Restoration Plan

Spring Creek Conservation Easement

June 1, 2011

Prepared for:
Upper Deschutes Watershed Council
Deschutes Land Trust

Prepared by:
Karen Allen, Aequinox
1567 NW Awbrey Rd.
Bend, OR 97701
541-617-1380

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Executive Summary

The Deschutes Land Trust (Land Trust), using Oregon Watershed Enhancement Board (OWEB) funds, is purchasing a conservation easement on a 25-acre property that encompasses the headwaters of Spring Creek, a large tributary to the Metolius River. The Land Trust and others, including the Upper Deschutes Watershed Council (UDWC), believe that restoration of the property, including stream and riparian conditions, will help meet shared restoration objectives for the Metolius sub-watershed. The Land Trust has integrated restoration planning into the easement process, and has cooperated with the UDWC to secure OWEB funds for the first phase of restoration, which is the evaluation of restoration opportunities and development of appropriate restoration actions. The UDWC has contracted with Aequinox to perform this work, the results of which comprise this restoration plan.

Throughout the planning process, Aequinox consulted representatives from the Deschutes Land Trust, Upper Deschutes Watershed Council, Oregon Department of Fish and Wildlife, Portland General Electric, Deschutes National Forest and United States Fish and Wildlife Service, as well as the landowner, to help ensure this plan meets mutual objectives.

Aequinox's assessment shows that past management and habitat alterations on the Spring Creek Conservation Easement and along Spring Creek to its confluence with the Metolius River have resulted in degradation of in-stream fish habitat conditions, a loss of woody riparian vegetation and alteration of native meadows. This Restoration Plan describes a series of restoration actions, including: a) placing up to 32 whole trees instream to enhance fish habitat, b) planting up to 290 native trees and shrubs in 0.15 acres along 0.4 miles of Spring Creek to restore diverse riparian habitat, c) controlling 8 species of invasive weeds on 25 acres, and d) planting 1000 native grasses and forbs to restore 0.8 acres of native meadows.

Introduction and Purpose

The proposed Spring Creek Conservation Easement (Easement) is approximately 25 acres in size and is located two miles north of Black Butte at 25519 SW Cold Springs Resort Lane in Camp Sherman, Jefferson County, Oregon (T13S, R09E, Sec10c, Tax Lot 400) (**Figure 1**). Several springs emerge from the property, creating Spring Creek, a major tributary to the upper Metolius River. Spring Creek enters the Metolius River 0.3 miles upstream from Camp Sherman. The Easement lies at approximately 2,980 ft. elevation and slopes gently eastward toward Spring Creek. The Easement is bordered on the north by Oregon Department of Fish & Wildlife (ODFW) property, on the west and south by Deschutes National Forest (DNF) property, and on the east by private property. Downstream of ODFW's property, DNF land borders Spring Creek to its confluence with the Metolius River (**Figure 2**).

Spring Creek provides important spawning habitat for bull trout, redband trout, kokanee and eventually sockeye and spring chinook salmon (Riehle, personal communication 7.23.10). Cold spring inputs, stable banks, a relatively stable flow regime and limited development all provide for excellent water quality. Historically, Spring Creek was an important spawning ground for spring chinook (Deschutes National Forest, 1998). With the return of anadromous fish to the Upper Deschutes Basin, Spring Creek will continue to be an important spawning and rearing stream. Currently rainbow trout and bull trout juveniles rear in the stream.

The purpose of the Restoration Plan is to identify potential restoration opportunities on the Easement and along Spring Creek to improve habitat conditions for fish and wildlife. The plan identifies four primary opportunities: in-stream habitat enhancement, woody riparian vegetation restoration, non-native plant control, and native meadow restoration. With respect to in-stream fish habitat enhancement and woody riparian vegetation restoration, the geographic scope of the Plan encompasses all of Spring Creek to the confluence. For invasive non-native plant control and native meadow restoration, the scope is limited to the Easement. The Plan describes existing conditions and restoration opportunities, reference site conditions and proposed restoration actions for each opportunity. It includes figures and tables showing species, quantities, sizes and cost estimates for implementation of the proposed restoration action.

To develop this Plan, Aequinox researched existing and historic habitat conditions in a number of referenced sources; mapped and assessed existing conditions by taking soil samples and identifying plants; consulted on-site with Bruce Livingston (landowner) and Nate Dachtler (fish biologist); consulted on the phone with fish biologists, ecologists, botanists, and hydrologists identified in the Acknowledgements; and assessed reference sites in the Metolius Basin.

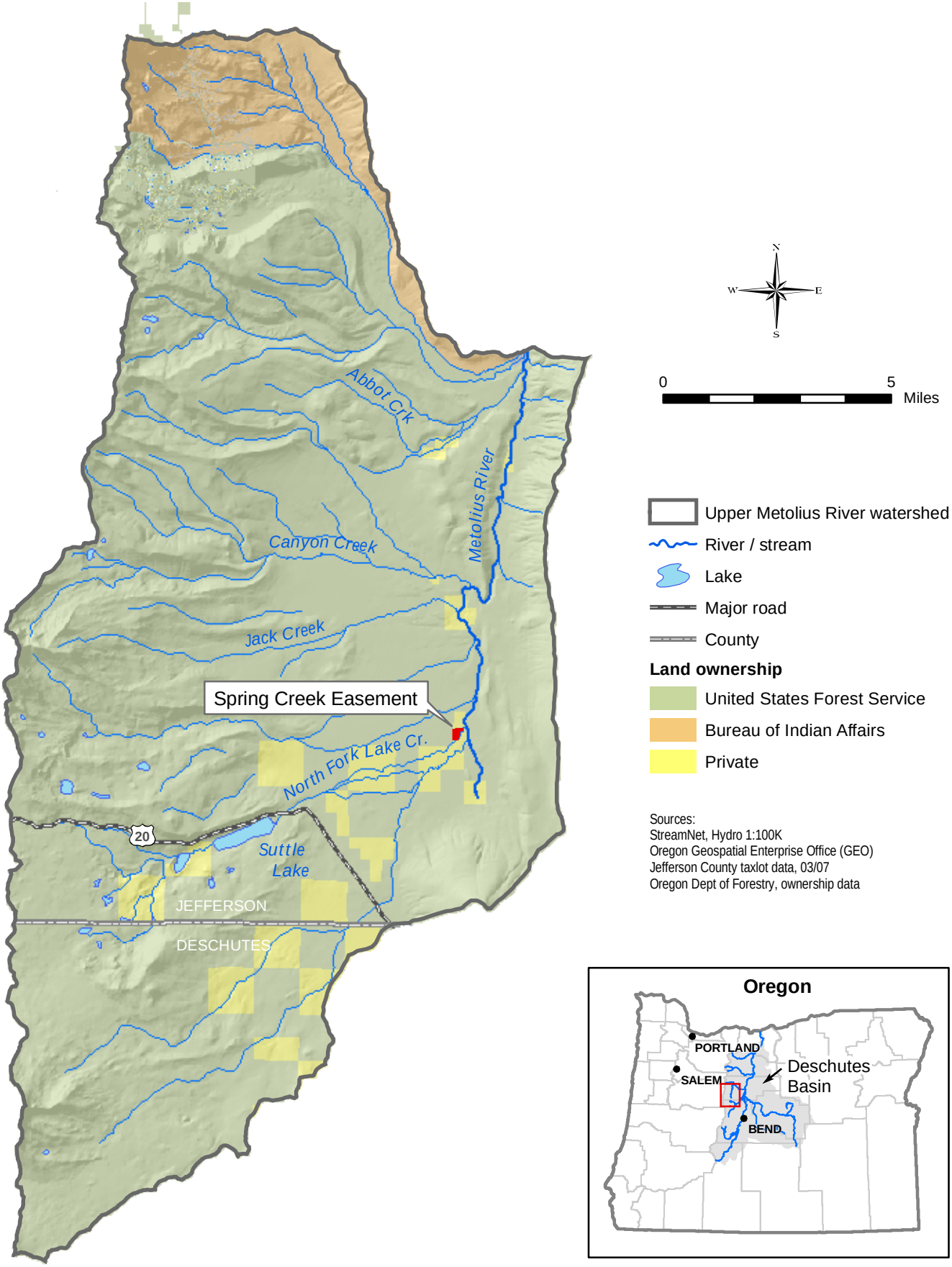

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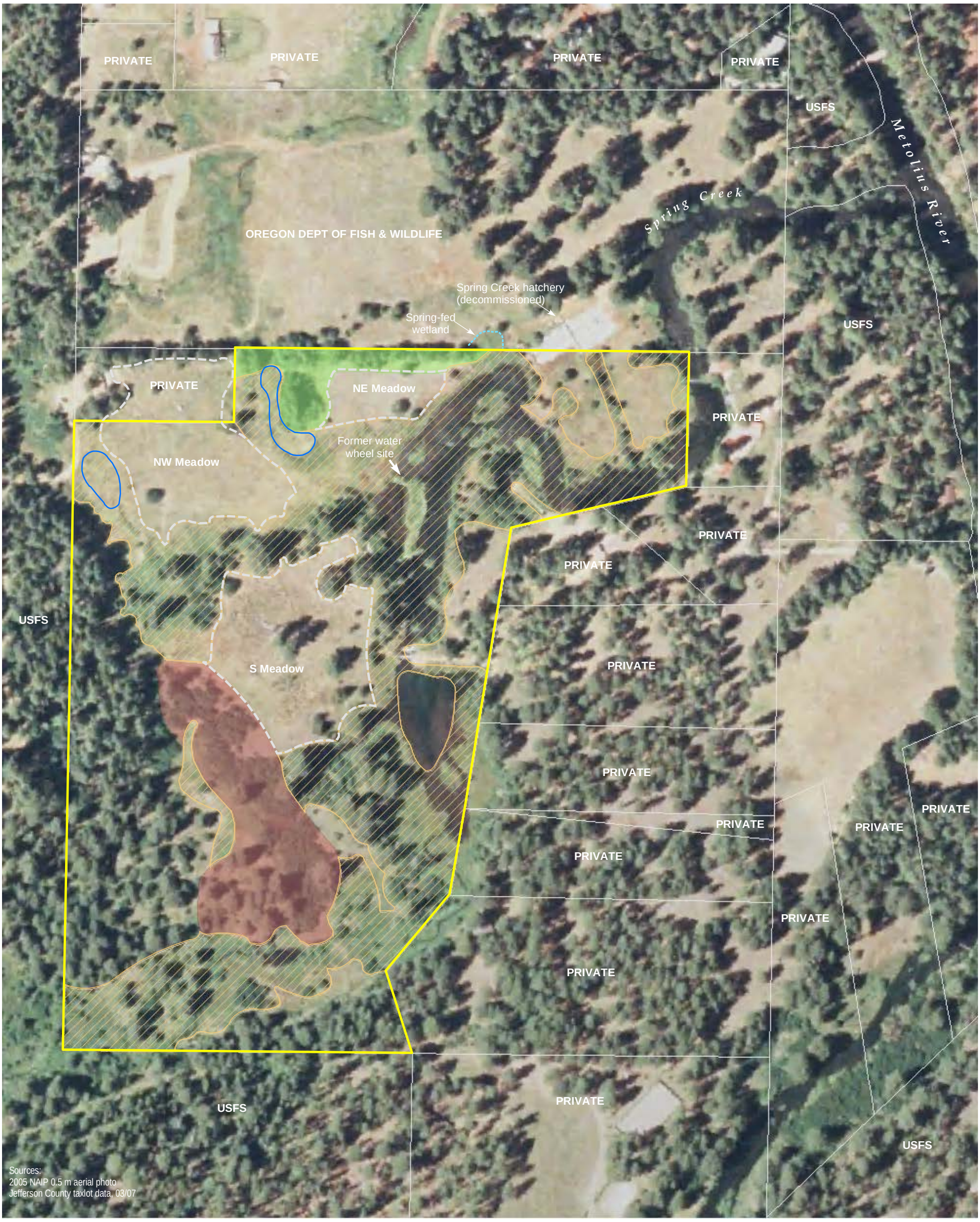
Figure 1. Project Location



Habitat

- Foothill and lower montane riparian woodland/ Freshwater emergent marsh
- Quaking aspen - aquatic sedge
- Black hawthorn - Woods rose
- Upland meadow
- Former pond
- Spring Creek Easement

N
W E
S

0 100 200 Feet

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Figure 2. Plant Communities, Spring Creek Easement
(includes OWEB Priority Systems and Associations)

Site Description and Background

Historical Use

The Easement was homesteaded by Mr. Barney Matson who grazed dairy cattle from the 1920's until the late 1930's or early 1940's. Mr. Matson had a small dairy nearby, but the exact location is unknown. In the 1920's, Matson built a stock pond at the confluence of the largest spring and Spring Creek to create head for a water wheel, located at the downstream end, to push water up to the dairy farm (Figure 2). The construction of this pond created a large island in the creek that persists today. The current landowners, the Livingston and Morley families, purchased the property in the 1950's and have owned it since that time. The Easement is undeveloped except for several small open-sided sleeping cabins and a small wooden shed constructed in the late 1950's by the current owners. Since then, the property has been used solely for recreational activities such as camping or hiking (Hydro-Logics, 2009).

The Oregon Fish Commission constructed the Spring Creek Fish Hatchery in 1947 on the property to the north of the Easement (Figure 2) and reared spring chinook and sockeye salmon there from 1948 – 1961. Most were released into Spring Creek (Nehlsen, 1995 in DNF, 1998). The Fish Commission built a 3.5-foot high dam at the upper end of Spring Creek to provide water to the hatchery. A wooden pipe made of 1" x 4" redwood with steel bands fed water from the dam to the hatchery. The steel bands remain but most of the wood is gone and the pipe is currently filling in with soil on its own. ODFW currently holds an easement on the dam and pipe where it passes across the Easement. No water is currently draining from springs or wetlands through this old pipe. ODFW intends to develop a plan to remove the hatchery ponds and provide for public use that is compatible with conservation (Wise, personal communication 8.1.10).

Existing Conditions

The primary ecological features of the Easement are the North Fork of Lake Creek (above the dam), Spring Creek and associated springs, natural and manmade wetlands, forested areas, and open meadows. High groundwater and spring flows support extensive emergent wetlands and riparian woodlands. Plant communities mapped on the Easement include riparian woodland and freshwater emergent wetlands, aspen groves, black hawthorn/wood's rose and upland meadows (Figure 2). Several short spring-fed tributaries and numerous other seeps enter Spring Creek on the Easement. The FLIR data also shows cold spring water emerging below the North Fork pond above the dam (Watershed Sciences, 2002).

In order to assess restoration opportunities, our analysis of existing conditions focused on in-stream fish habitat and riparian vegetation conditions along the entire length of Spring Creek to its confluence with the Metolius River. Our analysis of existing wetlands, soils, meadows, and invasive non-native plant species was restricted to the Easement.

Prior to beginning this planning effort, the UDWC, Land Trust, and other partners considered whether the project should address the existing dam. The partners determined that removal of the dam was beyond the scope of the project because: (1) the dam currently serves to prevent fish from moving upstream into the North Fork of Spring Creek, which in its lower reaches is a maze of unscreened diversions and ponds. See ODFW AQUATIC INVENTORIES PROJECT STREAM REPORT, North Fork Lake Creek, July 21-22, 2009 ("There were a number of unscreened diversions, culvert crossings, bridges, and fence crossings throughout the survey." Given this situation, ODFW's current management objective for the North Fork of Lake Creek is to keep fish out of the creek by blocking passage at the mouth (Spring Creek dam) and re-installing a historic fish screen where the North Fork diverges from the main channel, approximately 3.75 miles/6000 meters upstream; (2) Removal of the dam is a large-scale restoration project. ODFW owns the dam and will make any decisions regarding its removal. ODFW will assess dam removal in the context of its management of the ODFW Spring Creek Hatchery property and their long term management objectives for the North Fork of Lake Creek. ODFW is currently developing plans for removal of the hatchery infrastructure, but that planning effort will move more slowly than this planning effort, which the partners are integrating with the Land Trust's acquisition of a conservation easement; (3) the actions considered in this plan will provide immediate habitat gains that are independent of dam removal. It is unlikely that dam removal, when it occurs, will compromise any of the actions considered or proposed in this plan. While future dam removal by ODFW may be a possibility, ODFW's approach will depend on their long term fish management objectives for the Lake Creek watershed.

In-stream Fish Habitat

In 1998, the DNF surveyed stream habitat along Spring Creek (DNF, 1998). They found that the stream is dominated by wide, low gradient riffles. They found only three pools. These pools were shallow with an average residual pool depth of 1.67 feet. The main cover types noted for fish were emergent vegetation, woody debris and undercut banks. The DNF found that the lower half of the creek, primarily on USFS and ODFW lands, provides better cover for fish because it is narrower and deeper than the portion of the creek on the Easement. Spawning gravels were abundant but suitable spawning sites were limited to the few pools and slower riffles (DNF, 1998).

Due to its spring-fed nature, water temperatures are stable and cool. In 1995, water temperatures measured with a Hobo data recorder fluctuated between 45^0F and 50^0F. Water from above the dam fed by the North Fork Lake Creek may slightly warm the water in Spring Creek (DNF, 1998). The ODFW hatchery dam at the upper end of the creek is an upstream fish passage barrier.

In-stream wood in Spring Creek currently provides limited cover for fish (**Appendix A**). The 1998 survey found that most of the large wood was found in the lower portion of the stream. All of it was individual pieces except for one debris jam that had seven pieces in it. Wood was calculated at 18.9 large (large + medium) pieces per mile using SMART tables, just below the PACFISH RMO of 20 pieces per mile (DNF, 1998).

Riparian Vegetation

Throughout the length of Spring Creek, banks are covered with sedges, forbs and other herbaceous wetland plants that provide excellent bank stability and under-cut banks. The lower part of Spring Creek on DNF and ODFW lands has a well-developed overstory of large ponderosa pines that provides shade and large woody debris to the stream. On the Easement, this pine overstory is limited to the right side of the creek. Forest conditions have changed little since 1943, as shown in aerial photographs dating back to 1943 (**Appendix B**). Riparian trees and shrubs are dense and diverse on USFS property near the mouth, but are more scattered on the Easement and ODFW property. Tree species found on the Easement include alder, hawthorn and chokecherry (1 tree). The only riparian shrub species present on the Easement is spirea, which is not very abundant. Species present on the Easement and on USFS land (used as a reference site) are shown in Table 1. Photographs of existing riparian conditions are in the Riparian Vegetation Restoration Areas section of Appendix A.

A 1943 aerial photograph shows the riparian corridor was essentially devoid of deciduous trees and shrubs on the Easement and ODFW property (Appendix B). While it is possible that the dense cover of herbaceous plants along the banks inhibits the growth of riparian trees and shrubs like alder, ninebark and spirea, it is also likely that woody vegetation was removed prior to 1943 to favor cattle grazing. A 1951 aerial photograph shows a clearer shot of the riparian corridor devoid of woody plants following hatchery construction in 1948. By 1994, some alders appear to have reestablished. During the 1998 Stream Survey, alder stumps were found along Spring Creek (location not identified). The report recommends protecting (woody) riparian vegetation (DNF, 1998).

Sedges and forbs form a narrow band 2-6 feet wide along the channel margin. Conditions along some of the upper edges would be suitable for woody plants. The dense mat of roots within the sedge community can make it difficult for woody plants to become established. However, riparian trees and shrubs are well-established on other streams in the Metolius Basin with well-established sedge communities, such as Jack Creek, Lake Creek and further down Spring Creek on USFS property (see Riparian Vegetation Reference Areas section).

Wetlands

Two ponds built by Bruce Livingston's father in the 1960's (Figure 2) were watered by an irrigation ditch for over two decades. Bruce forfeited these water rights 15-20 years ago and the ponds have since filled in with native sedges, becoming emergent wetlands (Livingston, personal communication 7.22.10) (Appendix A). The ponds are visible in aerial photographs taken in 1976, 1979 and 1984 (Appendix B). By 1994, they had started to fill in. Based on the extent of wetlands visible in the aerial photo sequence before and after the ponds were dug, the ponds themselves do not appear to be having a negative effect on the surrounding wetlands. Bruce Livingston has observed significant fluctuation in water levels in these wetlands from year to year.

A spring-fed wetland originating on ODFW property west of the hatchery is contiguous with springs and wetlands that emerge on the Easement (Figure 2, Appendix A). All spring water originating on the ODFW property joins and enters Spring Creek in one channel at the sharp bend in the stream at the north end of the property (Appendix A). Since these wetlands are not drained by the old pipe or by any of the remaining hatchery works, no wetland restoration is recommended.

Soils

The Natural Resources Conservation Service (NRCS) mapped soils on most of the property as Cryaquolls, 0-3% slope (29A). Cryaquolls are poorly drained hydric soils that occur on floodplains between 3,000 to 4,500 ft. Textures include silt loam, loam and sandy loam and the soils support sedges, rushes and riparian shrubs. The western forested edge is mapped as Suilotem-Circle complex, 0-8% slope (143B). This soil occurs in outwash plains with a parent material of ash over alluvium. Textures include sandy loam, fine sandy loam and loamy fine sand. Suilotem-Circle complex soils support Ponderosa pine/bitterbrush/Idaho fescue forest associations (USDA, 2002).

Meadows

For the purposes of this plan, we have designated three meadows according to their relative locations: NW meadow, NE meadow and S meadow (Figure 2). Table 2 lists species present in the three meadows and at the three meadow reference sites, described below.

The 1.75 acre NW meadow is dominated on its edges by native sedges and in its center by pasture grasses and cheatgrass. Cusick's sedge forms dense clumps that extend up toward the drier meadow center. The center of the meadow is dominated by Kentucky bluegrass and meadow fescue, a perennial bunchgrass with a red silky stem. Meadow fescue is an escaped cultivar found throughout Oregon and California that is considered naturalized in the wild (CalFlora, 2010). Meadow fescue, Kentucky bluegrass and meadow foxtail were likely introduced for cattle in the early 1900's. Approximately one-fifth of the meadow consists of patches of cheatgrass.

We assessed soils by digging holes 12 inches deep on July 22, 2010. The soils in the center of the NW meadow where Kentucky bluegrass and meadow fescue occur were moist with a fine sandy clay loam texture. This same texture was present along the wetter edges of the meadow dominated by native sedges. Soils in cheatgrass dominated areas were dry, with a gravelly sandy loam texture. The clay component of the sandy clay loam helps hold available moisture better than the coarser gravelly sandy loam soils. This has implications on restoration of these cheatgrass dominated areas.

The NE meadow is a little less than half an acre and is dominated by cheatgrass. As with the cheatgrass dominated areas of the NW meadow, soils here were dry with a gravelly sandy loam texture. These soils had mild to moderate compaction based on a simple shovel test. Soil compaction may be contributing to the dominance of cheatgrass

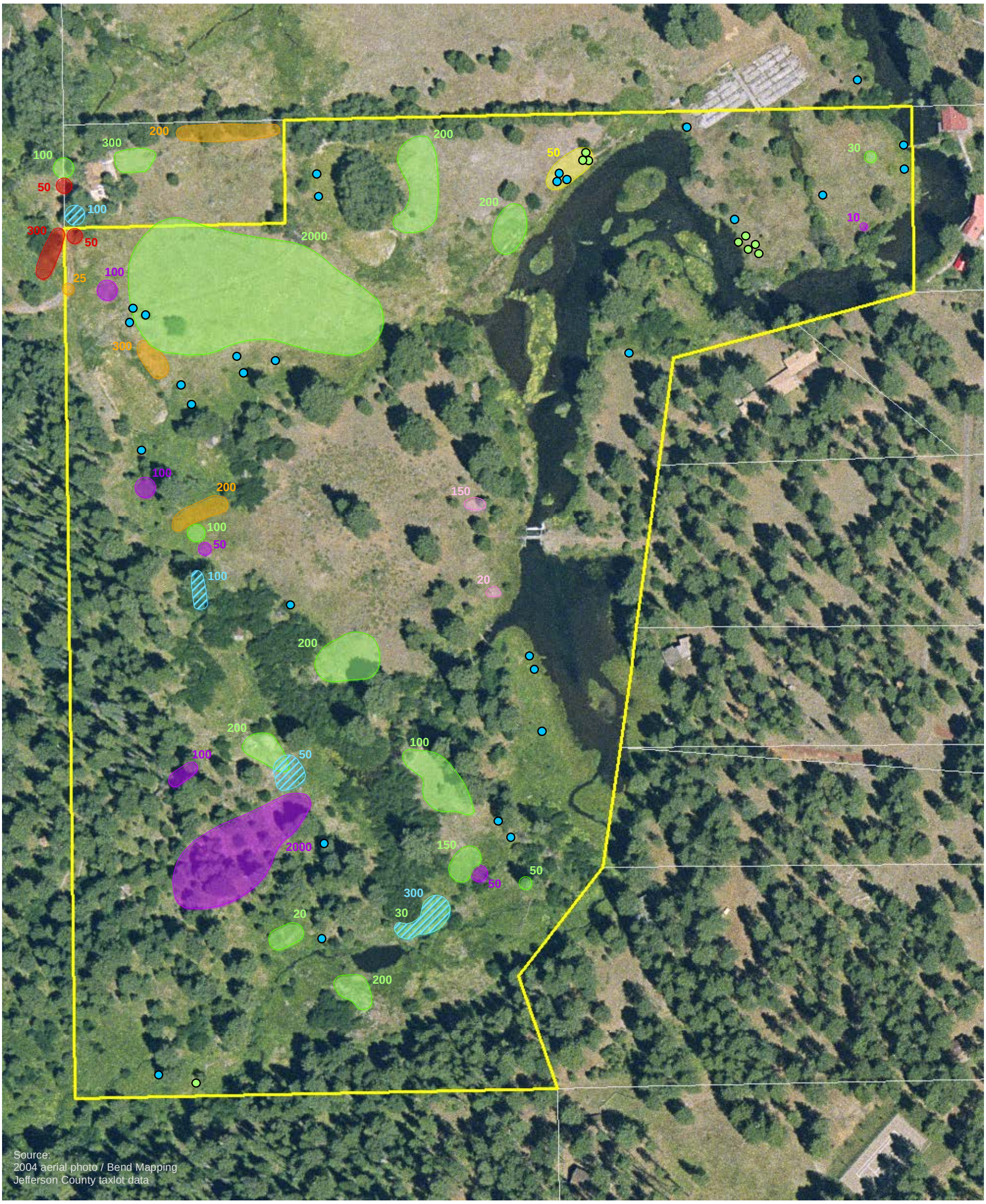
across most of the meadow. Close to the aspen grove, Kentucky bluegrass and dense silkybent dominate.

Both the NW and NE meadows appear to have historically been meadows. The 1943 aerial photo shows these areas as treeless meadows (Appendix B). Bruce Livingston has found no evidence of stumps in either meadow since his family purchased the property in 1957 (Livingston personal communication 7.22.10).

The South Meadow is approximately 1.9 acres in size. Shrubs account for about 30% of the area and consist primarily of green rabbitbrush with a few wax currant. The understory is cheatgrass interspersed with other species.

Invasive Non-Native Species

The location and abundance of invasive non-native species were mapped on July 20, 2010 (**Figure 3**). Seven species were found including mullein, bull thistle, Canada thistle, oxeye daisy, St. Johnswort, teasel and tumble mustard. All species included in the 2010 Metolius S&P Noxious Weed Project were mapped. Individual mullein and bull thistle plants were found throughout the property in addition to larger infestations. Native mountain thistle (*Cirsium callilepis var. oregonense*, also known as *Cirsium remotifolium*) was found along the west side of property in the vicinity of the 100 bull thistle plants mapped. The fringed tips on the involucral bracts are distinctive and will help to avoid pulling this native.



Spring Creek easement

Taxlot

Invasive plant, individual

- Mullein *(Verbascum thapsis)*
- Bull thistle *(Cirsium vulgare)*

Invasive plant, concentration

* Number on map indicates the number of plants.

- Bull thistle *(Cirsium vulgare)*
- Canada thistle *(Cirsium arvense)*
- Mullein *(Verbascum thapsis)*
- Oxeye daisy *(Chrysanthemum leucanthemum)*
- St John's wort *(Hypericum perforatum)*
- Teasel *(Dipsacus fullonum)*
- Tumble mustard *(Sisymbrium altissimum)*

0 100 200 Feet

N W E S

Notes:

1. Plants mapped on July 20, 2010.
2. Cheatgrass is mapped on upland meadow restoration figure.
3. Additional individual bull thistle and mullein plants are scattered throughout the property.

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Figure 3. Invasive Non-native Plant Species

Restoration Opportunities

Based on our analysis of existing and historic conditions, we identified four restoration opportunities:

1) In-Stream Fish Habitat Enhancement
2) Riparian Tree & Shrub Restoration
3) Invasive Non-native Plant Control
4) Upland Meadow Restoration

For the entire length of Spring Creek, we propose in-stream fish habitat enhancement and riparian tree and shrub restoration. The addition of large wood or log jams to Spring Creek would increase pool and cover habitat. Creating slower, deeper areas with log jams would add habitat for fry when they emerge from the gravels, protect juveniles and could produce additional adult redband habitat (Riehle, personal communication 7.23.10). Planting riparian trees and shrubs would provide additional shade to maintain cold water temperatures and enhance habitat for invertebrates, neotropical songbirds, raptors, mammals and other wildlife. Diversifying the flora (both vegetation structure and species) has consequent benefits to food webs and energy flow, improving habitat for a wide range of species.

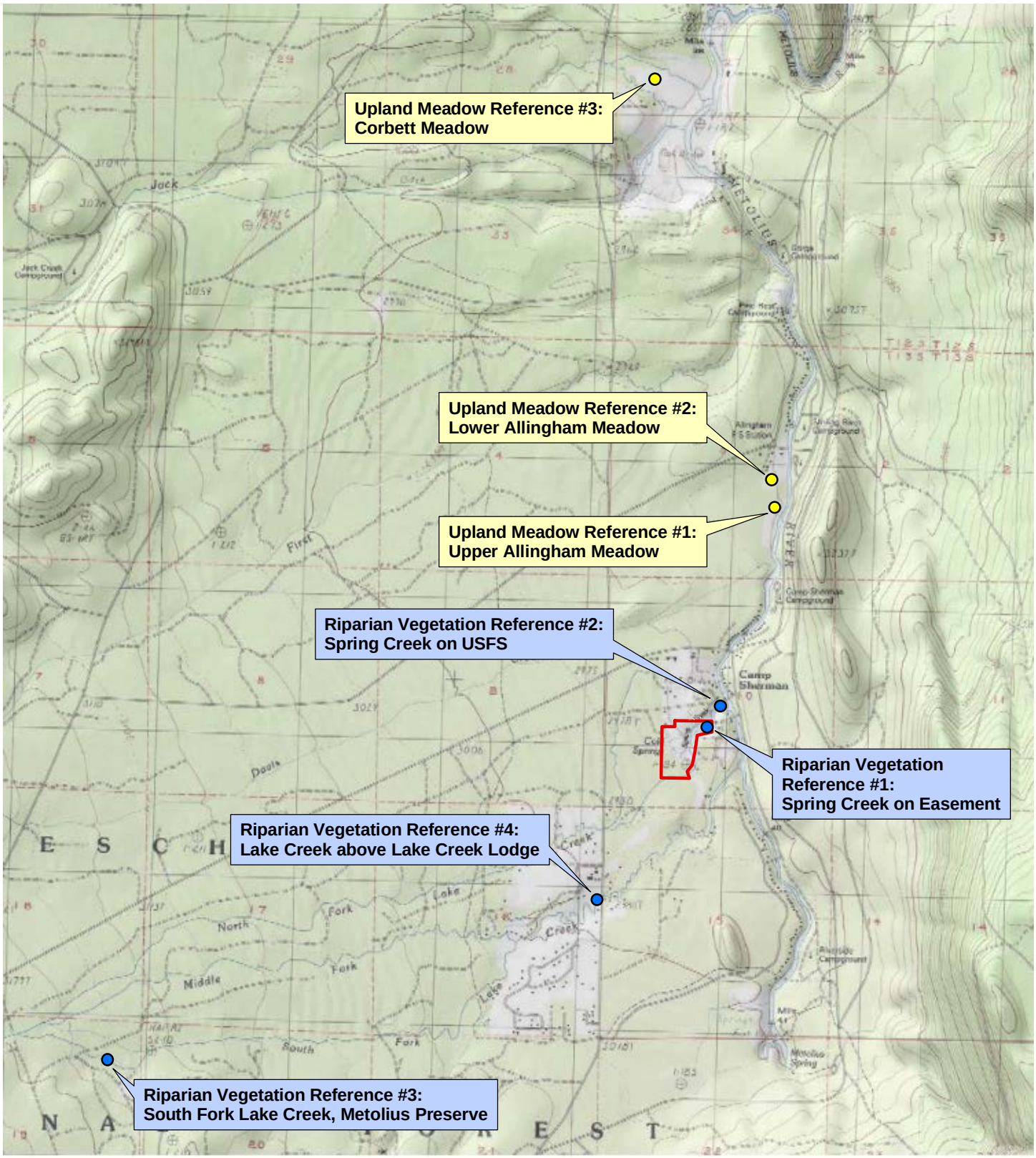
On the Easement, we propose controlling invasives and restoring upland meadows. Controlling invasive non-native species is a key component of native plant habitat restoration. In the NW and NE meadows, since cheatgrass grows in patches relatively isolated from other species, restoration may be possible over a period of three to five years by first controlling invasive non-native plants, controlling cheatgrass, then seeding and planting with natives. No restoration is proposed in the south meadow since to remove the cheatgrass would require eliminating other species growing with it.

A brief description of removing the pipeline and regrading the slope follows the upland meadow restoration section. Since ODFW holds an easement on the pipeline, it is their decision whether to remove it and regrade the slope, to leave it and fill it, or to do nothing. If ODFW decides to remove it, the work would likely coincide with removal of the hatchery infrastructure, for which planning is currently underway.

When we asked Bruce Livingston what restoration, if any, he'd like to see on the property, he said he was open to riparian plantings and to the addition of in-stream wood if impacts can be minimized. He also expressed a desire to better understand the steps necessary to remove cheatgrass and restore the NW and NE meadows to native-dominated meadows (Livingston, personal communication 7.22.10). He wants to leave the pipe between the dam and hatchery since it does not drain water from springs or wetlands and is part of the property's history that is important to preserve.

Reference Sites

Four reference sites for riparian vegetation and three for meadows were explored in order to better understand the species composition, abundance and distribution in each habitat and the potential for restoration (**Figure 4**; Appendix A).



Sources:
National Geographic 1:24K TOPO

- Riparian Vegetation reference site
- Upland Meadow reference site
- Spring Creek Easement

0 0.5 Miles

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Figure 4. Reference Sites

Riparian Vegetation Reference Sites

At each of the four reference sites, the tree and shrub species rooted along the bank and the relative abundance of each was noted. Slides 22-25 show conditions at the riparian vegetation reference sites (Appendix A).

Table 1. Trees & Shrubs at Reference Sites

SPECIES	**RIPARIAN VEGETATION REFERENCE SITES**			
	1	2	3	4
	Spring Creek Easement	USFS downstream from Easement	Deschutes Land Trust's Metolius Preserve	Lake Creek above Lake Creek Lodge
Trees				
Alder	X	X	X	X
Chokecherry	x		x	x
Pacific ninebark		X	X	X
Cascara		x		
Serviceberry		x	x	
Hawthorn	x			x
Shrubs				
Spirea	x	X		x
Nootka rose		x	x	
Snowberry		x	x	
Dogwood			x	

X = dominant; x = present

Reference site #1 is located on the Easement just downstream from the confluence of a spring-fed tributary that starts as multiple springs on the Easement and ODFW property. Alders line the bank at approximately 3-8 meter spacing.

Reference site #2 is located on USFS property on river left (facing downstream), immediately downstream from ODFW's property. The riparian corridor is dense with four species of trees and three species of shrubs. Ninebark and alder are the dominant trees, spaced approximately 3 meters between each tree, with a few cascara and serviceberry. Spirea grows on the bank with snowberry and rose rooted higher up the bank. All grow under the shade of a ponderosa overstory.

Reference site #3 lies along the South Fork of Lake Creek on DLT's Metolius Preserve. Alder and ninebark overhang the bank and shade the stream. Alders are spaced about every 2-10 meters. Chokecherry, dogwood, serviceberry, nootka rose and snowberry are present in less abundance and are rooted slightly higher on the bank.

Reference site #4 lies along Lake Creek above the Camp Sherman Road at Lake Creek Lodge, looking upstream. The photo shows the patchy distribution of alders and ninebark with trees rooted, on average, every 5-10 meters.

Meadow Reference Sites

Three upland meadow reference sites in the Metolius Basin were investigated (Figure 4). Upper Allingham meadow is a small meadow located ~1/2 mile upstream from the Allingham Bridge. It is approximately 2 acres in size and is surrounded by Ponderosa pine and western larch forest. Lower Allingham meadow, ~ 10-acres in size, is the upper-most of the two large meadows just upstream from the bridge. The upper end of the lower meadow transitions from moist meadow dominated by sedges to a dry meadow. This transitional area was the focus of reference site investigation. On the Corbett property along Jack Creek just above the confluence with the Metolius River, a few meadows were studied. All reference sites contain a mix of native and introduced grasses. No undisturbed native-dominated meadows without a history of grazing were located in the basin. Table 2 identifies dominant and non-dominant species found in each reference meadow. Slides 27-30 show meadow conditions at the reference meadows (Appendix A).

Table 2. Meadow Species Found at Spring Creek and in Reference Meadows.

COMMON NAME	LATIN NAME	ORIGIN	SPRING CREEK EASEMENT			REFERENCE MEADOWS		
		(Native or Introduced)	NW Meadow	NE Meadow	S Meadow	Upper Allingham Meadow	Lower Allingham Meadow	Corbett Meadow
Shrubs								
Green rabbitbrush	*Chrysothamnus viscidiflorus*	N			X			
Wax currant	*Ribes cereum*	N			x			
Grasses, sedges, rushes								
Kentucky bluegrass	*Poa pratensis*	I	X	x	X (edges)	X	X	X
Meadow fescue	*Schedonorus pratensis*	I	X		X (edges)			
Blue wildrye	*Elymus glaucus*	N				X		X
California brome	*Bromus carinatus*	N, invasive			x	X	x	x
Cheatgrass	*Bromus tectorum*	I	X	X	X	x	x	
Prairie junegrass	*Koeleria macrantha*	N				x	x	
Idaho fescue	*Festuca idahoensis*	N				x		
Meadow foxtail	*Alopecurus pratensis*	I	x				X	X
dense silkybent	*Apera interrupta*	I	x	x	X			x
Western needlegrass	*Achnatherum occidentalis*	N			x			
Bottlebrush squirreltail	*Elymus elymoides*	N			x			
Baltic rush	*Juncus balticus*	N			X (edges)			x
Cusick's sedge	*Carex cusickii*	N	X (edges)		x			
Unidentified sedge	*Carex sp.*	N	X(edges)				X	X
Forbs								
Bull thistle	*Cirsium vulgare*	I	x	x	x			
Mullein	*Verbascum thapsis*	I	X	X	x			
Teasel	*Dipsacus fullonum*	I	x					
Tumble mustard	*Sisymbrium altissimum*	I		x				
Peck's penstemon	*Penstemon peckii*	N			x			
Strawberry	*Fragaria virginiana*	N				x		x
Yarrow	*Achillea millefolium*	N, invasive			x	x		
Blue flax	*Linum lewisii*	N				x		
slender cinquefoil	*Potentilla gracilis*	N					X	
Oregon checkermallow	*Sidalcea oregana*	N	x				x	x
Velvet lupine	*Lupinus leucophyllus*	N			x			
Western St. John's-wort	*Hypericum formosum*	N						x

(X: Dominant; x: Present)

Proposed Restoration Actions

Specific restoration actions are described for the four projects proposed along Spring Creek down to the confluence with the Metolius River and on the Spring Creek Easement. Because Spring Creek is located on private, ODFW, and USFS properties, communication and buy-in on the restoration concepts and strategies are essential. Before any restoration actions occur, agreements with the appropriate landowners will be in place. Cost estimates for each action can be found in Appendix C.

In-Stream Fish Habitat Enhancement

The goal of in-steam fish habitat enhancement is to maintain existing spawning habitat and high water quality while increasing pool habitat and cover for spring Chinook salmon, bull trout, redband trout, and other native fish. The presence of wood slows water and creates deeper areas that provide for juvenile protection and may, over time, produce adult redband habitat (Mike Riehle, personal communication 7.23.10). Proposed in-stream wood placement is informed to a large extent by the USFS Metolius River Wood Restoration Project and by fish biologists with the Sisters Ranger District, Mike Riehle and Nate Dachtler. We propose eight log jams, each with an average of four logs, along Spring Creek (**Figure 5**). This includes three log jams on the Easement, four on ODFW property, and one on USFS land. All proposed actions must be acceptable to respective landowners.

The Metolius River Wood Restoration Project aims to enhance native fish habitat in the Metolius River, especially chinook salmon habitat, which is deficient due to the lack of pools. Wood forms pools and slows water, both important for rearing salmon in the first year of life (DNF, 2007). Lovtang (2005) found the highest density of chinook salmon in areas where water was slowed by wood or other obstructions. Wood also creates vegetated islands that are important for many aquatic species.

Historical removal of wood on the Metolius River has caused a shortage of in-stream wood, pools, and fish cover (DNF, 2007). While we found no record of historical wood removal specifically from Spring Creek, Nehlsen (1995) notes that Holloway et al. (1938) observed a deficiency of pools and cover in the upper 10 miles of the Metolius and its tributaries as a result of the removal of downed logs. Spring Creek was likely included in this assessment. It is reasonable to assume that Spring Creek historically had quantities of in-stream wood comparable to the Metolius River in areas with a ponderosa pine overstory. For the Metolius Project, the desired density of large wood is between 46 and 155 pieces per mile. The desired pool habitat is between 18 and 26 pools per mile. Good pool habitat for rearing chinook salmon occupies 40% to 60% of the stream (DNF, 2007). The proposed addition of 32 logs to Spring Creek, which is 0.4 miles long, falls within this range of desired large wood densities and will increase pool habitat toward the desired range.

The location of eight proposed log jams and access routes are shown in Figure 5. Several factors contributed to the proposed location of in-stream wood. First, we considered areas that historically had or currently have a ponderosa pine overstory

Sources:
2005 NAIP 0.5 m aerial photo
Jefferson County taxlot data, 03/07

Spring Creek Easement

Log complex

Access

0 100 200 Feet

DESCHUTES GEOgraphics

Figure 5. In-stream Fish Habitat Enhancement

where natural recruitment of trees occurs. On the Easement, pines are the dominant overstory tree on the right side of the creek. There is no evidence that pines were present on the west side of Spring Creek on the Easement upstream of the hatchery. Since it is unclear if pines were present on the left side just south of the hatchery (none present in the 1943 or later aerial photographs), no wood is proposed here. Downstream of the Easement, large pines grow on ODFW and DNF lands. Second, Nate Dachtler and Karen Allen assessed possible access routes to minimize disturbance while placing multiple pieces of wood per access. Third, Nate identified deeper areas in low gradient riffles or runs where additional wood may deepen existing pools and provide the greatest opportunity to enhance habitat.

A minimum of four pieces of wood per structure is ideal for slowing water and providing cover for fish, based on recent monitoring of logs placed in the Metolius River in 2009 (Nate Dachtler, personal communication 8.26.10). Large wood with a DBH of 14 inches or greater and a minimum length of 30-40 feet or longer is recommended. Trees with intact root wads are preferred over those with cut ends, if available. Hazard trees that landowners want to remove anyway can be utilized as in-stream wood if they are the appropriate size. Prior to implementation, the weight limit of the Spring Creek Lane Bridge should be obtained from the USFS engineer in the supervisor's office (Lisa Anelek, 541-383-5511).

Techniques for log placement include using an excavator from the river bank, and for the log structure on river left on ODFW property, using an excavator in the river bed, accessed from the right bank (Figure 5). Aggregations of logs can be integrated together to resist movement during high water. Because Spring Creek's flow regime is relatively stable, logs are not proposed to be keyed (buried) into the bank, just as logs were not keyed in along the upper Metolius River. Logs can be placed either with the root wad on the bank, as was done along the Metolius River across from the Spring Creek confluence (Photos 32 &33, Appendix A), or the excavator can push a cut end into the bank to secure and hide it. To increase the stability of log placements, these measures that also apply to Spring Creek were taken on the Metolius Project: 1) avoid clusters of sites and 2) consider reducing the current under placed wood with additional logs. If boater safety is an issue on Spring Creek (based on discussions with Bruce Livingston and other landowners), these two additional measures can be taken: 3) avoid placement of logs in the thalweg, and 4) remove branches, if possible, on the upstream side of wood, but keep the top branches (USFS, 2008). Prior to implementation, log placement locations will be reviewed with landowners to ensure landowner approval and to avoid hazardous log placements.

Seasonal work restrictions will be observed to protect fish spawning and raptor nesting. At the time of implementation, the source of wood, the contractor and supervisor of the wood placement will be determined. Costs have been estimated based on the Metolius River Wood Restoration Project costs (Appendix C).

Steps will be taken to minimize disturbance during wood placement, as was done in the Metolius River Wood Restoration Project. Existing roads will be used where available.

To restore access routes following wood placement, tracks along access routes will be raked, wood and duff pulled back, Idaho fescue seeded, and native plants such as rose, wax currant, and Idaho fescue planted. The USFS may choose to extend monitoring of the Metolius River Wood Restoration Project up into Spring Creek to evaluate the effectiveness of additional wood, however no formal monitoring is proposed.

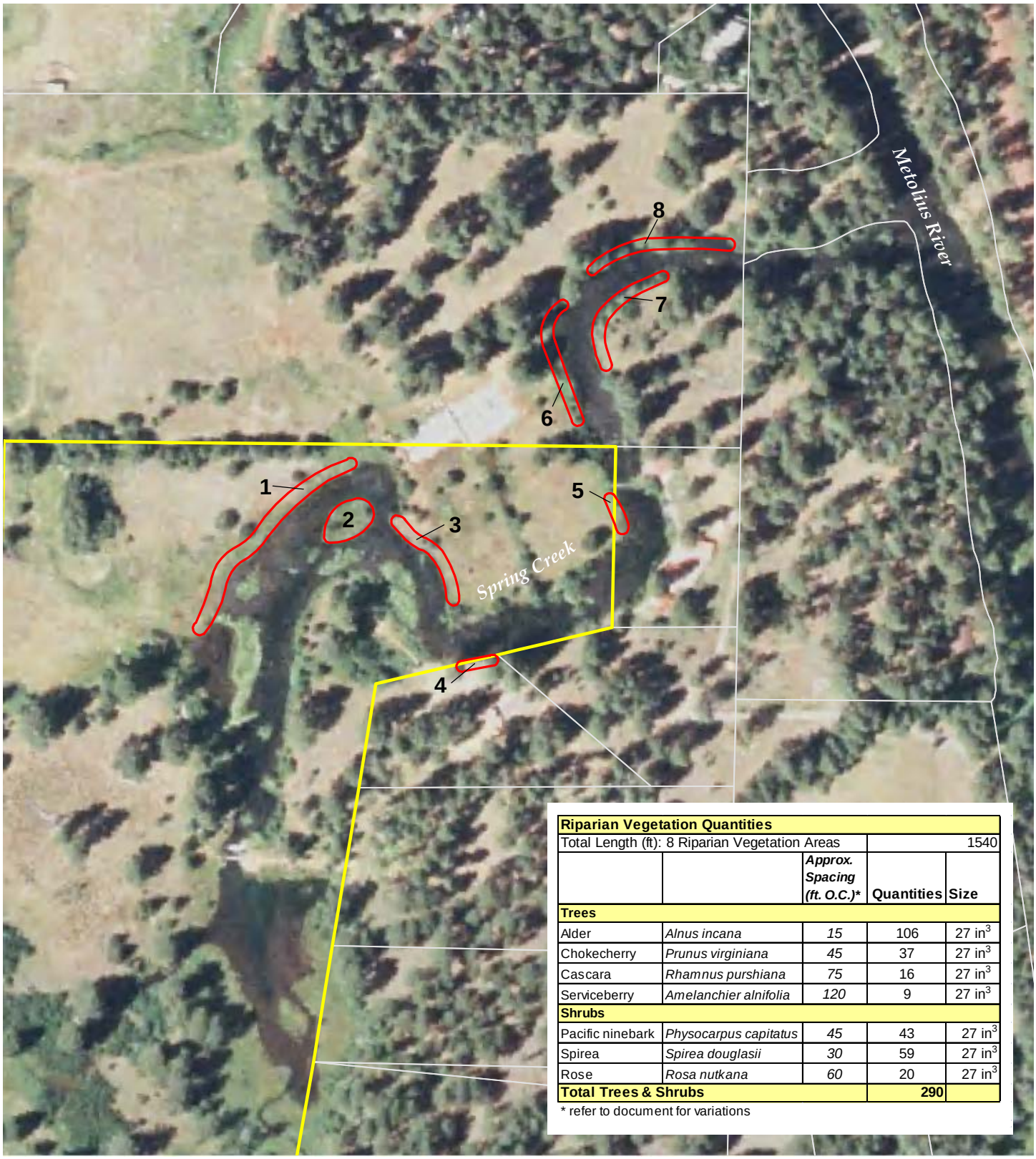
Riparian Vegetation Restoration

We delineated eight restoration areas along Spring Creek that may benefit from woody riparian plantings (**Figure 6**). Photos are in the Riparian Vegetation Restoration Areas section of Appendix A. The quantities of trees and shrubs were determined based on the approximate spacing of the different species observed at reference sites (Table 3). For instance, alder quantities are based on an average spacing of one plant every 15 feet along the bank. Since chokecherry is less common, a spacing of every 45 feet is proposed. At the variable spacing and quantities proposed in Table 3, the overall average spacing for all the trees and shrubs is one every 5 ½ feet. This overall average spacing is approximately twice the desired final densities, accounting for 50% mortality. If the project meets a success criterion of 50% survival, we will consider the project a success. Planting in clumps of 1-2 trees with 1-2 shrubs, leaving 10-12 feet between clumps, is recommended.

Several exceptions to the spacings identified in Table 3 were made to determine the final quantities shown. Riparian area #1 is very wet with dense herbaceous wetland plants. The overall spacing was spread out to every 8 feet on average. If 12-15 clumps are planted, this translates to one clump every ~25 feet. Riparian area #4 lies along a steep bank with a narrow 1-foot wide riparian corridor. The overall spacing was thinned out to every 6 feet on average. Riparian Area #2 is an island that currently has 1 hawthorn, 1 decadent alder and 1 young alder growing on it. A total of 32 trees and shrubs are suggested.

Table 3. Riparian Vegetation Quantities

		Spacing (ft. O.C.)	**Quantities by Area**								
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**
Length (ft)			**350**	**-**	180	75	60	350	300	225	1540
Width (ft)			6	-	2	1	6	6	2	3	
Trees											
Alder	*Alnus incana*	*15*	15	12	12	5	4	23	20	15	106
Chokecherry	*Prunus virginiana*	*45*	6	4	4	2	2	8	7	5	37
Cascara	*Rhamnus purshiana*	*75*	2	0	2.4	0	0	5	4	3	16
Serviceberry	*Amelanchier alnifolia*	*120*	0	0	1.5	0	0	3	3	2	9
Shrubs											
Pacific ninebark	*Physocarpus capitatus*	*45*	8	8	4	2	2	8	7	5	43
Spirea	*Spirea douglasii*	*30*	12	8	6	3	2	12	10	8	59
Rose	*Rosa nutkana*	*60*	0	0	3	1	1	6	5	4	20
Total Trees & Shrubs			**42**	**32**	**33**	**12**	**11**	**64**	**55**	**41**	**290**



Riparian Vegetation Quantities				
Total Length (ft): 8 Riparian Vegetation Areas				1540
		Approx. Spacing (ft. O.C.)*	**Quantities**	**Size**
Trees				
Alder	*Alnus incana*	*15*	106	27 in^3
Chokecherry	*Prunus virginiana*	*45*	37	27 in^3
Cascara	*Rhamnus purshiana*	*75*	16	27 in^3
Serviceberry	*Amelanchier alnifolia*	*120*	9	27 in^3
Shrubs				
Pacific ninebark	*Physocarpus capitatus*	*45*	43	27 in^3
Spirea	*Spirea douglasii*	*30*	59	27 in^3
Rose	*Rosa nutkana*	*60*	20	27 in^3
Total Trees & Shrubs			**290**	

* refer to document for variations

Sources:
2005 NAIP 0.5 m aerial
Jefferson County taxlot data, 03/07

Riparian Vegetation Restoration Areas

Spring Creek Easement

Taxlot

0 100 200 Feet

DESCHUTES GEOgraphics

Figure 6. Riparian Vegetation Restoration Along Spring Creek

Plants should be grown from locally-collected seed grown in 27 cubic inch containers. Plants should be delivered to the site well-watered just prior to planting. Early October is the best time to plant. By then, temperatures have cooled enough that plants' water needs are less than during the heat of the summer, making it easier to keep them well-watered. An early October planting also provides time for plants to spread their roots before winter hits, reducing the chance of frost heaving. Planting in select patches along the upper edge of the sedge community can improve the chances of survival of riparian trees and shrubs that need aerobic soil conditions. Estimated costs are identified in Appendix C.

Invasive Non-native Plant Control

The ability of invasive non-natives to outcompete native plants threatens biodiversity by replacing plant communities composed of many different native species with one or more aggressive, non-native species. Eliminating established infestations and controlling the spread of the seven invasive non-native plant species currently growing on the Easement is an important part of restoring native plant communities throughout the property. Invasives to be controlled include bull thistle, Canada thistle, mullein, oxeye daisy, St. Johnswort, teasel and tumble mustard (Figure 3). A consistent effort over two to three or more years to implement the control strategies recommended below can eliminate these species from the site. Cheatgrass is discussed separately under meadow restoration below since controlling cheatgrass is recommended only in the two northern meadows as the first step of restoring native species to these areas.

The overall goal of efforts to control non-natives is to eliminate existing populations and prevent their spread. This can be accomplished by a control strategy that aggressively removes new plants before they produce seed, thereby exhausting the seed bank in the soil. Control strategies suggested below were informed by research and by the Land Trust's 2010 Weed Management Plan for Camp Polk Meadow Preserve, prepared by Sherry Berrin, Land Steward (Deschutes Land Trust, 2010). Regular monitoring, weekly or bi-weekly, of the populations mapped in July 2010 is perhaps the most important aspect of control in order to treat each species at the most appropriate time. As populations change, they should be remapped. Control of invasive non-natives on adjacent properties just NW of the Easement, shown in Figure 3, is critical to the success of efforts to control invasives and restore native plant communities on the Easement.

The Fisheries Biological Assessment for the Deschutes and Ochoco National Forests' Invasive Plant Treatment Project offers guidance on good stewardship practices for herbicide use near streams that contain listed fish species, including bull trout, even though some activities on private land are not governed by the BA (Dachtler, 2009). Where recommended, herbicides should be applied by an herbicide applicator, certified and licensed by the Oregon Department of Agriculture. Herbicides will be applied according to the label. In order to avoid native plants, herbicides will generally be applied by spot spraying or wicking rather than broadcast spraying. Wicking or spot spraying eliminates the possibility of spray drift falling on non-target plants. Glyphosate is the only chemical proposed to be use on the species currently present on the

Easement. Glyphosate is the chemical contained in Roundup and aquatic-approved versions such as Rodeo and Killz All. Table 4 in the BA identifies 10 herbicides that are safe to use near fish-bearing streams, and Table 5 identifies surfactants, used to help herbicides adhere to target plants, approved by the Oregon Department of Agriculture (ODA), USEPA and the USFS for use near water.

Since the duration of the plant (annual, biennial, or perennial) and how it reproduces (from seed or roots) helps determine the most effective control strategies, plants are discussed in order from shortest lived to longest lived. Annual plants live only one growing season and reproduce by seed. Biennials live two growing seasons, producing a basal rosette of leaves during the first year and a flowering stalk the second year before they die. Biennials also reproduce only by seed. Perennials live multiple years and reproduce by seed or by producing shoots off of spreading roots. Perennials with extensive root systems that give rise to many shoots often require herbicides to control. A weed treatment implementation schedule shows recommended treatment by month for all species (**Appendix D**). This treatment schedule should be implemented until invasive populations are controlled.

Annuals

Tumble Mustard

Tumble mustard (*Sisymbrium altissimum*) is an annual plant, 2-5 feet tall with small pale yellow flowers and dissected leaves (Whitson, 2004). Only one small infestation of approximately 50 plants was found on the north end of the property along the old pipe line (Figure 3). Since the infestation is small and the plant reproduces from seed, tumble mustard can be easily controlled by pulling, bagging and removing the plant, seeds included, from the site. In early spring, new basal rosettes of leaves can be dug up and left on the ground. If the plants are pulled prior to flowering, they can be left on the ground. If the population of tumble mustard increases to a point that hand pulling is not feasible, control of young plants in the spring using glyphosate (e.g., Roundup) is possible. Tumble mustard is a high priority to control due to the small infestation and relative ease to control (Table 4).

Biennials

Bull thistle

Bull thistle (*Cirsium vulgare*) is a biennial plant that produces a spiny basal rosette of leaves in the first year and a many-branched flowering stem in the second year and then dies. Flowering occurs between July and October. Although bull thistle is a highly competitive weed that is favored by disturbance, its life history lends itself to being fairly self-limiting, especially if seed production is controlled.

Since bull thistle is a biennial, a control strategy that emphasizes removing flowering stems before they flower can be an effective means of eliminating the plant and exhausting the seed bank. Bull thistle can be easily killed by digging up or breaking the taproot. In the first year rosette stage, the roots can be dug up. In the second year of growth, flowering stems can be cut prior to seed production. If the flowers on the bolted stem have not opened, they can be left on the ground without risk of seed maturation. If

the flowers have opened, they should be removed from the site. Opened flowers may have been pollinated and seed maturation can occur after cutting.

Mullein

Mullein is a tap-rooted biennial plant that reproduces only from seed. In the first year, mullein forms a large basal rosette of thick fuzzy leaves. In year two, the plant bolts, produces a single flowering stalk, 2-6 feet tall, sets seed, then dies (Whitson, 2004). Several dense infestations of mullein, including a large infestation in the NW meadow, were found on the Easement (Figure 3). Where numerous plants grow, a large seedbank of mullein in the soil is likely, so repeated visits to these infestations over three or more years will likely be necessary to eliminate them. Numerous individual mullein plants are also scattered throughout the property.

As a biennial, mullein is relatively easily controlled by mechanical means. Seedheads of old plants can be cut, bagged, and removed from the property. First year rosettes of leaves can be pulled or dug up and left on the ground to decompose. Once the flowering stalk has come up, cutting it at the base will kill the plant. At this stage, it is not necessary to dig up the entire plant.

Teasel

Teasel (*Dipsacus sylvestris*) is a taprooted biennial or short lived perennial that grows to 6 feet tall (Whitson 2004). First year plants form a rosette with a thick taproot that may be up to two feet long. During the second year, the plant bolts and produces a spiny head full of purple flowers, sets seed, then dies. Teasel has been reported to flower from June to October, although in Central Oregon the flowering season is likely shorter. Immature flower heads, when cut, are capable of producing viable seed. Three infestations were found on the Easement and one large infestation off the NW corner of the property.

Since teasel tends to act as a biennial, a control strategy that emphasizes removing flowering stems before they flower can be an effective means of eliminating the plant and exhausting the seed bank. First year rosettes can be dug up, but much of the root must be removed to prevent resprouting. This can be accomplished on smaller rosettes by using a dandelion digger. Flowering stems can be pulled up or cut before they go to seed. Since seeds can mature on the stem after being cut, any flowering or seeding heads should be removed from the site.

Perennials

Canada thistle

Canada thistle (*Cirsium arvense*) is an introduced perennial rhizomatous plant that thrives in moist soil, but can also be found on dry, disturbed sites. Flowering generally begins in late June and continues through August and September in Central Oregon. Canada thistle forms dense clusters of clones and spreads primarily by vegetative horizontal growth of rhizomes. Since Canada thistle spreads readily from stem and root fragments, cutting the roots or disturbing the soil can increase thistle density. A small

infestation in the northwest corner of the Easement and two infestations adjacent to the property should be a high priority for removal due to its aggressive nature.

Since Canada thistle spreads primarily by expansion of its extensive root system, the key to successful control lies in depleting the plant's carbohydrate reserves. In general, the root carbohydrate reserves are lowest in the spring and summer when the plant is fully leafed out and its energy is up in its photosynthesizing leaves, buds or flowers. In the fall after flowering and seed set, the plant begins to pull its carbohydrate reserves back down into its roots. This has implications for the best time to cut or apply herbicides to Canada thistle.

A combination of cutting and herbicides can effectively kill Canada thistle. One strategy is to cut bolting plants in the spring and early summer when they are in late bud stage, just prior to flowering. Cut just below the bud, leaving the main stem, and avoid disturbing the root system. When the main stem is removed or when the root system is disturbed, rootbuds are stimulated to produce new shoots. Repeated cuttings at least every month throughout the growing season followed by fall application of glyphosate can kill the plants. A second strategy is to kill bolting plants in the spring or early summer when the plants are in bud stage by spot spraying or wicking with glyphosate, with a follow up treatment again in the fall when herbicide absorption is enhanced. Since the Canada thistle populations are close to the head of Cold Springs, an aquatic-approved glyphosate should be used. Table 8 in Appendix E identifies recommended buffers on wetlands and streams, depending on application method.

St. Johnswort

St. Johnswort (*Hypericum perforatum*) is a perennial plant introduced from Europe, 1-3 feet tall, that reproduces by seed or rhizomes (Whitson, 2004). It has bright yellow flowers with 5 petals. The flowers were all in bud stage on July 20, 2010 when invasives were mapped, making them difficult to find. Western St. Johnswort, native to the Metolius, is common on the property and its yellow flowers were in full bloom in mid-July. The leaves of the non-native are oblong in shape, opposite each other on the stem, and when held up to the light, reveal distinctive transparent dots that aid in identification. Only two populations, one with 20 plants and the other with approximately 150 plants, were found on the Easement.

Since St. Johnswort spreads by underground rhizomes, it is most effectively treated with herbicides. Aquatic-approved glyphosate can be spot sprayed or applied with a weed wiper in April and again in September according to the rate on the label. Recommended buffers on Spring Creek are shown in Table 8, Appendix E. Flowers can be removed in June and July.

Oxeye Daisy

Oxeye daisy (*Chrysanthemum leucanthemum*) is a short-lived perennial introduced from Europe, 10 to 24 inches tall, that reproduces from seeds or rhizomes. It has white ray flowers and yellow central disk flowers. It flowers between June and August (Whitson, 2004). It aggressively invades fields, where it forms dense populations, thus decreasing

plant species diversity. Seven populations of oxeye daisy were found on the Easement, the largest of which was approximated at 2000 plants. The plant can grow in sun to partial shade and is often found growing in the forest understory.

Oxeye daisy is not currently listed as an Oregon Class A or B noxious weed species. It is listed as a Class B Noxious weed in Washington and Colorado, and is a recognized noxious weed in Montana and Wyoming. Oxeye daisy was mapped since it was identified as part of the 2010 Metolius S&P Noxious Weed Project. However, no control measures are currently recommended for the plant. In other states and for future reference, Picloram and 2,4-D were effective at reducing canopy cover of oxeye daisy. Prior to any future chemical treatment of oxeye daisy, the USFS Biological Assessment should be referred to for guidance on chemicals, buffers, and application methods. Cutting the flowering heads can eliminate seed production. Mowing or pulling on the stems may stimulate shoot production and subsequent flowering (Dolph-Petersen, 2007).

Priorities

Table 4 shows the invasive non-natives on the Easement in order of treatment priority. A Priority 1 weed is the highest priority to control. Priority 1 weeds include species that are relatively easy to control and/or occur in small infestations, and those species that pose the greatest risk to the native ecosystem. A Priority 2 weed is a medium priority to control. Priority 2 weeds include species that are less competitive than high priority weeds. A Priority 3 weed is a low priority to control because it is either well-established, occupies a large area to make control efforts unreasonable, or is less competitive than Priority 1 and 2 weeds.

Table 4. Invasive Non-Native Control Priorities

SPECIES	PRIORITY	RATIONALE	RECOMMENDED TREATMENT
Tumble mustard	1	Small infestation; relatively easy to control.	Pull, remove seeds from site.
Bull thistle	1	Relatively easy to control	Dig, cut & remove seeds
Mullein	1	Relatively easy to control	Dig, cut & remove seeds
Teasel	1	Relatively easy to control	Dig, cut & remove seeds
Canada thistle	1	Poses high risk of spreading, especially to newly disturbed ground. Population small now, relatively easy to control.	Cut buds prior to flowering & spray in fall OR spray in Spring & Fall.
St. Johnswort	2	Less competitive than Priority 1 weeds	Spray in April & Sept. Cut buds June & July
Oxeye Daisy	3	Less competitive; not on Oregon Noxious Weed Lists	No treatment recommended

Upland Meadow Restoration

Restoration of the NW and NE meadows is proposed. Restoration may be possible over a period of three to five years by first controlling invasive non-native plants (described

above), simultaneously controlling cheatgrass (described below), then seeding and planting with natives. The proposed actions do not attempt to eliminate or control the well-established pasture grasses, including Kentucky bluegrass, meadow fescue, meadow foxtail and dense silkybent. Despite the presence of pasture grasses, native grasses are expected to have a good chance of establishing and spreading.

Cheatgrass dominated areas to be treated are shown on **Figure 7**. One-fifth of the NW meadow's 1.75 acres is cheatgrass (0.35 acres), including the several patches of cheatgrass on Lisa Livingston's property outside the NW corner of the Easement. To successfully restore the NW meadow, cheatgrass and other infestations of invasive non-natives adjacent to the Easement should also be controlled. All of the NE meadow's 0.43 acres is cheatgrass infested.

Cheatgrass (*Bromus tectorum*) is an aggressive annual or winter annual that reproduces only by seed. A cheatgrass control strategy should emphasize preventing the plant from producing and dropping seed and exhausting the seed bank. Cheatgrass sprouts early in the spring and throughout the growing season. Because of this, multiple treatments are generally required throughout a growing season. Consistent treatment efforts over 2-3 years may be required to eliminate cheatgrass from the meadows.

Cheatgrass infestations can be identified on the ground with pin flags to easily relocate and track them over time. New plants should be removed before seeds mature by either hand pulling if infestations are small enough, mowing or using herbicides. If hand pulling, seeds should be bagged and removed from the property. Mowing or use of herbicides should be done prior to seed set. Cheatgrass infested areas should be treated at least three times between April and September. In April or May when cheatgrass starts to germinate, mow or treat with glyphosate. Treat again in June or July when another flush of flowering occurs and again in September. Glyphosate is non-selective so other desirable plants should be avoided.

Another strategy to kill cheatgrass that can be used in addition to that described above is to apply a pre-emergent in the fall to kill the seeds. Plateau (or Panoramic, the generic version) sprayed at 6-8 ounces per acre in October or November has been found to greatly reduce cheatgrass populations. Mowing first will knock down any seeds remaining on the plants. If Plateau is used, seeding must be delayed 1 year if drill seeding and 2 years if broadcast seeding.

The NE meadow was found to be slightly compacted. Ripping the meadow prior to seeding and planting is recommended. Ripping it early on during cheatgrass control may encourage cheatgrass seed to germinate and help exhaust the seed bank.

Once cheatgrass is controlled, seeding and planting can follow in the fall. Once the area is seeded and planted, glyphosate should no longer be used in the restoration area because it is non-selective and will kill any plant it hits. Five grasses and four native wildflowers are proposed to be seeded (Table 4). Ten species are proposed to be

Meadow Restoration Quantities				
Total Acres	*0.8*			
Total square feet	*33977*			
NW Meadow (acres)	0.35			
NE Meadow (acres)	0.43			
SEED				
Common Name	**Latin Name**	**Seeding Rate (lb / acre)**	**Percent of Seed Mix**	**Total Seed (lbs.)**
Grasses				
Blue wildrye	*Elymus glaucus*	4	26%	3
Idaho fescue	*Festuca idahoensis*	4	26%	3
Prairie junegrass	*Koeleria macrantha*	2.5	16%	2
Bottlebrush squirreltail	*Elymus elymoides*	1	6%	1
Western needlegrass	*Achnatherum occidentalis*	0.5	3%	0.4
Forbs				
slender cinquefoil	*Potentilla gracilis*	1	6%	1
Oregon checkermallow	*Sidalcea oregana*	1	6%	1
Velvet lupine	*Lupinus leucophyllus*	1	6%	1
Blue flax	*Linum lewisii*	0.5	3%	0.4
Total lbs. seed		15.5		

PLUGS					
Species	**ft2**	**Spacing (ft)**	**Cover per plant (feet2 / plant)**	**Quantity**	**Size**
Blue wildrye	33977	20	314	108	10 in^3
Idaho fescue	33977	20	314	108	10 in^3
Prairie junegrass	33977	20	314	108	10 in^3
Bottlebrush squirreltail	33977	20	314	108	10 in^3
Western needlegrass	33977	20	314	108	10 in^3
slender cinquefoil	33977	20	314	108	10 in^3
Oregon checkermallow	33977	20	314	108	10 in^3
Velvet lupine	33977	20	314	108	10 in^3
Blue flax	33977	20	314	108	10 in^3
Baltic rush	3398	10	79	43	10 in^3
Total	33977	6.5	33	1017	

Cheatgrass *(Bromus tectorum)*

Upland meadow

Spring Creek Easement

Taxlot

N
W
E
S

0 50 100 Feet

DESCHUTES GEOgraphics

Figure 7. Upland Meadow Restoration

planted as 10 cubic inch plugs to speed the rate of revegetation in the meadows (Table 5). The mix of native species proposed includes those found at reference sites and covers a range of hydrologic needs from moderate (ex. baltic rush) to low (ex. squirreltail, prairie junegrass, western needlegrass). Rhizomatous species such as Kentucky bluegrass and meadow foxtail will likely fill in the newly opened areas over time. Since native upland meadow communities tend to be dominated by bunchgrasses that do not fully cover the soil surface, filling in with these established pasture grasses will help reduce the reestablishment of cheatgrass. While some would not consider this full restoration because pasture grasses would remain, the approach is practical and the beneficial functions of the pasture grasses can be considered (stabilize soil, compete with cheatgrass, facilitate holding water on the site, etc.).

Early October is the best time to plant, for reasons described above. The best time to seed is from late October through December. Seeding late in the year prevents seed from germinating in any remaining warm fall weather while exposing the seed to cold temperatures, a dormancy requirement for most. Germination success should not be fully evaluated until three years have passed.

Success of both seeding and planting will be greatly determined by the ability to water these areas after planting and during seed germination for at least the first year or two. If the project meets a success criterion of 50% survival, we will consider the project a success. The cost of a pump and hoses to water the NE and NW meadows is included in the cost estimates (Appendix C).

Table 5. Meadow Restoration Seeding

MEADOW RESTORATION QUANTITIES				
Total Acres	*0.8*			
Total square feet	*33977*			
NW Meadow (acres)	0.35			
NE Meadow (acres)	0.43			
SEED				
Common Name	**Latin Name**	**Seeding Rate (lb / acre)**	**Percent of Seed Mix**	**Total Seed (lbs.)**
Grasses				
Blue wildrye	*Elymus glaucus*	4	26%	3
Idaho fescue	*Festuca idahoensis*	4	26%	3
Prairie junegrass	*Koeleria macrantha*	2.5	16%	2
Bottlebrush squirreltail	*Elymus elymoides*	1	6%	1
Western needlegrass	*Achnatherum occidentalis*	0.5	3%	0.4
Forbs				
slender cinquefoil	*Potentilla gracilis*	1	6%	1
Oregon checkermallow	*Sidalcea oregana*	1	6%	1
Velvet lupine	*Lupinus leucophyllus*	1	6%	1
Blue flax	*Linum lewisii*	0.5	3%	0.4
Total lbs. seed		15.5		

Table 6. Meadow Restoration Planting

PLUGS					
Species	**ft2**	**Spacing (ft)**	**Cover per plant (feet2 / plant)**	**Quantity**	**Size**
Blue wildrye	33977	20	314	108	10 in^3
Idaho fescue	33977	20	314	108	10 in^3
Prairie junegrass	33977	20	314	108	10 in^3
Bottlebrush squirreltail	33977	20	314	108	10 in^3
Western needlegrass	33977	20	314	108	10 in^3
slender cinquefoil	33977	20	314	108	10 in^3
Oregon checkermallow	33977	20	314	108	10 in^3
Velvet lupine	33977	20	314	108	10 in^3
Blue flax	33977	20	314	108	10 in^3
Baltic rush	3398	10	79	43	10 in^3
Total	33977	6.5	33	1017	

Pipeline Removal

Pipeline removal on the Easement is a future possibility, and therefore warrants a brief description. Since ODFW holds an easement on the pipeline from the dam to the hatchery, any action is contingent on ODFW approval. ODFW is currently in the process of planning the removal of the hatchery infrastructure. Pipeline removal could easily coincide with these efforts.

From a sequencing standpoint, cheatgrass control, followed by pipeline removal, then riparian revegetation and meadow restoration would be ideal. Controlling cheatgrass along the eastern side of the NE meadow, as described above, should capture that growing along the pipeline. However, we recognize that to fully control cheatgrass may take years. Continued cheatgrass control following removal of the pipe will probably be necessary.

The pipeline is approximately 700 feet long and 24 inches in diameter. Once the pipe is removed, the fill that was originally excavated that lies adjacent to the pipe can be used to fill the hole and the slope can be recontoured. No importing of fill material should be necessary. Fill volume is estimated to be approximately 2800 square feet (700 ft x 2 t x 2 ft). Along the 400 feet north of the spring channel, native seed can be spread along the disturbed area. In the approximately 300 feet to the south of the channel, established plants can be set aside before pipe removal and transplanted following recontouring. Native seed may be spread here also, as necessary.

No cost estimates for pipeline removal are included in the Plan since ODFW will initiate the work. The project may be ideal for volunteers groups.

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Appendix A: Photographs

Existing In-Stream Conditions

Spring Creek through Easement has little in-stream wood. Downstream from here are two to three pieces before a large log shown in Photo 36 (on ODFW property).

Spring Creek on DNF property near the confluence of the Metolius River has little in-stream wood and the opportunity to add wood to enhance fish habitat conditions.

Existing Conditions in Wetlands

Former pond in NW corner of property, now an emergent wetland contiguous with other spring-fed wetlands. Recommend no action.

Former pond, now an emergent wetland adjacent to aspen grove at north end of property. Recommend no action.

A spring-fed wetland originating on ODFW property next to the decommissioned hatchery is contiguous with springs and wetlands that emerge on the Easement. Neither are being drained by the old pipe.

Spring water at north end of Easement enters Spring Creek in one channel at the sharp bend in the stream.

Riparian Vegetation Existing Conditions can be seen in Riparian Vegetation Restoration Areas section below

Existing Conditions in Meadows

NW Meadow from northwest corner looking southeast. Foreground dominated by Kentucky bluegrass. Dark plant in distance is mullein.

NW Meadow: close up of meadow fescue, a silky-stemmed introduced bunchgrass. Kentucky bluegrass in foreground.

NW Meadow: close up of one of several areas dominated by cheatgrass.

NW Meadow from NE corner looking W/SW. Sedges in foreground occur along edge of wetland adjacent to aspen.

NE Meadow, dominated by cheatgrass, from West to East.

NE Meadow, showing 100% cheatgrass, from East to West.

Cheatgrass in disturbed area along pipe and in NE meadow off photo right

S Meadow, taken from NE to SW. Shows cheatgrass and dense silkybent growing between green rabbitbrush.

S Meadow, taken from SE to NW. Shows baltic rush along meadow edge where moist soil, giving way to drier cheatgrass and green rabbitbrush.

Reference Areas: Riparian Vegetation

Riparian Vegetation Reference #1: On Spring Creek Easement, just downstream from confluence of spring flow that starts on Easement & ODFW. Shows clumps of alders, every ~3-8 meters.

Riparian Vegetation Reference #2: On USFS, river left (facing downstream), just downstream from ODFW property.

Riparian Vegetation Reference #3: South Fork Lake Creek on DLT's Metolius Preserve. Shows alder and ninebark overhanging bank.

Riparian Vegetation Reference #4: Lake Creek above Camp Sherman Road at Lake Creek Lodge, looking upstream. Shows patchy distribution of alders and ninebark.

Reference Areas: Meadows

Reference Meadow #1: Upper Allingham Meadow. Approximately 2 acres in size.

Reference Meadow #2: Upstream end of lower Allingham Meadow. Sedges (upper right) give way to more drought-tolerant grasses in foreground.

Reference Meadow #3: Transitional meadow to north of Corbett meadow, on House on the Metolius property. Dominant species same as Corbett Meadow.

Reference Meadow #3: Moist meadow on Corbett Property.

In-Stream Fish Habitat Enhancement

Metolius River Wood Restoration Project. A minimum of 4 pieces of wood per structure are recommended , as in this log jam across from the confluence with Spring Creek.

Metolius River Wood Restoration Project. Just downstream from confluence with Spring Creek. Shows how logs can be laid on bank without having to be keyed in since flows are stable.

Riparian Vegetation Restoration Areas

Riparian Vegetation Restoration #1

Riparian Vegetation Restoration #2

Riparian Vegetation Restoration #3

Riparian Vegetation Restoration #4,
on Katherine Livingston property

Riparian Vegetation Restoration #5

Riparian Vegetation Restoration #6, looking upstream


Riparian Vegetation Restoration #7, looking upstream. Below Shirley Ray's cabin.

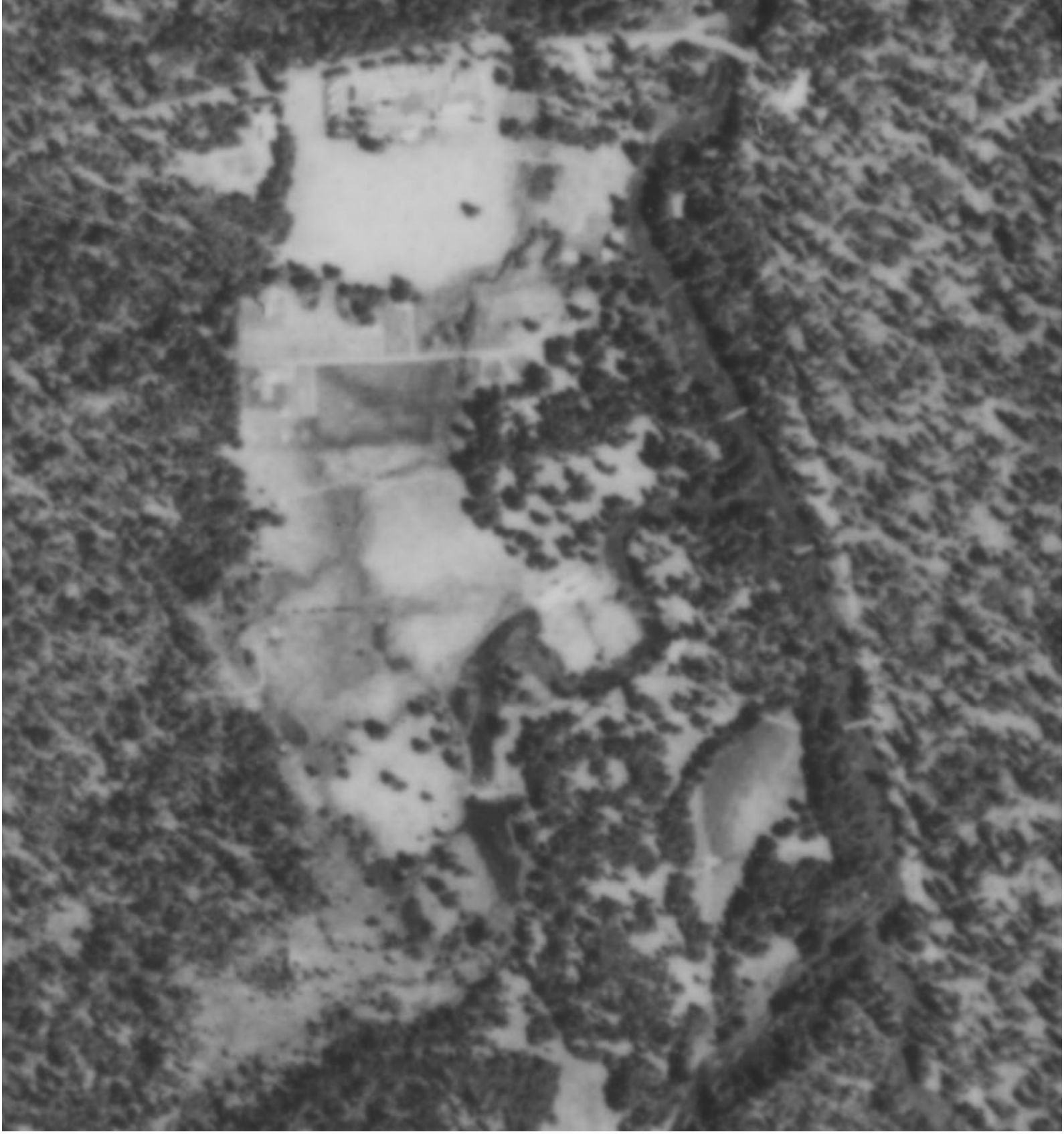
Riparian Vegetation Restoration #8, looking upstream. Distance measurement taken between alder patches only.

Appendix B: Aerial Photos

1943

1951

1959



1976

1979

1984

1994

Appendix C: Cost Estimate

Cost Estimate for In-Stream Wood Placement

# log structures	# trees/structure	Total Number of Trees			
8	4	32			
	Cost per Hour	**Hours**	**Total**		
Trees[1]					
Skidder	$ 100.00	10	$ 1,000.00		
Excavator	$ 140.00	10	$ 1,400.00		
Mobilization			$ 200.00		
Total Cost Trees			**$ 2,600.00**		
Haul Trees					
Self-loader logging truck	$ 100.00	10	**$ 1,000.00**		
Place wood					
Excavator	$ 140.00				
2 hours/structure x 8 structures		16	$ 2,240.00		
Mobilization			$ 200.00		
Supervisor of wood placement	$ 75.00	16	$ 1,200.00		
Total to place wood			**$ 3,640.00**		
Total In-Stream Wood Placement			**$ 7,240.00**		
Revegetation					
	Cost per Hour	**Hours**	**Total**		
Labor to Plant and Seed	$ 45.00	24	**$ 1,080.00**		
Seed	**Pounds per acre**	**Acres**	**Total Pounds**	**Cost per Pound**	**Cost**
Idaho fescue seed	8	*0.25*	2	$ 12.00	$ 24.00
Seed Total					**$ 24.00**
Plants	**Quantity[2]**	**Size**	**Cost per Plant**	**Cost**	
Idaho fescue	400	10 in^3	$ 1.15	$ 460.00	
Rose	50	27 in^3	$ 2.00	$ 100.00	
Wax currant	50	27 in^3	$ 2.00	$ 100.00	
Plants Total	**500**			**$ 660.00**	
Total Revegetation				**$ 1,764.00**	
Subtotal In-Stream Wood Placement				**$ 9,004.00**	
15% Contingency				$ 1,350.60	
Total In-Stream Wood Placement				**$ 10,354.60**	

1: Some trees may be available on landowner property; to be determined prior to implementation. Note from Kristine Senkier: UDWC usually gets trees from the Forest Service as in-kind or we pay their salary to supervise the skidder and self loader. Worst case scenario is we pay a skidder and excavator to fall and haul the trees, which is skidder $100/hour and excavator $140/hour for a 10 hour day.

2: assume 5 access points, 10 ft. x 150 ft = 1500 square feet each (0.17 acre for seed calc). Assume 100 plants each access point, or 500 total plants.

Note: This cost estimate includes direct costs of implementation only. It does not include costs for project management, grant administration, and long-term monitoring.

Cost Estimate for Riparian Vegetation Restoration

		Spacing (ft. O.C.)	Quantities by Area									Size	Cost per 20/27 in^3 Clearwater Native Nursery [1]	Total Cost Plant Material
Trees			**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**Total**			
Alder	*Alnus incana*	*15*	15	12	12	5	4	23	20	15	106	27 in^3	$ 1.85	$ 196.72
Chokecherry	*Prunus virginiana*	*45*	6	4	4	2	2	8	7	5	37	27 in^3	$ 1.85	$ 68.66
Cascara	*Rhamnus purshiana*	*75*	2	0	2.4	0	0	5	4	3	16	27 in^3	$ 1.85	$ 29.72
Serviceberry	*Amelanchier alnifolia*	*120*	0	0	1.5	0	0	3	3	2	9	27 in^3	$ 1.85	$ 16.26
Shrubs														
Pacific ninebark	*Physocarpus capitatus*	*45*	8	8	4	2	2	8	7	5	43	27 in^3	$ 1.85	$ 79.34
Spirea	*Spirea douglasii*	*30*	12	8	6	3	2	12	10	8	59	27 in^3	$ 1.85	$ 109.77
Rose	*Rosa nutkana*	*60*	0	0	3	1	1	6	5	4	20	27 in^3	$ 1.85	$ 36.69
Total Trees & Shrubs			**42**	**32**	**33**	**12**	**11**	**64**	**55**	**41**	**290**		$ 1.85	**$ 537.16**
Other Costs														
Plant Delivery[1]														**$65**
											hrs	**# planters**	**Cost per man hour**	
Planting crew (includes drive time & staging)											8	4	$ 45.00	**$ 1,440.00**
assume no browse protection														
Subtotal Riparian Vegetation Restoration														**#REF!**
15%Contingency														#REF!
Total Riparian Vegetation Restoration														**#REF!**
			Riparian Vegetation Area Number								Total			
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**				
	Length (ft)		350	-	180	75	60	350	300	225	1540			
	Width (ft)		6	-	2	1	6	6	2	3				
	Area		2100	360	360	75	360	2100	600	675	6630			

1: confirmed 2012 or 2013 price with Mike Lattig on 9.9.10

Note: This cost estimate includes direct costs of implementation only. It does not include costs for project management, grant administration, and long-term monitoring.

Cost Estimate for Invasive Non-Native Plant Control (accounts for 3 years of treatment)					
Mechanical treatment					
Species	**Man Hours per year**	**Years**	**Total Man Hours**	**Cost per man hour[1]**	**Total Estimate Cost**
Tumble mustard	4	2	8	$30	$240
Bull thistle					
assume 80 plants/hr to cut, bag, remove	8	3	24	$30	$720
Mullein					
Year 1: assume 80 plants/hr to cut, bag, remove	50	1	50	$30	$1,500
Year 2 & 3: fewer plants	20	2	40	$30	$1,200
Teasel					
assume 50 plants/hr to cut, bag, remove	15	3	45	$30	$1,350
Canada thistle					
cut buds	2	3	6	$30	$180
spot spray with herbicide (see below)					
St. Johnswort					
cut flower heads	1	3	3	$30	$90
spot spray with herbicide (see below)					
Total Mechanical Treatment Costs					**$5,280**
Chemical treatment					
Herbicide Application Fee[2] (Canada thistle, St. Johnswort)	12	3		$75	$2,700
Milestone herbicide (7 ounces per acre)	2 oz.			$4/oz	$8
Total Chemical Treatment Costs					**$2,708**
Materials	**number**				
Bags (boxes)	1	3		$ 10.00	$ 30.00
Disposal costs	4	3		$ 11.00	$ 132.00
Total Materials					**$ 162.00**
Subtotal Invasive Weed Control over 3 years					**$8,150.00**
15%Contingency					$1,222.50
Total Invasive Weed Control over 3 years					**$9,372.50**
1: based on Botanical Development 2010 Labor rates					
2: based on Modern Weed Control, Mike Crumrine, 2010 rates. Assumes 2 trips per year at 6 hrs each.					
Note: This cost estimate includes direct costs of implementation only. It does not include costs for project management, grant administration, and long-term monitoring.					

Cost Estimate for Cheatgrass Removal (part of Meadow Restoration)					
		quantity	**cost per ounce**	**total annual cost**	
Acres of cheatgrass	0.8				
Acres NW meadow	0.35				
Acres NE meadow	0.43				
Fall treatment					
Plateau - 8 oz. per acre		8	2.6 per oz.	$ 20.80	
Plateau Application Fee[1]		6 hours	$75 per hour	$ 450.00	
Spring/Summer Treatment					
Mow	3 times/yr	6 hours	$25 per hour	$ 450.00	
OR					
Glyphosate ($30/gal)				$ 30.00	
Glyphosate Application Fee[1]	3 times/yr	6 hours	$75 per hour	$ 1,350.00	
Number years application					3
Subtotal Cheatgrass Removal					**$ 4,050.00**
15% Contingency					$ 607.50
Total Cheatgrass Removal					**$ 4,657.50**
1: based on Modern Weed Control, Mike Crumrine, 2010 rates					
Note: This cost estimate includes direct costs of implementation only. It does not include costs for project management, grant administration, and long-term monitoring.					

Cost Estimate for Meadow Restoration

(See also Cheatgrass Removal Worksheet. Removing cheatgrass is first part of meadow restoration.)

Total Acres	*0.8*
Total square feet	*33977*
NW Meadow (acres)	0.35
NE Meadow (acres)	0.43

SEED

Common Name	Latin Name	Seeding Rate (lb / acre)	Percent of Seed Mix	Total Seed (lbs.)	Cost per Lb. (Deschutes Native Seedbank 2010)	Cost per Lb. Clearwater (hand collection of local material)[1]	Total Cost
Grasses							
Blue wildrye	*Elymus glaucus*	4	29%	3	$ 15.00		$ 46.80
Idaho fescue	*Festuca idahoensis*	4	29%	3	$ 12.00		$ 37.44
Prairie junegrass	*Koeleria macrantha*	2.5	18%	2	$ 16.00		$ 31.20
Bottlebrush squirreltail	*Elymus elymoides*	1	7%	1	$ 24.00		$ 18.72
Western needlegrass	*Achnatherum occidentalis*	0.5	4%	0.4		$ 150.00	$ 58.50
Forbs							
slender cinquefoil	*Potentilla gracilis*	0.5	4%	0.4		$ 150.00	$ 58.50
Oregon checkermallow	*Sidalcea oregana*	0.5	4%	0.4		$ 150.00	$ 58.50
Velvet lupine	*Lupinus leucophyllus*	0.5	4%	0.4		$ 150.00	$ 58.50
Blue flax	*Linum lewisii*	0.5	4%	0.4		$150	$ 58.50
Total Seed		**14**	100%				**$ 426.66**

PLUGS

Species	ft2	Spacing (ft)	Cover per plant (feet2 / plant)	Quantity	Size	Cost per 10 in^3 Clearwater Native Nursery 2012 & 2013[1]	Total Cost Plant Material
Blue wildrye	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Idaho fescue	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Prairie junegrass	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Bottlebrush squirreltail	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Western needlegrass	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
slender cinquefoil	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Oregon checkermallow	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Velvet lupine	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Blue flax	33977	20	314	108	10 in^3	$ 1.15	$ 124.44
Baltic rush	3398	10	79	43	10 in^3	$ 1.15	$ 49.77
Total Plugs	33977	6.5	33	**1017**			**$ 1,169.71**

	hrs	# planters	Cost per man hour	
Planting & Seeding crew (includes drive time & staging)	8	4	$ 45.00	**$ 1,440.00**

Additional treatments	Hours	Cost per Hour	Total
Rip NE Meadow (either before or after cheatgrass treatments)	8	$ 75.00	**$ 600.00**

Irrigation System[2]	Cost per item	Quantity	Total Cost
NE Meadow			
Pump: Honda 4 HP (40 psi)[3]	$ 400.00	1	$ 400.00
Pump hoses (10' intake hose, 4' connection hose, including all required hardware			$ 200.00
Fittings			$ 25.00
Rainbird 35A-TNT Series brass impact sprinkler (44 ft. radius, delivers 0.25" per hr)	$ 40.00	4	$ 160.00
T-posts for each head	$ 5.00	4	$ 20.00
2" schedule 40 PVC pipe to first head	$0.60/foot	40	$ 24.00
1" schedule 40 PVC pipe between heads	$0.30/foot	120	$ 36.00
Installation	$40/hr	8 hrs	$ 320.00
NE Meadow Subtotal			**$ 1,185.00**
NW Meadow			
Pump: Honda 4 HP (40 psi)[3]	$ 400.00	1	$ 400.00
Pump hoses (10' intake hose, 4' connection hose, including all required hardware			$ 200.00
Fittings			$ 25.00
Rainbird 35A-TNT Series brass impact sprinkler (44 ft. radius, delivers 0.25" per hr)	$ 40.00	9	$ 360.00
T-posts for each head	$ 5.00	9	$ 45.00
2" schedule 40 PVC pipe to first head	$0.60/foot	400	$ 240.00
1" schedule 40 PVC pipe between heads	$0.30/foot	280	$ 84.00
Installation	$40/hr	16 hrs	$ 640.00
NW Meadow Subtotal			**$ 1,994.00**
Site Visit by Botanical Development to spec out system, confirm materials	$40/hr	6 hours	$ 240.00
Maintenance Labor (for assist with watering or to maintain system. Assume landowner will manage system. Time allocated for maintenance.)	$25/hr	40 hrs.	$ 1,000.00
Subtotal Irrigation System and Maintenance			**$ 4,419.00**
Subtotal Meadow Restoration			**$ 8,055.37**
15% Contingency			$ 1,208.31
Total Meadow Restoration (excluding cheatgrass removal)			**$ 9,263.68**

1: personal communication, Mike Lattig, Clearwater Native Nursery. Clearwater prices comparable to BFI.

2: Cost estimate for irrigation system from Eric Evans, Botanical Development, 9/9/10. Note: Eric has not seen the site.

3: Honda 4 HP pumps run ~2.1 hrs/tank of gas. With sprinklers putting out 0.25" per hour, pump would need to run 4 hours to put out 1" water, requiring 2 tanks. Estimate assumes landowner will manage system.

Note: This cost estimate includes direct costs of implementation only. It does not include costs for project management, grant administration, and long-term monitoring.

Appendix D: Weed Treatment Schedule

Weed Treatment Schedule
Spring Creek Conservation Easement

Species	April	May	June	July	August	September	October
Annuals							
Tumble mustard	dig young plants before seed set; bag & remove mature plants						
Biennials							
Bull thistle		dig rosettes; cut flowering stems prior to seed production				cut and remove flowers/seeds	
Mullein	dig rosettes; cut flowering stem prior to seed production			cut and remove flowers/seeds			
Teasel		dig rosettes; cut flowering stems prior to seed production			cut and remove flowers/seeds		
Perennials							
Canada thistle	Apply herbicide					Apply herbicide	
	cut bolting stems prior to flowering			cut and remove flowering stems and seeds			
St. Johnswort	Apply herbicide using weed wiper		cut flower/seeds, bag & remove			Apply herbicide using weed wiper	
Oxeye Daisy	no treatment recommended						

Appendix E: Herbicide Use Guidelines from USFS Biological Assessment

The following text is copied directly from the *Fisheries Biological Assessment for the Invasive Plant Treatment Project, Deschutes National Forest and Ochoco National Forest and Ochoco National Grassland*, May 2009, as guidance for the use of herbicides near Spring Creek. In this Restoration Plan, glyphosate is the only chemical currently recommended (for the treatment of Canada thistle and St. John's wort). However, if in the future, other invasive populations require chemical treatment, the information provided in Appendix E may be useful, as will the complete Biological Assessment.

Project Design Features and Buffers

Project Design Features (PDFs) were developed to reduce some of the potential impacts the various treatments may cause. PDFs define a set of conditions or requirements that an activity must meet to avoid or minimize potential effects on sensitive resources. For PDFs involving herbicides, these are an added layer of caution to the already-regulated and approved use of these herbicides. PDFs are not optional and are incorporated in the effects analysis.

All PDFs including those that minimize or eliminate concerns for impacts on species of local interest are included in the EIS. PDFs shown in this BA are only those that pertain to fish and wildlife species. The PDFs add a significant degree of caution to the risks inherent in treating invasive plants growing near habitat for listed aquatic species. Site specific project design features were added for watersheds where listed fish and higher risk herbicides may be used to further protect federally listed fish and their habitat (Table's 6 and 7). Buffers for herbicide type, application method, and proximity to streams, and lakes is a PDF that specifies herbicide application buffer sizes across the project area (Table 8).

Table 6. Applicable fish Project Design Features (PDFs) for invasive plant treatment on the ONF, DNF and CRNG.

Concern	Project Design Feature	Source/Comments
Pre-Project Planning		
1.	The nature of invasive plant management requires ongoing project review and evaluation. The location of invasive plants in relation to various environmental components (i.e. plant species of local interest, special forest product gathering areas) is likely to change over the life of the project, thus animal species/habitats of concern, watershed and aquatic resources of concern (sensitive soils, streams, lakes, wetlands, high risk roadsides, municipal watersheds, domestic water sources), places where people gather, and range allotment conditions would be confirmed prior to treatment and appropriate design features would be applied. Apply PDFs (including Terms and Conditions from consultation with regulatory agencies) depending on site conditions.	This process based on similar projects nationwide. Implementation Planning discussed in Appendix F of the EIS.
To Ensure Effective, Safe, and Proper use of Herbicides and to Limit Potential Adverse Effects on People and the Environment		
Field Operations / Worker Safety		
2.	Herbicides would be used in accordance with label instructions, except where more restrictive measures are required as described below. Herbicide applications will only treat the minimum area necessary to meet site objectives. Herbicide formulations would be limited to those containing one or more of the following 10 active ingredients: chlorsulfuron, clopyralid, glyphosate, imazapic, imazapyr, metsulfuron methyl, picloram, sethoxydim, sulfometuron methyl, and triclopyr. Herbicide application methods include wicking, wiping, injection, spot, and broadcast, as permitted by the product label and these Project Design Features. The use of triclopyr is limited to spot and hand/selective methods. Herbicide carriers (solvents) are limited to water and/or specifically-labeled vegetable oil.	Standard #16 2005 R6 ROD; Pesticide Use Handbook 2109.14 Limits potential for adverse effects on people and the environment.
3.	Herbicide use would comply with standards in the *Pacific Northwest Regional Invasive Plant Program – Preventing and Managing Invasive Plants* ROD (2005), including standards on herbicide selection, restrictions on broadcast use of some herbicides, tank mixing, licensed applicators, and use of adjuvants, surfactants and other additives.	2005 R6 ROD Limits potential adverse effects on people and the environment.
4.	Lowest effective label rates would be used. **Spot** herbicide applications would not exceed application rates for the following herbicides: • Imazapyr would not exceed 0.70 lb of active ingredient	These application rates are below thresholds of concern for workers, the public and fish.

	per acre (ai/ac). • Sulfometuron methyl would not exceed 0.2 lb ai/ac. **Broadcast** application would not exceed application rates for the following herbicides: • Picloram at any rate higher than 0.5 lb. a.i./acre. • Sulfometuron methyl at any rate higher than 0.12 lb a.i. /acre. • NPE surfactant at any rate greater than 0.5 lb a.i./acre.	
5.	Use selective spray techniques, or other targeted application techniques (cut stump, basal spray, etc.).	To further reduce the amount of herbicide applied per acre.
6.	Favor Garlon 3A over Garlon IV Ultra wherever equally or more effective.	Garlon 3A has less concern for human health
7.	Herbicide applications would occur when wind velocity is between two and eight miles per hour. The less than 2 mph standard is to avoid spraying during inversions. During application, weather conditions would be monitored periodically by trained personnel.	Typical measure to reduce drift.
8.	Use low nozzle pressure, apply as a coarse spray, and use nozzles designed for herbicide application that do not produce a fine droplet spray, e.g., use a nozzle diameter to produce a median droplet diameter of 200-800 microns, with an objective of >500 microns.	Label advisory. These are typical measures to reduce drift.
9.	No spraying would occur if precipitation is occurring or is predicted to occur within 24 hours within the given treatment area. Local conditions to be monitored by the licensed applicators.	Label instruction. Reduces potential for runoff and ensures effective treatment of target vegetation.
10.	Choose transportation routes with fewer stream crossings, less traffic, and fewer blind curves. Use a guide vehicle when more than one vehicle is traveling to the site, or when large quantities or other circumstances dictate.	To reduce likelihood of spills.
11.	A spill cleanup kit would be available whenever herbicides are transported or stored.	To contain any accidental spills. Source: FSH 2109.
12.	The applicator is responsible for the immediate cleanup of all spills. An Herbicide Transportation and Handling Safety/Spill Response Plan would be the responsibility of the herbicide applicator. *At a minimum the plan would:* ▪ Address spill prevention and containment. ▪ Estimate and limit the daily quantity of herbicides to be transported to treatment sites. ▪ Require that impervious material be placed beneath mixing areas in such a manner as to contain small spills associated with mixing/refilling. ▪ Require a spill cleanup kit be readily available for herbicide transportation, storage and application (minimum FOSS Spill Tote Universal or equivalent). ▪ Outline reporting procedures, including reporting	Source: FSH 2109.14 Reduce likelihood of spills and to contain any spills. Reduce potential for adverse effects from accidental spills.

	spills to the appropriate regulatory agency. ▪ Ensure applicators are trained in safe handling and transportation procedures and spill cleanup. ▪ Require that equipment used in herbicide storage, transportation and handling are maintained in a leak proof condition. ▪ Address transportation routes so that traffic, domestic water sources, and blind curves are avoided to the extent possible ▪ Specify conditions under which guide vehicles would be required. ▪ Specify mixing and loading locations away from water bodies so that accidental spills do not contaminate surface waters. ▪ Require that spray tanks be mixed or washed further than 300 feet of surface water. ▪ Ensure safe disposal of herbicide containers.	
13.	Minimize traffic and disturbance in riparian reserves/RHCAs.	To minimize impact to riparian areas.
14.	Exact fueling sites will be identified prior to implementation of the project, and would be at least 150 feet from lakes, wetlands, or stream channels.	To minimize risk of fuel entering water.
15.	Some sites may only be reached by water or by crossing streams on foot. The following measures would be used to prevent a spill during water transport. • Herbicide would be carried in 1 gallon or smaller plastic containers. The containers would be wrapped in plastic bags and then sealed in a dry-bag. The dry bag would be secured to the watercraft. • Personnel applying herbicide by hand or with a backpack sprayer, or personnel manually pulling or grubbing invasive plants, would avoid, to the extent possible, standing or walking in wetted streams or other water bodies.	To reduce potential for spill in water.
To Protect Soils, Water Quality, Fisheries and Aquatic Organisms		
16.	Oregon Department of Fish and Wildlife (ODFW) Guidelines for Timing of In-Water Work Periods would be followed or negotiated with ODFW for pulling invasive plants located below the bankfull channel or ordinary high water mark.	To reduce potential for causing negative impacts to fish and fish habitat.
17.	Use only aquatic formulations or low aquatic risk herbicides on soils with seasonally high water tables, where label restrictions allow. Land types in treatment areas identified as having a high water table during parts of or all of the year would be field-checked; treatment methods would be modified based on ground conditions.	Source: SERA Risk Assessments; R6 2005 FEIS and Fisheries BA. To ensure herbicide is not delivered to streams in concentrations that exceed levels of concern.
18.	Use of herbicides within 100 feet of perennial waterbodies only allowed up to the typical application rate.	Protects aquatic organisms. Further Protects aquatic organisms by reducing

		amounts of herbicide applied near waterbodies that could runoff and cause effects.
19.	POEA and NPE surfactants would not be used in applications within 100 feet of surface water, wetlands or along roads with ditches that feed into streams.	Protects aquatic organisms.
20.	Do not use clopyralid or metsulfuron methyl on high porosity soils (texture class 3 or 4) where there is a potential for contamination of surface or groundwater (such as where water table is high).	Label advisory. To reduce potential for contamination of surface or groundwater.
21.	No more than one application of picloram or sulfometuron methyl would occur on a given area in a calendar year, except to treat areas missed during the initial application.	To reduce potential for accumulation in soil.
22.	Do not use chlorsulfuron on soils with high clay content (texture class 1).	Label advisory. To avoid excessive herbicide runoff.
23.	Do not use picloram and/or sulfometuron methyl on soils with a high clay content (texture class 1); shallow and unproductive soils; or acidic soils unless other methods are not available or feasible.	Label advisory. To avoid excessive herbicide runoff; reduce potential for entering surface and/or ground water, or to accumulate in soil.
24.	Garlon 4 (terrestrial formulation of triclopyr) is not allowed within 150 feet of any water body or stream channel. Outside of the 150 foot distance, Garlon 3a is preferred over Garlon 4 where it is effective.	To protect aquatic organisms. Lower risk herbicides are preferred where effective; protections of terrestrial wildlife and human health.
25.	Apply erosion control measures and native revegetation (*e.g.*, mulching, native grass seeding, planting) where detrimental soil disturbance or de-vegetation may result in the delivery of measurable levels of sediment to federally listed fish species' critical habitat.	Minimize sedimentation.
26.	Implement Mixture Analysis identified in Regional Fisheries Biological Assessment for tank mixtures proposed. The sum of Hazard Quotients (HQ) for tank mixtures shall not exceed 1.	R6 2005 ROD and Fisheries Biological Assessment
27.	All herbicide storage, herbicide mixing, refilling and post-application equipment cleaning is completed at least 300 feet from live water and in such a manner as to prevent the potential contamination of any riparian area, perennial or intermittent waterway, ephemeral waterway, or wetland.	To prevent water contamination.
28.	Limit the number of people and the number of entries in areas within 100 feet of streams.	To minimize trampling in riparian areas and fish habitat.
29.	Use selected buffers and application methods from Tables 7 and 8 for application of herbicides. Buffers can be increased on a site specific basis if analysis determines that characteristics such as soils, slope, groundwater depth, etc indicate high potential for the contamination of groundwater or surface waters. A Forest Service fisheries biologist will be consulted during project implementation planning to	Based on label advisories, SERA risk assessments. Demonstrate compliance with Standards #19 and 20. To reduce likelihood that herbicides will enter

	identify any steps necessary for identifying the areas during application.	surface waters in concentrations of concern.
30.	Hand pulling of invasive plants adjacent to streams known to contain spawning steelhead populations would be prohibited within the banfull channel from February 15th to July 15th. Pulling of invasive plants adjacent to streams known to contain spawning bull trout populations would be prohibited within the bankfull channel from August 15th to May 15th .	To reduce disturbance to TE listed fish during spawning.
31.	Broadcast treatments and spot treatments within 100 feet of perennial waterbodies, would not exceed typical label application rates as described in the SERA risk assessments (SERA 2001, 2003, 2004).	To protect aquatic fish and biota from herbicide exposure

Table 7. Project Area Unit-Specific Project Design Features.

Watershed Name and Number	Project Area Number	TE Species Affected	Project Design Feature
Upper Metolius 1707030109	All	Bull Trout	Use of triclopyr for treatment of Scotchbroom is only allowed up to the typical application rate.

Table 8. Minimum Buffers (ft) for Herbicide Applications.

Herbicide	Perennial stream			Seasonal intermittent stream			Lake/Wetland		
	Broadcast spray	**Spot-spray**	**Hand**	**Broadcast spray**	**Spot-spray**	**Hand**	**Broadcast spray**	**Spot-spray**	**Hand**
Clopyralid	100	15	bankfull	50	15	*bankfull	100	15	*bankfull
Chlorsulfuron	100	50	bankfull	50	50	bankfull	100	50	bankfull
Aquatic Glyphosate	**50**	**10x**	**0**	**15***	**10x**	***0**	***50**	***0**	***0**
Glyphosate	300	100	50	100	50	50	300	100	50
Imazapic	100	15	bankfull	15	15	bankfull	100	15	*bankfull
Aquatic Imazapyr	50	10x	0	50*	*10x	*0	*50	*10x	*0
Imazapyr	100	50	15	100	50	bankfull	100	50	bankfull
Metsulfuron Methyl	100	15	bankfull	15	15	bankfull	100	15	bankfull
Picloram	300	100	50	100	50	50	300	100	50
Sethoxydim	300	100	50	100	50	50	300	100	50
Sulfometuron Methyl	100	15	bankfull	50	15	bankfull	100	50	bankfull
Aquatic Triclopyr-TEA	X	15^{+}	0	X	$*15^{+}$	*0	X	$*15^{+}$	*0
Triclopyr-BEE	X	150	150	X	50	50	X	50	50
Tank Mixtures	Use greatest buffer identified above.								

*If channel/wetland is dry there is no buffer.
**Buffer of 10 feet for spot sp
+Follow up with EPA consultation.
X No broadcast spray of this herbicide allowed
x Buffer of 10 feet for spot spray except for treatment of above ground vegetation of *Phalarus* and *Iris* species emergent vegetation which could occur to edge of water.