CAREX WORKING GROUP

BOTANICAL SERVICES AND ECOLOGICAL ASSESSMENTS

Willamette Mainstem Vegetative Habitat Survey and Assessment

Final Report

Submitted to:
Benton Soil and Water Conservation District
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Introduction

Benton Soil and Water Conservation District (BSWCD) contracted with Carex Working Group (CWG) to develop and carry out a vegetative habitat survey and assessment along the main stem of the Willamette River between Corvallis and Albany. The purpose of the project was to "evaluate the character and health of vegetative communities, with an emphasis on invasive species." Results from the project will be used to develop management priorities with public and private landowners, managers, and other stakeholders.

The project was divided into three components:

1. Work with BSWCD personnel to design a replicable methodology that assures consistent data collection over time.
2. Conduct field surveys to determine location and extent of invasive species, particularly populations that are still small enough to control now; locate areas of high quality habitat and areas at greatest risk; identify areas where containment of invasives is a priority.
3. Provide analysis and assistance in developing priority actions and strategies for management and treatment.

The project area encompasses approximately 3000 acres on both sides of the Willamette River between Corvallis and Albany, and includes a mix of private and public ownerships. Public lands include areas owned by the cities of Corvallis and Albany, Benton and Linn Counties, and Oregon Parks and Recreation Department (OPRD). In 2012, 1618 acres were surveyed on 23 sites comprising 13 ownerships. In 2013, 1136 acres were surveyed on 35 sites comprising 32 ownerships. Included in the 2013 total are 188 acres on three ownerships that were surveyed both years to assess differences in seasonal phenology of native vegetation and target weed species due to the timing of the weed surveys.

Methods

Before the fieldwork commenced, a field protocol was developed based on a protocol used by the Portland Parks and Recreation Department's *Protect the Best Invasive Vegetation Management Program* (http://www.portlandonline.com/parks/index.cfm?c=47247). The *Protect the Best* protocol was modified for the 2012 surveys. The 2012 protocol was revised for the 2013 surveys. Site maps and ownership information were supplied as shape files and pdfs by

BSWCD. The inventories conducted in 2012 were concentrated on publicly owned lands although some private lands were also inventoried. The bulk of the acreage surveyed in 2012 was in large, public ownerships. The lands surveyed in 2013 were primarily small, private ownerships.

Each property is identified by a unique code. In 2012, within each property, individual habitat types (map units) were delineated in the field, assigned a number, and mapped on a transparent aerial photo overlay. Each map unit has a single predominant cover type, and is a contiguous area of similar dominant plant species, landform, and condition, an assessment of health of the ecological communities based on disturbance and degree of weed infestation. Each map unit was assigned one of 5 condition codes ranging from very good to severely degraded. Larger water features, such as marshes, ponds, and sloughs, were delineated as individual mapping units only when aquatic or emergent vegetation was observed. Field data sheets included a short written description of each map unit, and suggestions for future management or restoration activities that may be appropriate to control weeds, and enhance vegetative communities and fish and wildlife habitat. Vegetation sample plots were located in habitats that were identified as being in good condition to provide more detail on conditions in these areas.

The methodology was revised in 2013 to streamline the field data gathering process and concentrate limited field time on locating and mapping invasive species populations and native habitats that are in good condition. In particular, general habitat type mapping and vegetation sample plots in good condition habitat polygons were dropped from the methodology. These activities required significant field time in 2012 and did not contribute significantly to the primary objectives of the project, which were to map populations of invasive species and good quality habitats. Landform and slope class data were not collected and habitat condition was only recorded for good condition habitats, rather than for all areas surveyed. The streamlined protocol provided estimated timesaving of 25-30% and allowed for surveyors to increase the number of target invasive plant species that were mapped.

Field surveys took place between July and September of 2012 and between May and July in 2013. Surveys in 2013 were conducted earlier to obtain data of native and invasive plant species that may have been missed in 2012 due to seasonal phenology. Invasive plant populations were detected by grid searches in the field. Grids were informally defined for each map unit, and ensured thorough coverage to detect isolated populations of target species and

habitats that are in good condition. Areas influenced by human activities or other disturbances (e.g. roads, forest gaps, and agricultural margins) received especially careful examination. Target invasive species included noxious weeds listed by the ODA and capable of growing in the project area, whether already known from the region or not. A few additional species not listed by the ODA were also mapped. The streamlined protocol in 2013 allowed for more time for invasive plant surveys and four species were added to the list of plants that were mapped – Canada and bull thistles (*Cirsium arvense* and *C. vulgare*), tansy ragwort (*Senecio jacobaea*), and common tansy (*Tanacetum vulgare*). Two species of *Clematis* – the invasive old man's beard (*C. vitalba*) and the native western clematis (*C. ligusticifolia*) proved to be very difficult to identify accurately in the field. Because of this, and because we believe old man's beard is moving aggressively along the Willamette Mainstem, all *Clematis* populations were mapped without attempting to identify them to species.

Location and size of invasive plant populations were recorded. UTM coordinates of patch centers were recorded for patches with radii of more than 50 feet; larger patches were mapped directly on a transparent aerial photo overlay in the field. Accurate mapping of Himalayan blackberry (*Rubus bifrons*) and reed canarygrass (*Phalaris arundinacea*) was not always practical because these species are so common and widespread throughout the project area. We did not record specific locations for these species when they represented the dominant vegetative cover of map units. However, the locations of emerging populations of these species were noted, especially where they were observed to be encroaching upon high quality habitat. Absence of Himalayan blackberry and reed canarygrass was usually a major factor in determining that a habitat was in good or excellent condition.

Table 1. Target invasive plant species. Six letter codes are assigned to species that were detected within the project area. "Not detected" indicates species that were not detected within the project area. Oregon Department of Agriculture listed noxious weeds are indicated by "x" (ODA 2012).

Species code	*Species*	Common Name	ODA Listed
ACEPLA	*Acer platanoides*	Norway maple	
BETPEN	*Betula pendula*	European birch	
BRASYL	*Brachypodium sylvaticum*	false brome	x
BROTEC	*Bromus tectorum*	cheatgrass	
BUDDAV	*Buddleja davidii (B. variabilis)*	butterfly bush	x
CARPYC	*Carduus pycnocephalum*	Italian plumeless thistle	x
CENSTO	*Centaurea stoebe (C. maculosa)*	spotted knapweed	x

Species code	*Species*	Common Name	ODA Listed
CIRARV	*Cirsium arvense* (2013 only)	Canada thistle	x
CIRVUL	*Cirsium vulgare* (2013 only)	bull thistle	x
Clematis spp.	*Clematis vitalba/ligusticifolia*	old man's beard/w. clematis	x
CONMAC	*Conium maculatum*	poison hemlock	x
Cortaderia spp.	*Cortaderia spp.*	pampas grass	x
CYTSCO	*Cytisus scoparius*	Scotch broom	x
EGEDEN	*Egeria densa*	Brazilian waterweed	x
ELEUMB	*Elaeagnus umbellata*	autumn olive	
FALJAP	*Fallopia japonica (Polygonum cuspidatum)*	Japanese knotweed	x
GENMON	*Genista monspessulana*	French broom	x
GERLUC	*Geranium lucidum*	shining geranium	x
GERROB	*Geranium robertianum*	Robert geranium	x
Hedera spp.	*Hedera hibernica/helix*	Atlantic and English ivy	x
HELANN	*Helianthus annuus*	common sunflower	
HYPCAL	*Hypericum calycinum*	Aaron's beard	
ILEAQU	*Ilex aquifolium*	English holly	
IRIPSE	*Iris pseudacorus*	yellowflag iris	x
JUGNIG	*Juglans nigra*	black walnut	
JUGREG	*Juglans regia*	English walnut	
LINVUL	*Linaria vulgaris*	butter and eggs	x
LUDHEX	*Ludwigia hexapetala (L. grandiflora)*	water primrose	x
LUDPEP	*Ludwigia peploides*	floating water primrose	x
LYTSAL	*Lythrum salicaria*	purple loosestrife	x
MYRAQU	*Myriophyllum aquaticum*	parrot feather watermilfoil	x
PARQUI	*Parthenocissus quinquefolia*	Virginia creeper	
PENSEM	*Pentaglottis sempervirens*	evergreen bugloss	
PHAAQU	*Phalaris aquatica*	Harding grass	
PHAARU	*Phalaris arundinacea*	reed canarygrass	
PRUAVI	*Prunus avium*	sweet cherry	
PRULAU	*Prunus laurocerasus*	cherry laurel	
PRULUS	*Prunus lusitanica*	Portuguese laurel	
QUEPAL	*Quercus palustris*	pinoak	
QUERUB	*Quercus rubra*	red oak	
RANFIC	*Ranunculus ficaria*	lesser celandine	
ROBPSE	*Robinia pseudo-acacia*	black locust	
RUBBIF	*Rubus bifrons (R. discolor, R. armeniacus)*	Himalayan blackberry	x
RUBLAC	*Rubus laciniatus*	evergreen blackberry	
RUBVES	*Rubus vestitus*	European blackberry	
SENJAC	*Senecio jacobaea* (2013 only)	tansy ragwort	x
TAECAP	*Taeniatherum caput-medusae*	medusahead	x
TANPAR	*Tanacetum parthenium*	feverfew	
TANVUL	*Tanacetum vulgare* (2013 only)	common tansy	
VINMAJ	*Vinca major*	greater periwinkle	
VINMIN	*Vinca minor*	lesser periwinkle	
Not detected	*Ailanthus altissima*	tree of heaven	
Not detected	*Alliaria petiolata*	garlic mustard	x

Species code	*Species*	Common Name	ODA Listed
Not detected	*Carduus tenuiflorus*	slender-flowered thistle	x
Not detected	*Centaurea melitensis*	Maltese starthistle	
Not detected	*Centaurea nigrescens (C. jacea x nigra)*	Tyrol knapweed	x
Not detected	*Centaurea solsticialis*	yellow starthistle	x
Not detected	*Cynoglossum officinale*	houndstongue	x
Not detected	*Cytisus striatus*	Portuguese broom	x
Not detected	*Daphne laureola*	spurge laurel	x
Not detected	*Dipsacus laciniatus*	cutleaf teasel	x
Not detected	*Echium plantagineum*	purple viper's bugloss	x
Not detected	*Erica lusitanica*	Spanish heath	x
Not detected	*Heracleum mantegazzianum*	giant hogweed	x
Not detected	*Hieracium sp.*	hawkweed	x
Not detected	*Impatiens glandulifera*	ornamental jewelweed	x
Not detected	*Lamiastrum galeobdolon*	yellow archangel	
Not detected	*Nymphoides peltata*	yellow floating-heart	x
Not detected	*Onopordum acanthium*	Scotch thistle	x
Not detected	*Potentilla recta*	sulphur cinquefoil	x
Not detected	*Silybum marianum*	milk thistle	
Not detected	*Spartium junceum*	Spanish broom	x
Not detected	*Tribulus terrestris*	goatheads	x

Habitat patches in very good or good condition were mapped on a transparent aerial photo overlay in the field. Habitats rated as having very good condition were determined to have a high level of ecological function, with good native species and structural diversity. Habitats rated as having good condition were determined to have minor impacts from disturbance and invasive plant species. Sample plots were installed in these polygons in only 2012 to (1) document the current composition of plant communities, and (2) serve as future monitoring points to track the effects of management and restoration activities, and other changes over time. Circular plots with a radius of 18.5 feet (area = approximately 100 meters^2) were placed in non-randomized locations that demonstrated the typical conditions of the map unit. The number of sample plots within each map unit varied with the complexity, diversity, and size of the area. In general, one plot per 20-50 acres was installed in large map units. Plots were not permanently marked in the field, but the GPS locations of their centers were recorded so they may be relocated in the future. Cover of up to four dominant plant species (≥ 15% cover) in the tree (woody plants ≥ 15' tall), shrub (woody plants <15' tall), and herbaceous layer was recorded. Cover of all invasive plant species present was also recorded for each layer. At the center of each plot, photographs were taken in all four cardinal directions (north, east, south, and west) at breast height. Photos demonstrate reference conditions for management and restoration

activities, and may be used to visually document change over time. Plot photographs were submitted separately to BSWCD in digital format. In 2013, good or very good habitat was directly mapped on the transparent overlays. No sample plots were installed, but location, dominant species by vegetation layer (tree, shrub, and forb), a general habitat description, and threats were recorded for each good habitat area.

GIS Mapping

Locations of map units, noxious weed populations, high quality habitats, and vegetation plots were imported to GIS shapefiles. The 2012 and 2013 data were combined for the mapping. The maps were exported to pdf files for this report and the shapefiles are being submitted to BSWCD in digital format.

Results

Invasive Species

Populations of Himalayan blackberry, reed canarygrass, and common tansy were extensive throughout the project area. At least one of these species was documented on all private and public properties surveyed in 2012 and 2013. Himalayan blackberry generally dominated the shrub layer of forested habitats on high terraces, and in grasslands, but was often absent from sloughs and marshes that are inundated seasonally or year-round. Reed canarygrass occurred in all habitat types and landforms, and monocultures of this grass were frequent in low-lying areas within the floodplain. Populations of Himalayan blackberry and reed canarygrass colonized forest gaps, but in areas where the tree canopy remained intact (>55% coverage), these species were less common. Changes in methodology allowed for the inclusion of four invasive plant species not surveyed in 2012, Canada and bull thistle, common tansy, and tansy ragwort, all of which were almost exclusively found along agricultural margins and to a lesser extent on gravel bars, along riverbanks, in highly disturbed areas, and in low-lying grasslands within the river floodplain. Poison hemlock was only observed in 2013, primarily at the margins of agricultural fields. This may be due to two factors – (1) few surveys in 2012 covered agricultural field edges, (2) the 2012 surveys may have been were conducted too late in the season to capture poison hemlock, and surveyors may not have been keyed into the presence of senescing or senesced poison hemlock.

Target woody species with frequent occurrences throughout the project area included black locust (*Robinia pseudo-acacia*), Norway maple (*Acer platanoides*), various introduced cherries and laurels (*Prunus* spp.), English holly (*Ilex aquifolium*), and black walnut (*Juglans nigra*). Invasive woody plants were most common in forested habitats within the floodplain or on high terraces. On two sites black walnut occurred as a dominant species in the tree layer. English holly, although not present in large patches, was frequently observed growing in forested understories. This was especially apparent on the properties surveyed in 2013.

Ivy (*Hedera* spp.) and old man's beard (*Clematis vitalba*), were found invading forested habitat on high terraces throughout the project area, often completely covering mature trees. In 2013, 78% of the identified patches of old man's beard and 62% of ivy were observed ascending trees into the forest canopy. Ivy was observed as a dominant species in portions of interior forest habitat on various privately owned properties, and the majority of surveyed sites owned by the City of Albany. Significant mechanical and chemical ivy control efforts were being undertaken by one landowner in particular (figure 1). Isolated patches of ivy were detected at all sites except for 12 private properties. *Clematis* was present at most properties within the project area; however, due to the difficulty in reliably separating the native from the invasive species we decided in 2013 to map all *Clematis* that we encountered. Thus, some native western clematis may have been included among the mapped populations.

Figure 1. Ivy control landowner property

Low-density populations of false brome (*Brachypodium sylvaticum*) were commonly recorded in forested habitat on high terraces, and rarely along riverbanks. False brome was not found on most of the smaller private properties but was present on nearby properties. False

brome was absent from state owned properties, with the exception of a patch at Bowers Rock. False brome occurs on the majority of city owned properties (Albany and Corvallis).

Other invasive forbs were usually detected in areas that are inundated seasonally or year-round, and were largely comprised of aquatic and emergent plants. Two species of water primrose (*Ludwigia hexapetala and L. peploides*) were widespread throughout the project area, often forming monocultures in standing water. Water primrose was detected on four private properties, and formed large patches. Some patches were primarily observed in ponds formed by gravel extraction, which are likely connected to each other and the Willamette River during seasonal high water. Less common occurrences of purple loosestrife (*Lythrum salicaria*), yellowflag iris (*Iris pseudacorus*), and Brazilian waterweed (*Egeria densa*) were noted throughout the project area.

High Quality Habitat

High quality habitats were mapped on 13 sites in 2012 and 10 sites in 2013. Fewer and smaller high quality habitats were observed in 2013 primarily due to the small size of the properties surveyed. High quality patches occurred on a variety of landforms and habitat types. Forested habitats were generally of better quality when (1) a high percentage cover of trees was present (≥55%), (2) good native plant species component was present in the shrub layer, and/or (3) regeneration of native hardwood trees was observed. In these cases, invasive plants, such as Himalayan blackberry, were absent or represented a minor component of the vegetation in the upper structural layers, although ivy and reed canarygrass were recorded encroaching upon some high quality areas. Many of the high quality areas were located in interior forest habitats. Diverse native herbaceous vegetation layers were rarely encountered except on a few properties. Plots at these sites had more diverse herbaceous layers than occurred at other sites.

Grassland habitats never contained a large component of native plant species, but were included as high quality habitats when target invasive plant species were absent. These areas were generally dominated by introduced grasses, such as perennial ryegrass and colonial bentgrass, but may offer opportunities for restoring native prairie and savanna communities. They also provide wildlife habitat value as open and edge habitats and are valued by recreational users for camping and picnicking.

In high quality areas that are inundated seasonally or year-round (e.g. open water, gravel

bars, and marshes), native willows were commonly present. The herbaceous layer of these areas was comprised of aquatic and emergent native plants, such as wapato (*Sagittaria latifolia*), rice cutgrass (*Leersia oryzoides*), smartweed (*Persicaria* sp.), and various sedges (*Carex* spp., *Eleocharis* spp., *Scirpus* spp.). While most vegetated aquatic habitats were overrun with invasive plants, high quality aquatic habitats were documented on state land. High quality gravel bars and marshes were found on state and city lands.

Discussion

Himalayan blackberry and reed canarygrass have invaded large areas throughout the project area, in some cases forming extensive monocultures or dominating forest understories to the exclusion of virtually all native species (Figure 2). These species probably pose the greatest threat to the remaining native habitats along the project area along the Willamette River. Highest densities occur in disturbed areas, along roadsides and trails, and at the edges of forests fragmented by agricultural practices. Control of Himalayan blackberry and reed canarygrass may be impractical in most of the areas where these species dominate large areas. Control efforts should be concentrated on new, smaller populations and areas where these species are encroaching on high quality habitats. On one private property and in several public parks, establishment of these species has been controlled by densely planted hedgerows of native shrubs (e.g. rose spiraea (*Spiraea douglasii*), red osier dogwood (*Cornus sericea*), and hazelnut (*Corylus cornuta*). Mowing and herbicide treatments can also be effective.

Figure 2. Reed canarygrass and Himalayan blackberry at Horseshoe Lake.

Riparian forests in the Willamette Valley are important contributors to the biodiversity of the region, but their presence as a mosaic of communities of different successional stages may be threatened by human interventions, including influences from introduced plant species (Fierke & Kauffman 2006). Many of the small, private lands surveyed in 2013 are active farms, orchards, and personal perennial gardens that extend to or into forested riparian habitats. These small properties lack interior forest habitat but may be considered links between larger patches of

riparian habitat that are important corridors for native wildlife, insect pollinators, and plants to move between the larger patches. Hardwood and mixed forest was the most extensive habitat type within the project area and contained the largest amount of high quality habitat areas.

Invasive trees were common, and property owners should consider removing or girdling problematic woody species to prevent their spread. Black walnut was the only target tree species found to dominate portions of forest within the project area. Black walnut is known to have allelopathic qualities (Von Kiparski et al. 2007), and may inhibit the establishment and persistence of native plants in the shrub and herbaceous layers of forests. Sweet cherry is a serious pest in upland forests of the central Willamette Valley and should be controlled while populations are small.

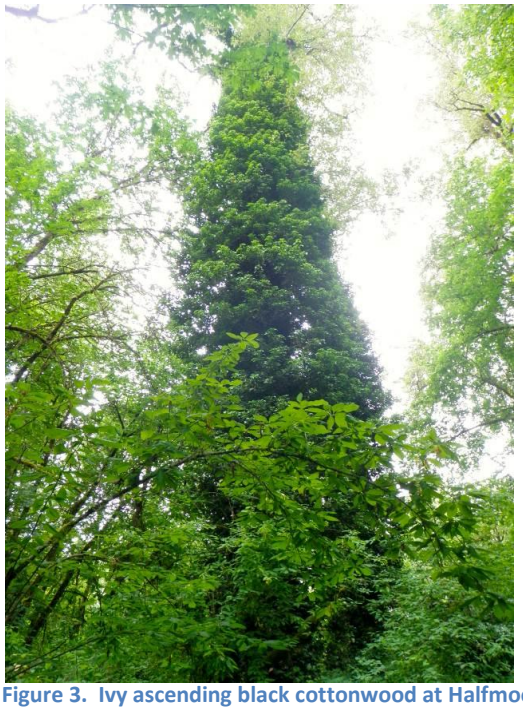

Figure 3. Ivy ascending black cottonwood at Halfmoon Bend State Park

Ivy and old man's beard infestations should receive high priority for control efforts. These species occur frequently in riparian forests, often in high quality habitats, and have the potential to overwhelm forest understories and constitute serious threats to standing trees that can be taken down by the weight of the vining plants (Figure 3). The additional foliage also causes increased windthrow. Ivy that climbs up trees into the forest canopy flowers and produces seed that is dispersed by birds that eat the ivy fruits. Control of "aerial" ivy in forest canopies helps reduce the spread of ivy by seed.

In forested habitats glyphosate and grass-specific herbicides may provide effective control of less extensive populations of invasive forbs and grasses, such as Japanese knotweed (*Fallopia japonica*), Robert geranium (*Geranium robertianum*), periwinkle (*Vinca* spp.), and false brome.

False brome, while relatively common within the project area, occurred in surprisingly sparse and relatively small populations, except on the Saxe property where a large dense population was found. This species has rapidly expanded recently in western Oregon and has the potential to completely dominate forest understories and grasslands (False Brome Working

Group 2003). Because of its limited extent in the project area regular monitoring and control efforts should be undertaken to minimize future impacts both within the project area and at downstream sites which would receive seed brought down by the river.

Areas where weed control efforts have been implemented should be replanted with native species to occupy habitat and prevent recolonization by invasives. Native trees, shrubs, forbs and graminoids can be planted in weed control areas as well as in gaps, edges, and disturbed areas. These plantings can also enhance wildlife habitat values. Flood tolerant native plants (e.g. various willows) that are easy to propagate should be top candidates for restoring areas within the floodplain of the Willamette River.

Presence and abundance of native understory species in riparian forests is strongly correlated with vertical structural diversity (Fierke & Kauffman 2006). Surveyors considered substantial regeneration of native trees and vertical layering to be components of high quality habitat. Very little black cottonwood (*Populus trichocarpa*) regeneration was observed throughout the project area. Others have documented the decline of black cottonwood forests along the Willamette River related to human influences (Fierke & Kauffman 2006). Changes in river hydrology caused by dams, channelization, and bank hardening have limited the regeneration of riparian forests, in part, by decreasing the amount of bar and island area in the floodplain (Dykaar & Wigington 2000). Preserving and restoring riverbanks and gravel bars to the extent possible is therefore of particular importance to improving the quality of the larger landscape. Gravel bars harbor sparse but beneficial native vegetation for waterfowl, such as tall mannagrass (*Glyceria elata*) and rice cutgrass (*Leersia oryzoides*). These areas provide open habitats necessary for regeneration of willows, alder, and cottonwood. Emergent invasive species, such as yellowflag iris and purple loosestrife, should be removed from shoreline habitats. These habitats could be improved by planting willow (e.g. *Salix hookeriana, S. lasiandra, S. melanopsis, S. sessilifolia*) and black cottonwood, seeding graminoids and forbs, and protecting unique plant communities, such as wapato (*Sagittaria latifolia*) marshes. In addition to invasive plant species, gravel extraction, recreational vehicles (e.g. four-wheelers), and the presence of riprap impact these habitats.

Figure 4. Water primrose in a side-channel system west of the Willamette River

Ponds, perennial side channels, and sloughs occur throughout the project area and are generally lined with flood tolerant native trees and shrubs. These aquatic habitats are essential for native fish and wildlife, including a variety of rare, threatened, and endangered species. Northern red-legged frogs, Western pond turtles, and salmonid fish have been documented within the project. Reed canarygrass and water primrose are widespread in aquatic habitats, forming dense infestations in some ponds and sloughs (Figure 4). Control of invasive plant species in these habitats can be difficult and the State of Oregon has instituted a program to prevent introductions. Integrated control of water primrose infestations in California and in Eugene, Oregon has shown promise, although careful follow-up is necessary to maintain control (WSSA 2013). The California and Oregon efforts have used a combination of chemical and mechanical control methods. These are combined with early detection rapid response approaches to eradicating new populations before they grow too large to control effectively. Similar efforts should be initiated in aquatic habitats along the Willamette mainstem to reclaim infested habitats and prevent further spread of water primrose.

Grasslands throughout the project area were generally of low quality and were frequently invaded by Himalayan blackberry and common tansy. Grasslands listed as high quality generally did not have a large native species component but have some value for their open character and the absence of large populations of target invasive species. Management of these habitats could range from simply maintaining them by controlling Himalayan blackberry to extensive restoration of native bunchgrass communities. Although we did not find any savanna habitat and found few shrublands within the project area, Oregon white oak and buckbrush were recorded at several locations. These species should be considered for grassland and savanna restoration activities in appropriate habitats.

Conclusions

Riparian habitats along the mainstem of the Willamette River between Corvallis and Albany are generally highly fragmented, influenced by hydrologic alterations and other human and natural disturbances, and heavily impacted by a diversity of invasive weeds. Although much of the high quality riparian habitat is located on publicly owned lands, efforts to maintain and expand high quality riparian habitat on small, private lands is important. Small parcels of riparian habitat provide linkages and corridors between larger patches that are integral to maintaining species diversity. The magnitude of the weed problem in riparian habitats necessitates that limited resources be used efficiently to protect the most valuable remaining habitats by targeting control efforts where they will have the greatest effect. Large areas of dense Himalayan blackberry and reed canarygrass are probably impractical to control at this time. It makes more sense to protect high quality habitats from invasion and to control smaller weed populations before they can spread. Ongoing monitoring and maintenance will be necessary to control invasive species in these areas. When the high quality habitats are secured, they can serve as centers from which control efforts can be expanded. Areas where invasive control has occurred will need to be replanted with native species to occupy the areas where invasive plant species were removed

Summary of results:

- Himalayan blackberry and reed canarygrass are nearly ubiquitous throughout the project area.
- False brome, ivy, old man's beard are common in the project area, but present in low density populations that can still be controlled.
- Aquatic weeds are particularly problematic because control options are limited, habitats in which they are located are often difficult to access, and there is a constant input of seed and plants from the river. However, integrated control methods may be effective against water primrose populations.
- Good quality habitats are mostly located in the interior of large tracts of forest that are not heavily influenced by edge effects of agricultural fields, roadsides, and trails.
- Oregon State Park land at Bowers Rock supports the largest areas of high quality habitat.

Management recommendations:

- "Protect the best" by starting weed control efforts within or adjacent to high quality habitats.
- Implement "Early Detection, Rapid Response" (EDRR) to detect and eradicate small and emerging populations of invasive plants before they become too large to control.
- Prioritize false brome, ivy, old man's beard and water primrose control.
- Remove aerial ivy to control seed production.
- Work with land-owners to identify weed control priorities and raise awareness of the value of native riparian habitats
- Conduct periodic monitoring to detect new infestations and follow up with control treatments.

Limitations and suggestions for improving the method:

- Impenetrable vegetation (especially Himalayan blackberry) limits ability to detect weed infestations, increases time and expense to cover the survey area.
- Late season timing in 2012 probably limited ability to detect high quality habitat due to senescence of native herbs. Best time to survey is late May to early July. Surveys conducted earlier in the season in 2013 documented higher diversity and cover of native herbs in good quality habitat areas.
- Information from vegetation plots did not justify the time and effort needed to gather it.
- Describing and mapping habitat types, landform, slope, condition, etc. in 2012 was very time consuming and limited the amount of time that could be devoted to mapping weed populations and good quality habitats. An estimated time savings of 25-30% was gained by dropping this element in 2013.

Literature Cited

Dykaar BB, Wigington J. 2000. Floodplain formation and cottonwood colonization patterns on the Willamette River, Oregon, USA. *Environmental Management* 25: 87–104.

False Brome Working Group. 2003. Invasive Plant Alert: False Brome (*Brachypodium sylvaticum*). http://appliedeco.org/invasive-species-resources/FBWG/brsybrochure.pdf

Fierke MK, Kauffman JB. 2006. Riverscape-level patterns of riparian plant diversity along a successional gradient, Willamette river, Oregon. *Plant Ecology* 185: 85–95.

Oregon Department of Agriculture (ODA). 2012. Noxious Weed Policy and Classification System. http://www.oregon.gov/ODA/PLANT/WEEDS/docs/weed_policy.pdf

Von Kiparski GR, Lee LS, Gillespie AR. 2007. Occurrence and fate of the phytotoxin juglone in alley soils under black walnut trees. *Journal of Environmental Quality* 36: 709–717.

Weed Science Society of America (WSSA). 2013. Headlines: WSSA weed watch: 'shape-shifting' primrose plant plagues communities in coastal states. (http://wssa.net/2013/07/wssa-weed-watch-shape-shifting-primrose-plant-plagues-communities-in-coastal-states/