ENVS 485:
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Cozine Creek Restoration Management Plan

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INTRODUCTION

Linfield's Cozine Creek property is located in the Lower Yamhill Watershed, which is comprised of 63,750 acres of land in a variety of uses including 56% in agricultural production, 38% in forestry, 4% in rural residential, and 2% urban. Cozine Creek flows through McMinnville, which can influence the surrounding water quality (ODEQ 2016). McMinnville experiences 41 inches of rain per year on average; approximately 50% of the total annual rainfall happens between December and February (Taylor 2016). The Cozine Creek area, and especially the Linfield owned property, serves to mitigate seasonal flooding that occurs mainly in the winter and spring (Gernhart et al. 2016). The use of this area for floodwater storage reduces hardships on human development during flooding months (Yamhill County 2009).

The property is a 30-acre parcel of oak woodland and riparian land through which an 11.3 mile long segment of Cozine Creek flows. It is bordered by Highway 99W on the north and west, Davis Street to the east, and the Linfield College campus to the south, with the creek running eastward through its center. The creek itself is heavily altered by culverts, stormwater and sewage pipes, and irrigation diversions. It has been owned by Linfield since the College's inception in 1858 and is currently managed by Linfield facilities services with collaboration by stakeholder groups from the greater community: the city of McMinnville, Greater Yamhill Watershed Council, USDA National Resources Conservation Services Oregon, the Yamhill Soil and Water Conservation District, Duniway Middle School, landowners along the creek, and the citizen stewards of the Cozine Coalition. It is thus historically, socially, and ecologically significant to this community (Gernhart et al. 2016).

As seniors in the Environmental Studies department and members of the greater Linfield community, we have big dreams for Linfield's Cozine Creek property. We believe that collaboration among the College, students, and Cozine stakeholders could make this area into an enriching resource for students and a natural area that is important for native flora and fauna. Through community-based work parties and with some professional guidance, the property could be restored to a healthy oak woodland habitat with a flourishing riparian zone free of invasive species, which could serve as a habitat for native wildlife. Cozine could be a clean and safe creek

that could become a hub of learning and appropriate activity. With some work, the Cozine property could be an incredible asset to the College.

In its current state, the Cozine property is underutilized by the community and in poor ecological condition. Despite its high diversity of native plant species, infrequent management has resulted in approximately 22% of the property being covered with the invasive species, Himalayan blackberry (*Rubus bifrons*) and English ivy (*Hedera helix*). Invasive species effectively outcompete and displace native species including the ecologically and culturally significant Camas lily (*Camassia quamash*) population. The Cozine Creek area also could provide habitat for a wider range of species (Gernhart et al. 2015). Although the property supports a wide range of bird species, there is limited data on the use of the habitat by other animals. In addition, there are significant barriers to community use of the property. Muddy and steep trails reduce accessibility, and few departments use the property in curriculum. Overall Cozine could benefit from a more sustained management and restoration effort.

A survey was sent out to determine the perceptions of members of the Linfield community as well as property owners along Cozine creek. The majority of respondents tended to prioritize the removal of invasive species and trash, improving water quality, improving safety, and improving habitat for birds, wildlife, and fish. We have used these survey findings as well as the investigations of the ENVS 486 Problem Solving classes to develop the following goals for the Cozine Creek property:

1. Maintain and restore the legacy oak and riparian woodland habitats in order to foster ecological health in the Cozine Creek property.
2. Restore and maintain native vegetation that will provide shelter and food to native wildlife, as well as increase our knowledge of the wildlife present.
3. Improve water quality and habitat for native species.
4. Cultivate stewardship by facilitating access and educational use.

In the following chapters, we will provide background information, a summary of last year's inventory and assessment, goals, and action steps to improve vegetation, habitat, water quality, and social use of the Cozine property. Further information and longer term goals can be found in

the appendices. We hope that this proposal can be used to begin a sustained community-based restoration of Linfield's Cozine Creek property.

VEGETATION

Lewis Faller

INTRODUCTION:

The vegetative landscape of Cozine Creek represents a cultural and ecological legacy that precedes the existence of Linfield College. Native Americans had widespread influences preserving oak woodland ecosystems, as found on the Cozine Creek property, through fire regimes that prevented the invasion of conifers. Presently, due to fire suppression and land conversion, less than 5% of the Willamette Valley's historic oak savanna habitat remains (Oregon Conservation Strategy 2011). Additionally, the continued expansion of McMinnville and the spread of agriculture have impacted the riparian woodland vegetation present along Cozine Creek (Cowell et al. 2016). Diminished vegetative buffers have increased temperatures and sedimentation. Maintaining and restoring vegetative buffers is necessary to minimize anthropogenic impacts on water quality (USDA 2009). In the end, conserving native vegetation along Cozine Creek will be ecologically important to support water quality and wildlife, as well as the cultural legacies and vegetative communities of the region.

SUMMARY ASSESSMENT:

As revealed by the 2016 ENVS Problem Solving (ENVS 485) class's Inventory and Assessment, the Cozine Creek property on Linfield College's campus contains both oak and riparian woodland habitat. The oak woodland habitat found on Linfield College's portion of Cozine Creek is identified by the presence of Oregon white oak (*Quercus garryana)* – all scientific names from Oregon Flora Project (Jaster et al. 2016). This is the most dominant species as determined by basal area, whereas the most common tree species is the Oregon ash (*Fraxinus latifolia*), whose distribution in the floodplain reflects its importance as a riparian woodland species. Other riparian species include red alder (*Alnus rubra*), willow (*Salix sp.),* snowberry (*Symphoricarpos albus*), chokecherry (*Prunus virginiana),* creek dogwood (*Cornus sericea*), Douglas spiraea (*Spiraea douglasii*), ninebark (*Physocarpus opulifolias*), and black cottonwood (*Populus trichocarpa*). In contrast, the Oregon white oaks are found mostly outside the floodplain in the drier areas of property. Relatively abundant species found outside the

floodplain also include Douglas-fir (*Pseudotsuga menziesii*), big-leaf maple (*Acer macrophyllum*), western red-cedar (*Thuja plicata*), coastal redwood (*Sequioa sempervirens*), and ponderosa pine (*Pinus ponderosa*). In total, 26 tree species and 54 herbaceous species were documented on the Cozine Creek property (Gernhart et al. 2016).

Despite the diversity of native plants, invasive species are a significant threat to the native flora and ecological health of the Cozine Creek property. Among herbaceous species present, 40% are native, 53% exotic, and 15% invasive; whereas of the woody species, 46% are native, 52% exotic, and 13% invasive. Approximately two-thirds of the creek bank is covered with invasive species, predominantly Himalayan blackberry (*Rubus bifrons*). Other invasive species include reed canary grass (*Philaris arundinaceae*), multiflora rose (*Rosa multiflora*), Italian arum (*Arum italicum*), English ivy (*Hedera helix*), and creeping Jenny (*Lysimachia nummularia*) (Gernhart et al. 2016).

The presence of camas lily (*Camassia quamash*) is an important feature of the Cozine Creek property. Camas lily is a culturally significant species because it was a historic staple food for Kalapuyan, native Americans (Yamhill Basin Council 2001). Camas lily covers approximately 2% (2500m^2) of the total property area, whereas Himalayan blackberry covers 22% (27,600m^2) of the property area. These two species have overlapping distributions and Himalayan blackberry threatens the colonize areas currently occupied by camas lily (Gernhart et al. 2016).

The relative abundance of invasive species along Cozine Creek is a significant threat to native plant communities in addition to the camas. Himalayan blackberry in particular effectively outcompetes and displaces native shrubs and herbaceous species present in both the riparian and oak woodlands. Therefore, to retain the cultural and ecological legacies of the Cozine Creek property it is important to control invasive species and promote native species and stewardship for years to come (Gernhart et al. 2016).

GOALS AND ACTION STEPS:

Maintain and restore the legacy oak and riparian woodland habitats to foster ecological health on the Cozine Creek property.

- Remove the invasive species Himalayan blackberry (*Rubus bifrons*) and English ivy

(*Hedera helix*) through an integrated management approach using herbicides, and mechanical and manual treatments.

Recommendation: It is our recommendation to prioritize the use of an integrated management strategy of cutting and herbicide removal (Figure 1.1). This treatment option is the most effective at Himalayan blackberry removal in consideration of the time and monetary aspects of control (Table 1.1). Cutting and herbicide blackberry removal is estimated to cost $50-$300 per acre, whereas removing rootstock by hand is time consuming and costly at 300-1000 hours/acre or $3500/acre. Please note that control methods of fire management, goats and infrequent mowing/cuttings were found to be ineffective.

Figure 1.1 Himalayan blackberry polygons and associated recommended treatment options (below).

Table 1.1 Summary of Himalayan blackberry (*Rubus bifrons*) removal methods and relative effectiveness (Modified from Oregon State University 2006).

	Treatment Summary	Effectiveness	Cost	Considerations
Most effective				
1. Cutting and Herbicide combination	1. H. blackberry is cut midsummer, allowed to grow back to 18 inches before herbicide sprayed in the fall OR 2. Area is sprayed in fall, and is mowed or cut in spring or fall	Effective if herbicide coverage is good. Herbicide application best in fall when transpiration in plants is active.	$50-$300/acre Also must factor in initial mechanical or hand treatment	Most cost effective, requires expertise in herbicide application. Control of resprouts will be needed
Somewhat or Possibly Effective				
2. Mechanically removing rootstock	Canes, roots and root crowns are uprooted by a mechanical implement	Can be effective if done thoroughly. Roots often broken and left in the ground	Highly variable, depending on site features (topology, slope, surrounding vegetation ect…). Estimated $500-$1000/acre	Significant soil disturbances
3. Removing rootstock by hand	Root crowns and roots are dug up	Effective if done thoroughly. Difficult due to likelihood of severed roots left in the ground	300-1000 hours/acre. Dependent on crew experience/conditions . Contract cost $3500/ acre.	Significant soil disturbance. Extremely labor intensive, thereby best suited for small projects or with large volunteer base.
4. Repeated tilling and cane removal	Area tilled and canes are raked and moved off site	Effective, but soil disturbance limits use in riparian projects. Slope also must be conducive for mechanical machinery.	$250- $500/acre. Additional raking costs.	Significant soil disturbance.
4. Multiple cuttings each year, continued over multiple years	Area mowed or cut for multiple years. Resprouts are cut back around planted trees or natural regeneration two or more times a year.	Effective if consistently cut multiple times per year and sustained for up to 3 years.	165-400 hours/acre for hand clearing, 40-100 hours/acre for release. Contract cost $1000/acre. Tractor mowing estimated $100-$150/acre.	Mowings are much more cost effective than cutting by hand but require flat ground and site accessibility.

Because Linfield College has access to a potentially large and motivated workforce, utilizing manual labor for removal could also serve as an effective

method of control. In addition, as described in the social use chapter of this proposal, we recognize the social benefit from Linfield student engagement in the Cozine Creek property and its value in fostering a culture of stewardship and preservation.

Recommendation: Treatment specifics found in Table 1.

Herbicide and mechanical cutting combination (*treatment 1*):

Polygons I, G, K, L D, E in figure 1.1. These polygons feature high-density blackberry and therefore require aggressive and cost effective methods of control.

Multiple cuttings/mowings each year *(treatment 4)*:

Polygons C, F and G. In consideration of the polygons close proximity to the Camas lily population, we recommend treatment that will safeguard the species. Further treatment details are given in the next action step.

Manual pulling and cutting *(treatment 3):*

Polygons J, B, H and meadow areas. High visibility, easily accessed areas should be focus of manual removal. Therefore, sporadic blackberry found in the meadows, surrounding trees, and highly visible polygons should be target for manual removal.

To be determined (TBD):

Polygons A and M. Due to privacy concerns brought about by removing blackberry from these regions, specific treatment has not been decided. Consultation with affected landowners is needed.

- Restore and protect the culturally significant population of Camas lily from Himalayan blackberry invasion and displacement.

Camas lily populations on the Cozine Creek property are currently threatened by Himalayan blackberry invasion. The blackberry outcompetes and displaces native flora due to its aggressive growth and difficulty of removal (Figure 1.2).

Figure 1.2 Himalayan blackberry and camas lily polygons in the Cozine Creek property. Shows Himalayan blackberry invasion into native camas lily habitat.

Recommendation:

Due to Himalayan blackberry's overlapping distribution with Camas lily (polygons F, C, and parts of G in figure 1.2) we recommend a treatment of multiple cuttings or mowings in combination with strategic chemical treatments *(Treatments 1 and 4 - Table 1.2).* Although relatively expensive compared to purely herbicide treatment, this method will limit Camas lily exposure to non-target chemicals or disruption of the soil communities due to aggressive rootstock removal. Mowing or cutting of polygons should start in the fall, when Camas lily vegetative parts are no longer present and continue into the early spring (until Camas lily vegetative parts become visible). At least three mowings/cuttings per year (polygons F, C, and G) in combination with limited chemical treatment are necessary to effectively kill blackberry rootstocks.

- Restore biodiversity of the native flora in oak and riparian woodland habitats through native plant revegetation

Recommendation:

Site preparation should be a major consideration before planting. In order to maximize plant survival, planting should only occur if the site is free from invasive species for two consecutive years. To determine proper location, care of, and timing of planting, restoration workers should consult the *Riparian Tree and Shrub Planting* (Robinson et al. 2011) guide as well as the *Restoring Native Habitats in the Willamette Valley* (Campbell 2004) document (See Appendix A).

Preliminary, recommended species to be planted in both oak and riparian woodlands of the Cozine Creek property are noted in Appendix A. Final species selection should take into consideration how well species will help achieve water quality goals for erosion control and shade improvement, presence of the plant on the site (plants already present are more likely to survive), availability from nurseries, and cost, along with growth time and tolerance of adverse growing conditions.

ADDITIONAL CONSIDERATIONS:

- Preserve the oak woodland habitat through the removal of invading conifers and broadleaf trees on the north hillside of the property

Oregon white oaks are shade intolerant species and require full sunlight for effective growth. Traditionally, conifers such as Douglas-fir were managed through Native American fire regimes that promoted the growth and acorn production of oak woodland. Now fire suppression measures favor the growth of faster growing conifers and broadleaf trees, leaving the shade intolerant Oregon white oak at risk of being shaded out (USDA 2006). Therefore removal of Douglas-fir and other fast-growing broadleaf species is necessary for long-term preservation of legacy oak woodland habitat (Table 1.3). Due to the long-term nature of oak release and our limited time and resources, this is not an immediate

action step (projected completion of five years or by 2022) and rather falls into the 'Additional Considerations.'

Table 1.2 Three general conifer removal strategies to facilitate oak release (Thiebes 2007).

Treatment Option	Description	Considerations
1. Cutting and Removal	Complete felling and removal of conifers species. Removal can range from seedling to adult trees. Requires the evaluation of professional forester.	- Potentially expensive -- depends on quantity and quality of wood - Risk of damaging surrounding 'leave trees' or oaks
2. Limbing and Topping	Remove all the trees limbs, while leaving one or two live-limbs farther down the tree. The tree is then topped to yield a 'snag'.	- Creates ecologically diverse habitats for animals - Monetarily expensive at $200-$350 - Relatively stable/safe—conducive for human use and recreation
3. Girdling	Cut through the cambium layer of the targeted conifer and spray with 50% glyphosate solution (Roundup). Ideally the cut will occur 10 feet from the base, where the tree will break-off and create a dead snag.	- Creates new niches for animals - Poses safety concerns -- dead limbs susceptible to fall during storm events

For more information consult a *Practical Guide to Oak Release* (Harrington et al. 2006) before facilitating conifer removal methods. Please note for the best oak release, conifer removal must occur before leaves of deciduous trees have flushed (fall through early spring). Failure to do so will expose released oaks to ill-adapted wavelengths of light and harm photosynthetic pigments of existing leaves.

Recommendation:

We recommend an integrated management using all three oak release methods (contingent on funding/grant procurement). In doing so, we aim to maximize diversity of habitat of standing dead wood, while maintaining the property as safe for recreational purposes.

In consideration of the recreational use goals of the Cozine Creek property and the safety risks posed by limbing/topping and girdling (options 2 and 3), professional consultation should be used in determining where to facilitate each treatment option. Furthermore, to protect the existing oaks from future invasion of conifer and broadleaf trees, small saplings and shrubs should be manually cleared (polygon G in figure 1.1). Unlike, larger conifer and broadleaf tree removal, this action can be completed in the short-term (less than five years).

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HABITAT

Tatiana Taylor

INTRODUCTION:

Habitat is a key component of ecosystems that provides shelter and food for wildlife. The Cozine Creek restoration project should focus on providing healthy habitat for native species of wildlife. On the Cozine Creek property we have two types of habitat, oak woodland and a riparian zone along the creek. The areas uphill from the flood zone of Cozine Creek are oak woodland. Oak woodland is characterized by 30-60% tree cover by Oregon white oak (*Quercus garryanna*) (Campbell 2004). Oak woodland is a critical habitat type important to a variety of species (Rosenberg and Vasely 2010). Numerous bird species can be found in the Cozine Creek Property, many important to the Willamette Valley and native to Oregon (list of birds observed on the property can be found in Appendix B). Large oak trees provide nesting for kestrels and other priority birds. There are 26 bird species that are highly associated with oak habitats in the Pacific Northwest (Altman and Stephens 2012). Acorns from Oregon white oak trees provide food for woodpeckers and nuthatches, including the declining white-breasted nuthatch. Native bunchgrasses that could be established in the oak woodland provide nesting areas for the western meadowlark (Boyer 2010). Another important part of the oak woodland ecosystem is pollinators that also are declining in number. There are 16 native bumble bees in the Pacific Northwest (list in Appendix B). Pollinators benefit the ecosystem and are important to agriculture (Pokarney 2017). The other major habitat on the Cozine Creek Property is riparian woodland. Downed logs are important to riparian species because they alter flow and are often used as homes. Species that benefit from riparian areas include northwestern salamander, long-toed salamander, ensatina, western toad, and the Pacific tree-frog (Woodland Fish and Wildlife 1997, Wegner 2003).

SUMMARY ASSESSMENT:

According to the 2016 ENVS 485 (Environmental Problem Solving) class's Cozine Creek Inventory and Assessment, 54 species of birds have been observed on the property, all of which are listed by the IUCN to be of least concern. Many of the birds are adapted to Oregon

white oak habitat, including the white-breasted nuthatch that is declining due to the loss of oak habitat. Other birds that rely on the Oregon white oak include mourning doves, acorn woodpeckers, downy woodpeckers, and American goldfinches (Gernhart et al. 2016). Acorns are important fall and early winter food for many species of wildlife including acorn woodpeckers and squirrels (Audubon 2017). Forty-two species of mammals have the potential to live on the property, but only 11 have been observed. The majority of the mammals are common such as black tailed deer (ODFW 2016a). There are bats on the property, but last year's class was not able to identify them. We could have Townsend's big-eared bats, a sensitive species found in the Willamette Valley (ODFW 2016b). We also have nutria, an invasive species. These rodents dig up roots, causing banks to collapse, and disrupting the riparian zone (ODFW 2016a). We have very poor data about the reptiles and amphibians on the property, and little to no data about the invertebrate species present (Gernhart et al. 2016). We recommend the following goal and action steps to improve and sustain the Cozine Creek Property for habitat for wildlife.

GOAL AND ACTION STEPS

Restore and maintain native vegetation that will provide shelter and food to native wildlife.

- Reduce invasive vegetation

  Removing invasive plants will allow the native vegetation to increase, providing better and more stable habitat for animals already making a home in the Cozine Creek Property.

- Let standing dead wood and downed woody debris decompose naturally

  Many types of birds use cavities in oak snags or dead branches as homes. Many animals, including flying squirrels and wood ducks, nest in cavities. Woodpeckers eat insects from snags and create cavities for other birds. The number of snags and cavities is often a limiting factor to populations of cavity nesting birds (Altman and Stephens 2012). If the dead tree must be downed for safety reasons, leave it in place as downed woody material to provide habitat for animals such as bats, beetles, and pacific tree frogs (ODFW 2001).

- Attract pollinators by incorporating native flowering plants

  I recommend the planting more flowering plants to attract pollinators such as bees and butterflies. Important plants include western trillium *(Trillium ovatum)*, tufted hairgrass *(Deschampsia caespitosa*), and Roemer's fescue *(Festuca roemeri) (*WMSWCD 2017), but there are many others. Willow will attract pollinators early in spring. The Xerces society has a table outlining native plants on their web page (Xerces Society 2015).

- Improve habitat for birds and bats to nest and roost

  Installing bird and bat houses on the property will increase the abundance of many species. Many bird species require snags and cavities for nesting. I recommend installation of bird and bat houses provided by Tom Brewster. Bats provide an ecological control for insect species and are vital to an ecosystem. Bat houses need to provide adequate temperature variance. Bats roost in cavities or under bark; bat boxes can provide roosting areas in the Cozine Creek area (Woodland Fish and Wildlife 2017,Altman and Stephens 2012).

ADDITIONAL CONSIDERATIONS

Increase our knowledge of the wildlife present.

- Increase our understanding of wildlife on the property

  A large challenge in restoring wildlife habitat is our lack of knowledge on what is on the property. Few mammal sightings have been made. I recommend using trail cameras to help increase the list of larger mammal species on the property. We have small animal traps that could be used to document small mammals. Bird counts could be done to better document species that breed on the site; we could also observe what species use the bird houses after they are installed. Several bat species of conservation interest may be present on property but we have not identified what we have. I recommend a bat survey. The U.S. Fish and Wildlife Service procedure can be found in Appendix B (Barnett 2014).

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WATER QUALITY

Shelby Thomas

INTRODUCTION:

The water quality variables of dissolved oxygen (DO), biological oxygen demand (BOD), pH, temperature, flow, turbidity, nutrients (nitrate, phosphate, and ammonia), bacteria (*Aeromonas*, *E. Coli*, *Salmonella*, and other coliforms), and macroinvertebrates are important in ascertaining the health of the aquatic environment. Many of these variables are related to each other, so changing one variable can help others. DO measures how much oxygen is available for use in the water and tends to be higher in areas of moving water; as temperature increases, DO decreases. Turbidity is the clarity of the water; areas that have low clarity often have decreased productivity and reduced habitat quality. Nutrients and bacteria can enter from agricultural lands, urban landscapes, or sewage leaks (USGS 2017). Excess nutrients can lead to eutrophication that promotes algal blooms. As organic material (like dead algal cells) is decomposed by bacteria, DO is used and reduced, and BOD increases (Nadakuvukaren 2011). The sewage lines adjacent to Cozine have leaked in the past, causing high *E. Coli* levels until the source was discovered and fixed (Gernhart et al. 2016). Studying macroinvertebrates is a good way to examine water quality and health of the system because population numbers directly correspond to the levels of dissolved oxygen and pollution. The presence of macroinvertebrates also influences higher trophic levels because they serve as a food source to support other levels (Wallace and Webster 1996).

SUMMARY ASSESSMENT:

Flooding:

Cozine Creek has a drainage area of 11.3 square miles from agricultural and urban lands (FEMA 2010). The major rainfall events that happen in this area between December and February cause the Linfield property to flood quite often. Because most of the area is agricultural or open spaces, the area can be used as floodwater storage during seasonal flooding, reducing the hardships put on human development during flooding months (Yamhill County 2009).

The Linfield College owned reach of Cozine Creek is in the middle of the urban portion of the City of McMinnville. Higher volumes of water from flooding often occur in urban areas because of impermeable surfaces such as roofs or roads. These structures reduce absorption of water into the soil and increase runoff into streams. Structures in the stream (e.g., bridges and culverts) can also increase upstream flooding by narrowing the channel and increasing the resistance to flow. The Linfield College property has two culverts and one bridge. Debris and sediment add to the constriction by collecting and building up in undersized culverts, which increase flooding. Lastly, flooding that occurs in urban streams frequently can result in channel straightening, loss of vegetation, increase in sediment, and bank erosion (all seen on the Linfield College property) (Figure 3.1). Flooding events tend to be more pronounced in areas that have moderate storms followed by dry periods, such as in McMinnville (USGS 2016)

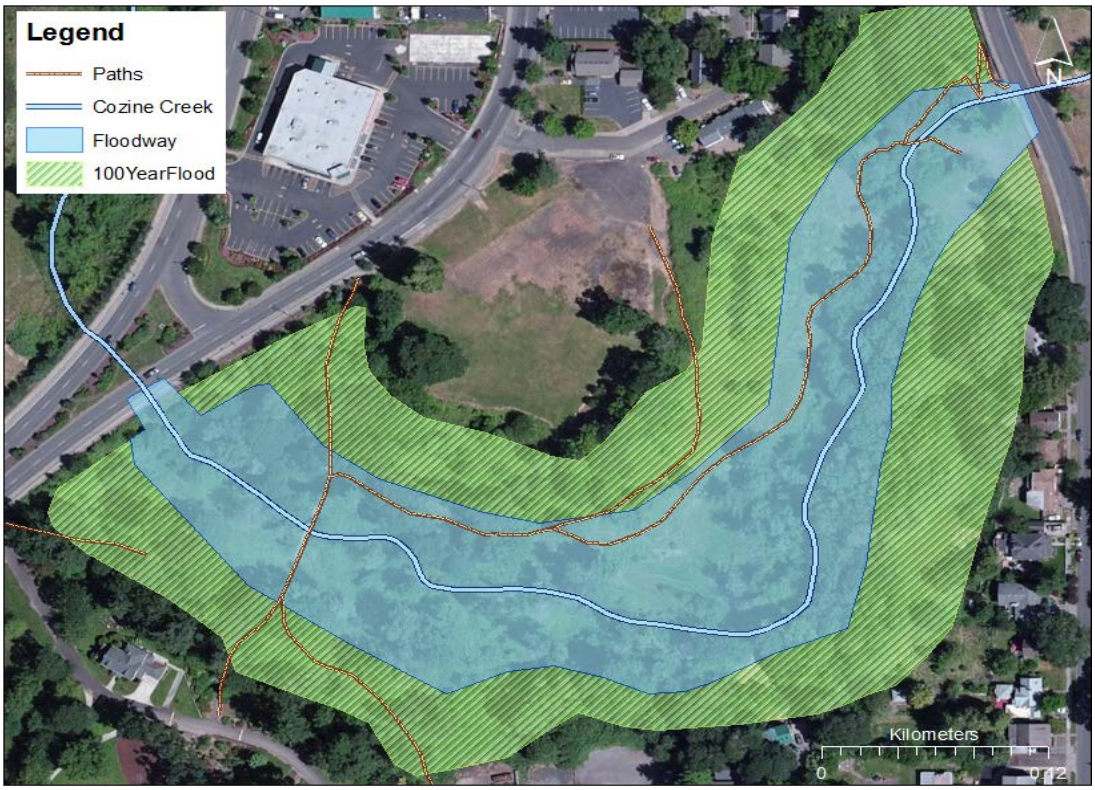

Figure 3.1 Floodway and one hundred year flood zone in Cozine Creek (Map by Rachel Blanco 2017).

Stormwater is another important concern on the Cozine Creek property. The City of McMinnville Storm Water Master Plan relies on the waterways in the lower Yamhill watershed to create a perimeter endpoint for stormwater storage. The drainage happens by pipes and also in naturally open areas (Figure 3.2). McMinnville also has an Urban Growth Boundary (UGB) that is about 11,505 acres; two-thirds of this area currently drains into Cozine Creek. The drainage system in McMinnville is generally adequate except some drains were designed for two year or less flood events. There currently is no requirement imposed by the Environmental Protection Agency (EPA) on the quality of stormwater because McMinnville is too small of a city (Yamhill Basin Council 2001). Storm water enters the Cozine Creek property at many different points. First, there are two pipes that channel water from Baker Street and enter adjacent to the culvert. Second, there are several pipes that enter at six various locations along the creek. Lastly, there is a pipe that comes in above the Davis Street culvert (Gernhart et al. 2016).

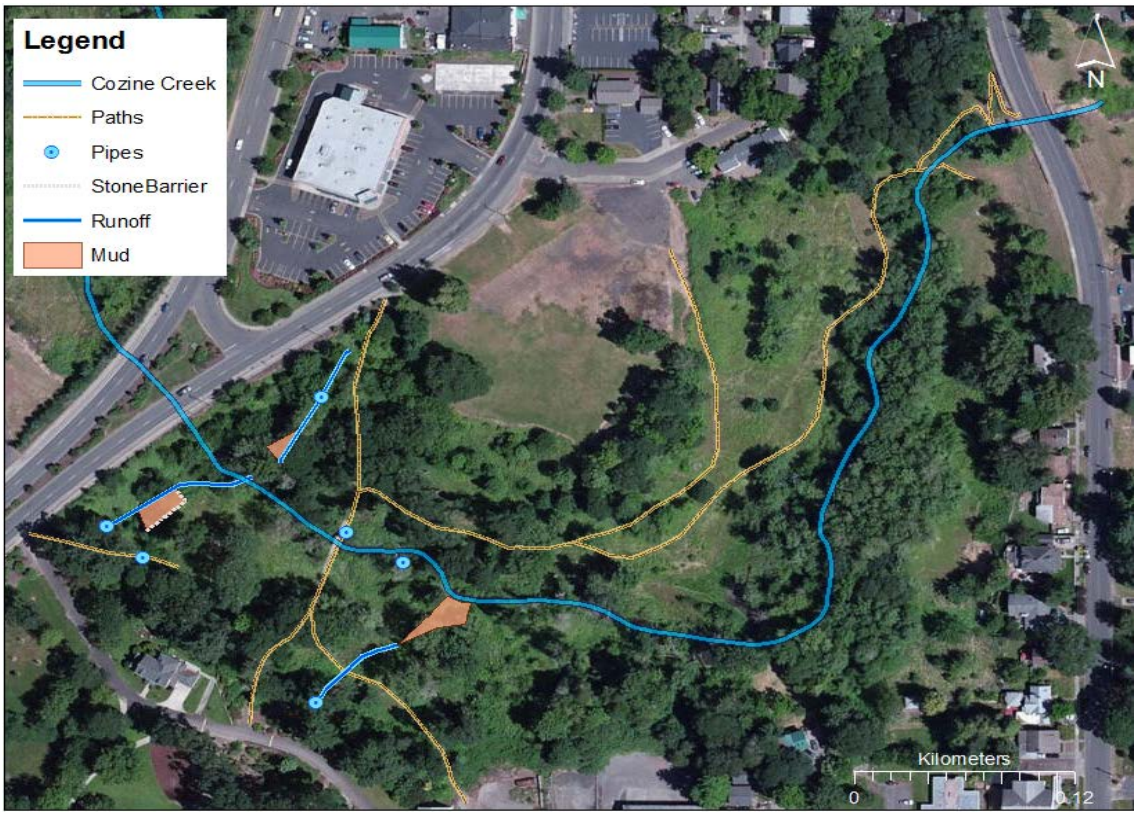

Figure 3.2 Sewer manhole covers and stormwater pipe placement (Map by Rachel Blanco 2017).

Erosion:

Erosion can occur naturally in streams for three main reasons. One, due to a change in the flow of the stream. Seasonal changes in rainfall and large storm events can cause natural differences in flow depth as well as velocity. As flow depth and velocity increase, the water flowing has more force against the streambank, which removes soil particles causing erosion. Second, water flowing over the streambank from rainfall and runoff also can remove soil particles and lead to erosion. Lastly, the large amount of the discharge of water discharged from the drainage systems can lead to erosion, especially in areas of the bank that are unstable (USDA 2017a).

Riparian buffers provide crucial water quality benefits to the stream. They are a complex system that can give food and habitat to the community as well as help control and mitigate nonpoint source pollution. Additional beneficial effects on water quality include removing excess sediments and nutrients from runoff, shading the stream to provide optimal light and temperature for aquatic animals and plants, ameliorate effects of some pesticides, and provide erosion and sediment control (USDA 2017b). Areas on the Cozine Creek property that are lacking a riparian buffer also experience erosion problems due to the rainfall events that contribute to bank erosion. One area of particular importance is the buffer zone downstream from the bridge.

Water Quality:

Data collected by the students in the ENVS 385 (Research Methods in Environmental Science) courses show that Cozine Creek has low pH and DO; and high BOD, coliform bacteria, phosphate, water temperature, and turbidity (Colahan et al. 2011; Bailey et al. 2012; Hollenbeck et al. 2013; Fahy et al. 2014; Blanco et al. 2015; Cowell et al. 2016). Tests in spring 2016 found levels above those recommended for nitrate and turbidity (Yamhill Basin Council 2004; EPA 2015). These elevated levels can harm fish by clogging gills and reducing birth rates (USGS 2015).

From fall 2015 to 2106, Cozine Creek has seen a decrease in DO, BOD, phosphate, *Aeromonas*, *Salmonella*, and other coliforms; pH, temperature, flow, ammonia, and nitrate have

remained about the same. The qualities that do not meet the minimum requirements are flow (in 2015), nitrate, and phosphate (Table 3.1).

Table 3.1 Measured average and recommended levels of water quality variables for freshwater. Recommended levels are from the Yamhill Basin Council 2004 and the EPA 2015.

Variables	Recommended levels of freshwater quality	Fall 2015	Spring 2016a	Spring 2016b	Fall 2016
DO (%)	N/A	58.84	X	X	45.63
BOD	N/A	14.16	X	X	5.73
pH	6.5-8.5	7.18	7.2	7.47	7.3
Flow (cm/s)	20 cm/s (minimum)	3	29.5	19.7	7
Temperature (°C)	18°C (maximum)	16.64	10.5	11.6	15.9
Turbidity (FTUs)	10 FTUs (maximum)	9.49	259	0	5.95
Ammonia (ppm)	0.2 ppm	0.14	0.169	0.13	0.2
Nitrate (ppm)	2 ppm	2.6	6.6	5.28	2.5
Phosphate (ppm)	0.1 ppm	0.31	0.165	0.07	0.07
E. Coli (# per 100ml)	406 per 100ml of water	25	20.1	0	5.7
Aeromonas (# per 100 ml)	N/A	126.7	116	30	10.4
Salmonella (#per 100ml)	N/A	30	77	4	5.2
Other Coliforms (# per 100ml)	N/A	25	3	0	5.6
PTI Intolerant (#)	N/A	9	X	X	8.4

Macroinvertebrate data collected by students in ENVS 385 (Research Methods in Environmental Science) courses indicate that Cozine Creek had PTI (pollution tolerance index) scores for macroinvertebrates under 10 for 2013 through 2016, indicating poor water quality (Hollenbeck et al. 2013; Fahy et al. 2014; Blanco et al. 2015 Cowell et al. 2016) (Table 3.1).

Fish:

Cozine Creek could potentially provide habitat for many native species (Table 3.2) (ODA 2013). Oregon Department of Fish and Wildlife (ODFW) have recommended that another fish inventory be done because it has not been tested for two decades (ODFW 2010).

Table 3.2 Aquatic invertebrate and fish species that are likely to be found in Cozine Creek as reported by ODFW (White 1995; Giannico et al. 2014).

Common Name	Scientific Name
Reticulate and prickly sculpin	*Cottus sp.*
Speckled dace	*Rhinichthys osculus*
Longnose dace	*Hinichthys cataractae*
Redside shiner	*Richardsonius balteatus*
Threespine stickleback	*Gasterosteus aculeatus*
Northern pike minnow	*Ptychocheilus oregonensis*
Largescale sucker	*Catostomus macrocheilus*
Signal crayfish	*Pacifasticus leniusculus*

Cozine Creek has three main culverts, two of which are located on the Linfield property. One culvert is under Ford Street, 0.3 miles downstream of Linfield College. This culvert acts as a barrier and prevents juvenile fish reaching the College property because of high water velocity. The second culvert is under Davis Street, and the third is under Baker Street. These culverts impede fish migration and movement and block use of upstream areas of Cozine Creek from serving as spawning ground (Gernhart et al. 2016).

Cutthroat trout are native to Cozine Creek; however, because of increased water temperature and nitrate, and deteriorated riparian zones, they have not been seen in many years (ODFW 2010). Winter steelhead trout are also native to this area. Cozine serves as part of their spawning habitat; the Linfield College owned portion is designated steelhead habitat by ODFW. Due to culverts blocking migration upstream of Ford Street, as well as poor water quality, they have not been seen (Yamhill Basin Council 2001; White 1995). Because water quality is important for the protection of human health and viability of native fish and other aquatic species, we recommend the following goals and action steps.

GOALS AND ACTION STEPS:

Improve water quality and habitat for native species.

Improving water quality on the Cozine Creek property would help create better habitat that would foster a more native and complete aquatic ecosystem.

- Replant creek bank with native species

  Planting of native species along the creek would help decrease erosion, stabilize the bank, provide sediment control, filter pollutants from runoff, and help increase water quality. Water quality variables that could be significantly changed include water temperature (from shading by vegetation), DO (due to shading and decreased water temperature), turbidity (due to sediment control), and nutrients (due to the filtering characteristics of plants) (USDA 2017b); refer to the Vegetation Chapter for planting details. A table showing the recommended buffer widths can be found in Appendix C. A rough minimum buffer width should be 30 feet to have a positive effect on each variable. However, the soil class, bank height, bank slope, and vegetation mix are important considerations due to rainfall, rate of absorption, type of vegetation, etc for an effective buffer (Yale 2005).

- Stabilize stream bank and reduce erosion.

  In areas that need riparian restoration, willow stakes can be used to increase stability and reduce erosion. Small to medium sized shrubs and creeping types of willows are best for use within channel banks. Depending on size and form of mature specimens, some may deflect currents or block stream flow if they get too big. The species chosen should be native to the area (USDA 2007a). A full list of commonly used willows can be found in the Appendix C. A detailed guide to using and planting willow stakes also can be found in the Appendix C.

  1) Willow stakes can be harvested or bought. Willow bundles of 100 count vary from $119-269 depending on size (Whole Sale Nursery 2017). However, we have willow on site and could get cuttings from them.
  2) Testing of willow stakes should be done before full scale implementation. Willow stakes can be harvested and used in test plots which should include areas with and without shrubs and within the riparian buffer. Testing different areas along the bank as well as different heights above summer water level could provide information on how well the stakes can handle flooding, stabilize the bank, and/or reduce erosion.

Using wattles also could help decrease the velocity of water, reduce runoff, and provide sites for seeds/plants to grow. The area along Cozine Creek that needs additional stabilization is adjacent to the bridge. It receives high velocity water that has eroded the stream sides (Figure 3.3). Use of wattles would help reduce bank erosion and sedimentation (Donat 1995). Although willow wattles are commonly used and cheaper, coconut wattles last longer (C. Thomas, personal communication, March 2, 2017). Coconut wattles in quantity of three, 12 inch diameter and 10 feet lengths can be purchased for $242 (Granite Environmental Store 2017). This would need funding, but it could provide restoration in areas that need the most help such as the banks along the bridge that have been worn down due to flooding.

Figure 3.3 Deteriorated areas of bank along the bridge. The GPS coordinates of this area are N45.20316, W123.19923.

ADDITIONAL CONSIDERATIONS:

Points in this section were separated from the action steps because, although equally valuable to action steps, they are not directly affecting water quality variables but still are important to consider.

- Partner with other colleges

  Other colleges in the area might be able to help with some projects. An exchange system could be set up to assist colleges to find resources they need to help with projects; this could include sending samples to another college's lab if they have the equipment needed for a specific test or sending each other materials. This provides more opportunities for research and creates a community of resources.

- Keep in contact with McMinnville

  Another consideration is the size of the culverts. The culverts are undersized, which poses many problems to the Cozine property. However, this is something McMinnville would have to change in the future. McMinnville should also implement some kind of green infrastructure in the future to reduce runoff. (Permits are also something to consider for some projects and a permit guide can be found in Appendix C).

- Continue monitoring water quality

  The ENVS 385 (Research Methods in Environmental Science) classes have done water quality testing beginning in Spring 2011 and have provided a lot of information about Cozine Creek. They should continue to do testing. The main water quality variables that can be influenced are the water temperature, DO, turbidity, and nutrients. Testing can provide educational opportunities for students, as well as raising awareness in students and the community. Testing should be expanded from fall into the spring and summer months to provide more information. Expanding testing sites upstream and downstream of the Linfield property will provide additional information. Data loggers may be useful for getting additional measurements such as water depth and would be a more precise

tool for measuring temperature (Steve Hanson, personal communication, March 13, 2017).

- Do additional monitoring and testing.

  A fish inventory has not been done in over two decades, and a new one would provide an updated list (ODFW 2010). Additionally, inventory of the substrate and habitat areas could help direct restoration projects. Dave Stewart, a stream restoration USFS biologist, has volunteered to help do an inventory by electroshock when the flow is low enough (summer). He also has offered to walk the creek to survey where natural patches of gravel and woody debris are when the creek is low. Areas with gravel and woody debris are potential habitat areas (Dave Stewart, Personal communication, March 23, 2017).

  Cozine creek is an area that experiences a lot of flooding and storm water, but we do not know the effects the frequent flooding is having on the creek, nor do we know what is being brought into the system in storm water. More information could help develop a better restoration plan. This could provide research opportunities through Linfield College or outside agencies. Dave Stewart recommended contacting the Oregon Department of Transportation (ODOT). They are working on analyzing the contents of runoff as well as investigating ways of treating it (Dave Stewart, Personal communication, March 23, 2017). Talking to people in McMinnville city government could give information that could help calculate the amount of runoff that enters Cozine Creek. Testing should be done to determine the amount of flow coming off roads, how much storm water the property receives, and what is in the storm water.

- Install green infrastructure.

  Linfield College could install green infrastructure (e.g., bioswales) to help reduce runoff from the campus into the creek. This would not require city approval because it is on private property. A test bioswale would allow the college to examine the potential for green infrastructure. Linfield College could use this as a drawing point to the college. Javier Mendoza should also be included when deciding where to place the green infrastructure.

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SOCIAL USES

Sarah Stark and Alaire Hughey

INTRODUCTION:

The Cozine Creek Property is an important and yet underutilized resource for the college. Despite its potential, the property's low accessibility, low integration into curricular activities, and disjointed stewardship have reduced its use. In this chapter will use the 2016 ENVS 486 (Environmental Problem Solving) class's Cozine Creek Inventory and Assessment to discuss land use history, current management of the site, and barriers to use (Gernhart et al. 2016). We will use this data to propose goals and specific action steps to enhance the utility of this resource. We hope that this will be a useful guide in leveraging the Cozine property as a resource for student use and as a connection between our campus and the greater community.

SUMMARY ASSESSMENT:

Land Use History:

The Cozine property has supported a long history of cultures and peoples. Archeological evidence point to at least 6,000 years of habitation of this region by the Yamhelas Tribe of the Kalapuyan Nation. Their complex cultural system co-evolved with the local ecology of the watershed and still exists in those now known as the Grand Ronde Confederated Tribes. The Yamhelas tribe primarily subsisted on local plants and wildlife such as camas, wapato, tarweed seeds, hazelnuts, various species that produce berries, small mammals, deer, birds, fish, and grasshoppers, many of which are still currently found in the Cozine property. In 1865, white colonists forcefully moved those not murdered or killed by European disease onto the Grande Ronde Reservation. Between the mid-1800s and late 1960s, Yamhill County transitioned into the agricultural area we know today. The urban center and residential areas of McMinnville began expanding in the mid-1900s (SWCA 2011).

Linfield College was established in 1858 and has had a long relationship with Cozine Creek. There were two historic bridges that crossed the Cozine area; the first bridge was once the edge of town and led up to the front stairs of Pioneer Hall. It was often referred to as "Linfield Lover's Lane." The more recent footbridge, which allowed wildlife and water to flow easily

underneath, was torn down in the summer of 1960 due to high maintenance and costly repairs (Figure 4.1). Shortly after, the property was named Storey Park in honor of an English Professor at the college. A homecoming tradition of “tug-o-war” between classes was held, with opposing teams on either side of the creek. Nearby, the now empty lot north of the Cozine property was once home to Columbus School that was destroyed in an earthquake in 1993 (Gernhart et al. 2016).

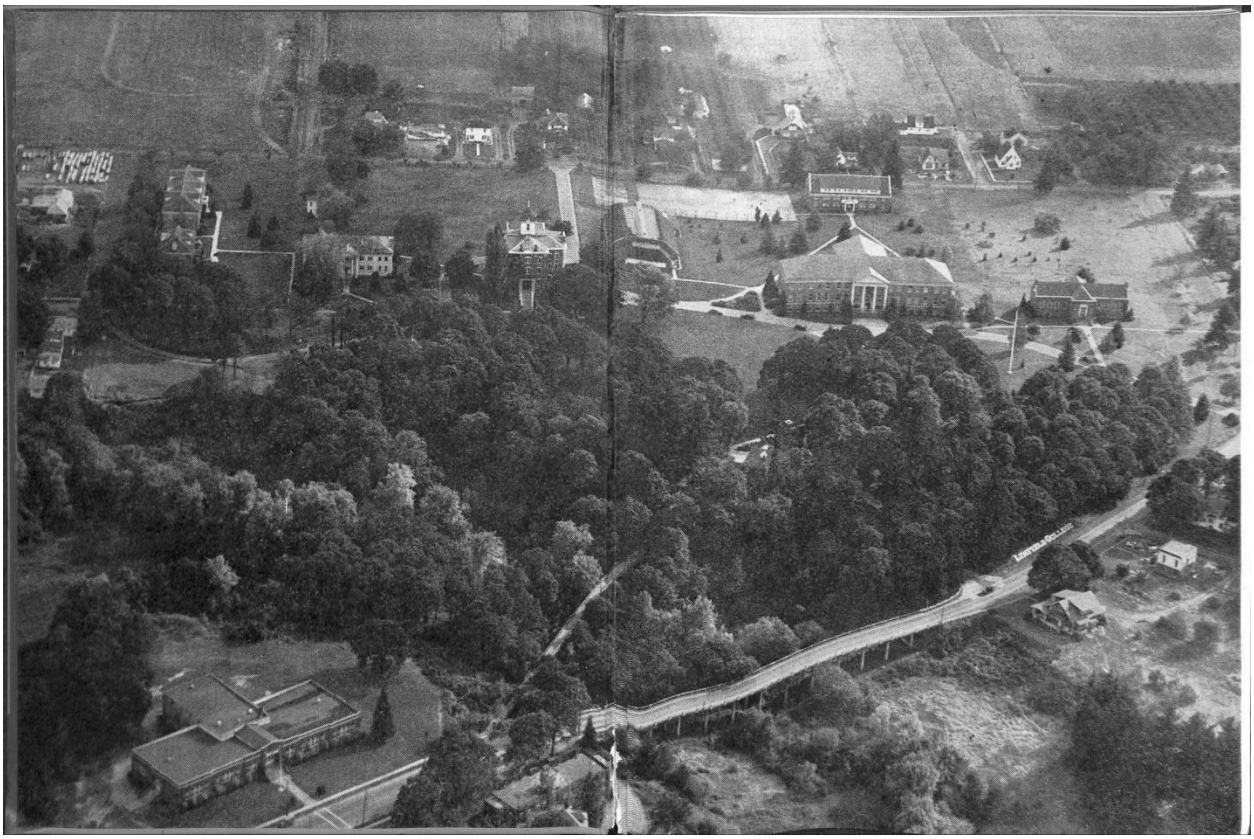

Figure 4.1 An aerial view of the footbridge leading through the trees and the old Columbus School (located in the lower left hand corner). The Baker Street bridge (Highway 99) forks to the right (Linfield College 1946).

Current Use and Management:

Today, the Cozine property is bound by Highway 99 to the north and west, Davis Street to the east, and the Linfield College campus to the south and west. The Greater Yamhill Watershed Council (GYWC), a 501c3 non-regulatory, non-profit organization, is dedicated to

helping local communities steward the lands and waters in the Yamhill and Chehalem Valleys (GYWC 2016). In the fall of 2016, students from the Environmental Studies Department began collaborating with the GYWC to organize restoration work parties to remove invasive species such as Himalayan blackberry and English ivy. There has been a partnership with the GYWC and Linfield College since spring of 2016 through the ENVS Department class projects and internship opportunities. A Memorandum of Understanding was established between Linfield, the GYWC, and the Yamhill Soil and Water Conservation District with a common goal of improving the stewardship and experiential learning opportunities (Linfield College 2017).

Linfield Facilities Services has done the bulk of the restoration and maintenance work on the Cozine property. The grounds maintenance staff mows twice a year as a preventative measure for fires. They also manage the blackberries with different methods including herbicides and hand trimming (Gernhart et al. 2016). Recently, there has been work to maintain the trails in the Cozine property although the frequent flooding makes this a difficult task.

Due to recent student interest in the property, there has been an increase in student-led service projects to restore the Cozine property. Projects typically focus on invasive species and trash removal, although educational components are included to connect and inform participants about the greater social and ecological context of the property. Current uses include class visits, research projects, bird watching, service projects, and recreation (walking, reading, etc.). Professors from Environmental Studies, English, Biology, History, Anthropology, and Sociology bring their classes to the Cozine property to provide an outdoor learning experience (Gernhart et al. 2016).

However, despite facilities maintenance and student interest, there are significant barriers to a healthy Cozine property. Facilities lacks the funding and personnel to fully restore and maintain the property. Muddy and steep trails create accessibility issues. Restoration efforts have been sporadic due to dependence on student and faculty interest. Maintenance has been a low priority that results in the property appearing to be unkempt especially when compared to the rest of campus.

In fact, the survey of Cozine Creek stakeholders and landowners from which our goals were formed, found that 13% of respondents considered the area surrounding Cozine Creek to be well maintained. Even if we were to restore Cozine to the vision we have for it, without a

positive public perception or general use of the area, our efforts would be in vain. Thus, we must facilitate our action steps through as much community-based restoration efforts as possible. Hence, we recommend the following goal and action step.

GOAL AND ACTION STEPS:

Cultivate stewardship and facilitate access and educational use.

- Facilitate access and appropriate use through control of water and stabilization pathways

  Waterflow across the current access paths needs to be channeled to prevent erosion and sedimentation into the stream. A culvert or similar structure should be placed on the primary access path below Newby hall where water is currently flowing and actively eroding the pathway. Waterbars should be placed in areas near the access points to prevent further downcutting and erosion of the trail (Figure 4.2). The pathways also are seasonally muddy, which discourages use and restricts student, maintenance, and CPS access to the property. Placing gravel on the muddiest areas may allow safer use of the Cozine property (Birkby 1996).

Figure 4.2 An example of trail erosion beneath Newby Hall at the southeast entrance to the Cozine Property (photo by Bill Fleeger, April 2017).

- Encourage stewardship through community-based work parties

We recommend using the pre-existing community and campus partners to create structured, consistent work parties. On campus, our partners include Linfield Facilities Services, Change Corps, The Office of Sustainability, Greenfield Club, and the LEAF Community (Leaders in Environmental Action Fostering Community). In the greater community, our partners include the city of McMinnville, Greater Yamhill Watershed Council, Yamhill Soil and Water Conservation District, Duniway Middle School, landowners up and downstream of us, and the citizen stewards of the Cozine Coalition. We recommend the expansion of partnerships to involve more of the community.

These partnerships will facilitate consistent community-based work parties (we recommend monthly, but acknowledge unforeseeable future variation in community needs and leadership structure). Following the action steps outlined in the vegetation section, we suggest an emphasis on community-based, manual restoration when possible, as opposed to relying entirely on efficient, mechanical methods because literature has shown that involving local people often engages the community in the ecology in such a way as to increase the overall, long-term efficacy of restoration (Leigh 2005). Involving citizens in local science and restoration can increase community resilience (Adger 2000), early detection of environmental disturbances, social capital of participants, and citizen inclusion in local issues (Conrad and Hilchey 2011). For example, Prescott College in Arizona has had ongoing restoration projects for over two decades that focus on community engagement and collaboration. A main goal of the restoration project is to provide accessible and non-technical information in the form of signage about the work to the local community so that anyone, regardless of education level or background, can understand and engage with the project (Prescott College 2014) (Figure 4.3). The student group also strives to make their volunteers have an enjoyable time by starting off with a pancake breakfast, local coffee, or birdwatching. By incorporating fun activities along with removing invasive species, there is a higher likelihood for volunteer retention (BCRC, 2016).

Thus, we suggest regular work parties that involve the previously mentioned partners in a way that encourages community. Though this recommendation is subject to interpretation of future stewards, we suggest that work parties involve education, enjoyable activities, and minimizing unpleasant labor to the extent possible while still being efficient. See Appendix D for full work party agenda and educational materials.

- Promote appropriate educational uses of the property

  We recommend an inclusion of the Cozine property on the official Linfield map so that more campus and community members know of its existence. We also suggest readily available interpretive materials in the Cozine property including laminated labels of key social and natural features to encourage learning through appropriate use of the Cozine property.

  Finally, we recommend the creation of a stewardship internship, perhaps in conjunction with the Office of Sustainability. The student manager would be in charge of long-term restoration and maintenance further expanded upon in other chapters. This intern would have the opportunity to learn the involved ecology, biology, environmental science, and restoration policy. In addition, they would coordinate with the previously stated stakeholder and partner groups. Furthermore, they would help coordinate student work parties and restoration projects, allowing them great opportunities in community organizing. This position would not only provide valuable experience to students interested in environmental management, but also facilitate the implementation of the previously mentioned action steps in the long term, namely encouraging stewardship through community-based work parties and facilitating appropriate use through control of water and stabilization of pathways. This internship would be the mechanism through which our goal of cultivating stewardship by facilitating access and educational use ultimately will be achieved.

ADDITIONAL CONSIDERATIONS:

- Development of designated spaces for education and recreation

  In the long-term, we believe stewardship and education can be facilitated through infrastructural expansion. We suggest the creation of safe, appropriate "hang out spots" for students to enjoy. We recommend the installment of benches and picnic tables in scenic areas, so students can study, read, or hold picnics when the weather is nice. We believe that this could enhance student value and participation in the property.

  Someday, we would like to see the creation of an outdoor classroom to allow for more interdisciplinary educational use of the Cozine property, as seen at George Fox. This could engage students in the property as well as the environment in which they live. For more information, see Appendix D.

- Expansion of curricular educational programs

  In the long-term, we suggest the expansion of the pre-existing curricular programs as well as new programming to include the Cozine property in classes that have not done so previously. We believe that greater educational use also may encourage students to care about, and participate in, the restoration of the Cozine property. For more information, see Appendix D.

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MAPS

Rachel Blanco

INTRODUCTION

Whenever discussing a topic related to geography one of the most useful tools for conveying vital spatial information is the map. Maps allow an overhead view of an area that helps visualize the relationships between important features that would otherwise be difficult or impossible to see from the ground such as the full extent of the Himalayan blackberry invasion in the Cozine Creek area. When data is taken over a long period of time maps can also be used to chart the progress of removal projects or the spread of unwanted invasive species over time.

SUMMARY ASSESSMENT

Within last year's ENVS 485 (Environmental Problem Solving) class's Cozine Creek Inventory and Assessment, readers are visually provided with information about the flood patterns in the Linfield Cozine Creek area, distribution of tree species in regards to those flood patterns, areas of concentrated invasive Himalayan blackberry and native camas lily, locations of storm water pipes, light fixtures, paths and trails, and in the appendix, a map of the creek's entire length (Gernhart et al. 2016).

The goal of maps within documents such as the assessment should be to quickly and clearly display spatial information in a way that enhances understanding of the document as a whole. To achieve this the included maps must be placed correctly in regards to the relevant textual information. The assessment frequently provides detailed text descriptions of Cozine Creek's spatial properties and watershed, however it does not always accompany these with maps. While not all of these descriptions warrant a map, many of them are complicated and difficult to understand without a visual aid, and comprehension could be improved by their use. The topics are revisited multiple times, but those maps that are available are not always brought up with the first mention (i.e, the distribution of invasive blackberries). It may help to either be sure maps are included with the first mention of an issue and the page number referenced in future mentions or concentrate the maps within their own section of a paper to be referenced throughout (Gernhart et al. 2016).

Maps being used to enhance documents such as this must take into consideration printing and accessibility. In regards to printing, these images may be printed in black and white if used in an academic context. If a map has too little contrast or relies entirely on color to convey information this can render it useless once in a physical format. Similarly, there exists a part of the population that is not able to fully differentiate color. For color-blind individuals, maps can be rendered unreadable even in their natural full-color digital formats by lack of contrast and use of color as the only indicator among categories. Many of the maps in last year's assessment fall into this category. In the future it would be extremely helpful to use different shapes, line thicknesses, and fill patterns as well as color to separate areas of information to improve accessibility (NEI, 2015).

All of the spatial analysis including mapping is possible through the use of programs such as ArcMap, a tool of ArcGIS. ArcMap is a program that facilitates the analysis and conversion of datasets into usable maps that can be printed, or shared digitally (ArcGis, 2016).

GOALS AND ACTION STEPS:

Provide accurate and up to date visual representations of the important features of the Cozine Creek area that will aid in decision making regarding the restoration project.

- Provide readable, accessible, printable maps of the Cozine Creek area and restoration project.

  Ensuring maps are easily interpreted by the general reader as well as those already familiar with the area will facilitate communication between restoration organizers and volunteers/workers. Creating maps that are readable by those with color vision impairment, as well as when printed in grayscale, will make them more accessible as well as reducing cost in physical distribution.

- Facilitate decision making within the restoration project

  Through the collection and visual depiction of data related to the project decisions about which areas need to be focused on most immediately can be created and conveyed quickly and easily, reducing confusion or misinformation between coordinators and volunteers.

- Chart the progress of the removal of Himalayan blackberry and other invasive species.

  Remapping the distribution of invasive species over time will provide both spatial data and a visual representation of the success or failure of removal projects. Doing this in tandem with test-plots can also provide data about efficacy of various removal methods.

MAPS:

Figure 5.1 Polygons overlaying the Cozine Creek property showing Himalayan blackberry invading native camas lily habitat.

Figure 5.2 Polygons overlaying map of Linfield Cozine creek area showing areas of invasive Himalayan blackberry.

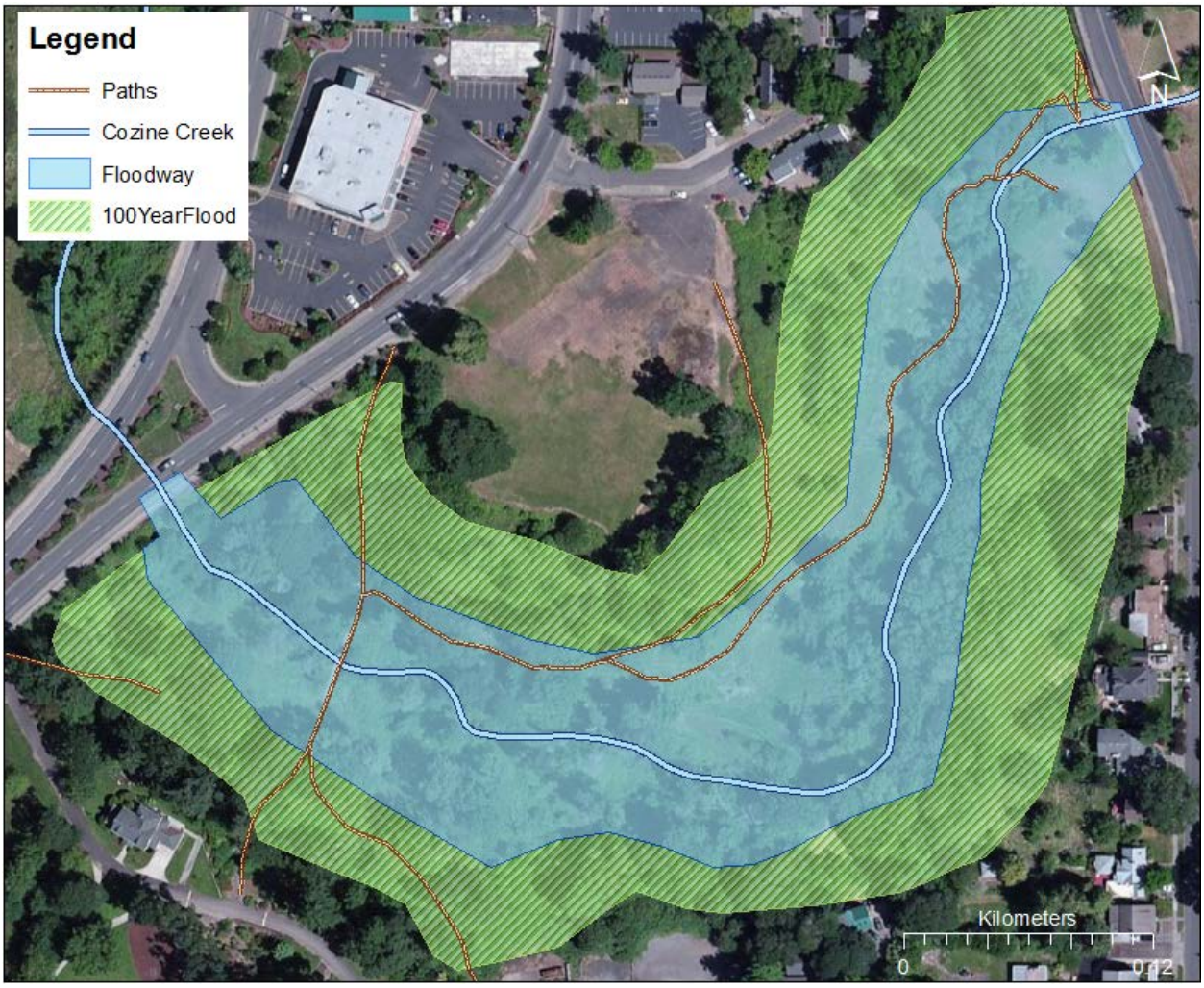

Figure 5.3 Blue polygon indicates the area of yearly floods outlined with green striped polygon indicating 100 year flood zone.

Figure 5.4 Map indicating location of stormwater pipes, the paths of their runoff, and resulting accumulations of mud

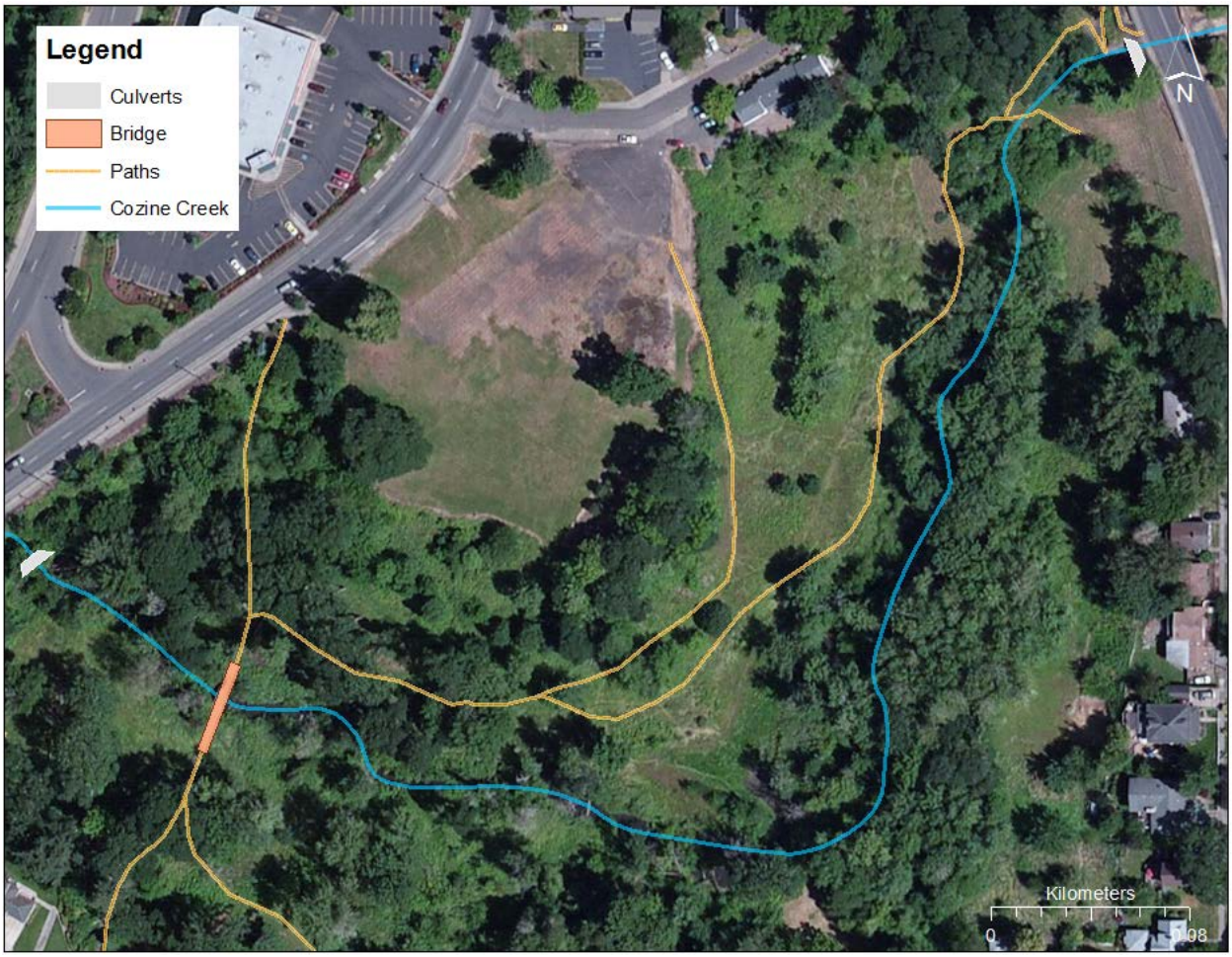

Figure 5.5 Map indicating the locations of culverts and footbridge in relation to roads and pathways

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APPENDICES

APPENDIX A:

Recommended tree and shrub species to be planted in upland woodland habitat.

Upland tree species	Scientific Name	Tree (T) or Shrub (S)
Oregon white oak	*Quercus garryana*	T
Oregon ash	*Fraxinus latifolia*	T
Bigleaf maple	*Acer macrophyllum*	T
Pacific madrone	*Arbutus menzeisii*	T
Western hemlock	*Tsuga heterophylla*	T
Grand-fir	*Abies grandis*	T
Pacific Yew	*Taxus brevifolia*	T
Western red-cedar	*Thuja plicata*	T
Vine maple	*Acer circinatum*	T
Tall-Oregon-grape	*Berberis aquilifoliaceae*	S
Salal	*Gaultheria shallon*	S
Snowberry	*Symphoricarpos albus*	S
Thimbleberry	*Rubus parviflorus*	S
Sword fern	*Polystichum minutum*	S
Bracken fern	*Pteridium aquilinum*	S
Ocean spray	*Holodiscus discolor*	S

Recommended tree and shrub species to be planted in the riparian zone.

Riparian Species	Scientific Name	Tree (T) or Shrub (S)
Black cottonwood	*Populus trichocarpa*	T
Oregon Ash	*Fraxinus latifolia*	T
White Alder	*Alnus rhombiflolia*	T
Western red-cedar	*Thuja plicata*	T
Ninebark	*Physocarpus capitatus*	S
Douglas spiraea	*Spiraea douglasii*	S
Ocean Spray	*Holodiscus discolor*	S
Mockorange	*Philadelphus lewisii*	S
Cascara	*Rhamnus purshiana*	S
Red elderberry	*Sambucus racemosa*	S
Willow	*Salix sp.*	S
Creek dogwood	*Cornus servicea*	S

Red-flowering currant	*Ribes sanguineum*	S
Snowberry	*Symphoricarpos albus*	S
Salmonberry	*Rubus spectabilis*	S

*Species compiled from *Riparian Tree and Shrub Planting Guide* (Robinson et. al 2011) guide. Please consult before planting.

Herbicide Treatment Recommendation:

Herbicide treatment should be carefully selected and applied as to minimize exposure to native species while maximizing mortality to invasive Himalayan blackberry). Successful mortality of blackberry can also be achieved through lower chemical concentrations, although consultation with licensed herbicide applicator is necessary.

Recommended herbicides to be applied with consideration to fish, aquatic invertebrates and native vegetation.

Herbicide Treatment	**Environmental Considerations**	**Recommended Concentration (%)**	**Application Timeframe**
Garlon 3A (Trichopylr)	Controls broadcast herbs and woody species. Does not affect grasses; pines very susceptible. Toxic to fish at high concentrations	2% solution mixed with nonionic surfactant	Midsummer- early November
Rodeo (Glyphosate)	Broad-spectrum foliar herbicide that kills/damages most vegetation it contacts. Nontoxic to vertebrates and no-mobile in soil	7.5% with .5% nonionic surfactant	September- early November

* For more information consult *Managing Himalayan Blackberry* (Bennet 2007). For maximum mortality of H. blackberry, application of herbicide should coincide with peak transpiration of water within plants (mid-September).

APPENDIX B:

Bird Species spotted on Cozine Creek Property that use oak savannah for habitat.

Common Name	Scientific name	Habitat Type
Turkey Vulture	*Cathartes aura*	Riparian, edge, snags, logs
Band-tailed pigeon	*Patagioenas fasciata*	Riparian, edge
Mourning dove	*Zenaida macroura*	Riparian, edge
Barn Owl	*Tyto alba ?*	Riparian, edge, snags
Western Screech owl	*Megascops kennicottii*	Riparian, edge, snags
Vaux's swift	*Chaetura vauxi*	Riparian, edge, snags
Anna's Hummingbird	*Calypte anna*	edge
Acorn woodpecker*	*Melanerpes formicivorus*	Edge, snags, logs
Northern flicker	*Colaptes auratus*	Edge, snags, logs
Western wood pewee	*Contopus sordidulus*	Riparian, edge
Tree swallow	*Tachycineta bicolor*	Riparian, edge, snags
Violet-green swallow	*Tachycineta thalassina*	Riparian, edge, snags
Scrub jay	*Aphelocoma californica*	Edge
American crow	*Corvus brachyrhynchos*	Riparian, edge
Black-capped chickadee	*Poecile atricapillus*	Riparian, edge, snags
Common Bushtit	*Psaltriparus minimus*	Edge
White-breasted nuthatch*	*Sitta carolinensis*	Snags, logs
Bewick's wren	*Thryomanes bewickii*	Riparian, edge, snags, logs
American Robin	*Turdus migratorius*	Edge
Warbling Vireo	*Vireo gilvus*	Edge
Orange-crowned warbler	*Vermivora celata*	Edge
Yellow-rumped warbler	*Setophaga coronate*	Riparian, edge
Dark-eyed junco	*Junco hyemalis*	Edge
Black-headed grosbeak	*Pheucticus melanocephalus*	Riparian, edge
Song sparrow	*Melospiza melodia*	Riparian, edge, log
American goldfinch	*Spinus tristis*	Edge
Lesser goldfinch	*Spinus psaltria*	Edge

*Completely dependent on Oregon White Oak.

Most common bees native to Willamette Valley (Powell 2015)

Common Name	Scientific Name
White-shouldered Bumble Bee	*B. appositus*
California Bumble Bee	*B. californicus*
Black-tailed Bumble Bee	*B. melanopygus*
Fuzzy-horned Bumble Bee	*B. mixtus*
Nevada Bumble Bee	*B. nevadensis*
Yellow-faced Bumble Bee	*B. vosnesenskii*

Bat Survey Procedure Methods

The following study was accomplished by Jennifer Barnett, U.S. Fish and Wildlife Service. This study can be accessed for a detailed account of her methods. Bat surveys are typically located near riparian zones as many bats eat insects, thus are attracted to water that provides habitat for food. Barnett completed her survey in Eastern Oregon Wildlife refuges. In her methods she demonstrates a bat detector set up along with how she analyzed her data. (Barnett 2014).

Appendix C:

Recommended widths for riparian buffer zones (Yale 2005)

Resource Being Protected	Recommended Riparian Buffer Width (ft)
Nutrients	16-164
Pesticide	49-328
Biocontamination	30
Aquatic Wildlife	33-164
Litter and Debris	10-328
Stream Temperature	30-230

Species with very good to excellent ability to root from live materials that are found on the Cozine Creek property (USDA 2007b)

Scientific Name	Common Name
Poplus balsamifera ssp trichicarpa	Black cottonwood
Salix sp	willow

*For more information consult the *Plant Species with Rooting Ability from Live Hardwood Material for use in Soil Bioengineering Techniques* program (USDA 2007b).

Planting willow stakes

After choosing the best species for the area, *How to Plant Willows and Cottonwoods for Riparian Restoration* should be consulted next on how to proceed. It gives you information on site assessment and considerations as well as planting designs. This document also explains in detail how to do different types of plantings, how to harvest, and how to manage and maintain the site (USDA 2007a).

Stream Restoration Permit Guide

Some projects may require a permit and should be considered before moving forward, *A Guide to Oregon Permits* is focused on watershed restoration and the corresponding permits needed (Oregon Plan for Salmon and Watersheds 2017).

Appendix D

Long-term Social Goals (5-10 years)

- Development of designated spaces for education and recreation.

  In the long-term, we believe that stewardship and education can be facilitated through infrastructural expansion. We suggest the creation of safe, appropriate "hang out spots" for students to enjoy. We also suggest the creation of an outdoor classroom to allow for more interdisciplinary educational use of the Cozine property. Outdoor benches at the natural area of George Fox University (Bill Fleeger, March 2017). An example of a student recreation area, potentially utilized by small classes or students seeking a relaxing spot to read or chat with a community member.

- Expansion of curricular educational programs

  In the long-term, we suggest the expansion of the pre-existing curricular programs (HIST 152: Environmental History of the United States, HIST 276: Native American

History, SOAN 330: Society and Community, and SOAN 250: Environmental Sociology), as well as new programming to include the Cozine property in classes that have not done so previously. For example, courses in Human Health Performance and Athletics, Art, or Education. There is a lot of potential for more interdisciplinary approaches in utilizing the Cozine property.

Work Party Agenda

Cozine work parties should be scheduled consistently, at the convenience of the organizers. We suggest monthly, on the same week every month. Saturdays at 9am-12pm have worked well in the past.

Agenda

9:00-9:10 - Introductions (us & participants)

9:10-9:30 – Explain Cozine History, Plants & Wildlife, and Restoration Efforts

Show participants what invasives look like: English ivy, Himalayan blackberry & poison oak

9:30-10:30 - Work!

10:30-10:45 - Snack/water break

10:45-11:30 - Work!

11:30-12:00 - Clean up and distribute feedback forms (collect forms before they leave)

After 12pm - Pizza in ENVS Lab (or outside if weather is nice!)

Information to explain to participants

Cozine Creek History

Cozine Creek is 11.3 miles long and is a part of the Greater Yamhill Watershed. It runs through both agricultural fields and urban areas that provides challenges to water quality management. In the past, the Cozine property was a well-known hangout for Linfield students. Before the culverts were put in, a wooden bridge was designed to let the water flow more naturally under the road which gave easier access to aquatic organisms and wildlife. The bridge, sometimes referred to as “Lover’s Lane,” was often occupied by couples spending time together. There were tug-o-war contests between the senior and freshmen classes and when it flooded, students would often bring their canoes or go for a swim. Over time, the growing populations of

McMinnville and Linfield College has impacted the status of the Cozine property and its reputation has changed. The influx of pollution running off of the surrounding urban areas, farms, and even our campus has influenced the water quality which has had a ripple effect on the overall relationship with the area.

As the (name of group hosting: Cozine Conservation Corps, ENVS Department, LEAF Community, etc.) we hope to improve and restore Cozine to the best of our ability. The purpose of this restoration is not simply to have a nice park to enjoy, although that is one of our goals. We hope to facilitate a more long-lasting and meaningful impact through the very act of restoring Cozine. This area and the water that runs through it provide a way to connect with our greater community. It also offers students experiential learning opportunities to engage in thoughtful work that takes history, both indigenous and colonial, into account as we design a new vision for the area. Lastly, we want to create an accessible sense of place for both the Linfield community and McMinnville.

Cozine Creek Plant and Wildlife

- Two main habitat types: Riparian Forest and Oak Woodland
- Dominant vegetation: black cottonwood, Oregon white ash, and poison oak
- Many species of birds including mallard duck, green heron, barn owl, spotted sandpiper
- Mammals such as the deer mouse, opossum, raccoon, black tailed deer
- Amphibians and reptiles such as red bellied newt, Pacific tree frog, common garter snake
- Fish such as Steelhead, Coho, and Chinook Salmon have used the creek for rearing/spawning in the past, however, because of the conditions of the creek have yet to improve in recent years.
- Stream water quality can be observed through macroinvertebrate counts as well.
- Upstream sources are the majority of water quality issues in the creek.

Additional Notes

We have found that retention is crucial. This means that making participants feel comfortable and excited to be there is as important, if not more important, than the actual work itself.