Sustainability of Whatcom Forests Under Climate Change

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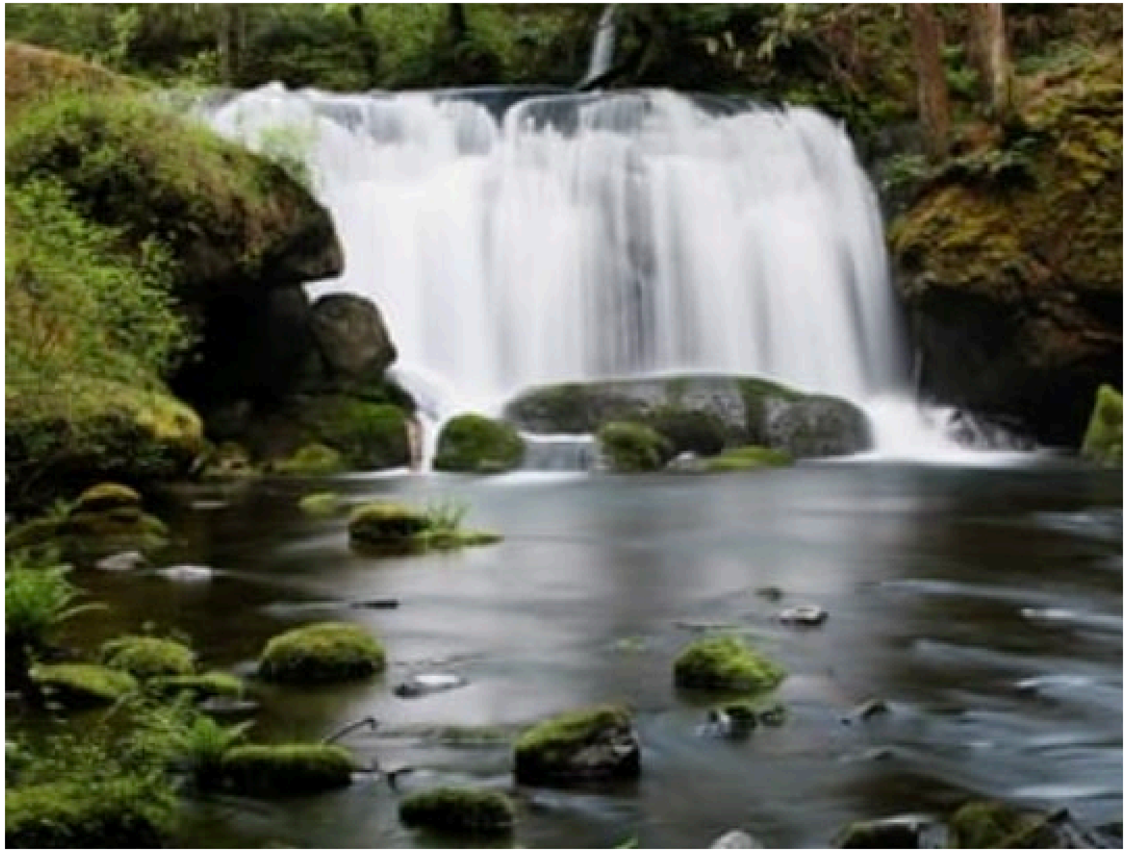
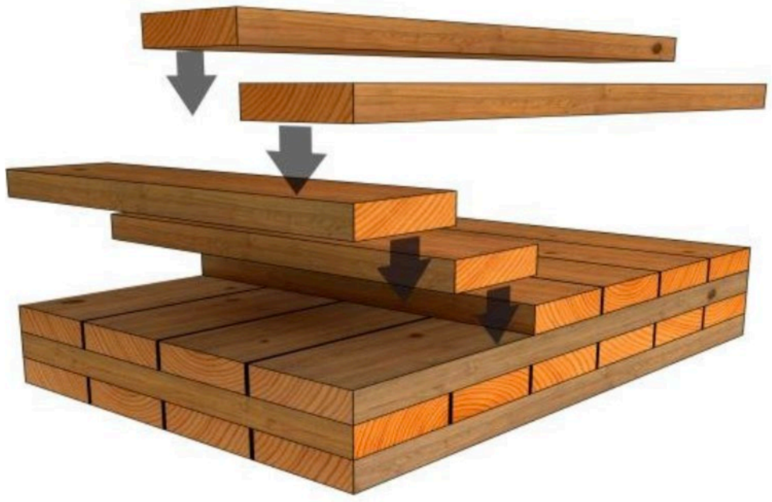
Forests Provide Multiple Environmental, Societal, and Economic Benefits

1. Clean water and air, flood protection, fish & wildlife habitat, food, soil formation, biodiversity, cool temperatures, etc.
2. Natural open space, recreation, education, etc.
3. Support cultural activities & provisioning
4. Wood products industry
5. Carbon mitigation & storage



Lumber Wood Products Provide Additional Carbon Storage

- Mass-timber or cross-laminated timber has the strength of steel in construction.
- The flexibility of CLT provides greater resilience to earthquakes compared to steel.



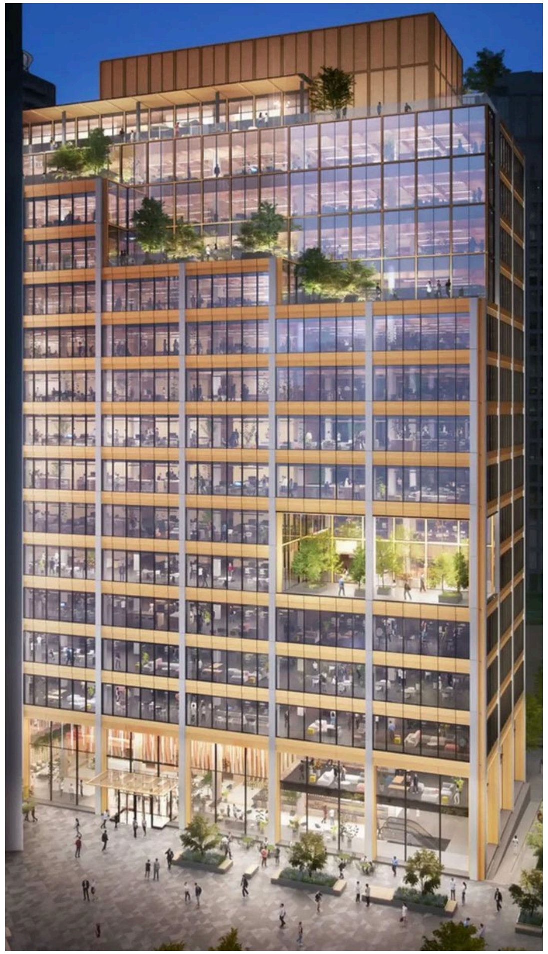
Cross-laminated timber (CLT) is a rapidly growing opportunity; requires less energy to produce than steel & cement, while offering substantial fire retardation and reduced CO_2 emissions.

CLT Reduces Carbon Emissions in Buildings

Cement causes ~8% of the world's carbon emissions

Steel causes ~11% of the world's carbon emissions

More Mass-Timber (CLT) buildings have been built in B.C. than almost the entire U.S.



Proposed 16-story Burrand Exchange in Vancouver's central Bentall Centre Complex

- 12-story Tallwood in Langford
- 9-story Capstone in Kelowna
- 10-story Keith Dr. Vancouver office building
- 12-story B.C. Institute of Technology student housing

Many more CLT structures are planned for B.C. – some of them high-rises.

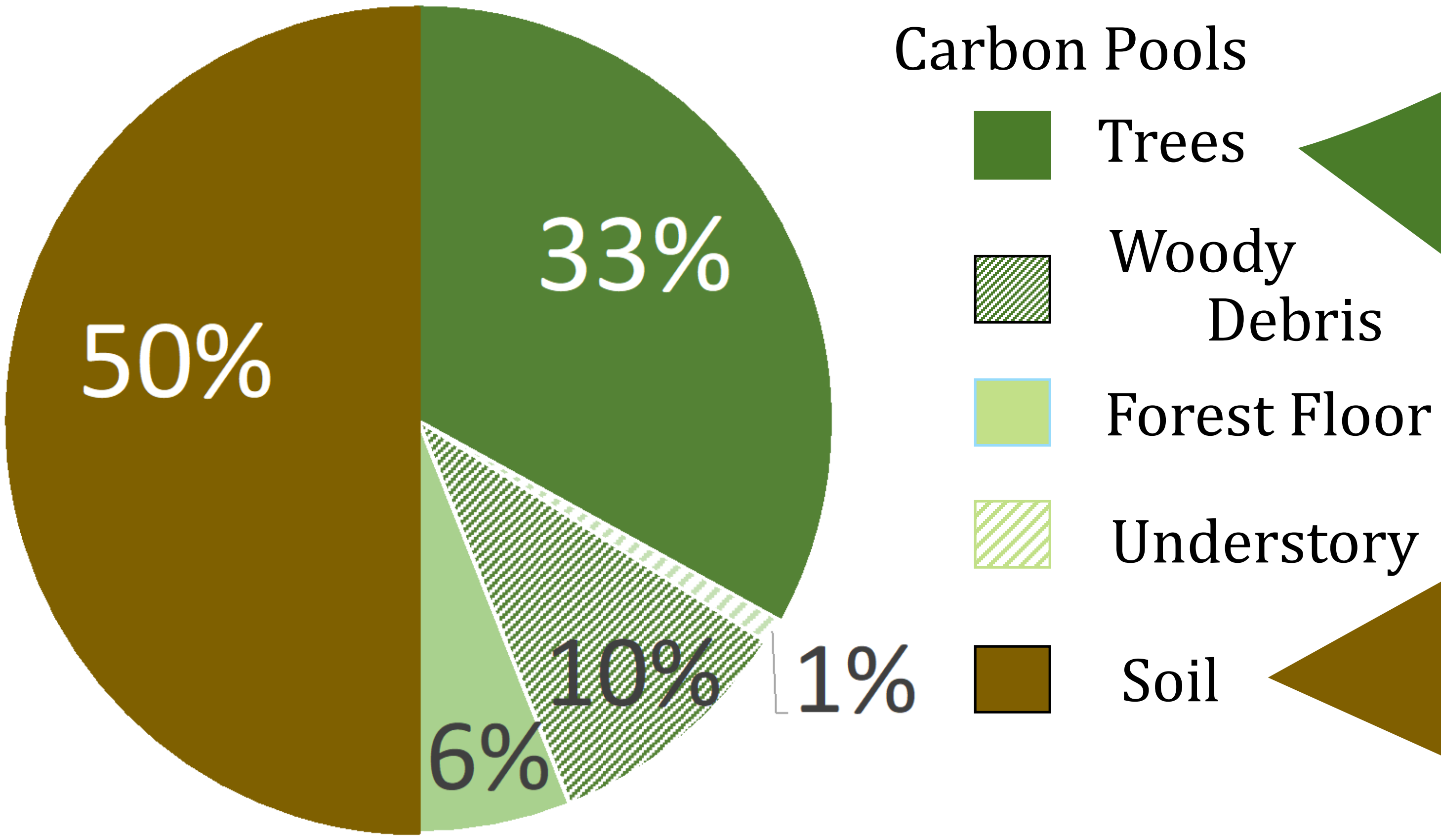
Supports innovation and the province's large forest industry (part of a B.C. government initiative).

Whatcom County can lead the way by using CLT for the new Northwest Annex

Carbon Storage vs Carbon Sequestration in Whatcom Forests

c.1975 measuring stomatal resistance in Doug-fir, Oregon.

Average Carbon Storage in Forest Carbon Pools



- Roughly half of the tree C is in the main tree trunk – remainder is in the roots, bark, branches, leaves or needles.

- Most soil C stable - changes very slowly over 100's of years.
- About 10% of soil carbon is labile.

Distribution of Total Carbon in an Acre of Forestland

Figure 1 from "Forest Carbon in the United States: Opportunities & Options for Private Lands'" by Wayburn, et al., Pacific Forest Trust

ClearPath Model calculates the *Net GHG Flux*

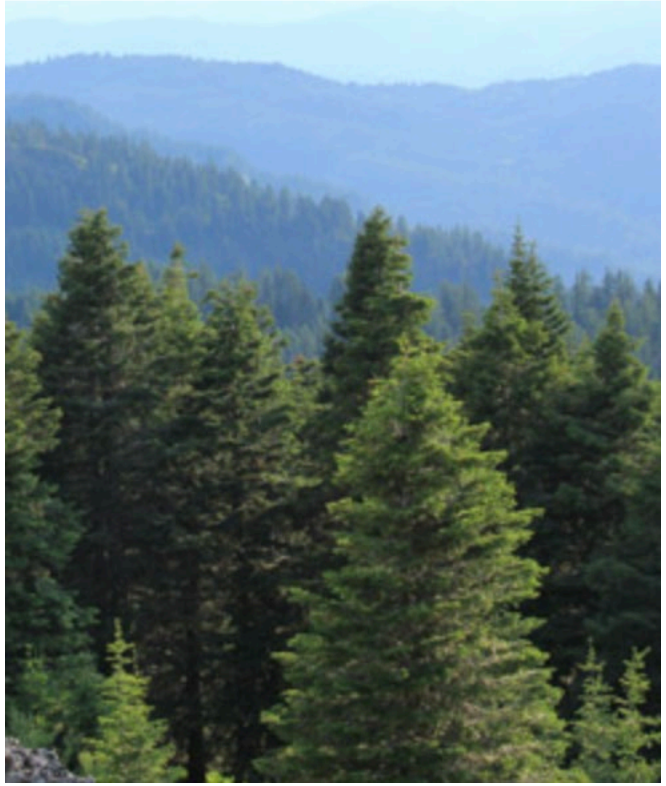
(tonns of carbon per acre per year)

*Net GHG Flux is Carbon uptake (photosynthesis) minus Carbon emissions (respiration, decay) by analyzing **all** above ground Carbon Pools on an acre of land over a period of one year.*

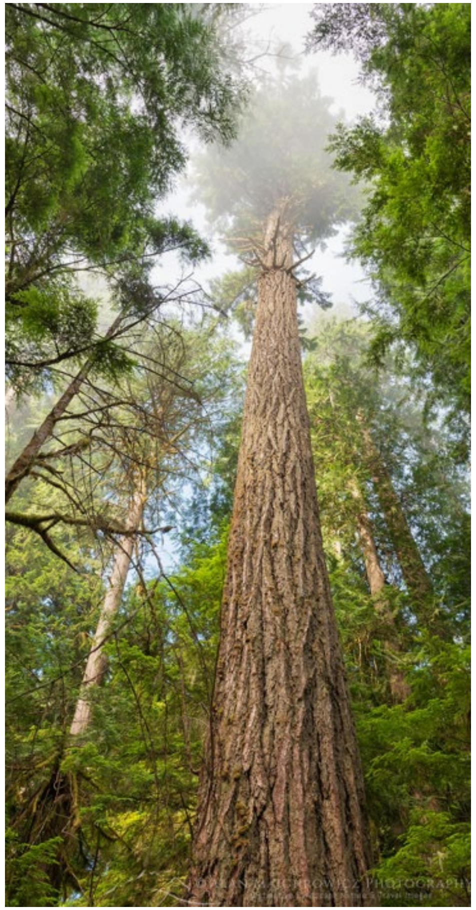
Uptake of C: total leaf area per acre, tree & vegetation type, stand age, location, etc.

Release of C:
vegetation type & age determines respiration + release from decaying organic matter

Age ~4-5 years



Age ~50 years



Old Growth Doug-fir
Olympic Peninsula

Example: *Net GHG Flux* for Douglas fir *Forest*

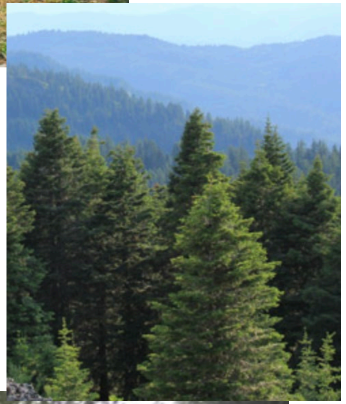
(In ClearPath model negative numbers indicate more carbon uptake than release)

0 – 20 Years

Individual seedlings/trees have the highest *rate* of carbon uptake due to their rapid growth. (lowest *net GHG flux/ac/yr* removal due to small mass & leaf area)

20 – 100 Years

Highest annual carbon removal from atmosphere per acre *(Net GHG flux/ac/yr)*



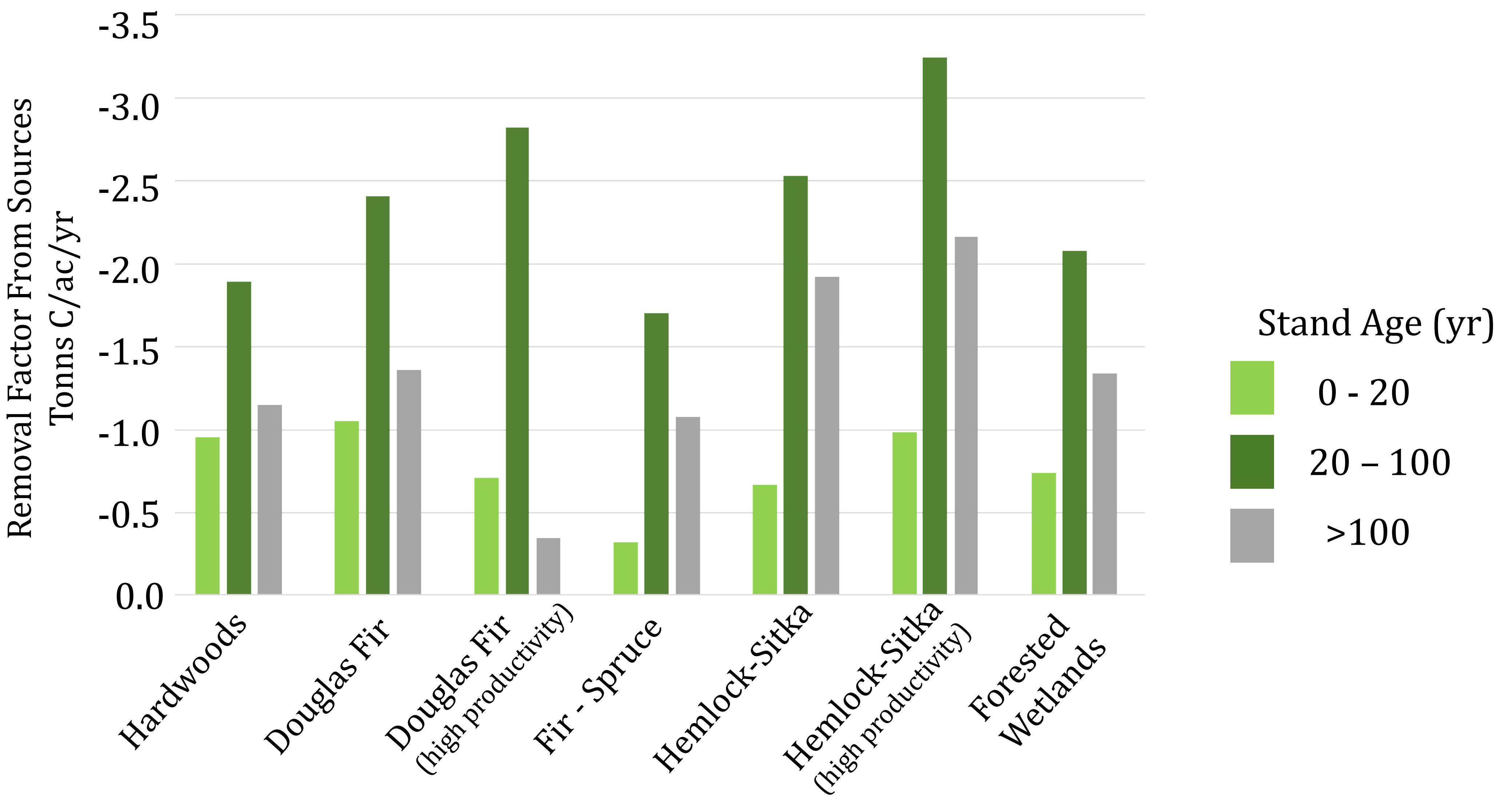
>100 Years

Greatest amount of carbon stored due to overall tree mass. Second highest Net GHG flux/ac/yr.

Net GHG Flux by Douglas fir Forests in tonns C/ac/yr

0-20 yr	-1.05
20-100 yr	-2.41
>100 yr	-1.36

Net GHG Flux per Acre per Year for Different Forest Types Used in ClearPath Modeling (PWW Region)



Climate Vulnerability of Whatcom Forests

Whatcom Forests & Woodlands Have High Vulnerability to Climate Change

Forest & Woodland Ecosystems
High Vulnerability

Exposure	High
Sensitivity	High
Adaptive Capacity	Medium

Forests and woodland ecosystems encompass nearly 60% of Whatcom County. Over 70% of the County's forested area is managed federally (e.g., national parks, forests, and recreational areas).

Significant risk of wildfire and pest damage that would harm the forest ecosystem and negatively affect timber and recreation industries.

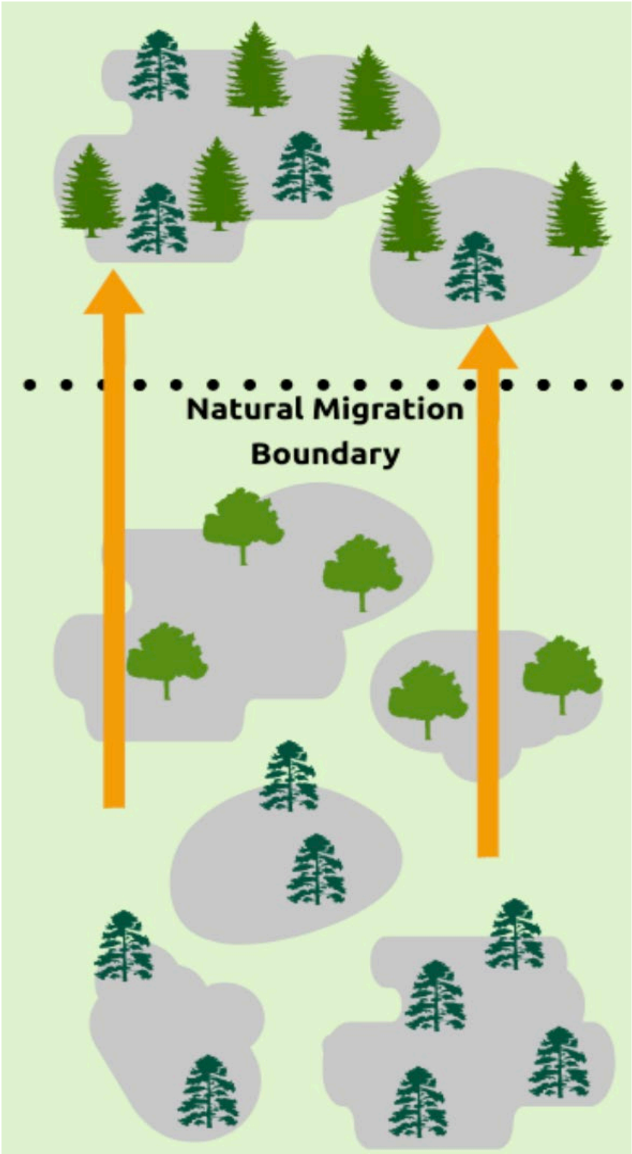
The U.S. Forest Service has conducted a comprehensive vulnerability assessment for national forests in the Pacific Northwest and developed management actions in response. *Many species cannot tolerate rapid change.*

Key Impacts of Climate Change on Forests in PNW

Increases in
Pest Outbreaks

Larger and more frequent ***Wildfires***

Changes in geographic range, growth, & productivity



*https://www.dnr.wa.gov/Wildfire_Strategic_Plan

CIAC Recommendations for Adapting Forests to Climate Change

Strategies for Forest Ecosystems in the Whatcom Climate Action Plan

1. Protect and enhance carbon storage and sequestration in forest ecosystems.
2. Increase forest health, survival and climate resilience through forest management practices that reduce wildfire risk, increase soil moisture and stream flows, and preserve wildlife habitat.
3. Promote climate resilience planning and programs to maintain our forest economy for watershed health, wood products, and recreational/cultural benefits through leadership, education, and successful programs.

Objectives of Managing Forests for Timber vs Climate Change

Managing Forests for Timber

Sustainable timber production for a strong wood products economy.

Over the last ~60 - 80 yrs the practice of managing forests for *maximum sustained yield of timber* **has largely been replaced by *maximizing return on investment*** (net present value, NPV) leading to shorter rotations on timberlands.

Objective *of* Managing Forests for Climate Change

Sustainable forests for ecosystem services, wood products, cultural benefits, and recreation under our changing climate.

Climate adaptation strategies that maximize carbon mitigation & storage, sustained timber yield, while minimizing the opportunity cost involved in transitioning away from the short rotations associated with NPV.

"Shorter Term Emphasis often Works in Opposition to Climate Goals."

*The Forest Management Act does not take into account climate change.

Managing Forests for Both Timber & Climate Change

Continue to Do This for Timber:

- **Site Preparation for Planting:** slash pile burning, herbicides for brush control, or alternative.
- **Seed Selection:** from existing high-quality forest trees and plant seedlings with the highest growth potential for current site conditions.
- **Seedling & Mature Tree Protection:** from animal damage.
- **Thin Young Stands:** to reduce competition & remove invasive species.
- **Removal of Diseased Trees.**

Consider Additional Management for Climate Change

1. **Climate vulnerability checklist** for sites scheduled for harvest.
2. **Structure harvests to create diversity** in patch sizes and age classes to create natural fire breaks.
3. **Select seeds based on tolerance** to heat, low soil moisture, and emerging diseases.
4. **Prioritize diversity of species** over uniform age monocultures.
5. **Adopt *variable size stream buffers*** on steep slopes adjacent to fish-bearing streams that account for the intensity and frequency of rainfall under climate change.

Managing Forests for Climate Change

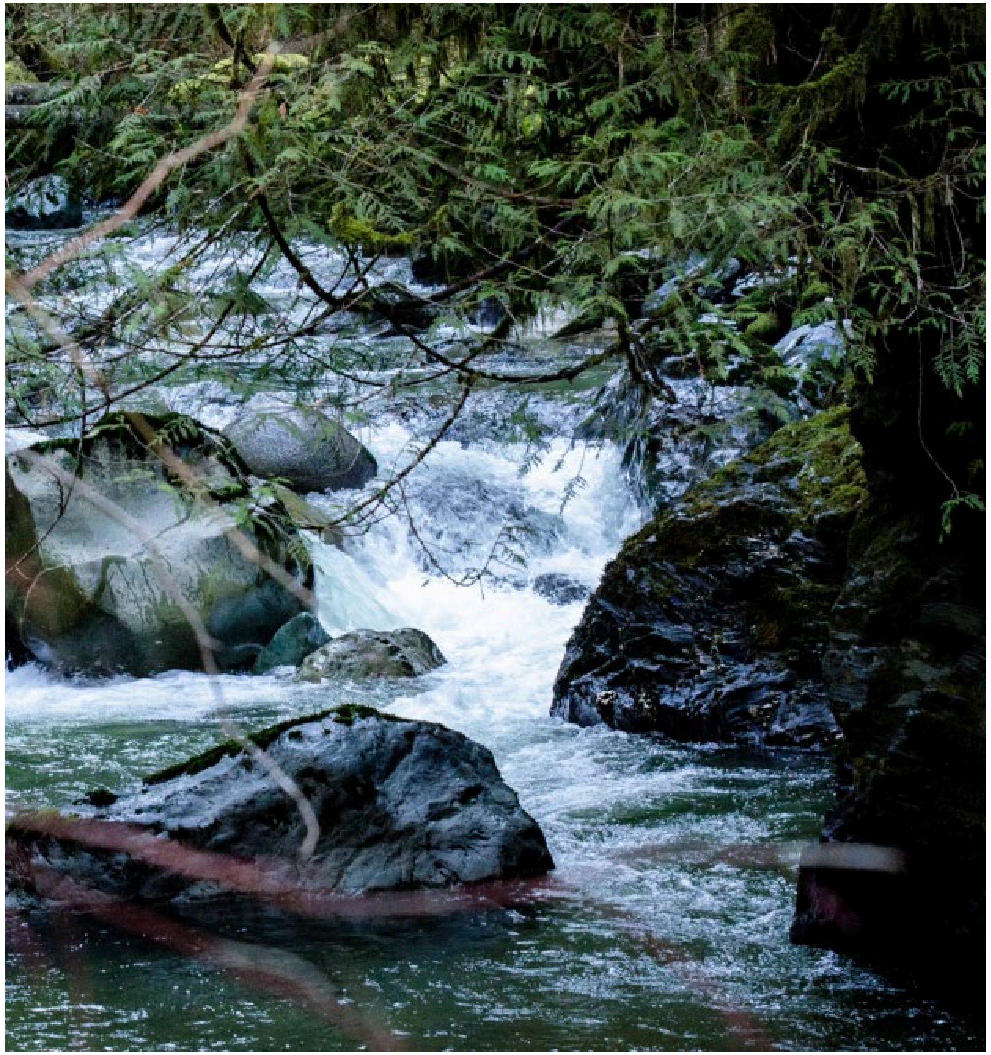
Climate Management Approach	Climate Adaptation	In-Use?
1. Develop a climate vulnerability checklist for sites scheduled for harvesting.	Creates a site-specific management plan of the needs and costs of re-establishing forest under climate change.	No?
2. Structure harvests to create patch sizes and age classes that create natural fire breaks. Longer rotations maximize carbon sequestration & reduce waste from lumber production.	Reduce the cost of fighting wildfires and the damage from wildfires. Deciduous trees are more fire resistant. Longer rotations and lumber production maximizes carbon storage.	No?
3. Select seeds based on tolerance to warmer temperatures, lower soil moisture, and emerging disease. Incorporate pines & hardwoods.	Douglas-fir at same latitude, but higher elevation have been shown to be more drought tolerant. Hardwoods in general & some pines are mores resistant to wildfires & adapted to warmer, drier sites.	Yes/No?

Managing Forests for Climate Change (continued)

Management Approach	Climate Adaptation	In-Use?
4. Planting: prioritize diversity of species over uniform monocultures. Diversity creates resilience & facilitates migration of species. Open spaces creates riparian corridors & diverse biota like nitrogen fixers.	Incorporate a pine in Doug-fir/Hemlock stands, such as rust-resistant Western White Pine, Sugar & Ponderosa Pine. Hardwoods are more resilient to wildfire. Both Maple & Black Oak in fire strips do well with Doug-fir. Diversity ensures greater survival, pest resistance, and fire resistance.	No?
5. Adopt variable size stream buffers on steep slopes adjacent to fish-bearing streams to account for increasing intensity & frequency of rainfall under climate change.	Climate change impacts were not considered in the 1974 Forest Practices Act. The risk of slope failure increases with storm intensity and threatens fish survival. Adjustment to buffer size to ensure water quantity/quality & lower stream temperatures	No?

Fresh Water is the Fundamental Resource Supporting our Fisheries, Forests, Agriculture & Critical Ecosystems

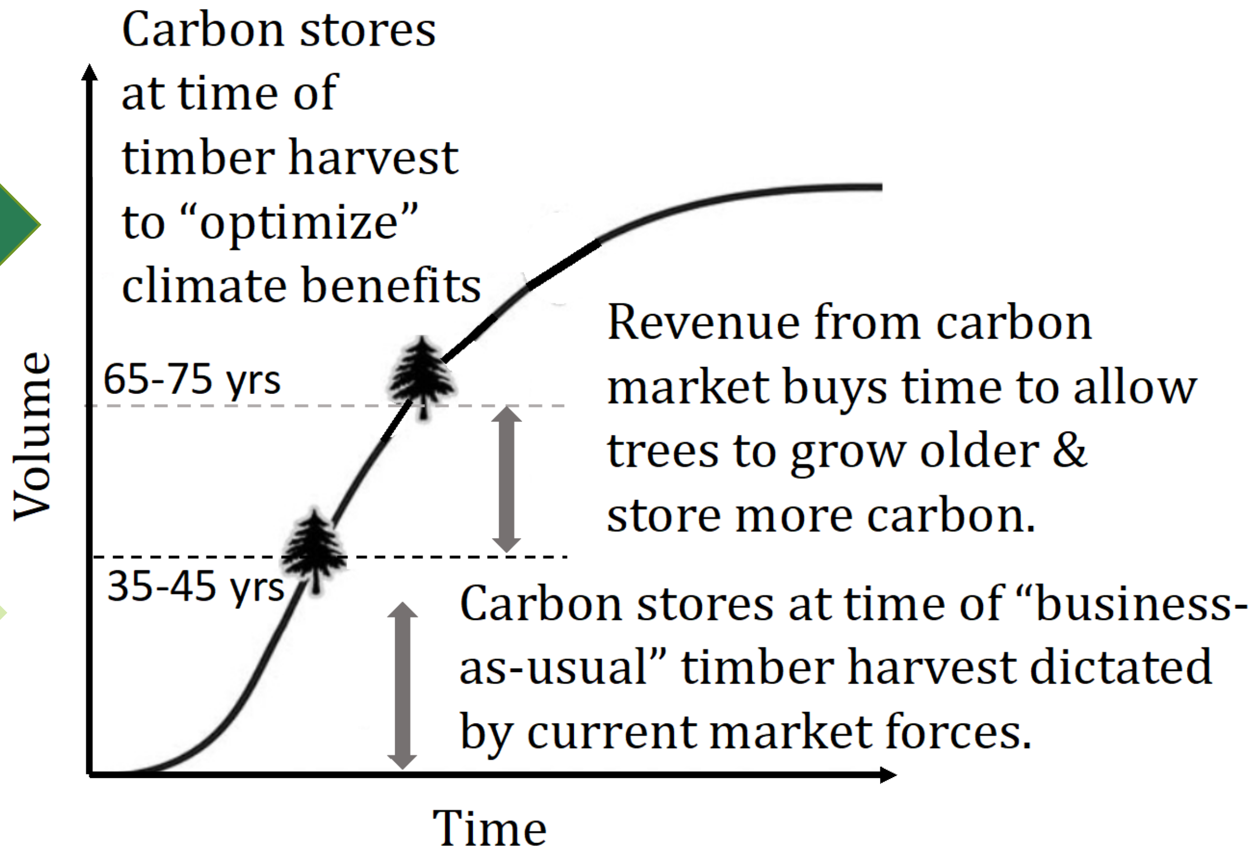
- Climate change is and will continue to impact the availability of fresh water – *protecting water resources is critical*
- Intensity of rainfall increasing in PNW affecting slope stability.
- Mature trees use water more efficiently than seedlings and young trees.



Would a Carbon Market Optimize Climate Benefits?

One 60-year rotation stores more carbon than two 30-year rotations due to the greater C uptake by mature trees, on-site decay of forest carbon after harvest and less wastage during lumber production.

Repeated short rotations cause net declines in forest productivity, requiring greater time periods to achieve the same amount of carbon storage.



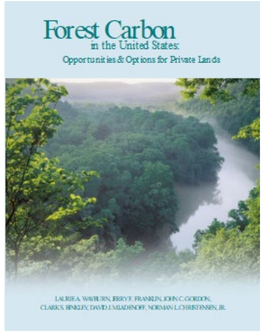


Figure from: Forest Carbon in the United States: Opportunities & Options for Private Lands, by Laurie Wayburn, Jerry Franklin, John Gordon, et al. 2007. Pacific Forest Trust

Can we Increase Forest Carbon Storage While Minimizing Impact to Net Present Value?

- There are high startup and transaction costs for carbon market participation - substantial financial barrier particularly for small landowners.
- Break-even carbon price for a 65-year rotation to match the NPV of a 45-year rotation was ~$50 per tCO_2e.*
- 2023 cost of carbon allowances from the Washington Climate Commitment Act = Feb $48.50; May $56; Aug $63

Carbon Market may be a solution for extending short rotations
(CAP suggested funding a study on feasibility for Whatcom County)

*Fischer, P.W., Cullen, A.C., Ettl, G.J., Risk Anal. 2017, 37, 173-192.

Blaine Chamber of Commerce, Cascade Loop

Key Summary Points

- CIAC will continue to *promote* forest management practices to create forests adapted to climate change.
- Climate adaptation is necessary to sustain healthy forest watersheds and ensure the long-term availability of fresh water.
- CIAC's recommendations for adapting forests to climate change may challenge the timber-related industries … however, everyone's goal is to perpetuate healthy, sustainable forests for future generations..
- *Communication/dialogue is vital.*

Recommendation to County Council

Hire a staff member or consulting firm (strong background in sustainable forestry) to do the following:

- Educate rural forest owners on climate adaptation actions for sustainable forests. Review forest management plans for rural forestry zones.
- Oversee/implement the management plans for Lake Whatcom Park, Canyon Lake Community Forest, and Stewart Forest.
- Work with the Climate Action Manager on assessing net carbon flux and health trends of Whatcom Forests.
- Consult on restoration of riparian areas.
- Develop and perform a climate vulnerability checklist on sensitive watershed areas slated for logging & advise the Council/Executive.

The End

Washington & Whatcom County Forests

Washington

- Forest cover 21 million acres or ~50% of state.
- Ownership: 44% Federal, 13% state & local, and 43% private.
- DNR manages ~2.1 million acres
- WA is second largest producer of lumber in U.S., ~12% of supply
- Forest products sector supports ~42,000 workers; gross business income of $36 billion annually.

Whatcom County

- Forests cover just over 1 million acres or over 60% of County.
- Ownership: 63% Federal, 11% DNR, 26% private.
- DNR manages ~87,156 acres
- Sector supports ~2,000 direct or ~4,800 total jobs (direct, indirect, & induced). Total wages ~$255 million; Taxes ~$11.7 million.

Key Impacts of Climate Change on Forests in PNW

1. Larger and more frequent ***Wildfires***
    a) Drier, warmer conditions are increasing the annual area burned by forest fires.
    b) Failure to adopt International building codes for Wildland Urban Interfaces increases the risk of wildfires. (over 70% of wildfires are human caused)
    c) Fire season in Washington has increased from 2 months to 9 months; annual cost of firefighting in WA has quadrupled from $37M (2008-2012) to $153M (2013-2018).*
2. Increases in ***Pest Outbreaks***
    1. Water stress makes trees susceptible to pest outbreaks.
    2. Warming will expose higher elevation forests to pine beetle; Doug-fir beetle outbreaks increase with drought-stress; & fungal disease – Swiss Needle Cast.
3. ***Changes in geographic range, growth, & productivity***
    1. Area of climate suitability for Douglas-fir will decline, especially at lower elevations.
    2. Changes in forest structure & composition will be driven by disturbances like fires & pests.
    3. Tree growth may increase in areas energy (light)-limited (higher elevations) & decrease in water-limited areas. Carbon sequestration & storage also impacted.

*https://www.dnr.wa.gov/Wildfire_Strategic_Plan

Value of Measuring the Forest Net GHG flux

Trends in the overall health and sustainability of Whatcom Forests under a changing climate

- Changes in land use designations
- Amount of wildfires, disease, and weather damage under different forest management regimes
- Decline or increase in forest health
- Information to guide climate adaptation measures