CLACKAMAS COUNTY URBAN FOREST PRODUCTS COOPERATIVE PROGRAM

Feasibilty Study **May 2017**

CLACKAMAS COUNTY

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Executive Summary

Every year in North America, billions of dollars' worth of potential lumber from urban trees are wasted when trees are cut up for firewood, mulched or taken to a landfill. In Oregon, millions of dollars are spent on tree removal due to disease, hazard situations and development.

Traditionally, urban forestry has focused on tree preservation and the environmental and public health benefits of trees. Seldom asked is the question of what happens to a tree at the end of its life. All trees in every city will need to be removed at some point when they die or pose a threat to public safety or are removed to make way for development. The result is an expensive process leaving landowners apprehensive about replanting new trees for future generations.

In 2015, Clackamas County was awarded funding by the Oregon Legislature to study the feasibility of creating an urban forestry cooperative program (Urban Lumber Program) that generates revenue for cities, increases economic activity and increases the tree canopy. The planting, maintaining, harvesting and marketing of newly planted trees on municipal or public agency owned land to produce logs for sale. House Bill 2984 (2015) (Chapter 733, Oregon Laws 2015) restricts participation by private landowners and excludes existing trees more than five years old from the program. The goal of the study is to design a system where trees in urban Clackamas County can be planted, geo-tagged and enrolled in a cooperative program.

This study examines:

- Economic feasibility
- Economic development
- Governance feasibility
- Business planning
- Technical feasibility

Seldom asked is the question of what happens to a city tree at the end of its life.

The County hired a project team from Cogan Owens Greene, LLC, ECONorthwest, Ecotrust, and Fiddleheard, LLC to conduct the feasibility study. To guide the study, Clackamas County appointed a fourteen-member Urban Lumber Advisory Committee (ULAC) composed of professionals and local officials with roles and interests in forestry, urban planning, wood products and nursery industries, and economic development to guide the project. The County conducted outreach to city managers, planners and foresters through face-to-face meetings and a survey addressing existing city practices, challenges and needs for urban forestry.

Primary research is included in the Appendices:

- Literature review
- City survey results
- Wood products financial and economic analyses
- Governance organizational and financing options
- Business plans for a cooperative organization
- Land base analysis
- Software recommended for tree management over time
- Urban tree for lumber tracking tool
- Draft promotional kit
- List of recommended tree species

Initial "seed" money is needed to develop an economically feasible urban lumber program.

Key Findings

The findings of the feasibility study are mixed based on initial assumptions. On the positive side, growing urban trees for lumber in a systematic way can generate positive economic returns when ecosystem service co-benefits, especially the sale of carbon credits, are added to the future sale of saw logs. There are real challenges to overcome including the length of time before revenue from initial harvests is realized (40-60+ years), limited on-going funding sources for planting and maintaining trees, and quantifying and monetizing ecosystem service co-benefits (e.g., carbon credits). With revenues from carbon credits the program could offset initial costs.

Economic Feasibility

Without considering ecosystem services, the net present value of program losses range from $603,541 to $4.0 million, depending on assumed interest rates. Rates of return range from -0.2% to -2.6%. If a zero interest rate is assumed, the program would generate a return on investment (ROI) of 2.1% over 70 years.

High annual costs associated with planting and maintaining trees and the long lag-time between planting and harvest are the primary barriers for attaining net positive revenues, without benefits from ecosystem services.

Considering ecosystem services, the program increases net revenues from carbon sequestration, air quality and stormwater management by a present value of $19.7 million to $76.9 million over 70 years. The program yields positive net benefits when financial revenues and ecosystem services are combined, generating a net positive benefit of $1.9 million in economic value until harvesting begins in year 60.

The production of new timber would support $2.8 million to $12.9 million in total economic output

Economic Development Potential

Estimating economic potential of an industry 60 years into the future is speculative. The future success of local and US timber sectors depends, primarily, on how competitive producers will be in the global market. The stock of Western hardwoods and softwoods will continue to increase through 2050, which should assure a supply of timber for processing.

Economic multipliers of 1.62 for economic output and 1.57 for employment would support an average of eleven jobs annually. The production of new timber, including secondary effects along the supply chain the program, would support $2.8 million to $12.9 million in total economic output during a ten year harvest cycle.

A variety of industries would benefit from the program including: commercial logging, support activities for agriculture and forestry, wholesale trade, retail trade, full-service restaurants, limited service restaurants, hospitals, retail trade and truck transportation.

Governance Feasibility and Business Planning

An intergovernmental agreement organization or non-profit organization can be formed to assist public agencies implement an urban lumber program. A partnership among cities, utilities, special districts and other partners can initiate and coordinate the urban lumber program via an Intergovernmental Agreement. This organization can help cities and partners enroll, plant, maintain, harvest and market trees for sale. The organization would hire a part-time coordinator or consultant to provide technical assistance to the participating cities and other partners to advance the program. Revenues would be generated from tree enrollment fees, annual membership dues, logs brokered at the time of sale, and a variety of additional funding sources such as the sale of carbon credits.

Technical Feasibility

Approximately 1,559 acres of publicly owned land in Clackamas County are potentially available for the urban lumber program. This area represents the portion of undeveloped, non-forested lands, and plant-able lands likely to be available for inclusion. These acres include small pocket forests, large planting, and linear plantings along roadways.

1,559 acres publicly owned land is potentially available for the urban lumber program.

We established enrollment criteria and program policies and procedures for administering an urban lumber program. The early stage of this work and uncertainty as to which agencies would participate and how, necessitated that these be general and broadly applicable. The criteria, including a list of priority tree species will help participating entities determine which tree species meet the parameters necessary for removal and processing. The list of criteria includes: wood value, commodity value, rate of growth, native range, and suitability for Clackamas County and maintenance needs.

The Team developed a strategy for building a web-based tool that maps, monitors and models urban trees to support management by foresters, reporting for decision-makers, and understanding by the general public. The strategy includes data collection requirements, enrollment workflows, and other technical requirements that adhere to urban forestry standards. Next steps in developing this tool would include gathering feedback from users to inform the tool's design, building tool functionality, and testing and refining the tool.

Real Challenges and Real Opportunities

Challenges

- The legislation limits the study to publicly owned lands and tree plantings within the last five years. The study does not include the potential of harvest from the existing stock of urban trees. New plantings of high value trees take 40-60+ years to mature, meaning the program would be unprofitable during that time period without other sources of funding.
- Carbon credits appears especially promising as a funding source for initial planting and maintenance with the creation of the Urban Carbon Registry in Seattle focused on certifying urban trees for the sale of carbon credits. However, the study does not monetize the carbon sequestration, air quality, and stormwater ecosystem service benefits at this time.
- The study does not quantify cost and benefits from planting and managing urban forests for lumber production compared to the current system of expensive harvest of mature, dead and dying trees in urban areas.

The study does not include the potential harvest from the existing stock of urban tress

Further study is needed to monitize ecosystem benefits and estimate avoided costs.

Opportunities

- Conduct a more detailed analysis to determine potential revenues from monetizing carbon credits for trees planted using the protocols of the Urban Forest Carbon Registry.
- In cooperation with Clackamas County cities, estimate the costs associated with current tree harvest practices on city and other public agency lands compared to managed urban forests.
- Examine other sources of funding that can support the program's start-up and the long time period from initial planting to harvest.
- Consider expanding the program to other land owners to increase its scope.
- Individual cities and other public agencies are free to explore appropriate harvesting of existing trees, although that is not addressed in this study.
- Examine current land use plans and urban tree ordinances to see how they can facilitate an urban lumber program.

Introduction

The 2015, Oregon Legislature passed and the Governor signed House Bill 2984 (Chapter 733, Oregon Laws 2015). The bill requires Clackamas County to establish a pilot project to determine the feasibility of creating the Clackamas County Forest Products Cooperative Program (Urban Lumber Program).

The aim of the bill is to address severe inefficiencies of urban tree removal in municipalities and determine the potential of urban trees as a source of positive revenues and economic development.

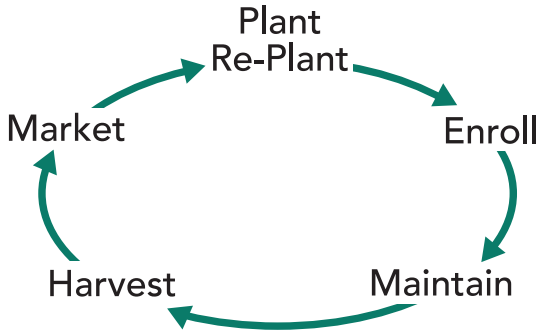
Every year in North America, billions of dollars' worth of potential lumber from urban trees is cut up for firewood, mulched or taken to the landfill. In Oregon, millions of dollars are spent on tree removal due to disease, hazard situations and development. Due to the high cost of planting, maintaining and removal, some urban areas are losing the canopy of large form trees.Traditionally, urban forestry has focused on the aesthetic, environmental and public health benefits of trees. Preservation of mature or culturally significant trees has also been a priority for cities. Tree codes are primarily intended for the preservation of healthy trees, often requiring permits to remove existing trees and replant new trees.

All trees in every city will need to be removed when they die or pose a threat to public safety. Dead or declining trees also may require a city permit for removal and assessment by a certified arborist. Seldom anticipated in tree codes is what happens to a tree at the end of its life. Cities normally do not address the potential to generate revenue or economic value from tree harvests. The result is an expensive and impromptu process, leaving landowners opposed to tree removal and hesitant to plant new trees.

Objectives for the legislation include generating income for cities, expanding the forest product and related industries, and increasing the urban tree canopy. Future objectives may include reducing the waste of existing and future wood fiber, carbon sequestration, increasing the number of trees benefiting public health by improving air and water quality, reducing the cost of stormwater management and cooling streams, increasing property values, and better connecting the wood products industry to urban residents.

HB 2984 envisions a cooperative program among cities and other public sector partners to support the development of urban commercial forestry (planting, enrolling, maintaining, harvesting and marketing) comprised of specialty lumber products, principally high value hardwoods. The legislation limits the program to new plantings on non-forest lands in urban areas. The study was undertaken by a Project Team composed of Cogan Owens Greene, LLC, ECONorthwest, Ecotrust, and Fiddlehead, LLC, guided by Clackamas County staff. The study annotated bibliography was a main resource for the study (Appendix 1).

URBAN LUMBER PROGRAM



Clackamas County Urban Lumber Program study process accomplished the following:

- Outreach: Established an Urban Lumber Advisory Committee (ULAC) and conducted outreach to six cities (cities of Canby, Happy Valley, Lake Oswego, Milwaukie, Oregon City, and West Linn) in the county to gain stakeholder guidance on the structure and operations of a future program. A survey of cities was also conducted.
- Economic Analysis: Determined the necessary area and volume of production and related time to harvest as necessary to establish, grow and sustain a cooperative program.
- Governance: Recommended two potential cooperative governance options:
  -A county-city intergovernmental agreement cooperative program (IGO).
  -A new nonprofit organization (NPO).

- Business Plan: Identified expenses, revenues and other sources of funding needed to establish and support the "cooperative" and to provide funding to participating partner organizations (cities, county, other agencies and institutions) in the future.

The County, cities, special district and other agencies would "opt-in" to the program.

- Technical Feasibility: Defined the city land base available for the program, defined tree enrollment criteria and processes, developed a recommended species list, and recommended methods for geotagging, growth modeling, program management software, and reporting processes.

Outreach

The Project Team conducted face-to-face meetings with city staff members and a survey of city interests in the program. The County, cities, special districts and other agencies agreed to participate in the Clackamas County Forest Products Cooperative Program at their discretion or "opt-in" (Appendix 2).

Outreach identified:

- Interest in the Urban Lumber Program, especially if it can be shown to be financially viable and contribute to the urban quality of life.
- Interest in cities working together with other partners.
- Interest from cities with urban forestry programs, sustainability efforts, park plans, ecosystem protection programs, or climate change policies in the positive contributions of urban forests can make.
- The cost of current city tree harvesting practices are significant but unquantified.
- Interest from city officials in protecting the visual and environmental benefits of existing urban trees.
- Concern from city residents over the impacts of tree harvesting on neighborhoods, livability and property values.
- Land available for the program varies by city from a few acres to several hundred acres.

Cities currently treat urban trees as an expense rather than a source of income.

Current Situation

Cities and other land owners currently plant and maintain trees that provide a great variety of ecological, economic and social/health benefits to local governments and urban dwellers. However, they receive little or no revenue or economic benefit from the wood fiber potential of these trees. Most dead and dying trees are disposed of as waste, chipped or sold as fire wood. There are significant costs associated with dying or damaged trees. Each large dead or damaged tree removed in cities costs between $500 and $5,000 to remove; a major expense to the city governments and other land owners.

City tree ordinances generally do not address the disposal of trees for revenue or economic development value within the urban landscape. The market for salvaging existing urban trees in cities is expensive and inefficient. Tree removals are often unplanned clean-up activities after storms or when severely diseased trees become a safety hazard. Tree codes generally do not address lowering the cost of tree removal.

Under HB 2984 (ORS Chapter 733), the Clackamas County Forest Products Cooperative Program study is not permitted to consider the potential value of existing urban trees. The study is limited to recently planted trees (five years or younger) and trees planted in the future. This "Bare Land Scenario" envisions developing an urban lumber program on open land in urban areas from scratch.

Economic Feasibility – Bare Land Scenario

This scenario envisions newly planted trees along roadways, in pocket forests and relatively small urban forest plantations. Trees are maintained and harvested for high-value logs when their economic value is at its peak. Revenues from the harvests flow to cities and the lands are replanted and harvested again at appropriate intervals. The trees are a source of increased economic activity and revenue -- not a major expense to city budgets. That is the motivation behind HB 2984 and this study. Appendix 3 addresses economic feasibility and economic development opportunities.

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The Program creates $1.9 million when ecosystem is included	***Otherwise, the program loses $603,542 to $4.0 million***

However, the economic feasibility of producing wood for harvest is challenging. Requirements include city policies to support long-term investments in trees for harvest, available land, planting of species that will produce the most value and waiting decades before initial harvest (40-60+years).

There is demand for using a portion of high-quality urban trees in the region for high-value wood products in the hardwood and softwood log markets. Oregon's existing timber production infrastructure provides the basis for supporting an urban lumber program.

Economic Feasibility Findings

The goal of the analysis is to determine if the program is financially viable, creating a new revenue source for cities and generating economic development for the region. The analysis uses standard forest valuation techniques to calculate economic returns to the program. Cost data assumptions generated by the county and other participants and data from the Oregon Department of Forestry and the US Bureau of Land Management (Appendix 3).

Other assumptions include:

- 1,559 acres of suitable bare land available (Appendix 4).
- 110 trees per acre of high value hardwoods.
- Unit costs include site preparation, planting bare root stock (in the first five years), vegetation control, pre-commercial thinning, pruning/vegetation control, final pruning at 10 and 20 years and harvest beginning at approximately 60 years for some tree species.
- Three sizes of forest operations: linear (< 1.0 acre), pocket forest (1.0 acre - 2.5 acres), and small forests (> 2.5 acres).

Findings include:

- The program yields positive net benefits when financial revenues and ecosystem services are combined, generating a net positive benefit of $1.9 million in economic value until harvesting begins in year 60.
- The Clackamas County Urban Lumber Program does not generate net positive revenue after 60 years or 70 years. Ecosystem service financing, revenues from the sales of carbon credits can make the program more feasible.

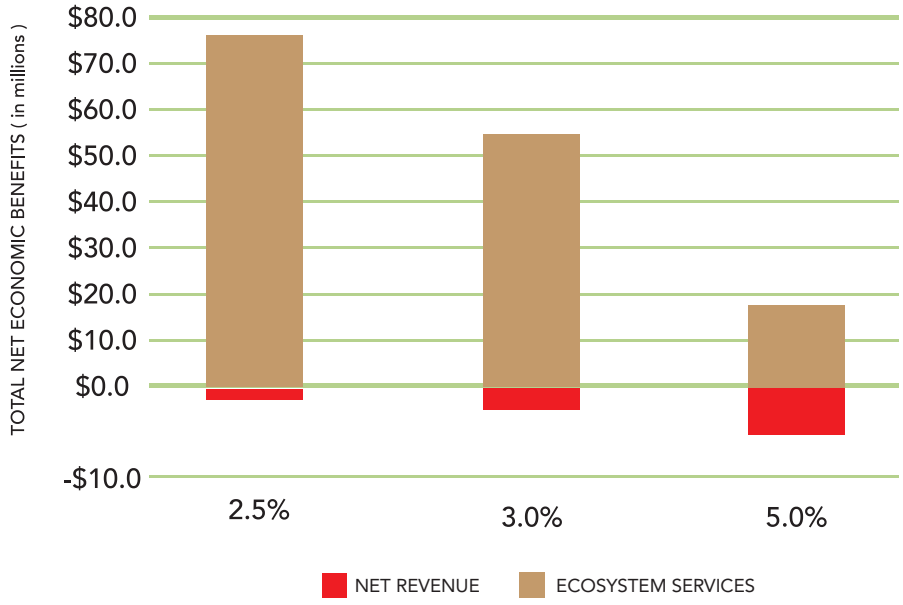
Urban forest carbon sequestration provides economic benefits to the cities, but they have not been monetized in this study.

- The net present value of program losses range from $603,541 to $4.0 million, depending on assumptions about interest rates.
- Rates of return on investment (ROI) range from -0.2% to -2.6% over 70 years.
- The program would generate a ROI of 2.1% over 70 years at a zero interest rate.

Potential co-benefits associated with increasing the number of urban trees are derived from enhancing ecosystem services. For this analysis, ecosystem service benefits are quantified for carbon sequestration, stormwater management, and air quality during the lifetime of the trees planted. The co-benefits analysis estimates that:

- The program increases economic benefits from carbon sequestration, air quality, and stormwater management by a present value of $24.0 million to $77.5 million over 70 years.
- Increasing urban trees yields other unquantified ecosystem service benefits from increased access to recreation, improved home values and public health benefits.

Figure 1. Total Net Economic Benefits, by Assumed Interest Rate



Source: ECONorthwest using data from Ecotrust

Alternative Scenario

An alternative scenario examines using a mixed hardwood forest to increase revenues earlier in the pilot program. This scenario envisions planting a mix of high-value hardwoods and Red alder (Alnus rubra). The high-value hardwoods are harvested at 60 years, as in the scenario summarized above. Red alder are harvested in a 40-year cycle (a shorter life cycle and less impact from interest rates). In this scenario, stands would double the number of trees at 220 trees per acre with similar planting and maintenance requirements. The return on investment (ROI) for this scenario is -3.3% over 60 years. Again, the long time frames involved, without revenues prior to harvest, present a major challenge to economic viability.

Study Limitations

During the course of this pilot program, the Team explored a variety of options while pursuing economic feasibility. Starting from a "bare land" scenario to the "alder/high-value mix" scenario, the Team learned that the Urban Lumber Program would not be self-sustaining without added revenues and that the primary limitations are:

- The study does not monetize the carbon sequestration, air quality, and stormwater ecosystem service benefits. Carbon sequestration appears especially promising as a funding source for initial planting and maintenance with the creation of the Urban Carbon Forest Registry in Seattle.[1]
- The study does not quantify avoided costs from planting and managing urban forests for lumber production compared to the current system of expensive harvest of mature, dead and dangerous trees in urban areas.
- HB 2984 prevents the study from considering the potential of selective harvest of existing urban trees. Harvesting existing stock could produce revenues to offset initial costs.
- HB 2984 also dictates that the study cannot include trees on private lands, which severely limits the eligible planting area.
- The study does not include detailed species-specific scenarios that might produce the most revenue. For example, a mix of species and intercropping (e.g. with berry plants), might produce more revenue than the Bare Land Scenario.

New opportunities discovered toward the end of the process could offset the high investment costs before the first harvest. A strong case may be made to support a city urban lumber program in Clackamas County, but more study is needed, as discussed below, to make the program self-sustaining in the long run.

Recommendations

Overcoming the start-up costs: A major constraint on feasibility is the high cost of starting the program. The cost of trees, planting, pruning, geotagging, and enrollment in carbon credit programs require upfront financing. It appears that this could be addressed by obtaining financing through monetizing carbon credits and seeking other funding sources such as foundations or patient capital sources (Appendices 4 and 5). Carbon credits may be certified under the Urban Forest Carbon Registry protocols and marketed through California and other markets.

Overcoming long time frames to harvest: A second constraint is the 40+ year timeframe to harvesting planted trees. This challenge might be addressed by combining innovative financing, tree species selection to reduce time to harvest, selective harvest of existing trees on public and private lands, and city financial planning to reduce current high costs of tree removal with no income to cities.

1 Current estimates from the Urban Forest Carbon Registry, obtained during telephone interviews, are that urban forest carbon credits will generate 80 percent of their value in the first five years for trees that are registered for at least 25 years. Current guidance is that urban forest carbon credits could be valued at a premium price in the global carbon markets. (See: http://www.ufregistry.org/).

Economic Development Potential

Estimating the economic development potential of an industry 60 years into the future is speculative, as both demand and technology used in production changes over time. Employment in the timber sector across the US and in Clackamas County has declined since the 1990s. The wood products cluster (sawmill, preservation and manufacturing) experienced a rapid decline in employment prior to the Great Recession (late 2007 – early 2010), but has since begun to recover. On the other hand, the forestry cluster (timber tract operations and logging) remains consistent, hovering around 210 employees since 1998 (Appendix 3).

Another way to consider the program's economic potential is through the industry's economic multipliers. These multipliers [2] represent how the short-run demand for goods and services increase or decrease given a change in production. For Clackamas County the 2015 economic output and employment multipliers for commercial logging are: 1.62 – economic output and 1.57 – employment.

The 1.62 multiplier indicates that $1 million in local farm spending would yield $620,000 in local indirect and induced economic activity. For example, when a logger purchases equipment locally, that company pays employees and other local business to support its operations.

Employment multipliers are similar to spending multipliers, but interpreted slightly differently. The employment multiplier of 1.57 indicates that each 1.0 full-year equivalent in demand for employment resulting from increased spending, would result in an additional 0.57 support and non-timber jobs (in FTE) in Clackamas County.

The economic contributions of the Clackamas County Urban Lumber Pilot Program use the multipliers described above, along with the gross revenues calculated in the financial feasibility analysis. Table 1 shows the average annual results of the economic effects of the program using the 2015 IMPLAN data for Clackamas County.

2 These multipliers represent a short-run and static perspective on the timber industry. We do not attempt to estimate the future changes in productivity of workers or structure of the economy, but rather estimate the effects of the program based on current relationships between the logging industry and its supply-chain in Clackamas County.

Table 1. Annual Economic Effect of the Clackamas Urban Lumber Pilot Project

Interest Rate	Employment	Gross Revenue	Secondary Effects	Total Output
2.5%	11	798,348	492,438	1,290,787
3.0%	11	586,768	361,931	948,699
5.0%	11	174,101	107,389	281,490

Source: ECONorthwest using 2015 IMPLAN

Based on the short-run multipliers described on page 12, the project would support an average of 11 jobs (7 direct jobs and 4 indirect jobs) in the county annually. The production of new timber would result in additional economic activity along the supply chain for firms that support logging in Clackamas County. When including the average secondary effects from production, the program would support $2.8 million to $12.9 million in total economic output during the 10-year harvest cycle.

The pilot project would support an average 11 jobs in Clackamas each year, during the 10-year harvest cycle.

Table 2 displays the top 10 industries affected by the program under the current supply chain relationships in Clackamas County. These totals represent the annual average economic effect supported during the assumed 10-year harvest cycle. Support activities for logging that serve as inputs for the industry would experience a small increase in demand from the program. Likewise, industries in transportation and other local service sectors would experience a small increase in demand from supply chain purchases and consumption spending.

Table 2. Top 10 Industries Affected by the Clackamas County Urban Lumber Pilot Project

Industry	Employment	Output		
		2.5%	3.0%	5.0%
Commercial Logging	7.2	798,369	586,783	174,106
Support activities for agriculture and forestry	0.4	24,390	17,926	5,319
Wholesale trade	0.2	56,137	41,260	12,242
Real estate	0.2	38,625	28,388	8,423
Full-service restaurants	0.2	7,264	5,339	1,584
Limited-services restaurants	0.2	11,886	8,736	2,592
Hospitals	0.1	18,852	13,856	4,111
Retail-General merchandise stores	0.1	6,936	5,098	1,513
Retail- Food and beverages stores	0.1	7,653	5,625	1,669
Truck transportation	0.1	16,112	11,842	3,514

Source: ECONorthwest using 2015 IMPLAN

Governance Feasibility

The study examines the potential to create an organization to guide Clackamas County, cities and other partners in an urban lumber program. Several types of organizations can be formed to provide technical support services to cities and other partners with shared urban lumber and forest goals. Project Team research identifies ten potential governance options and multiple ways of funding (Appendix 5 and Appendix 6). Criteria for selecting the recommended options from the ten studied include political feasibility, legal feasibility, mission alignment, ease of launch, funding sources available, ease of management, stability and expandability. Based on input from the Urban Lumber Advisory Committee ten governance options were narrowed to the two most viable:

- Intergovernmental Agreement Organization (IGO)
- Nonprofit Organization (NPO)

The IGO is flexible, well understood and commonly created by local governments through intergovernmental agreements. As public entities, they have access to funding sources commonly accessed by local governments. NPOs are versatile and generally created so that a wide variety or partners can participate in the organization's activities. They can access both private and foundation funding to the extent their activities are structured to be charitable in nature and thus donations can be tax deductible. It may be desireable to start with an IGO, formed by local governments and expand to an NPO as more partners join the urban lumber program.

The functions of this organization would include:

- Hire a part-time coordinator or contractor to guide the cooperative organization.
- Prepare a recommended high-value tree species list for planting.
- Support local nurseries to meet the needs of the participating partners.
- Provide individual tree enrollment and geotagging services.
- Develop tree planting and maintenance guidelines by species.
- Coordinate harvest schedules and contractors.
- Provide information on marketing to promote local economic development and maximize commercial value from trees enrolled in the program.
- Assist partners in managing urban forest carbon credits and taking advantage of other co-benefits.
- Provide other services as requested by the members of the cooperative organization.

Business Plan for Urban Lumber Organization

Based on extensive experience and knowledge in the field, Fiddlehead, LLC prepared a detailed business plan for the organization (Appendix 7). The plan addresses revenues, one-time start-up costs, annual operating expenses, and other matters.

Revenues

Land Owners and carbon offsets appears to be the primarly source of program funding.

The urban lumber organization would charge for its services to remain financially self-sufficient. Revenues can be generated by:

- Charging enrollment fees on a per tree basis.
- Charging annual membership fees.
- Charging a fee on each log brokered at the time of timber sale.

Logically, landowners enrolling their trees would be the primary group paying enrollment fees. However, this may be a large cost burden for municipal landowners. Connecting landowners with carbon credit tree planting funders and foundations can help shift the cost burden away from landowners and reduce barriers to entry. The cost to enroll each tree would be $5-$10 depending on the number of trees enrolled annually. The more trees enrolled, the lower the enrollment costs.

Potential funding opportunities include a variety of sources: appropriations by the state, cities or counties; membership dues; tree enrollment fees; federal, state and local grants and contracts; foundation grants or investments; bonding proceeds; selective thinning and harvesting existing trees; understory crops; sales of trees at maturity; tax incentives/new markets; private equity (seed, venture, patient capital); federal, state, and local loans; and sales of carbon credits.

One Time Start-Up Costs

The Urban Lumber Program requires start-up capital to be successful. Program operations could be self-funded by year five by tapping a variety of funding sources. Start-up funding should be considered by the State of Oregon in 2017 - 2019. Total funding needed is $450,000 including:

- One time capital expense to build the geo-tagging, growth modeling, and web-based platform: $150,000
- Year 1 logistical and strategic planning: $50,000
- Gap funding covering annual costs until the program is self-sustaining (estimated at year five based on progressive build up to full capacity of required annual tree enrollments) and generation of income from other funding sources. The program would progressively reach full capacity during that time via annual tree enrollments: $200,000
- Services to members, marketing, outreach, demonstration tree plantings, seed stock inventory: $50,000

Annual operating expenses

Staffing or consulting and some basic infrastructure would be needed to successfully manage the program over time. A part-time staff over the first few years may be sufficient if tree enrollment is limited.

- Forester (1 FTE) $75,000
- Office space $10,000
- Administrative (website/database management) $15,000

Total $100,000

Technical Feasibility: Land Availability

The Project Team assessed lands that could be available for participation in an urban lumber program in Clackamas County. Categorizing land by ownership, use, and operational considerations both informed the feasibility analysis and provided programmatic parameters describing where to plant and enroll trees (Appendix 4).

Publicly-owned properties within incorporated cities and urban growth boundaries in the County were categorized by public ownership, from the local to federal level. Major roadways (spanning paved areas, medians, and rights-of-way) were also included in the analysis. To understand the future potential of this program, privately-owned institutional land was summarized separately as possible "partner" land. Just over 6,000 acres of the total area is publicly-owned, with another 1,300 acres owned by potential partners.

From this broad collection of properties, areas unavailable for tree planting and harvest were removed, including riparian buffers and developed areas. Additionally, forested areas were removed from public lands and along major roads only. The resulting patchwork of available lands was filtered to remove patches too small to plant trees.

We identified 1,159 acres as the land base available for initial planting.

Findings:

- There are 3,871 acres of publicly-owned, undeveloped and non-forested patches of land.
- Patches range from 324 square feet (the analytical minimum threshold) to 131 acres.
- Patches larger than 2.5 acres make up 57% of the total area of potentially available land despite only 248 being identified.
- The vast majority of patches (13,697) are between 400 square feet and 1 acre in size.
- More than 90% of patches fall outside areas that could increase harvest costs, such as steep slopes and regulatory stream buffers.

- Because of limitations in the resolution and accuracy of available input data, the Project Team further restricted the area identified by 60% to inform the economic analysis.
- With these limitations, there are 1,559 acres for inclusion in the analysis.

Technical Feasibility: Guidelines for Tree Enrollment

A major challenge to the use of existing urban trees in a lumber harvest program is the widely variable condition of current urban trees (Appendix 4). For jurisdictions initiating an urban lumber program, the Project Team recommends the following criteria for tree selection and enrollment (Appendix 4):

- Enrollment criteria need to be established for inclusion in the program along with policies and procedures for administration.
- Enrollment criteria would include: wood value, commodity value, rate of growth, native range, and suitability for Clackamas County and maintenance needs.
- These criteria align well with the certification protocols for carbon credits.

There is a significant range of economic value attached to different tree species. Some trees are more ideally suited to lumber production than others. Softwoods like Douglas fir, Hemlock and Western red cedar are processed for saw logs by mills in the Pacific Northwest. A limited number of species are typically milled by the traditional hardwood market[3], and a few northwest mills process Red alder, Big leaf maple and Oregon ash. Other hardwoods, such as Myrtle wood, Pacific madrone and Oregon white oak, are often sent to pulp mills. Some species may be purchased in small quantities by specialty mills, particularly large logs free of any defects.

A major challenges to the use of existing urban trees in a lumber harvest program is the widely variable condition of current urban trees.

Essential Tree Qualities

1. Trees must be straight with a single, undamaged leader.

   Trees with multiple leaders, top of tree growth, or off-center main stems generally produce low quality lumber. Trees that are not straight are also difficult or impossible to mill, or require cutting to shorter lengths that affects their ability to be milled. Additionally, leaning trees, or those bent by a storm or other disturbance, produce "reaction wood" as it straightens itself during processing and becomes unusable.

3 One source lists aspen, ash, basswood, beech, birch, cherry, cottonwood, hackberry, hard maple, hickory/pecan, red oak, soft maple, sap (sweet) gum, sycamore, walnut, white oak, willow, and yellow poplar (Cassens and Makra 2014).

2. Trees must be free of defects.

Trees are subject to a wide variety of defects caused by both internal and external forces. Traditional whole log markets prefer vigorous growth that has not been impacted by fire, mineral staining, grazing, insect defoliation, mechanical damage, or other factors that affect wood quality. Urban trees are also much more likely to contain pieces of metal, such as nails or other hardware. This usually occurs at heights people can reach, but also may occur higher up near electrical wires.

3. Trees should be spaced at a distance that allows for efficient growth, management and harvest.

In forest stands, trees grow close together and compete for light, resulting in tall, straight main stems with little side branching. Although open-grown and individually grown trees should not be excluded from the program, trees grown in forest stands will produce wood ready for milling with less management during their lifetime than open-grown trees. When planting, trees should be spaced at intervals appropriate for species, location and long-term management plans. Existing stands of trees should be thoughtfully assessed at the time of enrollment to understand if established spacing will limit their growth or inhibit future management or harvest.

Urban Lumber trees should be:

- ***Straight***
- ***Defect Free***
- ***Spaced appropriately***
- ***Accessible for management and harvest***
- ***Right tree in the right place***

4. Trees must be accessible for management and harvest.

Trees located close to buildings or infrastructure may need specialized equipment for removal by a trained professional. Also, the limited space and weight of the tree may require the bole to be cut in more manageable but potentially less valuable lengths. The extra skill, time and equipment involved makes urban tree removal considerably more expensive than traditional forest logging (Appendix 9).

5. Guidelines for planting trees.

   When planting trees for enrollment, bare-root 1-3' seedlings are recommended. These trees should be grown as whips, with a strong central leader and minimal side branches. Smaller trees are less expensive to plant because the cost of the tree and the labor to plant it are significantly less than that of a larger tree. Additionally, stock can be purchased from commercial wholesale nurseries specializing in commodity forest seedlings (instead of landscape nurseries) at bulk prices. Tree planting should follow proper protocols recommended by the Urban Lumber Forester in conjunction with the OSU Extension Forester agent.

Technical Feasibility: Tree Enrollment Tracking and Management

Many urban and traditional forestry programs rely on tools that allow managers to track and model the growth of trees, plan forestry activities, and share that information with their team. To support an urban lumber program, the Project Team initiated the process for building a web-based tool to enroll, track, and manage trees over time. We interviewed key stakeholders, including government and private arborists, planners, and managers already familiar with the urban lumber feasibility study from Happy Valley, Lake Oswego, Milwaukie, Corvallis, and Oregon Department of Transportation. These interviews, as well as input from the Urban Lumber Advisory Committee meetings, identified the user needs that drive the development of this tool. The most commonly identified attributes were simplicity, flexibility, compatibility with existing software, mobile device and tablet accessibility, and the ability to work offline and sync upon service availability. Adhering to existing protocols for forest management software, software requirements were developed to support the functionality identified in these interviews, including an enrollment workflow to input and geotag trees. The wireframes developed outline the essential elements of the tool and how users might interact with it. Appendix 4 presents these findings and describes the resulting framework for building a web-based tool that maps, monitors, and models urban trees to support urban forest management by foresters, reporting for decision-makers, and understanding by the general public. Next steps in building the tool would include soliciting user feedback on the workflows developed and creating a compelling user interface. The Project Team also developed related prototype outreach materials for use once the urban lumber program has been established.

Technical Feasibility: Tree Species Rating System

This section provides land owners, who want to plant trees for future harvest, with guidance on the best trees for an urban lumber program. The rating system evaluated several characteristics of each tree species with a total of 12 points available (See Table 3 and Appendix 8). Several characteristics had a range in scores. Higher scores were given for better performing trees. The following numbers explain the potential of each species:

Overall Ranking Scores

- Very good: 11-12
- Good: 9-10
- Mediocre: 7-8
- Poor: 5-6

A wide variety of trees would work in the Lumber Urban Program.

Different characteristics

- Wood value: high 3, moderate 2, low 1, unknown 0
- Commodity: common 3, available 2, specialty 1, unknown 0
- Rate of growth: extremely fast 4, fast 3, moderate 2, slow 1
- Native range: Pacific NW 2, West Coast 2, Midwest/East Coast 1, South
- America 0, Europe 1, Asia 0, Africa 0
- Suitability for Clackamas County: excellent 3, good 2, poor 1

A few characteristics reduced points off the total score including:

- Insects/Pests (e.g., Emerald Ash Borer and Asian Longhorn Beetle)
- Disease/Pathogens (e.g., Thousand Cankers, Root Rot, and Dutch Elm Disease)
- Common defects in logs (e.g., Ring Shake, Root Rot, excessive bark inclusion)

Other characteristics were considered, but not given a numeric score, including:

- Basic uses/characteristics of wood
- Maintenance issues
- Preferred habitat
- Water needs

The tree species list should give interested parties a general scope of options available. However there are some limitations worth considering. Some of the ratings are arbitrary, such as scoring native plant species higher when some non-native trees. For example, Deodar cedar grows extremely well in Clackamas County. Also, some trees received a high score, such as Black locust, but its invasive tendencies render it a less desireable choice.

Faster growing trees were given a higher score. Red alder is a good choice for this reason. However, some trees that grow slowly like Oregon white oak may yield valuable lumber in the future and should be strongly considered.

Some trees, such as Oregon ash, lost points because of the future risk of Emerald Ash Borer (EAB) coming to Oregon. It is possible EAB will not arrive to the west coast for several decades, in which case Oregon ash would be a sutiable tree to plant in an urban lumber program in the short term.

Different types of trees will grow at different rates and produce varying quality of lumber based on the size of the planting. For example, Douglas fir is more prone to defects like Ring Shake in small stands or in lineal plantings due to wind stress, making it a poor choice on smaller parcels. However, on land over a few acres, Douglas fir becomes a good candidate for planting in stands. The rating system does not evaluate parcel size.

The information comes from several books and conversations with arborists, urban forestry professions, and people in the wood products industry. Anyone selecting and planting trees is encouraged to due further research about the suitability and marketability of specific trees for their land.

The highest rated trees grow to a marketable size quickly, command a strong price in the marketplace, and are not prone to threats from pests and diseases. Trees were given extra points for being native to the Pacific NW. Many trees rated at the top of the list are hardwoods such as Red alder, but Western red cedar, a softwood tree, is in high demand as well.

* Additional resources	
National Wildlife Federation's Field Guide to Trees of North America by: Kershner, Mathews, Nelson and Spellenberg	Western Garden Book by: Sunset Magazine
Plants of the Pacific NW Coast by: Pojar and MacKinnon	With the Grain: A Craftman's Guide to Understanding Wood by: Christian Becksvoort
The Illustrated Excyclopedia of Trees-Second Edition by: David More and John White	Understanding Wood by: R. Bruce Hoadley
North American Landscape Trees by: Arthur Lee Jacobson	

Not included in this list are trees listed as regional nuisance species, like Norway maple, Tree-of-heaven, and White poplar ("Portland Plant List" 2016). Nuisance invasive species should not be considered for inclusion in this program.

Table 3. Tree Species Rankings for Clackamas Urban Lumber Program

Common Name	Scientific Name	Ranking
HARDWOOD SPECIES		
Northern red oak	*Quercus rubra*	12
Red alder	*Alnus rubra*	12
Sweet gum	*Liquidambar styraciflua*	12
Myrtlewood	*Umbellularia californica*	12
Big leaf maple	*Acer macrophyllum*	11
Black cherry	*Prunus serotina*	11
Paper birch	*Betula papyrifera*	11
Tulip poplar	*Liriodendron tulipifera*	11
Black locust	*Robinia pseudoacacia*	10
American ash	*Fraxinus americana*	10
American elm	*Ulmus americana*	10
Black walnut	*Juglans nigra*	10
Kentucky coffee tree	*Gymnocladus dioicus*	10
Red maple	*Acer rubrum*	10
Silver maple	*Acer saccharinum*	10
Oregon white oak	*Quercus garryana*	10
American beech	*Fagus grandifolia*	9
Bitter cherry	*Prunus emarginata*	9
Honey locust	*Gleditsia triacanthos*	9
Linden	*Tilia americana*	9
Mulberry	*Morus Spp.*	9
Oregon ash	*Fraxinus latifolia*	9
Sugar maple	*Acer saccharum*	9

Sycamore	*Platanus occidentalis*	9
American persimmon	*Diospyros virginiana*	8
Chestnut	*Castanea sativa/mollissima*	8
Chinese elm	*Ulmus parvifolia*	8
Sassafras	*Sassafras albidum*	8
Osage orange	*Maclura pomifera*	8
Catalpa	*Catalpa bignonioides*	7
Empress tree	*Paulownia tomentosa*	7
English walnut	*Juglans regia*	7
Pacific dogwood	*Cornus nuttallii*	7
Silk wood (mimosa)	*Albizia julibrissin*	7
Eucalyptus	*Various species*	7

Common Name	**Scientific Name**	**Ranking**
SOFTWOOD SPECIES		
Western red cedar	*Thuja plicata*	12
Western hemlock	*Tsuga heterophylla*	12
Douglas fir	*Pseudotsuga menziesii*	11
Alaska yellow cedar	*Cupressus nootkatensis*	11
Sitka spruce	*Picea sitchensis*	11
Coastal redwood	*Sequoia sempervirens*	10
Port Orford cedar	*Chamaecyparis lawsoniana*	10
Deodar cedar	*Cedrus deodara*	9
Ponderosa pine	*Pinus ponderosa*	7
Giant sequoia	*Sequoiadendron giganteum*	7
Monkey puzzle	*Araucaria araucana*	7
Black pine	*Pinus nigra*	6
Scotch pine	*Pinus sylvestris*	6
Lodgepole pine	*Pinus contorta*	6

Source: Fiddlehead, LLC

Appendices[4]

1. Urban Trees Annotated Bibliography, ECONorthwest, April, 2016
2. City Survey Results, Clackamas Urban Lumber Cooperative Program, Cogan Owens Greene, Fall, 2016
3. Clackamas County Urban Lumber Pilot Project, Economic Analysis, ECONorthwest, May, 2017
4. Clackamas County Urban Lumber Pilot Project: Technical Feasibility, Ecotrust, May, 2017
5. Governance Options for Clackamas Urban Lumber Program, Cogan Owens Greene, LLC, 2016
6. Management Options and Potential Funding Sources, Cogan Owens Greene, LLC, February, 2017
7. Clackamas County Urban Lumber Co-op Entity Business Plan, Fiddlehead, LLC, May, 2017
8. Species Recommendations for Urban Lumber Program, Fiddlehead, LLC, 2017
9. Crane Utilization in Urban Lumber Program, Fiddlehead, LLC, 2017

4 Because of their size and diversity appendices are available from the Clackamas County Business and Community Services Department.

*"Without natural resources life itself is impossible.
From birth to death, natural resources, transformed for
human use, feed, clothe, shelter, and transport us.
Upon them we depend for every material necessity,
comfort, convenience, and protection in our lives.
Without abundant resources prosperity is out of reach."*

-Gifford Pinchot

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