial investment of resources into sequestration actions and significant changes to development patterns and land use practices. In addition, TCMP partners should consider how future land cover changes could reduce sequestration capacity from the baseline discussed above, potentially pushing emissions targets farther out of reach. Alternatively, the TCMP partners could consider adjusting the sequestration target to a more attainable amount and increasing targets for reducing emissions from other sectors to close the gap. Findings from this review are summarized below; for additional detail, see Appendix A.

Table 1. Estimated sequestration potential of climate mitigation actions.

Sequestration Strategies	Estimated Sequestration Potential (MTCO ₂ e/year)	
	Low	High
Sequestration actions included in the TCMP		
Regenerative agriculture (A2.1)	340*	6,990‡
Reforestation/afforestation (A5.1)	170*	118,820†
Prairie preservation (A7.3)	1*	4,760 [§]
Other sequestration actions		
Extended timber harvest	117,600*	171,180*
Tidal wetland restoration	4,300*	12,540*
SUBTOTAL	122,411	314,290
Actions that maintain sequestration capacity		
Avoided conversion of forests [°]	11,310*	56,490*
Sources – see Appendix A for additional detail: * Robertson et al. (2021). Note that this analysis does not distinguish between activities occurring in urban versus rural areas. Most forested areas (93%) are in rural portions of Thurston County. † Reforestation Hub ‡ NRCS COMET-PLANNER, Washington Climate Smart Estimator § CARB Land Restoration Benefit Calculator Tool ° Avoiding forest conversion will not increase total sequestration in the region. It will only reduce future net emissions.		

Sequestration Potential of Actions Included in the TCMP

Regenerative Agriculture – TCMP Action A2.1

The TCMP set a target that 30 percent of cropland would be managed with regenerative agriculture practices by 2050 (6,600 acres). Data more recently developed for the Washington State Department of Agriculture and Conservation Commission suggests that the plan’s analysis underestimates sequestration potential from this sector—land management practices are likely to have higher rates of sequestration than that used in the plan’s analysis, and these practices could be applied on more land area, resulting in potential sequestration of nearly 7,000 MTCO₂e/year.

Reforestation/Afforestation – TCMP Action A5.1

Reforestation Hub, a project of Nature Conservancy and American Forests, identified just under 54,000 acres of land in Thurston County with reforestation potential, which, if restored at an average rate of 2,000 acres per year over 30 years, could sequester an estimated 119,000 MTCO₂e/year (Cook-Patton et al., 2020). This estimate is likely a high mark of how much reforestation is possible in Thurston County, but still falls short of the sequestration target for afforestation and reforestation in the TCMP (375,000 MTCO₂e/year).⁶ It assumes an approach that includes planting trees on large areas of urban open space and agricultural lands, which may be incompatible with other climate mitigation strategies and community goals. A more moderate approach that focuses on reforesting sensitive riparian areas at a rate of approximately 40 acres per year could result in additional sequestration of around 2,000 MTCO₂e/year by 2050 (Robertson et al., 2021).

Prairie Preservation – TCMP Action A7.3

Under Thurston County’s approved Habitat Conservation Plan, nearly 3,500 acres of prairie land will need to be managed to mitigate for projected impacts from future development on listed species over the next 30 years (Thurston County 2022). These activities include enhancing existing reserve areas, establishing new reserves, and securing working land easements in areas that overlap with agricultural activities. Conservation and restoration also will be included in the Bush Prairie Habitat Conservation Plan under development for land within the Tumwater Urban Growth Area. Completing the conservation activities identified in Thurston County’s approved Habitat Conservation Plan could increase sequestration by nearly 5,000 MTCO₂e/year, and additional efforts in the region could add to this potential.

Sequestration Potential of Additional Actions

Extended Timber Harvest

Most timberlands in Washington State are harvested after 30 or 40 years of growth—deferring harvests until 70 or 80 years allows substantial additional carbon to be stored in trees. One study estimates that extending harvest times on a greater proportion of private, state, and federal timber lands across the county could result in additional sequestration of up to 171,200 MTCO₂e/year in Thurston County (Robertson et. al, 2021). Extending timber harvests could affect the amount of timber excise taxes collected and distributed to counties and the state General Fund.

⁶ Though the study identifies a greater amount of potential land than needed in the plan, it uses a much more conservative sequestration rate.

Several actions on the long list considered for the TCMP focused on extending the length of timber harvest rotations, but none were ranked as a priority in the TCMP. With a better understanding of their sequestration potential, it may be worthwhile to revisit these actions and add them to the priority list.

Tidal Wetland Restoration

According to one analysis, restoration of tidal areas in Thurston County could sequester between 4,000 and 13,000 MTCO₂e/year. Two actions on the long list for the TCMP focused on increasing carbon sequestration in marine ecosystems, and these actions were a priority of the Squaxin Island Tribe, although they did not rank highly enough to be included in the plan. Revisiting these actions could help close any gap created by reducing expectations for other strategies.

Avoided Conversion of Forests

Forest conversion both creates a direct source of carbon emissions (by releasing a portion of the carbon stored in trees and roots into the atmosphere as carbon dioxide⁷) and reduces capacity for future forest carbon sequestration. Reducing the loss of forested areas to new development will not increase carbon sequestration, but could have substantial benefits by maintaining the region's existing baseline of carbon storage capacity. If future land use change is considered, the region will need to reduce emissions further to overcome the impacts of forest conversion and meet the TCMP targets. Avoiding forest conversion will minimize this additional gap.

The scenario analysis for the TCMP did not include an estimated rate of future forest conversion. One analysis estimates that if forest conversion continues at the rate seen in past decades, the region would lose 3,800 acres over next 30 years (Robertson et al., 2021). In contrast, TRPC estimates that by implementing existing local zoning and development codes that comply with the Growth Management Act—concentrating growth in urban areas and preserving rural character—local partners are already on a track to limit forest loss to nearly half that amount (2,100 acres). Concentrating a greater proportion of new development in urban areas and reducing development pressure on rural areas (as called for by the Sustainable Thurston land use targets adopted in the plan and actions listed under strategy T1) would further shrink that loss to around 1,300 acres of forest cover.⁸ This outcome could maintain an estimated 56,490 MTCO₂e/year of sequestration from forested areas that may otherwise be converted to developed land uses.

Several actions listed in the TCMP focus on tree cover in urban areas (A6.5, A6.9)—these actions are likely to have limited impact, given the relatively small contribution that urban areas make to the baseline sequestration estimate. Partners may wish to consider actions that focus on reducing forest conversion in rural areas, which have the bulk of forested land. The long list of actions considered for the TCMP included a strategy focused on land preservation (Strategy A4)—actions under this strategy did not rank as a high priority in the TCMP, since the greenhouse gas inventory at that time did not include an estimate of emissions from land conversion. With a better understanding of their sequestration potential, it may be worthwhile to revisit these actions and add them to the priority list.

⁷ Net emissions from forest conversion depend on how the timber cleared is used – some carbon continues to be stored for the long term as wood products.

⁸ Estimates of future forest cover used TRPC's land capacity model and population and employment forecast. See Appendix B and TRPC 2021.

6. Community Perspectives and Opportunities

TRPC staff interviewed local stakeholders⁹ to gain a better understanding about opportunities and concerns around the carbon sequestration targets and actions in the TCMP. Common themes from those interviews are listed in Table 2. For additional detail, see Appendix B.

Table 2. Summary of stakeholder perspectives on a regional carbon sequestration program

Vision	• Regional in scale • Includes wide range of practices: trees, agriculture, prairie preservation • Accessible to all types of land owners (urban, rural, small and large) • Supports other community goals related to habitat protection, open space protection, cooling • Focuses on voluntary and incentive-based tools, including education and technical support, with some regulatory support • Coordinated with state efforts
Opportunities	• Develop a baseline estimate of carbon sequestered through existing land uses (agriculture, forests, prairies) to account for impact of land conversion • Develop outreach materials and provide technical assistance for various practices: regenerative agriculture, forest management (including extended rotations), urban tree preservation and landscaping • Connect to existing programs, like Transfer of Development Rights (TDR), Voluntary Stewardship Program (VSP), existing city tree programs • Develop more consistent/complementary tree protection policies and standards across partner jurisdictions • Regulatory reform to remove barriers to regenerative agriculture practices
Concerns	• Appropriate balance among different sequestration forms: ex., where reforestation potential overlaps with existing agricultural lands or prairie areas • Appropriate balance between tree protection in urban areas, need for dense urban development (another TCMP strategy), and residential development • Financial cost of programs and staff time • Lack of interest among landowners/land managers • Ongoing maintenance requirements of lands used to account for sequestration • How to keep all stakeholders involved in the process • Voluntary, flexible tools are preferred, but may not meet the need • More land use needs than available land • Focus on carbon sequestration will reduce action on carbon reduction, allowing continued emissions from polluting entities • Accounting, so carbon sequestration benefit is not counted more than once

These interviews suggest there is considerable interest among potential community partners in activities that increase carbon sequestration, but that any future steps should carefully consider how those actions support other regional goals. Existing federal, state, and local resources may help support the development of carbon sequestration actions. These resources are summarized in Appendix C.

⁹ Interviews were held with representatives from Thurston Conservation District, Capitol Land Trust, South of the Sound Community Farmland Trust, WSU Extension (Forestry), Thurston Climate Action Team, City of Lacey, and City of Olympia

7. Carbon Sequestration in Practice: Case Studies

Other cities, counties, and organizations have existing programs that incorporate elements of carbon sequestration, though few have done so as part of broader climate mitigation strategies. TRPC staff interviewed representatives from several different types of programs to better understand how sequestration could be addressed in the Thurston region.¹⁰ Complete information on the case studies is included in Appendix D.

The carbon sequestration initiatives profiled take three forms: carbon credit programs, community forests, and urban forestry programs. The profiled programs offer the following insights into the potential for a carbon sequestration program in the Thurston region.

Partnerships help leverage expertise and make efficient use of resources. Rather than developing programs entirely in-house, all the profiled programs depend on some level of partnership between local government, private entities, nonprofits, and the community. For example, the Tucson Million Trees Initiative is operated by the nonprofit Tucson Clean and Beautiful and the mayor's office. The nonprofit is responsible for primary operations while the directive and goal came from the mayor's office. Similarly, King County's carbon credit program operates through county partnerships with City Forest Credits, Verified Carbon Standard, Microsoft, and other local businesses. This allows the County to outsource the time-consuming process of determining credit value to an outside third-party, rather than taking on the expense and accountability for developing that expertise within its own staff. Partners can also help fund and staff programs. The staffing demands for each program differ but are supported and distributed through local partnerships.

Urban tree canopy programs can serve multiple community goals, are the most established type of program, and potentially are the easiest place to start, but they have a limited climate mitigation benefit and tracking for sequestration adds significant complexity. Representatives from Pierce Conservation District, Tucson Million Trees Initiative, Tacoma Urban Forestry Management Plan, and King County recommended using urban tree programs to meet carbon sequestration targets in combination with other community goals. Generally, these programs require less overhead management than programs that cover a wider range of habitat types, and tree maintenance falls on individual renters or property owners. Most existing urban tree planting initiatives identify equity, public health, and a cooling effect as their primary goals rather than sequestration. These examples are in line with broader studies of urban tree planting and tree management programs that conclude such programs have broad benefits for climate *adaptation*—including through cooling, stormwater absorption, and health benefits—but limited potential to appreciably mitigate greenhouse gas emissions (Pataki et. al, 2021). Accurately measuring the additional carbon sequestration provided by urban forestry programs can pose a challenge; for tracking the program's benefits relative to a specific climate mitigation goal like that in the TCMP, practitioners recommend using an established certification organization.

Communicating with the community and gaining support or approval prior to program implementation is essential. Community engagement is critical for urban forestry programs to

¹⁰ TRPC conducted interviews with representatives of the following profiled programs: King County Forest Carbon Program, Pierce Conservation District Partnership with City Forest Credits, Nisqually Community Forest, Tucson Million Trees, Tacoma Urban Forestry Management Plan

understand resident needs, ensure that individuals have tools to care for trees, and place trees in appropriate spaces. Community support is also essential for rural reforestation, preservation, and afforestation efforts to understand land use needs and develop maintenance plans. Carbon credit programs rely on community and local interest in purchasing the credits. Determining interest and support before initiating the program can increase participation and overall success.

Seed funding from grants, utilities, or taxes are key to initiating programs, but partners should consider developing a sustainable funding source for long-term program needs. Most programs received grant funding to initiate a small-scale pilot program before expanding efforts. Each program requires funding for initiation and ongoing maintenance and oversight. Funding from carbon credit sales were identified as essential in continuing preservation and maintenance work. Many tree planting efforts are transitioning to use funding from stormwater management to increase the availability and security of funding.

Carbon sequestration programs should highlight options to benefit marginalized or historically disadvantaged communities. The programs reviewed incorporate equity considerations to varying degrees. Carbon sequestration can raise equity and environmental justice concerns, including that sequestration projects may be located at a distance from the emissions they are intended to offset, and that their co-benefits (such as improved air and water quality) do not accrue to the people whose health and communities may be most directly impacted by sources of emissions and climate impacts. For example, programs intended to increase tree cover may disproportionately benefit white and affluent communities. Particularly in urban areas, such programs can have the unintended effect of increasing property values and housing costs, leading to gentrification and the displacement of low-income residents, people of color, and other vulnerable and marginalized communities (Wolch et al., 2014). Representatives from urban tree planting programs suggest designing regional programs to distribute trees to historically underserved communities. Similarly, preserving open spaces can occur in areas that increase accessibility to green spaces for marginalized communities. Many tree planting program representatives recommended working with American Forests to designate priority regions.

8. Policy Options

Regional partners have many options to move toward meeting the 2050 carbon sequestration targets outlined in the TCMP. TRPC staff developed a list of potential policy options based on conversations with stakeholders, case studies, and sequestration potential in the Thurston region; details of each action are included in Appendix E.

Cost Estimates

- \$ = less than \$100,000
- \$\$ = \$100,000-\$1,000,000
- \$\$\$ = \$1,000,000

More detailed cost estimates are included with the description of each action in Appendix E.

Staff Estimates

- Low = less than 1 FTE for limited duration, across all partners
- Medium = 1 FTE for longer duration, across all partners
- High = More than 1 FTE, for indefinite duration, across all partners

Carbon Sequestration Potential

	Low/High Baseline Sequestration Category	Low/High Sequestration Potential	Confidence/Probability of Impact
Overall Carbon Sequestration Potential	Low (Urban Trees, Agriculture, Prairies)	Low/Medium (regenerative agriculture, prairie preservation, avoided conversion of urban areas, tidal wetland restoration)	Low (voluntary education/outreach, limited ability to scale)
	Med (Urban Trees, Agriculture, Prairies)	Low/Medium (regenerative agriculture, prairie preservation, avoided conversion of urban areas, tidal wetland restoration)	Medium/High (monetary incentives, regulation, or capital project; potential for widespread application)
	High (Rural Forest)	High (avoided conversion of rural forest areas, extended timber harvest)	Low (voluntary education/outreach, limited ability to scale)
	High (Rural Forest)	High (avoided conversion of rural forest areas, extended timber harvest)	Medium/High (monetary incentives, regulation, or capital project; potential for widespread application)
	Enabling	No direct sequestration benefit, but enables other actions.	

Table 3. Policy Options to Support Carbon Sequestration in the Thurston region. For details on each action, see Appendix E.

Action	Initial Cost	Ongoing Costs	Staff Requirements	Carbon Sequestration Potential	Potential Lead
Forests and Trees					
Rural/Forest Landowner Outreach and Technical Support Program	\$\$	\$\$	Medium	Medium	TCD, WSU Extension
Urban Tree Outreach and Technical Support	\$\$	\$\$	Medium	Low	Lacey, Olympia, Tumwater
Regional Urban Tree Canopy Assessment	\$	\$	Low	Enabling	TRPC, Thurston County, Lacey, Olympia, Tumwater
Tree Canopy Targets	\$	\$	Low	Enabling	TRPC, Thurston County, Lacey, Olympia, Tumwater
Urban Tree Management Plans and Code Review	\$\$	\$	Medium	Medium	Thurston County, Lacey, Olympia, Tumwater
Forest Conversion Ordinance and Rural Tree Standards Update	\$\$	\$	Medium	High	Thurston County
Comprehensive Plan Review and Update	\$\$	-	Medium	High	Thurston County, Lacey, Olympia, Tumwater
State Forest Lands Management Advocacy	\$	\$	Low	High	Thurston County, CASC
Working Forest Conservation Easements	\$\$\$	\$\$\$	High	High	Thurston County
Community Forests	\$\$\$	\$\$\$	High	High	Thurston County, Land Trusts
Regional Tree Fund	\$\$	\$	Medium	Enabling	Thurston County
Urban Forest Carbon Credit Program	\$	\$	Low	Low	Thurston County, Lacey, Olympia, Tumwater, TCD
Rural Forest Carbon Credit Program	\$\$	\$\$	Medium	High	Thurston County, TCD
Transfer of Development Rights Program Update	\$	\$	Medium	Medium	Thurston County
Land Conservation and Restoration Capacity	\$	\$	Medium	Enabling	Thurston County, Lacey, Olympia, Tumwater, Land Trusts

Action	Initial Cost	Ongoing Costs	Staff Requirements	Carbon Sequestration Potential	Potential Lead
Reforestation/Afforestation Projects¹¹	\$\$	\$\$\$	High	High	Thurston County, TCD, Land Trusts
Agriculture					
Regenerative Agriculture Practice Tracking	\$	\$	Low	Enabling	TCD, WSU Extension
Regenerative Agriculture Outreach and Technical Assistance	\$\$	\$\$	Medium	Low	Thurston County, TCD
Agriculture Zoning and Development Code Review	\$	\$	Low	Medium	Thurston County
Conservation Programs Update	\$	\$	Low	Medium	Thurston County
Regional Agriculture Fund	\$	\$	Low	Enabling	Thurston County
Agriculture Carbon Credit Program	\$	\$\$	Medium	Medium	Thurston County, Lacey, Olympia, Tumwater, TCD
Prairies					
Prairie Soil Analysis	\$	\$	Low	Enabling	WSU Extension
HCP Implementation	\$\$\$	\$\$\$	High	Medium	Thurston County, Tumwater, Port of Olympia
Prairie Conservation and Enhancement Carbon Credit Program	\$	\$\$	Medium	Medium	Thurston County, CNLM
Supporting/Other Actions					
Land Use Change Emissions Inventory	\$	\$	Low	Enabling	TRPC
TCMP Action Update	\$	\$	Low	Enabling	TRPC
TCMP Target Update	\$	\$	Low	Enabling	TRPC
Sequestration Working Group	\$	\$	Medium	Enabling	TRPC
Blue carbon/Tidal restoration	\$\$\$	\$\$\$	Medium	Medium	Squaxin Island Tribe, cities, county

¹¹ A reforestation program focused on planting in rural areas would have the most potential for contributing to TCMP sequestration targets; planting projects incorporated into urban forest management programs would have limited sequestration potential.

9. Conclusion and Next Steps

This report outlines existing information and resources for policymakers and staff to consider in creating a regionally coordinated carbon sequestration program, though gaps remain that would help partners understand the long-term impacts of carbon sequestration. The carbon sequestration targets identified in the TCMP were based on what the region required to meet climate goals, but looking ahead, TCMP partners will need to balance the role of sequestration with other climate mitigation strategies and available resources.

As a first phase of addressing this sector, partners may opt to focus resources on the following areas:

- **Initiate actions with low to medium staff requirements that address areas with the greatest carbon sequestration potential—rural forests.**
 - Forest Conversion Ordinance and Rural Tree Standards Update
 - State Forest Lands Management Advocacy
- **Lay the groundwork for more intensive actions that address sequestration in rural forests, including looking at feasibility of:**
 - Working Forest Conservation Easements
 - Community Forests
 - Rural/Forest Landowner Outreach and Technical Support Program
 - Regional Tree Fund
 - Carbon Credit Programs
 - Reforestation/Afforestation Projects
- **Ensure the role of carbon sequestration is recognized and aligned in existing programs.**
 - Comprehensive Plan Updates
 - Transfer of Development Rights Program Update
 - Conservation Program Amendments
 - Habitat Conservation Plan Implementation
 - TCMP Action and Target Update
- **Fill priority data gaps to better enable and inform future work and sequestration estimates.**
 - Land Use Change Emissions Inventory
 - Regional Urban Tree Canopy Assessment
 - Prairie Soil Analysis
 - Regenerative Agriculture Practice Tracking
- **Help build relationships and capacity among regional partners**
 - Land Conservation and Restoration Capacity
 - Sequestration Working Group

10. References

- Badgley, G., Freeman, J., Hamman, J., Haya, B., Trugman, A., Anderegg, W. R. L., Cullenward, D. (2021). Systematic over-crediting of forest offsets <https://carbonplan.org/research/forest-offsets-explainer>.
- Case, M. J., Johnson, B. G., Bartowitz, K. J., & Hudiburg, T. W. (2021) Forests of the future: Climate change impacts and implications for carbon storage in the Pacific Northwest, USA. *Forest Ecology and Management*, 482, 118886. <https://doi.org/10.1016/j.foreco.2020.118886> Carbon sinks and sequestration. UNECE. <https://unece.org/forests/carbon-sinks-and-sequestration>.
- Cook-Patton, S. (2021) Reforesting the U.S.: Here's where we can put all those trees. The Nature Conservancy. <https://www.nature.org/en-us/what-we-do/our-priorities/tackle-climate-change/climate-change-stories/reforesting-united-states-susan-cook-patton/>.
- Cook-Patton, S., Gopalakrishna, T., Daigneault, A., Leavitt, S.M., Platt, J., Scull, S.M., Amarjargal, O., Griscom, B.W., McGuire, J.L., Yeo, S.M., Fargione J.E. (2020) Lower cost and more feasible options to restore forest cover in the contiguous United States for climate mitigation. *Elsevier Inc.* <https://doi.org/10.1016/j.oneear.2020.11.013>
- Garcia Freites, S. and Jones, C. (2020) A Review of the Role of Fossil Fuel-based Carbon Capture and Storage in the Energy System. Tyndall Centre for Climate Change Research for Friends of the Earth Scotland. https://foe.scot/wp-content/uploads/2021/01/CCS_REPORT_FINAL.pdf
- Giller, K. E., Hijbeek, R., Andersson, J. A., & Sumberg, J. (2021) Regenerative Agriculture: An agronomic perspective. *Outlook on Agriculture*, 50(1), 13–25. <https://doi.org/10.1177/0030727021998063>
- Hammerschlag, R. (2020) Scenario Analysis Tool and User's Guide developed for the Thurston Climate Mitigation Plan. https://www.trpc.org/DocumentCenter/View/8317/TCMP_A5
- IPCC, 2018: Summary for Policymakers. In: *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp.
- Janowiak, M., Connelly, W., Dante-Wood, K., Domke, G., Giardina, C., Kayler, Z., Marcinkowski, K., Onto, T., Rodriguez-Franco, C., Swanston, C., Woodall, C.; Buford, M. (2017) US Forest Service General Technical Report WO-95. Considering Forest and Grassland Carbon in Land Management. https://srs.fs.usda.gov/stateline/2017-08-17/resources/docs/gtr_wo95.pdf.
- Newton, P., Civita, N., Frankel-Goldwater, L., Bartel, K., & Johns, C. (2020) What is regenerative agriculture? A review of scholar and practitioner definitions based on processes and outcomes. *Frontiers in Sustainable Food Systems*. 4:577723. doi: 10.3389/fsufs.2020.577723

- Nowak, David J, & Crane, Daniel E. (2002) Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution* (1987), 116(3), 381–389. [https://doi.org/10.1016/S0269-7491\(01\)00214-7](https://doi.org/10.1016/S0269-7491(01)00214-7)
- Pataki D.E., Alberti M., Cadenasso M.L., Felson A.J., McDonnell M.J., Pincetl S., Pouyat R.V., Setälä H. and Whitlow T.H. (2021) The Benefits and Limits of Urban Tree Planting for Environmental and Human Health. *Front. Ecol. Evol.* 9:603757. doi: 10.3389/fevo.2021.603757 <https://www.frontiersin.org/articles/10.3389/fevo.2021.603757/full>
- Robertson, J. C., Randrup, K. V., Howe, E. R., Case, M. J., & Levin, P.S. (2021) Leveraging the potential of nature to meet net zero greenhouse gas emissions in Washington State. *PeerJ*, 9, e11802. <https://doi.org/10.7717/peerj.11802>
- Thurston Regional Planning Council. (TRPC 2021). Thurston County Current and Future Basin Conditions Assessment. <https://www.trpc.org/DocumentCenter/View/8901/BasinConditionReport2021>. Note that to develop the estimates of future forest cover used in this report, TRPC re-ran the land capacity model using the under the Sustainable Thurston land use alternative developed for the 2021 Buildable Lands Report for Thurston County: <https://www.trpc.org/DocumentCenter/View/8542/2021-Buildable-Lands-Report-2021-08-22?bidId=>
- Thurston County. (2022) Thurston County Habitat Conservation Plan. <https://www.thurstoncountywa.gov/planning/HCP/Documents/HCP-February-2022-Combined.pdf>
- West, Tristram O., & Marland, G. (2002) “A Synthesis of Carbon Sequestration, Carbon Emissions, and Net Carbon Flux in Agriculture: Comparing Tillage Practices in the United States,” *Agriculture, Ecosystems & Environment* 91, no. 1–3 (2002): 217–32, [https://doi.org/10.1016/S0167-8809\(01\)00233-X](https://doi.org/10.1016/S0167-8809(01)00233-X)
- Wolch, Jennifer R, Byrne, Jason, & Newell, Joshua P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities ‘just green enough’ *Landscape and Urban Planning*, 125, 234–244. <https://doi.org/10.1016/j.landurbplan.2014.01.017>

FEBRUARY 2023

The logo for the Thurston Climate Mitigation Plan is located in the upper right quadrant. It consists of four stacked rectangular boxes, each containing a word in white, sans-serif, uppercase letters. The first box is teal and contains the word 'THURSTON'. The second box is dark red and contains the word 'CLIMATE'. The third box is dark blue and contains the word 'MITIGATION'. The fourth box is orange and contains the word 'PLAN'. To the right of these boxes is a thin, vertical green line that extends slightly above and below the stack of boxes.

**THURSTON
CLIMATE
MITIGATION
PLAN**

**CARBON SEQUESTRATION AS A CLIMATE
MITIGATION STRATEGY FOR THE
THURSTON REGION:
APPENDICES**

THURSTON REGIONAL PLANNING COUNCIL

Appendices

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Appendix A

Carbon Sequestration Potential in Thurston County

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Appendix A: Carbon Sequestration Potential

1. Background

The Thurston Climate Mitigation Plan (TCMP) set a target that the Thurston region sequester an estimated 380,000 tons of CO₂ annually by 2050 to meet its emission reduction goal. To create that target, the scenario analysis for the plan combined estimates for two strategies: increased carbon storage in soils in agricultural lands and increased carbon storage in trees.

Table 1. Carbon sequestration targets in the Thurston Climate Mitigation Plan

	Description	Estimated Sequestration Rate	Land area needed	2050 Sequestration Target
Agriculture Soil Carbon	Managing agricultural land to store carbon in soil through regenerative agriculture.	0.14 MTCO ₂ e/acre-year*	6,600 acres [†]	3,300 MTCO ₂ e/year
Afforestation/Reforestation	Managing forested land to store carbon by establishing trees in areas not previously forested or where trees have been cleared.	10.18 MTCO ₂ e/acre-year [‡]	37,000 acres	376,000 MTCO ₂ e/year

* West and Marland, 2002

† Equivalent to 30% of 22,109 acres cropland identified in Thurston County in the USDA 2017 Agricultural Census.

‡ Estimates provided by Dylan Fischer, professor in Forest Ecology at The Evergreen State College, based on reforestation projects in the Olympia area. Estimated sequestration rates were found to increase with time, ranging from 4.05 MTCO₂e/acre-year for first ten years, 8.65 MTCO₂e/acre-year over twenty years of growth, and 10.18 tCO₂/acre-year over thirty years of growth.

As noted in the plan, these estimates were developed to provide a rough calculation of how much sequestration may be needed to meet the region's overall emissions reduction targets, rather than an estimate of what might be reasonable or feasible for local jurisdictions given practical constraints. In particular, the estimate for afforestation/reforestation is ambitious, accounting for approximately 8 percent of the total land in Thurston County. The scenario analysis also lacked data for several other strategies discussed in the plan that could contribute to a more complete estimate of sequestration potential:

- Baseline sequestration provided by existing land cover and land practices
- Sequestration rate of alternative forest and tree canopy management practices, including in urban areas
- Sequestration rate of existing and restored prairie areas

These data gaps mean that while the TCMP recognizes the climate mitigation potential of conserving existing trees, forested areas, and prairies, these benefits were not quantified to set targets for the plan.

Appendix A: Carbon Sequestration Potential

Similarly, the potential benefits of restoring prairies and marine areas are discussed in the plan, but were not included in the sequestration target.

Two key questions were raised during discussions about using carbon sequestration as a climate mitigation strategy in the Thurston Climate Mitigation Plan:

- How much carbon sequestration is currently occurring in Thurston County in existing land uses?
- How much carbon could certain land covers/uses (forests, agriculture, prairies) potentially sequester in the future, as a climate mitigation strategy?

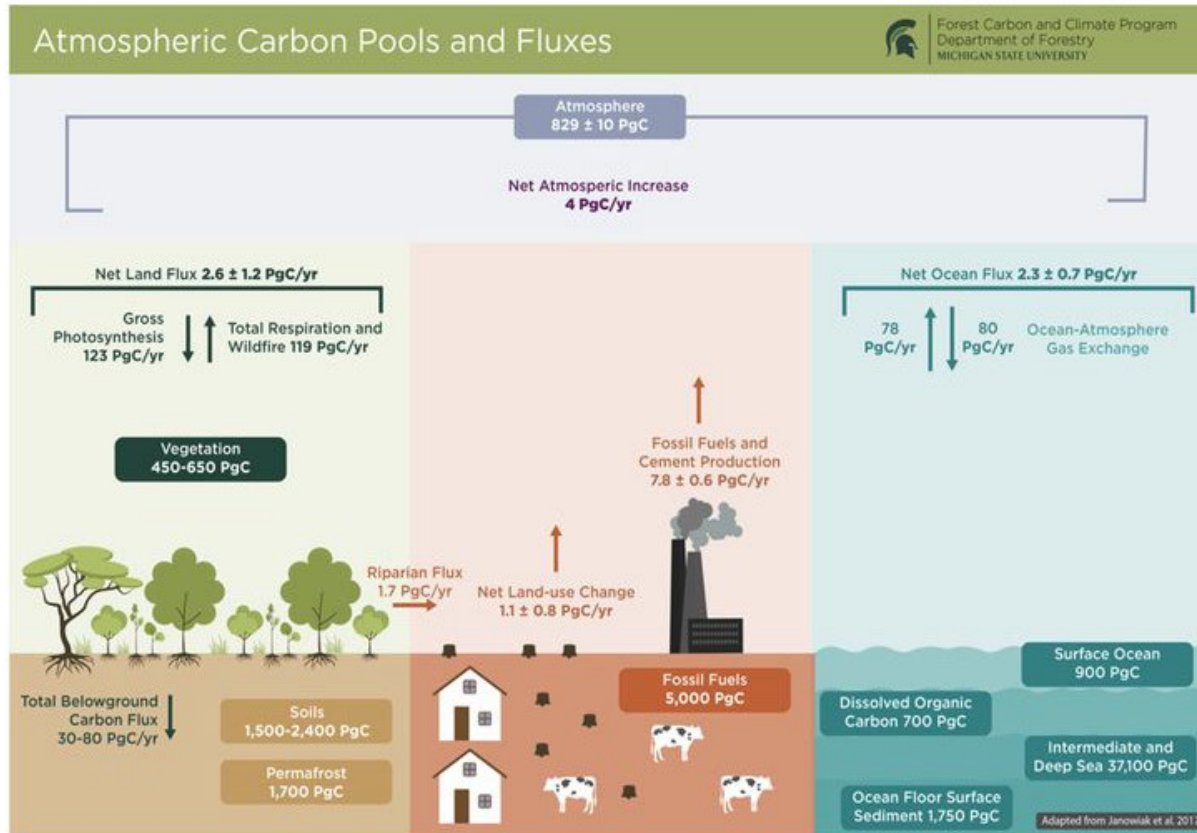
This appendix reviews some existing, available methodologies and data sources that provide information on carbon sequestration and carbon sequestration potential in Thurston County. The concluding section presents conclusions from this review that can inform future work.

2. Terms

The global carbon cycle includes movement of carbon (C) among vegetation, soil, ocean, rock, and atmosphere. It is important to understand two concepts from that cycle that are sometimes conflated when discussing the potential for carbon sequestration as a climate mitigation strategy.

- **Carbon Stock** is the amount of carbon stored in a “pool” at a given time. Carbon pools include live and dead vegetation, soil, rocks, liquids, or gases. When we talk about the total amount of carbon stored (or sequestered) in existing ecosystems, like forests or agricultural soils, we are referring to carbon stocks. In this report, carbon stocks are reported as metric tons of carbon (tC).
- **Carbon Flux** is the movement of carbon from one pool to another over a length of time. **Carbon sequestration** is one type of carbon flux – it is a process that removes carbon dioxide from the atmosphere and stores it a solid or liquid form where it can’t contribute to the greenhouse effect that is causing climate change. For example, photosynthesis takes carbon dioxide from the atmosphere and changes it into the organic carbon that makes up the leaves or roots of a plant. **Carbon emissions** are another type of carbon flux – a process where carbon in a solid or liquid form changes and is released into the atmosphere as carbon dioxide, such as when wood is burned as fuel. For consistency with the TCMP, this report uses metric tons of carbon dioxide equivalent (MTCO_{2e}) when discussing carbon fluxes.

Figure 1. Global Carbon Stocks and Fluxes. Source: Michigan State University Forest Carbon and Climate Program.



3. IPCC Guidance and US Greenhouse Gas Inventory

The Intergovernmental Panel on Climate Change (IPCC) is an international body charged with assessing science related to climate change. IPCC guidelines for National Greenhouse Gas Inventories outline methods for evaluating greenhouse gas emissions and removals (sinks or sequestration) from managed land use (IPCC 2019). The United States has applied this guidance at a national level, as part of its requirements under the United Nations Framework Convention on Climate Change (EPA 2021).

The IPCC recommends that greenhouse gases from land uses be reported in six main categories: Forest Land, Cropland, Grassland, Wetlands, Settlements, and Other Land. These categories are defined generally by the IPCC, and more specifically by individual nations or other practitioners – the definitions used by both the IPCC and the United States in the national greenhouse gas inventory are summarized in Table 2.

These land-use categories can be further subdivided by climate, soil type, management practices or other relevant factors. The guidelines include looking at how much land has changed from one category to another (converted) during a specified period, and estimating carbon stock changes in those different categories from various ecosystem components, including plant biomass, dead organic matter, and soils.

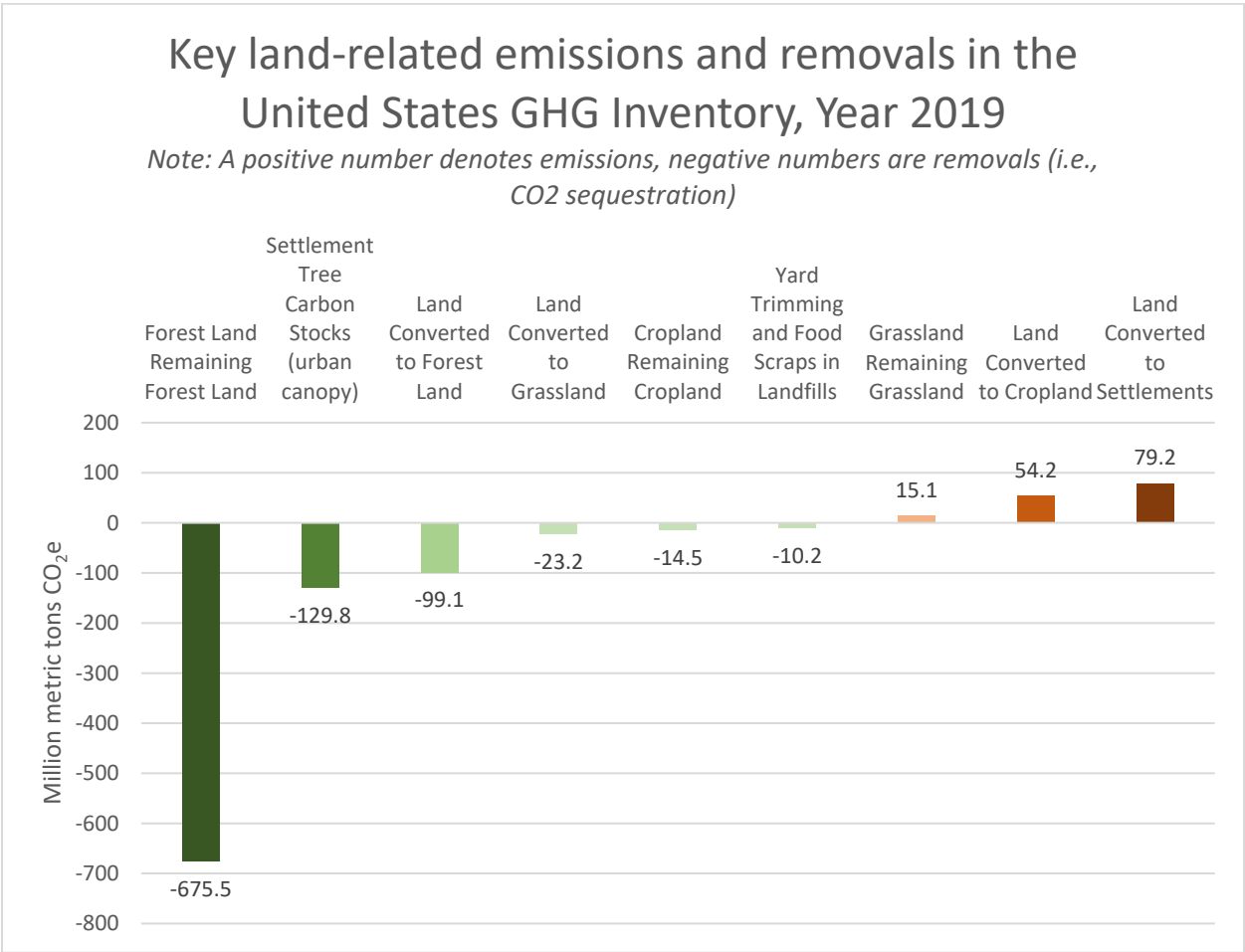
Appendix A: Carbon Sequestration Potential

Table 2. Land Use Category Definitions for Greenhouse Gas Inventories

Land Use Category	IPCC Definition (IPCC 2019)	US Definition (EPA 2021)
Forest Land	All land with woody vegetation consistent with thresholds used to define Forest Land in the national greenhouse gas inventory.	Areas at least 120 feet wide (36.6 meters) and 1 acre (0.4 hectare) in size with at least 10 percent canopy cover (or equivalent stocking) by live trees. Land with such tree area and cover is not classified as forest if completely surrounded by urban or developed lands (such land is classified as Settlements); land that is predominantly under agricultural land use is also not considered Forest.
Cropland	Cropped land, including rice fields, and agro-forestry systems where the vegetation structure falls below the thresholds used for the Forest Land category.	Areas used for the production of adapted crops for harvest. This category includes both cultivated (row crops, close-grown crops) and non-cultivated (hay, orchards) land.
Grassland	Rangelands and pastureland that are not considered Cropland. It also includes systems with woody vegetation and other non-grass vegetation such as herbs and bushes that fall below the threshold values used in the Forest Land category. The category also includes all grassland from wild lands to recreational areas as well as agricultural and silvi-pastoral systems, consistent with national definitions.	Areas on which the plant cover is composed principally of grasses; grass-like plants (i.e., sedges and rushes); forbs; or shrubs suitable for grazing and browsing. It includes both pastures and native rangelands. Grassland includes pasture and rangeland that are primarily, but not exclusively used for livestock grazing. Rangelands are typically extensive areas of native grassland that are not intensively managed, while pastures are typically seeded grassland (possibly following tree removal) that may also have additional management, such as irrigation or interseeding of legumes. Woodlands are also considered grassland and are areas of continuous tree cover that do not meet the definition of forest land.
Wetlands	Areas of peat extraction and land that is covered or saturated by water for all or part of the year (peatlands and other wetland types) and that does not fall into the Forest Land, Cropland, Grassland or Settlements categories.	Land covered or saturated by water for all or part of the year, as well as areas of lakes, reservoirs, and rivers.
Settlements	All developed land, including transportation infrastructure and human settlements of any size, unless they are already included under other categories.	Developed areas consisting of units of 0.25 acres (0.1 hectare) or more that include residential, industrial, commercial, and institutional land (including farm buildings and road networks). Also includes tracts of less than 10 acres (4.05 hectares) that may meet the definitions for Forest Land, Cropland, Grassland, or Other Land but are completely surrounded by urban or built-up land.
Other Land	Bare soil, rock, ice, and all land areas that do not fall into any of the other five categories.	Bare soil, rock, ice, and all land areas that do not fall into any of the other five land use categories; carbon stock changes and non-CO ₂ emissions are not estimated for Other Land, because these areas are largely devoid of biomass, litter, and soil carbon pools.

The most recent United States greenhouse gas inventory estimates that in 2019, land use categories, including forestry, contributed to a net removal of 789 million MTCO₂e (EPA 2021). Forestland and urban trees (trees in settlements) are the two most significant carbon sinks estimated for that inventory (Figure 2). Land use conversion, including converting forested areas to settlements (which may or may not be urban) and to agricultural use are two sources of land use emissions.

Figure 2. Key land-related emissions and removals in the United States GHG Inventory. Source: EPA 2021



Developing a greenhouse gas inventory for land use requires landscape-scale data that is complete across the area being assessed, capable of representing land-use categories and conversions over time, and consistent in its reporting. The United States Greenhouse Gas Inventory uses a combination of three datasets for its analysis:

- **National Resources Inventory (NRI)** – Used for non-federal, non-Forest lands in the mainland US and Hawaii. The NRI is a statistical survey conducted by the USDA Natural Resources Conservation Service with information on land use, soil conditions, and land management

Appendix A: Carbon Sequestration Potential

practices, which makes it useful for assessing carbon stock changes for Cropland and Grassland categories. Land use trends are available in five-year intervals, with the most recent from 2017.

- **Forest Inventory and Analysis (FIA)** – Used for Forest Land estimates. The FIA is an inventory survey conducted by the US Forest Service with detailed information on forest conditions. In the western United States, a portion of survey plots are sampled each year, with all plots sampled every 10 years. The most recent data available for Western Washington runs through 2019.
- **National Land Cover Database (NLCD)** – Used for federal, non-Forest lands, and to cover any other gaps in NRI and FIA data. NLCD data is also used to estimate percent tree cover in settlement areas. The NLCD is released by the United States Geologic Survey (USGS) which uses 30-meter resolution imagery to map land cover. It is available in five-year increments, with the most recent data from 2019.

Appendix A: Carbon Sequestration Potential

4. Thurston County Land Cover and Land Use Estimates

TRPC typically uses data from NOAA's Coastal Change Analysis Program (C-CAP) to estimate land cover. C-CAP data provides more detailed land cover categories for coastal areas, especially wetlands and shorelines, and is intended to be consistent with NLCD categories, however, a comparison of 2016 NLCD and C-CAP land cover data for Thurston County found significant differences in how land was classified (Table 3).

Table 3. Thurston County Land Cover Categories, comparing 2016 NLCD and C-CAP Data. Land cover categories were consolidated into the six IPCC categories, using the same reclassification scheme employed by Birdsey and Harris (2021) for the ICLEI LEARN tool discussed below. Note that the total land amounts may differ from other estimates due to differences in map projections and data boundaries.

IPCC Categories	NLCD Categories Included	C-CAP Categories Included	NLCD 2016 (acres)	C-CAP 2016 (acres)	Difference (acres)
Forest Land	Deciduous Forest, Evergreen Forest, Mixed Forest, Woody Wetlands	Deciduous Forest, Evergreen Forest, Mixed Forest, Palustrine Forested Wetland	238,090	230,011	8,079
Cropland	Cultivated Crops	Cultivated	1,009	6,302	-5,294
Grassland	Pasture/Hay, Grassland/Herbaceous, Scrub/Shrub	Pasture/Hay, Grassland, Shrub/Scrub	133,028	146,132	-13,104
Wetland	Open Water, Emergent Herbaceous Wetlands	Water, Palustrine Scrub/Shrub Wetland, Palustrine Emergent Wetland, Estuarine Emergent Wetland, Unconsolidated Shore, Palustrine Aquatic Bed, Estuarine Aquatic Bed	42,583	47,901	-5,319
Settlement	Developed Open Space, Developed Low Density, Developed Medium Density, Developed High Density	Developed Open Space, Developed Low Density, Developed Medium Density, Developed High Density	78,041	62,459	15,582
Other Land	Perennial Ice/Snow, Barren Land	Barren Land, Snow/Ice	2,469	2,414	55
Total			495,220	495,220	0

Appendix A: Carbon Sequestration Potential

Excluding open water categories, Thurston County's land area is approximately 462,000 acres. The Scenario Analysis Tool used for the development of the TCMP used a land area estimate provided by Thurston County of 462,080 acres. Table 4 shows how the six IPCC land categories are distributed among some land use categories relevant to the TCMP.

Table 4. Comparing Thurston County Land Cover Categories by some land uses. Land cover categories were consolidated into the six IPCC categories, using the same reclassification scheme employed by Birdsey and Harris (2021) for the ICLEI LEARN tool discussed below. Note that the total land amounts may differ from other estimates due to differences in map projections and data boundaries.

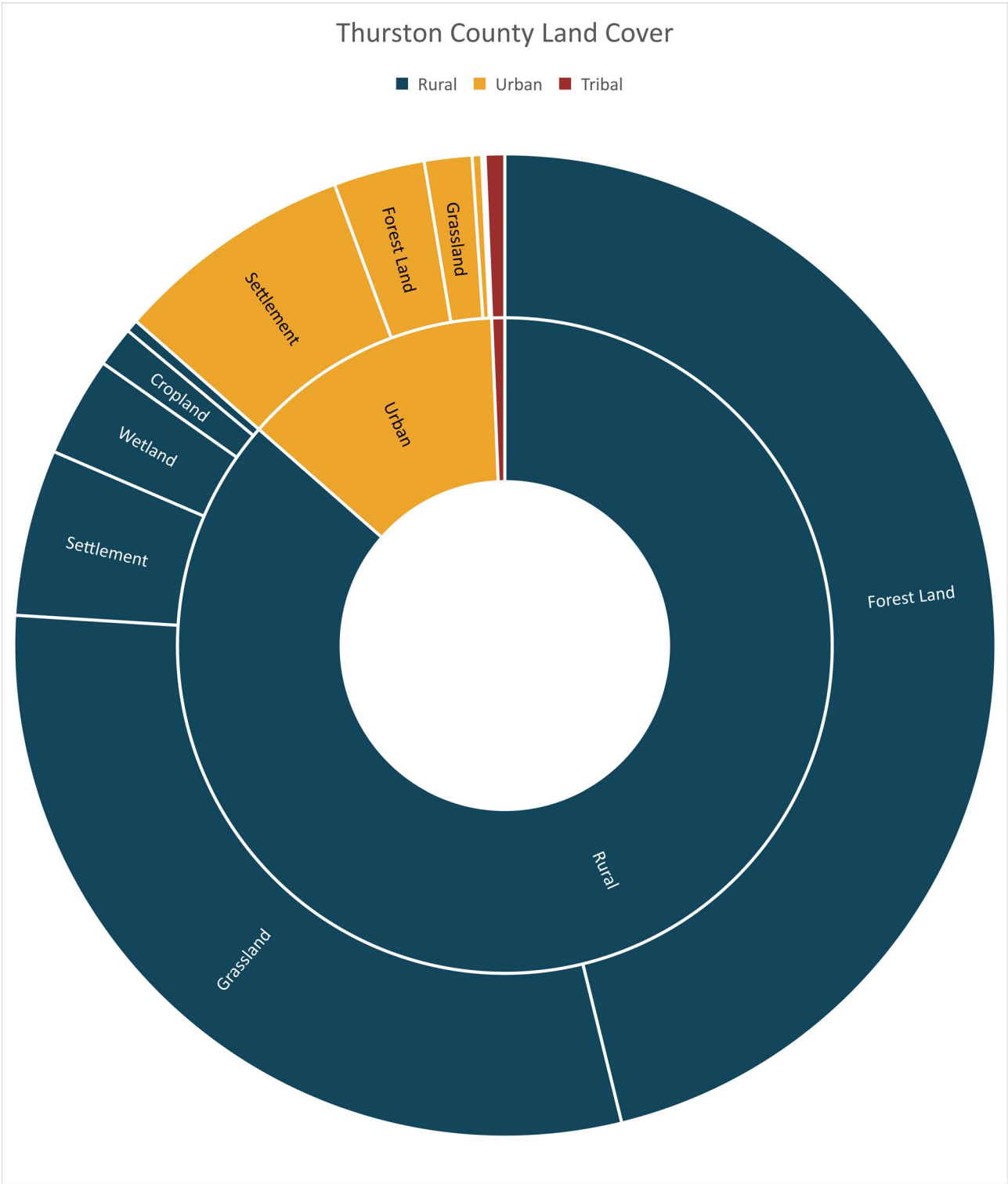
IPCC Land Cover Category	Land Uses (acres)							
	<u>Rural</u>				<u>Urban</u>		Tribal Reservation	Total
	Park	Forestry	Prairie Soils	Other	Park	Other		
Forest Land	6,681	124,532	26,770	55,349	1,534	12,339	1,791	228,996
Cropland	250	89	3,447	2,335	11	117	38	6,287
Grassland	3,582	61,604	31,953	40,605	303	6,939	689	145,676
Wetland	2,472	2,809	566	9,314	160	1,277	116	16,715
Settlement	308	1,115	12,581	11,288	838	35,638	281	62,050
Other Land	6	1,020	574	277	4	389	53	2,324
Total	13,299	191,169	75,891	119,168	2,850	56,699	2,968	462,048

Notes:

- Data Source: 2016 NOAA C-CAP
- Rural = Land in unincorporated rural Thurston County
- Urban = Land in an incorporated city or Urban Growth Area (UGA).
- Park = Land identified as a public park, open space, or preserve.
- Forestry = Land zoned as Long-Term Forestry (LTF) or in current use forestry or open space timber tax program (Assessor use codes 88 and 95), excluding 'Park.'
- Prairie Soils = Soils in which Thurston County CPED requires a prairie plant review prior to permitting. Excludes 'Forest' and 'Park.' List of soils:
<https://www.thurstoncountywa.gov/planning/planningdocuments/gopher-2021-soils-list-gopher-prairie.pdf> (7/26/2021)

Appendix A: Carbon Sequestration Potential

Figure 3. Relative Area of Thurston County Land Cover Categories, Comparing Rural, Urban, and Tribal Areas.
Source: 2016 NOAA C-CAP

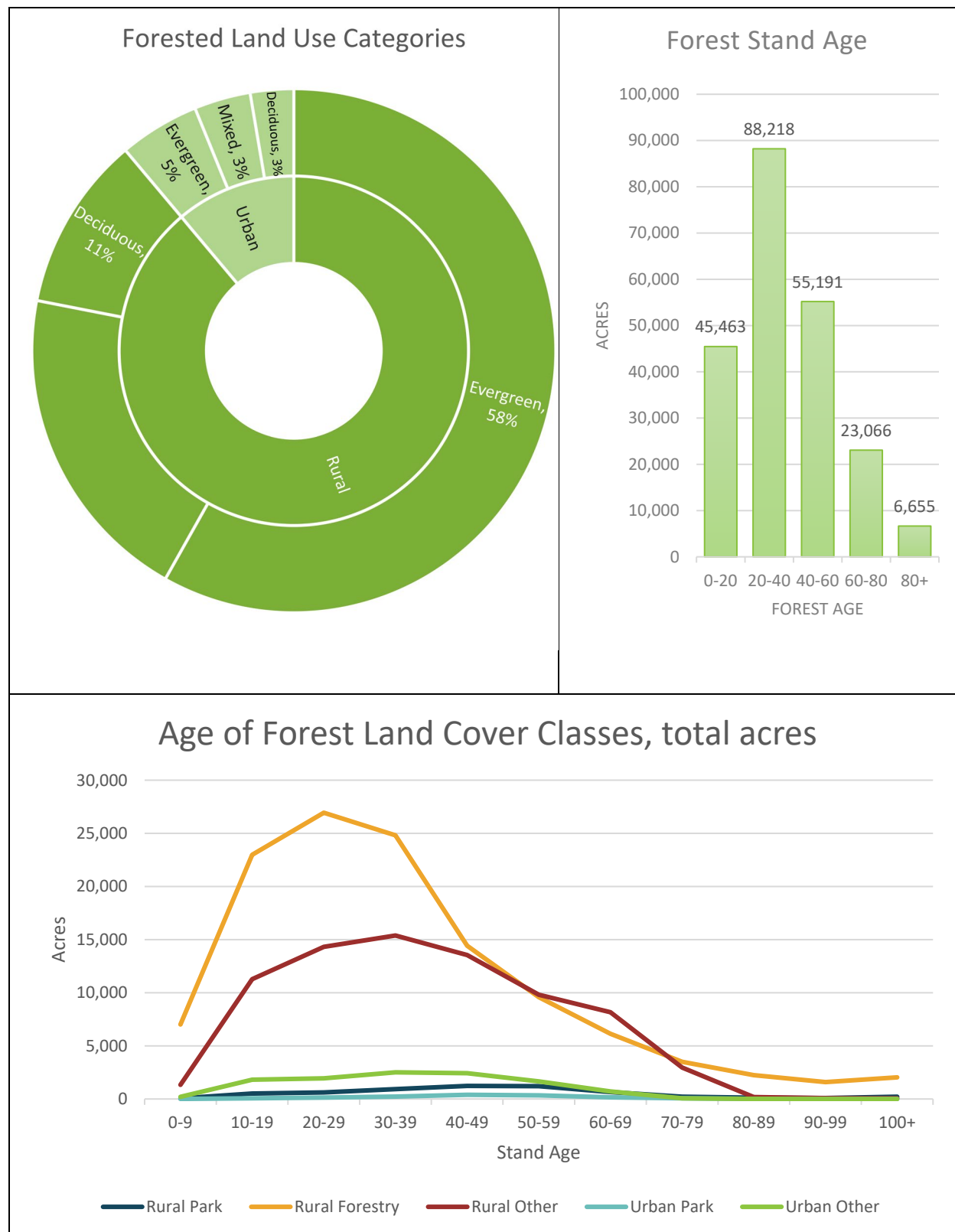


This review suggests a few observations relevant to developing and reviewing estimates of carbon sequestration potential in Thurston County, in line with the Thurston Climate Mitigation Plan:

- **Land Cover Estimates.** Estimates of Thurston County land cover area will vary depending on the methodology used, including differences in boundaries, map projections, and definitions.
- **Urban and Rural.** Rural unincorporated areas account for most of Thurston County's land area (86 percent); cities, towns, and unincorporated urban areas account for 13 percent of all land. These divisions do not correspond cleanly to the IPCC Settlement category—about 60 percent of areas classified as settlement are within a designated Urban Growth Area (UGA) boundary. This is because a portion of development in Thurston County exists outside designated UGA) boundaries.
- **Forested Areas and Timberlands.** Half of Thurston County's land area (50 percent) is covered by forested land covers. Evergreens dominate, making up 64 percent of forested areas. Mixed forest and deciduous forest cover make up smaller proportions (23 percent and 13 percent of forested areas, respectively). The bulk of forested land cover is in the rural area (93 percent), and about 60 percent of that is in "Forestry" use, including two-thirds of all evergreen forest areas. Only a small portion of forested land (3 percent) is in a designated park or preserve—the remaining 40 percent is in private (non-forestry use) ownership.
 - **Forest Age.** The age of trees can play a role in planning for carbon sequestration. A study using data from Pacific Northwest National Forest lands suggests that older, larger trees are important carbon stocks and accumulate more carbon individually, while younger stands of smaller trees accumulate more carbon by area (Gray et al. 2016). Data from the Washington Department of Natural Resources indicates that most forested areas in Thurston County have relatively young trees, with 60 percent of stands under 40 years. As shown in Figure 4, areas managed for forestry generally have younger trees, especially when compared to those within public parks and preserves.
 - **Future Loss of Forest Cover.** TRPC estimates that under current regulations, future development will result in a loss of about 1,000 acres of forest cover by 2030 and 2,100 acres of forest cover by 2045 – less than one percent of all forest cover in Thurston County (0.4 percent) (TRPC 2021). This loss is evenly split between rural areas and urban areas. Achieving the Sustainable Thurston preferred land use scenario included as a target in the TCMP, which concentrates a higher proportion of new development in urban areas and within urban centers and corridors, would reduce the loss of forest cover 1,300 acres by 2045 (0.3 percent of Thurston County forest cover). While this difference in acreage is small, it shows that concentrating development in urban areas can reduce the loss of carbon sequestering forested areas countywide.

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Figure 4. Forest Land Cover and Forest Stand Age, Thurston County. Source: NOAA C-CAP 2016; DNR Remote Sensing Forest Inventory 2021



- **Agriculture.** The IPCC-based land classifications result in a much more limited estimate of agricultural land than has been used in other estimates for Thurston County. In part, this outcome occurs because the methodology focuses only on cultivated area and excludes pasture/hay, which is the predominant agricultural land cover in Thurston County. Even with this consideration, the total acreage is small (~6,000 acres). The U.S. Department of Agriculture's 2017 Census of Agriculture estimated approximately 62,250 acres of farmland in Thurston County, including 22,100 acres of cropland (23 percent of which was used for growing hay). The TCMP used the USDA cropland estimate as the basis for estimates of carbon sequestration from regenerative agriculture practices.
- **Prairies.** Restoration of prairies is a particular interest in Thurston County, with a specific regulated definition, but this definition does not fit neatly into the IPCC classification categories. Most lands classified as "Grassland" do not have underlying soils associated with Puget Sound prairies, so the Grassland category cannot be used as a proxy for sequestration provided by prairies. While nearly half of the land with prairie soils (42 percent) falls into the "Grassland" category, most of that is in areas used for pasture and hay, which is frequently considered an agricultural use. A third of the land with prairie soils (34 percent) currently has forest cover, mostly evergreen forest. Because of these overlaps between prairie soils and areas in agricultural and forestry uses, careful thought will need to be given to any estimates of carbon sequestration for this land use.

5. Estimates of Sequestration in Existing Land Uses

TRPC staff reviewed several existing tools to develop an initial, rough estimate of sequestration from different land uses in Thurston County.

5.1 Forests and Trees

Both older, larger trees and younger, smaller trees contribute to carbon sequestration, though they do so in different ways. Older, larger trees serve as important carbon stocks and accumulate more carbon individually, while younger stands of smaller trees accumulate more carbon by area on an annual basis (carbon flux) (Gray et al. 2016).

ICLEI Protocol and LEARN Tool

The United States chapter of the International Council for Local Environmental Initiatives (ICLEI – also called Local Governments for Sustainability) develops tools and technical assistance to advance climate action, including industry standard guidance for community-scale greenhouse gas inventories. Appendix J of ICLEI's protocol provides guidance on estimating greenhouse gas emissions from land uses, with a focus on Forest Land and Trees (Birdsey et al, 2019). Because ecological processes and land use practices can vary from year to year, ICLEI recommends using an annual average over a period of five to ten years that span the community's baseline year to develop a baseline inventory of greenhouse gases from land use.

ICLEI's Land Emissions and Removal Navigator (LEARN) tool compiles national land cover data into an interactive map that applies the protocols developed by ICLEI for estimating emissions from forests and trees outside of forests, including in urban areas. The tool does not estimate emissions and sinks from

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other types of land uses, such as croplands and grasslands. The LEARN tool uses NLCD data to estimate land cover change, including data from 2001 through 2019.

TRPC staff used the LEARN tool to estimate baseline land cover change and net carbon flux for forests and trees (emissions + sequestration). Staff used current jurisdiction boundaries; selected Seattle, Washington, as the reference community for emission and removal factors; and used an inventory interval of 2006 to 2016. This ten-year period spans the region's emission reduction baseline year of 2015. Note that the LEARN tool only provides emissions estimates for trees outside forest land for the period of 2011-2016.

Table 5. Thurston County's GHG fluxes from forests and trees for inventory period 2006-2016, using ICLEI LEARN tool. All values reported in (MTCO₂e/year).

	Removals (MTCO₂e/year)	Emissions (MTCO₂e/year)
Undisturbed Forest	-996,786	
Forest Disturbances from insect/disease		71,945
Non-Forest to Forest (Reforestation/Afforestation)	-184,637	
Forest Conversion to Settlement		17,568
Forest Conversion to Grassland		328,043
Forest to other non-forest lands		2,241
Trees outside forests (i.e., trees in settlement areas, urban trees)	-183,690	18,459
TOTAL	-1,365,113	438,256
Net GHG Balance	-926,857	

This analysis estimates that in Thurston County, forests and trees annually sequester an approximate net 926,900 MTCO₂e/year. This figure could be used as a provisional baseline estimate of carbon sequestration from trees in Thurston County. A review of the results from the tool suggests the following findings:

- The bulk of sequestration (93 percent) takes place in rural portions of the county; trees within urban areas contribute a relatively small proportion to sequestration countywide (7 percent).
- Undisturbed forestland makes up the largest source of sequestration in the Thurston region (73 percent)—this estimate includes areas within forested timberlands as well as forested areas not used for forestry. Trees outside forest lands include, but are not exclusively, trees within designated urban areas—these comprise a relatively small source of sequestration (13 percent).
- Reforestation (non-forested areas restored to forest) accounts for 14 percent of overall sequestration. Forest land increased by approximately 32,800 acres between 2006 and 2016

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- Conversion of forest land to other land uses is the most significant source of emissions in this sector (80 percent), and most of that conversion was land that changed from a forested condition to grassland. As noted in the previous section, most land classified as “grassland” in Thurston County is used for pasture or hay or has a land cover of scrub/shrub. The conversion shown is most likely change from forested cover to these land conditions, rather than prairie restoration.
- The tool estimates carbon sequestration at rates that fall within the range of estimates used for the TCMP (4.05-10.18 MTCO₂e/year), but well below the sequestration rate of 10.18 MTCO₂e/acre-year used to generate estimates for the longer term 2050 target. That higher rate was based on results of a local study that indicated older forest stands would sequester at higher rates:
 - Forest Remaining Forest (Undisturbed) = 5.88 MTCO₂e/acre-year average
 - Reforestation = 5.60 MTCO₂e/acre-year average
 - Trees Outside Forests (including Urban Trees) = 4.19 MTCO₂e/acre-year average

The LEARN tool does not report a margin of error for its estimates, but ICLEI does include this caveat:

There are significant uncertainties in the estimates. Although not quantified here, typical greenhouse gas inventories of forests using similar approaches, including the national GHG inventory, report uncertainties in the net GHG balance that can be as high as ±45% (with 95% confidence). In the results presented here, the most uncertain estimates involve emissions from land-use change which are based on well-documented remote-sensing products, but relatively few field observations from a statistical sampling of county forests. While uncertainties can be high, the estimates can still provide useful information on the relative magnitude and importance of such GHGs; subsequent analyses can also provide information on the directionality of emissions and removals from land management.

US Forest Service Forest Inventory and Washington Forest Carbon Inventory

As noted above in Section 2, the USDA Forest Service conducts regular surveys of forest plots throughout the country, and maintains detailed information on forest conditions through the Forest Inventory and Analysis Program (FIA). In response to a request from the Washington State Legislature, the US Forest Service, Pacific Northwest Research Station partnered with the Washington Department of Natural Resources to develop the first forest ecosystem carbon inventory for the state of Washington (Christensen et al., 2020).

Through the FIA, a portion of survey plots are sampled each year, with all plots sampled every 10 years. The assessment compared survey data gathered from 2012-2016 to the previous inventory (2002-2011) to develop estimates of changes in carbon stocks, fluxes, and trends, and provides some data at the county scale. Carbon stocks are measured or modeled from various carbon pools, including live trees, dead trees, understory vegetation, and soil. Forest Service staff shared updated information from the 2019 survey for forest area and aboveground live tree carbon estimates (USDA 2021).

The FIA defines forest land as:

“...land with at least 10 percent cover by live forest trees of any size, or that formerly had such cover and that will be artificially or naturally regenerated (i.e., is not being managed for non-

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forest uses). The area must be at least 1 acre in size and at least 120 feet wide. Tree-covered areas where management precludes natural vegetation development (e.g., through mowing, disking, regular herbicide application, or intensive grazing) are not considered forest land.”

It excludes areas with trees that are surrounded by urban or developed land—these are classified as “Settlement” areas. Using this definition, the FIA estimates Thurston County as having 234,000 acres of Forest Land. This total falls between the areas estimated by NLCD and NOAA C-CAP data described above. Most of Thurston County’s Forest Land (73 percent) is in private ownership.

Table 6. 2019 Forest Land Ownership, Thurston County. Source: USDA 2021

Forest Ownership, Thurston County	Acres	Percent of Total Forestland
Federal	12,000	5%
State/Local	52,000	22%
Private	170,000	73%
TOTAL	234,000	

Researchers estimated carbon flux, the change in the amount and rate of gaseous carbon being emitted or sequestered by various carbon pools in the forest, including live and dead trees, understory vegetation, roots, forest floor, and soils. The authors indicate a greater confidence in their results for carbon pools that are based on field measurements (including aboveground trees and downed wood) and less confidence in the results for modeled carbon pools (including belowground roots, soils).

The USFS study found that there are approximately 27 million tons of carbon stored in forest land in Thurston County, including in forest soils. The analysis estimates that between 2007 and 2016, forest land in Thurston County annually sequestered a net 541,800 tons of carbon dioxide equivalent (MTCO₂e/year). However, the USFS figure has a high sampling error that indicates a high level of uncertainty in the results. The study authors have higher confidence in statewide estimates, and less confidence in estimates for smaller areas like the County scale.

This sequestration estimate is substantially lower than that offered by the ICLEI LEARN tool, which is approximately 845,000 MTCO₂e/year after removing the estimate for trees within urban (settlement) areas. By including modeled estimates of soils and belowground, the FIA analysis predicts a larger amount of sequestration overall, but also estimates greater emissions from tree mortality and forest harvest than shown in the ICLEI tool. It does not estimate emissions from forest land converted to other uses at the County scale.

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Table 7. Washington State and Thurston County Forest Ecosystem Carbon Summary, 2007-2016. Source: Christensen et al., 2020. Note high sampling errors for County-scale estimates.

	Unit	Thurston County		Washington State	
		FIA Inventory Estimate	Sampling Error of the Estimate (SE)	FIA Inventory Estimate	Sampling Error of the Estimate (SE)
Total forest carbon stocks	million tons C	27.3	4.6	2,718.20	18.5
Average carbon stocks per acre (all ownerships)	tons C/acre	114.1	7.8	122.9	0.7
Annual net change in forest carbon (flux) vegetation only	MTCO ₂ e/year	462,100	690,600	16,060,500	4,274,300
Annual net change in forest carbon (flux) including soils and forest floor	MTCO ₂ e/year	541,800	706,000	16,135,100	4,396,300
Average annual flux per acre (sequestration rate)	MTCO ₂ e/acre-year	2.27	2.95	0.73	0.20

A review of the results from the USFS analysis suggests the following conclusions to inform sequestration activities in Thurston County:

- Counties west of the Cascades account for 93 percent of Washington's annual forest carbon sequestration (annual carbon flux), with Lewis, Skamania, and King Counties generating the most carbon storage. Thurston County, which is much smaller in total area with less forest land than these counties, accounts for just 3 percent of the state estimate, and has a lower average carbon stock per acre when compared with the state average.
- Trees are often the focus of sequestration efforts, though the analysis finds that almost half of all stored carbon in forests is found belowground in soils (45 percent). These stocks are less likely to change from year to year compared with tree growth, so soils make up only a small percentage of statewide annual carbon flux (2 percent) while gross tree growth accounts for 94 percent of annual carbon flux.
- The study found significant differences in carbon stock and carbon flux among forest lands with different ownership. Carbon stocks were highest in areas under federal management, including National Forests, because these lands tend to have older stands of trees and more down and dead wood than intensively managed private forest land. Though National Forests are sequestering the highest total quantity of CO₂e per year in the state, the rate of sequestration per acre from tree growth is highest on private corporate and state DNR lands, where trees are younger on average. These gains in sequestration are partially offset by higher timber harvest

Appendix A: Carbon Sequestration Potential

rates, so a full accounting would need to include the amount of carbon stored in harvested wood products. In Thurston County, most forest lands are in private ownership, rather than under state or federal jurisdiction, and as described in Section 3, these lands tend to have younger stands of trees when compared with the relatively small areas designated as parks.

i-Tree

i-Tree is a suite of free software tools offered by the USDA Forest Service that can be used to assess the condition, value, and benefits of urban and rural forest resources. The i-Tree Landscape tool combines 2011 National Land Cover Database (NLCD) land cover data with environmental data to develop area estimates for various benefits and risks including carbon storage and sequestration, air pollution removal, wildfire potential, and more. Within urban areas (settlements), the tool uses a statewide estimate of net sequestration, based on the same data used for urban trees in the ICLEI LEARN tool. Within forest lands, the tool uses USDA Forest Service Inventory and Analysis (FIA) survey data combined with NLCD data for forest canopy cover.

i-Tree estimates approximately 12 million tons of carbon stored in forest land in Thurston County, though this estimate only includes aboveground sources. The analysis estimates that forest land in Thurston County annually sequesters a net 588,800 tons of carbon dioxide equivalent (MTCO₂e/year). The tool estimates the value of carbon storage and sequestration at \$188/metric ton of carbon, using values from the Interagency Working Group.

Appendix A: Carbon Sequestration Potential

A comparison of the three studies discussed above shows there is variation in their estimates of how much trees and forest areas sequester in the Thurston region. ICLEI's LEARN tool generates the highest estimates among the three, but also most closely follows international guidance for greenhouse gas inventory estimates.

Table 8. Comparison of forest sequestration assessment tools for Thurston County, WA.

Tools & Assessments				
	Unit	ICLEI LEARN*	WA Forest Carbon Inventory ⁺	iTree-Landscape [#]
Period		2006-2016	2007-2016	2011
Canopy/Forest Land	Acre	238,175	234,000	235,852
Carbon Storage	ton C	n/a	27,300,000	11,790,336
Baseline Annual CO₂ Equivalent Sequestration	MTCO ₂ e/year	926,860	541,800	588,340
Sequestration Rate	MTCO ₂ e/acre-year	4.1-5.88	2.27	2.49
Comparison		- Based on national land cover estimates - Estimates change between two years - Includes rural and urban areas - Includes land conversion - Does not estimate carbon storage	- Based on local tree plot survey data sampled over a 10-year interval - Includes only rural forest areas - Does not include land conversion at county scale (though data may be available) - Estimates above and belowground carbon storage	- Based on national land cover estimates - Provides a point-in-time estimate, rather than change in land cover between two years - Includes rural and urban areas - Does not include land conversion - Only includes aboveground carbon storage
Notes – initial estimates were generated or reviewed in December 2021. ICLEI LEARN tool estimates were updated in December 2022 to reflect updates to the tool. * ICLEI Land Emissions and Removal Navigator (LEARN): https://iclei.org/tools/learn/ + Washington Forest Carbon Inventory, Christensen et al., 2020 # i-Tree Landscape: https://landscape.itreetools.org/				

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5.2 Agriculture

Agricultural lands can be either a net source or sink of emissions, depending on land management practices (EPA 2021). Currently, no tool provides the same level of geographically specific baseline estimates of greenhouse gas emissions and removals for cropland, as ICLEI's LEARN tool provides for forestland, though this tool may provide support for this category in the future. Additional information is needed to develop estimates relevant to TCMP sequestration strategies using ICLEI's protocol, including:

- What land base (acreage) should be used for assessing agricultural land?
- What soil types characterize these areas (organic or mineral)?
- What is the area of various management practices?
 - Crop types and acreages, to provide estimates of biomass and dead organic matter
 - Mineral Nitrogen fertilizer application
 - Manure amendment
 - Tillage practices
 - Cover crop management

The 2017 USDA Census of Agriculture estimated that in 2017, Thurston County had 62,250 acres of farmland, of which, 22,109 was classified as cropland (growing a crop for harvest). It also includes information on the extent of a few types of management practices relevant to the TCMP, including acres of crop types, acres of fertilizer application, and acres of a few regenerative practices, including no-till and cover cropping. This information was used to develop the sequestration estimates in the scenario used for the TCMP. The Census also includes information on the number of farms that use other regenerative practices, but does not provide acreage (alley cropping, silviculture). The next Census of Agriculture is scheduled for release in 2024.

The Voluntary Reporting Carbon Management Tools developed by the USDA NRCS (COMET-FARM and COMET-PLANNER) estimate carbon sequestration and greenhouse gas emission reductions associated with different conservation practices for cropland, pasture, rangeland, orchards, and agroforestry.

Table 9. Carbon sequestration from existing agricultural activities, using USDA's COMET-PLANNER tool

Practice	2017 Acres*	Sequestration Rate (MTCO ₂ e/acre-year)	2017 GHG Reductions** (MTCO ₂ e/year)
No-till† (CPS 329)	403	0.23	94
Cover Crop+ (CPS 340)	416	0.15	61
TOTAL			155
Notes: * Source: USDA 2017 Census of Agriculture; acreages are not totaled since they may overlap. https://quickstats.nass.usda.gov/ ** Source: NRCS COMET-PLANNER; all estimates were generated in December 2021 using the highest estimates for each practice category. http://comet-planner.com/ † Intensive till to no till or strip till on irrigated cropland + Add legume seasonal cover crop (with 50% Fertilizer N Reduction) to irrigated cropland			

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This estimate could be used as a rough baseline for the carbon sequestration provided by existing regenerative agricultural practices in Thurston County, but it is limited in scope and not comparable or consistent with the land use change protocol used for greenhouse gas inventories, such as described above for forests. It does not include any estimates for carbon flux on land using regenerative agriculture practices other than no till and cover cropping, and does not consider the carbon flux and storage of other agricultural lands. Additional information is needed to understand how to best use this data to develop a more complete baseline estimate, especially where different management practices (and data sources) overlap. Research underway at Washington State University Extension could contribute to improved estimates.

5.3 Prairies

In general, established grasslands sequester more carbon than croplands and much more than settlement areas (though less than forest lands), so understanding the contribution of this land category is critical to understanding the sequestration of existing land use in Thurston County.

Currently, there is no tool that provides geographically specific estimates for greenhouse gas emissions and removals for grasslands, as ICLEI's LEARN tool provides for forestland. In addition, Thurston County's definition of prairies does not coincide with the definition typically used for grasslands in developing an estimate of carbon sources and sinks. Prairie areas in Thurston County include dry, upland areas with well-drained gravelly soils and wet, clay-rich outwash areas; they may have little tree cover or include oak woodland habitat. Prairie areas can coexist with some agricultural uses, and often require active management, such as regular burning, to maintain native species. Additional data on prairie land cover and spatial information on management approaches is needed to develop estimates relevant to the TCMP sequestration strategies using ICLEI's protocol, including:

- What land base (acreage) should be used for assessing grasslands and prairies?
- What subcategories define grasslands, such as shrublands, and pasture? Different types of grassland will have different estimates of aboveground and belowground biomass.
- What is the area of different disturbances, such as managed fire?
- What is the area of different management practices?

6. Future Sequestration Potential

The TCMP sequestration target (380,000 MTCO₂e/year) relied on roughly estimated benefits of just two actions, with a very heavy reliance on reforestation/afforestation (376,300 MTCO₂e/year) and a lesser focus on expansion of regenerative agriculture practices (3,300 MTCO₂e/year). One goal of this white paper was to gather information that can provide a more nuanced picture of sequestration potential that includes a wider range of actions.

A study by a team from The Nature Conservancy and University of Washington (Robertson et. al. 2021) quantified potential emissions reductions from natural climate solutions in Washington state at the county scale. Looking out 30 years at three levels of implementation intensity, they estimated the strategies considered could reduce annual emissions in Thurston County by between 0.31 and 0.2 million metric tons of CO₂ equivalent. The study modeled several strategies similar to those highlighted in the TCMP, including regenerative agricultural practices, replanting trees along riparian areas, and prairie conservation and preservation. The authors estimated these practices could contribute substantial, but relatively small annual offsets – not sufficient to meet the TCMP sequestration target.

Appendix A: Carbon Sequestration Potential

Greater reductions were predicted for three strategies not evaluated for the TCMP: extending harvest rotations, avoiding conversion of existing forestland, and restoring tidal wetlands. Collectively, even the most ambitious scenario does not estimate enough sequestration to meet the TCMP target.

Table 10. Estimated Emissions Reductions from Natural Climate Solutions, Thurston County. Adapted from Robertson et. al., 2021

	Estimated Emissions Reductions by Scenario (MTCO ₂ e/year in year 30)		
Natural Climate Solutions	Ambitious	Moderate	Limited
TCMP Sequestration Strategies			
Regenerative agricultural practices (cover crop application, no-till, and nutrient management)	-5,129	-2,435	-340
Riparian reforestation	-6,881	-1,789	-166
Restoration and avoided conversion of grassland	-14	-14	-1
Other Strategies			
Extended timber harvest	-171,177	-117,598	-172,665
Avoided conversion of forests to urban development	-114,373	-56,491	-11,310
Tidal wetland restoration	-12,544	-8,622	-4,302
TOTAL	-310,117	-186,948	-188,784

6.1 Forests and Trees

Natural Climate Solutions

One measure assessed by Robertson et al. (2021) focuses on reforesting riparian areas. This moderate approach increases the amount of area restored to approximately 40 acres per year and could result in additional sequestration of around 1,800 MTCO₂e/year by 2050. A more ambitious effort that would ramp up to restoring around 200 acres annually would sequester an additional 6,900 MTCO₂e/year by 2050. Neither estimate would be sufficient to meet the sequestration target in the TCMP, and both are based on more conservative sequestration rates than used in the TCMP's scenario analysis.

An additional strategy not included in the TCMP—extended timber harvests—could have substantial sequestration potential. Most timberlands in Washington State are harvested after 30-40-years. Deferring harvests to 70-80 years allows substantial additional carbon to be stored in trees. This strategy also can have co-benefits like improved habitat, and improved water and soil quality. The study estimated that a moderate increase in extended harvest times¹ could result in additional sequestration of 117,600 MTCO₂e/year in Thurston County. A more ambitious approach² could result in greater reductions (Robertson et. al, 2021). In combination with other strategies, extended harvest times could make the TCMP sequestration target more feasible. Extending timber harvests could affect the amount of timber excise taxes collected and distributed to counties and the state General Fund.

¹ Moderate scenario assumes extended timber harvest applied on 30 percent of private lands, 15 percent of state lands, and 75 percent of federal lands.

² Ambitious scenario assumes extended timber harvest applied on 40 percent of private lands, 32 percent of state lands, and 100 percent of federal lands.

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Robertson et al., also propose that avoiding conversion of forests to urban and rural development could have substantial carbon storage benefits (11,310-114,373 MTCO₂e/year). Avoiding forest conversion will not increase the rate of carbon sequestration, but can help maintain the region's existing carbon storage. The researchers assumed the rate of conversions from forest to developed area will be the same over the next 30 years as it was between 1994 and 2013 (equivalent to a loss of approximately 1,280 acres over a decade or 3,800 acres over 30 years). This baseline is likely high, and the authors acknowledge that, "recent analysis by the Washington Department of Fish & Wildlife and the Puget Sound Partnership found that conversion of forest cover loss to development has declined considerably and continuously in the region since 1991.... If the existing declining trend in forest conversion rates continues, this study may over-calculate the NCS potential of avoiding forest conversion in Washington State, though the net emissions reductions would likely still occur with or without implementing NCS under our scenarios."

TRPC's population forecast model suggests that under current regulations, a greater proportion of future development in our region will locate in areas that are already developed. Under those regulations, TRPC estimates that future development will result in a loss of about 1,000 acres of forest cover countywide by 2030 and 2,100 acres of forest cover by 2045 (TRPC 2021). This outcome corresponds most closely with the Limited scenario. Concentrating a higher proportion of new development in urban areas and within urban centers and corridors, as proposed in the T1 actions of the TCMP, could reduce the loss of forest cover by 800 acres by 2050.³ This estimate is most closely represented by the Moderate scenario.

Reforestation Hub

The Reforestation Hub, developed by The Nature Conservancy and American Forests, maps reforestation opportunities across the United States (Cook-Patton et al., 2020). The analysis identifies areas of opportunity that historically had more than 25 percent tree cover, but currently have less. It excludes many areas where reforestation may be unpractical or undesirable, such as urban cores, along major roads, wetlands, native prairies, and productive croplands, and focuses on areas adjacent to streams (riparian areas), within floodplains, and along migratory bird corridors.

The analysis identified just under 54,000 acres of land in Thurston County with reforestation potential, which, if restored, could sequester an estimated 119,000 MTCO₂e/year. This estimate falls short of the sequestration target for afforestation and reforestation in the TCMP. Though the study identifies a greater amount of potential land than needed in the plan, it uses a much more conservative sequestration rate of 2.2 MTCO₂e/acre-year. Most land identified (95 percent) is in private ownership, and the most likely land types are pasture, urban open space (mostly lawn areas), and floodplains.

This acreage estimate is likely a high mark of how much reforestation is possible in Thurston County, and would require a planting effort of nearly 2,000 acres per year. The authors caution that an understanding of site-specific needs is essential to determine the best options at any given location and maximize sequestration potential.

³ Estimates of future forest cover used TRPC's land capacity model and population and employment forecast. See TRPC 2021.

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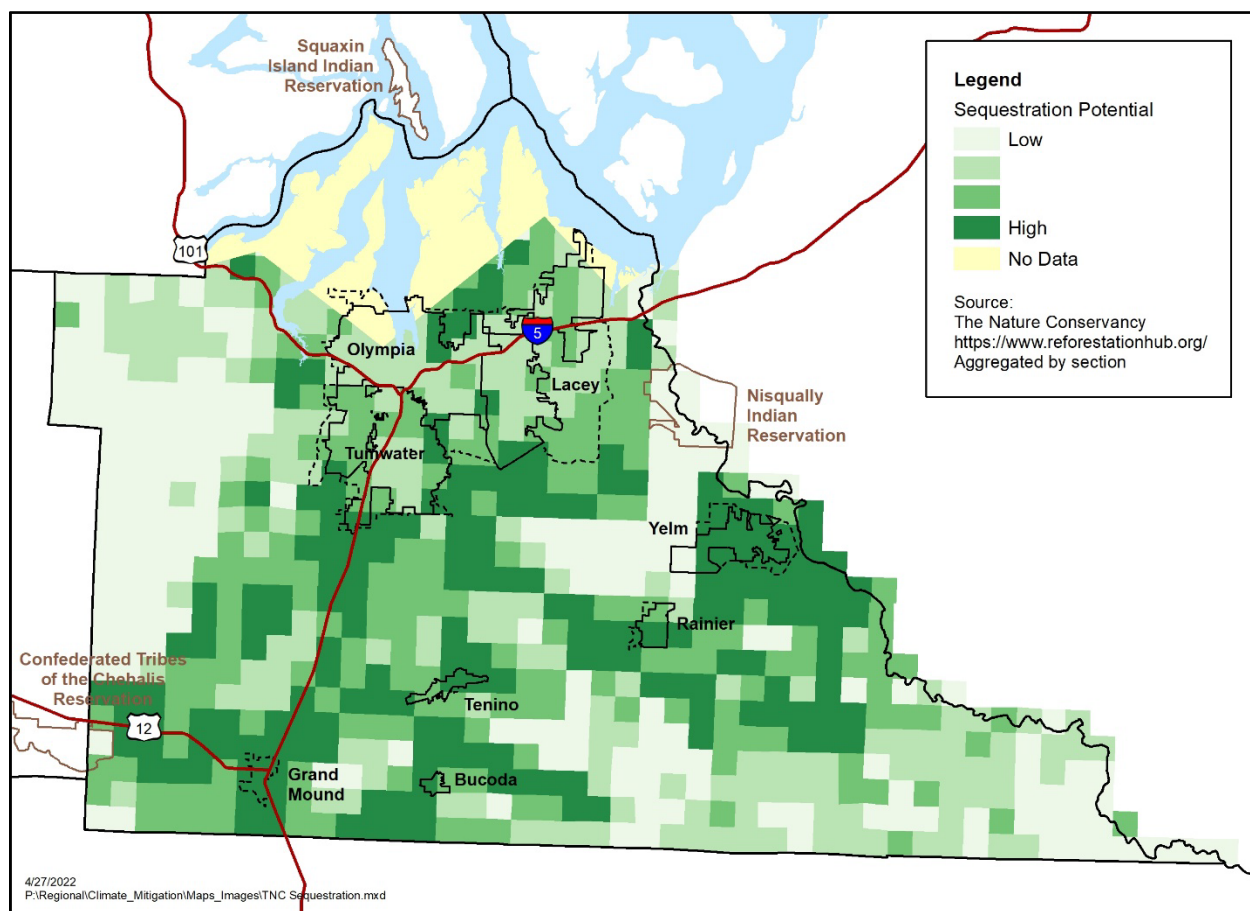
Table 11. Reforestation Opportunities in Thurston County. Source: Reforestation Hub, Cook-Patton et al., 2020

	Acres with Reforestation Opportunity	Sequestration Potential (MTCO₂e/year)
Total opportunity	53,955	118,816
Land Type*		
Pasture	28,817	63,509
Urban Open Space	21,854	48,207
Floodplains	11,337	24,964
Corridors	3,494	7,710
Postburn	1,428	3,114
Streamside/Riparian	1,152	2,536
Grassland	766	1,607
Shrub	672	1,452
Forest	376	816
Challenging Cropland	235	513

* Note that the total opportunity is less than the sum of individual land types listed, as some land type categories overlap.

The study also looked at cost-effectiveness of reforestation, and estimated that the restoration of forest cover across the United States can cost less than \$50/tCO₂, not including any potential timber or carbon revenue. In urban areas, where trees provide additional benefits including mitigation of heat islands, pollution reduction, and improved human health outcomes, the study estimates that every dollar spent on urban tree planting and maintenance delivers \$5.82 in benefits (Cook-Patton et al., 2020).

Figure 5. Reforestation potential in Thurston County. Source: The Nature Conservancy (Cook-Patton et al., 2020)



6.2 Agriculture

Robertson et al. (2021) suggests a moderate approach to applying regenerative agriculture practices could sequester an additional 2,000 MTCO₂e/year, while a more ambitious approach could offset emissions by 5,000 MTCO₂e/year (Robertson et. al, 2021). This scenario is limited to the same categories of regenerative agriculture practices assessed for the TCMP – no-till management, cover cropping, and nutrient management.

NRCS COMET-PLANNER and Washington Climate Smart Estimator

As noted above, NRCS's COMET-PLANNER tool develops generalized estimates of the greenhouse gas impacts from conservation practices. The Washington Climate Smart Estimator, a new application developed by the Washington State Department of Agriculture, uses the same NRCS information to estimate greenhouse gas emission reduction potentials from different conservation practices across Washington State.

Sequestration rates vary greatly among different agriculture practices, depending on many conditions, including the intensity of the change and whether the land is irrigated. The practices with the greatest sequestration potential focus on planting trees and shrubs, including in hedgerows and buffers, though some of the practices identified may overlap with reforestation strategies considered on other lands.

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Most provide higher rates of greenhouse gas reductions than the 0.14 tCO₂/acre-year used in developing agricultural sequestration estimates for the TCMP.

Table 12. Comparison of average sequestration rates of different regenerative agriculture practices.

Regenerative Agriculture Practices	Average sequestration rate (MTCO ₂ e/acre-year)
Cropland Management	0.29
Conservation Crop Rotation	0.22
Cover Crop	0.08
Mulching	0.32
Residue and Tillage Management	0.14
Stripcropping	0.24
Forage and Biomass Planting	0.84
Vegetative Barriers (Conservation Cover/Contour Buffer Strips/Field Border/Filter Strip/Herbaceous wind barriers/riparian herbaceous cover)	0.46
Grazing Lands	0.19
Prescribed grazing	0.03
Range planting	0.50
Restoration of Disturbed Land	2.05
Critical area planting/Riparian restoration	2.05
Woody Planting	5.43
Hedgerow Planting	4.72
Riparian Forest Buffer	5.89
Tree/shrub establishment	5.23
Windbreak/Shelterbreak Establishment	6.93
Windbreak/Shelterbreak Renovation	0.40
Average sequestration rate of all practices	1.95

Source: Washington Climate Smart Estimator; excludes strategies related to nutrient management, reduced use of fertilizer, and increased efficiency of farm equipment which are covered under non-sequestration strategies of the TCMP.

The TCMP set a target that 30 percent of cropland would be managed with regenerative agriculture practices by 2050 (6,600 acres). This review suggests that the estimate created in the scenario analysis underestimates sequestration potential from this sector. Additional conservation practices are likely to have higher rates of sequestration than that used in the initial analysis, and these practices could be applied on more land area.

An alternative target, presented in Table 12, creates a scenario where 30 percent of cropland is managed with a range of relevant regenerative practices, 30 percent of rangeland (pasture and grazing areas) are managed with a range of relevant regenerative practices, and 2.5 percent of cropland (1 acre per 80 acres) is converted or restored to woody plantings. This scenario would generate a sequestration target close to 7,000 MTCO₂e/year.

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Table 13. Alternative Target Estimate of Sequestration Potential from Regenerative Agriculture Practices

	Acres	Sequestration Rate (MTCO ₂ e/acre-year)	Sequestration Potential (MTCO ₂ e/year)
Cropland Management	6,600*	0.29	1,910
Grazing Lands	11,000**	0.19	2,090
Woody Planting	550†	5.43	2,990
TOTAL			6,990

Notes:

* 30 percent of USDA 2017 Cropland

** 30 percent of NOAA C-CAP 2016 Land Cover, Pasture/Hay (36,785 acres)

† 2.5 percent of USDA 2017 Cropland, based on guidance of Monette and Hobbs (2020).

6.3 Prairies

CARB Grassland Conservation and Restoration Benefit Tool

Though there is an extensive and growing body of research on the carbon storage potential of grassland areas, little of this research has been focused on the prairie ecosystem specific to the South Puget Sound. Carbon sequestration may be increased through two general strategies: reducing conversion of grasslands to other land uses (such as agriculture or settlement) and restoring grassland areas. Gains in sequestration vary based on soil and vegetation type as well as management practices (grazing, irrigation, etc.) – as with reforestation efforts, gains in sequestration continue to accumulate and may increase over time as underground root systems develop (Diaz et al. 2014). Active restoration of sites, with a focus on creating a greater diversity of species, can significantly increase carbon storage over time (Yang 2019).

Under Thurston County's approved Habitat Conservation Plan, nearly 3,500 acres of prairie land will need to be managed to mitigate for projected impacts from future development on listed species over the next 30 years. These activities include enhancing existing reserve areas, establishing new reserves, and securing working land easements in areas that overlap with agricultural activities. Conservation and restoration also will be included in the Bush Prairie Habitat Conservation Plan under development for land within the Tumwater Urban Growth Area.

As part of California's cap-and-trade program, the California Air Resources Board (CARB) has developed guidance for quantifying greenhouse gas emission reductions from land restoration projects, including grasslands. Using the Grassland module of the Land Restoration Benefits Calculator Tool, TRPC staff developed a rough estimate of the carbon sequestration potential of the land proposed to be conserved and restored through the draft Thurston County HCP. This estimate includes a range of soil types, but does not account for the additional sources, sinks, and reservoirs associated with these improvement types, such as reduced fertilizer application or increased managed burning. In addition, the tool is designed for application to a temperate dry climate, rather than the cooler, moister conditions of Thurston County. With these caveats, the analysis provides a starting place for estimating the role that

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prairie restoration could play in achieving the emission reduction targets of the TCMP. These estimates are substantially greater than those proposed in the analysis by Robertson et al. (2021).

Table 14. Sequestration potential of conserved and restored prairie habitat proposed through the draft Thurston Habitat Conservation Plan using California Grassland Restoration Tool

HCP Conservation Objective	Acres*	Improvement Type and Sequestration Rate (MTCO ₂ e/acre-year)**	Sequestration Potential (MTCO ₂ e/year)**
New Reserves – Acquire, from willing sellers, new reserves to secure, stabilize, and expand species strongholds, while also building the framework for covered species recovery. Habitat on each permanently protected parcel will be enhanced and funded for long-term management.	2,698	- Convert from severely degraded grasslands (0.33-1.11) - Restore to improved grassland (0.12-0.40)	1,220-4,080
Working Lands Easements – Secure permanent Working Lands Easements, via Conservation Easements with willing landowners, to conserve, stabilize, and expand species distributions, and demonstrate land uses compatible with Covered Species. Habitat on each permanently protected parcel will be maintained with funding for long-term management.	433	- Convert from farmland (0.33-1.11) - Restore to improved grassland (0.12-0.40)	180-590
Enhance Existing Preserves - Enhance the habitat for covered species populations at existing, protected preserves with current or historical populations of the Covered Species.	339	- Convert from moderately degraded grasslands (-2.28 - 0.15) - Restore to improved grassland (0.12-0.40)	30-90
TOTAL	3,469		1,420-4,760
Sources: * Draft Thurston County Habitat Conservation Plan, Table 7.7 ** California Air Resources Board (CARB) Benefits Calculator Tool, Grassland. Results are rounded to the nearest ten. The range reflects results for two soil types common in Thurston County prairie areas covered by the Thurston County HCP: Nisqually (Inceptisol) and Spanaway (Andisol).			

7. Conclusions and Opportunities

This analysis used publicly available data and tools to develop a partial response to two questions posed in the development of the TCMP: how much do existing land types in Thurston County sequester carbon, and how much could certain land uses sequester in the future? The results of this review are summarized in Table 15 and in the conclusions below.

Table 15. Summary of sources reviewed to show the range of baseline carbon sequestration from existing land covers in Thurston County.

	Existing Annual GHG Sequestration (MTCO2e/year)	
	Low	High
Forests	541,800*	926,900†
Agriculture	155‡	Additional information needed
Prairies	Additional information needed	
Sources: * Washington Forest Carbon Inventory; † ICLEI LEARN tool; ‡ NRCS COMET-PLANNER		

Table 16. Summary of sources reviewed to show the range of carbon sequestration potential from climate mitigation strategies in the Thurston region.

Sequestration Strategies	Estimated Sequestration Potential (MTCO ₂ e/year)	
	Low	High
Sequestration actions included in the TCMP		
Regenerative agriculture (A2.1)	340*	6,990‡
Reforestation/afforestation (A5.1)	170*	118,820†
Prairie preservation (A7.3)	1*	4,760§
Other sequestration actions		
Extended timber harvest	117,600*	171,180*
Tidal wetland restoration	4,300*	12,540*
SUBTOTAL	122,411	314,290
Actions that maintain sequestration capacity		
Avoided conversion of forests°	11,310*	56,490*
Sources – see Appendix B for additional detail: * Robertson et al. (2021). Note that this analysis does not distinguish between activities occurring in urban versus rural areas. Most forested areas (93%) are in rural portions of Thurston County. † Reforestation Hub ‡ NRCS COMET-PLANNER, Washington Climate Smart Estimator § CARB Land Restoration Benefit Calculator Tool ° Avoiding forest conversion will not increase total sequestration in the region. It will only reduce future net emissions.		

Appendix A: Carbon Sequestration Potential

Sequestration from Existing Land Uses

- ***Additional information and analysis is needed to develop a comprehensive estimate of emissions from existing land uses in Thurston County.*** The IPCC and ICLEI provide guidance for evaluating greenhouse gas emissions and removals from land use and land use change (LULUC) as part of a greenhouse gas inventory, and such information would be useful for providing a more complete picture of emissions across Thurston County, including from changes among land use categories. A complete analysis is more complex than other sectors, and partners would need to fill information gaps on the land area of different management practices before including it in the Thurston County greenhouse gas inventory. The land use categories in this methodology do not match the definitions typically used in the region for other analyses, and could pose a communication challenge. Alternatively, the region could choose to assess changes only in land uses that are the focus of the TCMP (forests, agriculture, prairies), though such an approach would not provide as complete a picture of how trends like land conversion affect emissions over time. LEARN is the best tool currently available for this purpose although it only provides information on forest land and trees—additional information would be required to match the accuracy of other sectors. Because most land cover data is updated infrequently (5-10 years), this information would not be tracked annually.
- ***Forests and trees are a significant carbon sink in the Thurston region.*** There are approximately 230,000 acres of forested land across Thurston County – this accounts for about half of Thurston County’s land area. These areas store approximately 27 million tons of carbon, and annually sequester up to 927 thousand MTCO₂e—equivalent to about a third of the annual emissions of the Thurston region (2.9 million MTCO₂e).
- ***Rural areas are most important to carbon storage and sequestration; urban trees provided limited sequestration.*** The bulk of forested land cover is in the rural area (93 percent), including two-thirds of all evergreen forest area. This means most sequestration (93 percent) comes from rural areas—trees within developed areas contribute a relatively small proportion to countywide sequestration (7 percent).
- ***Timberlands, areas managed for commercial harvest of trees, play a significant role in the region’s sequestration picture.*** Most forested areas in Thurston County (60 percent) are managed as commercial timberlands. Most timberlands in Thurston County are in private ownership (73 percent), rather than public (local, state, or federal). Areas in private ownership that are managed for timber harvest tend to have the youngest trees among forested lands, with most stands less than 40 years old.
- ***Reforestation is happening, but not at a pace to outweigh the loss of sequestration capacity from conversion of forested areas.*** Between 2006 and 2016, Thurston County gained more forest cover than it lost – however, emissions from converted forest land are greater than the sequestration benefit provided by the reforested land. Most of this forest land conversion is occurring in rural areas of the county, rather than urban areas. Some of this change may be attributable to commercial timber harvest patterns, where the loss is not permanent, or to differences in methodology. Additional review of ICLEI’s methodology could help reduce this uncertainty and better identify trends.
- ***Additional information is needed to assess the sequestration provided by existing management of agricultural and prairie lands.*** Information available on the extent of some regenerative agriculture practices suggest these existing practices annually sequester 155 MTCO₂e, but this estimate provides a very limited picture. TCMP entities could work with other regional partners, like Thurston

Appendix A: Carbon Sequestration Potential

Conservation District and WSU Extension, to gather more specific relevant information, or could wait for the development of better information through ICLEI or the state.

Sequestration Potential

- The sequestration target set in the TCMP is highly ambitious, and likely infeasible with the actions currently included in the plan.*** The TCMP sequestration target (380,000 MTCO₂e/year) relied on the estimated benefits of just two actions, with a very heavy dependence on reforestation/afforestation (375,000 MTCO₂e/year) and a lesser focus on expansion of regenerative agriculture practices (3,300 MTCO₂e/year). It did not include an estimate of a future baseline that accounts for how changes in land use might reduce sequestration provided by forests and other ecosystems. Nor did it estimate how strategies and actions included in the plan might help maintain that sequestration capacity, such as avoided conversion of forest land through more concentrated growth in urban areas (T1), preservation of existing tree canopy in urban areas (A6.5 and A6.9) or preservation of prairie areas (A7.3). The information reviewed for this report suggests that the reforestation sequestration rate used in the TCMP scenario analysis, though based on local data, is higher than that used in most other assessments. By contrast, the regenerative agriculture sequestration rate that was used for the scenario analysis is lower than suggested by a review of rates for Washington State, and was applied to a smaller land base than might be feasible. With these adjustments, and the addition of several actions discussed below, the sequestration potential ranges from 122,411-314,290 MTCO₂e/year, still below the TCMP sequestration target. Achieving even these levels of sequestration would require extensive investment of resources into sequestration actions and significant changes to development patterns and land use practices. Alternatively, the TCMP partners could consider adjusting the sequestration target to a lower amount and increasing targets for reducing emissions from other sectors to close the gap.
- Forest and tree strategies provide the greatest sequestration potential, but TCMP partners should continue to evaluate what level of effort is practically feasible.*** Depending on how extensively they are implemented, avoiding forest conversion, restoring forest areas, and extending timber harvest rotations have the potential to sequester between 130,000-406,000 MTCO₂e/year. The high estimates for this sector likely push the limits of credible feasibility, because they come at the cost of avoiding all conversion of forestland, dramatically changing forest practices, and planting trees on large areas of urban open space and agricultural lands. Adopting a more moderate approach would increase the likelihood of success, but would make it challenging to reach the current sequestration target, and would require that other TCMP targets be revisited to further reduce emissions.
- Future updates to the TCMP should include refining actions focused on avoiding loss of forest areas and adding actions focused on extending timber harvest rotations, in addition to setting a more feasible reforestation target.*** Several actions in the TCMP reduce loss of forest areas (T1 actions, A6.5, A6.9), but these mostly focus development patterns and tree cover in urban areas; actions should also look for ways to reduce loss of forest in rural areas, which have the bulk of forested land and are seeing the highest rate of forest land conversion. Extending the length of timber harvest rotations was included as an idea on the long list of actions considered for the TCMP (A5.3), but was not ranked as a priority. With a better understanding of the potential sequestration benefit, it may be worthwhile to revisit this action and add it to the priority list. Reforestation efforts could focus initially on restoring degraded riparian and floodplain areas to provide the broadest community benefit, as well as working with rural landowners, where the largest opportunities are available.

- ***Applying a wider range of regenerative agriculture practices to a broader land area could increase the sequestration benefit of this strategy.*** Expanding the application of regenerative agriculture practices (Action A2.1), including through cropland management, on grazing lands, and with woody plantings could increase sequestration in the Thurston region by nearly 7,000 MTCO₂e/year. Future work may also want to consider the sequestration benefit of limiting conversion of farmland to other uses.
- ***Restoring prairie habitat can be a substantial source of carbon sequestration.*** Completing the conservation activities identified in Thurston County's Habitat Conservation Plan could increase sequestration by nearly 5,000 MTCO₂e/year, and additional work in the region could add to this potential. Action A7.3 of the TCMP calls for aggressive implementation of local plans to support federally listed endangered and threatened prairie species.
- ***Opportunities for sequestration through forests, agriculture, and prairies overlap, and it will be important to define how these different approaches should be combined and prioritized.*** For example, some areas with reforestation potential are currently managed as agriculture or may have the potential for prairie restoration. Should the highest priority be for reforestation—which would result in the most sequestration—or should the sequestration target be balanced with other community goals, like preservation of agricultural lands and prairie restoration? In other areas, combinations of reforestation, regenerative agriculture, and prairie conservation practices may be complementary on the same piece of land.
- ***Additional sequestration opportunities, especially restoration of marine areas, could help meet the sequestration target.*** According to one analysis, restoration of tidal areas in Thurston County could sequester between 4,000 and 13,000 MTCO₂e/year. An effort focused on this action could help close any gap created by reducing expectations for other strategies.

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8. References

Birdsey, R, N. Harris, D. Lee, S. Ogle. (2019) U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, USCP Appendix J, Forest Land and Trees. <https://icleiusa.org/ghg-protocols/>

Birdsey, R, N. Harris. (2021) Methods for Calculation of Activity Data and Removal and Emission Factors for Community-scale Forest and Tree Greenhouse Gas Inventories.

<http://d1ps9kreypzu9a.cloudfront.net/GHGInventory/LEARN%20tool%20documentation.pdf>

California Air Resources Board (CARB) (2020). Revised Quantification Methodology for Land Restoration.

https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/landrestore_QM_18-19_revised_final.pdf

CARB Land Restoration Benefits Calculator Tool available for download:

<https://ww2.arb.ca.gov/resources/documents/ci-quantification-benefits-and-reporting-materials>

Christensen, G, Gray, A, Kueger, O, & Siemann, D. (2020) Washington Forest Ecosystem Carbon Inventory: 2002-2016. U.S. Forest Service, Pacific Northwest Research Station, and Washington Department of Natural Resources.

https://www.dnr.wa.gov/publications/em_wa_carbon_inventory_final_111220.pdf

Cook-Patton, S.C., T. Gopalakrishna, A. Daigneault, S.M. Leavitt, J. Platt, S.M. Scull, O. Amarjargal, P.W. Ellis, B.W. Griscom, J.L. McGuire, S.M. Yeo, and J.E. Fargione. (2020) Lower cost and more feasible options to restore forest cover in the contiguous United States for climate mitigation. *One Earth* 3, 739-752.

Diaz, D., B. Rashford, S. De Gryze, S. Zakreski, R. Dell, M. Niles. (2014) Evaluation of Avoided Grassland Conversion and Cropland Conversion to Grassland as Potential Carbon Offset Project Types. The Climate Trust. <https://climatetrust.org/wp-content/uploads/2014/07/Evaluation-of-Avoided-Grassland-Conversion-and-Cropland-Conversion-to-Grassland-as-Potential-Carbon-Offset-Project-Types-.pdf>

Environmental Protection Agency (EPA). (2021) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2019. Most information used in this report comes from Chapter 6 – Land Use, Land Use Change, and Forestry. <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2019>

Eve, M., D. Pape, M. Flugge, R. Steele, D. Man, M. Riley-Gilbert, and S. Biggar, (Eds), 2014. Quantifying Greenhouse Gas Fluxes in Agriculture and Forestry: Methods for Entity-Scale Inventory. Technical Bulletin Number 1939. Office of the Chief Economist, U.S. Department of Agriculture, Washington, DC. 606 pages. July 2014. https://www.usda.gov/sites/default/files/documents/USDATB1939_07072014.pdf

Gray, A. N., T. R. Whittier, and M. E. Harmon (2016) Carbon stocks and accumulation rates in Pacific Northwest forests: role of stand age, plant community, and productivity. *Ecosphere* 7(1):e01224. 10.1002/ecs2.1224. https://www.fs.fed.us/pnw/pubs/journals/pnw_2016_gray001.pdf

IPCC (2019) 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 4 Agriculture, Forestry and Other Land Use. Calvo Buendia, E., Tanabe, K., Kranjc, A., Baasansuren, J., Fukuda, M., Ngarize S., Osako, A., Pyrozhenko, Y., Shermanau, P. and Federici, S. (eds). Published: IPCC, Switzerland. <https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html>

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Monette, P, J. Hobbs. (2020) A guide to Hedgerows: Plantings that Enhance Biodiversity, Sustainability, and Functionality. Oregon State University.

<https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8721.pdf>

Nowak, D. (2021) Understanding iTree: 2021 Summary of Programs and Methods. USDA Forest Service, General Technical Report NRS-200-2021. https://www.fs.fed.us/nrs/pubs/gtr/gtr_nrs200-2021.pdf

Palmer, M, Christensen, G, Kuegler, O. (2019) Washington's Forest Resources, 2007-2016: 10-Year Forest Inventory and Analysis Report. United States Department of Agriculture, General Technical Report PNW-GTR-976. https://www.fs.fed.us/pnw/pubs/pnw_gtr976.pdf

Siemann, D. (2020) Safeguarding Our Lands, Waters, and Communities: DNR's Plan for Climate Resilience. Washington State Department of Natural Resources.

https://www.dnr.wa.gov/publications/em_climateresilienceplan_feb2020.pdf

Thurston Regional Planning Council (TRPC). (2021) Thurston County Current and Future Basin Conditions Assessment. <https://www.trpc.org/DocumentCenter/View/8901/BasinConditionReport2021>. *Note that for the estimates of future forest cover used in this report, TRPC re-ran the land capacity model using the under the Sustainable Thurston land use alternative developed for the 2021 Buildable Lands Report for Thurston County:* <https://www.trpc.org/DocumentCenter/View/8542/2021-Buildable-Lands-Report-2021-08-22?bidId=>

U.S. Department of Agriculture, Forest Service (USDA) (2021) Pacific Northwest Research Station, Forest Inventory and Analysis Database (PNW-FIADB). Version 2019. Portland, OR: <https://www.fs.usda.gov/pnw/tools/pnw-fiadb-forest-inventory-and-analysis-databases> (Accessed 8 December 2021).

Yang, Y., Tilman, D., Furey, G. et al. (2019) Soil carbon sequestration accelerated by restoration of grassland biodiversity. *Nat Commun* 10, 718. <https://doi.org/10.1038/s41467-019-08636-w>

Appendix B

Stakeholder Interview Summary

Overview

As part of the development of the carbon sequestration white paper, Thurston Regional Planning Council (TRPC) staff conducted a series of interviews with community stakeholders to gain a better understanding about local opportunities and concerns around the carbon sequestration targets and actions in the Thurston Climate Mitigation Plan. Interviews were held with representatives from the following organizations: Thurston Conservation District, Capitol Land Trust, South of the Sound Community Farmland Trust, WSU Extension (Forestry), Thurston Climate Action Team, City of Lacey, and City of Olympia. Interview subjects were asked versions of the following questions:

- Do you have a vision for what carbon sequestration should look like in Thurston County? What is needed to accomplish that vision?
- How do you see the role of regenerative agriculture practices, reforestation, and habitat preservation balancing in a carbon sequestration program?
- What role do you see (your organization) having in a regional carbon sequestration plan going forward?
- Who do you think is best positioned to oversee a carbon sequestration program? Ex: local organizations, city governments, conservation district, county jurisdictions, etc.?
- What concerns do you have about a carbon sequestration program?

Interview responses are summarized in the table below.

Carbon Sequestration as a Climate Mitigation Strategy for the Thurston Region
Appendix B: Stakeholder Interview Summary

February 2023

Stakeholder	Vision/Ideas for Carbon Sequestration	Role	Leading Administrator	Concerns
Thurston Conservation District	Includes technical and financial support and incentives for a variety of programs to support regenerative agriculture, forest management planning, and conservation grazing. Takes a multi-scale approach that focuses on voluntary participation and that is accessible to all Encourages innovation through site-specific plans. Emphasis on soil health. Regulatory reform to remove barriers for regenerative agriculture. Mentorship opportunities to support the next generation of farmers.	Partner: • Education on link between carbon sequestration and land management • Support leading entity	Non-regulatory, regional, and neutral entity Partnership of multiple entities with all stakeholders included: agricultural community	All forms of carbon sequestration must be incorporated. Involvement of all stakeholders and entities in the process.
Capitol Land Trust	Focuses on trees and agriculture, including increased urban tree canopy. Regional in scale, or possibly state scale. Collaborates with the Department of Natural Resources and Capitol State Forest. Incentive program to promote regenerative agriculture	Participant: • Collaborate with individual landowners to preserve parcels • Outreach • Interest in a regional credit program	Should be broad - County State (Ecology, Agriculture, DNR) Conservation District	Balance the need for residential development with habitat preservation Conflict between land demands for sequestering carbon through agriculture, prairies, and trees. Concerned about pressure to plant trees on sensitive prairie areas.

Carbon Sequestration as a Climate Mitigation Strategy for the Thurston Region
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Stakeholder	Vision/Ideas for Carbon Sequestration	Role	Leading Administrator	Concerns
	Program to support habitat maintenance work. There are resources available for tree planting, but few resources available for maintenance. Prairie preservation has a high management requirement.			Lack of interest among private landowners/managers Ongoing maintenance requirements
South of the Sound Community Farmland Trust	All landowners participate, all sizes of property Create a baseline for amount of carbon already sequestered through agriculture, forests, and prairies. Includes strategy for preserving farmland and accounting for loss of sequestration potential through conversion to development Should be coordinated with the Voluntary Stewardship Program (VSP)	Participant: - Collaborate with individual landowners to preserve agricultural land - Outreach to support regenerative agriculture	Conservation District	Concern about accounting for sequestration already occurring. Defining regenerative agriculture practices Regenerative agriculture practices can increase the amount of Nitrous Oxide released Preserving existing agricultural land
WSU Forestry Extension	Prioritize afforestation and incorporate agroforestry Complete a coordinated research effort and outreach campaign on agroforestry in the region for small landowners	Participant: Outreach and Education: Demonstration Sites	Conservation District WSU Extension Department of Natural Resources	Difficulty of facilitating a flexible and voluntary program while also maximizing potential Financial cost of programs and required staff time More land use needs than available land.

Carbon Sequestration as a Climate Mitigation Strategy for the Thurston Region
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February 2023

Stakeholder	Vision/Ideas for Carbon Sequestration	Role	Leading Administrator	Concerns
	Cost-sharing program for small landowners participating in outreach campaign. Planting trees is more easily implemented than protecting existing trees or preserving habitat for immediate action.			
Thurston Climate Action Team (TCAT)	Tree protection and policies across jurisdiction and coordination to identify areas to plant. Regenerative agriculture education campaign. Restrictions on commercial forestry including requiring longer rotations and managed thinning. Point system to account for and protect trees during development	Oversight: - Minimal active role - Outreach and Education Support	Regulatory Entity	Allowing large-scale industries/operations to pollute. Development threatening existing trees.

Carbon Sequestration as a Climate Mitigation Strategy for the Thurston Region
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February 2023

Stakeholder	Vision/Ideas for Carbon Sequestration	Role	Leading Administrator	Concerns
City of Lacey	Incorporate local codes and jurisdictional requirements into the program. Regional tree policies and standards around measuring Combine tree canopy and urban density goals to protect open spaces.	Enforcement and Implementation	County Jurisdictional application and enforcement	Focus on carbon sequestration will reduce action on carbon reduction Flexibility in a carbon sequestration program to identify opportunities and not limit planning efforts. Feasibility of the carbon sequestration goal in the TCMP
City of Olympia	Countywide approach to tree codes to create a more consistent approach that also supports existing local programs County policy reducing tree removal Supports longer-lived and larger trees for urban tree canopy Created incentives for increased rotation of timber harvest Incorporate potential for blue carbon. Transfer of Development Rights program	Enforcement and Implementation	Unified Effort TRPC County	Double counting - If carbon credits are purchased can they also be counted in a regional sequestration program? Need a clear distinction between the role of individual trees in urban areas and the shade, cooling, health, etc., benefits vs carbon sequestration benefit

Appendix C

Existing Community Resources and Programs

Existing Resources to Support a Carbon Sequestration Program

While new resources and programs are necessary to meet the carbon sequestration goals outlined in the TCMP, existing federal, state, and local resources may help support the development of a carbon sequestration program.

Key to Program Application

	Program applies to agriculture.
	Program applies to trees and/or forests.
	Program applies to prairies.

			
Federal			
US Department of Agriculture			
The Natural Resources Conservation Service (NRCS) administers several technical and financial assistance programs, including: - The Healthy Forests Reserve Program (HFRP) provides financial assistance to landowners to restore and protect forestland on private and tribal lands. This program provides easements with 30-year contracts and ten-year cost-share agreements to promote the recovery of endangered species, improve biodiversity, and enhance carbon sequestration (USDA).		X	
- The Environmental Quality Incentives Program (EQIP) provides financial and technical assistance to agricultural producers and forest managers to address environmental concerns and improve environmental health. The program aims to support	X	X	

Appendix C: Existing Community Resources

			
historically underserved participants with advanced payments to offset the costs of purchasing materials and contracting services. In 2021, the department offered a Climate-Smart Agriculture and Forestry EQIP Pilot program that emphasizes building soil health based on demand for climate-smart practices.			
- The Conservation Stewardship Program (CSP) provides technical and financial assistance to implement and maintain conservation activities on land in agricultural production. In Washington State's program, CSP enhancements include many regenerative practices, including no-till, crop rotation, and cover cropping.	X		
The US Forest Service Community Forest Program is a competitive grant program that provides financial assistance to tribal entities, local governments, and qualified conservation non-profit organizations to acquire and establish community forests that provide community benefits.		X	
State			
Department of Natural Resources DNR manages over 2 million acres of forest trust land in Washington State, including more than 60,000 acres in Thurston County. The agency's recently completed Climate Resilience Plan (2020) and Forest Action Plan (2020) highlight the agency's shift toward incorporating carbon sequestration opportunities within its programs.		X	
- The Small Forest Landowner and Stewardship programs provide family forest owners with assistance to improve forest health, reduce vegetative fuels, support revenue generation, enhance fish and wildlife habitat, and increase recreation opportunities.		X	
- The Urban and Community Forestry Program provides technical, educational, and financial assistance to create urban and community forestry programs that preserve, plant, and manage forests and trees for stormwater mitigation, public health benefits, and quality of life.		X	
- Launched in 2022, DNR's Carbon Project conserves areas of state trust land previously intended for harvest in order to generate carbon offset credits. The funds from sale of the credits will be used as a revenue stream to offset the loss of revenue from timber harvest.		X	

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Washington State Conservation Commission			
- The Washington State Conservation Commission administers the Voluntary Stewardship Program (VSP) and works to protect and enhance critical environmental habitat areas overlapping agricultural activities to better regulate conversion. The program is flexible and helps develop free site-specific individual stewardship plans for landowners based on Natural Resources Conservation Service (NRCS) procedures. Suggested practices of the VSP include cover cropping, exclusion fencing, and prescribed grazing. The Thurston Conservation District is the technical provider for the VSP program in Thurston County.	X		
- The Sustainable Farms and Fields Program is a grant program established in 2020 to help farmers implement projects that increase carbon sequestration and reduce greenhouse gas emissions. Funding for the program has not yet been dedicated by the legislature.	X		
Department of Ecology			
- The Climate Commitment Act , passed in 2021, tasked Ecology with setting a cap on greenhouse gas emissions from entities that emit more than 25,000 metric tons of carbon annually. The policy may help fund sequestration efforts if it allows carbon credits to be sold to participants in the program. The program will begin in January 2023, and the allowances will slowly decline over time, driving a potential market for offsets.	X	X	X?
Local			
The Thurston Conservation District offers many kinds of technical assistance to local farms, including soil testing services, equipment rental, and assistance developing conservation plans.	X	X	
Washington State University – Thurston County Extension develops research and provides technical assistance to support the South Sound food system.	X	X	X
Thurston County's Conservation Futures program uses a portion of local property taxes to acquire land for conservation purposes, including outright purchase and easements.	X	X	X
All four partner jurisdictions involved in the TCMP have urban tree management programs. ⁴		X	

⁴ See the Appendix for an outline and comparison of existing tree ordinances in Lacey, Olympia, and Tumwater.

Appendix C: Existing Community Resources

			
- Olympia has an Urban Forestry Manual (2016) that outlines tree protection, maintenance, and planting standards. The Urban Forestry Manual is updated annually. - Lacey has an Urban Forest Management Plan (2021) that outlines goals for tree canopy cover, protection, and planting. - Tumwater also has an Urban Forest Management Plan (2021) that focuses on community and urban forests, implementation plans, and monitoring techniques. - Thurston County's Urban Forest Data Development Report (2011) analyzed existing tree canopy and highlights opportunities for future plans.			
Several local jurisdictions are developing Habitat Conservation Plans (HCPs) to allow development activity to proceed while protecting several federally listed threatened and endangered species, most associated with prairie habitat. Mitigation fees will help fund conservation and restoration of prairie lands as a means to protect viable population of the species covered by the plans. These projects could also have carbon sequestration benefits. - Thurston County's draft HCP estimates a need to mitigate more than 5,200 functional acres of prairie habitat over the next 30 years. - Tumwater and the Port of Olympia are partnering to develop a Bush Prairie HCP.			X
All four partner jurisdictions collect funding through Stormwater utility Fees that could potentially be directed to programs that also benefit water quality and water flow.		X	
Thurston Waterways is a collaborative partnership among the South Sound Salmon Enhancement Group, Thurston Conservation District, and Thurston County to offer tools and resources to smaller, rural landowners for restoring riparian areas.		X	
A number of local nonprofits and community groups have existing expertise in land conservation and habitat restoration, including: - Capitol Land Trust - Center for Natural Lands Management - Creekside Conservancy - Nisqually Land Trust - Olympia Coalition for Ecosystems Preservation - South of the Sound Community Farmland Trust - South Sound Salmon Enhancement Group	X	X	X
The Thurston Climate Action Team is a nonprofit focused on unifying the community to address climate change. Their Tree Action Group meets once a month to promote tree planting and forest protection and develop a plan to protect mature trees. They also have a Food and	X	X	

Appendix C: Existing Community Resources

			
Agriculture Group focused on supporting a transition to regenerative agriculture.			

Urban Tree Management Plans and Policies

Lacey, Olympia, and Tumwater each have a series of tree ordinances and urban forestry plans to address the urban tree canopy. The tree ordinances for each city address tree removal, replacement, protection, and maintenance while the urban forestry plans highlight each city's goals and vision for the urban forest, plan for future action, and challenges in protecting the urban forest. Thurston County also has tree protection and forest preservation efforts, but this appendix focuses on city-level ordinances.

As the Thurston region grows in population and density, its urban trees will continue to face increasing pressure. The tree canopy faces competition with solar panels, views, utilities, transportation systems, and denser development (Seattle Urban Tree Plan, 2020). A one percent increase in the percent of the population living in urban areas corresponds with a .54 percent loss of forest cover in the city (Clement, Chi, & Ho, 2015). As the population in Lacey, Olympia, and Tumwater continues to grow, plans and policies ordinances to protect urban trees may need to be reviewed and updated to maintain and increase their effectiveness in supporting climate and other community goals.

While an estimate of urban tree carbon sequestration for the entire region is under development, Zarghami (2020) determined that Olympia street trees sequester roughly 210 tons (420,000 pounds) of atmospheric carbon dioxide in the above-soil and below-soil parts of trees. This estimate does not account for trees that die or decompose and carbon released during tree maintenance. As of 2020, Olympia's street tree forest stored more than 2,500 tons of carbon (5,023,314 pounds. Zarghami, 2020). From these estimates, the Northern red oak sequesters the most carbon (approximately 16.1 percent of total carbon stored). These estimates can provide guidance for the scale of sequestration possible in Thurston County's urban regions and the role that urban forestry plans and ordinances can have in a regional carbon sequestration program.

Urban Forestry Plans

Lacey

Lacey revised its Urban Forestry Plan in Fall 2021. The city planning commission, staff, and an ad hoc citizen task force prepared the plan as an element of Lacey's Comprehensive Plan after evaluating maps, aerial photos, Landsat photos, and the city transportation plan. The evaluation included interviews with city council members, discussions with Lacey Public Works staff, and an inventory of all private street trees. The updated plan recognizes the environmental, psychological, and economic benefits of urban trees and highlights the existing 28.3 percent canopy cover in city limits and 31.3 percent canopy cover in the Lacey Urban Growth Area.

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Tumwater

The City of Tumwater also recently updated and approved its Urban Forestry Management Plan with a detailed zone-by-zone analysis of planting potential. Tumwater's plan builds on the city's 1996 Urban Forestry Plan and 2002 Comprehensive Street Tree Plan to provide recommendations for updating the Tumwater Municipal Code and guide improvement of the urban forest over the next twenty years. The city designed the report through a series of public meetings, inventories, and surveys. The Peninsula Environmental Group completed the inventories and assessments while city staff led public engagement on the plan. The assessment consolidates 23 land use designations into nine categories, and evaluates the potential for expanding the urban canopy in each zone. The existing canopy cover and 2040 canopy cover goal for each zone is outlined in the chart below. The plan estimates a 42 percent average canopy cover with significant differences in each zone.

Table 17. Tumwater urban forestry canopy cover goals per land use designation. Table from the Tumwater Urban Forestry Plan.

Tree Canopy Cover Percentages					
Land Use Type	2019 Developed Area	2019 Undeveloped Area	2019 Undevelopable Area	2019 Total Area of City and UGA	Recommended 2040 Goal
Port of Olympia-Olympia Regional Airport	2%	53%	6%	3%	3%
Port of Olympia-Industry	18%	54%	49%	41%	25%
Industrial	17%	40%	39%	32%	25%
City Core Mixed Use	23%	43%	25%	27%	25%
Other Mixed Use	27%	34%	22%	30%	25%
General Commercial	22%	55%	50%	41%	30%
Single-Family Residential	45%	58%	54%	52%	50%
Multifamily Residential	34%	45%	51%	40%	40%
Open Space & Green Belt	61%	59%	46%	49%	55%
Tumwater+ Urban Growth Area	31%	50%	48%	42%	39%

Olympia

Unlike Lacey and Tumwater, the City of Olympia has series of documents that outline tree protection requirements and guidelines but does not have an urban forest management plan. Olympia has an Urban Forestry Manual that describes a vision for Olympia in twenty years with a sustainably managed

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and diverse urban forest (City of Olympia, 2016). The manual highlights the existing tree ordinances and requirements for developers, property owners, and city maintenance staff, and describes six levels of tree plan standards. The Urban Forest Manual is updated annually to provide clarity and clear instructions for developed and developing parcels. Olympia is the only jurisdiction of the three cities with an urban forester on staff, and since 2011, Olympia has had a Recommended Street Tree list that is regularly refined in consultation with a veteran arborist. The list includes classification by tree species, 'soil volume' requirements, and also includes data on height, spread, form, flower, fall color, and planting strip width. This list is restricted to climate adapted species. While the City of Olympia does not have an overarching canopy cover goal or updated urban forestry plan, the Urban Forestry Program Manager hopes to apply for grants to develop an urban forest management plan.

Future urban forestry plans could benefit from a detailed canopy cover comparison by zone, similar to the analysis in Tumwater's Urban Forestry Plan. Achieving the goals and timelines outlined in the plans will require additional staff time and, in some cases, the expertise of a contract forester.

Tree Ordinances

Lacey, Olympia, and Tumwater each have a series of tree ordinances that present standards for maintenance, planting, replacement, and removal. The existing ordinances for each City provide strong protection standards and planting guidelines, but the average canopy cover continues to decline. Although the tree ordinances for each city take different forms, they share many common characteristics. Each city addresses hazard trees, heritage or landmark tree designations, critical root zones, tree maintenance, replacement, and removal. The chart below outlines common elements in the existing tree ordinances for each jurisdiction. Note that this information was gathered in 2021 and 2022, and may be out of date. As of early 2023, several jurisdictions are reviewing their tree ordinances and may have updated their ordinances and other program components.

Areas for Growth

While existing plans and ordinances protect trees, each of the cities could benefit from an updated tree planting list to accommodate changing climate conditions and space availability, outreach and education for developers and residential property owners, enhanced fee-in-lieu programs for development, and clarified maintenance standards. Strengths and areas for growth for each city are outlined in the chart below.

The City of Woodinville offers an example of a strong tree ordinances and goals. As of 2017, Woodinville had an average canopy cover of 45 percent with eleven percent possible planting area and a goal to maintain a tree canopy of 40 percent. The City of Woodinville's ordinances outline clear standards for maintenance and require a minimum tree density of 70 tree credits for residential zones. The city also has a tree fund supported by payments from fees-in-lieu of supplemental plantings, civil penalties, sale of trees or wood from city property, and donations. Woodinville's urban forestry plan analysis and maintenance standards could guide future code updates or Urban Forestry Plan editions for Lacey, Olympia, and Tumwater.

	Lacey	Olympia	Tumwater
Urban Forestry Plans			
Plan Name	Urban Forest Management Plan	Urban Forestry Manual	Urban Forestry Management Plan
Year Adopted	2021	2016 (updated 2021)	2021
Goals	Achieve and maintain a vibrant, healthy, and diverse urban forest in Lacey and Lacey’s urban growth area consisting of both native and non-native landscape components. Preserve and maintain native forest components in areas conducive to the lifecycle of native plants such as critical areas (wetland and habitat areas and buffers), conservation parks, large tracts of open space and other areas that can be naturalized while maintaining compatibility with the anticipated land use of the surrounding area. Preserve natural forest components recognizing and considering the nature of urban zoning classifications and limitations particular zones and users have on the preservation of Indigenous trees. Recognize the benefits of tree cover in consideration of drainage and watershed planning, habitat management, passive recreation opportunities, urban aesthetics and pedestrian benefits for street design, and maintain and improve Lacey’s overall tree canopy for these benefits and purposes. Provide significant habitat value in Lacey’s urban forest	Vision for an Olympia in twenty years where land is preserved and sustainably managed, a healthy and diverse urban forest is protected, expanded, and valued. Technical guide for developers, contractors, tree service providers, landscapers, and property owners. To provide for the protection, preservation, replacement, proper maintenance and use of trees, soils, and native vegetation located in this city in order to preserve and enhance the city’s physical aesthetic character by preventing untimely and indiscriminate removal or destruction of trees, healthy soils, and native vegetation; To promote the public health, safety, and general welfare of the citizens of Olympia without preventing the reasonable development of land; To provide for the preservation and proper maintenance of landmark trees located in this city, to minimize disturbance to the trees themselves, and to prevent other environmental damage from erosion or destruction of wildlife habitat;	Restore and enhance the community and urban forest Protect and preserve the community and urban forest, which includes trees, understory, habitat, and soils Manage City-owned community and urban forestry resources for maximum benefit Balance the protection and support of community and urban forest with other City strategic priorities, which include, in part, providing affordable housing, developing a walkable, urban community, economic development, and protecting endangered species. Promote the use of incentives to leverage community and urban forestry aims Promote community and urban forest stewardship, education, and achievement Optimize opportunities for partnerships in community and urban forest preservation and enhancement Give community and urban forest resources an appropriate emphasis within City

	Integrate urban forestry concepts and preferences with development design. Maintain tree canopy in developed areas. Develop a street tree program as an essential component of Lacey’s Urban Forestry Plan. Create a heritage and specimen tree program that recognizes special trees worthy of extra attention, notoriety, and protection. Develop an Urban Forestry Plan that promotes safety and healthy trees. Create an Urban Forestry Program that is publicized, easily understood, has broad support, promotes pride in our Tree City USA distinction and is enforced. Create a citizen advisory board for urban forestry issues. Develop a method to process Class IV Forest Practice Applications pursuant to requirements of RCW 76.09.240.	Encourage the planting of new trees and the maintenance of existing trees for all the benefits they provide to the community. Protect critical areas, associated buffers, and their functions, and values while allowing reasonable use of property	
Current Canopy Cover Estimates	28.3 percent canopy cover in City Limits 31.3 percent canopy cover in Urban Growth area 3,208 privately maintained street trees 2,973 street trees maintained by Parks Maintenance staff Tree City USA	60 new street trees are typically planted each year. 2,500 street trees are maintained by the City Tree City USA	53 percent of inventoried trees under ten years old 82 percent of trees under 25 years old Three types street trees account for over ten percent of the street tree population 42 percent canopy cover in 2019 Tree City USA
Existing Staff	Two Contract Foresters	City Forester on Staff	Contracted Forester (Sound Urban Forestry)

Existing Community Resources			Tumwater Tree Board
Strengths	Evaluation of urban growth areas Recognition of urban tree benefits	Accessible outline of existing tree ordinances and requirements Detailed requirements for different levels of tree plans, depending on site characteristics.	2040 recommended canopy cover goal by land use type Criteria for the Sustainable Community Framework
Areas for Growth	- Canopy cover goals by land use type - Update urban forest planting plan	- Develop a long-term urban forest management plan - Canopy Cover strategies and targets by land use types - Estimate and publish existing canopy cover	- Additional contract forester/staff member - Update approved street tree list to account for changing climate
Tree Ordinances <i>Note that ordinances were reviewed in late 2021 and early 2022 – as of early 2023, several jurisdictions are actively reviewing their regulations, and the information in this table may not reflect the most current version.</i>			
Ordinances	LMC 14.32: Vegetation Protection and Preservation Ordinance LMC 16.24.040: Standards for development LMC 16.80.050 Types of Landscaping LMC 16.80.070 Species Choice LMC 16.80.080: Maintenance of plant materials	OMC 16.48: Clearing OMC 16.56: Landmark Tree Protection OMC 16.58: Public Trees OMC 16.60 Tree, Soil, and Native Vegetation Protection and Replacement OMC 18.36: Landscaping and Screening OMC 13.16.017: Drainage Design and Erosion Control Manual; and The Engineering Design and Development Standards (specifically Chapter 4 Transportation and 4H.100 Street Trees) OMC 18.32: Critical Areas OMC 12.44 Street trees	TMC 12.24 <i>Street Trees</i> TMC 16.08 <i>Protection of Trees and Vegetation.</i> TMC 18.47: <i>Landscaping</i>
Hazard Trees	Any tree that is dead, dying, damaged, diseased, or structurally defective, recently exposed by adjacent clearing, or some other factor that will subject the tree to failure, and the tree could reasonably reach a target, as	Any tree with a combination of structural defect and/or disease that makes it subject to a high probability of failure, and is within close proximity to where persons or property	Any tree that, due to its health or structural defect, presents a risk to people or property (TMC 16.08).

	determined by the tree protection professional (LMC 14.32).	could be harmed or damaged if the tree were to fail (OMC 16.60.020).	
Heritage/Landmark Trees	Historical tree” is a tree or group of trees designated as such by the city because of its historical value to the residents of the city. <u>Process:</u> 1. Nomination by the property owner, a neighborhood organization, or any person by submitting a map, a photograph, and a narrative description including the location, species, approximate age, and the characteristics on which the nomination is based. 2. The director decides if the tree meets requirements and records designation. <u>Removal:</u> A permit is required for removal of a historical tree. Permit is granted if tree is dead, diseased, or hazardous (LMC 14.32).	A tree or group of trees designated as such by the city because of its exceptional value to the residents of the city. Value is determined by factors such as a. association with historic figures, events, or properties, b. rare or unusual species, or c. exceptional aesthetic quality. <u>Process</u> Nomination by owner, neighborhood organization, or any person submitting by a map, photograph, and narrative description including the location, species, approximate age, and the characteristics on which the nomination is based. The Director evaluates the nomination and hears public comment. If owner of tree does not approve of designation the nomination is disapproved. Appeals must be submitted within 10 days of decision <u>Removals</u> No person shall remove landmark tree. Any proposals for removal must apply for tree removal permit. Approval is based on health of tree or potential hazard. If the tree is determined to be healthy or treatable the director will deny. The advisory board holds public meeting within 30 days of appeal for landmark tree removal.	Trees designated by the city and their owners as historical, specimen, rare, or a significant grove of trees (TMC 16.08) <u>Process:</u> 1. Application signed by landowner and nominator with short description including address or location and landowner’s name and phone number. 2. Tree board reviews application. 3. Heritage tree added to city tree inventory and public works maps. 4. Classified as historical, specimen, rare, or significant grove. <u>Removal:</u> Tree removal permit required and city tree protection professional evaluates the tree before decision on the removal permit. Dead or hazardous trees are exempt from a tree removal permit after verification by the city tree protection professional.

Critical Root Zones	Root protection zone” is an area around the tree to be saved equal to one foot of radius for each one inch of tree diameter measured four and one-half feet above the ground line (DBH), unless otherwise designated by the city’s tree protection professional (LMC 14.32).	The area where the tree’s roots are located, generally the area surrounding a tree at a distance which is equal to one foot for every inch of tree diameter breast height (OMC 16.60.020).	Area on the ground with radius of one foot for every inch of tree diameter, measured from four and one-half feet above ground level, not less than a six-foot radius (TMC 16.08)
Maintenance	Thinning activities shall be strictly limited to less than thirty-five percent of the volume every ten years. High grading or top-down thinning shall not be permitted (LMC 14.32).	No landmark tree shall have major pruning or disturbance of over 10 percent of the root zone within a 3-year period. Topping of trees is prohibited. Pruning Standards: Deciduous Trees: Year One: only dead/broken branches removed Year Two: Class one prune to American National Standard Institute a 300. Year 3: Prune to establish permanent architecture Conifer Trees: Year One: minimal pruning Year Two: Maintain soil hydration Year 3: Retain brown areas of growth and only remove bottom branches when necessary,	“Trees are to be maintained in a vigorous and healthy condition, free from diseases, pests and weeds. Trees which become diseased, severely damaged or which die shall be removed by the owner as soon as possible but no later than sixty days after notification by the city” (16.08)
Replacement	Order or Priority 1. On site 2. Off site: When space is unavailable for planting the required trees on-site, then they may be planted at another approved location within the city of Lacey or Lacey’s growth area.	Number of replacement trees determined by tree units. Tree units are determined by measuring the trunk size of existing individual trees. Larger and more mature trees are worth more tree units.	Replacement trees replaced by healthy trees of the same size and species required by the approved tree protection plan for the property (16.08). If tree dies due to construction, the city tree protection professional will determine the

	When both on and off-site locations are unavailable, the applicant must pay the replacement cost to the city’s tree account plus planting and maintenance cost for three years (LMC 14.32).		value of the tree, and the applicant plants the equivalent value of trees on site.
Tree Removal	Removal of no more than five trees in any thirty-six consecutive months or ground cover for the purposes of solar access, general property and utility maintenance, landscaping or gardening, provided a minimum tree threshold is maintained. This exemption does not apply to historical trees or trees and ground cover in environmentally sensitive areas (LMC 14.32).	A tree removal permit is required to remove or destroy any tree within the city, and a soil and vegetation plan is required to obtain a tree removal permit (OMC 16.60.030). OMC 16.60.050 establishes six levels for required Soil and Vegetation Plans, based on the type of project or activity. Requirements for each level are delineated in the Urban Forestry Manual. Tree removal is just one element considered in the analysis required as a part of development review. On undeveloped properties, a maximum of six trees per acre, up to a total of six trees within any twelve-month consecutive period, may be removed from an undeveloped property without a permit. (OMC 16.60.040 – Exemptions) Removal of any public tree must be approved by the city’s urban forester, and is only allowed when the tree is infected to prevent transmission, public nuisance, safety hazard, severely interferes with growth of another tree, infrastructure work would kill tree, necessary for vegetation management plan, access to private property (OMC 16.58.060 – Public Trees).	No more than thirty percent of the trees on any parcel of land shall be removed within any ten-year period, unless the clearing is accomplished as part of an approved development plan. One tree must be planted for every tree removed. Replacement trees must be seedlings of similar species to those removed and at least two years old. In lieu of planting replacement trees, applicants can make a cash payment to the city’s tree account equal to one hundred twenty five percent of the retail value replacement cost. For land clearing permits that are part of a development plan, trees removed count towards required tree retention/replacement.

Strengths	Opportunities for off-site tree planting replacement	Ordinance Specificity Requirements for Tree, Soil, and Native Vegetation Areas Pruning Standards Six levels of tree plan standards	Heritage Tree Program
Areas for Growth	- Clarification of regulations contained in LMC 14.32 pertaining to tree replacement on individual lots as suggested in the Lacey Urban Forestry Plan (2021) - Clarification of definitions contained in LMC 14.32 as suggested in the Lacey Urban Forestry Plan (2021) - Clarification of recommendations for tree protection required in tree protection professional reports in LMC 16.24.040 - Implementation of Fee-in lieu program discussed in the Lacey Urban Forestry Plan (2021)	- Update recommended tree planting list - Develop Urban Forest Management Plan	- Expansion of tree ordinances to meet goals identified in the Tumwater Urban Forestry Plan (2021) - Tree maintenance requirement specificity

Appendix D

Case Studies

Other cities, counties, and organizations have existing programs that incorporate elements of carbon sequestration, though not many have done so as part of broader climate mitigation strategies. TRPC staff interviewed representatives from several different types of programs to better understand how sequestration could be addressed in the Thurston region. The carbon sequestration initiatives profiled take three forms: carbon credit programs, community forests, and urban forestry programs. These programs include:

- [King County Forest Carbon Program](#)
- [Pierce Conservation District Partnership with City Forest Credits](#)
- [Nisqually Community Forest](#)
- [Tucson Million Trees](#)
- [Tacoma Urban Forestry Management Plan](#)

Carbon Credit Programs

Carbon credit programs provide local businesses and organizations the opportunity to offset carbon emissions by purchasing carbon credits. Each carbon credit generated is equivalent to one ton of CO₂ taken out of the atmosphere. Crediting programs offer multiple benefits including quantifying sequestration, supporting conservation work, and fostering community support for sequestration. Most carbon credit programs involve a partnership with an outside crediting organization. Organizations like City Forest Credits (CFC), Gold Standard, South Pole, and Verified Carbon Standard (VCS) have established protocols for verifying carbon credits from reforestation efforts to offset emissions. Each organization has unique eligibility requirements, verification processes, and support protocols. Either the crediting organization or a third party will market the generated credits, which are commonly purchased by private companies or groups looking to offset their emissions.

King County's Forest Carbon Program is part of the county's [Land Conservation Initiative](#), a partnership between King County, cities, businesses, farmers, and environmental partners to protect forests, farms, rivers, trails, and urban green spaces with a goal to protect 65,000 acres of natural lands and urban greenspaces by 2050. The county's Forest Carbon Program has two branches: urban carbon credits and rural carbon credits. Both programs aim to generate carbon credits and support King County's goals by preserving parcels of land that would otherwise be harvested or developed. The Land Conservation Initiative that houses both programs has committed to addressing the historic and unequal lack of investment in open space, and dedicated \$160 million toward increasing underserved communities access to open space. This commitment has influenced where new parcels are acquired for use in the crediting program. King County requires all generated credits to be sold within the county.

The urban credit program operates through a partnership with CFC. King County acquires parcels in or directly adjacent to urban regions, preventing further development on each parcel and ensuring that all credits generated are an addition to what was already being sequestered in the county. The first round of verification was completed in 2017 by CFC and produced 3,025 mtCO₂e of verified and registered

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credits, while also producing local community and environmental co-benefits. 2,360 credits were purchased by three local companies and 265 credits are currently available for purchase (CFC).

King County's rural program partners with VCS and is open to any parcels that are not eligible for the urban program. The County completed the first round of verification for the rural program in September 2020 with almost 900 acres and 26,317 mtCO₂e of verified credits. Microsoft purchased all the generated credits from the first round of verification and the second round is expected to be completed in Fall 2021. All land enrolled in the program is currently county-owned and includes forestlands, floodplains, some agricultural areas, riparian areas, and wetlands. King County does not currently include prairies in the program because they are not prominent in that region. However, some crediting organizations have protocols focused on grasslands and different land types that might apply to prairies in Thurston County.

Pierce Conservation District has a similar carbon credit program and partnership with CFC. The District received a grant from Boeing's community support program to create a pilot program operated within the District's existing water quality and habitat restoration programs. The first round of verification generated 4,630 credits from a 10-acre parcel, and the District has partnered with South Pole, a carbon broker program, to begin selling the credits. The estimated co-benefits from the site include a total savings or avoided cost of \$166,145.21 per year and \$4,153,630.21 over 25 years. This includes savings for rainfall interception, air quality improvement, cooling effects, and natural gas ([CFC](#)). Unlike King County, Pierce Conservation District is not committed to selling credits locally. They hope to apply funds generated from selling carbon credits to habitat maintenance and enroll more acres in future years.

Carbon credit programs are relatively new and still developing protocols. One significant challenge for both carbon credit programs is selling generated credits. While Microsoft purchased the first round of King County's rural credits, the County will have to find interested buyers for future rounds of verification. Identifying and building relationships with buyers requires significant staff time or a partnership with another organization, like South Pole. Both King County and Pierce Conservation District shared that overhead requirements for urban programs and partnerships with CFC are limited. However, rural programs require more planning, staff time, and are more difficult to maintain. Additionally, identifying initial project funding and conducting preparational surveys require significant staff time and resources.

Nisqually Community Forest

The Nisqually Community Forest is a wholly owned subsidiary of the Nisqually Land Trust but is largely operated as an independent body. The vision for the forest is a locally-owned, economically self-sustaining forest with multiple benefits including sustainable forestry, recreation, and education. The forest aims to redefine how profit is measured to include the additional benefits. Funding for the early stages of the forest development came from the Washington Wildlife and Recreation program, Pierce County Conservation Futures, US Forest Service Community Forest Programs, Conservation Fund, and Puget Sound Energy Foundation.

In 2016, the community forest developed the first carbon credit program in the Pacific Northwest. This program registered and sold credits on the California market. The community forest enrolled 520 acres in the project and sequestered carbon equivalent to taking 6,600 cars off the road. In 2020, the community forest developed a new project to enroll 3,400 acres in a crediting program.

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The community forest is managed in accordance with a comprehensive forest management plan specific to separate stands within the forest. The community forest prioritizes ecological health and logged about 24 acres in 2018, 25 acres in 2019, and 40 acres in 2020 which is well below the sustained yield or annual allowable harvest. The revenue from logging helps to make the community forest self-sufficient and supports local communities with jobs. Reaching the annual allowable harvest would facilitate eight local jobs in the community. The community has been certified by the Forest Certified Council which increases the value of timber. The forest also follows a silvocultural strategy to create a more diverse forest with variable degrees of thinning and encourage natural regeneration.

Urban Forestry Programs

Most of the carbon sequestration required to meet 2050 climate goals is assumed to come from reforestation and afforestation. Urban forestry efforts address these goals while generating community support for climate efforts by involving the community in planting efforts and increasing access to green spaces. The Tucson Million Trees Initiative and Tacoma Urban Forestry Management Plan are two urban tree-planting programs.

Tucson Million Trees in Tucson, Arizona, involves a partnership with Tucson Clean and Beautiful and the mayor's office with a goal to plant one million trees by 2030. The initiative aims to increase tree canopy cover for enhanced air quality and cooling effect and does not measure sequestration rates. The program is funded by local businesses and organizations. Tucson Clean and Beautiful, a local nonprofit, oversees most operations and heavily depends on relationships with volunteers and community groups. The program supplies and plants trees on residential properties at no cost and has generated wide-spread community support. Since 2020, the initiative has planted 3,100 trees. While there is a high demand for trees from the program, the primary challenge is maintaining tree health with a water shortage.

Tacoma's Urban Forestry Management Plan set a target to increase tree canopy cover from 20 percent to 30 percent by 2030 to create a vibrant and healthy community and promote safety by improving air quality, saving energy, reducing the need for street maintenance, raising property values, conserving water and soil, protecting wildlife, diminishing urban heat islands, and increasing resident quality of life. Tacoma's strategy places a strong emphasis on supporting neighborhoods that have been historically underserved. Tacoma has an Equity Index that uses 29 data points to highlight disparities in the Tacoma community and determine where resident needs are not being met. The Urban Forestry Management Plan uses the Equity Index to determine where trees are most needed in the community and develop programs to distribute new trees. Tacoma's tree coupon program offers individuals a \$30 discount on trees planted on residential properties or in the right-of-way. Similarly, the Grit City Tree program provides free trees to individuals in underserved neighborhoods highlighted in the Equity Index, some of which have a tree density below three percent. The plan also highlights concentrated tree planting efforts around the Tacoma Mall neighborhood, plans for a landmark tree program, and ongoing research in Tacoma with the Nature Conservancy on how tree planting impacts overall health.

Urban forestry and tree-planting efforts like the Tucson Million Trees Initiative and Tacoma Urban Forestry Management Plan also present challenges. Tree maintenance is the responsibility of the property owner or renter and can pose a challenge. However, at least 90 percent of trees planted through Grit City Trees and the Tree Coupon program in Tacoma survive the first three years. Tree maintenance, transportation of trees, water access, and landowner approval are additional barriers in distributing trees or tree coupons. In Tacoma, city code also poses a challenge. The city permitting

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requirements make removing a tree easier than planting new trees, so further policy work and code updates are currently underway. Additionally, neither program identifies carbon sequestration as the primary goal, largely due to difficulty in tracking sequestration. It is likely that additional tree surveys or a partnership with a crediting organization would be necessary to track sequestration in newly planted urban trees.

Common Themes

The profiled programs offer insight into the potential for a carbon sequestration program in the Thurston region.

- Partnerships help leverage expertise and make efficient use of resources.** Rather than developing programs entirely in-house, all the outlined programs depend on some level of partnership between local government, private entities, nonprofits, and the community. For example, the Tucson Million Trees Initiative is operated by the nonprofit Tucson Clean and Beautiful and the mayor's office. The nonprofit is responsible for primary operations while the directive and goal came from the mayor's office. Similarly, King County's carbon credit program operates through county partnerships with City Forest Credits, Verified Carbon Standard, Microsoft, and other local businesses. This allows the County to outsource the time-consuming process of determining credit value to an outside third-party, rather than taking on the expense and accountability for developing that expertise within its own staff. Partners can also help fund and staff programs. The staffing demands for each program differ but are supported and distributed through local partnerships.
- Urban tree canopy programs can serve multiple community goals, are the most established type of program, and potentially are the easiest place to start, but tracking for sequestration adds complexity.** Representatives from Pierce Conservation District, Tucson Million Trees Initiative, Tacoma Urban Forestry Management Plan, and King County strongly recommended using urban tree programs to meet carbon sequestration targets. Generally, these programs require less overhead management than programs that cover a wider range of habitat types and tree maintenance falls on individual renters or property owners. Most existing urban tree planting initiatives identify equity, public health, and a cooling effect as the primary goal rather than sequestration. Measuring carbon sequestration for individual urban forestry program poses a significant challenge and likely requires partnership with an established certification organization.
- Communicating with the community and gaining support or approval prior to program implementation is essential.** Community engagement is critical for urban forestry programs to understand resident needs, ensure that individuals have tools to care for trees, and place trees in appropriate spaces. Community support is also essential for rural reforestation, preservation, and afforestation efforts to understand land use needs and develop maintenance plans. Carbon credit programs rely on community and local interest in purchasing the credits. Determining interest and support before initiating the program can increase participation and overall success.
- Seed funding from grants, utilities, or taxes are key to initiating programs.** Most programs received grant funding to initiate a small-scale pilot program before expanding efforts. Each program requires funding for initiation and ongoing maintenance and oversight. Funding from

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carbon credit sales were identified as essential in continuing preservation and maintenance work. Many tree planting efforts are transitioning to seek funding from stormwater management to increase the availability and security of funding.

- **Carbon sequestration programs should highlight options to benefit marginalized or historically disadvantaged communities.** All of the highlighted programs incorporate equity considerations to varying degrees. Representatives from urban tree planting programs suggest designing regional programs to distribute trees to historically underserved communities. Similarly, preserving open spaces can occur in areas that increase accessibility to green spaces for marginalized communities. Many tree planting program representatives recommended working with American Forests to designate priority regions.

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Case Studies

Program: King County Land Conservation Initiative/Forest Carbon Program- Rural

Contact Information: Anne-Gigi Chan, annchan@kingcounty.gov

Year Implemented: 2018

Goals:

Generate carbon credits and support the land conservation initiative by preserving parcels that might otherwise be harvested or developed.

Progress/Current Status:

Two Components: urban and rural

- Urban credit program is verified by City Forest Credits and has strict geographical restrictions. All parcels must be in areas identified as urban spaces in the US Census data, directly adjacent to an urban area, or touching an urban growth boundary.
- The Rural Program is open to any areas in the county that cannot be included in the urban program. The rural program operates with a more traditional verified carbon standard and any forested land the county acquires is verified under rural standards. During the first round of verification the rural program had approximately 900 acres and will include 700 more acres during the next round of verification.
- Currently, all land enrolled in a crediting program is county owned. The county is in the process of opening the programs to third parties to increase participation.
- Traditionally, at least 1,000 acres are required to make crediting economically feasible. However, at the county level several parcels are combined, making crediting economically feasible.
- Only parcels acquired by King County from 2015 and onwards can be enrolled in the program to emphasize additionality and the protection of new areas that otherwise would be developed or deforested.
- Protection of existing trees is not counted in the urban program, eliminating questions about whether the trees would or would not have been harvested and if the program adds to existing sequestration.
- The land the county acquires includes floodplains, some agriculture lands/conservation easements, forestlands, land along the river, wetlands. King County does not currently include prairies in the crediting program, but there are protocols focused on grasslands and available for different land types.
- Currently, the rural program is undergoing the second round of verification. Microsoft committed to buying all credits from the first verification from the rural program, and funds from that sale will be used to purchase parcels in the future. Future rounds of verification will have to actively find buyers. King County was approached by individuals from Atlanta interested in purchasing credits but did not sell the credits and remains dedicated to building local partnerships and selling credits within the county.

Challenges:

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- Significant challenges exist in both the urban and rural programs.
- In the urban program, the county has faced difficulty acquiring eligible urban parcels.
- The rural program requires more management than the urban program. The urban program requires familiarity with GIS, but all spreadsheets and resources are provided by City Forest Credits. CFC also has a third-party verification already in place. The rural program requires an additional contractor and auditor to verify credits.
- A challenge for both programs is marketing the credits. While Microsoft committed to purchasing the first round of credits, it is likely that significant staff support and time will be needed to market the next round of credits.

Recommendations:

- The representative from King County highly recommended partnering with City Forest Credits as the project design is more straightforward and includes the possibility for including tree planting initiatives along with land conservation efforts.

Future:

- King County is considering implementing a pilot program with tree planting that would further the urban credit program. Tree planting provides an opportunity to further engage the community and unite existing tree efforts into the carbon programs.
- The carbon credit program is still new in King County and is the first crediting program at the county level. As such, staff are focused on establishing strong processes and comprehensive protocols so that all parties are coordinated.

Program: Pierce County Conservation District Partnership with City Forest Credits

Contact Information: Allan Warren

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253-845-9770 ext 1121

Year Implemented: 2020

Goals:

Pierce Conservation District aimed to expand existing habitat restoration efforts, measure the impact of restoration work, and create a revenue stream through its partnership with City Forest Credits.

Progress/Current Status:

- Following a one-year pilot program funded by a Boeing Grant, the conservation district's partnership with CFC is focused on two projects: water quality and habitat restoration. These projects generate credits by protecting or restoring natural areas and planting trees or native plants.
- Although staffing and workload was initially a concern, it has not posed a challenge for the conservation district. There was some additional paperwork required at the beginning of the process, but the long-term monitoring is limited. Monitoring involves a simple annual report and overall has few overhead requirements. The conservation district was already

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doing restoration work prior to the partnership, so a restoration and maintenance team was already established.

- Pierce Conservation District's partnership with CFC includes a twenty-five-year commitment. The pilot program included ten acres and generated 4,600 carbon credits that were just certified and will be sold soon.
- The conservation district expects approximately \$75,000 upon completion of the partnership that is paid in semi-regular portions to ensure that all trees generating credits are still living and viable.
- Funds generated from the program are reinvested to help with ongoing maintenance and stewardship of the restored area.
- While CFC provides most resources, the conservation district contracted South Pole, a broker, to sell credits. CFC is looking to launch a program to sell all of the credits it helps generate on a national scale.
- The information and verification from CFC now help the conservation district quantify the economic benefit of restoration work to gain public support.

Funding:

- The partnership between CFC and Pierce Conservation District was supported by a grant from Boeing's community support program. The conservation district used the grant funds for a one-year pilot program and a GIS analysis to identify eligible properties according to the conservation district's priorities and CFC's requirements.

Challenges:

- Some staff members initially had concerns about green washing and selling credits that are not creating something new or performing additional sequestration. But, in this program the protocol system is only for new trees. While CFC established the system, a third-party verifier confirms the credits based on established criteria that minimized concerns.
- Concern about who is purchasing the credits. The conservation district does not monitor or restrict who can purchase the credits, but some concerns were raised about who the credits can be sold to. Originally, the conservation district wanted to sell credits locally, but plans shifted with the pandemic. Conversations are ongoing as the first sale is approaching.

Future:

- Pierce Conservation District hopes to integrate more habitat restoration areas into its partnership with City Forest Credits. The conservation district is looking for bigger acreage programs in water quality and farm areas but remains focused on habitat restoration.
- The Conservation District is interested in learning more about CFC's programs for one-off tree plantings. Representative suggested that these programs might be ideal for a city or county scale, but the conservation district remains focused on larger acreage.

Program: Nisqually Community Forest

Goals:

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The Nisqually Community Forest is a locally-owned, economically self-sustaining forest with multiple goals including sustainable forestry, recreation, and education.

Progress/Current Status:

- The Land Transferred 1,920 acres to the Land Trust in 2020. Then, in April 2021 the Land Trust acquired 960 acres along Busy Wild Creek that will be transferred to the Community Forest. The Nisqually Indian Tribe will also acquire 1,240 acres that will be managed under the Community Forest Management plan.

Future

- The Nisqually Community Forest is working to continue increasing opportunities for carbon credit programs and sustainable harvesting to become financially self-sufficient. The forest is also looking to incorporate new acreage.

Program: Tacoma Urban Forest Management Plan

Contact Information:

trees@cityoftacoma.org
(253)-502-2138

Goals:

The Urban Forest Management Plan was designed out of a need for a broader and more unified plan that identifies a decadelong strategy for urban forestry. The plan followed policies dating back 2010 and a tree canopy goal of 30 percent tree canopy by 2030. The plan development began in 2017 and involved two years of external community engagement and work to connect urban forestry goals with equity and climate.

Progress/Current Status:

- The urban forestry programs are operated under environmental services in the sustainability office. The team includes three full time staff members and additional arborists and tree-related positions around the city. Currently, the city has 20 percent existing tree canopy, one of the lowest in the region and not equitably distributed.
- The Urban Forestry Management Plan engages several programs to reach the 2030 tree canopy goal. The Tree Coupon Program planted 2,500 trees in 2020. The GRIT City Trees program provides free trees to Tacoma residents and prioritizes individuals from neighborhoods identified as historically underserved. The program is open to individuals who rent or own their homes, but the resident is responsible for tree maintenance and the tree must be planted in the right of way. The city supplies some watering supplies with the GRIT City tree to support maintenance. Both GRIT City Trees and the Tree Coupon Program are successful programs that grow at least ten percent every year. The survivability of planted trees is over ninety percent in the first three years.
- The urban forest management plan includes working with one neighborhood each year to increase tree canopy. Currently, the Tacoma Mall area in the south-central part of the city is

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a focus area. This region has one of the lowest tree canopies, a high renter population, lots of impervious surfaces, is not pedestrian friendly, and is increasing in density. Efforts in the neighborhood have centered around community outreach and a partnership with the Tacoma tree foundation.

- The city has a contract with Tacoma Tree Foundation which supplies advertising for GRIT City Trees and helps provides feedback for what residents in the Tacoma Mall neighborhood would like to see. Tacoma also has a partnership with the Nature Conservancy to observe public health outcomes from increased greening in the Tacoma Mall neighborhood.
- Carbon sequestration is not an explicit goal in the tree planting efforts, largely because of monitoring difficulties. However, the city is currently drafting an updated environmental action plan for the coming decade that may place a greater emphasis on carbon sequestration. Each of the programs employs a 'Right Tree, Right Place' framework and focuses on tree diversity for pest and disease resistance. The program has found success with trees that are more drought tolerant and relies on tree inventories to ensure diversity of species.

Funding:

The forestry programs have a stable budget from surface water funds because of the demonstrated benefit trees can have on surface water quality and protection.

Challenges:

- Each of the programs within the urban forestry management plan has unique challenges. However, inconsistencies within the right-of-way code around tree protection pose a challenge to meeting the 2030 goal. The management plan identified discrepancies that make it easier to remove trees than it is to plant trees.
- Tree planting efforts have also encountered challenges with the bureaucratic system as tree removals are automatically approved in the permitting department.
- While public response the programs has been very positive, the efforts always encounter concerns about green gentrification and place a strong emphasis on acquiring neighborhood support prior to project implementation.
- There have also been some challenges in collaborating with outside partners and working across jurisdictions.

Future:

- In the coming years, Tacoma is looking to introduce a heritage tree program to protect existing trees. In this program, community members could nominate a tree on their property, in the right of way, or on public property for heritage tree status. Once granted, the trees are protected unless they are dead, dying, or pose a significant safety hazard.
- The city also plans to identify additional regions to initiate focused efforts like the Tacoma Mall area.

Recommendations:

The program representative highly recommended emphasizing community collaboration and engagement at the start of all tree planting initiatives. He also recommended analyzing tree canopy data to identify regions with the most need for tree planting. While he recognized the benefit of carbon sequestration, he suggested that sequestration is a secondary benefit to the public health effects of tree planting.

Program: Tucson Million Trees Initiative

Contact Information:

Year Implemented: 2020

Goals:

The Tucson Million Trees Initiative aims to plant one million trees by 2030 to provide shade and have a cooling effect on the city. The initiative seeks to build a more equitable community and create opportunities to engage community in creating a sustainable future.

Progress/Current Status:

Currently, the initiative has planted 3,100 trees in neighborhoods where individuals are responsible for tree maintenance and care. The program does not have any data on who is most likely to participate in the program. However, the initiative works with American Forests to prioritize regions with demonstrated need.

Funding:

Secure funding for the Tucson Million Trees initiative has posed a challenge. The program is operated as a partnership between Trees Clean and Beautiful, a nonprofit, and city government. All funding for trees in the nonprofit comes from private business investments. The city also contracts with arborists for specialized care, but there are no arborists on city staff. The initiative has had success in finding funding through stormwater management utility fees. The nonprofit regularly relies on volunteers to help plant trees and offers an opportunity for young people to help plant trees on weekend mornings for a small stipend.

Challenges:

The primary challenge for the Tucson Million Trees Initiative has been keeping trees alive. The region is prone to extreme heat and drought conditions and representatives cited keeping trees watered until they are established as the most significant challenge. All trees planted are drought-tolerant and determined to be suited to the local climate but still require additional support and watering in the warmer months. Additional challenges include tree maintenance, secure funding, and greenwashing concerns. The plan also aims to plant one million trees by 2030, which at the current rate of planting is likely unattainable. The scale of the project and distance from the goal poses a challenge in public support, coordination, and long-term planning. Support from the city government and direct connection with the Mayor's office has helped the program and drawn in community and business support.

Future

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The Tucson Million Trees Initiative remains dedicated to working towards the goal of a million trees by 2030. Future efforts involve propagating trees, addressing tree cost, securing funding, and expanding planting efforts.

Recommendations:

Carbon sequestration is not the primary goal of the Tucson Million Trees Initiative and is not measure in the program. The program representative suggested that the greatest benefit is not from sequestration but from the cooling effect, air quality changes, and overall health benefits. Suggestions for tree planting efforts included planting native trees and fruit/food trees.

Appendix E

Policy Options Detail

Overview

Regional partners have many options to move toward meeting the 2050 carbon sequestration targets outlined in the TCMP. TRPC staff developed policy options based on conversations with stakeholders, case studies, and sequestration potential in the Thurston region.

Cost Estimates

- \$ = less than \$100,000
- \$\$ = \$100,000-\$1,000,000
- \$\$\$ = \$1,000,000

More detailed cost estimates are included with the description of each action.

Staff Requirements

- Low = less than 1 FTE for limited duration, across all partners
- Medium = 1 FTE for longer duration, across all partners
- High = More than 1 FTE, for indefinite duration, across all partners

Carbon Sequestration Potential

	Low/High Baseline Sequestration Category	Low/High Sequestration Potential	Confidence/Probability of Impact
Overall Carbon Sequestration Potential	Low (Urban Trees, Agriculture, Prairies)	Low/Medium (regenerative agriculture, prairie preservation, avoided conversion of urban areas, tidal wetland restoration)	Low (voluntary education/outreach, limited ability to scale)
	Med (Urban Trees, Agriculture, Prairies)	Low/Medium (regenerative agriculture, prairie preservation, avoided conversion of urban areas, tidal wetland restoration)	Medium/High (monetary incentives, regulation, or capital project; potential for widespread application)
		High (Rural Forest)	Low (voluntary education/outreach, limited ability to scale)
	High (Rural Forest)	High (avoided conversion of rural forest areas, extended timber harvest)	Medium/High (monetary incentives, regulation, or capital project; potential for widespread application)
	Enabling	No direct sequestration benefit, but enables other actions.	

Carbon Sequestration as a Climate Mitigation Strategy for the Thurston Region
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February 2023

Table 18. Policy Options to Support Carbon Sequestration in the Thurston region

Action	Initial Cost	Ongoing Costs	Staff Requirements	Carbon Sequestration Potential	Potential Lead
Forests and Trees					
Rural/Forest Landowner Outreach and Technical Support Program	\$\$	\$\$	Medium	Medium	TCD, WSU Extension
Urban Tree Outreach and Technical Support	\$\$	\$\$	Medium	Low	Lacey, Olympia, Tumwater
Regional Urban Tree Canopy Assessment	\$	\$	Low	Enabling	TRPC, Thurston County, Lacey, Olympia, Tumwater
Tree Canopy Targets	\$	\$	Low	Enabling	TRPC
Urban Tree Management Plans and Code Review	\$\$	\$	Medium	Medium	Thurston County, Lacey, Olympia, Tumwater
Forest Conversion Ordinance and Rural Tree Standards Update	\$\$	\$	Medium	High	Thurston County
Comprehensive Plan Review and Update	\$\$	-	Medium	High	Thurston County, Lacey, Olympia, Tumwater
State Forest Lands Management Advocacy	\$	\$	Low	High	Thurston County, CASC
Working Forest Conservation Easements	\$\$\$	\$\$\$	High	High	Thurston County
Community Forests	\$\$\$	\$\$\$	High	High	Thurston County, Land Trusts
Regional Tree Fund	\$\$	\$	Medium	Enabling	Thurston County
Urban Forest Carbon Credit Program	\$	\$	Low	Low	Thurston County, Lacey, Olympia,

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Action	Initial Cost	Ongoing Costs	Staff Requirements	Carbon Sequestration Potential	Potential Lead
					Tumwater, TCD
Rural Forest Carbon Credit Program	\$\$	\$\$	Medium	High	Thurston County, TCD
Transfer of Development Rights Program Update	\$	\$	Medium	Medium	Thurston County
Land Conservation and Restoration Capacity	\$	\$	Medium	Enabling	Thurston County, Lacey, Olympia, Tumwater, Land Trusts
Reforestation/Afforestation Projects	\$\$	\$\$\$	High	High	Thurston County, TCD, Land Trusts
Agriculture					
Regenerative Agriculture Practice Tracking	\$	\$	Low	Enabling	TCD, WSU Extension
Regenerative Agriculture Outreach and Technical Assistance	\$\$	\$\$	Medium	Low	Thurston County, TCD
Agriculture Zoning and Development Code Review	\$	\$	Low	Medium	Thurston County
Conservation Programs Update	\$	\$	Low	Medium	Thurston County
Regional Agriculture Fund	\$	\$	Low	Enabling	Thurston County
Agriculture Carbon Credit Program	\$	\$\$	Medium	Medium	Thurston County, Lacey, Olympia, Tumwater, TCD
Prairies					
Prairie Soil Analysis	\$	\$	Low	Enabling	WSU Extension
HCP Implementation	\$\$\$	\$\$\$	High	Medium	Thurston County, Tumwater, Port of Olympia
Prairie Conservation and Enhancement Carbon Credit Program	\$	\$\$	Medium	Medium	Thurston County, CNLM

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Action	Initial Cost	Ongoing Costs	Staff Requirements	Carbon Sequestration Potential	Potential Lead
Supporting/Other Actions					
Land Use Change Emissions Inventory	\$	\$	Low	Enabling	TRPC
TCMP Target and Action Update	\$	\$	Low	Enabling	TRPC
Sequestration Working Group	\$	\$	Medium	Enabling	TRPC
Blue carbon/Tidal restoration	\$\$\$	\$\$\$	Medium	Medium	Squaxin Island Tribe, cities, county

Forests and Trees

Rural/Forest Landowner Outreach and Technical Support Program

- **TCMP Action:** Supports existing Action A5.1
- **Description:** Develop an educational outreach campaign for rural landowners with guidance and technical support on best management techniques for conserving existing trees, extending timber rotations, and planting new trees to maximize carbon sequestration benefits. Campaign should provide options targeted to both small and large landowners, and include connecting landowners to funding resources like conservation easements and cost-share programs. Such campaign could build off existing programs, including the Voluntary Stewardship Program, Thurston Waterways, and Thurston Conservation District's technical support programs.
- **Potential Lead:** Thurston Conservation District, WSU Extension
- **Partners:** Thurston County, DNR Small Forest Landowner Office
- **Estimated cost:** \$150,000 to establish program; ongoing funding to support outreach staff would depend on scope and reach of program
- **Potential Funding source:** Grant for program establishment

Urban Tree Outreach and Technical Support

- **TCMP Action:** Supports existing Action A6.5
- **Description:** Develop an educational outreach campaign for urban residents that highlights the social, environmental, and health benefits of trees while also sharing information on existing tree regulations and best practices for working with trees in an urban setting to maximize carbon sequestration as well as other community benefits. This could include developing a recommended tree list and siting and maintenance considerations for trees on urban properties. Materials could provide general information across all three cities and UGAs, but implementation would be within each jurisdiction.
- **Potential Lead:** Olympia, Lacey, and/or Tumwater
- **Partners:** Thurston Conservation District, WSU Extension, DNR Urban and Community Forest Program

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- **Estimated cost:** \$150,000 to establish program; ongoing funding to support outreach staff would depend on scope and reach of program
- **Potential Funding source:** Grant for program establishment; local funds

Regional Urban Tree Canopy Assessment

- **TCMP Action:** Supports existing Action A6.9
- **Description:** Measuring the carbon sequestration potential of urban trees generally requires a detailed tree inventory with information about tree age, height, width, and type. Some jurisdictions have gathered or are in the process of gathering information on trees within their boundaries, but this data is not available for the region at a scale that would be helpful for tracking carbon sequestration benefits. A complete tree inventory of the region's urban areas would supply the information needed to include urban trees in total carbon sequestration estimates. Such an inventory could build off the canopy assessment currently under development for Olympia, and would need to be updated periodically to track changes over time.
- **Potential Lead:** Thurston County, TRPC, or individual cities
- **Partners:** Olympia, Lacey, Tumwater
- **Estimated cost:** \$50,000 to develop first layer; additional costs would depend on frequency of updates
- **Funding source:** Grant – DNR Urban Forest program

Tree Canopy Targets

- **TCMP Action:** Supports existing Action A6.9
- **Description:** Set targets for tree canopy, consistent with extent needed to support TCMP sequestration target. These could be set at a regional level, with general targets for individual jurisdictions. In addition to the regional goal, each jurisdiction could opt to establish urban tree canopy targets per land use designation. This action is dependent on partners completing the regional tree canopy assessment identified in a previous action.

Alternatively, partners could set a more general land-use related target for forest cover through a task described above.

- **Potential Lead:** TRPC, Thurston County, and/or individual cities
- **Partners:** Cities, community stakeholders
- **Estimated cost:** \$80,000
- **Funding source:** Grant or TCMP Work Program

Urban Tree Management Plans and Code Review

- **TCMP Action:** Supports existing Action A6.5
- **Description:** A comparison of existing urban tree management policies of Lacey, Olympia, and Tumwater (summarized in Appendix D) suggests some areas for improvement, including updated tree planting list to accommodate changing climate conditions and space availability, outreach and education for developers and residential property owners, enhanced fee-in-lieu programs for development, and clarified maintenance standards. Both Lacey and Tumwater have recently completed updates to their urban forest management plans, and have code updates underway or planned, and work is planned in Olympia and in

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Thurston County for the Urban Growth Areas of Lacey, Olympia, and Tumwater as part of the Joint Plan code update process (currently planned for 2023-2024). One short term action could include a regional informational summit on approaches to urban tree management to share information, successes, lessons, and best practices.

- **Potential Lead:** Olympia, Thurston County
- **Partners:** Lacey, Tumwater, community stakeholders
- **Estimated cost:** Will vary depending on scope identified by each jurisdiction
- **Funding source:** Individual jurisdictions

Forest Conversion Ordinance and Rural Tree Standards Update

- **TCMP Action:** New Action
- **Description:** Update Thurston County's forest conversion ordinance and tree planting standards (TCC 17.25 and Title 18) to minimize the impacts of forest conversions with the aim of growing and restoring forests in the rural areas of the county.
- **Potential Lead:** Thurston County
- **Partners:** community stakeholders
- **Estimated cost:** This effort is currently funded through the Thurston County Development Code Docket
- **Funding source:** Thurston County

Comprehensive Plan Review and Update

- **TCMP Action:** New Action, but also supports existing actions T1.1, T1.2, T1.3, and T1.4
- **Description:** Review, and if necessary, update existing Comprehensive Plans and associated zoning and land use policies to increase urban density and minimize the conversion of forests, agricultural lands, and prairies consistent with the Sustainable Thurston land use targets adopted in the TCMP, which will help maintain the region's existing sequestration capacity.
- **Potential Lead:** Thurston County, cities
- **Partners:** community stakeholders
- **Estimated cost:** Will vary depending on scope for each jurisdiction, costs will be for additional staff time and community outreach
- **Funding source:** County and city budgets, state grants may support some portion of the updates

State Forest Lands Management Advocacy

- **TCMP Action:** New Action, but could connect to G5.5, legislative agenda
- **Description:** Washington State manages significant areas of timberland within Thurston County (52,000 acres, according to the US Forest Service), mostly through the Department of Natural Resources (DNR). TCMP partners could advocate for changes to DNR forest cutting permit rules, such as requiring a carbon impact analysis, increasing protections of critical areas, creating incentives for climate-smart forestry practices (including prescribed fire applications, diverse plantings, variable density thinning/retention harvests, etc.), and longer harvest rotations. Partners could also advocate for DNR to enroll more of its land in its Carbon Project and employ extended harvest rotations on its lands in Thurston County. Note that land enrolled in the Carbon Project program could not count toward the TCMP

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target, unless the credits generated by the change are purchased by an entity within Thurston County to offset emissions that contribute to the Thurston region's countywide total or purchased and not used to offset emissions.

- **Potential Lead:** Thurston County, Climate Action Steering Committee
- **Partners:** TCMP partners
- **Estimated cost:** none for advocacy, could be included within standing tasks of the TCMP Work Program. There would be a cost to purchase the value of certified credits.
- **Potential Funding source:** TCMP Work Program

Working Forest Conservation Easements

- **TCMP Action:** New Action
- **Description:** Work with owners of private timberlands to establish conservation easements that set permanent requirements for extended timber harvest cycles and other benefits, like maintaining a certain percentage of older trees. Amend Thurston County's Conservation Futures program to make these types of projects eligible for funding and develop other sources of funding. According to the US Forest Service estimates, there are 170,000 acres of privately owned working forest land in Thurston County, and the scenarios reviewed for the emission potential section proposed that extended rotation be applied on 30-40 percent of these lands (51,000-68,000 acres).
- **Potential Lead:** Thurston County
- **Partners:** Land Trusts, Community stakeholders
- **Estimated cost:** Difficult to estimate as the cost of conservation easements vary considerably based on their specific conditions. Assuming a rough easement cost of \$1,000/acre⁵ the total cost would be \$51-68 million. Spread over a 25-year time period (2025-2050), this would equate to \$2-2.7 million per year. This strategy could be combined with a carbon crediting system, as described below, which could offset some costs.
- **Potential Funding source:** Conservation Futures, State and Federal grants, Utility Funds, Private funding

Community Forests

- **TCMP Action:** New Action, Promotes A5.2 from Communitywide Long List of TCMP Actions
- **Description:** Expand community forest model into Thurston County, leveraging existing infrastructure of Nisqually Community Forest. This action would expand sequestration capacity if new community forests are managed with longer harvest rotations and climate-smart forestry practices. This action would go one step further than purchasing working forest easements (described above), by establishing new entities that would purchase forest land and manage for multiple community benefits (including sequestration). The Nisqually Community Forest in Pierce County grew to 4,120 acres over five years; assuming that rate of expansion could be matched in Thurston County over 25 years, this would result in around 20,000 acres of forestland managed in the Community Forest model by 2050.
- **Potential Lead:** Thurston County, Land Trusts
- **Partners:** Land Trusts

⁵ Review of Pacific Forest Trust working forest easements - <https://www.pacificforest.org/>.

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- **Estimated cost:** High - \$\$\$\$. Initial costs include the administrative tasks to establish a new community forest (\$500,000) and purchase of initial 2,0000 commercial forestland (\$7 million, estimated at \$3,5000/acre⁶). Ongoing costs would include personnel and other cost to support administration and financial management, land stewardship, and outreach, as well as average acquisition rate of 800 acres/year over 25 years – an estimated \$3-4 million/year. Costs could be offset through revenue from timber sales, recreation fees, and/or fundraising, depending on the structure of the organization.
- **Potential Funding source:** Conservation Futures, State and Federal grants, Utility Funds, Private funding, Timber sales

Regional Tree Fund

- **TCMP Action:** New Action
- **Description:** Establish a regional fund, coupled with replanting requirements, that would allow developers to pay a set amount if clearing is unavoidable, and tree planting can't occur on site. Funds could be directed to pay for replanting in degraded riparian corridors, identified heat islands, or other areas identified as a priority by the partners.
- **Potential Lead:** Thurston County, individual cities
- **Partners:** TCMP partners
- **Estimated cost:** Initial costs would be moderate to establish program administration; ongoing program administration could be paid for out of program fees, but success would be dependent on having enough developers paying into the account to offset costs.
- **Potential funding source:** TCMP Work Program, State or Local Grants, Development fees

Urban Forest Carbon Credit Program

- **TCMP Action:** Supports existing actions A5.1 and A6.5
- **Description:** An urban carbon credit program could be a means to preserve trees and increase planting in urban areas, quantify progress toward sequestration targets, and generate funding to offset administrative costs. This type of program would likely involve a partnership with an organization like City Forest Credits or Verified Carbon Standard to certify credits. Challenges to carbon credit programs include that projects expected to count toward the TCMP sequestration target should only be used to offset emissions included in the Thurston region's countywide total, and not be double counted toward some other offset measurement. Areas also may need to demonstrate a tangible threat of conversion. With this restriction, part of the program effort would need to include marketing the credits to potential local purchasers. This strategy could have three general phases:
 - **Phase 1** – Assess feasibility and applicability of program
 - **Phase 2** – Program development and set up
 - **Phase 3** – Ongoing program administration
- **Potential Lead:** Thurston County, individual cities, Thurston Conservation District
- **Partners:** TCMP partners, private carbon credit certification and verification company, land trusts, local businesses
- **Estimated cost:** Phase 1: \$15,000, Phase 2: \$50,000, Phase 3: \$20,000. Case study examples suggest administrative overhead for urban credit programs is relatively low, at least through

⁶ Source: Nisqually Land Trust

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City Forest Credits. Costs, especially for Phase 1, could be combined with other Carbon Credit Program strategies.

- **Potential funding source:** TCMP Work Program, State or Local Grants, Private investment

Rural Forest Carbon Credit Program

- **TCMP Action:** Supports existing Action A5.1
- **Description:** A rural carbon credit program could be a means to preserve forested areas, extend harvest rotations, and increase planting on rural lands; quantify progress toward sequestration targets; and generate funding to offset administrative costs. This type of program would likely involve a partnership with an organization like Verified Carbon Standard to certify credits. Challenges to carbon credit programs include that projects expected to count toward the TCMP sequestration target should only be used to offset emissions included in the Thurston region's countywide total, and not be double counted toward some other offset measurement. Areas also may need to demonstrate a tangible threat of conversion. With this restriction, part of the program effort would need to include marketing the credits to potential local purchasers. This strategy could have three general phases:
 - **Phase 1** – Assess feasibility and applicability of program
 - **Phase 2** – Program development and set up
 - **Phase 3** – Ongoing program administration
- **Potential Lead:** Thurston County, Thurston Conservation District
- **Partners:** TCMP partners, private carbon credit certification and verification company, land trusts, local businesses
- **Estimated cost:** Phase 1: \$15,000, Phase 2: \$180,000, Phase 3: \$40,000. Costs, especially for Phase 1, could be combined with other Carbon Credit Program strategies.
- **Funding source:** TCMP Work Program, State or Local Grants, Private investment

Transfer of Development Rights Program Update

- **TCMP Action:** Supports existing Action T1.1 and could benefit from a new action focused on rural land conservation
- **Description:** Review and update Thurston County's Transfer of Development Rights program to permit lands important to carbon sequestration to be included as sending areas. For this tool to be successful, there would need to be ongoing costs dedicated to administering and marketing the program.
- **Potential Lead:** Thurston County
- **Partners:** cities
- **Estimated cost:** \$80,000 (0.25 FTE over two years)
- **Potential Funding source:** Thurston County; state grant

Land Conservation and Restoration Capacity

- **TCMP Action:** Supports existing Action A5.1
- **Description:** There already exist numerous programs focused on funding land conservation and restoration work in the region, including programs tied to salmon recovery, water quality and quantity improvement, flood mitigation, and recreation that fund projects with potential sequestration benefits. One of the bottlenecks that limits work on the ground is

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staff capacity at local organizations to identify, develop, and manage projects through the application and implementation process, and maintain projects over the long term. Another bottleneck is a lack of sufficient local matching funds for state and federal grant opportunities. This strategy could look for ways to increase the number and extent of conservation and restoration projects being implemented locally, and quantify and track their carbon sequestration benefit as part of the overall TCMP monitoring program. It could also include updating Conservation Futures program eligibility to prioritize funding for projects with a carbon sequestration or climate benefit and reviewing and updating stormwater utility or other local funding mechanisms to ensure they can be used as match for appropriate projects. Scaling up to achieve large reforestation targets faces significant constraints, including current nursery production of tree seedlings and available workforce (Fargione et al 2021). Part of this strategy could include working with local economic development partners to help address these constraints and develop local workforce opportunities.

- **Potential Lead:** Land Trusts, Thurston County, cities
- **Partners:** Community stakeholders
- **Estimated cost:** \$50,000/year (0.25-0.3 FTE) Could include additional local funds provided as match for projects or to fund projects outright.
- **Funding source:** TCMP Work Program, Conservation Futures, Thurston Waterways program, local Utility rates, State and Federal grants, other local funds

Reforestation/Afforestation Projects

- **TCMP Action:** Supports existing Action A5.1
- **Description:** Looking at land use change from 2011 to 2016, substantial reforestation is happening in the Thurston region without an active focus on increasing sequestration rates. It is not clear whether this trend will continue, and to what extent it may be sufficient to meet the TCMP targets, a gap that may be partially addressed by the monitoring strategies identified. To accelerate that trend, TCMP partners could directly fund planting projects on suitable land. A program focused on planting in rural areas would have the most potential for contributing to TCMP sequestration targets, though some planting projects could be incorporated into urban forest management programs. Projects could also prioritize replanting areas with multiple benefits, like riparian corridors and floodplains. This strategy could have three general phases:
 - **Phase 1** – Assess feasibility and applicability of program
 - **Phase 2** – Program development and set up
 - **Phase 3** – Ongoing program administration
- **Potential Lead:** Thurston County, Thurston Conservation District, Land Trusts,
- **Partners:** Thurston County, cities, Community stakeholders
- **Estimated cost:** Varies depending on program scope and details. According to one review, the median cost of reforestation in the western United States is \$428 per acre (range of \$349-522 per acre).⁷ Assuming a goal of 800 acres/year over 25 years (20,000 acres) and

⁷ Fargione J. et al (2021) Challenges to the Reforestation Pipeline in the United States. Front. For. Glob. Change 4:629198. doi: 10.3389/ffgc.2021.629198. <https://www.frontiersin.org/articles/10.3389/ffgc.2021.629198/full>

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program administration costs of 1 FTE, such a program would cost an estimated \$500,000 annually, with costs likely to increase over time with inflation.

- **Funding source:** TCMP Work Program, Conservation Futures, Thurston Waterways program, local Utility rates, State and Federal grants, other local funds

Agriculture

Regenerative Agriculture Practice Tracking

- **TCMP Action:** Supports existing Action A2.1
- **Description:** Survey Thurston County farmers on a recurring basis to track the implementation and extent of various regenerative agricultural practices, in order to track progress toward the TCMP target. Survey could also identify barriers to implementing such practices more widely.
- **Potential Lead:** WSU Extension, Thurston Conservation District
- **Partners:** Thurston County
- **Estimated cost:** \$50,000
- **Funding source:** Grant, TCMP Work Program

Regenerative Agriculture Outreach and Technical Assistance

- **TCMP Action:** Supports existing Action A2.1
- **Description:** Develop an educational outreach campaign for farmers with guidance and technical support on best management practices for implementing regenerative agriculture practices to maximize carbon sequestration benefits. Campaign should provide options targeted to both small and large landowners, and include connecting landowners to funding resources like conservation easements and cost-share programs. Such campaign could build off existing programs, including the Thurston Conservation District's technical support programs.
- **Potential Lead:** Thurston County, Thurston Conservation District
- **Partners:** WSU Extension, Washington State Department Agriculture and Conservation Commission
- **Estimated cost:** \$160,000 to establish program; ongoing funding to support outreach staff would depend on scope and reach of program
- **Funding source:** Sustainable Forest and Fields grant program

Agriculture-related Zoning and Development Code Review

- **TCMP Action:** New Action
- **Description:** Review and update planning codes and permit processes to expand zoning protections for lands in agricultural use, and incentivize regenerative agriculture and climate-smart conservation practices.
- **Potential Lead:** Thurston County
- **Partners:** Thurston Conservation District, WSU Extension, Washington State Department Agriculture and Conservation Commission
- **Estimated cost:** Low - \$. Initial costs cover staff review and development of code changes, stakeholder outreach, and public process.
- **Funding source:** State grant, local funds

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Conservation Program Amendments

- **TCMP Action:** New Action
- **Description:** Review and update existing County land conservation efforts including the Transfer of Development Rights, Conservation Futures, and Open Space Taxation programs to include criteria for carbon sequestration through conservation of agricultural lands and expansion of regenerative agriculture practices. Review whether cost of application to programs are a barrier and, if so, reduce fees to increase participation.
- **Potential Lead:** Thurston County
- **Partners:** Thurston Conservation District, WSU Extension, Washington State Department Agriculture and Conservation Commission
- **Estimated cost:** Low - \$. Initial costs cover staff review and development of code changes, stakeholder outreach, and public process.
- **Funding source:** State grant, local funds

Regional Agriculture Fund

- **TCMP Action:** New Action
- **Description:** Establish a regional fund to provide direct support to farmers in their transition from conventional to regenerative agriculture. Fund also could also be used for fee-simple acquisition of agriculture lands or agricultural easements that support regenerative practices.
- **Potential Lead:** Thurston County, individual cities
- **Partners:** TCMP partners, Conservation District, WSU Extension
- **Estimated cost:** Initial costs would be moderate to establish program administration; ongoing program administration could be paid for out of program fees, but success would be dependent on having enough developers paying into the account to offset costs.
- **Potential funding source:** TCMP Work Program, State or Local Grants, Development fees

Agriculture Carbon Credit Program

- **TCMP Action:** Supports existing Action A2.1
- **Description:** An agricultural carbon credit program could be a means to increase application of regenerative agriculture practices, quantify progress toward sequestration targets, and generate funding to offset administrative costs. This type of program would likely involve a partnership with an organization like Verified Carbon Standard to certify credits. Challenges to carbon credit programs include that projects expected to count toward the TCMP sequestration target should only be used to offset emissions included in the Thurston region's countywide total, and not be double counted toward some other offset measurement. Areas also may need to demonstrate a tangible threat of conversion. With this restriction, part of the program effort would need to include marketing the credits to potential local purchasers. This strategy could have three general phases:
 - **Phase 1** – Assess feasibility and applicability of program
 - **Phase 2** – Program development and set up
 - **Phase 3** – Ongoing program administration
- **Potential Lead:** Thurston County, individual cities, Thurston Conservation District
- **Partners:** TCMP partners, private carbon credit certification and verification company, land trusts, WSU Extension, local businesses

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- **Estimated cost:** Phase 1: \$15,000, Phase 2: \$180,000, Phase 3: \$40,000. Costs, especially for Phase 1, could be combined with other Carbon Credit Program strategies.
- **Funding source:** TCMP Work Program, State or Local Grants, Private investment

Prairies

Prairie Soil Analysis

- **TCMP Action:** Supports existing Action 7.3
- **Description:** Develop range of estimates of carbon sequestration rates provided by South Sound prairies under different land management approaches. Project could include a review of scientific literature and local soil sampling. Integrate this information into future greenhouse gas emission inventories.
- **Potential Lead:** WSU Extension
- **Partners:** Center for Natural Lands Management, WDFW
- **Estimated cost:** \$80,000
- **Funding source:** Sustainable Forest and Fields Program; TCMP Work Program

Habitat Conservation Plan Implementation

- **TCMP Action:** Supports existing Action 7.3
- **Description:** Support aggressive implementation of habitat conservation plans that provide for preservation and restoration of prairie habitat for endangered and threatened prairie species.
- **Potential Lead:** Thurston County, Tumwater, Port of Olympia
- **Partners:** HCP partners
- **Estimated cost:** \$4.17 million annually; \$125 million over 30 years
- **Funding source:** HCP mitigation fees, Conservation Futures

Prairie Conservation and Enhancement Carbon Credit Program

- **TCMP Action:** Supports existing Action 7.3
- **Description:** A prairie conservation carbon credit program could be a means to increase restoration of prairie habitat, quantify progress toward sequestration targets, and generate funding to offset administrative costs. This type of program would likely involve a partnership with an organization like Verified Carbon Standard to certify credits. Challenges to carbon credit programs include that projects expected to count toward the TCMP sequestration target should only be used to offset emissions included in the Thurston region's countywide total, and not be double counted toward some other offset measurement. Areas also may need to demonstrate a tangible threat of conversion. With this restriction, part of the program effort would need to include marketing the credits to potential local purchasers. This strategy could have three general phases:
 - **Phase 1** – Assess feasibility and applicability of program, including potential for connecting with HCMP strategy
 - **Phase 2** – Program development and set up
 - **Phase 3** – Ongoing program administration
- **Potential Lead:** Thurston County, Center for Natural Lands Management
- **Partners:** TCMP partners, private carbon credit certification and verification company, land trusts, local businesses

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- **Estimated cost:** Phase 1: \$10,000, Phase 2: \$180,000, Phase 3: \$40,000. Costs, especially for Phase 1, could be combined with other Carbon Credit Program strategies.
- **Funding source:** TCMP Work Program, State or Local Grants, Private investment

Supporting Actions

These activities do not directly increase sequestration, but could help fill information gaps and better guide progress toward achieving the carbon sequestration targets.

Land Use Change Emissions Inventory

- **TCMP Action:** Supports existing actions G4.1 and G4.3
- **Description:** A land use change emissions inventory would provide a comprehensive picture of the climate impact of land management across Thurston County, including from agriculture, forest land, and developed areas, and allow TCMP partners to track the impact of changes on local emissions. This action was recommended by Cascadia Consulting Group in their 2019 review of the countywide GHG inventory methods.

Work would include reviewing IPCC and ICLEI Guidance, working with local stakeholders to establish meaningful definitions for land categories, gathering data on land management practices, completing analysis, and developing report of results to incorporate into the monitoring and assessment program.

Alternatively, TRPC could limit initial work to reviewing and refining results for forest lands using ICLEI's LEARN tool, using a training available through the region's existing membership. Wait for additional land use change data to come available through the state or ICLEI.

- **Potential Lead:** TRPC
- **Partners:** TCMP partners, ICLEI, WSU Extension (agriculture data)
- **Estimated cost:** \$25,000 for full land use change inventory; LEARN tool review could be incorporated into existing monitoring task in 2023
- **Funding source:** TCMP Annual Work Program

TCMP Action Update

- **TCMP Action:** Supports existing Action G4.2
- **Description:** Update the TCMP to add priority actions to the plan that are important to the region's mitigation strategy (ex., an action related to supporting extended timber harvests).
- **Potential Lead:** TRPC
- **Partners:** TCMP partners, community stakeholders
- **Estimated cost:** \$10,000; could be incorporated into standing tasks of TCMP work program
- **Funding source:** TCMP Work Program

TCMP Target Update

- **TCMP Action:** Supports existing Action G4.2
- **Description:** Update TCMP targets to incorporate information related to sequestration. This could include reviewing and updating the overall sequestration target and establishing targets and performance measures for tracking progress in areas like land cover change.

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- **Potential Lead:** TRPC
- **Partners:** TCMP partners, community stakeholders
- **Estimated cost:** \$20,000; could be incorporated into standing tasks of TCMP work program
- **Funding source:** TCMP Work Program

Sequestration Working Group

- **TCMP Action:** Supports implementation of several sequestration-related actions
- **Description:** Convene a working group of technical experts and community stakeholders to provide guidance and momentum for implementation of sequestration activities. Such a group could help build regional capacity and partnerships for implementation of sequestration actions, and specifically be the sounding board for developing approaches to the following activities described in other actions:
 - regional sequestration targets and actions for the TCMP
 - guidance for landowner outreach programs
 - feasibility and guidance for connecting with voluntary carbon credit programs and to the state credit program under development through the Climate Commitment Act in ways that appropriately support the goals of the TCMP
- **Potential Lead:** TRPC
- **Partners:** TCMP partners, Thurston Conservation District, WSU Extension, Washington State Department of Natural Resources, USDA-NRCS, Center for Natural Lands Management, other community stakeholders
- **Estimated cost:** \$15,000, for up to 6 meetings per year.
- **Funding source:** TCMP Annual Work Program – Task 1 includes funding set aside for up to 6 working group meetings per year

Blue Carbon/Tidal Restoration

- **TCMP Action:** New Action, draws from Action A7.2 in the TCMP long list
- **Description:** Research and implement blue carbon programs in Thurston County aimed at sequestering carbon through the conservation and restoration of coastal and marine ecosystems.
- **Potential Lead:** Squaxin Island Tribe, cities, county
- **Partners:** TCMP partners
- **Estimated cost:** Varies depending on program scope and details. Cost to establish program and conduct restoration is likely high. Costs could be offset if paired with a carbon credit program.
- **Funding source:** State and federal grants