PLANTS FOR PEOPLE: Bringing Traditional Ecological Knowledge to Restoration, 2014-2016

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Project Completion Report for OWEB Restoration Grant #214-3054-10944

Report prepared by Peter Moore and Andy Neill

Institute for Applied Ecology

PREFACE

IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations and the private sector. IAE aims to link its community with native habitats through education and outreach.

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Cover photograph: Camas bulbs about to be planted at raised beds at Confederated Tribes of Grand Ronde, October 2015.

SUGGESTED CITATION

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PLANTS FOR PEOPLE: Bringing Traditional Ecological Knowledge to Restoration, 2014-2016

1. PROJECT SUMMARY

The Plants for People project integrated native plant production, culturally important plant species, and traditional ecological knowledge into restoration at two Willamette Valley sites in 2014-16. Seeds of coast tarweed, cow parsnip and barestem biscuitroot were collected and put into production, with 10 pounds of tarweed seed harvested in 2016. Large camas, Gairdner's yampah and four other species were grown in raised in beds, with large bulbs and roots harvested two years later. Cuttings of six shrub species were planted in beds, with Pacific willow being the most successful. Restoration at Herbert Farm and Natural Area and Champoeg State Park included herbicide treatments, mowing, and a prescribed burn to prepare sites for planting and manage weed invasion. Diverse native seed mixes, bare root forbs, trees, and shrubs were planted at the restoration sites. Tribal elders contributed knowledge about traditional uses and restoration plans and performed a tribal ceremony to celebrate the planting of camas and yampah from the tribal nursery. Building on these successes, a Tribal Native Plant Materials Program Development Plan was created to guide plant production at Confederated Tribes of Grand Ronde.

2. BACKGROUND

The Willamette Valley spans 11,200 square miles and is home to some of Oregon's most valuable wetland, riparian, and biological resources. Large tracts of prairies and riparian habitat have been converted to use for urban, agriculture, forestry, and industry since European settlement in the ecoregion. Consequently, the small remnants of habitat that remain are often isolated from each other and are frequently impacted and degraded by invasive plant species.

Native Americans have been present in North America for more than 15,000 years, and during that time developed harvesting and landscape manipulation practices which shaped the environment around them. The Kalapuya in the Willamette Valley relied on many native plant species for food, medicine, weaving, and ceremonies. Over time Native Americans developed a unique relationship with the natural environment. They became the first habitat stewards in the Willamette Valley, and their management practices were integral to the character and biological richness of the landscape. Traditional ecological knowledge (TEK) refers to cumulative indigenous knowledge, practice, and belief concerning the relationship of living beings with one another and with their environment. For example, the use of frequent burning of prairies and oak savanna maintained open landscapes to improve habitat for hunted and gathered species.

TEK is no longer at work on Willamette Valley landscape. With the exception of fire, TEK has not been incorporated into modern restoration practices. Anthropogenic fire suppression since the early 1900s led to the encroachment of woody plants and invasive species on remaining prairie habitats. This contributed to the decline of prairie habitat and the loss of species diversity. Recently, controlled and prescribed burning has been accepted as a valued management tool to control of woody vegetation, susceptible weeds, and overgrown vegetation, and has become a key technique to prepare the ground for planting and seeding.

For the most part, the human element is missing from the modern-day restoration formula. Current restoration practices typically do not consider designs that integrate human foraging and habitat complexity. Plant selection, landscape design, and harvesting are all areas where TEK could be applied to habitat restoration in the Willamette Valley.

There are few locations that host culturally significant plants and allow gathering by local Native American tribes. If TEK is to be incorporated into prairie restoration practices, a lack of available commercial production of many culturally important species could hinder these efforts. Outreach is needed to build awareness by land managers of culturally significant species, their availability, and the ecological and social benefits of inviting cultural gathering.

The Confederated Tribes of the Grand Ronde (CTGR) began developing a Tribal Native Plant Materials Program with the help of the Institute for Applied Ecology (IAE) to address the lack of culturally important plant materials and to provide materials for tribal restoration sites. These factors provided the impetus for the collaborative effort, coordinated by IAE, to develop the Plants for People project. The proposal was approved and funded by the Oregon Watershed Enhancement Board (OWEB) (Restoration Grant Agreement Number 214-3054-10944) for a three year period (5/16/14 to 12/30/16). A separate Plant Establishment Grant Agreement (214-3054-11262) continues to 4/30/19.

This report describes project restoration actions by IAE and partners for the duration of the Plants for People project grant.

2.1 Project objectives

The objectives of the Plants for People project were to:

- Integrate TEK with standard restoration practices to restore prairie and riparian habitats and create harvesting and demonstration areas at two culturally important restoration sites: Champoeg State Park and Herbert Farm and Natural Area (Figure 1).
- Establish a Tribal Native Plant Materials Program at CTGR, with additional production at the Natural Resources Conservation Service Plant Materials Center (PMC).

2.2 Restoration sites

- **Herbert Farm and Natural Area** (Herbert Farm) is a 221 acre property south of Corvallis in Benton County (Figure 1). It is owned by City of Corvallis (City) and has an Oregon Department of Fish and Wildlife (ODFW) conservation easement through the Willamette Wildlife Mitigation Program (City of Corvallis 2011). IAE has been working with partners since 2013 to restore a range of habitats in Phase I areas west of Matt Creek (Menke et al. 2013), and since 2015 has been restoring areas east of Matt Creek (Moore 2017a). The Plants for People project targeted restoration in Phase I areas, helping

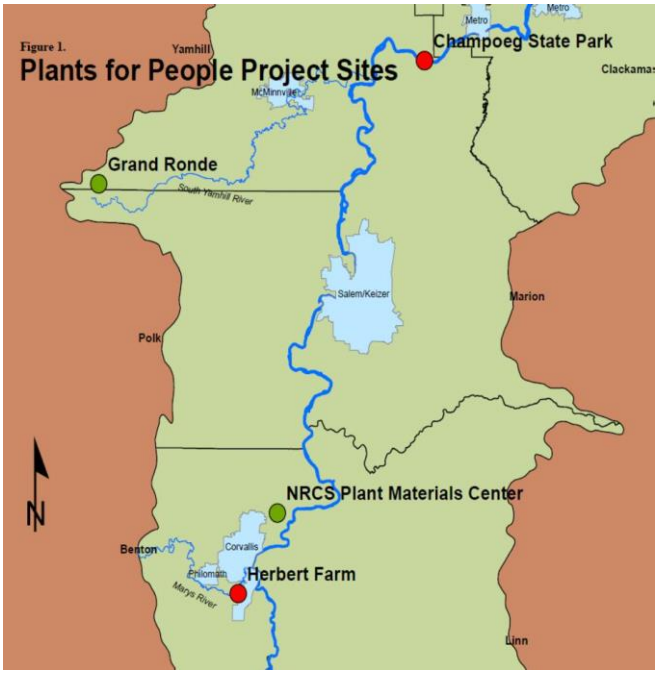

Figure 1. Plants for People project sites. Red dots indicate restoration sites. Green dots indicate plant materials production sites.

to restore former agricultural land to riparian forest (29 acres) and prairie habitats (39 acres) (Figure 2).

- **Champoeg State Park** (Champoeg) is a 615 acre property adjacent to the Willamette River, near Newberg in Marion County, and is managed by Oregon Parks and Recreation Department (OPRD). IAE has been helping restore 45 acres of native prairie habitat (see Champoeg Management Plan, Axt 2014), including 7.9 acres of forb introduction plots, since 2013 (Figure 3).

2.3 Plant material program sites

- **The Natural Resources Department of CTGR** is located near Grand Ronde in Yamhill County (Figure 1) and was the location for new plant production beds.
- **The Natural Resources Conservation Service's Corvallis Plant Material Center (PMC)** near Corvallis (Figure 1) was the location for a seed production bed and the source of some plant materials. PMC staff also provided advice on plant production.

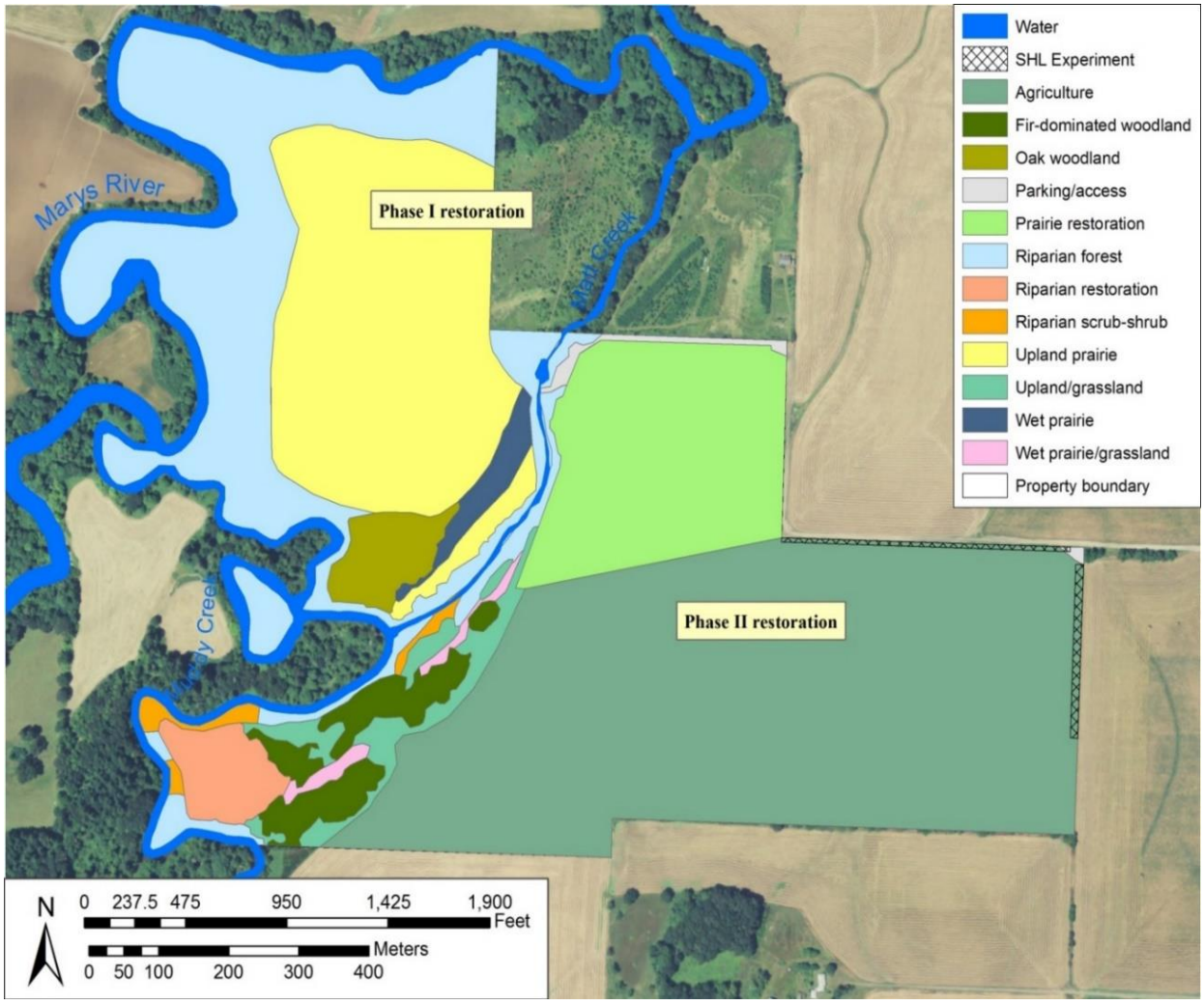

Figure 2. Current habitats at Herbert Farm and Natural Area in 2016. The Plants for People project targeted restoration in Phase I restoration areas, west of Matt Creek.

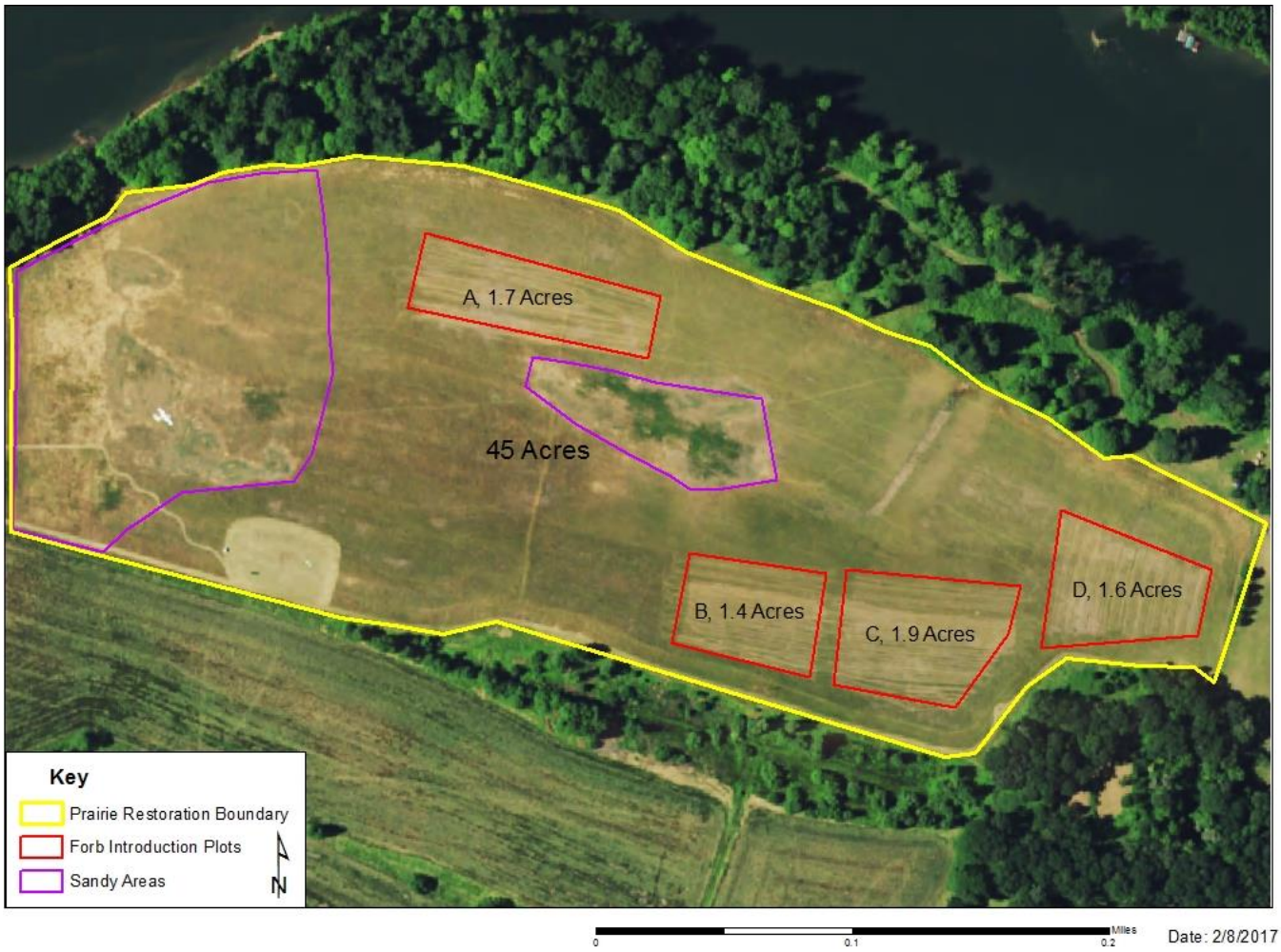

Figure 3. Map of prairie restoration areas at Champoeg State Park. Red polygons show the location of forb introduction plots.

3. PROJECT DESCRIPTION

Habitat restoration supported by this grant occurred over three years from 2014 to 2016. Complete restoration schedules are summarized for Herbert Farm and Natural Area (Table 1) and Champoeg State Park (Table 2).

3.1 Site Preparation

Prescribed Burn

Other fire management needs precluded a prescribed burn at Champoeg in both 2014 and 2016, but a prescribed burn of the 45-acre prairie is planned for the fall of 2017.

A prescribed burn was conducted on a two-acre upland prairie habitat site at Herbert Farm in late September of 2016. A fire line was mowed by City of Corvallis Parks and Recreation Department prior to the Corvallis Fire Department conducting the burn (Figure 4). The burn reduced thatch and provided a seed bed for sowing native seed in the fall of 2016.

Figure 4. Left: Prescribed burn in two-acre upland prairie at Herbert Farm, September 2016 (Photo: City of Corvallis); Right: U.S. Fish and Wildlife Staff seeding the newly burned prairie, October 2016.

Invasive species management

IAE staff and subcontractors conducted broadcast and spot spray herbicide treatments, mowing, and hand weeding in prairie and riparian habitat project areas at Herbert Farm (Table 1) and Champoeg (Table 2) during 2014-2016 (Figures 5-7). OWEB grant funds contributed to contractor costs for herbicide applications in 2016, but invasive species management at both restoration project sites was primarily funded by other grants from ODFW and OPRD. These restoration actions contributed to site preparation before planting and to management of introduced broadleaf weeds and grasses after planting. Partners, including ODFW, U.S. Fish and Wildlife Service (USFWS), the City of Corvallis, and OPRD conducted complementary actions such as herbicide treatments and mowing throughout the project period (Tables 1-2).

Figure 5. Left: Contractor from Habitat Restoration, LLC broadcasting herbicide in fallow grassland as part of site preparation before seeding native grasses and planting riparian trees and shrubs, June 2014. Middle: Skid steer mowing of riparian margin of blackberry, June 2015. Right: IAE staff spot spraying thistles, July 2016.

Table 1. Schedule of restoration actions that occurred in Phase I areas of Herbert Farm and Natural Area in 2014-

Year	Habitat	Riparian forest	Upland prairie	Woodland	Wet prairie	Upland prairie
	acres	**29**	**37**	**4**	**2**	**2**
	Plants for People Project areage	**29**	**37**			**2**
	Funder	ODFW, OWEB	ODFW, OWEB	ODFW	ODFW	ODFW, OWEB
2014	Spring (Mar-May)	Broadcast & spot spray				
	Summer (Jun-Aug)	Skid steer mow	Broadcast spray	Tractor mow	Broadcast spray	Spot spray Tractor mow
	Fall (Sep-Nov)	Broadcast & spot spray Seed broadcast	Tribal elder visit Broadcast spray Seed broadcast		Broadcast & spot spray Seed broadcast	Spot spray
2015	Winter (Dec-Feb)	Cultural resource survey	Cultural resource survey	Cultural resource survey	Cultural resource survey	Cultural resource survey
	Spring (Mar-May)	Plant trees & shrubs				
	Summer (Jun-Aug)	Circle, row and spot spray tractor & hand mow Hand water Hand weed	Broadcast spray Spot spray Hand weed		Spot spray	Spot spray
	Fall (Sep-Nov)	Hand mow	Seed drilled		Seed drilled	
2016	Winter (Dec-Feb)	Plant trees & shrubs				
	Spring (Mar-May)	Row spray Monitor weeds & threatened species	Monitor weeds & threatened species	Monitor weeds & threatened species	Monitor weeds & threatened species	Plant Kincaid's lupine plugs Monitor weeds & threatened species
	Summer (Jun-Aug)	Circle & spot spray Hand mow Tractor mow	Spot spray Tractor mow	Girdle fir trees	Spot spray Monitor threatened species	Spot spray Monitor threatened species
	Fall (Sep-Nov)		Spot spray Seed broadcast Rushes hand planted	Tractor mow	Tractor mow Plugs hand planted	Spot spray Prescribed burn Broadcast spray Seed drilled Plugs hand planted

Table 2. Schedule of restoration actions that occurred at Champoeg State Park in 2014-2016.

Year	Habitat	Forb Introduction Plots	Grassy Meadow	Sandy Areas
	acres	**6.6**	**27.4**	**11**
	Season			
2014	Spring (Mar-May)	Glyphosate spray strips and soil testing	Spot spray	Broadcast glyphosate
	Summer (Jun-Aug)	Glyphosate spray strips		
	Fall (Sep-Nov)	Spot spray	Broadcast spray with pre-emergent	Broadcast spray with pre-emergent
2015	Winter (Dec-Feb)	Weed assessments and forbs seeded and planted	Weed assessments	Weed assessments
	Spring (Mar-May)	Spot spray	Spot spray	
	Summer (Jun-Aug)		Broadcast spray with broadleaf specific	Broadcast spray with broadleaf specific
	Fall (Sep-Nov)	Weed assessments, spot spray, milkeweed planted, and forbs seeded	Weed assessments and spot spray	Weed assessments
2016	Winter (Dec-Feb)			
	Spring (Mar-May)	Weed assesments and spot spray	Weed assesments and spot spray	Weed assesments
	Summer (Jun-Aug)		Broadcast spray with broadleaf specific	Broadcast spray with broadleaf specific
	Fall (Sep-Nov)	Weed assesments and spot spray	Weed assesments, spot spray, and haying	

Figure 6. Left: A contractor crew member using a backpack sprayer to spray grasses while protecting a tree seedling with a plastic shield, May 2015. Right: Riparian rows two weeks after line spraying to release trees from competition with weeds.

Figure 7. Left to Right: Institute for Applied Ecology staff flame weeding rat-tailed fescue, November 2014; Broadcast herbicide treatment area to control rat-tailed fescue, May 2015; Restoration field after mowing and haying, August 2016.

3.3 Plant propagation

Seed production beds

Seed of coast tarweed (*Madia sativa*) and cow parsnip (*Heracleum lanatum*) were collected from throughout the Willamette Valley (Figure 8) by the IAE Seed Collection Crew in July-September 2014 for the purpose of establishing seed production beds at CTGR (Table 3). A total of 3.8 pounds of tarweed seed was collected from 37 sites in eight counties and 3.6 pounds of cow parsnip were collected from 23 sites in six counties. Barestem biscuitroot (*Lomatium nudicaule*) was also collected during 2015 using funds from other grants for the purpose of establishing a seed production field. Species were chosen for their cultural significance (Appendix 1) and lack of commercial availability.

A 0.2 acre production bed of coast tarweed was sown in the fall of 2015 at PMC and 10 lbs of seed was harvested from this field in 2016. The production seed is currently in cold storage at PMC

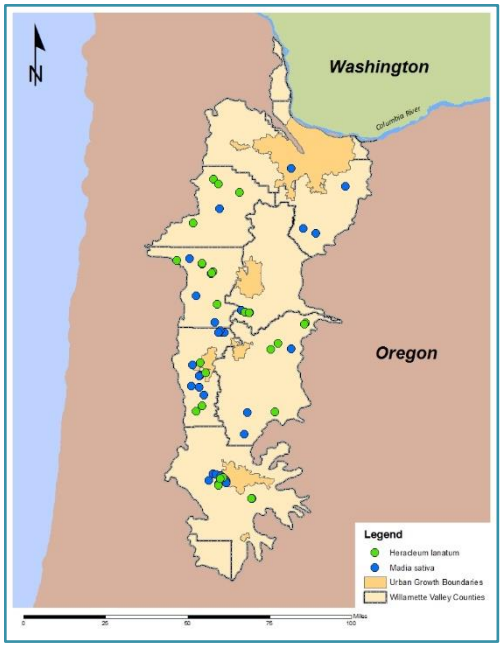

Figure 8. Collection sites for coast tarweed and cow parsnip seed in 2014.

and the remaining collected seed is stored in IAE's seed cooler. Cow parsnip seed was cold stratified at PMC and sown in a bed at CTGR in spring 2016 (Figure 9). The first seed harvest from this field is expected in 2018 or 2019. Plugs of barestem biscuitroot were grown at PMC in 2016, and will be used to establish a seed production field at IAE's farm in 2017. This latter species is being grown in partnership with the Willamette Valley Native Plant Materials Partnership, and CTGR will receive a future share of seed produced by this field.

Table 3. Native plants collected or purchased for plant production beds in 2014 and 2015.

Bed Type	Common name	Species	Source	Number collected 2014	Number collected 2015	Location of bed
Seed production bed	Coast tarweed	*Madia sativa*	Willamette-wide seed collection	3.8 pounds		PMC
	Cow parsnip	*Heracleum lanatum*	Willamette-wide seed collection	3.6 pounds		CTGR
	Barestem biscuitroot	*Lomatium nudicaule*	Willamette-wide seed collection			IAE farm
Raised Bed	Gardner's yampah	*Perideridia gairdneri*	City of Eugene bed at Heritage Seedlings	1200		CTGR
	Large camas	*Camassia leichtlinii*	PMC	1200		CTGR
	Tolmie star-tulip	*Calochortus tolmiei*	Sevenoaks	300	300	CTGR
	Crown brodiaea	*Brodiaea coronaria*	Sevenoaks	300		CTGR
	Narrowleaf onion	*Allium amplectens*	Sevenoaks	300		CTGR
	Barestem biscuitroot	*Lomatium nudicaule*	Sevenoaks	300		CTGR
Cutting bed	Lewis' mock orange	*Philadelphus lewisii*	PMC	74	119	CTGR
	Pacific ninebark	*Physocarpus capitatus*	PMC	48	59	CTGR
	Redosier dogwood	*Cornus sericea sericea*	PMC	56	33	CTGR
	Pacific willow	*Salix lucida*	PMC	28		CTGR
	Ocean spray	*Holodiscus discolor*	PMC	75		CTGR
	Indian plum	*Oemleria cerasiformis*	PMC	57	81	CTGR

Figure 9. Cow parsnip seed production bed at the Confederated Tribes of Grand Ronde, September 2016 (photos: Jeremy Ojua).

Raised beds

Two raised beds (60' long x 5' wide x 2.5' high) were constructed by IAE and CTGR staff at the Natural Resources Department headquarters at CTGR during July 2014 (Figure 10). The beds were built with untreated cedar siding, lined with wire mesh and ground cloth to limit invasion by voles and weeds, and filled with soil (71% sandy loam, 23% compost, and 6% pumice).

IAE and CTGR staff harvested approximately 1200 large camas (*Camassia leichtlinii*) bulbs at PMC (Figure 10) and 1200 Gairdner's yampah (*Perideridia gairdneri*) tubers from Heritage Seedlings, Inc. in October 2014. These materials were donated to the project by PMC and the City of Eugene, respectively.

Figure 10. Left: Gabe Clift, Jeremy Ojua (Confederated Tribes of Grand Ronde), and Guy Banner and Peter Moore (Institute for Applied Ecology) building raised beds at CTGR, July 2014. Middle: Filling the beds with soil. Right: Harvesting camas at the Corvallis Plant Materials Center, October 2014.

Camas was planted in one raised bed in October 2014 (Figure 11) and yampah was planted in half of the second bed by IAE and CTGR staff in November 2014. The rest of the bed was planted with bulbs of Tolmie star-tulip (*Calochortus tolmiei*), crown brodiaea (*Brodiaea coronaria*), and narrowleaf onion (*Allium amplectens*) and root divisions of barestem biscuitroot with the help of 12 AmeriCorps volunteers in November 2014. The latter species were purchased from Sevenoaks Native Nursery by CTGR. Establishment and growth of the camas and yampah was spectacular in 2015 (Figure 12) and 2016, and 200 very large camas bulbs and 200 yampah roots (Figure 11) were harvested in November 2016 for planting at Herbert Farm. During the harvest it was noted that countless new recruits had established from seed from the original cohort of plants. Tolmie star-tulip survivorship in the first season was poor, and new bulbs were planted in November 2015 (Figure 12). Deer browse has been a problem at times and this was partly rectified by covering the beds with netting early in the growing season.

Figure 11 Left: Peter Moore (IAE) and CTGR staff planting camas bulbs in a raised bed at CTGR, October 2014, Middle: Tribal Council member Jon George blessing camas bulbs held by Guy Banner (IAE), October 2014; Right: Yampah roots harvested from raised bed, November 2016.

Figure 12. Left: Large camas in raised beds at the Confederated Tribes of Grand Ronde's Natural Resources Department office, May 2015. Middle: Rebecca Currin (Institute for Applied Ecology) beside the Gairdner's yampah raised bed, August 2015. Right: Tolmie star-tulip in one of the raised beds, May 2015.

Cutting beds

Two cutting beds (60' long x 5' wide) were prepared by CTGR staff by spraying grass with glyphosate herbicide followed by tilling with a tractor in August 2014. Cuttings from six native shrub species (Table 3), including Lewis' mock orange (*Philadelphus lewisii*), Pacific ninebark (*Physocarpus capitatus*), redosier dogwood (*Cornus sericea* ssp. *sericea*), Pacific willow (*Salix lucida*), oceanspray (*Holodiscus discolor*), and Indian plum (*Oemleria cerasiformis*) were harvested from PMC and planted directly in the soil of the cutting beds in December 2014 (Figure 13). Ground water saturation in the winter and spring frosts killed many of the plants, but the use of bark mulch and drip irrigation from June 2015 helped with summer survival. Replacement cuttings of four species were harvested from PMC and planted in the beds in December 2015 (Table 3).

Figure 13. Left: Jeremy Ojua (Confederated Tribes of Grand Ronde) spreading bark mulch on the tree cutting beds, June 2015; Right: Pacific willow cuttings, June 2015.

Restoration areas

Bare root bulbs and divisions, trees, and shrubs for planting at Herbert Farm were purchased from Sevenoaks Native Nursery. Bare root bulbs, divisions, and plugs planted at Champoeg in 2014 were grown by Metro at no cost to this project.

3.4 Seeding and planting

Seed for restoration at Herbert Farm (Tables 4-5) and Champoeg (Tables 6) was purchased from commercial nurseries such as Heritage Seedlings and Pacific Northwest Natives. Diverse seed mixes were created for prairies and included several culturally significant species (Appendix 1).

Nearly 600 pounds of seed of 18 forb species and six grass species (Table 4) was broadcast by ODFW staff using an ATV mounted spreader in prairie and riparian habitat at Herbert Farm in late October 2014. It was not possible to drill seed because all ground disturbing restoration techniques, including use of a no-till drill, was not approved for use at Herbert Farm until a cultural resource compliance process had been completed by Bonneville Power Administration (BPA). There was relatively patchy germination observed the following spring, possibly because the broadcast was followed by a wet winter, and inundation of portions of the site might have caused seed to be washed away.

In fall 2015 more than 340 pounds of seed of 18 forb species and 10 graminoids were drilled into the Phase I prairie at Herbert Farm by USFWS (Figure 14). Whereas a single seed mix had been applied over the entire 37 acre prairie in 2014 (Table 4), in 2015 both an upland mix (sown in the higher ground) and a wet swale mix (sown in the low lying areas) were applied (Table 5). With a mild and relatively dry fall, early germination was observed in 2015 and there was spectacular growth of forbs the following spring, particularly in the southern part of the prairie (Figures 15-16). Further seed was purchased with matching funds from ODFW in 2016 and sown in the northern part of the prairie.

Figure 14. Left: Nate Richardson (U.S. Fish and Wildlife Service) calibrating the no-till drill. Middle: Grass seed in the drill hopper. Right: Tractor and no-till drill seeding native forb and grasses in the 37 acre upland prairie at Herbert Farm, October 2015.

Figure 15. Left: Prairie vegetation after the second year of seeding native forbs and grasses, showing abundant common madia, yarrow, farewell to spring and grand collomia, July 2016. Middle: Common madia in restored upland prairie, July 2016. Right: Oregon sunshine in restored upland prairie, May 2016.

Table 4. Native seed mixes sown in prairie and riparian restoration areas of Herbert Farm in 2014.

Species	Scientific Name	Growth Form	Pounds/ acre		
			Upland prairie (37 acres)	Wet prairie (2 acres)	Grass cover riparian (28 acres)
Common yarrow	*Achillea millefolium*	Forb	0.03	0.48	
Showy milkweed	*Asclepias speciosus*	Forb		0.25	
Large camas	*Camassia leichtlinii*	Forb	0.25	0.50	
Farewell to spring	*Clarkia amoena*	Forb	0.38		
Winecup clarkia	*Clarkia purpurea*	Forb	0.06		
Grand collomia	*Collomia grandiflora*	Forb	0.50		
Denseflower willowherb	*Epilobium densiflorum*	Forb		0.50	
Oregon sunshine	*Eriophyllum lanatum*	Forb	0.44	1.00	
Toughleaf iris	*Iris tenax*	Forb	0.75		
Barestem biscuitroot	*Lomatium nudicaule*	Forb		1.00	
Oregon bird's foot trefoil	*Lotus unifoliatus*	Forb		0.50	
Common madia	*Madia elegans*	Forb	0.50		
Oregon yampah	*Perideridia oregana*	Forb		0.75	
Shortspur seablush	*Plectritis congesta*	Forb		0.50	
Slender cinquefoil	*Potentilla gracilis*	Forb	0.75	0.50	
Common selfheal	*Prunella vulgaris*	Forb	1.00	1.00	
Western buttercup	*Ranunculus occidentalis*	Forb	0.50		
Dwarf checkermallow	*Sidalcea virgata*	Forb	0.69		
		Total forbs	***5.85***	***6.98***	***0.00***
Spike bentgrass	*Agrostis exarata*	Grass		1.00	0.08
California oatgrass	*Danthonia californica*	Grass		2.50	2.02
Tufted hairgrass	*Deschampsia cespitosa*	Grass		0.75	0.23
Blue wildrye	*Elymus glaucus*	Grass			1.45
Roemer's fescue	*Festuca roemeri*	Grass	3.00		1.31
Meadow barley	*Hordeum brachyantherum*	Grass		2.03	2.18
		Total grasses	***3.00***	***6.28***	***7.27***
		Total pounds per acre	**8.85**	**13.26**	***7.27***
		Total pounds	**354.00**	**25.20**	**218.00**

Table 5. Native seed mixes sown in prairie areas of Herbert Farm in 2015.

Species	Scientific Name	Growth Form	Pounds/ acre	
			Upland prairie (27 acres)	Wet swales (10 acres)
Showy milkweed	*Asclepias speciosus*	Forb		0.06
Large camas	*Camassia leichtlinii*	Forb	0.26	0.44
Farewell to spring	*Clarkia amoena*	Forb	0.21	0.21
Winecup clarkia	*Clarkia purpurea*	Forb	0.02	
Grand collomia	*Collomia grandiflora*	Forb	1.07	
Denseflower willowherb	*Epilobium densiflorum*	Forb		0.51
Oregon sunshine	*Eriophyllum lanatum*	Forb	0.19	0.19
Puget Sound gumweed	*Grindelia integrifolia*	Forb		0.34
Toughleaf iris	*Iris tenax*	Forb	0.47	
Barestem biscuitroot	*Lomatium nudicaule*	Forb		
Oregon bird's foot trefoil	*Lotus unifoliatus*	Forb		0.50
Common madia	*Madia elegans*	Forb	0.20	
Oregon yampah	*Perideridia oregana*	Forb		0.05
Fragrant popcornflower	*Plagiobothrys figuratus*			0.49
Shortspur seablush	*Plectritis congesta*	Forb		0.17
Slender cinquefoil	*Potentilla gracilis*	Forb	0.03	0.15
Common selfheal	*Prunella vulgaris*	Forb	0.65	0.54
Dwarf checkermallow	*Sidalcea virgata*	Forb	0.33	
Total forbs			***3.45***	***3.65***
Spike bentgrass	*Agrostis exarata*	Grass		0.04
California brome	*Bromus carinatus*	Grass	0.57	
Alaska brome	*Bromus sitchensis*	Grass	0.57	
One-sided sedge	*Carex unilateralis*	sedge		0.20
California oatgrass	*Danthonia californica*	Grass	3.11	1.56
Tufted hairgrass	*Deschampsia cespitosa*	Grass		0.15
Blue wildrye	*Elymus glaucus*	Grass	0.54	
Roemer's fescue	*Festuca roemeri*	Grass	0.87	
Poverty rush	*Juncus tenuis*	rush		0.02
Meadow barley	*Hordeum brachyantherum*	Grass		2.18
Total graminoids			***5.67***	***4.14***
Total pounds per acre			**9.12**	***7.79***
Total pounds			**264.4**	***77.9***

Native forb seed was purchased with OPRD funds and sown in the forb introduction plots at Champoeg in 2014. Additional native forb seed was purchased with grant funds in 2015 (Table 6) and broadcast by IAE staff using belly seeders in the forb introduction plots in November 2015 (Figure 16). Because there was no prescribed burn in 2016 and additional weed control is required, the grass seed is being held in storage until after herbicide treatments and a prescribed burn are implemented in 2017. Native forbs have

established well in the introduction plots at Champoeg with several species flowering and setting seed in 2015 (Figure 16).

Bulbs and bare root plants of culturally important species were purchased from Sevenoaks Native Nursery in 2016 with the intention of planting at Herbert Farm and Champoeg (Table 7). However a temporary hold on using ground disturbing techniques at Champoeg prevented planting at that site. Therefore, all 15,230 plants were planted at Herbert Farm. The planting was completed by IAE staff and 12 AmeriCorps volunteers in upland and wet prairie habitat at Herbert Farm in November 2016 (Figures 17-18). In addition to these plants, CTGR staff harvested 200 camas bulbs and 200 yampah roots from the CTGR raised beds and planted them at Herbert Farm (Figures 16-17). Other plant materials have been planted at the restoration sites using other funds.

Table 6. Native seed mixes for Champoeg State Park in 2015 and 2016.

Species	**Scientific Name**	**Year**	**Growth Form**	**Pounds/ acre**	
				Forb Plots (7.9 acres)	**Sandy Areas (11 acres)**
One-sided sedge	*Carex unilateralis*	2015	Sedge	2.5	
Farewell to spring	*Clarkia amoena var. lindleyi*	2015	Forb	0.3	
Denseflower willowherb	*Epilobium densiflorum*	2015	Forb	2.8	
Oregon sunshine	*Eriophyllum lanatum*	2015	Forb	3.5	
Bluehead gilia	*Gilia capitata*	2015	Forb	0.4	
Poverty rush	*Juncus tenuis*	2015	Rush	0.05	
Broadleaf lupine	*Lupinus latifolius*	2015	Forb	0.6	
Shortspur seablush	*Plectritis congesta*	2015	Forb	0.2	
Western buttercup	*Ranunculus occidentalis*	2015	Forb	0.2	
Dwarf checkermallow	*Sidalcea virgata*	2015	Forb	1.2	
Lemmon's needlegrass	*Achnatherum lemmonii*	2016	Grass		1
California brome	*Bromus carinatus*	2016	Grass		3
Blue wildrye	*Elymus glaucus*	2016	Grass		4.5
Roemer's fescue	*Festuca roemeri*	2016	Grass		2.5
			Total forbs	***9.2***	***0***
			Total graminoids	***2.55***	***11***
			Total pounds per acre	**11.75**	**11**
			Total pounds	**92.8**	**121.0**

Figure 16. Left: Ben Axt (Institute for Applied Ecology) spreading native seed in forb introduction plots with a hand-crank seeder, December 2015. Right: Bigleaf lupine in a forb introduction plot, April 2016 (photos by Andy Neill).

Figure 17. CTGR staff planting camas (left) and AmeriCorps volunteers Harris Holland holding Oregon iris (middle) and: Karissa Red Bear planting iris (right) at Herbert Farm, November 2016.

Figure 18. Institute for Applied Ecology, Confederated Tribes of Grand Ronde staff and AmeriCorps volunteers holding camas bulbs during a planting day at Herbert Farm, November 2016.

Table 7. Bulbs and bare root plant materials planted at Herbert Farm in November 2016.

Common name	Scientific Name	Type	Number
Tapertip onion	*Allium acuminatum*	bulb	800
Narrowleaf onion	*Allium amplectens*	bulb	1800
Harvest brodiaea	*Brodiaea elegans*	bulb	2000
Tolmie star-tulip	*Calochortus tolmiei*	bulb	2000
Large camas	*Camassia leichtlinii*	bulb	200
Small camas	*Camassia quamash*	bulb	1000
Virginia strawberry	*Fragaria virginiana*	bare root	1900
Toughleaf iris	*Iris tenax*	bare root	2450
Common rush	*Juncus effusus*	division	1100
Gairdner's yampah	*Perideridia gairdneri*	bare root	200
White brodiaea	*Triteleia hyacinthina*	bulb	830
California compassplant	*Wyethia angustifolia*	bare root	950
		Total	***15,230***

Figure 19. A crew from R. Franco Restoration planting trees and shrubs at Herbert Farm, March 2015.

Over 44,000 trees and shrubs (Table 8) were planted by a contractor in new riparian habitat at Herbert Farm in winter 2015 (Figure 19). Twenty-two acres were planted in high density rows (1900 stems/acre), and seven acres in low density rows (350 stems/acre). The timing of planting at the end of March 2015 was later than planned due to a temporary hold on ground disturbing activities until BPA had completed the cultural resource consultation process. More than 14,000 additional trees and shrubs were inter-planted in the rows in February 2016 to help offset attrition of the 2015 cohort. Although no funds were allocated to the watering of trees, there was concern about tree and shrub survival because of a drought in 2015. Consequently, non-project funds were used to hand water 1150 trees and shrubs in the low density zone in summer of 2015 (Figure 20). By the fall of 2016 some of the riparian plantings were becoming well established (Figure 20).

Figure 20. Left: Stacy Moore (Institute for Applied Ecology) watering trees at Herbert Farm, June 2015. Right: Riparian trees and shrubs becoming well established in high density planting rows, July 2016.

Table 8. Trees and shrubs planted at Herbert Farm in 2015 and 2016.

Common name	Scientific name	Number planted Mar 2015	Number planted Feb 2016	Total
bigleaf maple	*Acer macrophyllum*	238	635	873
white alder	*Alnus rhombifolia*	3130	1100	4230
red alder	*Alnus rubra*	0	170	170
serviceberry	*Amelanchier alnifolia*	68	517	585
redosier dogwood	*Cornus sericea occidentalis*	3300	825	4125
Oregon ash	*Fraxinus latifolia*	5000	1285	6285
ocean spray	*Holodiscus discolor*	2200	550	2750
Oregon grape	*Mahonia aquifolium*	68	517	585
Indian plum	*Oemleria cerasiformis*	1931	1050	2981
Pacific ninebark	*Physocarpus capitatus*	5750	1650	7400
black cottonwood	*Populus trichocarpa*	2200	550	2750
Oregon white oak	*Quercus garryana*	675	170	845
cascara	*Rhamnus purshiana*	2306	567	2873
Nootka rose	*Rosa nutkana*	1100	275	1375
Pacific willow	*Salix lucida lassiandra*	4400	1100	5500
Scouler willow	*Salix scouleriana*	135	534	669
Sitka willow	*Salix sitchensis*	6770	1650	8420
red elderberry	*Sambucus racemosa/cerulea*	135	35	170
Douglas spiraea	*Spiraea douglasii*	135	34	169
snowberry	*Symphoricarpos albus*	4603	1151	5754
	Total	**44144**	**14365**	**58509**

3.5 Working with tribal elders

Tribal elder visits to the restoration sites occurred in October 2014, with three elders visiting Herbert Farm and six elders visiting Champoeg (Figure 21). These visits provided an opportunity for elders to engage with the landowners (City of Corvallis and OPRD, respectively) and IAE restoration ecologists, reconnect with the sites, give feedback about traditional uses of the areas, and offer ideas and input to the restoration plans. Lively discussions occurred, especially at Champoeg, where interest was expressed in organizing future

cultural events, volunteer work parties, and harvest of cultural plants. The name Champoeg apparently derives from a Kalapuya word for yampah, an indication of a strong cultural connection to the site. In early November 2016, CTGR staff and community members harvested camas bulbs and yampah roots from the raised beds at CTGR for planting at a restoration site. A tribal ceremony was planned as part of a planting event at Champoeg, however, the need for an archaeological survey to allow further restoration work at the park resulted in the event being shifted to Herbert Farm.

Figure 21. Left: Tribal elders discussing restoration and cultural values with Confederated Tribes of Grand Ronde, Institute for Applied Ecology and City of Corvallis staff during a visit to Herbert Farm, October 2014. Right: Ben Axt (IAE) describing the restoration program to tribal elders and Oregon Parks and Recreation Department and IAE staff at Champoeg State Park, October 2014.

3.6 Tribal Native Plant Materials Development Plan

A Tribal Native Plant Materials Program Development Plan for CTGR (Currin et al. 2016) was created as part of this project (Appendix 2). The process of developing the plan involved extensive discussions with CTGR staff and feedback from the Intertribal Nursery Council. Ultimately the plan was approved by the CTGR Tribal Council in October 2016. The document provides the context and goals of a tribal plant materials program and sets out a strategy for expanding production started during the Plants for People project.

3.7 Monitoring

Effectiveness monitoring was not funded as part of this project, however some monitoring was conducted with other funding at Herbert Farm, and results are summarized here.

Invasive species were mapped in Phase I areas of Herbert Farm in May 2013 (Menke and Moore 2013) and 2016 (Moore et al., in prep. 2017). The extent of Himalayan blackberry (*Rubus armeniacus)* and reed canarygrass (*Phalaris arundinacea*) was greatly reduced from the river terraces as a result of the species being targeted for control during site preparation. Canada thistle (*Cirsium arvense*) occurred in dense patches in the fallow grassland prior to restoration, and was found scattered throughout the riparian plantings and new upland prairie in 2016. Bull thistle (*Cirsium vulgare*), field bindweed (*Convolvulus arvensis*) and St. Johnswort (*Hypericum perforatum*) were also found in scattered patches in these habitats.

In restored riparian areas, tree cover increased from 0.9 to 3% on average. Shrub cover remained at 0.3% between 2013 and 2016 (as estimated from subsampling cover in 30 randomly placed 5m x 5m plots within the restored riparian habitat). This indicates that the newly planted trees and shrubs are still at the early

stage of growth, and do not yet create much cover. Invasive species cover decreased from 17% to 2% on average in the plots (IAE 2017a), indicating successful control over the duration of this project. Prairie vegetation will be monitored in 2017.

The drought in summer of 2015 may have had a major impact on survival of riparian plantings. Average survival of trees and shrubs during the first growing season (March-November 2015) was 49% (59% in low density areas and 39% high density areas, n=17 transects). Survival was higher in the second year (2016), with 66% of the original number of stems surviving (62% low density and 71% high density) (Moore 2017b). The 2016 tree to shrub ratio was 1:1.9 in high density areas, and 2.2:1 in low density areas. The most abundant tree species were Oregon ash (*Fraxinus latifolia*), Oregon white oak (*Quercus garryana*) and bigleaf maple (*Acer macrophyllum*), and the most common shrub species were Pacific ninebark, Douglas spirea, snowberry (*Symphoricarpos albus*) and Pacific willow (Moore et al., in prep. 2017).

Survival of shrubs established from cuttings in the cutting beds at CTGR was also monitored. 100% of the Pacific willow, 40% of the redosier dogwood and 17% of the ninebark survived the first two years after planting. However, none of the Indian plum, mock orange or oceanspray survived in the second bed.

Ten photopoints were established in Phase I areas of Herbert Farm (Appendix 3). Photographs were taken in multiple directions at each point annually at similar times of year. Photopoints were also repeated at differing times of year to reflect key stages of restoration. Sample photographs are shown in Appendix 3 and a full set of photos is held on IAE files. Four photopoints were established at Champoeg in 2013 and 2014 and repeated in 2016 (Appendix 4).

4. PROJECT CHANGES

At Champoeg, partners provided plant materials for the forb introduction plots in 2014 and 2015, requiring less funding from this grant for plant materials at this site. In 2016, we were unable to plant bare root material at Champoeg because the archaeological survey was not yet completed at the park, so the plants ordered for the site were planted at Herbert Farm instead. Grass seed for the sandy areas at Champoeg was to be drilled in fall 2016, but a resurgence of weeds and the planned prescribed burn for fall 2017 resulted in a decision to delay the seeding a year and apply another herbicide application prior to the burn.

Seed of two species (tarweed and cow parsnip) was collected through the grant with the plan to create two seed production fields at PMC. A field of tarweed, an annual species, was created and harvested for one season at PMC. Cow parsnip, since it is a perennial species and will not seed for 2-3 years, was more appropriate to grow at a new bed at CTGR. A third species, barestem biscuitroot, is being established at IAE's farm, and grant funds contributed to growing plugs for the new production field. This field is owned by the Willamette Valley Native Plant Materials Partnership, and CTGR will receive a percentage of the first five years of harvest.

5. PUBLIC AWARENESS

5.1 Media

Several posts were made on the IAE Facebook page during the course of the project, including articles about the propagation workshop and planting events held at Herbert Farm and the CTGR raised beds. ODFW interviewed two IAE staff at Herbert Farm in a Facebook live event featuring a series of interviews titled "Conservation Conversation: Herbert Farm Natural Area" (ODFW 2016). A presentation on the project was given at the IAE Open House event in 2015. News articles were posted on the IAE webpage, including "Seeding the Prairies" (Moore 2015a), "Plants for People – bringing traditional ecological knowledge to

restoration" (Moore 2016a), and "New report: Tribal native plant materials program development plan for the CTGR (Moore 2016b). Articles also appeared in the CTGR "Smoke Signals" newspaper, including "Bulb planting" (Anon. 2014), "Returning to our roots – native plant workshop held at Chachalu" (Karten 2015), "Natural Resources starts native plants nursery" (Merrill 2015), and "Natural Resources harvests traditional plant bulbs" (Merrill 2016).

5.2 Plant production workshop

A native plant propagation workshop was conducted by IAE at CTGR in January 2015. Participants from the tribal community learned how to sow native seed and prepare tree cuttings for planting in pots (Figure 22).

Figure 22. Left: Stacy Moore (Institute for Applied Ecology) demonstrates how to prepare tree cuttings during the plant propagation workshop at Grand Ronde, January 2015. Middle: Stacy Moore and Greg Archuleta (Confederated Tribes of Grand Ronde) planting tree cuttings in a pot. Right: Sowing native seeds in planting trays. Photos by Michelle Alaimo/Smoke Signals.

5.3 Interpretive sign

An interpretive sign was designed for the project by IAE, printed by NW Graphic Imaging on durable material, and installed by CTGR staff beside the raised beds (Figure 23). The sign summarizes the cultural significance of camas and yampah and provides the context of the nursery for the Plants for People project (Figure 24).

Figure 23. Informational sign at raised beds at Confederated Tribes of Grand Ronde's Natural Resources Department (photo: Jeremy Ojua).

Figure 24. Informational sign for the raised beds at Confederated Tribes of Grand Ronde.

6. LESSONS LEARNED

Cultural resource surveys may be required by state and federal authorities before ground disturbing actions such as planting with tools and drilling seed are allowed, even if areas have been farmed for over 100 years. Consultation should be started at least two years before planting starts to minimize delays in the restoration process. Despite starting the process for Herbert Farm in 2013, permission to use ground disturbing techniques was not given by BPA until March 2015. Consequently, seed had to be broadcast instead of drilled in fall 2014 and tree planting was delayed until the end of March 2015.

The timing and method of planting and growing conditions combine to influence planting success. In 2016, we were able to plant trees and shrubs earlier than we had in 2015. This earlier planting time, combined with the more favorable growing season in 2016 (2015 was a drier year), contributed to higher survival rates in 2016. Similarly, prairie seed establishment was relatively poor in 2015 after broadcast seeding, yet was very good in 2016 after drilling seed. Drilling of seed combined with the favorable climatic conditions may have combined to create successful prairie vegetation establishment in 2016. These two examples highlight the need for multiple introductions over several years to ensure restoration success.

Starting a new nursery has its challenges, but the pilot program at CTGR started during this project was very successful. It is important to seek advice from plant propagation experts. We received invaluable native plant propagation information from Amy Bartow and Tyler Ross from PMC and Lynda Boyer from Heritage

Seedlings, Inc. during our project which helped set the framework for success of the plant materials program at CTGR.

The elder visits to restoration sites in 2014 were an important opportunity for incorporating traditional knowledge into restoration. Valuable discussions were started about accessibility to traditional harvesting areas, use of herbicides, and re-connecting the tribal community to culturally important sites. With time, this improved connection will lead to more sites being available for cultural harvest.

7. RECOMMENDATIONS

We recommend that the Plants for People project be continued and expanded, including:

- Continue restoration of prairie, oak, and riparian habitats with a focus on establishing culturally significant plants to support wildlife and people at existing restoration sites, such as Herbert Farm and Champoeg State Park, and expansion to other sites administered by CTGR, such as Rattlesnake Butte.
- Incorporate traditional ecological knowledge into restoration practices by engaging elders, CTGR staff, and tribal community volunteers in restoration, cultural events and nursery production.
- Increase availability of culturally significant plants by implementing the Tribal Native Plant Materials Program Development Plan, through employment of a nursery manager and seasonal technicians, maintaining the current nursery production, and establishing new culturally significant species production.
- Improve access of tribal members to new sites for traditional harvest by creating a harvest plan at Champoeg State Park.

With these objectives in mind, IAE has submitted a proposal to OWEB for Phase II of the Plants for People project.

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9. APPENDICES

APPENDIX 1.

List of potential cultural species for restoration

Form	Common name	*Scientific name*	Cultural Use
Forbs	Tapertip onion	*Allium acuminatum*	food
	Narrowleaf onion	*Allium amplectens*	food
	Crown brodiaea	*Brodiaea coronaria*	food
	Subalpine mariposa lily	*Calochortus subalpinus*	food
	Tolmie star-tulip	*Calochortus tolmiei*	food, medicine
	Large camas	*Camassia leichtlinii*	food
	Virginia strawberry	*Fragaria virginiana*	food
	Cow parsnip	*Heracleum lanatum*	food, medicine, dye
	Toughleaf iris	*Iris tenax*	cordage
	Barestem biscuitroot	*Lomatium nudicaule*	food, medicine, ceremony
	Common madia	*Madia elegans*	food
	Mountain tarweed	*Madia glomerata*	food
	Grassy tarweed	*Madia gracilis*	food
	Coast tarweed	*Madia sativa*	food
	Gairdner's yampah	*Perideridia gairdneri*	food, medicine
	Oregon yampah	*Perideridia oregana*	food
	Wapato	*Sagittaria latifolia*	food
	Yerba buena	*Satureja douglasii*	medicine
	White brodiaea	*Triteleia hyacinthina*	food
	Stinging nettle	*Urtica dioica*	medicine, food, cordage
Graminoids	Common rush	*Juncus effusus*	weaving
Shrubs	Vine maple	*Acer circinatum*	tools, cooking stakes, fiber
	Serviceberry	*Amelanchier alnifolia*	food
	Redosier dogwood	*Cornus sericea ssp. occidentalis*	medicine, smoking, dye
	California hazelnut	*Corylus cornuta*	food, weaving, medicine
	Ocean spray	*Holodiscus discolor*	medicine, tools, weapons
	Oregon grape	*Mahonia aquifolium*	food, medicine
	Indian plum	*Oemleria cerasiformis*	food, tea, anesthetic
	Pacific ninebark	*Physocarpus capitatus*	food, medicine, dye, arrows
	Oregon white oak	*Quercus garryana*	food
	Cascara	*Rhamnus purshiana*	medicine
	Nootka rose	*Rosa nutkana*	food, medicine, crafts
	Thimbleberry	*Rubus parviflorus*	food, medicine
	Salmonberry	*Rubus spectablilis*	food
	Pacific willow	*Salix lucida*	medicine, fiber, tools

Form	**Common name**	***Scientific name***	**Cultural Use**
	Douglas spiraea	*Spiraea douglasii*	tea, brooms, cooking tools
	Snowberry	*Symphorcarpos albus*	medicine, soap, arrows
Trees	Red alder	*Alnus rubra*	dye, medicine
	White alder	*Alnus rhombifolia*	medicine
	Oregon ash	*Fraxinus latifolia*	tools, basketry
	Lewis' mock orange	*Philadelphus lewisii*	tools, arrows, furniture, soap
	Black cottonwood	*Populus trichocarpa*	medicine, firewood, rope, traps, basketry, structures
	Pacific yew	*Taxus brevifolia*	Tools, arrows, digging sticks, bows, fiber
	Western red cedar	*Thuja plicata*	planks, canoes, weaving

APPENDIX 2.

Tribal Native Plant Materials Development Plan for the Confederated Tribes of Grand Ronde

Tribal Native Plant Materials Program Development Plan for the Confederated Tribes of Grand Ronde

10/20/2016

Prepared by Rebecca Currin, Peter Moore, and Andy Neill
Institute for Applied Ecology

Funded by the Oregon Watershed Enhancement Board
Grant #214-3054-10944

PREFACE

This project is coordinated by the Institute for Applied Ecology (IAE) and is funded by the Oregon Watershed Enhancement Board. IAE is a non-profit organization whose mission is conservation of native ecosystems through restoration, research, and education. IAE provides services to public and private agencies and individuals through development and communication of information on ecosystems, species, and effective management strategies. Restoration of habitats, with a concentration on rare and invasive species, is a primary focus. IAE conducts its work through partnerships with a diverse group of agencies, organizations, and the private sector. IAE aims to link its community with native habitats through education and outreach.

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(Confederated Tribes of Grand Ronde Natural Resources Department)

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CITATION

Currin, R., P. Moore and A. Neill. 2016. Tribal Plant Materials Program Development Plan for the Confederated Tribes of Grand Ronde. Institute for Applied Ecology, Corvallis, Oregon.

Table of Contents

1 INTRODUCTION

1.1 Project history

1.1.1 Overview

The Confederated Tribes of Grand Ronde (CTGR) have long been interested in reestablishing the collection and utilization of native plant materials for culturally important purposes such as food, art, and spiritual practices. Certain plant materials can be challenging for CTGR members to access on their own, and various CTGR departments (Natural Resources Department, Historic Preservation Department, Culture Department, etc.) often provide different levels of support when appropriate. Plant materials have traditionally been gathered from CTGR's ceded lands and Usual and Accustomed Areas, but gathering locations have become fewer, less accessible, and farther away from Grand Ronde. Currently, the Natural Resources Department purchases plant materials needed for restoration efforts, but the availability of many culturally important species is limited, and those that are available are expensive. Consequently, the need for a CTGR plant materials program has been building for several years.

1.1.2 Plants for People

In 2013, the Institute for Applied Ecology (IAE) partnered with CTGR, the Oregon Parks and Recreation Department, the Oregon Department of Fish and Wildlife, the City of Corvallis, and the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) to apply for an Oregon Watershed Enhancement Board restoration grant. The resulting "Plants for People" project focuses on enhancing restoration activities through utilizing culturally significant plants, applying Traditional Ecological Knowledge to restoration, and establishing a CTGR plant materials program. As part of the latter aspect of the project, and building on the early stages of plant production, IAE and CTGR committed to creating a development plan for an expanded tribal native plant materials program. This plan is a result of that collaboration.

1.2 Confederated Tribes of Grand Ronde background

1.2.1 Tribal background

The CTGR are the descendants of tribes and bands from western Oregon, southwest Washington, and northern California. These tribes and bands include but are not limited to the Tillamook, Clackamas, Rogue River, Molalla, Kalapuya, Umpqua, Nestucca and Chasta Tribes. The ancestors lived along the coast and interior valleys of Oregon for more than 14,000 years before the arrival of the first European explorers and settlers. The CTGR were decimated by several epidemics as a result of their first contact with Europeans.

Several treaties were ratified between CTGR and the U.S. Government, which resulted in the relocation of Grand Ronde ancestors to a Reservation near Grand Ronde, Oregon between1855-1875. The original Reservation was established in 1857 under executive order, encompassed an area of more than 60,000 acres, and was located on the eastern side of the Coast Range at the headwaters of the Yamhill River, approximately 25 miles east of the Pacific Ocean.

Only a small portion of the original Reservation was held in common by the CTGR in 1954 when Congress terminated the Government's relationship with CTGR. Though stripped of their lands,

the CTGR never went away in heart, and in 1983, their status was restored by the Government. In 1989, the Natural Resources Department of CTGR was created to manage the land.

1.2.2 Tribal organization

Several different groups or departments residing within CTGR have an interest in developing a native plant materials program. Below is a brief description of the stakeholders who are, or will be, involved with the development of the program.

- **Tribal Council and General Manager**: The Tribal Council is a nine member board having final decision making authority and responsibility for approving budgets and providing long range direction for CTGR resources. The Council directs the General Manager who supervises CTGR programs, such as the Natural Resources Department.
- **Natural Resources Department**: The Natural Resources Department engages in responsible management and stewardship of natural resources important to CTGR members. It will be the lead department in planning and managing the infrastructure for a plant materials program.
- **Cultural Resources Department:** The Cultural Resources Department is able to support a plant materials program through transfer of relevant ethnobotanical knowledge.
- Other relevant groups, departments, programs not yet involved:
    - Tribal elders
    - Education Department (youth programs)?
    - Social Services (prevention programs)
    - Health and Wellness Department (nutrition programs)
    - Food Programs
    - Community Garden (growing food)

1.2.3 Tribal lands restoration

CTGR owns and manages 10,212 acres of Reservation forestland (Fig. 1). Non-Reservation trust land holdings total approximately 523 acres and fee land holdings total approximately 1,641 acres. CTGR also owns over 1,000 acres of conservation properties in the Willamette Basin. Each of these ownership types and locations has a unique purpose and management plan, with goals that include restoration and native plant use. However, the specific focus of the restoration efforts and plant needs will be determined and outlined in the ongoing planning process. For instance, the Reservation is a working forest, therefore the majority of the plant needs will be for reforestation following a timber harvest. There will be a minor need for plant needs in meadows and riparian restoration projects on the Reservation. In contrast, the management plans for the conservation properties will focus efforts to restore habitat for fish and wildlife.

The Natural Resources Department manages the natural areas for the following uses:

- Oak savanna
- Wildlife habitat
- Fish habitat
- Threatened or endangered species

- Other rare plant species
- Recreation
- Education

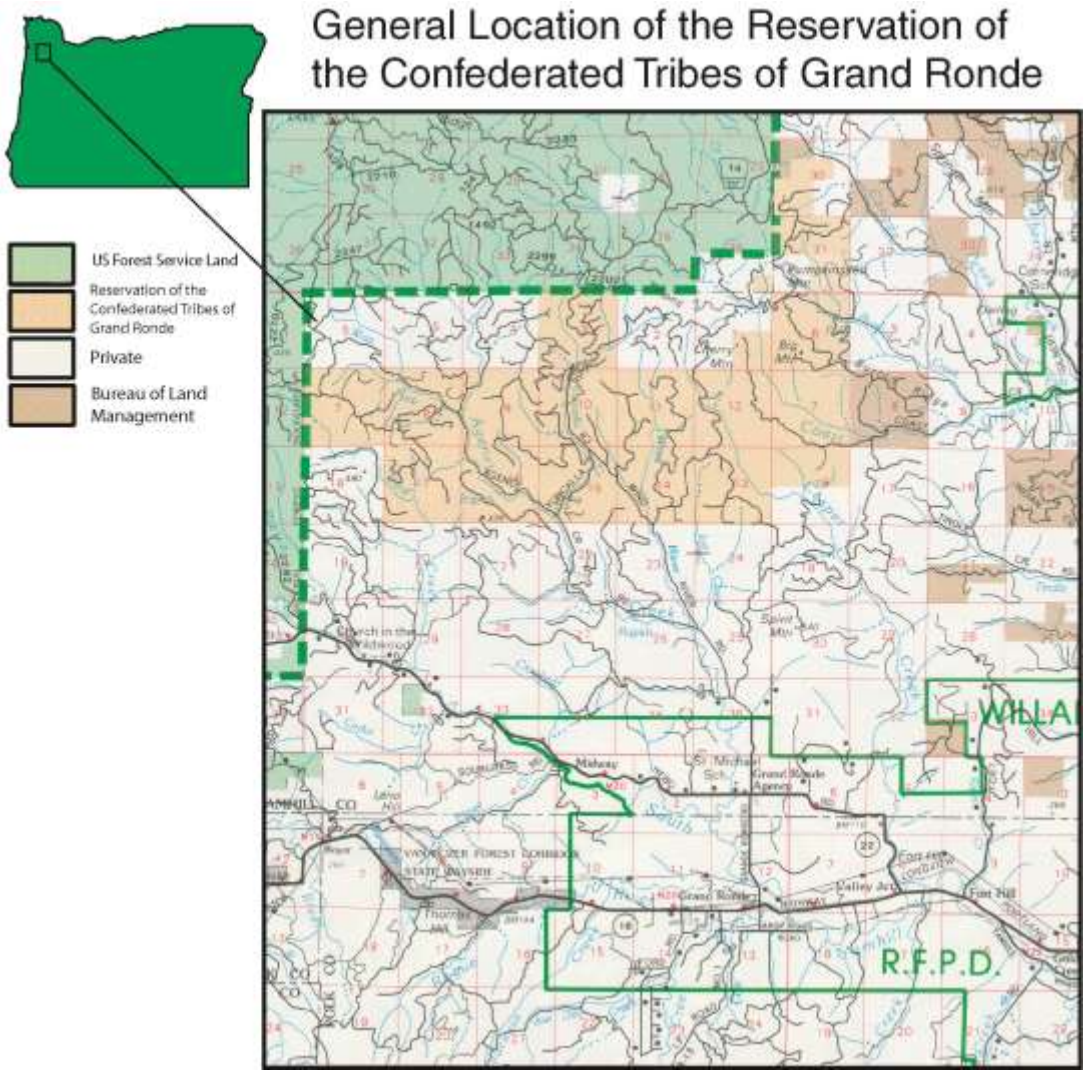

Figure 1. General location of the Reservation of CTGR

1.2.4 Tribal use of culturally significant plant materials

Native plants are essential to the traditional and current tribal lifeways, economy, and wealth of the CTGR people. Plants were, and still are, used for food, clothing, housing materials, hunting, fishing, cooking, medicines and many other things.

The following CTGR groups use or have an interest in culturally significant native plant materials:

- Individual members that gather cultural plants for a variety of purposes, including foods, arts, and ceremonies
- Departments and Programs
    - The Cultural Resources Department for hosting cultural education classes and cultural events
        - Social Services Department for hosting events that include cultural components
    - Natural Resources Department staff engaging in habitat restoration efforts

1.2.5 Current tribal plant materials resources

As part of the Plants for People grant, CTGR and IAE have already implemented a pilot plant materials program:

- **Raised beds**: two 60' x 5' raised beds were built adjacent to the Natural Resources Department building in Grand Ronde during July 2014 (Figs 2, 3). CTGR members and staff helped plant these beds with 1200 large camas (*Camassia leichtlinii*) bulbs (Fig.2) harvested and donated from the NRCS Corvallis Plant Materials Center and 1200 Gardner's yampah (*Perideridia gairdneri*) tubers donated by City of Eugene and harvested from Heritage Seedlings during fall of 2014. These species were supplemented with additional native plants, including Tolmie star-tulip (*Calochortus tolmiei*) (Fig. 3), crown brodiaea (*Brodiaea coronaria*), narrowleaf onion (*Allium amplectens*), and barestem biscuitroot (*Lomatium nudicaule*), purchased from Sevenoaks Native Nursery during fall of 2014 and 2015.

Figure 2. Left: Gabe Clift, Jeremy Ojua (Natural Resources Department), Guy Banner, and Peter Moore (IAE) building raised beds, July 2014; Middle: Filling the beds with soil; Right: Tribal Council member Jon George blessing camas bulbs held by Guy Banner, October 2014.

Figure 3. Left: Large camas in raised beds in at Natural Resources Department; Middle: Rebecca Currin beside the Gardner's yampah raised bed, August 2015; Right: Tolmie star-tulip at the raised bed.

- **Cutting beds**: Two 60' x 6' cutting beds were prepared at the Natural Resources Department during fall of 2014. Cuttings of six tree and shrub species, including Lewis' mock orange (*Philadelphus lewisii*), Pacific ninebark (*Physocarpus capitatus*), redosier dogwood (*Cornus sericea* ssp. *sericea*), Pacific willow (*Salix lucida*), Indian plum (*Oemleria cerasiformis*), and ocean spray (*Holodiscus discolor*) were collected and donated from the NRCS Corvallis Plant Materials Center and installed at the cutting beds in December of 2014 and 2015 (Fig. 4).

Figure 4. Left: Jeremy Ojua spreading bark mulch on the tree cutting beds, June 2015; Right: Pacific willow cuttings, June 2015.

- **Production beds**: In 2014, the IAE seed crew collected seed for three culturally significant species, coast tarweed (*Madia sativa*), barestem biscuitroot and cow parsnip (*Heracleum lanatum*), for the purpose of establishing seed production fields for these species. A coast tarweed bed was established at the Corvallis Plant Materials Center in spring 2016 and a single harvest of seed occurred in the fall of that year. A cow parsnip bed was established at the Natural Resources Department in spring 2016, and seed will be available in 2-3 years. Barestem biscuitroot plugs were grown in 2016, ready for transfer to a production bed in a new IAE facility in fall 2016. This latter bed will be shared with the Willamette Valley Native Plant Materials Partnership.

- **Plant propagation workshop**: In January of 2015, IAE hosted a native plant propagation workshop for CTGR members in Grand Ronde (Fig. 5). Participants learned how to collect and store native seed, prepare planting media, plant seed and care for germinating seedlings, and plant bare root cuttings. Species planted included farewell-to-spring (*Clarkia amoena*), denseflower willowherb (*Epilobium densiflorum*), Oregon sunshine (*Eriophyllum lanatum*), bigleaf lupine (*Lupinus polyphyllus*), selfheal (*Prunella vulgaris*), and sea blush (*Plectritis congesta*).

Figure 5. Left: Stacy Moore (IAE) demonstrates how to prepare tree cuttings during the plant propagation workshop at Grand Ronde, January 2015; Middle: Stacy Moore and Greg Archuleta planting tree cuttings in a pot; Right: Sowing native seeds in planting trays. Photos by Michelle Alaimo/Smoke Signals.

In addition, the Natural Resources Department has purchased a 20’ x 30’ hoop-style greenhouse with other grant funds. The greenhouse is being established near the raised beds (Fig. 6) and will have electricity and access to water.

Figure 6. Left: Greenhouse being constructed at Natural Resources Department, December 2015); Right: Completed greenhouse in March 2016.

1.3 Why establish a Tribal Native Plant Materials Program?

Given this background information, a clear interest and need for a CTGR-managed plant materials program exists at Grand Ronde. Having such a program would allow CTGR members and department staff to:

- Obtain low cost native plant materials, including culturally significant species, for land restoration projects
- Acquire plant materials to be used for educational purposes
- Harvest culturally significant plants for use as food, arts, and/or ceremonies in an appropriate manner
- Improve native plant species availability
- Better control native plant material quality (i.e. locally adapted, free of herbicides, etc.)
- Build on in-house knowledge base

Along with restoration partners, the tribal native plant materials program will contribute to ecosystem scale restoration and the reestablishment of native and culturally important plants in the Willamette Valley.

This development plan outlines the goals of such a program, and describes possible steps needed to achieve these goals.

1.4 Plan development process

1.4.1 Tribal input to Plants for People grant proposal

During preparation for the Plants for People grant proposal, considerable input was provided by the former iterations of what is now the Cultural Resources Department, particularly David Harrelson (Cultural Resources Department Manager), who created a list of culturally important species that could be used for restoration and/or production. This input and advice has continued with the involvement of Jordan Mercier (Cultural Education Coordinator).

1.4.2 Visits by tribal elders to Plants for People restoration sites

In October of 2014, elders and staff toured the two Plants for People restoration sites: Champoeg State Park and Herbert Farm and Natural Area. Discussions about historical cultural uses of the sites, ways that sites might be used in the future, culturally-significant plant species that tribal members would like to see at the site, and restoration approaches, design, and special considerations ensued. Input was incorporated into the overall restoration plans for each site.

During these visits, the need for culturally significant plant materials was discussed. Input was solicited regarding high priority plant species, native plant material uses, and cultural and community needs addressed by access to high quality, culturally significant plant materials. These comments were incorporated into this plan.

1.4.3 Meetings

In January and August of 2015, IAE staff met with staff from the Natural Resources and Land and Culture departments to discuss the development of a plan for establishing a plant materials program. The following topics were discussed:

- Tribal plant materials program goals
- Current available resources
- Economic aspect
- Scale of operations
- Funding

1.4.4 Tribal community forum

A tribal community forum may be an avenue to explore community input and interest in the program.

1.4.5 Draft plan review process

IAE staff completed a draft Plant Materials Program Development Plan during fall of 2015. Further drafts were completed in 2016. Drafts were reviewed by staff from the Natural Resources and Cultural Resources departments. The draft plan followed an internal tribal review process including: appropriate Departments, Tribal Planning Department, General Managers Office and Tribal Council. Technical expert reviewed by Kasten Dumroese (USDA Forest Service; Intertribal Nursery Council).

2 NATIVE PLANT MATERIALS PROGRAM PURPOSE AND GOALS

2.1 Purpose

The purpose of the CTGR Native Plant Materials Program is to provide locally-adapted, high quality, cost-efficient, and accessible native plant materials for restoration and cultural uses.

2.2 Program assumptions

The following assumptions guide the development of this plan:

- Only native plant species will be produced
- Plant production will occur on tribal lands and in partnership with other nurseries
- A tribal plant program will integrate restoration and cultural plant needs where possible while recognizing there can be different goals and opportunities.
- The program will incorporate multiple methods of propagation (i.e., seed production fields/beds, cuttings, container plants, bulbs, and divisions, etc.) and will be based Traditional Ecological Knowledge and available science and expertise.

2.3 Goals and objectives

2.3.1 Short-term goals

The following short-term goals will be achieved within the first five years of establishment of the CTGR Native Plant Materials Program:

Goal 1: Create a plant materials program that provides locally-adapted, high quality, cost-efficient native plant materials that meet a significant portion of the Natural Resources Department's habitat restoration plant materials needs.

Objective 1.1: Continue to implement the current pilot program in Years 1 and 2 of program implementation (see Section 1.2.4).

Objective 1.2: Implement larger-scale production of at least three high priority species used in habitat restoration on CTGR lands within five years.

Objective 1.3: Develop infrastructure, such as greenhouses, shade houses, and associated facilities.

Goal 2: Create or enhance accessible CTGR gathering and harvesting locations for high quality native plants of cultural significance.

Objective 2.1: Create a local, accessible, cultivated source of three culturally significant plant species: tall camas, Gardner's yampah, barestem biscuitroot.

Objective 2.2: Create or augment populations of culturally significant plant species at two natural area sites that are available for gathering plant materials within 60 miles of Grand Ronde.

Objective 2.3: Create a network of agencies, and other landowners, who are supportive of utilizing cultural plants in restoration and the potential of cultural harvest in the future.

Goal 3: Generate tribal interest in Traditional Ecological Knowledge and transfer that knowledge among tribal members.

Objective 3.1: Sponsor two culturally significant plant materials gathering workshops or field trips within the first five years.

Objective 3.2: Support restoration efforts at two natural areas (one CTGR-managed site and Champoeg State Park) by organizing at least two volunteer work parties per year.

Objective 3.3: Organize at least two CTGR celebrations or events that involve planting, harvesting and/or utilizing culturally significant plant materials within the first two years. Support First Foods Celebration and Food Bank.

Objective 3.4: Develop partnership between the CTGR Plant Materials Program and programs involving school-aged CTGR members.

Goal 4: Create work and volunteer opportunities for tribal members.

Objective 4.1: Employ at least two staff within the CTGR Plant Materials Program within five years.

Objective 4.2: Develop apprenticeship/internship/volunteer program for CTGR members interested in learning about plant materials production and/or joining the program.

2.3.2 Potential long-term goals

CTGR will revisit the goals during the fourth year of the program. At that time, the project decision making body will review short-term and potential long-term goals, and develop or update long-term goals and objectives.

Goal 5: Generate income through the commercial sale of native plant materials.

Goal 6: Develop partnerships with higher education institutions to create research opportunities.

Goal 7: Increase CTGR food sovereignty.

3 NATIVE PLANT MATERIALS PROGRAM DEVELOPMENT STRATEGY

3.1 Overview

Many choices need to be made before beginning a plant materials development program. Decisions regarding species selection, propagation systems, propagation methods, resource allocation, and many other factors need to be aligned with the overall project goals and objectives. It is easy to think big with a project like this but getting too big, too fast, has been cited as a prevalent and persistent problem for plant materials programs because demand for plant materials tends to fluctuate yearly.

The Nursery Manual for Native Plants (Dumroese et al. 2009) outlines many of the factors that should be considered before setting up a plant production program. The Tropical Nursery Manual (Wilkinson et al. 2014) also provides useful information to help decision making.

"Every nursery is unique. The environmental, social, and economic context is different for each nursery. A wide variety of species and outplanting environments contributes to nursery diversity. In addition, each nursery has a distinct vision and purpose. The methods a nursery will use to bring people together, produce high-quality plants for the community, and share knowledge about those

plants will also be unique. With so many diverse factors to consider, no standard blueprint for how to design a particular nursery exists. On the contrary, the very best nursery design will be matched to a particular situation, resources, and objectives. Although outside resources may be consulted during the planning phase, ultimately it is the nursery team that best understands the place, the plants, and the community" (Dumroese et al. 2009).

The following steps are recommended in order to develop CTGR's Native Plant Materials Program plan.

3.2 Review the current pilot program

Before embarking on an expanded plant materials program, the pilot program of the Plants for People project should be reviewed.

A review of the pilot program will answer these questions:

- Costs- were these anticipated accurately?
- Labor- did the project to date take more or less time than expected?
- Plants- what plants did or did not grow well?
- Knowledge – what have we learned that can be used for the Program?

CTGR's restoration needs should also be reviewed, as outlined in Section 3.5.4.

3.3 A scoping process

3.3.1 Scoping

Learning from others and building on previous efforts will be the success of this program. The philosophy of the program is to build on what has been learned already in experiential, scientific, and commercial context. The Natural Resources Department will liaise with the following entities, as needed, to keep the program viable and to meet its goals:

- Tribal elders and members
- Education Department
- Tribal Nutrition Program
- Housing Department
- Cultural Resources Department
- Health and Wellness Department
- External advisor – e.g., Intertribal Nursery Council, IAE, the NRCS Corvallis Plant Materials Center, tribal nurseries and other nurseries

3.4 Select location(s) of operations

The location of the program will in part depend upon the species selected, the method of propagation, and the scale of operations. Because of this, all of these decisions will probably be made in conjunction with each other.

3.4.1 Develop list of possible locations

Create a list of possible locations. Some options are listed below:

- Land adjacent to CTGR Natural Resources offices
- Other Grand Ronde community locations
- Other Grand Ronde ownerships in the Willamette Valley
- Other nursery

3.4.2 Assess possible locations

This assessment will be completed in conjunction with determining species and scope of operations. Factors that should be considered when deciding where to locate a plant materials program include:.

Tribal properties:

- **Ownership**: This plan assumes that all, or a significant portion, of the program will be located on CTGR lands.
- **Accessibility**: Site(s) should be accessible to CTGR staff and members.
- **Near staff/offices**: Locating operations centrally near the Natural Resources office allows easy access and efficiency.
- **Near CTGR members/residential houses:** Locating at least some operations near residential housing increases the likelihood of tribal member participation.
- **Soils analysis**: Consider soil type, depth, and nutrient levels at any site where seed production or cutting beds may be installed.
- **Hydrology**: Soil moisture and drainage will impact the type of species that can be grown at a site.
- **Accessibility of water**: If irrigation is required, a site will need to have access to water.
- **Climate**: Climate can play a large role in which species will grow and thrive at a location, and which will not. Average growing conditions, extremes (temperature, precipitation, frost days, etc.) can be site-specific, and should be investigated.

Nurseries:

- **Plant production**: The pilot program established one bed at the NRCS Corvallis Plant Materials Center and a second bed will be at a new nursery facility being established by IAE. Beds of other species could be established at these facilities, or at other nurseries such as Heritage Seedlings, to supplement production efforts at Grand Ronde.
- **Expertise:** The advantage of contracting with an existing nursery is that nursery managers have a wealth of knowledge, which increases the likelihood of success. A disadvantage is that CTGR staff and members are less likely to become fully engaged in plant propagation if they are not actively participating. Nevertheless, even when contracting with a nursery, valuable experience can be gained by learning techniques that can be used for CTGR's own nursery operation.
- **Existing infrastructure:** Utilizing nurseries with existing infrastructure could reduce some establishment costs if funds are limiting for start-up at Grand Ronde.

3.5 Select plant species

3.5.1 Overview

An assessment that identifies the potential demand for plant species and how many plants of those species are needed can improve the likelihood of success of a plant materials program. The Target Plant Concept (Dumroese et al. 2009) suggests that knowing what species are needed and the environment they are to be outplanted can influence how plant materials are propagated. See Section 3.5.4 below for a list of questions to ask when determining which species to include.

3.5.2 List desired native plants used in habitat restoration

See Appendix A for an initial list of plants used in habitat restoration.

3.5.3 List desired culturally significant native plants

Used for food, traditional arts, medicine, and ceremonies, see Appendix A for an initial list of culturally significant plants.

3.5.4 Analyze species

Answering the following questions will help determine the list of desired target species (adapted from Dumroese et al. 2009):

- What species are most appropriate for planned restoration projects by CTGR and other partner groups and agencies?
- What restoration objectives do the species meet (e.g. shade for salmon habitat, food, foraging habitat, ground cover, diversity, etc.)?
- Which of these species also fulfill cultural needs?
- What is the cultural significance of the species (e.g., food plant, artisanal material, tool making, etc.)?
- Are some high priority species of cultural significance not high priority habitat restoration species?
- What types of restoration does the Natural Resources Department anticipate implementing over the next five years (habitat type, # acres, etc.)?
- What ecological role does CTGR want target species to fill?
- What plant material propagation techniques of plant materials best fit selected species, restoration objectives, and site characteristics?
- What is the best season to outplant?
- What is the expected ease of establishment of target species in natural areas?
- How easy are target species to propagate?
- How many individuals of each species will be needed annually?
- Are target species known to be vulnerable to any pests, diseases, or herbivory?

Develop a template checklist/matrix for species selection analysis.

3.5.5 Research current commercial availability of high priority species

If appropriate plant materials are already commercially available for some of the high priority species, it is worth considering the cost/benefit analysis of growing your own vs. buying from an outside source.

The Native Seed Network (http://www.nativeseednetwork.org/) is a useful resource for locating vendors and exploring the availability and cost of seed, however, more up-to-date information should be obtained from the growers.

The following information might be particularly relevant:

- Source of plant material (e.g., local genetics)
- Availability
- Cost

3.5.6 Opportunities with the Willamette Valley Native Plant Materials Partnership

Some species of interest may already be under development by the Willamette Valley Native Plant Materials Partnership. As a member organization, CTGR can participate in production or purchase of seed. For more information, view the website http://wvcoop.nativeseednetwork.org/, or contact the Plant Materials Coordinator from IAE.

3.5.7 Select highest priority plants

In order to meet the first four objectives of the CTGR Plant Materials Program, three high priority restoration and three high priority cultural plants need to be selected. Ideally, some or all of the species selected will fall into both categories.

3.5.8 Determine appropriate propagation method for selected species

Species selected can impact the type of plant materials that will be grown (Withrow-Robinson and Johnson 2006). For example, annuals such as tarweed (*Madia* sp.) are best grown from seed, whereas willows (*Salix* sp.) and other shrubs may be best cultivated in cutting beds and outplanted as rooted and non-rooted cuttings.

For each high priority species, determine the best way to propagate that species to fulfill the restoration and/or cultural use needs. The most commonly used propagation methods are listed below.

3.5.8.1 Seed production in raised beds or production (increase) fields

Typical use: For species that establish well by seed (i.e. annuals, grasses) and when large areas must be restored.

Pros: Seeds are small and easy to handle, store for long periods, are easy to outplant by sowing or broadcast, and are generally less expensive than other propagation methods.

Cons: Considerable effort is needed to collect seed from wild sources. If more seed is required than what can be collected, then field production, requiring dedicated field space, harvesting equipment, and seed cleaning facilities are necessary. The process of increasing the seed can affect genetic diversity.

Steps involved: To produce seed for restoration purposes, seed is first collected from local sites and then increased by sowing seed from subsequent harvests until enough seed has been harvested for desired purposes. Depending on the species, the field may also be started from one-year-old plugs grown from the collected seed.

Other options: Direct purchase of seed from growers/brokers in the Willamette Valley, or, contract growing with local growers.

3.5.8.2 Container production

Typical use: For species that do not establish well by seed (i.e. slow-growing perennials) and when specific planting densities or compositions are required.

Pros: Plants of many sizes can be produced. Makes the most efficient use of seeds, especially those of limited supply or high value. Specific plant densities and compositions can be achieved. Can take advantage of nursery/greenhouse growing conditions and growing media. Handling and storage is less demanding than bareroot materials.

Cons: Nursery production requires constant attention and regular watering and fertilization. Depending on when outplanting occurs, plants may require special storage conditions. Require high quality and pure seeds. Higher costs to ship container seedlings and more labor intensive to plant compared to direct seeding or non-rooted cuttings.

Container type selection: Many types of containers, ranging from small plugs aggregated into blocks or trays to large multi-gallon containers are available. The correct container varies with expected root morphology, outplanting site criteria, and economics of the species selected. The most important factors to consider when selecting a container are volume, height, diameter, and shape. Volume determines the size of plant that can be grown, height determines the depth of the root system that will be planted, diameter relates the type of species being grown, and shape relates to the tools required for out planting (Dumroese et al. 2009). Descriptions of a variety of container options and handling techniques are available in Dumroese et al. (2009). Smaller containers are relatively easy to plant with traditional planting tools, such as hoedads, or dibbles, which can make a hole matched exactly to container shape.

3.5.8.3 Bulb/rhizome production

Typical use: For species with these structures that take a long time to establish by seed, have seeds that does not store well, are needed to increase native plant diversity of restoration site, or are culturally significant because the bulb or rhizome is the part of plant of interest. Either raised beds or production fields.

Pros: Relatively easy to establish, renewable resource of plant materials for restoration and cultural uses, can be stored under refrigeration, good survival after outplanting.

Cons: Can be very labor intensive to harvest and replant the propagules and may be less useful for large-scale restoration projects.

3.5.8.4 Bareroot production

Typical use: Tree or shrub species.

Pros: An efficient way to produce large numbers of plants and can be stored under refrigeration. Bareroot seedlings are typically less expensive to produce and ship than container seedlings.

Cons: Compared with container seedlings, bareroot seedlings require more attention during shipping and outplanting because the roots can be damaged more easily. Sizes of plant materials are limited compared to containers. Bareroot plant materials may not be the best option as the starting point for a plant materials program because it is difficult to locate appropriate soils for production and the start-up costs for equipment are high. (Note: Gail Redberg, nursery manager of the Confederated Tribes of the Umatilla Indian Reservation Tribal Native Plant Nursery, indicated they have bareroot equipment that they are not using and would be willing to part with).

3.5.8.5 Cutting production

Typical use: Shrubs that establish best from rooted or non-rooted cuttings, or for culturally significant species used in traditional arts such as basketry.

Pros: Renewable source of plant material for restoration, bank stabilization, and cultural uses. Outplanting non-rooted cuttings can be very cost-effective, especially compared with container seedlings. Large, pole-size cuttings can be produced for riparian restoration. Cutting beds can be established for future needs. Rooted cuttings can be grown in a variety of container types and sizes, and are a good option when seeds are unavailable or have complex dormancy.

Cons: Species that require rooting before outplanting can have additional, complicated steps. Care must be taken with dioecious species (male and female plants) to ensure both sexes are represented on the outplanting site.

3.5.9 Determine plant material sources

Appropriate native plant materials for restoration projects are suitable for the site, grown from locally adapted sources, and have a diverse genetic composition (Withrow-Robinson and Johnson 2006). This means collection of parent materials from a variety of sites, plant sizes, and morphologies is critical quality of plant materials for habitat restoration projects.

Steps:

- Research possible collection sites for each target species
- Determine type of plant material to be collected (i.e., seeds, cuttings, divisions, bulbs/rhizomes, etc.)
- Obtain permission to scout and/or collect at high priority sites
- Scout and map potential plant materials collection sites
- Develop collection protocols
    - Maintain genetic diversity
    - Do not over-collect/harm source population

- Collect plant material
- Store or implement propagation

3.6 Conduct pilot study to determine cultivation protocols for each species

3.6.1 Overview

A logical starting point for a plant materials program is to establish a pilot project that selects a small number of species and then produces a small number (500-1000) of plants of each species. As program operations streamline and propagation techniques improve, the pilot project could expand to produce more plants to fulfill a greater proportion of habitat restoration and cultural needs. Until enough plants can be cultivated, habitat restoration and cultural needs can be supplemented with purchases from local growers.

A second option is to select a few species and propagate a larger number of plants of each species using a variety of cultivation techniques. This will assess the feasibility of each technique and may also fulfill more of the habitat restoration and cultural use plant material needs in the short term.

Draw on knowledge from other growers (see Section 7).

Recommendation:

- Grow small amounts of 4-6 target species for first few seasons to supplement restoration projects and provide material for cultural uses
- Of the target species, select as many species as possible that meet both restoration and cultural use needs
- Assess time, equipment and material requirements
- Determine whether or not to:
    - Expand raised and cutting beds?
    - Grow using pots/cones/bareroot/plugs/non-rooted cuttings?
    - Create seed and/or cutting production beds.

3.6.2 Research cultivation needs and protocols

- Review species cultivation literature
    - Native Plant Network (http://nativeplantnetwork.org)
- Talk to local growers (e.g., NRCS, Heritage Seedlings, Sevenoaks Native Nursery)
- Talk to other tribal plant materials program staff.

3.6.3 Implement small scale operations for target species

Initiate small scale production of seed production beds, container species, and cutting beds. Record protocols followed, challenges, and results. If a species takes more than one year to produce seed or plants large enough for outplanting, focus on initial survival and vigor of plants rather than end product.

3.6.4 Revise target species list and/or protocols

Review pilot project results. For species not successfully grown, determine if the cultivation methodology can be adjusted to improve success. If challenges are too difficult or costly to overcome, consider selecting an alternative species.

3.7 Implement larger scale production

3.7.1 Determine annual yield needs

Project numbers of acres of restoration implemented, quantity of cultivated culturally significant plants needed, and numbers of tribal members intending to gather materials in natural areas each year.

3.7.2 Decide scale of production

Using desired annual yields, calculate scale of operations needed for each species in order to meet those needs, including:

- Seed production fields
- Container plants
- Cultivated raised beds and/or cutting beds
- Harvesting population size

3.8 Develop infrastructure

Once decisions have been made on location and plant species needs, and the pilot program has been evaluated, decisions about nursery infrastructure will be needed.

Chapters 1 (Planning a Native Plant Nursery) and 4 (Propagation Environments) in Dumroese et al. (2009), and the equivalent chapters in Wilkinson et al. (2014), offer excellent guidance when deciding on infrastructure. Most nurseries will start with a basic infrastructure and expand as funding allows.

Growing environments to consider:

- Field beds – e.g., cutting beds or seed production beds
- Raised beds
- Open growing compounds – for regular production and/or for hardening plants
- Cold frames – covered frames without heating
- Shade houses – shaded frames to protect plants from sun and wind
- Greenhouses – propagation structures with fully controlled environments. A great variety of type and sizes are available.

Equipment and other infrastructure to consider:

- Deer fences to protect plants from browsing
- Storage sheds and staff facilities
- Security
- Heating, ventilation, and lighting

- Water supply and greenhouse watering systems, including drainage, storage and recycling of water
- Irrigation for outside areas and beds
- Tractors and hauling and carrying equipment
- Cultivation and harvesting equipment
- Seed cleaning equipment
- Sterilizing equipment
- Shade cloth and weed mat
- Herbicides and pesticides
- Pots and other containers
- Weeding and propagation tools.

4 PROJECT TIMELINE

Table 1. Native Plant Materials Program development and implementation timeline.

Phase	Task	Who responsible	When
Phase 1: Planning	Determine decision-making structure	Planning group	Year 1
	Hold community forum	Historic Preservation and/or Lands Dept.	Year 1
	Select location	Natural Resources Dept.	Year 1
	Select species	Planning group	Year 1
Phase 2: Pilot project implementation	Select pilot species	Planning group	Year 1
	Research cultivation requirements	Natural Resources Dept.	Year 1
	Develop cultivation infrastructure	Natural Resources Dept.	Year 1
	Collect plant materials needed to start propagation	Natural Resources Dept.	Year 1-2
	Cultivate target species	Natural Resources Dept.	Year 1-2
Phase 3: Large-scale implementation	Determine annual needs for each species	Planning group	Year 2
	Implement larger scale cultivation	Natural Resources Dept.	Year 3-5
Phase 4: Program expansion/ long-term goals	Revisit goals and revise as needed	Planning group	Year 4
	Create objectives, tasks, timeline, budget, etc. for revised goals (update plan)	Planning group	Year 4
	Implement	Natural Resources Dept.	Year 5

5 PROJECT COST ANALYSIS AND BUDGET DEVELOPMENT

5.1 Cost analysis

Because cost efficiency is one reason for developing a plant materials program, it is a good idea to develop a cost analysis for plant production that examines the cost/benefit trade-offs of buying plants commercially, contracting with a grower, or growing on site as part of a CTGR plant materials program. Bear in mind, however, that many other reasons and benefits may be more important than economics for starting a nursery program, as outlined in Sections 1.1 and 1.3.

A sample cost analysis is provided for coast tarweed (Table 2). This species was selected as a species for seed production as part of the Plants for People project for a variety of reasons, including cultural significance, the fact that it is not currently available commercially (although it has been grown previously by Heritage Seedlings), and because it is an annual species, a harvest is available in the same year it is planted. Three other tarweed species were available from Heritage Seedlings in 2015 for $76-132/pound for orders >10 pounds. The contract grow-out of coast tarweed at the NRCS Corvallis Plant Materials Center for the Plants for People project is $2,500 for a 0.2 acre field –taking into account the seed collection costs, and projected yields of 99 pounds per 0.2 acre, each pound would cost approximately $49 (Table 2). The equivalent estimates for growing a field at Grand Ronde is at least two times more expensive for one year of production, based on anticipated needs of staff time and supplies (Table 2). However, costs will be much lower in subsequent years if seed from the original collection is stored and re-used, and/or the field continues through self-sowing and field maintenance is reduced compared with the first year – under that scenario it is expected that the second year of production would result in a similar cost to the contract grower (Table 2). Additional start-up costs and new equipment have not been factored into this comparison, as the share of these costs would gradually be reduced over time with ongoing production. Production and management costs would also decrease with time as a result of improved infrastructure, bulk purchases, and efficiency gained through experience and increasing the scale of the operation.

Cost comparisons for other species or propagation methods will vary greatly. For example, perennial species, such as barestem biscuitroot, will take 2-3 years to mature before seed can be harvested. Consequently, a cost analysis would be required over a 5-year period. Other species, such as camas, produced in a raised bed, or shrubs produced in a cutting bed, have relatively low ongoing maintenance, yet continue to produce bulbs or cuttings for many years, providing very low-cost plant materials.

Approximate costs for the current pilot tribal plant materials program at CTGR and projected maintenance costs during 2017-19 are included in Table 3. Costs for the first two years (2015-16) included materials and labor for site preparation and bed construction, and the collection and purchase of plant materials. Projected annual maintenance costs in 2017-19 are lower than the first two years, as the infrastructure is largely set up, and most of the labor will be spent on watering, weeding and harvesting. Costs in Table 3 do not include any costs for expansion of the program, which will be outlined in a new grant proposal to OWEB, being prepared in late 2016.

Table 2. Estimated costs of coast tarweed seed purchased commercially, by contract grow-out on 0.2 acres, or equivalent costs at Grand Ronde, for one year of production.

	Commercial nursery	Contract grower e.g. PMC	Projected Grand Ronde costs [3] Year 1	Grand Ronde Year 2
Management		$330	$1,800	$1,440
Seed collection		$2,000	$2,000	$0
Field preparation, maintenance and harvesting		$2,500	$5,600	$3,700
Supplies[1]			$800	$400
Total Cost		$4,830	$10,200	$5,500
Approx. pounds yield per 0.2 acres [2]		99 (range 10-340)	99 (range 10-340)	99 (range 10-340)
Cost per pound	Not available, but other tarweed cost $76-$132	$49 (range $14 - $480)	$103 (range $25 - $1,180)	$56 (range $13 - $670)

[1] General supplies including weed mat, soil amendments, herbicides, tools etc. Costs for larger equipment for tilling, harvesting and cleaning seed have not been included.

[2] Based on data from Heritage Seedlings for coast tarweed (ranges are from yields for other Madia species grown at the NRCS Corvallis Plant Materials Center (PMC) (Bartow 2015).

[3] Estimated costs – these would be refined during a pilot program.

Table 3. Approximate materials and labor costs of pilot tribal plant materials program at CTGR in 2015-16 and projected total maintenance costs for 2017-19.

5 Year Pilot Tribal Plant Materials Program Costs					
		2015	2016	2017-19 (3 year total)	5 year Total
Raised beds	Materials	$5,600	$400	$450	$6,450
	Labor	$7,200	$3,500	$4,500	$15,200
Cutting beds	Materials	$400	$400	$450	$1,250
	Labor	$2,000	$2,000	$6,600	$10,600
Greenhouse	Materials	$7,000	$250	$750	$8,000
	Labor	$2,750	$2,750	$4,500	$10,000
Plant Materials	Materials	$3,600	$450	$900	$4,950
	Labor	$2,500	$2,500	$1,500	$6,500
Total	Materials	$16,600	$1,500	$2,550	$20,650
	Labor	$14,450	$10,750	$17,100	$42,300
Grand Total		**$31,050**	**$12,250**	**$19,650**	**$62,950**

As an example cost analysis for production of a planting bed, if we assume an annual maintenance cost of $825 for the camas bed, and if two pounds of seed are collected (at a commercial value of $260) and 400 bulbs harvested, then the cost per bulb will be $1.41. Commercially produced bulbs cost approximately $0.90. Although the estimated cost is higher at the CTGR nursery, it is expected that over time, skills, efficiency and production will increase, resulting in a decrease in cost per bulb.

5.2 Budget

The budget for the development of a tribal plant materials program will depend on the results of all of the decisions mentioned earlier in this plan. The following budget categories should be considered when developing the project budget:

- Start-up vs. operating costs.
- Seed and plant material scouting and collection.
- Field preparation and maintenance.
- Infrastructure (e.g., greenhouses) and facilities.
- Equipment and tools.
- Weed and pest control.
- Planting/sowing.
- Growing (containers, water, fertilization, growing media).
- Transportation (of staff and plant materials).
- Hiring costs.
- Employee salaries and benefits.
- Training.

6 FUNDING OPTIONS

Once a program budget has been developed, funding can be solicited and acquired. There are a variety of potential funding sources for a tribal plant materials program.

6.1 CTGR general tribal funds

General funds are provided for through annual budget process. These limited funds serve many other needs and are not anticipated to provide a substantial portion of the operating costs for this program. The Natural Resources Department is funded through a variety of sources including general funds. During this pilot time period staff wages will indirectly support the project. If the project develops further and matching grant funds or direct staffing dollars are needed, NRD staff with make these request in the formal budgetary process.

6.2 Governmental grants

One of the most common sources of tribal native plant materials program start-up funding is governmental grants. Grant programs vary in their availability on an annual basis, so it is important to research what programs are currently available, and the submission deadlines for proposals.

- Search for opportunities on the Grants.gov website: http://www.grants.gov/web/grants/home.html

- The catalog of federal funding sources for watershed protection is another useful website: https://ofmpub.epa.gov/apex/watershedfunding/f?p=109:1:::NO:::

The following agencies have provided grant funding, or are potential funding sources, for tribal native plant materials programs:

6.2.1 Bureau of Indian Affairs

- www.bia.gov;
- Northwest Regional Office, Portland 503-231-6702;
- e.g., Forestry on Indian Lands Program.

6.2.2 Environmental Protection Agency

- www.epa.gov;
- Region 10 (Pacific Northwest) Seattle main office: 206-553-1200 or 800-424-4372, email: epa-seattle@epa.gov;
- A calendar for EPA community grants is available at http://www.epa.gov/grants/epa-grant-competition-forecast-calendar-year-2016;
- Indian Environmental General Assistance Program: http://www.epa.gov/tribal/indian-environmental-general-assistance-program-gap;
- Wetlands Program Development Grants: http://www.epa.gov/wetlands/funding-and-other-resources

6.2.3 US Fish and Wildlife Service (Department of the Interior)

- www.fws.gov;
- Oregon Fish and Wildlife Office, Portland, 503-231-6179;
- Tribal Wildlife Grant Program: http://wsfrprograms.fws.gov/Subpages/GrantPrograms/TWG/TWG.htm;
- Partners for Fish and Wildlife Program: http://www.fws.gov/partners/.

6.2.4 Natural Resources Conservation Service (Department of Agriculture)

- www.nrcs.usda.gov;
- There are a range of financial and technical assistance programs: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/;
- Conservation Stewardship Program;
- Conservation Technical Assistance;

6.2.5 Rural Development (Department of Agriculture)

- http://www.rd.usda.gov/programs-services

6.2.6 Oregon Watershed Enhancement Board

- Small Grant Program,

http://www.oregon.gov/OWEB/GRANTS/pages/smgrant_main.aspx

- Outreach grants: http://www.oregon.gov/OWEB/GRANTS/pages/education_grants.aspx

6.2.7 Bonneville Power Administration

6.3 Private foundations

6.3.1 Meyer Memorial Trust

- http://mmt.org/,

6.3.2 National Fish and Wildlife Foundation

- www.nfwf.org/whatwedo/grants/

6.3.3 Spirit Mountain Community Fund

- http://www.thecommunityfund.com/funding

6.3.4 Ecotrust

- Whole Watershed Restoration Initiative: http://www.ecotrust.org/work/;

6.4 Cost recovery & commercial plant sales

A self-sustaining business is not current goal of CTGR, however, cost recovery through growing plant materials for restoration projects would be appropriate. As outlined earlier in this document, Tribal lands are in need of restoration plants. If this program is successful the Tribes will not be purchasing the plants from commercial nurseries but will be purchasing these plants from their own nursery operation.

7 RESOURCES

7.1 Other tribal plant material programs

- Tribal Nursery Directory (http://www.rngr.net/resources/directory).

7.2 Federal and state

- USDA Forest Service:
  - Reforestation, Nurseries, & Genetics Resources (RNGR) website http://www.rngr.net/ has many useful publications and resources, including a page on propagation protocols;
  - Intertribal Nursery Council, http://www.rngr.net/inc/intertribal-nursery-council;
  - Jeremiah Pinto (Tribal Nursery Specialist);
  - Kasten Dumroese (National Nursery Specialist).
- USDA Natural Resources Conservation Service (NRCS):
  - http://plants.usda.gov/ website provides a plants database with links to factsheets on species of interest;
  - Corvallis Plant Materials Center – Amy Bartow and Tyler Ross;
  - Seed Production Manual (Bartow 2015).
  - Other PMC publications: http://www.nrcs.usda.gov/wps/portal/nrcs/publications/plantmaterials/pmc/west/orpmc/pub/#PU.

7.3 Higher Education

Make use of current research at institutions such as Oregon State University, University of Oregon and Portland State University.

7.4 Other technical assistance

- Lynda Boyer of Heritage Seedlings provides several useful documents on the Prairie Oak Restoration Resources page of their website: http://www.heritageseedlings.com/page_27_50/prairie-and-oak-restoration-resources.

8 REFERENCES

Bartow, A. 2015. Seed Production Manual for the Pacific Northwest. USDA-NRCS Corvallis Plant Materials Center. Corvallis, OR. 192 p.

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9 APPENDICES

Appendix A: Potential plant species list, including culturally important species and priority restoration species

Form	Common name	Scientific name	Restoration use/Habitat	Cultural use
Herbaceous forbs	common yarrow	*Achillea millefolium*	Prairie, matrix, nectar	
	tapertip onion	*Allium acuminatum*	Prairie	food
	narrowleaf onion	*Allium amplectens*	Prairie	food
	crown brodiaea	*Brodiaea coronaria*	Prairie	food
	farewell-to-spring	*Clarkia amoena*	Prairie, nectar	
	Tolmie star-tulip	*Calochortus tolmiei*	Prairie	food, medicine
	large camas	*Camassia leichtlinii*	Wet prairie	food
	small camas	*Camassia quamash*	Prairie	food
	Oregon sunshine	*Eriophyllum lanatum*	Prairie, matrix, nectar	
	Puget Sound gumweed	*Grindelia integrifolia*	Prairie, structure, nectar	
	wild strawberry	*Fragaria virginiana*	Prairie	food
	cow parsnip	*Heracleum lanatum*	Riparian, wet	food, medicine, dye
	toughleaf iris	*Iris tenax*	Prairie, edge	cordage
	barestem biscuitroot	*Lomatium nudicaule*	Prairie	food, medicine, ceremony
	common tarweed	*Madia elegans*	Prairie	food
	coast tarweed	*Madia sativa*	Prairie	food
	Gardner's yampah	*Perideridia gairdneri*	Prairie	food, medicine
	Oregon yampah	*Perideridia oregana*	Prairie	food
	slender cinquefoil	*Potentilla gracilis*	Prairie, matrix, nectar	
	common selfheal	*Prunella vulgaris var. lanceolata*	Prairie, matrix, nectar	
	wapato	*Sagittaria latifolia*	Wetland	food
	yerba buena	*Satureja douglasii*		medicine
	dwarf checkermallow	*Sidalcea virgata*	Prairie, nectar	
	hyacinth brodiaea	*Triteleia hyacinthina*	Prairie	
	stinging nettle	*Urtica dioica*	riparian, understory	medicine, food, cordage
	narrowleaf mule's ears	*Wyethia angustifolia*	Prairie, structure	

Note – list includes commonly used restoration species. Other species can be added, depending on restoration needs for diversity and structure.

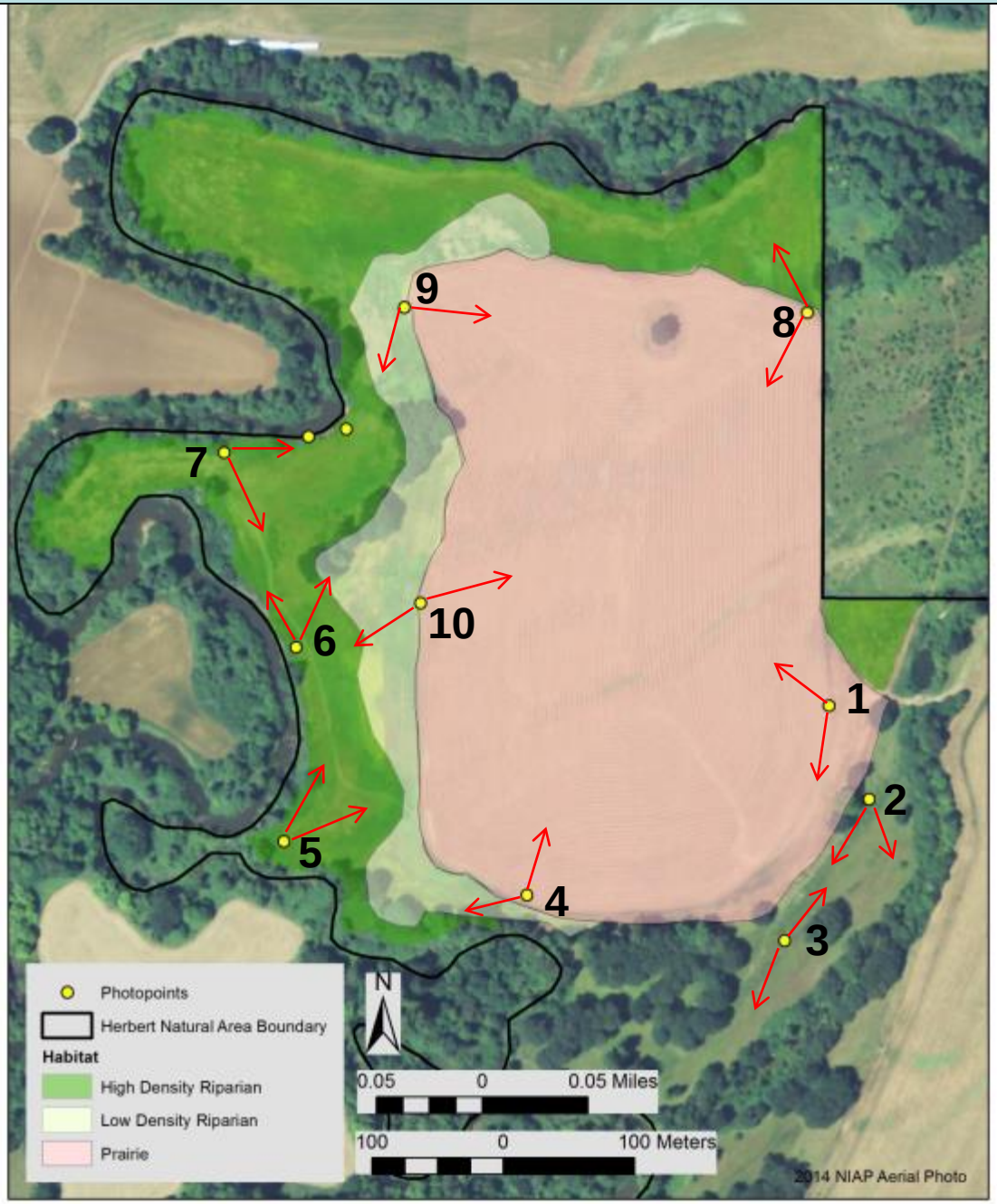
Form	Common name	Scientific name	Restoration use/Habitat	Cultural use
Graminoids	spike bentgrass	*Agrostis exarata*	Wet prairie, matrix	
	California brome	*Bromus carinatus*	Prairie, matrix	
	one-sided sedge	*Carex unilateralis*	Prairie, matrix	
	California oatgrass	*Danthonia californica*	Prairie, matrix	
	tufted hairgrass	*Deschampsia cespitosa*	Wet prairie, matrix	
	blue wildrye	*Elymus glaucus*	Prairie, matrix	
	meadow barley	*Hordeum brachyantherum*	Wet prairie, matrix	
	soft rush	*Juncus effusus*	Wet prairie	weaving
	poverty rush	*Juncus tenuis*	Wet prairie, matrix	
	Roemer's fescue	*Festuca roemeri*	Prairie matrix	
Shrubs	vine maple	*Acer circinatum*	Forest edge	tools, cooking stakes, fiber
	serviceberry	*Amelanchier alnifolia*	Understory, edge	food
	Indian hemp	*Apocynum cannabinum*	Riparian, understory	cordage
	redosier dogwood	*Cornus sericea occidentalis*	Understory	medicine, smoking, dye
	California hazelnut	*Corylus cornuta*	Understory	food, weaving, medicine
	ocean spray	*Holodiscus discolor*	Understory	medicine, tools, weapons
	Oregon grape	*Mahonia aquifolium*	Forest/woodland understory	food, medicine
	Indian plum	*Oemleria cerasiformis*	Forest/woodland understory	food, tea, anesthetic
	Oregon white oak	*Quercus garryana*	Oak woodland, oak savanna	food
	cascara	*Rhamnus purshiana*	Forest/woodland	medicine
	nootka rose	*Rosa nutkana*	Understory, edge	food, medicine, ceremony, crafts
	thimbleberry	*Rubus parviflorus*	Understory	food, medicine
	salmonberry	*Rubus spectabilis*	Understory	food
	Pacific willow	*Salix lucida*	Riparian	medicine, fiber, tools
	Elderberry	*Sambucus racemosa/cerulea*	Riparian, understory	
	Douglas spiraea	*Spiraea douglasii*	Wet	brooms, cooking tools
	snowberry	*Symphoricarpos albus*	Forest/woodland	medicine, soap, arrows

Form	Common name	Scientific name	Restoration use/Habitat	Cultural use
Trees	white alder	*Alnus rhombifolia*	Riparian	medicine
	red alder	*Alnus rubra*	Riparan	dye, medicine
	Oregon ash	*Fraxinus latifolia*	Riparian	tools, basketry
	Lewis' mock orange	*Philadelphus lewisii*	Riparian	tools, arrows, furniture, soap
	black cottonwood	*Populus trichocarpa*	Riparian	medicine, firewood, rope, traps, weaving, structures
	Pacific willow	*Salix lucida*	Riparian	medicine
	Scouler willow	*Salix scouleriana*	Riparian	
	Sitka willow	*Salix sitchensis*	Riparian	
	Pacific yew	*Taxus brevifolia*	Riparian	Tools, arrows, bows, digging sticks, fiber
	Western red cedar	*Thuja plicata*	Forest/woodland	planks canoes, weaving

APPENDIX 3.

Herbert Farm and Natural Area photopoints, 2013-2016

Appendix 3: Photopoints at Herbert Farm & Natural Area, 2013-2016.



Number	GPS location	Direction (degees)
PP1	44 31' 17.2"; 123 17' 45.4"	186, 304
PP2	44 31' 14.9"; 123 17' 44.0"	210, 158
PP3	44 31' 11.4"; 123 17' 46.9"	33, 205
PP4	44 31' 12.5"; 123 17' 55.8"	355, 256
PP5	44 31' 13.8"; 123 18' 04.2"	24, 80
PP6	44 31' 18.6"; 123 18' 03.8"	331, 24
PP7	44 31' 23.4"; 123 18' 06.3"	85, 170
PP8	44 31' 26.9"; 123 17' 46.2"	208, 326
PP9	44 31' 27.0"; 123 18' 00.1"	195, 95
PP10	44 31' 19.7"; 123 17' 59.5"	250, 75

Red arrows indicate approximate direction that photos were taken

Photopoint 1

1A: Pretreatment – harvested ryegrass, 28 June 2013

1A: After first seeding of prairie forbs, 5 June 2015

1A: After second seeding of prairie forbs & grasses,1 July 2016

1B: Pretreatment – ryegrass field, 24 April 2013

1B: After one year site preparation, 15 Aprils 2014

1B: After second seeding of prairie forbs & grasses,31 May 2016

Photopoint 2

2A: Pre-treatment - reed canary-grass in foreground,10 May 2013

2A: After 2 years site prep and seeding of forbs, 21 April 2015

2A: After seeding with native forbs & grasses, 31 May 2016

2C: After one year treatment,15 April 2014

2C: After two years treatment, 5 May 2015

2C: After seeding with native forbs & grasses, 5 June 2016

Photopoint 3

3A: Pre-treatment – mowed swale, 18 September 2013

3A: After one year herbicide treatment, 15 April 2014

3A: After seeding with native forbs & grasses, 5 June 2016

3B: After spot spraying 21 April 2014

3B: After 3 years limited spot spraying, 5 June 2015

3B: After 4 years limited spot spraying, 31 May 2016

Photopoint 4

4B: After 1 year site treatment, 21 April 2014

4B: After first seeding of forbs, 5 June 2015

4B: After 2nd year of seeding forbs and grasses, 1 July 2016

4D: Pre-treatment – fallow grassland, 24 April 2013

4D: After 2 years of site prep and seeding grasses, 21 April 2015

4D: After 2 years planting riparian trees, after mowing,1 July 2016

Photopoint 5

5A: Pre-treatment – blackberry in riparian margin, 24 April 2013

5A: After one year mowing and herbicide treatment, 15 April 2015

5A: After 2 years planting riparian trees, 31 June 2016

5B: after one year of site preparation, 15 April 2014

5B: After seeding grasses & 2 years planting trees, 31 May 2016

5B: After 2 years planting, and after mowing, 1 July 2016

Photopoint 6

6A: Mowed blackberry & reed canarygrass, 6 June 2013

6A: After first year sowing grasses, planting trees 5 June 2015

6A: After 2 years planting trees, 31 May 2016

6B: After one year site preparation,15 April 2014

6A: After first year sowing grasses, planting trees 5 June 2015

6A: After 2 years planting trees, after mowing,1 July 2016

Photopoint 7

7A: Pre-treatment – blackberry, 13 September 2013

7A: After first year treatment, 15 April 2014

7A: After 2 years planting trees & shrubs, 1 July 2016

7C Fallow grassland after 1 year site preparation, 15 April 2014

7C, One month after planting trees & shrubs 21 April 2015

7C, After 2 years riparian plantings, soon after mowing, 1 July 2016

Photopoint 8

8B: Pre-treatment – ryegrass field, 24 April 2013

8B: After 2 years site prep and first seeding forbs, 21 April 2015

8B: After 2nd year seeding forbs and grasses, 31 May 2016

8D: After 1 year site preparation, 15 April 2014

8D: After first planting of trees, 21 April 2015

8D: After second year planting trees, 31 May 2016

Photopoint 9

9A: After 2 years of site prep and 1st year tree planting, 21 April 2015

9A: After 2nd year of tree planting, before mowing 31 May 2016

9A: After 2nd year of tree planting, after mowing, 1 July 2016

9D: After 2 years site prep and first forb seeding, 21 April 2015

9D: Prickly lettuce infestation, 5 June 2015

9D: Stinking chamomile infestation, 1 July 2016

Photopoint 10

10A: After first year planting trees, 5 June 2015

10A: After second year planting trees, before mowing, 21 May 2016

10A: After second year planting trees, after mowing, 1 July 2016

10D: After first year sowing native forbs, 5 June 2015

10D: After 2nd year sowing native forbs & grasses, 31 May 2016

10D: After 2nd year sowing native forbs & grasses, 1 July 2016

APPENDIX 4.

Champoeg State Park photopoints, 2013-2016

Appendix 4. Photopoints at Champoeg State Park, 2013-2016.

B: Before forb introduction plot creation, August 2013.

B: Seeding in forb introduction plots, December 2015.

B: Forb establishment in forb introduction plot and after mowing, August 2016.

C: Before herbicide treatments, May 2014

C: After herbicide treatments, August 2016

Champoeg Photopoints continued

D: Meadow with tufted hairgrass, August 2013.

D: Meadow with tufted hairgrass, May 2015.

D: Meadow with tufted hairgrass, August 2016.

E: Before forb introduction plot creation, July 2013

E: Plant establishment in forb introduction plot, May 2016