



[URBAN FORESTRY MANAGEMENT PLAN]

A plan to sustainably, holistically and efficiently manage Bozeman's urban forest to realize the full expanse of benefits urban trees can provide

Acknowledgements:

Mitch Overton: Director of Parks and Recreation Bozeman

Bozeman Tree Advisory Board

The Bozeman Citizenry

Jamie Kirby: Montana DNRC

This document was funded by an urban forestry program development grant from the State of Montana - Department of Natural Resources & Conservation – Urban & Community Forestry Program



BOZEMAN^{MT}
Parks, Recreation,
Forestry & Cemetery

Table of Contents

Abstract 4

Introduction..... 4

 History and People 6

 Process and Plan Development 7

 Climate and Environment 7

 Population Dynamics 8

 Value of Urban Forest..... 8

Organization of Plan 9

Goals of the Plan..... 10

Bozeman’s Relationship with the Urban Forest..... 11

Why Urban Trees 12

 Public Health..... 13

 Social Benefits 13

 Hydrology 13

 Environmental Energy Savings..... 14

 Air Quality 14

 Economic Value..... 14

Bozeman’s Urban Forest..... 16

Tree Infrastructure 17

 Condition 18

 Species Diversity 18

 Age Diversity 19

 Age and Size Diversity Analyzed 20

 Increasing the Canopy Cover in Bozeman..... 21

 Tree Infrastructure Recommendations and Expected Outcomes 22

Management of Urban Forest 23

 Current Management 23

 Analysis of Current Management 25

 Preferred Management..... 27

 Superintendent of the Forestry Department Position 27

Maintaining Public Trees	28
Contracting Work.....	34
Maintaining Private Trees	35
Bozeman Public Schools.....	36
Budget/Funding.....	36
Risk Management	38
Tree Characteristics Associated with Tree Failure	39
Risk Management Plan	40
Management of Urban Forest Recommendations.....	42
Community Engagement	43
Forestry Advisory Board.....	44
Health and Welfare Benefits	45
Community Planning	46
Planting Trees	46
Education	48
Coordination	48
Assistance	48
Bozeman School District (Planting Partnership)	49
Partnering with Montana State University	49
Community Engagement Recommendations.....	50
Conclusion	51
Appendix 1. Job Description for Urban Forester/Superintendent of Forestry	52
Appendix 2. Planting Trees in Paved Areas	53
Appendix 3. SWOT Analysis	54
References.....	55

Abstract

The Bozeman Urban Forest Management Plan (UFMP) aims to sustainably, holistically, and efficiently manage Bozeman’s urban forest and to illustrate the full expanse of benefits urban trees can provide. This plan focuses on finding the most cost-effective ways to accomplish these goals in Bozeman. The City of Bozeman and the public have given the urban forest in Bozeman more attention and priority in recent years, resulting in more effective management and an increase in the maintenance of public trees. This plan considers maintaining public trees an essential element of successful urban forestry management, but it is only one component. This plan emphasizes strategies to maximize the benefits the urban forest provides. These benefits provide solutions to many of the issues faced by our modern-day society, especially in the environmental, psychological, sociological, and economic areas.

The Bozeman UFMP is supplemented with the Bozeman Emerald Ash Borer Course of Action Plan, and together they offer a comprehensive approach to building a healthy urban forest and preserving it from invasive pests. The Bozeman UFMP is comprised of three main parts: Tree Infrastructure, Management of the Urban Forest, and Community Engagement. These three components work together to build the most efficient urban forest in Bozeman.

Introduction

The Bozeman Urban Forestry Management Plan is an updated version of the previously created Tree City Master Plan created in 2011 by the Bozeman Tree Advisory Board and adopted by the City Commission. This project is the accumulation of much work done by



South Church Avenue, Bogert Park

the Bozeman Tree Advisory Board, the Director of Parks and Recreation, and the public. Monthly tree board meetings were held preparing this plan during the six-month drafting period. A series of four public meetings were conducted on the topics of tree infrastructure, management of the urban forest, emerald ash borer, and community engagement. Public comments were

collect during the series of meetings. A draft version was created, and the final document was produced from revisions of the draft.

Bozeman’s Urban Forestry Management Plan presents the most cost-effective management possible, yet it preserves the existing canopy cover, substantially grows canopy, and maximizes benefits. Every opportunity to “do more with less” is stressed in this plan, and the budget recommendations will result in greater overall efficiency while gaining a remarkable return on investment. This plan represents an impartial overview of the current structure and offers a management strategy that focuses on increasing work productivity while addressing issues related to risk and liability.

An important component to the efficacy of this plan is the immediacy of its implementation. This is because Bozeman’s urban forest is particularly vulnerable to a looming forest pest, the Emerald Ash Borer. The sooner recommendations are implemented; the more prepared Bozeman will be for such an event. Without immediate action, Bozeman’s urban forest will be compromised, which will limit the ability of the City to respond to or handle large-scale impacts from invasive pests as well as storm events, urban development, and risk management. Therefore, the urgency of implementation is critical and cannot be understated.



Elm Tree in Cooper Park

The urban forest is the only community infrastructure that increases in value over time. Bozeman’s urban forest offers immense benefits and is worth the investment.

Mission Statement

The City of Bozeman is committed to providing a healthy, safe, and aesthetically pleasing community forest for its residents and visitors. By maintaining, managing, and

preserving its trees, the city raises its citizens' standard of living and maximizes the benefits offered by its urban forest.

Vision Statement

Bozeman's community forest is an essential component of municipal infrastructure, one that creates efficiencies and long-term solutions to achieving a sustainable community. The community forest is cared for by the city and its people, creating a high quality of life, a healthier citizenry, and making it a leader of towns in the Mountain West.

This plan does not address the technicalities of tree maintenance, such as pruning or planting trees. Suggestions are made when deemed appropriate as to new trends or when a cost-saving measure can be made. This plan format summarizes recommendations at the end of each of the three sections. These recommendations are steps that can be prioritized and "checked off."

History and People

The City of Bozeman is Montana's fourth largest city, with a population of 39,860, according to the 2012 census estimate, and it is the seat of Gallatin County. Bozeman has a rich history of notable figures, starting with its founder and namesake, John Bozeman, who platted the town in 1864. William Clark passed through and camped in the area, documenting this location.

The city has its roots in agriculture, and many of its earliest institutions reflect that, including the Agricultural College of the State of Montana, established in 1893 and later renamed Montana State University.

The Bozeman National Fish Hatchery was established in 1892 and is the fourth oldest fish hatchery in the United States. Much of the Gallatin Valley was planted with peas in the early 1900s. Pea canneries in Bozeman produced 75% of the seed peas in the



View of canopy in Bogert Park

United States, and Bozeman was once known as the “sweet pea capital of the nation.” The Sweet Pea Festival, held the first weekend in August every year, is one of Montana’s largest festivals and a source of community pride.

Bozeman prides itself in being a great place to raise families and a healthy place to live and work. It has been documented in many publications as the “most livable” and recognized for its recreational opportunities. It is located in a valley surrounded by mountain ranges that create beautiful surroundings and great recreation. Tourism is an important part of the Bozeman economy, with its proximity to Yellowstone National Park and area ski resorts. Bozeman’s positive attributes have been noted in literature, film, and television media, ranging from author John Steinbeck, filming locations for *A River Runs Through It*, and references in TV shows “The Big Bang Theory” and “CSI: NY.”

Montana State University is located in Bozeman and annually enrolls about 15,000 students. This influences the character of the town in many ways, mostly giving the town a youthful feel and adding to its vibrancy.

Process and Plan Development

During the development of this plan, four public meetings were held in City Hall. On three of those occasions, there were other meetings occurring in different rooms at the same time as the urban forest meetings. The other meetings were affordable housing, stormwater management, and sustainable transportation. Urban trees have a direct relationship to every one of these topics:

- Urban trees provide cost-saving benefits and raise the quality of life for people, especially where affordable housing is concerned.
- Trees reduce stormwater runoff.
- Trees make sustainable transportation much easier by slowing down traffic and moderating the elements.

Trees were not mentioned at any one of these individual meetings, and that is an opportunity lost for the City of Bozeman. An urban forester could be involved in all of these planning meetings to make Bozeman run more efficiently.

Climate and Environment

Bozeman is technically in the Zone 4B climate zone, represented in the gray.

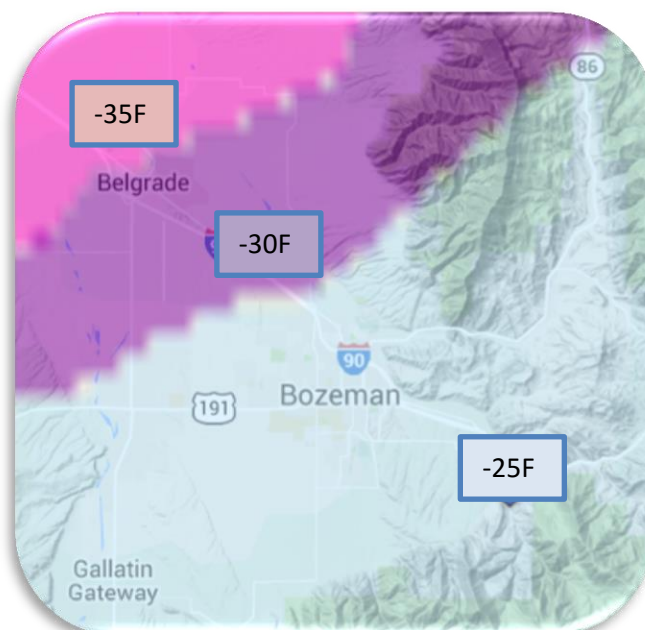


Figure 1. USDA Plant Hardiness Zone Map

Zone 4A closely borders Bozeman and affects the trees that will grow. In the Plant Hardiness Zones map, the purple represents Zone 4A and pink is Zone 3B. The climate zone map is based on average extreme low temperatures. Bozeman's yearly average precipitation is 16.23 inches, which is higher than surrounding areas in Montana but still considered a semi-arid climate.

The soil in Bozeman is generally a silty loam and conducive to tree growth. The soils are derived from alluvial sources and are pH neutral to slightly alkaline. There are some poisoned soils in the northeast part of Bozeman, but generally they are not an issue for tree growth.

Population Dynamics

Bozeman's population grew by 40% between 2000 and 2013 and continues to grow. The urban forestry department in Bozeman has had no net change in its number of arborists since the year 2005. As Bozeman grows, the urban forestry department must keep pace with the amount of development and the increasing demand on its resources.

Value of Urban Forest

The replacement value of Bozeman's municipal forest is \$21 million. This is a substantial asset and investment, one that requires maintenance, one that grows in value over time, and one that exponentially pays its community back in benefits.

Urban forest management is a relatively new, yet vital, concept across the U.S., as well as in Bozeman. This is due to the change in how we, as a community, value our trees. New studies and developments show clear ties to mental, social, and physical health benefits from the community forest. In addition, the ecological benefits of having trees in an urban environment are now more important than ever. Because of this greater understanding, managing an urban forest has evolved from the number of trees and how often they need pruning to now figuring out how the community can receive—and sustainably grow—the greatest benefits from their urban forest.

Implementing recommendations from this plan will benefit Bozeman particularly well. This is because Bozeman has a resource in its urban forest that has much potential, meaning the true benefits of the urban forest have not been maximized. A stronger urban forest will mean a stronger community in Bozeman. By investing in the urban forest and implementing the plan right away, the City of Bozeman can make cost-effective, long-term solutions to human and environmental issues. Such potentials include:

- Gain efficiencies and cost savings in city operations, namely hard infrastructure
- Improve water quality, and stormwater management
- Increase human health and welfare
- Increase the health and biodiversity of the urban forest

- Differentiate Bozeman from most other Mountain West towns by further establishing itself as a leader in sustainable practices and economic growth
- Combat climate change and increase environmental health
- Create a more environmentally literate population
- Create recreational opportunities
- Ensure Bozeman is a thriving community for future generations
- Lessen the negative impacts of development
- Lessen liabilities from neglecting urban trees
- Create food sources for people, overwintering birds, and wildlife
- Enhance stewardship opportunities for its citizenry and building community
- Proliferate social justice and sanctuary for the underserved in our community

It is now more important than ever to invest in the future of Bozeman because of the need to improve human health and welfare. This plan offers realistic, achievable solutions to critical community issues; however, if Bozeman is to realize the full array of environmental benefits, a thought paradigm shift must take place. The urban forest must be thought of as an essential component of Bozeman's infrastructure and must be included in the planning of Bozeman's growth and development.

It is difficult to grow an urban forest when it is implemented as an afterthought. Bozeman is well positioned to implement many of the recommendations made in this report in a relatively quick timeframe. This is due to the receptive citizenry, the growth of Bozeman, and the timing of this plan with respect to changes in the Urban Forestry Department.

Organization of Plan

This plan first gives the background necessary to understand why an urban forest is beneficial to the community that lives in it and why a plan is needed to achieve the principles of a sustainable urban forest. Once this background is understood, three management components are analyzed. These components are:

- **Tree infrastructure.** This includes an assessment of the current condition and characteristics of the urban forest.
- **Management of the urban forest.** This includes the people and departments charged with caring for and implementing this plan. Such entities include the Urban Forestry Department, designated city employees, elected officials, and Bozeman's Tree Advisory Board.
- **Community engagement.** This is the relationship between the City of Bozeman and the community that supports its endeavors. This management component shows the

important role the city has in engaging the public to raise awareness of the urban forest, given that at least half of the urban forest is on private property.

After analyzing one of these components, the plan makes recommendations on how to most efficiently improve in that area.

Goals of the Plan

The goal of this plan is to coordinate the management of Bozeman's urban forest. The plan addresses environmental considerations; clarifies roles and responsibilities; and provides tools for implementation, such as action items and suggested time frames. This plan creates a holistic urban forest. A holistic urban forest is one that:

- Enhances the City of Bozeman through environmental and economic benefits.
- Is resilient to climate change and invasive pests.
- Is valued by the community as an essential resource and asset.

A sustainable urban forest is one that is healthy, diverse, continually being added to, and well adapted to the local climate and urban conditions. A healthy urban forest requires maintenance, and this plan

seeks to find the most cost-effective way of maintaining the urban forest. A diverse urban forest has a variety of species, which contributes towards resilience in the event of insects and diseases, as well as offers a rich canopy in various



View of Bozeman from Pete's Hill

sizes and appearance. Continuous planting will ensure trees grow to maturity at different stages and will strengthen the age diversity of the urban forest. A well-adapted urban forest is one that uses species that are resilient to pests and urban conditions and suited to withstand harsh Montana climates. Urban trees face a unique set of challenges in an urban environment, including mechanical damage, soil disturbances, and above-ground limitations.

This plan has seven essential elements, and if implemented correctly, will save the City of Bozeman millions of dollars in management costs, preserve the existing canopy, and greatly expand the urban forest and the benefits it provides. Five of these elements directly prepare the City of Bozeman for the arrival of the Emerald Ash Borer (EAB), and in doing so they create a healthy, sustainable urban forest. The seventh element expands benefits and reduces liability. The seven essential elements are as follows:

- Create an urban forester position to oversee Bozeman’s urban forest.
- Plant a new generation of trees with appropriate species diversity.
- Establish a systematic and coordinated detection effort for EAB.
- Remove trees that are deemed hazardous, in poor condition, or in inappropriate locations.
- Establish a healthy and vibrant relationship between the community and Bozeman’s Urban Forestry Department.
- Complete and maintain the tree inventory.
- Implement a proactive maintenance cycle.

The plan is not organized around these elements, rather they are addressed in many ways and through multiple management strategies throughout the plan. When necessary, they are highlighted to show how the three management components (tree infrastructure, urban forest management, and community engagement) work together symbiotically—not independent of each other.

If EAB were to arrive in Bozeman without these essential elements being addressed, the city would spend between \$1.8 million and \$7 million in response efforts and still potentially lose 9,000 of its 20,000 trees, as detailed in Bozeman’s Emerald Ash Borer (EAB) Course of Action Plan. The EAB Course of Action Plan operates as a supplementary plan to this UFMP and elaborates on specific management decisions related to Bozeman’s ash trees. Together, both plans will complement each other when looking into the long-term care and planning for the urban forest.

Bozeman’s Relationship with the Urban Forest

The urban forest in Bozeman, Montana, is a cherished part of the city for its citizens and a crucial part of the city infrastructure. The influence of the urban forest on quality of life and the town’s character cannot be overstated. The significance Bozeman places on its urban forest differentiates it from other western towns and makes Bozeman a more attractive place for people to visit and make their home.

Bozeman continues to have a greater influence in the West among destination mountain towns. The urban forest is a major component of this draw and separates Bozeman from other towns in the state and Rocky Mountain region. Bozeman is unique in that many other Montana towns look here for guidance

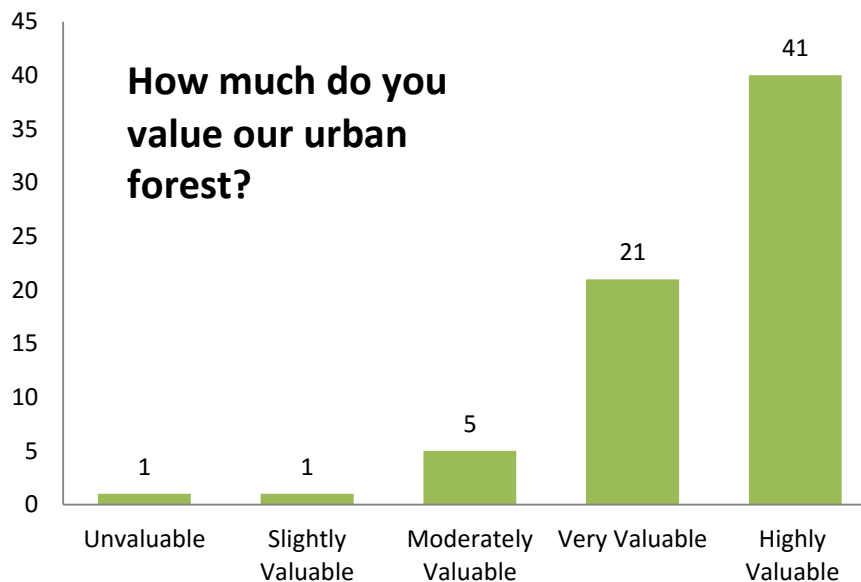


Figure 2

on matters such as urban forest management and

economic growth. Bozeman is well positioned as one of the most desirable places to live and visit. Investing in the urban forest is an essential part of realizing this future.

This plan was developed with guidance from public input. From this input, it is clear that the people of Bozeman place a high value on their urban trees and exhibit a willingness to invest in the urban forest. Ultimately, the people of Bozeman remain the driving force in supporting this Urban Forestry Management Plan.

Why Urban Trees

Urban trees increase human quality of life in many ways. Trees in the urban landscape provide economic benefits such as increased property values, reduced demand on sewer systems through reduced storm water runoff and erosion,



reduced wear on city streets, enhanced air quality, carbon sequestration, energy conservation through shade and wind protection, and noise abatement. There are public health benefits offered by urban trees, and investing in the community forest benefits everyone, not just the privileged, thus adding an element of social justice. Other non-monetary yet important benefits of urban trees include wildlife habitat for animals, especially birds, and the higher quality of life created by having trees in the viewshed.

Public Health

Communities with a healthy urban forest will have a healthier population. People who live around trees are three times more likely to be physically active and 40% less likely to be overweight (Donovan, G.H et. al.). They also offer important air purification benefits. In a study conducted by the U.S. Forest Service, it was found that communities that have lost massive numbers of trees were linked to higher death rates. Urban trees also lower stress levels and even improve recovery time for patients when given a view of trees.

Social Benefits

Urban trees contribute to important social and community dynamics. Trees provide an opportunity for citizens to engage in an issue that benefits themselves, their neighbors, and the entire landscape. Urban trees promote sustainable transportation in many ways. Trees slow down vehicle traffic and help guide motorists, making them physically safer by providing a barrier, and thus creating a naturally convenient design in transportation (Tarran, 2009).

Urban trees aid in reducing crime rates. Areas with high numbers of healthy trees can reduce crime rates as much as 50% compared to areas with low levels of vegetation (Kuo and Sullivan, 2001). Moreover, a 10% increase in canopy cover can result in a 12% reduction in crime levels (Troy, Grove and O’Niel-Dunne, 2012). These trees also lower the fear of crime, thus lowering stress levels (Donovan and Prestemon, 2013).

Hydrology

Urban trees work symbiotically with other parts of the city infrastructure. Urban trees reduce the demand on sewer systems during periods of stormwater runoff. Tree canopies absorb rainwater, lessening the amount of water entering the sewer system. Much of the water that runs down the trunk of a tree is taken up by the roots. As much as 80% of rainfall in the summer months can be absorbed by trees on impervious surfaces with tree pits (Stringer and Ennos, 2013). When a raindrop is intercepted by a tree’s canopy, it does not impact the soil, thus limiting erosion. These valuable soils are retained, and the sewer system does not have to process the particulate matter. An average mature ash tree will intercept 1,209 gallons of water every year with an implied value of \$13 per year per tree (McPherson et.al, 2003). Trees also increase the soil’s capacity to store rainfall through transpiration, and they increase soil organic matter.

Environmental Energy Savings

Trees can also provide energy conservation services in an urban environment. This is done by shading buildings from the summer's sun and insulating them from the winter wind. Deciduous trees are able to absorb radiant energy from the sun in the summer, yet in the winter they allow it through their leafless

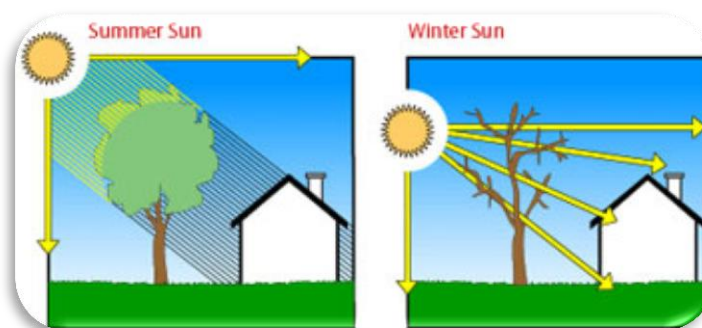


Figure 3

branches. In winter, we value the sun's radiant energy, and because of this we should plant strategically around our homes and buildings to realize the best energy savings (ISA website and Matheny and Clark, 2008). Trees planted on the west and north sides of buildings dissipate winter winds coming from those directions. Air mass in a building with poor insulation can change two to three times each hour, and even in well-sealed homes, the air mass can change once every two to three hours. Trees that deflect winter wind can reduce air infiltration by up to 50%, resulting in a heating savings of 10 to 12% (Heister, 1986).

Air Quality

Trees improve air quality by absorbing gaseous pollutants such as sulfur dioxide, nitrogen dioxide, ozone, and smog. Trees also intercept particulates in the air associated with soil tillage, construction, and erosion. These airborne contaminants have been associated with asthma, heart and lung disease, and cancer. Trees sequester carbon, initially through photosynthesis, by converting carbon into sugars. Over time these sugars are made into woody material, storing the carbon from the atmosphere. Trees release oxygen through photosynthesis and lower air temperatures via shading and transpiring water into the air. These trees can also block undesirable views while reducing noise, especially from vehicles and construction.

"One acre of forest absorbs six tons of carbon dioxide and puts out four tons of oxygen." U.S. Department of Agriculture

Economic Value

A well-maintained urban forest creates value. A survey by Arbor National Mortgage, Inc. found that a building lot with trees would "be as much as 20% more saleable than a house on a lot without trees." These investments in trees pay off in perceived values and in tax revenue from

A study conducted by the U.S. Forest Service in Amherst, Massachusetts, concluded that trees on a lot can raise a lot's value as much as 15%.

increased lot values. Mature trees also reduce the temperatures of the streets below and in turn, decrease the need for street maintenance from every seven to 10 years to every 20 to 25 years (Matheny and Clark, 2008).

Consumers in shopping districts that are shaded by urban trees tend to linger and shop longer (Matheny and Clark, 2008).

These consumers are also willing to pay higher prices and tend to have greater patronage for goods and services in these districts.



Church Street shaded by ash trees

Landscaping with plants and trees positively influences businesses by:

- Increasing workplace productivity and morale
- Helping to recruit new employees
- Attracting new customers or new business tenants
- Being viewed as an employee benefit
- Playing a role in creating a corporate image
- Playing a role as a marketing tool

(Relf, 1996)

Bozeman's Urban Forest

Bozeman's publicly owned forest can be assessed in many different ways. According to the i-Tree analysis software, the average tree in Bozeman provides \$111 in benefits annually. The canopy cover from Bozeman's public trees offers benefits equivalent to \$58 per person annually. If no greater investment is made, these benefits will decrease. However, when invested in, the benefits grow in an exponential manner in comparison to the amount of money spent. Bozeman's tree infrastructure is an investment like any other infrastructure, such as public buildings and sewer. Moreover, "unlike other public infrastructure components, properly planted and maintained trees increase in value over time." (APWA. Urban Forest Management Practices)

Bozeman

Total Annual Benefits of Public Trees by Species (\$)

12/4/2014

Species	Energy	CO ₂	Air Quality	Stormwater	Aesthetic/Other	Total (\$)	Standard Error	% of Total \$
Ash	154,799	31,287	23,155	147,525	1,081,053	1,437,820	(N/A)	61.7
Maple	32,271	6,264	4,377	31,167	291,352	365,432	(N/A)	15.7
Littleleaf linden	3,709	599	299	3,758	65,719	74,084	(N/A)	3.2
Honeylocust	4,008	680	164	3,963	75,134	83,948	(N/A)	3.6
Elm	8,250	1,532	1,423	8,950	51,257	71,413	(N/A)	3.1
European mountain ash	3,762	708	732	1,979	26,804	33,984	(N/A)	1.5
Common chokecherry	1,865	417	250	952	20,455	23,939	(N/A)	1.0
Quaking aspen	4,521	805	307	4,017	33,073	42,723	(N/A)	1.8
Oak	1,331	260	132	1,068	20,659	23,450	(N/A)	1.0
Crabapple	1,549	327	245	805	14,691	17,618	(N/A)	0.8
American basswood	2,764	442	155	2,211	32,567	38,139	(N/A)	1.6
Japanese tree lilac	542	114	44	195	10,540	11,435	(N/A)	0.5
Amur maple	860	196	139	454	8,172	9,821	(N/A)	0.4
Spruce	2,841	438	-257	6,739	12,254	22,015	(N/A)	0.9
Plum	511	80	107	690	3,103	4,491	(N/A)	0.2
Cottonwood	2,651	499	452	2,849	13,467	19,917	(N/A)	0.9
European white birch	1,104	217	134	999	9,975	12,429	(N/A)	0.5
Hawthorn	131	28	15	54	2,049	2,276	(N/A)	0.1
Northern hackberry	307	41	23	387	4,865	5,624	(N/A)	0.2
Ohio buckeye	482	83	27	373	4,835	5,800	(N/A)	0.2
Tatar maple	94	20	7	38	1,591	1,749	(N/A)	0.1
Sweet mountain pine	280	35	-34	569	2,027	2,877	(N/A)	0.1
Pine	285	43	-2	698	2,726	3,750	(N/A)	0.2
Pear	57	10	3	64	553	687	(N/A)	0.0
Willow	515	97	95	586	2,293	3,586	(N/A)	0.2
Russian olive	197	36	44	105	1,065	1,446	(N/A)	0.1
White fir	161	28	-12	376	1,231	1,785	(N/A)	0.1
Common juniper	21	5	-14	210	438	660	(N/A)	0.0
Black walnut	150	29	17	135	1,370	1,701	(N/A)	0.1
Sumac	59	13	12	30	436	549	(N/A)	0.0
Juniper	6	1	-1	10	176	192	(N/A)	0.0
Douglas fir	151	22	-16	359	426	942	(N/A)	0.0
Black locust	206	35	42	246	555	1,084	(N/A)	0.0
Horsechestnut	45	9	6	55	318	433	(N/A)	0.0
AC SCHWEDL	0	0	0	0	0	0	(N/A)	0.0
Butternut	44	9	6	39	311	407	(N/A)	0.0
Western redcedar	28	5	-2	65	165	261	(N/A)	0.0
Citywide Total	230,555	45,416	32,072	222,719	1,797,704	2,328,466	(N/A)	100.0

Figure 4

Tree Infrastructure

Bozeman is fortunate to have an extensive urban forest offering numerous benefits. The current inventory is continuously being updated but only one-half complete; hence, approximately 21,000 trees are recorded in Bozeman’s municipally owned forest. This number does not include the wild trees growing along stream banks and on undeveloped city-owned properties.

Page 1 of 1

Bozeman										
Complete Population of Public Trees										
1/2/2015										
Species	DBH Class (in)									Total Standst Error
	0-3	3-6	6-12	12-18	18-24	24-30	30-36	36-42	> 42	
Broadleaf Deciduous Large (BDL)										
Ash	1,541	2,124	1,586	1,684	2,276	596	70	6	4	9,887 (±0)
Maple	1,256	892	878	256	148	136	56	22	18	3,662 (±0)
Littleleaf linden	480	394	170	24	2	2	0	0	0	1,072 (±0)
Honeylocust	428	342	134	16	4	4	0	0	0	928 (±0)
Elm	324	134	130	18	22	60	38	26	10	762 (±0)
Oak	264	132	22	2	2	4	2	0	0	428 (±0)
American basswood	98	176	110	24	8	8	0	0	0	424 (±0)
Cottonwood	8	6	18	34	24	8	8	2	8	116 (±0)
European white birch	24	14	32	18	10	0	0	0	0	98 (±0)
Northern hackberry	26	36	4	4	0	0	0	0	0	70 (±0)
Willow	2	0	6	4	2	2	4	0	2	22 (±0)
Black walnut	0	0	6	4	0	0	0	0	0	10 (±0)
Black locust	0	0	0	0	2	2	0	2	0	6 (±0)
Butternut	0	0	0	2	0	0	0	0	0	2 (±0)
Total	4,451	4,250	3,096	2,090	2,500	822	178	58	42	17,487 (±0)
Broadleaf Deciduous Medium (BDM)										
Quaking aspen	54	94	242	48	10	8	0	0	0	456 (±0)
Ohio buckeye	12	34	16	6	0	0	0	0	0	68 (±0)
Pear	10	10	4	0	0	0	0	0	0	24 (±0)
Horsechestnut	2	0	0	0	2	0	0	0	0	4 (±0)
Total	78	138	262	54	12	8	0	0	0	552 (±0)
Broadleaf Deciduous Small (BDS)										
European mountain ash	134	246	170	80	46	12	16	2	2	708 (±0)
Common chokecherry	134	300	174	20	2	2	0	0	0	632 (±0)
Cornbottle	106	148	140	20	8	6	0	0	0	428 (±0)
Japanese tree lilac	304	76	28	0	0	0	0	0	0	408 (±0)
Amar maple	34	56	98	22	0	0	0	0	0	210 (±0)
Plum	20	56	70	4	0	0	0	0	0	150 (±0)
Hawthorn	46	20	6	2	0	0	0	0	0	74 (±0)
Tatar maple	28	34	0	0	0	0	0	0	0	62 (±0)
Russian olive	0	2	6	8	2	2	0	0	0	20 (±0)
Sumac	0	2	2	4	0	0	0	0	0	8 (±0)
Total	806	940	694	160	58	22	16	2	2	2,700 (±0)
Conifer Evergreen Large (CEL)										
Spruce	2	6	28	50	44	28	6	2	0	166 (±0)
White fir	0	0	10	4	2	0	0	0	0	16 (±0)
Douglas fir	0	0	0	0	4	0	2	0	0	6 (±0)
Western redcedar	0	0	0	2	0	0	0	0	0	2 (±0)
Total	2	6	38	56	50	28	8	2	0	190 (±0)
Conifer Evergreen Medium (CEM)										
Pine	2	6	30	8	2	0	0	0	0	48 (±0)
Total	2	6	30	8	2	0	0	0	0	48 (±0)
Conifer Evergreen Small (CES)										
Sweet mountain pine	0	0	22	18	2	4	2	0	0	48 (±0)
Common juniper	0	2	6	0	4	4	0	0	0	16 (±0)
Juniper	2	4	0	0	0	0	0	0	0	6 (±0)
Total	2	6	28	18	6	8	2	0	0	70 (±0)
Grand Total	5,341	5,346	4,148	2,386	2,628	888	204	62	44	21,047 (±0)

Figure 5

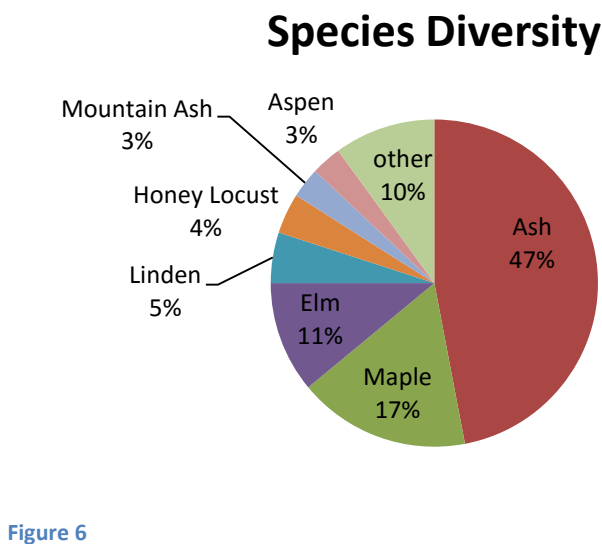
The urban forest is going to face increasing threats from climate change and invasive pests. Climate change will result in increased storm severity, heat and drought periods, lower temperature extremes, and changing weather patterns. These factors will exploit the weaknesses in the urban forest. Addressing the health of the urban forest is among the highest priorities for Bozeman.

Condition

In the past four years, the Urban Forestry Department provided maintenance on 3,805 trees. Out of 21,000 trees, this represents 5.5% of the population. The majority of Bozeman's community-owned forest has not been maintained, and the condition of the trees reflects this lack of management. Roughly 50% of Bozeman's community-owned forest is in good condition, but this figure is largely comprised of young trees that have a diameter of six inches or less, which represents almost half of Bozeman's public forest.

Species Diversity

The major weakness in Bozeman's urban forest is its lack of species diversity. In the downtown area, the urban forest is composed of approximately 75% ash trees. Citywide, ash trees make up 47% of the tree population. Bozeman's downtown streets, especially the through-streets, are dominated by ash. Church Avenue across from Bogart Park is entirely ash; Main Street, Willson, and Cleveland are marginally better.



Generally, recommended species diversity is to have no more than 30% of any family, 20% of any genus, and 10% of any species represent the total tree population. This may not be fully achievable in Bozeman; however the concept should be employed.

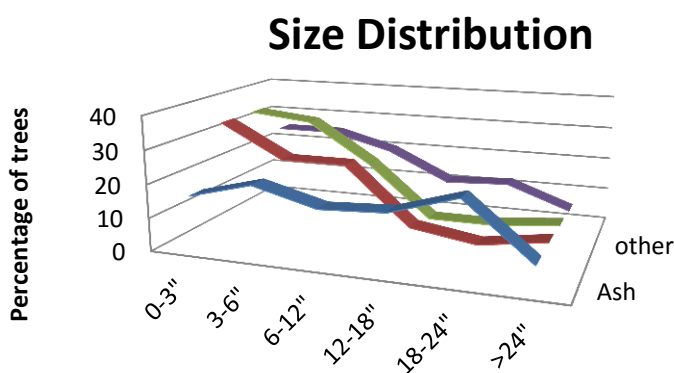
Species diversity is important to any plant population for the ecology to thrive. Monocultures harm the greater environment by inviting disease and depleting soil resources and diversification of symbiotic animal life. The same principles hold true when looking at the population of trees in an urban forest. When low species diversity is present, the tree population is especially vulnerable to insects and disease. If an insect or disease were to be introduced to an area and affected the dominant species of that area, it would devastate the tree population.

Unfortunately, this is the problem Bozeman faces, and it is particularly disturbing in light of the looming Emerald Ash Borer (EAB). Emerald Ash Borer is an invasive species that infests any *Fraxinus* (ash) species. This pest will eventually kill every ash tree left untreated in Bozeman. The EAB Course of Action Plan is to be used in conjunction with this plan, and for that reason this UFMP plan will not go into great detail on matters of EAB. As the EAB Course of Action Plan is carried out, species diversity goals will be addressed by the strategic reduction of the ash tree population.

Age Diversity

Age diversity is another indicator of urban forest health and uses similar-sized trees of a particular species for comparison against the total tree population.

With principles similar to species diversity, no more than 33% of one age class (young, medium, or old) should comprise the urban forest. This rule provides a basic resource structure so a younger age class is always ready to replace the older age classes.



	0-3"	3-6"	6-12"	12-18"	18-24"	>24"
Ash	16	21	16	17	23	7
Maple	34	24	24	7	4	7
other	34	32	20	4	4	6
City wide total	25	25	20	11	12	5

Because of a strong tree planting program, Bozeman has a relatively young urban forest.

Figure 7

It is important that when an older tree dies, a younger tree is planted in its place. When an older tree is removed, there is a significant loss of benefits, as a large tree provides three to eight times the benefits that a small tree provides (Rogers, 2011). In light of this, Bozeman should continue its tree planting program in order to build canopy cover and replace the aging ash trees.

Percent of Species that are >12"

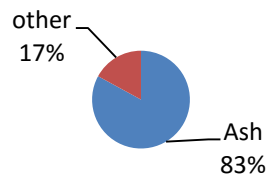


Figure 8

Age and Size Diversity Analyzed

Age and size distribution are important statistics and reveal useful information regarding Bozeman's urban forest:

- The city-wide total age distribution is fairly in line with where it should be. However, when interpreting the graph, it shows some concerning factors, especially when compared to the species diversity graph (Figure 8). The vast majority of the mature trees are in the downtown area, reflected in the blue ash line. This means 83% of Bozeman's mature trees are ash, leaving Bozeman in a very tenuous position considering EAB.
- When the ash trees are not considered, or the downtown area is taken out, Bozeman has far

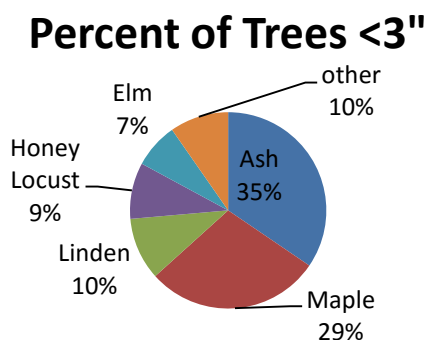


Figure 9

more young trees than old. This points to a young, growing forest,

and it would be good if the species being planted were diverse and appropriate. However, "Percent of Trees <3 inches" shows otherwise.

- Many of the new plantings are in the newer developments and subdivisions, reflected in the city-wide total line. When looking at species and size diversity graphs, ash trees still are the majority of new trees planted.

This information depicts what species of trees to plant as well as what not to plant. It is likely that public education would be very useful in conveying the liability of planting too many of any one species, especially ash. Using the 30-20-10 species diversity rule should be the goal. In the downtown area, the urban forest's age class is heavily weighted to mature trees. It is important to plant new trees as well as facilitate good growing conditions for the established young trees. Planting new trees most likely means locating planting spots and also pushing to remove decrepit ash, thus making way for the new generation.

Plant trees for function and performance. A large tree with a broad-leaved canopy offers more benefits over time. These trees can reach heights of 60 feet and life spans of 100 years, and planting should be encouraged where root and canopy space is adequate. Small, ornamental trees that require less growing space are a wise choice where root development or overhead constraints exist.

Increasing the Canopy Cover in Bozeman

Planting new trees with species diversity in mind is just one way to address overall urban forest health. Consistently planting trees over time addresses age diversity, while planting more trees increases canopy cover.

Canopy cover refers to the amount of land area covered by tree crowns, as viewed from the air. This figure can also describe improvements toward quality of life. For example, a tree with a large canopy in a park setting improves the park's quality because it provides an ideal spot to have a picnic or sit while taking a rest from summer activities. Similarly, trees over streets and sidewalks reduce frequency of resurfacing streets and offer cooler temperatures in the vehicles parked under them. The extent of community tree canopy cover is a good indicator of urban forest sustainability (Clark et al., 1997).

Currently between 7% and 9% of Bozeman is under the canopy of publicly owned trees. Bozeman would greatly benefit from increasing this number, or even doubling it. The ways to increase canopy cover are to plant more trees and protect the trees in the ground. Planting more trees can happen with community support, education, and citizen involvement. Also, enforcing city ordinances for planting requirements will increase the number of trees planted. Moreover, updating ordinances for new developments to have a plan to achieve a 33% canopy cover in 15 years will help address the goal of increasing canopy cover.

The second way to increase canopy cover is to protect the trees already in the ground so they can thrive. It is important to enforce ordinances regulating who can work on public trees. Bozeman does a good job of this. Furthermore, educating the public on reasons why they should protect their own trees is important. Street tree stand age—meaning the age of a particular generation of trees—is typically 20 to 60 years (Maco, McPherson, 2002). Thus, maintaining a consistent maximized canopy cover can be difficult because a stand will maximize its canopy and then decline. If trees in poor condition or problem trees are removed and replaced with trees that have appropriate mature canopy attributes for their location, a consistent canopy cover can be achieved.

One possible option to strengthen the tree planting program is to develop and utilize city-run tree lots or nurseries. The city has a nursery in the cemetery, and cost savings can be achieved to make greater use of this and encourage neighborhoods to start their own nurseries in common spaces. These programs can be very cost-efficient.

A greater partnership and relationship can be formed with our local nurseries to accomplish the goal of a more species-diverse urban forest. Also, the city can be a greater resource to residents looking to plant trees on their property. The city's cost-share and voucher programs have been popular, and these are an easy avenue for educating people. These programs can be expanded to plant more trees and should focus on trying a wider variety of species. Planting a new generation

of trees is an essential element of the Bozeman UFMP and is explored in detail later in this report under “Community Engagement.”

Tree Infrastructure Recommendations and Expected Outcomes

The following table states the primary issues needing attention, makes a variety of recommendations, and provides expected outcomes. The outcomes can be used as checks to evaluate if the recommendations are providing the desired outcomes. The issues are all considered important; therefore no particular order is provided.

Issue	Recommendation	Expected outcome
Structuring and strengthening City’s Urban Forestry Department	<ul style="list-style-type: none"> -Create a superintendent of forestry division/urban forester position within city hierarchy. -Partner with other management plans, such as sustainable transportation, water conservation. -Support the use of contracted arborists for initial aid to bring tree maintenance cycle up to speed, and as first responders after storms. 	<ul style="list-style-type: none"> -Improved management, planning, and oversight for the urban forest -Internal cross-program support -Higher level of tree care and consistent approach to tree maintenance
Age diversity	<ul style="list-style-type: none"> -Educate public as to the value of mature shade trees. -Implement tree protection strategies, such as requiring site plans for building permits and enact measures to prevent or minimize damage. -Use Montana’s Big Tree Program as a way to increase awareness of heritage trees. -Structure tree planting program around species diversity . -Use “Right Tree, Right Place” model as tool for public education. 	<ul style="list-style-type: none"> -Sustainable, healthy urban forest -Increased public awareness
Species Diversity	<ul style="list-style-type: none"> -Equip local nurseries with information on recommended planting species. -Educate public on EAB and appropriate species to plant. 	<ul style="list-style-type: none"> -Sustainable, healthy urban forest -Higher resilience from threats to the urban forest
Increase number of new plantings	<ul style="list-style-type: none"> -Enforce ordinances for planting street trees, especially in newer neighborhoods and for developers. -Maximize the amount of “plantable” space in new developments. -Update ordinances for new developments with impervious surfaces to have a plan implemented to achieve 33% canopy cover over 15 years. 	<ul style="list-style-type: none"> -Sustainable, healthy urban forest -A more robust urban forest with a better-educated public investing in it -Cost-effective

	<ul style="list-style-type: none"> -Incorporate planting trees into capital improvement programs, street and sidewalk improvements, and other city infrastructure projects. -Develop educational materials on the benefits of urban trees and disperse them to neighborhood meetings and in the community. -Explore new methods such as gravel bed plantings for tree-growing sites, community and volunteer-run nurseries, etc. -Expand tree voucher and cost-share programs and awareness of these programs. -Explore cost-share programs for schools and nonprofits planting anywhere on their property. -Work with utility companies to offer tree replacement programs. 	<p>measures implemented</p> <ul style="list-style-type: none"> -Increased canopy cover -Trees better-adapted to local climate
Preserving mature trees	<ul style="list-style-type: none"> -Support ordinance specification on who can work on city trees. -Develop ordinances on who can work on private trees. -Educate the public on the value of urban trees. -Create a heritage tree program to increase awareness for legacy trees. 	<ul style="list-style-type: none"> -Increased age diversity -Improved tree protection and preservation
Sustainability and utilization	<ul style="list-style-type: none"> -Explore urban wood use opportunities, i.e. use wood chips produced by tree service activities to mulch trees. -Bring logs from non-diseased or uninfested removals to a yard where the public can have access to them. 	<ul style="list-style-type: none"> -Increased public relations -Decreased wood waste

Management of Urban Forest

Once the city understands the overall composition and condition of the urban forest in relation to its population, it can then decide how to best manage the resource. This is an important component of the Urban Forestry Department because it:

- Keeps the citizenry safe
- Creates a healthier tree population
- Models proper tree care
- Is one of the areas where cost efficiency is a premium and investing wisely is a priority

Current Management

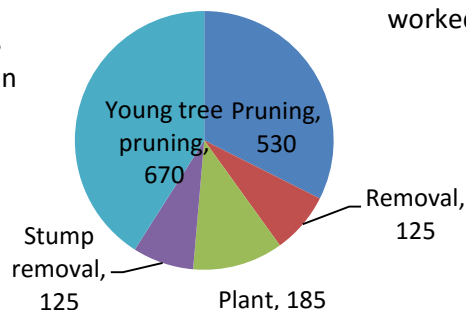
The current Urban Forestry Department in Bozeman has four full-time staff. The department is responsible for the care of all trees on the city’s land. This includes pruning, removal, storm cleanup, and responding to maintenance calls from the public. The department is also responsible for integrating the urban forest into city planning and growing the urban forest. It is the responsibility of the Urban Forestry Department to do community outreach and education.

Completed Maintenance per Year

4 Arborists performing this work

On this schedule Bozeman's trees are on a 13 year pruning rotation.

Each arborist worked on



Planting on city ground can be done by anyone who is following city ordinances. The Urban

Figure 10

Forestry Department does plant trees and is responsible for planting projects on reconstructed roads or new roads. The department plants all of the “Cost Share” trees.

The Urban Forestry Department has not grown at the same rate as the city. Since 2005, the city has employed four arborists. Two arborists were hired in 1998, one in 2005 and one prior to 1998. In

Population and Size of Forestry Division

September of 2014, the head of the department (equivalent to the City Forester) retired, and subsequently one of the seasonal tree workers was hired full-time. Under the current structure, the department’s head is

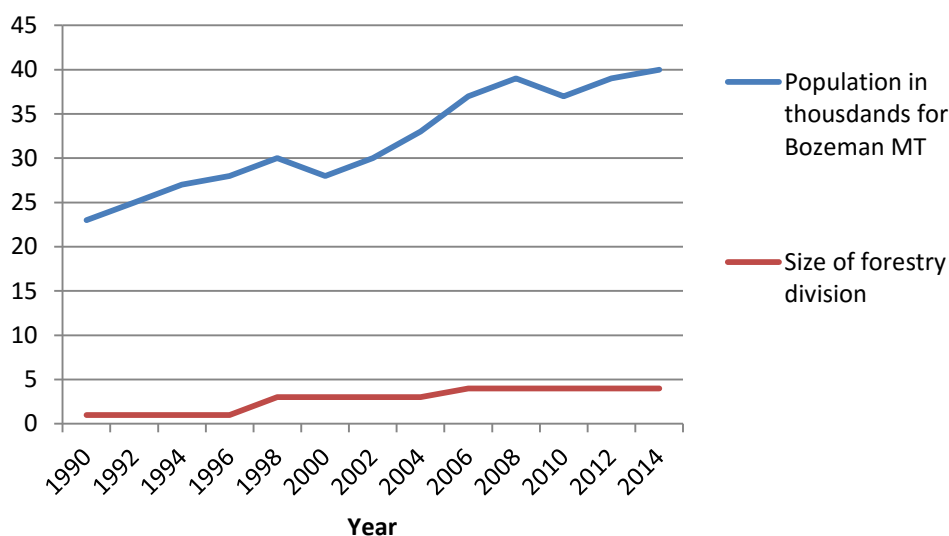


Figure 11

effectively the “crew boss,” although their title is Urban Forester. The department is under the governance of Parks and Recreation. Strategic planning for the Urban Forestry Department, municipal forest, and personnel management is executed by the head of Parks and Recreation.

Management of the community forest in Bozeman has been on a reactionary basis. The department is bogged down with service calls and trees that have broken or hazardous branches.

Homeowners and private tree care companies maintain the privately owned urban forest. Currently the only requirement

for a business to work on trees in city limits is to have a business license.

A tree board exists in Bozeman and is active. The board was formed in 1992 and formally adopted into city code in 1993. The board meets a minimum of quarterly and a maximum of monthly. It discusses recent matters concerning the urban forest and plays a role in developing policy. The board has a wide range of talents and experience and a deep pool of knowledge.

Analysis of Current Management

The Urban Forestry Department does quality work but lacks in efficiency and public perception. This is largely because it has suffered from lack of direction and the department’s growth has not kept pace with the growth of Bozeman as a community. The optimal pruning cycle is 5-7 years. With the current pace, a tree will only be pruned every 13 years. Managing the municipal forest on a reactionary basis is often a challenge and ultimately unsustainable. Often the department is pulled from preventative maintenance work to respond to individual issues, creating an ever-increasing backlog in work.

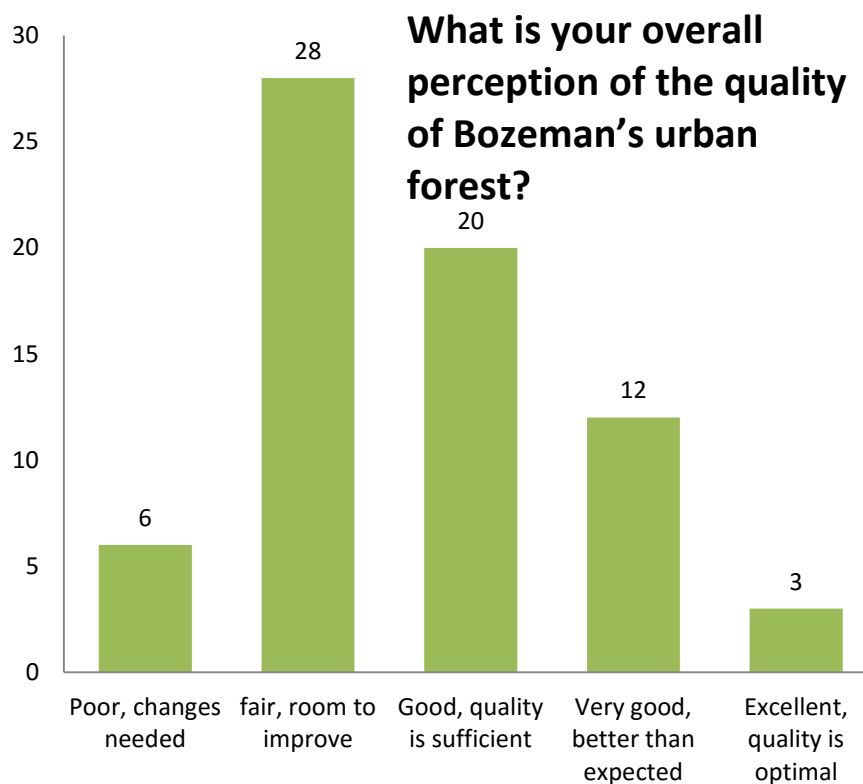


Figure 12

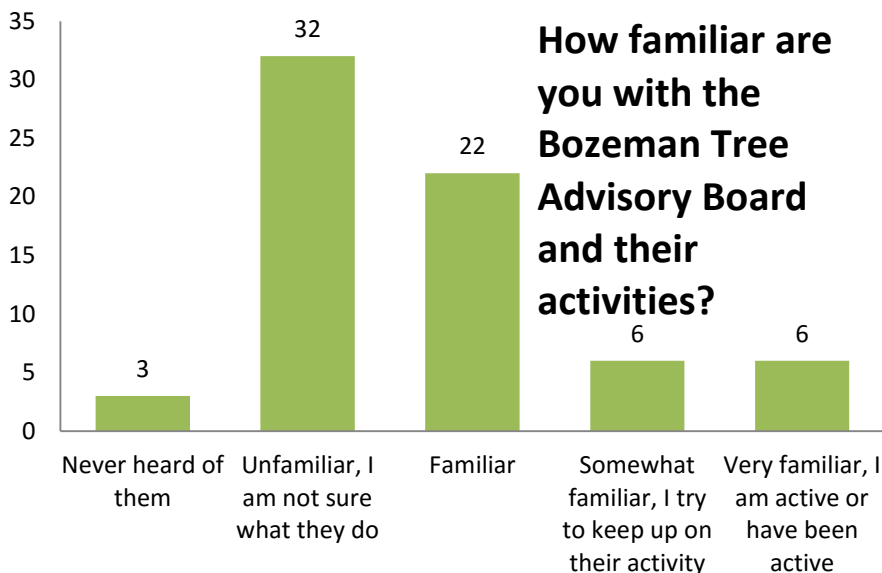
The department does not currently have the capacity to proactively manage the urban forest. This is concerning from multiple standpoints:

- An increased level of liability exists from unmaintained trees.
- The trees are more susceptible to storm damage, having excessive limb load.
- The department will be ill-adapted to deal with unplanned events, such as disease or infestations.
- The department will be unable deal with foreseeable events, such as Emerald Ash Borer.

The Urban Forestry Department in Bozeman is well established within the city system of government, and this relationship is beneficial. Municipal trees in the ground are rarely disturbed without consulting the department. Generally, the same is true for the public disturbing municipal trees. For the public to work on a municipal tree, the head of the department must be notified, the head must approve the tree work, and the person performing the work must be a certified arborist as per the ANSI Standards and the International Society of Arboriculture. This system has benefited the municipal forest.

The director of Parks and Recreation is assuming the role of implementing policy, vision, and personnel management for the forestry department. The director’s time and talents are not efficiently used when meeting with municipal arborists in matters concerning the management of the department; this creates a loss of efficiency for the city.

Bozeman’s ordinances concerning trees are adequate. However, because they are largely not enforced, they don’t provide protection or help the urban forest grow the way they potentially could. The current enforcement mechanism in Bozeman has the code enforcement officer issuing citations for violations or lack of action. This mechanism has the potential to work; however, there is a lack of communication with



the point person in the Urban Forestry Department

detecting violations and fielding information from the public.

Currently, the Tree Advisory Board is revising the street tree-planting guide. The board does great work but is probably underutilized. This is a willing group of people that could be doing more to serve the urban forest with minimal direction or better utilization.

Preferred Management

Management of the department encompasses much more than instructing the crews on what trees will be pruned each week. To implement the vision, goals, and objectives laid out in this plan, it is recommended that a manager/superintendent (urban forester) position be created and filled in the Urban Forestry Department. By doing this, the level of care of the public and private urban forest will increase, as will the community support, creating a positive feedback loop. This “urban forest Manager” is a professional experienced in all aspects of arboriculture, providing a broad managerial view and responsibilities to help the staff, city officials, and citizens get the most for their investment in trees (Urban Forestry Best Management Practices for Public Works Managers: Staffing, 2006).

Superintendent of the Forestry Department Position

The urban forest is considered part of the city’s core infrastructure. One of the high-priority recommendations from this plan would be creating a superintendent of the forestry department position as soon as possible. This position is synonymous with what could also be called an urban forester. The “superintendent of the forestry department” terminology is used to fit into the existing Bozeman city job titling, and if possible, using the urban forester title would be preferred as it is easily recognizable throughout municipal organizations. An urban forester is necessary to execute many of the cost-saving elements and the community engagement movement. The urban forester should be a part of any decision that is made affecting the city’s infrastructure. This includes decisions in planning, utilities, architecture, and development from the beginning of planning processes. This person should see the urban forest from a 30,000-ft. view, rather a 55-ft. view from the inside of the bucket truck. With a strong leader and advocate, the community forest will become more of a solution for many community problems. Public awareness of the urban forest can become of equal importance and provide social benefits on par with transportation, services for the under-served, and other important growth concerns particular to Bozeman.

A point person that manages the department will be able to stay abreast of the latest technology developments. Many improvements have been made in recent years for efficiently managing the urban forest with inventories, strategic planting, and modeling. Implementing these technologies will make the department more efficient and the forest more sustainable. The department will also be able to better maximize the benefits of a well-planned community forest.

Finding and hiring the correct person for the urban forester position will be an important, and relatively easy, task to accomplish. When conducting the search, the Department of Natural

Resources & Conservation, International Society of Arboriculture, and the American Society of Consulting Arborists have resources to assist in recruitment. It is also very possible the right person exists in the department or lives in Bozeman.

The benefits of this option include (Urban Forestry Best Management Practices, 2006):

- Deepen ties with the community
- Build institutional knowledge
- Someone who is always available, more flexible for other work assignments, and can respond to emergencies
- Someone who is directly responsible to citizens and their department
- Quality will improve over time with training to meet community standards
- Workforce is more stable
- Workforce is motivated by pride and residency and is knowledgeable about the community
- More control over training and specializations
- Less administrative time needed to write and oversee contracts
- It will liberate the municipal arborists to do their work, instead of defining their own roles in the department

Maintaining Public Trees

Inventory

Bozeman has a half-completed inventory and completing this inventory is an important step in maintaining public trees. Keeping track of maintenance performed on trees is important for managing the population but also for liability reasons. Knowing the locations of all the trees, especially the ash trees, is important for planning for EAB and implementing the EAB Course of Action Plan. It is also important to know to location of available planting spots for the new generation of trees. The inventory will help save our mature tree population and save the city millions of dollars in management costs. As detailed in the EAB plan, the city will proactively manage ash trees in a systematic manner. Knowing the locations of these trees, which ones have been treated, and which ones need treatment will be of the utmost importance. Having a completed inventory prior to the arrival of EAB is essential. Potentially, time is not on Bozeman's side.

Proactive pruning cycle

Setting trees up on a five- to seven-year pruning rotation will increase the benefits offered by the urban forest and reflect positively on the city. Proactively maintaining the trees will reduce the workload of maintenance calls and decrease the amount of storm damage that occurs almost yearly in Bozeman. Proactively maintaining the community forest is one of the essential

elements of this plan. By implementing this element, Bozeman is enacting a cost-effective measure that maximizes the benefits of the urban forest. When not performing timely tree maintenance on trees, an opportunity is lost in benefits received. (Hauer, 2015)

Upon planting a tree, the cost of maintaining that tree initially outweighs the benefits received from the tree. In addition to planting costs, watering and pruning the tree for good branch structure after establishment are also costs. However, ensuring proper form and structure when trees are small is less expensive than large-scale pruning when they mature. Such neglect results in an even higher cost of either replacing a dead tree or long-term maintenance restoration pruning after storm damage or due to general weak branch attachments (Gilman, 2001).

Once the tree is mature, proactively maintaining trees on a five- to seven-year pruning rotation becomes less costly than reactive (i.e. crisis) maintenance (Hauer, 2015). The trees will still offer benefits, but with regular pruning more benefits will be realized and fewer maintenance costs will be experienced. A lack of regular maintenance results in a shorter lifespan of the tree. It also creates higher maintenance costs due to increased storm damage, debris, pests, and branches blocking intersections or roads. This concept is similar to changing the oil in a car. The car will still run without proper maintenance for a while, but in the end regular servicing will result in a lower cost by avoiding a major breakdown.

When considering this concept, an inverse relationship exists between maintenance costs and return on investment. The more trees are maintained, the lower the cost. Also, the more often trees are maintained, the higher the amount of benefits provided by the trees, thus a higher rate of return. The optimal pruning cycle for trees is four to five years (Miller, 1981). In Bozeman, the optimal time is pushed back because of the slightly shorter growing season. The optimal pruning cycle is where the cost of maintaining the trees intersects with the return on investment.

The investment in pruning trees on a five-year pruning rotation yielded a \$1.47 to \$1.69 return on the costs of pruning the trees. Moreover, every dollar deferred in pruning costs yielded a two-fold increase in maintenance costs (Browning, 1997). When Bozeman is considering EAB, the costs of managing an infestation is greatly reduced by having a healthier ash tree population.

Currently, Bozeman's Urban Forestry Department is not adequately staffed to proactively maintain the community forest, and hiring additional arborists or contracting out pruning/removals is recommended.

The City of Bozeman owns approximately 21,000 trees, based on the trees inventoried thus far. A program to maintain the trees the city currently owns is a priority and should be implemented before new tree planning takes place. Using the work history of Bozeman's four arborists for the past four years, it would take a total of 13 arborists to accomplish the goal of pruning the municipal trees on a seven-year pruning rotation. Hiring nine arborists is not realistic in Bozeman, so efficiency must increase as well as management. Bozeman can accomplish the goal of responsibly maintaining its trees within a realistic budget by first hiring a superintendent for

the Urban Forestry Department. This position will hold city arborists accountable for performance and systematically implement pruning schedules. Additionally, the city should consider ways to reach the recommended seven-year pruning cycle. The following alternatives recommend either hiring two arborists in addition to the existing four or contracting out pruning and removal. The following breakdown will articulate the changes to the department needed to accomplish a proactive management.

Alternative 1: Hiring two additional arborists

Number of trees	Number of trees to be pruned each year on a 5- 7 year rotation	Number of trees each arborist will work on each year	Number of additional arborists	Cost approximation
21,047	4,209 - 3,007	702 - 502	2	\$120,000/year*

*Wages are \$30,000/year/arborist. Wages are doubled to account for benefits, taxes and insurance.

For hiring two additional arborists, these figures double the number of trees each arborist will work on each day compared to the past four years. However, it is still very reasonable, and only two additional arborists are hired. These figures only assume the arborists are working 100 days per year. At 20 work days per month, this is five months of pruning trees. The department still has seven months to not work on extremely cold days, hang Christmas lights, chip Christmas trees, shovel snow from sidewalks, and other activities with which the forestry department is currently tasked.

Proactive management can also be achieved by using the same allocated funds to contract out the tree maintenance. Pros and cons are highlighted later on in this report. In either management approach, hiring an urban forester is still recommended in order to wisely execute the actions. The numbers given here assume the same work performance from the four existing municipal arborists.

Alternative 2: Contracting out maintenance

Number of trees	Number of trees to be pruned each year on a 5-7 year rotation	Number of trees to be pruned each year in house for 5-7 years	Number of trees to be contracted out every year for 5-7 years	Cost to be allocated for contract work
21,047	4,209 - 3,007	2,808 - 2,007	1,401 – 1,000	\$120,000/year

By implementing a proactive pruning schedule, the department will set the number of trees to be pruned. At the end of the year, the department will assess and review its goal number of trees to be pruned and gauge the level of success. This unbiased number will represent the potential performance and efficiency of the department and thus provide measurable reports to the city commissioners and public who have invested in the department. This yearly work plan will include all tree-related activities for street and park trees, including tree planting, maintenance/pruning, tree replacement, inspections, and tree removals.

Alternative 3: Catch-up period

A third and less-sustainable alternative would be to contract the pruning and removals of all publicly owned trees, accomplishing this task in two to three years. After all of the tree work in Bozeman has been executed, in theory, the Bozeman Urban Forestry Department would then be able to keep up with tree work. A superintendent position would still be needed to manage a sustainable urban forest, as articulated in “Community Engagement.” This option is only short-term and would not likely address the long-term care and needs of the urban forest. Once the work is completed, Bozeman would have spent a lot of money and would still have an urban forest with poor species diversity. They would lack the ability to move forward with planting new trees because resources were allocated to maintenance, most likely at the expense of creating a sustainable, holistic urban forest.

Number of trees	Number of trees to be pruned each year for 2.5 years*	Number of trees to be pruned in house each year for 2.5 years	Number of trees to be contracted out each year for 2.5 years	Cost at \$150/tree/year
21,047	8,419	2,500	5,919	\$887,850/year

*Alternative 3. This expenditure only is in place for 2-3 years while the first two alternatives are yearly costs.

After this “catch up” period has been executed, Bozeman can then address hiring two additional arborists or contracting out work as needed.

The Urban Forestry Department is quite competent as to tree care activities, and this report will not discuss this aspect or what a tree needs to be correctly maintained. Rather, it will explore areas where greater efficiencies can be made.

Tree pruning should be done year round. Of course, on particularly cold or snowy days, working on trees is not productive. Pruning trees in the winter offers many benefits, such as being able to better see branch structure and minimizing damage to the tree since it is dormant.

Ensuring that trees with a caliper less than 6 inches receive special attention for structural pruning will save considerable resources over time. When pruning a young tree, many long-term benefits are realized by eliminating potential weak branch attachments, rubbing or crossing branches, removing co-dominant leaders, or improving the general shape of the canopy. On

young trees this task can take only 10 minutes while a large tree can take much longer and is more expensive. Trees should not be pruned at planting except for dead, damaged branches or serious structure problems. It is appropriate to prune for structure after the tree has established itself for a year. By doing this, the tree will have much less liability and experience less storm damage when it reaches maturity.

Removals

Removing trees that are in poor condition or poor locations is a part of proactively managing the community forest. Keeping current on the removal schedule is an essential element of this plan because it plays a crucial role in preparing for EAB. When EAB arrives, the removal schedule of ash trees in poor condition or bad locations is enacted, as outlined in the EAB Course of Action Plan. Thus, reducing that workload in advance will help the city tremendously. Currently there are 78 trees slated to be removed this year and another 300 mature ash trees in poor condition, according to the half-completed inventory. This plan does not recommend increasing a line-item budget for removals, but it does recommend increasing the number of removals on a yearly basis by increasing efficiencies produced by creating the urban forester position. The department will get its crew boss arborist back to managing the crew, where their talents are suited, and doing what their job description states. In effect, the department will be doing much more in relation to what investments have been made.

Planting

Planting trees reflects well on a forestry department and creates a positive public perception. Planting a new generation of trees is an essential element of this plan. How to most efficiently execute this element is described in “Community Engagement,” p. 48. Choosing the right tree for the right place is an important consideration when planting, especially with street trees. It is important to remember that planting a large tree can deliver as much as eight times the value of a small growing tree or a medium stature tree. On Bozeman streets and in parks, it is important to understand the site, how the tree will be maintained, and then select the right tree. The following are considerations for choosing trees at specific locations (Clark and Matheny, 2008):

- Available growing space—above ground (horizontal and vertical), below ground (soil volume), and ground level (distance to pavement)
- Light—daily and seasonal
- Wind—daily and seasonal
- Soil—structure and texture, drainage, pH, chemistry
- Surface cover—turf, mulch, herbaceous or woody plants
- Irrigation—quality and quantity
- Management—pest control
- Use—litter, canopy (above street)

On downtown roads such as Main Street, where much of the surface is impervious, trees have a shorter lifespan due to compaction, lack of water, and restricted root growth. If these streets were to be redone or upgraded, installing acceptable planting space for trees is advisable. (See greater detail in Appendix 2.)

Another way to encourage root growth in paved areas is to implement the use of pervious pavements (Volder et al. 2009; Morgenroth and Visser, 2011; Mullaney and Lucke, 2014). These pervious pavements make stormwater and oxygen available to the soils and tree roots. This approach is greatly beneficial to tree growth but also reduces stormwater runoff.

Planting trees in residential parts of the city, especially in new neighborhoods, also needs to be addressed. These trees are of equal priority, and resources should be allocated appropriately. Trees planted in neighborhood areas will be greatly valued by the residents, and in turn they would provide care. These areas have many families that will benefit from more urban trees, and many times these trees are less susceptible to vandalism and damage. Public perception of the Urban Forestry Department will be higher because the residents, many of whom are invested in their communities and neighborhoods, will see the direct benefits of municipal investment.

The residents in these areas should utilize the tree voucher and cost-share programs. These trees have greater survival rates because the residents have an invested interest in seeing the trees reach maturity. When a tree is removed, having a plan for its replacement should be a part of the removal process. This can be as simple as enforcing ordinances or alerting the homeowner of the tree voucher or cost-share programs.

Detection

Detection and monitoring for invasive species or disease is



Bouldercolorado.gov

an essential element of this plan. One invasive species of particular concern is Emerald Ash Borer (EAB). Detecting the arrival of EAB as early as possible is very



important. EAB traps are installed

in ash trees to detect and monitor the infestation. The use of traps may help Bozeman detect EAB very early in its arrival, which would give better chances to manage and contain the infestation. If EAB is detected early, more trees could be saved, which could potentially save the city millions of dollars. Additionally, a technique called “destructive branch sampling,” is another effective detection method. This method is currently being used by the Urban Forestry Department and should be continued. The Bozeman EAB Community Response Plan provides more detail on management and monitoring techniques.

The superintendent of the Urban Forestry Department should be designated as a reliable and qualified resource for the community, serving as a primary contact for suspected EAB reports. This will establish a consistent protocol. This person will coordinate with Montana State University's detection efforts, neighboring communities like Belgrade, and any other significant landowners in the Gallatin Valley monitoring for EAB. The importance of a diligent and consistent monitoring effort cannot be understated. Upon detection, the response plan detailed in the EAB Course of Action Plan can be implemented immediately.

Contracting Work

On certain projects, Bozeman may consider contracting out work. Contracting out this work has certain advantages, as detailed below:

- Cost savings. In many cases, private tree care, for even very big cities, can be less expensive.
- Funds are paid only if work is performed to specifications and satisfaction.
- Labor is performed for peak demands.
- Contractor provides all equipment, repair, maintenance, and downtime costs.
- Insurance and workman's compensation is provided by the contractor.
- Contractor provides all training, supervision, and certifications.
- Liability for damages is the contractor's responsibility.

Contractors can be used as a complement towards operations in municipal tree care. There are reputable tree services in Bozeman with certified arborists that are capable of performing any project the city might have. This approach may be useful upon the arrival of EAB and when planned removals are a priority. Also, it may be cost efficient to contract out for bulk pricing the treatment of trees for EAB. In such a scenario, it is possible a tree service in Bozeman would donate its service to support the department and the urban forest.

According to the booklet titled "Urban Forestry Best Management Practices for Public Works Managers: Staffing," often a combination of using both in-house personnel and contractors is chosen to ensure that the urban forest management services provided are performed at the lowest possible cost, as efficiently as possible, and with the greatest level of expertise. Upon using a contractor, it is important to ensure they are qualified and maintain proper certifications, such as having an ISA Certified Arborist or similar credentials on staff. To verify ISA Certification, go to <http://www.isa-arbor.com/>.

At a Bozeman public meeting during plan development, discussion arose about shifting the pruning and removals from the Bozeman Urban Forestry Department to contract work. This option arises from a few public members who feel the urban forest has not been maintained to a

level of their satisfaction. While understandable, this option cannot be relied upon solely to maintain public trees because it does not manage the public forest. It merely puts a Band-Aid on a problem, is shortsighted, not cost effective, and does not maximize the benefits of urban trees. This plan outlines the most cost-effective way to create a sustainable, healthy, and holistic urban forest; and to do that, the superintendent position in the forestry department must be created. The superintendent/urban forester position will increase efficiency within the department and contract out work when deemed appropriate. Bozeman’s urban forest can eventually reach a proactive five- to seven-year pruning rotation. Contracting out work should be kept as a management option when the superintendent determines it’s necessary and/or cost effective.

Maintaining Private Trees

As the level of care of the public trees increases in Bozeman, the private tree care will, in turn, rise. This is because the city will be modeling good tree care and the private property owners will be educated through this. Also inevitably, with the implementation of this plan, the Urban Forestry Department will have a greater influence on the community, and the citizenry will be more educated as to the benefits of a healthy urban forest.

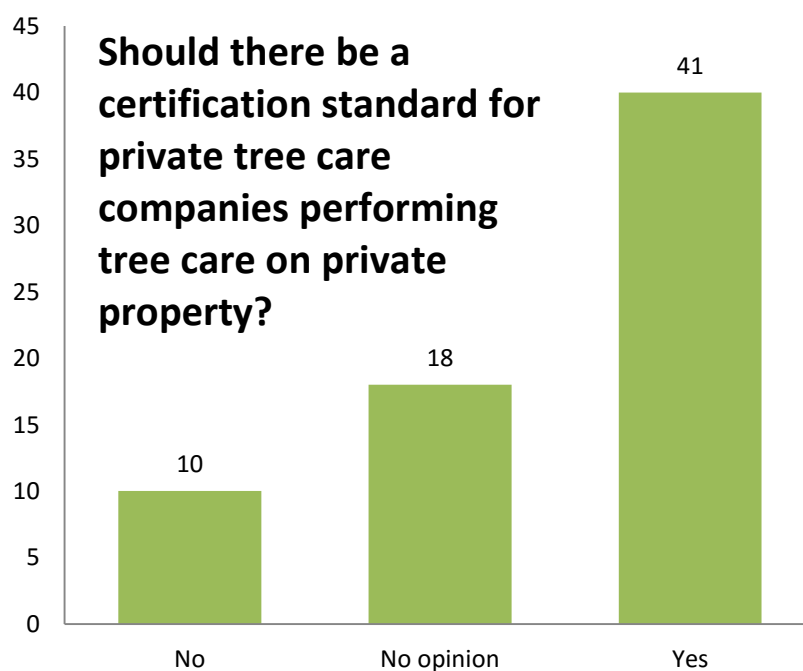


Figure 14

The only recommendation this report makes as to the care of private trees is that anyone hired to work on trees—private or public, within the city limits—be a certified arborist or tree worker. If a private company is hired to perform tree work, the arborist working for the company must maintain a minimum set of credentials. A large majority of survey respondents indicated they wanted this, as it will raise the level of care in the entire urban forest.

Bozeman Public Schools

An area for opportunity for the city is to work more closely with Bozeman Public School District (BSD). The public schools in Bozeman have their own jurisdiction as to



Figure 14 2015 Arbor Day event at Bozeman Public Library

tree care, and the city is not responsible for the planting or maintenance of trees on school property. Trees are priority for BSD and they have a maintenance fund for trees. Bozeman School District has additional concerns when planning trees on their property, such as not blocking line of sight and raised crown heights. However, BSD still has a reliance on the city to lead and instruct on best management practices and appropriate species to plant. The city relies on BSD to provide continuity to the urban forest. For example, if the city has tree-lined streets with large canopy trees and an adjacent school property has no trees or smaller-stature trees, there is an opportunity to work with the school on planting suitable trees. The city has an invested interest in a strong working relationship with BSD, to provide expert counsel and possibly provide resources for additional plantings. Partnering with the schools will improve relationships and strengthen the ties to the community. This is a natural fit for incorporating an urban forest curriculum into the schools. For example, the city could offer presentations and information to science classes or perhaps donate removed hardwood trees for use in woodshop classes and in turn receive products such as benches to display in local parks.

Budget/Funding

Additional funding will be required to implement many of the recommendations in this report. Budget increases will allow for the addition of the superintendent position in the Urban Forestry Department and the implementation of a proactive management approach.

Investment	Estimated expenditure salary
Superintendent of the Forestry Department (Urban Forester)	\$50,000-\$65,000

Arborists (2) or contract out pruning and removal work	\$30,000 X 2 or \$60,000
--	--------------------------

The Bozeman Urban Forestry Department’s budget is approximately \$450,000 per year. A modest 30% increase of \$135,000 per year and corresponding tree assessment is recommended to implement the Bozeman UFMP. Currently, the average city lot is assessed around \$16 per year to maintain the public trees. The recommendation is to raise the assessment by approximately \$5 per year. This new assessment is comparable to other Montana communities, such as Helena and Billings.

A level of funding exists where an acceptable level of investment in the urban forest is made and it maximizes the benefits. “Cost-efficiency in relation to benefits provided can make a difference. Maintaining program funding is intimately tied to demonstrating the importance of the urban forest to the health, safety, and economic vitality of the community, and the effectiveness of the program in providing those goods and services” (Matheny, Clark 2008).

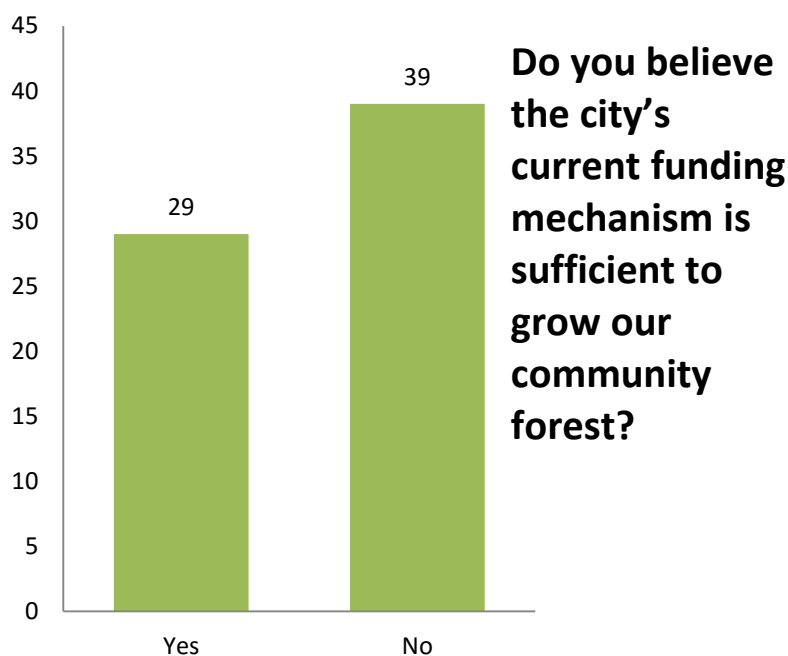


Figure 15

Additional ways to implement funding for community trees include (Urban Forestry Best Management Practice, 2006):

- Grants. Grants play an important role in funding the current street tree-planting program and will continue to do so in the future. The superintendent/urban forester can help apply for and acquire grants. However these are not static sources of funding and cannot be solely relied upon to support a local urban forestry program.
- Taxes, special assessments and tax districts
- Capital improvement project funds
- Tree work permits, development and inspection fees. When a development occurs with private business or developers, the urban forest goals should be considered and fees assessed appropriately.

- Compensatory payments when a public tree is damaged by a car or by construction activity
- Utility bill donations. Residents could be encouraged to fund tree programs by rounding up their utility bill or voluntarily adding a small fixed amount, such as 50 cents, to each bill.
- Mill levy(s)
- Gas tax
- Partnerships with utilities
- Community groups
- Corporate and local business donations and sponsorships

Risk Management

Risk Management is defined as follows: “Risk is simply a measurement of potential of deviation of an expected outcome, and the consequence of this deviation may either be good (resulting in opportunity) or bad (resulting in loss). The process of dealing with this uncertainty and trying to achieve the best outcome ... in a changing environment is the essence of risk management” (Reiss, 2004).

There is an inherent risk with all trees. We choose to live among trees because their benefits far outweigh their potential risk if managed appropriately (Rogers, 2011). Controlling risk can be articulated in five ways according to Young (2002):

- Risk avoidance. Ex. planting the right tree in the right spot, and not putting structures or people under a tree with structural defects.
- Loss prevention. Ex. performing all regular maintenance and care such as pruning.
- Loss reduction. Ex. having a plan to deal with emergency situations such as in a storm.
- Uncertainty reduction. Ex. obtaining risk evaluations from qualified risk assessors or removing tree if risk level is not tolerable.
- Risk transfer. Ex. contracting with a tree risk consultant.
(Clark and Matheny, 2008)

Managing liability is of main concern. Acknowledging that it is the duty of the city to maintain the public trees, Bozeman must maintain the trees to a reasonable standard of care. Bozeman must account for the hazardous tree conditions existing today or those that may develop in the future. If the standard of care falls below what is reasonable and prudent, liability resulting from injuries or damages may result. The standard of care is one component of a risk management document.

When a tree is identified as having a defect or being hazardous, the factors that must be considered when deciding on the best option for that tree will include: involving the public as a

legitimate partner, planning/evaluating performance, and collaborating with other credible sources (Covello and Allen, 1998).

Tree Characteristics Associated with Tree Failure

Bozeman has variable weather conditions, making it a place where there is a potential for tree failure. Tree characteristics and weather to consider will include:

- Unusual storms with strong winds, snow
- Winds or snow from prevailing direction
- Weak branch attachment
- Decay/ loss of structure
- Crown decline or root decline
- Diseases associated with either:
 - Excessive end weight on branches
 - Excessive root loss or defects
- Leaning trees
- Cracks



Figure 15 Obvious structural defect.

There are many considerations when deciding to remove a tree. First, the urban forester's recommendations will be considered. Next, influences such as site conditions and weather, which affect the likelihood of failure, are considered. These conditions include:

- Climate and seasonal precipitation
- Site management history, including changes in grade or root injury
- Soil drainage conditions
- History of other tree failures
- Obstructions to tree development such as pavement or structures (Clark and Matheny, 2008)

Tree risk involves the potential for a tree or part of a tree to cause harm or damage to a target, and public trees are located in areas where objects and people are consistent targets. Educating the public is an important step when deciding if a specimen tree is to be removed, as emotion can influence this decision making process.

The risk pertaining to the public could take the form of:

- Tree failure

- Grey infrastructure damage, including sidewalks and pavement, underground services, and overhead utilities
 - Line of sight along streets
 - Vehicle clearance over streets and sidewalks
 - Emergency planning
 - People in parks or community space
- (Clark and Matheny, 2008)

Risk Management Plan

Having a risk management plan in place is beneficial to limit liabilities. An actual risk policy statement could be developed by the Urban Forestry Department and approved by the tree board and city commission. Implementing the plan will be the duty of the urban forester. A policy statement concerning risk should include:

- A statement of commitment by the top officials stating they believe risk management is important and identifying the overall purpose of risk management
 - A statement designating who is responsible for risk management and their authority
 - A charge to select and implement risk control and how to finance it
 - A demand audit and report on risk management efforts
- (Young, 2002)

The International Society of Arboriculture has developed a Tree Risk Assessment Qualification (TRAQ) for certified arborists to assess and evaluate risk and to recommend mitigation to achieve the acceptable level of associated risk. A plan for risk management should incorporate the Best Management Practices (ISA) and the ANSI A300 (Part 9) Standard Practices on Tree Risk Assessment, guided by TRAQ methodology and procedure.

Proposed risk management policy statement for Bozeman:

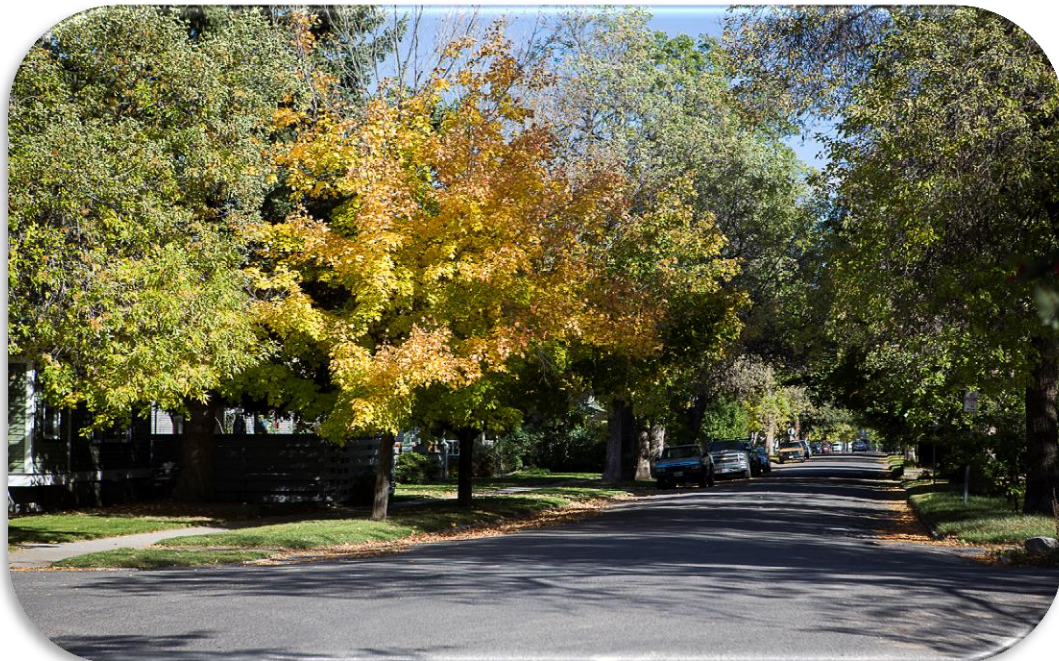
Bozeman has an active policy in mitigating potentially high-risk trees on city property. To prevent harm or damage to potential targets, the Forestry Division will strive to eliminate, in a timely fashion, any tree that poses an unacceptable level of risk. Proactive management of the community forest is an effective tool to ensure all city-owned trees have been maintained to a reasonable standard of care. Identifying potential high-risk trees will rely on any of the following: public concern, the periodic updating of the tree inventory, maintenance performed by city arborists, or maintenance performed by contracted private arborists. The city urban forester will facilitate the communication and documentation for the management of high-risk trees, and make the final judgment concerning mitigation measures taken for trees exhibiting an unacceptable level of risk.

In addition to the risk management policy statement, a standard of care should be established. The practice most likely will be carried out by an arborist conducting the pruning.

Proposed Standard of Care for Bozeman:

Bozeman will provide a reasonable level of care for all trees residing on publicly owned spaces and adjacent vegetation that may impact safe public passage. This may occur through outsourcing contracts and/or through the development of in-house expertise. The arborist performing the maintenance will be technically proficient in current arboricultural techniques, recognized through International Society of Arboriculture (ISA). While maintaining a tree of concern, a systematic inspection shall occur by examining the canopy of the tree and performing a vertical 360-degree inspection. The inspection shall be documented and captured in an inventory update. The urban forester shall determine the risk of the tree of concern based upon the observations and recommendations according to the Risk Policy Statement. The tree in concern shall be removed or treated as deemed appropriate. The arborists' practices shall adhere to the industry standards according to International Society of Arboriculture's *Best Management Practices* and adhere to the ANSI A300 pruning guide and the Z133.1 safety practices. Pruning goals should reduce failures of limbs.

Proactively addressing risk is imperative. Pruning a tree at a young age to develop good branch structure and planting the appropriate tree in the appropriate location is always good practice. Maintaining records of all treatments for the tree is in the best interest of the city as it demonstrates performance of duty and builds a history for each individual tree.



Management of Urban Forest Recommendations

This table is to be used as a quick source for a list of actions that can be “checked off” or a list of goals to be implemented by the forestry division.

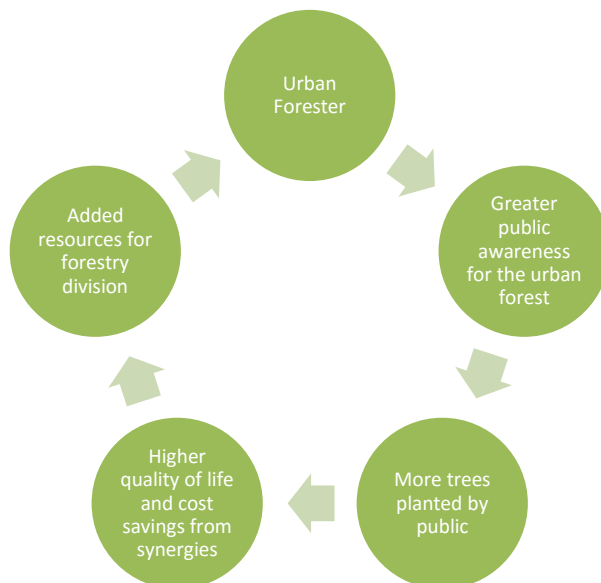
Issue	Recommendation	Expected outcome
Maintaining the urban forest and increasing the level of care	<ul style="list-style-type: none"> -Create superintendent/urban forester position in the forestry department position to implement Bozeman UFMP. -Implement a 5-7 year pruning rotation for public trees. -Focus especially on young tree pruning as a way to diminish structural problems and pruning needs as the tree matures. -Develop a plan for replacing removed trees. -Incorporate open planting spots into the tree inventory. -Promote honorary or memorial tree planting. -Post the vision and mission statements in forestry office to motivate and remind. 	<ul style="list-style-type: none"> -A more efficiently managed department -A healthier urban forest -An increased number of trees worked on every year
Funding for Urban Forestry Department	<ul style="list-style-type: none"> -Increase funding for department by increasing the tree assessment fees or implementing similar funding strategy. -Explore new funding sources. Ex. partnering with health care organizations, community welfare organizations, private organizations such as alternative energy, downtown businesses, etc. -Explore state and national grants for urban forestry. 	<ul style="list-style-type: none"> -Ability to meet present workload requirements -Efficient and timely response to the expectations of residents - Ability to successfully fulfill mission and vision
Increase the level of care of privately owned trees	<ul style="list-style-type: none"> -Require that tree services working on privately owned trees use qualified and licensed tree care companies. -Model proper tree care by implementing a 5-7 year pruning rotation of municipal trees. 	<ul style="list-style-type: none"> -Higher level of care of the urban forest -Minimize and prevent poor tree care practices
Consistency of care in the urban forest	<ul style="list-style-type: none"> -Work with BSD to create congruency and build support for the urban forest. -Create a public outreach and communication plan. 	<ul style="list-style-type: none"> -A higher level of care of the urban forest -Increased exposure and awareness to the benefits of urban forests
Support conditions conducive to tree growth	<ul style="list-style-type: none"> -Limit impervious surfaces where possible. -Establish monitoring schedule to inspect newly planted trees and improve grow space around existing trees (i.e. mulch, protection measures, widening cutouts, etc.) -Use pervious paving surfaces when possible. -Develop tree care adoption/watering program with residents in needed areas. 	<ul style="list-style-type: none"> -Healthier more robust urban forest -Potentially increased lifespan of trees

Community Engagement

The third component of a holistic, sustainable urban forestry program in Bozeman is community engagement. It is the community that builds and supports its urban forest, and it's the community that reaps the benefits from the urban forest. Establishing a vibrant relationship between the community and the Urban Forestry Department is an essential element in this plan and a key component to the plan's success. More and more research shows that many of the issues we face in our world today can be addressed by the urban forest. The urban forest helps combat climate change and alleviate resource demands, among other environmental issues. It also builds community, educates the youth, provides social justice, and promotes a healthy lifestyle for everyone.



The urban forest is our habitat; it is where we live. If Bozeman were to have a point person whose job it was to raise public awareness of the urban forest, a positive feedback loop would start. The more people that are involved, the more support the department will have, and the more resources it can draw from.



Thus the cycle continues. A campaign that articulates the benefits of the urban forest will make it fashionable and in the best interest of business to support the community forest.

Bozeman’s culture includes trees, which highlights the importance of community engagement. Partnering with the community possibly offers the most potential in this whole plan. The key here is for the Bozeman Urban Forestry Department to be a leader and a key player in this culture of trees.

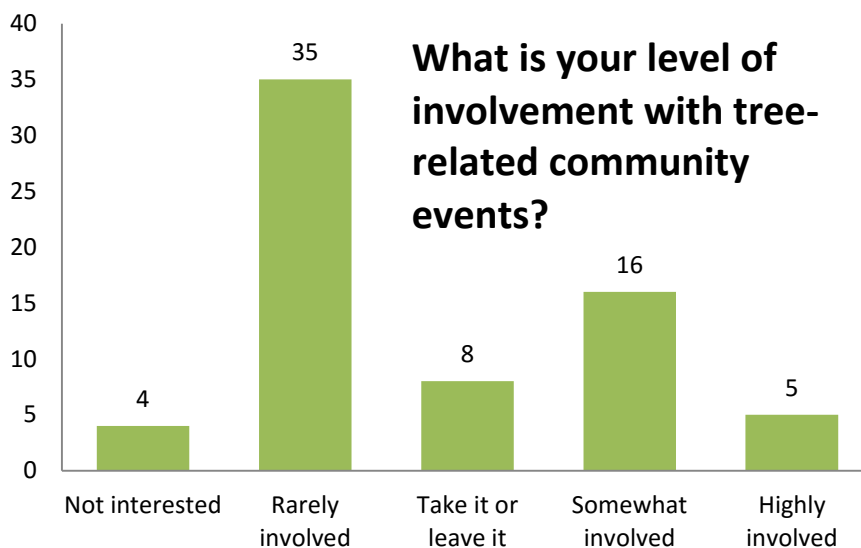


Figure 16

Churches and civic groups often have a network of people ready to perform community projects. Having “shovel-ready” projects for these organizations would be advantageous and reflect well upon the Urban Forestry Department.

A point person for community outreach in the Urban Forestry Department will be able to keep up on the latest technology developments in social media and community engagement. Use of such technology, such as smartphone apps and online inventory management, will help illustrate the benefits coming from Bozeman’s urban forest. The department will become a primary resource for community education, and in turn the community will develop support for the department.

A trained volunteer workforce could accomplish a multitude of tree-care activities, including planting, mulching, watering, and maintenance. This would raise the vitality of the urban forest and aid the Urban Forestry Department. A coordinated effort between a volunteer group and the department could also keep the inventory and work maintenance records updated. These records and relationships could be sourced through the forestry website.

Forestry Advisory Board

The Forestry Advisory Board in Bozeman is a wealth of talent and knowledge and an asset to the community. Here again much potential exists because the board is underutilized. Projects that would suit the board well include:

- Technical review of management of trees or developing management strategies

- Development of technical literature or public outreach material
- Community education programs in the schools, at the Museum of the Rockies, or partnering with education groups like Montana Outdoor Science School
- Tree planting or volunteer programs with neighborhoods or interested groups
- Media relationships or developing periodic PSAs
- Assist with certain implementation phases from this plan

This is a ready workforce that is available to the city with minimal investment. Moreover, it is likely that on certain projects, especially community events, the tree board members will enlist their families and/or friend networks to be involved and engaged. This group would work closely with the city urban forester position.

Health and Welfare Benefits

Bozeman's investment in the community forest has further potential to serve its population, especially the underserved through the concept of community orchards. Bozeman currently plants trees with edible fruit. However, this practice should be expanded. Fruit trees provide a healthy food source for Bozemanites and are a healthy alternative to processed foods. Organizations such as the Alliance for Community Trees offer grants to help develop and plan community orchards, which could be a unique program for the community.

The urban forest lowers heating and cooling bills by shading houses from the summer's sun and blocking the winter's wind, which could be very important for those who depend on energy efficiency. The average ash tree provides \$145 per year in energy saving benefits such as heating and cooling according to the i-Tree analysis for Bozeman's public trees. The community forest also improves psychological-social well-being and promotes a healthy lifestyle that benefits all, especially those who don't have the opportunity to recreate in Bozeman's outdoors.



This aspect of the urban forest provides an important opportunity for the city to partner with local nonprofits that work with the underserved. A healthy urban forest can help build a healthy community. By partnering with these organizations, Bozeman's Urban Forestry Department can gain access to this key part of the population. This is an important relationship and a potential source for supplemental funding to the department.

Considering the options cities have for creating affordable housing, it has been the case that park space and urban trees are often not incorporated or the requirements are less stringent in these developments. This is the exact opposite of what is cost effective, for a multitude of reasons. Trees should be incorporated even more in affordable housing situations because trees increase the standard of living for people who reside around them. Cost savings in other aspects of affordable housing are made up for when a proper investment is made in the urban forest.

Community Planning

Trees should be considered as an essential component in the planning of Bozeman's growth. Trees have special requirements for both above-ground and below-ground space. Healthy soils need to be made available as well as efficient watering mechanisms. These elements are difficult to implement after construction has begun and are much easier to incorporate early in the planning process. An effort of outreach to designers and architects as to the importance and requirements of trees needs to take place. A strong city contact, such as the superintendent/urban forester, will aid in this process, both in city workings and in the private sphere.

Regular meetings should be scheduled with homeowner associations to encourage and instruct neighborhoods on how to manage their trees. The city will be a resource for the neighborhoods and will raise the overall quality of the urban forest by increasing the level of care of privately owned trees.

The community could be engaged through the forestry website where they can view and perhaps contribute updates to the inventory of the urban forest. By doing this, the community can take ownership of the urban forest and see how their trees function as part of the big picture of Bozeman's urban forest. There would also be an education piece for the community associated with this online inventory, furthering the goal of a healthy urban forest.

Planting Trees

Planting a new generation of trees is one of the essential elements this plan recommends for creating a healthy and sustainable urban forest. By doing this, it creates an urban

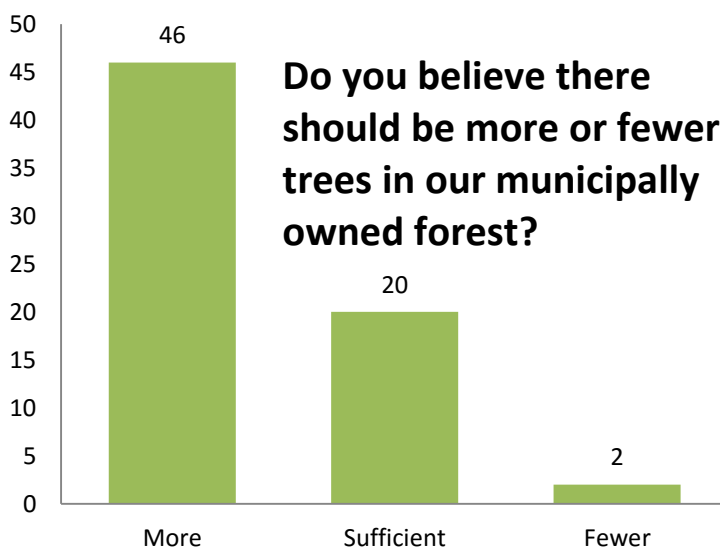


Figure 17

forest for future generations of Bozemanites, prepares the urban forest for the arrival of EAB, and improves the population dynamics of the urban forest in Bozeman. The forestry division currently plants many trees through its cost-share program. Instead of recommending the forestry division budget for a great increase in planting a new generation of trees, the Bozeman UFMP relies on the public to incur the cost of planting the trees while being guided by the city urban forester. This is done by the urban forester forming relationships with largely untapped resources:

- The public
- Businesses
- School and parent organizations
- Neighborhood groups/HOAs
- Downtown Bozeman and Chamber of Commerce/tourism industry
- Churches/civic organizations
- Nonprofits of every kind, including: The CO-OP, Friends of ... , Cancer Support, Craighead Institute, Polar Bears International, Montana Environmental Education Association, etc.
- Bozeman Health, Community Health Partners, Bozeman Creek, and other healthcare groups
- Environmental and recreational groups, e.g. trail improvement, parks/recreation, biking, hiking, running, etc. etc.

Forming these relationships would be the job of the urban forester, a position that this plan recommends creating. Bozeman's Urban Forestry Department is maintaining more trees, integrating itself into the city

workings, planting more trees, maximizing the benefits of the urban forest, and gaining support for the department all by creating one position.

To plant a new generation of trees, it is the city's responsibility to coordinate this undertaking. Once Bozeman's residents know and understand the need, direction and motivation

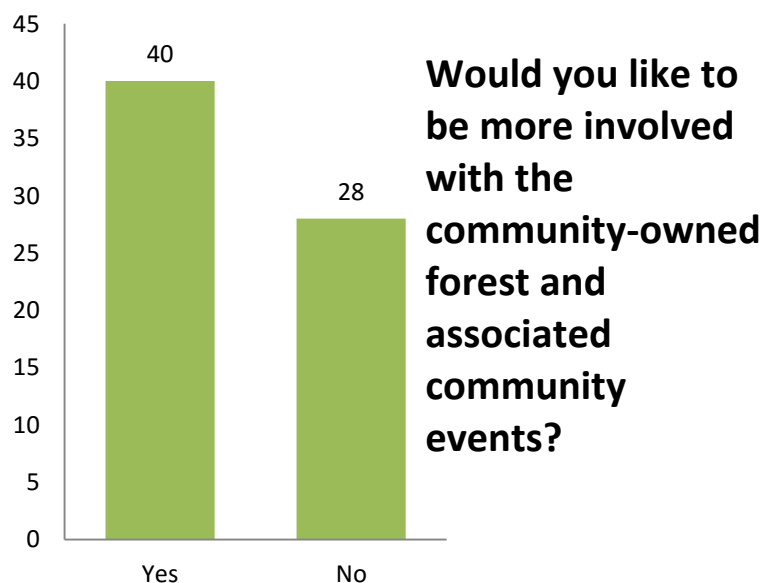


Figure 18

must be given by identifying the engines that will enable tree planting. Coordination needs to take place so species diversity goals are met and the groups planting trees are doing so correctly. Any assistance needed is addressed by providing resources or creating new entities such as neighborhood nurseries. These steps are detailed in the following paragraphs.

Education

A massive education movement must be initiated to educate the public as to the benefit of urban trees and what is at risk concerning EAB. Training workshops or guidance for proper selection and planting would be promoted. In terms of planting trees, partnerships formed with the community will fit into one of two categories: those doing the planting and those serving a supporting role. Some of the groups will probably fit into both categories. These groups must be identified and utilized according to their skills and available resources (i.e. equipment, materials, etc.). These groups include civic groups, school/parent groups, homeowner associations, etc.

Trees and materials will come from the supportive groups, such as Downtown Bozeman, healthcare organizations, nonprofits, businesses, etc. These newly formed relationships are vital towards bettering our community and must be publicly recognized to continue their involvement.

Coordination

Ultimately these newly planted trees will reflect on the integrity of the Urban Forestry Department. Is there appropriate species diversity? Are the trees planted correctly and in good locations? All groups buying trees and planting trees must be educated on how to do so correctly. Possibly all the tree purchasing would be done through the City of Bozeman to ensure proper species diversity. If all tree purchasing is not done through the city, then some mechanism must be set in place to accomplish species diversity. Planting clinics can be held for those doing the planting, or an urban forestry arborist could be present at planting time to give direction and assistance. A monitoring schedule may also be necessary to inspect new tree plantings periodically in the first few years following planting.

Assistance

Currently Bozeman runs the cost-share and tree voucher programs, which are two popular programs for planting trees. These programs could be expanded in their current state if desired, but this plan does not rely on these programs to plant a new generation of trees. This plan does recommend creating provisions for these programs, such as access to city nursery trees or assistance to start nurseries on their own on city property. The neighborhood groups could be responsible for transplanting the trees on their own or contracting with a tree service. A gravel bed system could be utilized if appropriate. If neighborhoods had access to the city nursery in its current state, mechanized equipment would need to be employed. Again, education will be needed to ensure species diversity and proper placements of the trees.

Bozeman School District (Planting Partnership)

Bozeman is fortunate to have a citizenry that is active in the natural surroundings and is largely environmentally literate. Students will take their knowledge home and educate their parents, furthering the cause. An educational program could be spearheaded by the city urban forester and aided greatly by the Tree Board.

Tree planting programs on school grounds would also be beneficial. Planting orchards is a great way to engage students and is currently being done at a couple of the schools. These efforts are mostly carried out by the parent organization at the school. These efforts could be furthered by the Urban Forestry Department

Montana Outdoor Science School (MOSS) would be a potential partner for educating in the schools. Instructors could be provided by MOSS and a curriculum provided by the city, MOSS, or teachers. This partnership could go further than the schools, and the urban forester could become a resource for MOSS's summer camps and adult education programming.

Partnering with Montana State University

Partnering with Montana State University (MSU) is a natural alliance. They have an urban forest within their own campus and an urban forestry department. Montana State University has a large number of ash trees and is facing the same lack of species diversity that exists in the municipal forest. Montana State could also monitor for EAB and assist in the effort for detection of pests and diseases.

MSU is currently a Tree Campus USA and has an active work plan. Like the relationship with BSD, the city and MSU would benefit from a continuity of tree planting and tree maintenance. Best management practices and ecological advances in the urban forest could be studied and shared between both entities. A common philosophy and appreciation for the urban forest currently exists, and positive outcomes will result from a closer relationship.

MSU students can also be used as a resource:

- Help teach an urban forestry curriculum in the public schools and in the community
- Students clubs could take on tree planting projects
- Develop research projects relating to urban forestry
- Assist in developing a marketing plan for the city urban forestry department and the benefits of the urban forest
- Help develop modeling and survey techniques relating to the urban forest

Community Engagement Recommendations

The following action list is a summary of recommendations to promote and strengthen relationships with the community.

Issue	Recommendation	Expected outcome
Public Education	<ul style="list-style-type: none"> -Create a superintendent/urban forester position in the forestry department within the city hierarchy to spearhead these programs. -Engage the Tree Advisory Board to start an urban forest community awareness program. -Create a school program for K-12 engagement. -Partner with MOSS for public education in the schools, at the Museum of the Rockies, in the community, or at their summer camps. -Always have a special project in the works and keep information updated on the city webpage. -Work with MSU to create congruency and explore possibilities for continued education regarding urban forestry. 	<ul style="list-style-type: none"> -A coordinated volunteer workforce -A new generation of urban foresters -A more engaged citizenry
Raise public awareness for the urban forestry department	<ul style="list-style-type: none"> -Start a community urban forest newsletter or the electronic equivalent to educate, keep the public current, and recognize local businesses that have contributed. -Brand the Urban Forestry Department using social media, website, and utilizing local marketing companies. -Use partner groups to help to raise awareness and funds. -Recognize partners that contribute to the urban forest department on the city's website or on materials. 	<ul style="list-style-type: none"> -An urban forestry department that is the leader of the tree culture in Bozeman -A high public perception of the Urban Forestry Department in Bozeman -An urban forestry department that receives monetary and labor support from the community
Raise public awareness for the benefits of trees	<ul style="list-style-type: none"> -Work with public health departments and medical organizations for funding and to raise awareness of the health benefits to the urban forest. -Work with environmental and climate change organizations to focus on how the urban forest can be a part of the solution. -Meet with the Downtown Business Association and businesses to discuss tree canopy and preservation goals. -Seek financial support for department. -Possibly set up a nonprofit the community 	<ul style="list-style-type: none"> -A sustainable, holistic healthy urban forest

	<p>and businesses can donate to.</p> <ul style="list-style-type: none"> -Create an online community engagement page on the forestry website where the public can view the city-wide urban forest inventory. -Save firewood and lumber from tree removals to provide to the community. - Register historical trees on Montana’s big tree list. -Create a legacy tree recognition program in Bozeman. - Meet with HOAs to educate and provide assistance for caring for the urban forest. 	
Continuity of urban forest and synergetic relationships	<ul style="list-style-type: none"> -Strengthen relationship with BSD and offer expert council. -Strengthen relationship with MSU for expertise and student resources. 	-A stronger relationship with community organizations

Conclusion

Investments in the urban forest offer a cost-efficient expenditure by working symbiotically and reducing stress on other parts of the city infrastructure while offering benefits of their own accord.

The Bozeman Urban Forestry Management Plan makes recommendations on how to most efficiently make improvements to Bozeman’s Urban Forestry Department and in turn raise the quality of Bozeman’s urban forest. Much good work is currently being done and much potential exists for managing Bozeman’s urban forest. This plan relies heavily on some changes to the department and community involvement. By doing this, the tree infrastructure in Bozeman will be healthier and more robust. Incorporating the recommendations made here will create a sustainable, holistic, and healthy urban forest, providing benefits for all who inhabit it.

A key step to realizing the potential that exists is to create and fill the superintendent of urban forestry position. This person is charged with executing the second key principle of this plan: planting a new generation of trees. This is done by engaging the public, gaining the support of the forestry division, and becoming a resource for the community.

Investing in the urban forest is a worthwhile endeavor for its citizenry. Maybe more importantly, it is even more valuable for future generations and the climate. Previous generations invested greatly in planting all of the mature trees Bozeman now has, and now is the time to continue that legacy.

Appendix 1. Job Description for Urban Forester/Superintendent of Forestry

This person will possess a unique set of qualities and physical abilities. Some of the qualities to hire for will be:

- **Leadership.** This person will communicate the vision and benefits of trees to stakeholders. Working with the city bureaucracy will be a part of this job, and cooperating with and obtaining commitment from these departments is crucial. Maintaining open lines of communication with stakeholders and the public is important to build relationships. This person will delegate responsibilities and provide motivation for subordinates to execute their jobs effectively.
- **Team Orientation.** This person will work effectively with others and actively contribute to group and organizational goals. They will take ownership and share responsibility of projects and utilize strengths of individuals within the group with which they are working.
- **Customer Service.** Ultimately, this person works for the public, and when this person is out in the community, they will serve as a useful resource to residents. This person will assume ownership for the municipal trees and greater urban forest. They will respond to the public's concerns and the trees' needs.
- **Problem Solving/Decision Making.** This person will make decisions using the information they have in a timely manner. They will use the resources they have and involve the appropriate people.
- **Interpersonal Communication.** This person will listen well to others and ask the appropriate questions when they need clarification. This person will receive and give suggestions well. Bozeman has an eclectic citizenry, and adapting to different communication styles will prove useful. This person will recognize and manage conflict as appropriate.
- **Flexibility.** This person will be able to adjust their behavior when faced with changing or uncertain situations. They will still be effective when adapting to change and dealing with ambiguity. They will acquire new information to meet changing demands.
- **Performance Management.** This person will distinguish between good and bad performances and adjust the plan going forward. Providing feedback and receiving feedback are important qualities in being an effective superintendent of the Urban Forestry Department. This person will also acquire the appropriate help for each task.
- **Arboricultural Aptitude.** While this person won't be working in trees as much, having that experience and knowing current practices are a priority.

(adapted from Indiana University Human Resources Services, 2005)

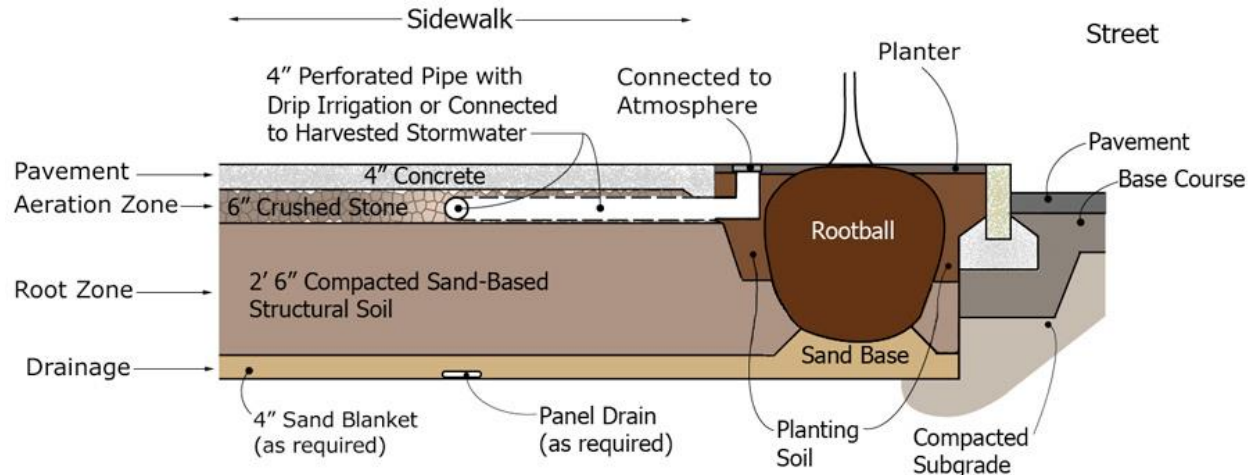
A list of job duties will include the following. All are important while the first three are crucial:

- Must be proficient in arboricultural duties such as, but not limited to, pruning techniques, removing trees, diagnosing disease, and plant health care
- Coordinate with other departments in Bozeman to direct all tree-related activities
- Engage the public to build a culture of trees, and enlist the community to plant a new generation of trees
- Alert the code enforcement officer of violations of laws, ordinances, rules, and regulations
- Influence the interests of the Urban Forestry Department and express the benefits of urban trees
- Prepare and supervise budgets
- Prepare and supervise planning documents
- Analyze programs and policies
- Manage employee selection, supervision, and employee relations
- Manage department operation and maintenance
- Manage, analyze, and update the urban forest inventory software program
- Maintain contracts with groups and people outside of the municipality
- Fit short-term work plans into the long-term UFMP

Appendix 2. Planting Trees in Paved Areas

A minimum of 100 cubic feet of irrigated soil is needed to sustain long-term tree growth (DeGaetano, 2000). In these planters, after 2 feet in depth is reached, an increase in soil surface area is of greater benefit than greater depth. This would make a realistic planter size a minimum of 2 feet deep, 3 feet wide, and 16 feet long.

If a city street is ever reconstructed, the city should consider suspended pavement sidewalks, which are an ideal way to provide future planting locations. This suspended pavement sidewalk does not bear extreme loads and is placed over non-compacted soils in hardscapes. According to a study conducted by Bartlett Tree Research Lab (2006), trees with room to grow their roots under concrete in sidewalks were “larger, faster growing, had better color, and more root growth than most other treatments.” On these pavement plantings, or any plantings in sidewalks, surrounding pavement should slope away from the planters, thus not sending contaminated water into the tree. The following is a description of what this might look like.



Appendix 3. SWOT Analysis

Strengths

- Place for community engagement and building
- Synergetic relationships with other city infrastructure
- Provides essential canopy cover in parks and on streets
- Competent forestry division
- Dedicated, passionate and educated citizenry that supports the urban forest
- Tree board

Weakness

- Age and species diversity
- Forestry division prioritization in city government
- Enforcement of city ordinances involving trees

Opportunities

- Potential for a new generation of trees
- Added cost savings to city through appropriate management of the urban forest
- Volunteer opportunities in the urban forest through the coordination of the Urban Forester
- Environmental benefits

Threats

- Climate and environmental stressors
- Damage to sidewalks and roads

- Exotic pests and diseases
- Forestry Division not growing in proportion the population of Bozeman

References

American Public Works Association. Urban Forestry Best Management Practices for Public Works Managers

Abby, B, 1998. *U.S. Landscape Ordinances: An Annotated Reference Handbook*. John Wiley & Sons, Inc., New York, NY.

Appleton, Bonnie, 2003. Right Tree Right Place. International Society of Arboriculture, Tree Selection and Planting. A CEU Compendia.

Ball, J. 2003. Tree Planting the Foundation of Plant Health Care. International Society of Arboriculture, Tree Selection and Planting. A CEU Compendia.

Browning, D.M., and H.V. Wiant, 1997. The economic impacts of deferring electric utility maintenance. *Journal of Arboriculture*, 23(3): pp. 106-112.

Coder, Kim D., 2003. Preserving Trees During the Construction Process. International Society of Arboriculture, Plant Health Care. A CEU Compendia .

Council of Tree and Landscape Appraisers (CTLA), 2000. *Guide for Plant Appraisal*, 9th edition. International Society of Arboriculture, Champaign IL, pp. 143.

Covello, V.T., and Allen, F., 1988. *Seven Cardinal Rules of Risk Communication*. US Environmental Protection Agency, Office of Policy Analysis, Washington, DC.

Clark, J.R., N.P. Matheny, 2008. *Municipal Specialist Certification Study Guide_2008* International Society of Arboriculture, Champaign IL, pp. 279.

Clark, J.R., Matheny, N.P., Gross, G., and Wake, V., 1997. A model of urban forest sustainability. *Journal of Arboriculture*, 23(1): pp. 17-30.

DeGaetano, L.R., 2000. Specifications of soil volume and irrigation frequency for urban tree containers using climate data. *Journal of Arboriculture* 26(3): pp. 142-151

Donovan, G. H., Butry, D. T., Michael, Y. L., Prestemon, J. P., Liebhold, A. M., Gatzolis, D., et al. (2013). The relationship between trees and human health: Evidence from the spread of the Emerald ash borer. *American Journal of Preventative Medicine*, 44, pp. 139–145.

www.Emeraldashborer.info

Gilman E.F., 2001. Effect of Nursery production method, irrigation and inoculation with mycorrhizae forming fungi on establishment of *Quercus virginiana*. *Journal of Arboriculture* 27(1): pp. 30-39

Greenpassivesolar.com/passive-solar/scientific-principles/movement-of-the-sun/

Heisler, G.M., 1986. Energy Savings with Trees. *Journal of Arboriculture*. 12(5): pp 113-125

International Society of Arboriculture website <http://www.isa-arbor.com/education/onlineResources/>

Kuo, F. E., & Sullivan, W. C. (2001). Environment and crime in the inner city: Does vegetation reduce crime? *Environment and Behavior*, 33, pp. 343–367.

Kuhns M.R., B. Lee, and D.K. Reiter. 2005 Characteristics of urban forestry programs in Utah, U.S. *Journal of Arboriculture* 31(6) : pp. 285-295

Matheny, N., and J.R. Clark, 1994 *Photographic Guide to the evaluation to Hazard Trees in Urban Areas*, 2nd edition, International Society Of Arboriculture, Champaign, IL.

McPherson, G., and Rowntree, 1993. Energy conservation potential of urban tree planting. *Journal of Arboriculture*, 19: pp. 321-331

McPhearson, G., and J. Simpson, 1999. *Carbon Dioxide Though Urban Forestry: Guidelines for Professional and Volunteer Tree Planters*. USDA Forest Service Pacific Southwest Research Station. General Technical Report PSW_GTR-171.237.

Maco, Scott E., McPherson, Gregory E., 2002. Assessing Canopy Cover Over Streets and Sidewalks in Street Tree Populations. *Journal of Arboriculture*, 28(6): November 2002.

Miller, R., 1997 *Urban Forestry: Planting and Managing Urban Green Space*, 2nd edition. Prentice Hakk, Upper Saddle River, NJ. 502 pp.

Miller R.W. and W.A. Sylvester, 1981. An economic of the pruning cycle. *Journal of Arboriculture*, 7(4): pp. 109-112

Reiss, C.L. 2004, *Risk Management for Small Businesses*. Public Entity Risk Institute, Fairfax, VA.

Rogers, Dan. Edits for the 2011 Dillon Community Forest Management Plan.

Suspend pavement.

http://www.asla.org/uploadedFiles/CMS/Meetings_and_Events/2010_Annual_Meeting_Handouts/Sat-B1The%20Great%20Soil%20Debate_Structural%20Soils%20Under%20Pavement.pdf

Swiecki, T.J., and E.A. Bernhardt, 2001. *Guidelines for Developing and Evaluating Tree Ordinances* <https://www.isa-arbor.com/Portals/0/Assets/PDF/Certification/Tree-Ordinance-Guidelines.pdf>

Tarran, J. (2009). People and trees, providing benefits, overcoming impediments. In D. Lawry, J. Gardner, & M. Bridget (Eds.), Proceedings of the 10th national street tree symposium Adelaide University, Adelaide, South Australia, pp. 63–82.

Tate, R.L., 2007. Urban and Community Forestry: Financing and Budgeting. Kuser, J. (ed.). *Urban and Community Forestry in the Northeast*, 2nd edition. Springer-Verlag, New York, New York, pp. 133-146.

Thompson, R.P., and J.J. Ahern, 2000. The State of Urban and Community Forestry in California: Status in 1997 and Trends Since 1998, California Department of Forestry and Fire Protection, Technical Report No. 9 Urban, Forest Ecosystem Institute, Cal Poly State Univ., San Luis Obispo, CA, 48 pp.

Troy, A., Grove, J. M., & O'Neil-Dunne, J., 2012. The relationship between tree canopy and crime rates across an urban–rural gradient in the greater Baltimore region. *Landscape and Urban Planning*, 106, pp. 262–270.

United States Department of Agriculture Forest Service, 2005. Benefits of Urban Trees. Urban and Community Forestry: Improving Our Quality of Life.

Ulrich, R.S., 1986. Human responses to vegetation and landscapes. *Landscape and Urban Planning*, 13: pp 29-44.

Urban Forestry Best Management Practices for Public Works Managers: Budgeting and Funding, 2006.

Urban Forestry Best Management Practices for Public Works Managers: Staffing, 2006.

Urban Forestry Best Management Practices for Public Works Managers: Ordinances, Regulations, & Public Policies, 2006.

Volder, A., Watson, W. T., & Viswanathan, B., 2009. Potential use of pervious concrete for maintaining existing mature trees during and after urban development. *Urban Forestry and Urban Greening*, 8, pp 249–256.

Warriner, J.W., 2006. Contracting with municipal agencies. Part 1; Reasons for privatization, *Tree Care Industry*, February: pp. 52-56

Western Forestry Leadership Coalition. <http://www.wflccenter.org/across-the-western-landscape/six-point-plan.php>