Yakama Nation's Wetlands and Riparian Restoration Project

Project Number 1992-06200

Fiscal Year 2015 Annual Report

Submitted to:
Bonneville Power Administration

Tom Elliott
Yakama Nation Wildlife Resources Management

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Cover photo: Restored area of the Toppenish Creek Floodplain, looking east from the South Lateral A wildlife area, October 2015.

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Introduction

This is the annual activities report for the Lower Yakima Valley Riparian and Wetland Restoration Project, project number 1992-06200. Under this project, the Yakama Nation Wildlife Program protects, restores, and managed land to mitigate for wildlife habitat losses incurred during construction and operation of the McNary, John Day, the Dalles, and Bonneville dams on the lower Columbia River. An important goal of the project is to protect and manage 27,000 acres of wildlife habitat in the Yakama Reservation. To date 21,500 acres have been protected.

This report conveys the highlights of budget year 2015, which ran from April 1st, 2015 to March 31st, 2016. For other activities and further details please consult the Pisces scope of work and status reports.

Land Securing Activities

In fiscal year 2015 the project's land protection continued with two new leases, one on Toppenish Creek and one on the Yakima River. The process for both of these leases was initiated with a farm plan and lease application. Although it may take the Bureau of Indian Affairs (BIA) some time to completely process the lease, control of the parcels now rests with the Yakama Wildlife Program and we will begin assessing the parcels immediately for restoration and management planning. Together these leases add 720 acres to the projects protected land base.

<u>Allotment 1967 and various (Old McCoy unit, 46.394646°, -120.267815°)</u>

This 360 acre lease was initiated in 2015 with funding from BPA, and the Yakama Nation Wildlife Program (YN Wildlife) assumed management control in spring 2016. This lease is adjacent to the existing Meninick Wildlife Area and extends the contiguous protected floodplain area. It occupies the Yakima River floodplain, and contains 260 acres of riparian forest, 48 acres of riparian wetland, 42 acres of active channel, and 16 acres of open water as mapped in a preliminary desktop assessment. In addition it protects 1.4 miles of Yakima River channel and 2.3 miles of river bank.

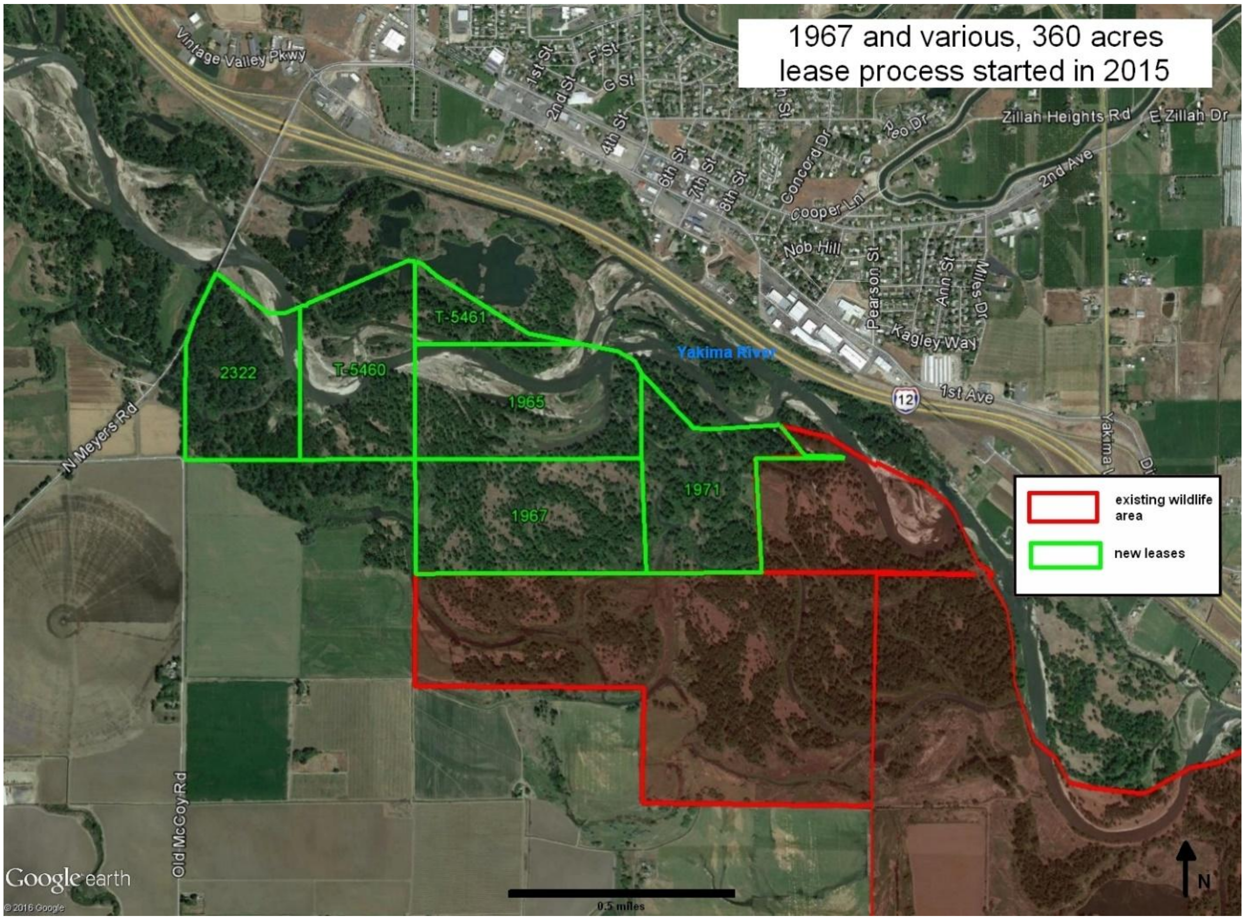


Figure 1. Allotment 1967 and various (Old McCoy lease).

Allotment T-2270 and various (West Island Road unit, 46.339323°, -120.615341°)

This 360 acre lease was initiated in 2015 with funding from BPA, and the Yakama Nation Wildlife Program (YN Wildlife) assumed management control in spring 2016. This lease is adjacent to the existing Island Road Wildlife Area and extends the contiguous protected habitat area to 2800 acres in that section of the Toppenish Creek floodplain. It contains primarily shrub-steppe and lowland grassland habitat (340 acres), along with 20 acres of wetlands according to preliminary habitat mapping.

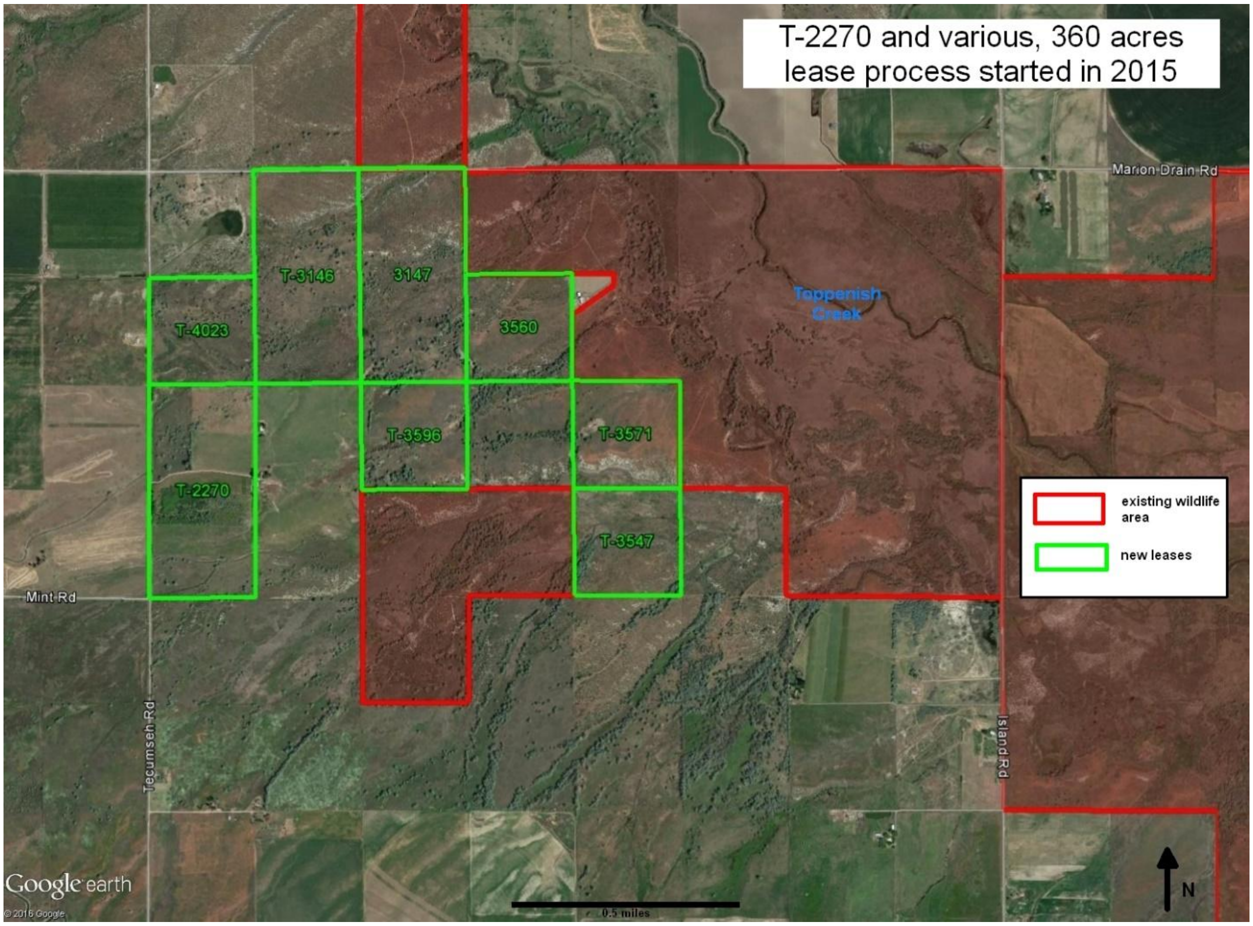


Figure 2. T-2270 and various on the Toppenish Creek floodplain.

Hydrological Restoration Activities

Circle Lake Spillway Repair

The north spillway at Circle Lake was damaged by floods in winter of 2014-2015. Using BPA funding, we repaired the spillway using rock from the Yakama Reservation as a cost-cutting measure. Work was accomplished by YN Wildlife staff while the engineering and design was contracted out.

Figure 3. Rebuilt spillway out of Circle Lake in December 2015, Satus Wildlife Area.

Planning for North Satus Drain Project

Planning activities began for the North Satus Drain wetland enhancement. The objective of the project is to re-route the North Satus Drain, an agricultural drain which currently discharges directly into steelhead bearing portions of Satus Creek, through wetlands in the Satus Wildlife Area. The project is expected to improve water quality in 3.3 miles of Satus Creek and enhance over 100 acres of wetlands. It will be funded using an NRCS grant. Construction is expected to begin in 2016 and be completed by fall of 2017.

Floodplain Vegetation Restoration Activities
Begin: Island Road, Blair Witch, Shattuck, and Grahams

The Yakama Nation Wildlife Program focuses on creating sustainable native habitat that provides a variety of wildlife, cultural and natural resource values. Terrestrial vegetation restoration occurs on an estimated 500-1,000 acres per year within the project area. Intensive restoration activities require approximately five years of higher labor and materials costs, followed by smaller maintenance costs needed to prevent re-infestation of noxious weeds.

Sites vary widely in their hydrology and vegetation. Properties also vary in their use history; some properties were homesteads, others were farmed and still others were grazed or used as stockyards. The broad steps involved are site preparation, weed control, revegetation with grasses, and reintroduction of forbs and shrubs. The methods used are selected to reduce initial construction costs as well as long-term maintenance costs.

Pre-planting weed control typically occurs for 1-3 years to control or suppress weed species required to allow native plant establishment. Native grasses adapted to particular site conditions are seeded using rangeland drills in the fall prior to rains. Genetically local seed sources of Basin wildrye (*Elymus cinereus*), bluebunch wheatgrass (*Pseudoregneria spicata*), and squirreltail (*Elymus elymoides*) are available; these species were collected from the Reservation and are propagated as a seed crop by a regional seed producer. Occasionally, funding is supplemented by NRCS grants such as the Wildlife Habitat Improvement Program or groups such as Pheasants Forever funding for purchase of native grass seed. Post-planting weed control generally is required for 1-2 years as slow-growing species native to the arid west become established. Upland native shrubs and forbs may be reintroduced after native grasses are established. Costs per acre are kept to a minimum by utilizing large-scale agricultural methods and rotating weed control techniques to reduce chemical herbicide use.

Site preparation

- removal of structures, debris and interior fences
- construction of interior or exterior fences to exclude trespass cattle
- removal of invasive trees that prevent restoration

Weed control

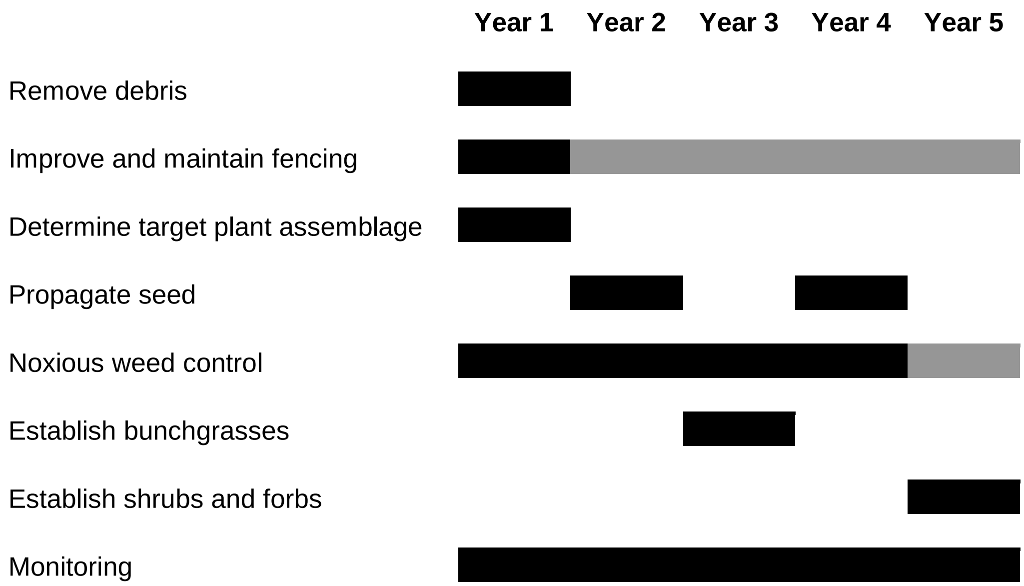
- weed control prior to revegetation
  1-3 years pre-treatment for perennial/difficult to control weeds
  1 year treatment for annual weeds
- weed control after revegetation
  1-3 years treatment during grass establishment to control broadleaf weeds.
- includes mowing, disking, broadcast spray of herbicides and hand spray of herbicides.

Revegetation

- native bunchgrasses are introduced after weeds are successfully suppressed
- native forbs and shrubs are introduced after grass establishment is successful
- grasses and shrubs grow very slowly in our region (6-9” average precipitation), especially with deeper water tables’

The table below illustrates the average timeline for floodplain terrace restoration projects:

Table 1. restoration timeline



Terrestrial vegetation restoration activities occurred on approximately 920 acres in the project area, which included site preparation (removal of internal fences and debris, improvement of property boundary fences, and site-specific weed control) and native plant revegetation (seeding and planting native bunchgrasses and shrubs).

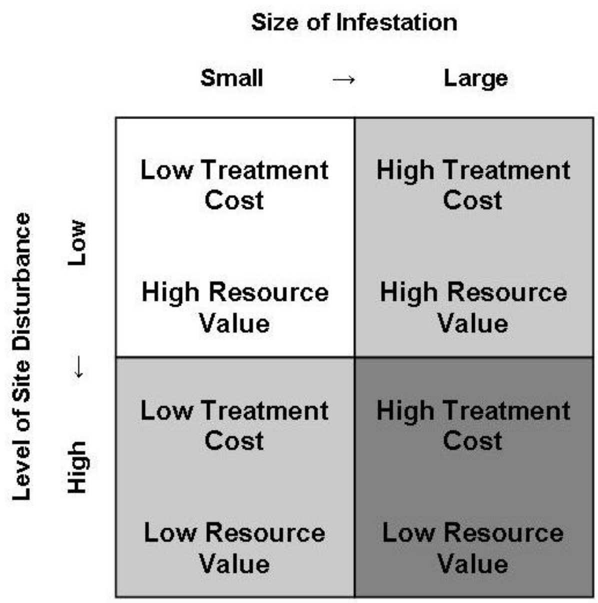
Table 2: sites under restoration with restoration phase and acreage

site	**restoration phase**	**acres**
Island Road	weed control	50
Island Road south	weed control	120
Grahams east	site prep/weed control	70
Grahams west	site prep/weed control	90
Grahams central	site prep/weed control	40
Shattuck	weed control	250
	total acres	**620**

Invasive Plant Species Control Activities

Noxious weeds are one of the primary threats to terrestrial habitats under this project, and thus weed management is a focal maintenance activity. General noxious weed control is one of the most cost-effective methods of protecting habitats from degradation. Weed management is a broad approach to protecting and restoring habitats for wildlife. In remote areas or relatively undisturbed areas, weed management includes treatment of noxious weed populations as they are located, or as they occur, and preventing weed populations from expanding into uninfested areas. Where habitats have high resource values, such as riparian corridors and wildlife movement corridors, but where the habitats are moderately to severely degraded, weed management is achieved through habitat restoration to native species that assist with long-term suppression of noxious weeds.

Our approach to prioritizing weed management is summarized by the chart below.



Treatment priorities

Sites and weed infestations are addressed by level of priority. High priority sites (*white box*) are the most cost-effective and highest habitat values. Moderate priority sites (*grey boxes*) are cost effective but resource values are still high. Low priority sites (*dark grey box*) have larger treatment costs, are already disturbed and impacted, and have low resource values.

Figure 4: Approach for prioritizing weed management.

Weed treatments are selected based on site conditions and weed species' biology. Weed management activities include the following actions.

<u>Mapping</u>
Weed mapping is a critical component of invasive species management. Target weeds are mapped on selected properties using GPS units. Data is recorded and analyzed in a Geographical Information System.

<u>Chemical treatment</u>
Herbicide treatments (used in accordance with BPA policies on herbicides and adjuvants) are generally highly effective and more cost-effective than mechanical or manual methods for many species. Weed suppression may require 1-5 years of treatment to eliminate weed infestations. Due to the location of floodplain and riparian habitats of the over 21,000 project acres within a larger agricultural setting, ongoing surveys and weed treatment of new infestations is required.

<u>Mechanical removal</u>
Mechanical removal has proved to be effective for the removal of mature Russian olive trees. This method entails using an excavator to pluck Russian olive trees in late summer and fall when presumably the trees are drought-stressed. The excavator is operated

extremely carefully so as to minimize ground disturbance. To date, resprouting of Russian olive has been minimal using this method.

<u>Habitat restoration</u>
Restoration includes reintroduction of native species that assist with suppression of noxious weed species. Restoration requires a higher short-term cost input than chemical treatment, but results in lower long-term maintenance costs. Restoration typically requires a minimum five-year investment to reach weed suppression. Restoration is addressed in detail under the heading “Vegetation Restoration for Weed Suppression”. Information about grazing management is reported in the Floodplain Vegetation Restoration Activities section of this report.

<u>Grazing management</u>
Grazing includes weed suppression using domestic livestock in areas where habitat restoration in the short-term is not feasible. For example, a property infested with noxious weeds that requires hydrologic restoration is a good candidate for grazing management. When hydrologic features are improved, resulting in higher water table, habitat restoration is feasible. In the interim, grazing management is a very cost-effective tool to prevent noxious weeds from expanding. Grazing management prescriptions are developed and local ranchers selected to implement prescriptions at no cost. Information about grazing management is reported in the Vegetation Management section of this report.

In 2015, project-wide invasive plant control took place across approximately 4,700 acres of managed properties. This included use of herbicide spray and mechanical removal of Russian olive. All herbicide spraying was approved and reported through the BPA herbicide reporting process. The following species were targeted for control over their respective acres. Species treatment areas overlap so the acres do not sum to the total acres treated. These control activities are separate and distinct from weed control on sites that are under active restoration.

Table 3. Invasive species targeted for control in non-restoration areas

species	**acres**
Russian olive (*Elaeagnus angustifolia*)	3,800
Scotch thistle (*Onopordum acanthium*)	1,100
poison hemlock (*Conium maculatum*)	1,100
goatheads (*Tribulus terrestris*).	10

Vegetation Management Activities
In order to maintain habitat values, ongoing management of native vegetation communities is needed. This is necessary and important because of altered ecological processes, including disturbance regimes, relative to pre-European conditions. For example, freshwater wetlands most likely experience less disturbance in the form of fire and trampling by large ungulates than in historical times; therefore management activities such as managed burns, mowing, controlled grazing, and tilling must be used to maintain desired habitat conditions. The tables below show the objective for each type of management actions, and units and acres with respect to each type of management action.

Table 4. Objectives for each management action

action	habitat type	objective
Burning	wetlands	remove biomass, accelerate nutrient cycling, increase vegetation diversity
	uplands	remove biomass, accelerate nutrient cycling, rejuvenate dominant grasses
Mowing	wetlands	reduce cover of dominants, remove biomass (when hay is baled), increase vegetation diversity
Managed grazing	Reed canary (*Phalaris arundinaceae*)grass dominated wetlands	increase open water habitat by reducing vegetation height and density
Managed grazing	uplands	suppress invasive species
Tilling	wetlands	increase open water habitat, decrease cover of dominant monocots, increase vegetation diversity

Table 5. Vegetation Management Activities by management unit and acres

activity	management unit	acres	note
burning (follow up)	Satus Wildlife	18	follow up from 2014 burn
	South Lateral A	28	
burning (initial burn)	North White Swan	15	
burning (Russian Olive piles)	Island Road	1	burn piles of pulled Russian Olive trees
	total acres burned	**62**	
mowing	Carl Property	65	
	South Lateral A	115	
	Satus Wildlife Area	410	
	Campbell Road	140	
	Old Goldendale	70	
	Island Road	30	
	total acres mowed	**830**	
managed grazing	Island Road	875	
	Olney Flat Drain	115	
	Campbell Road	130	
	Satus Wildlife Area	1660	
	Carl Property	70	
	Yost Road	155	
	total acres grazed	**3005**	
tilling	South Lateral A	9	

Cost Share

Each year staff of the Yakama Nation Wildlife program actively seek grants to complement BPA funding and to accelerate the pace of hydrological and vegetation restoration. In 2015-2016 we were successful in being awarded grants from the Yakima Basin Integrated Plan and from the Natural Resources Conservation Service. These totaled $1,250,000 and included:

$600,000 from the Yakima Integrated Plan for aquifer recharge on the Toppenish Creek Fan. The project, which was implemented by the Yakama Nation Department of Natural Resources, is situated in the footprint of the Lower Yakima Valley Riparian and Wetlands Restoration Project and will increase water supply for riparian and wetland habitat on the Toppenish Creek fan, as well as provide increased groundwater levels throughout the Toppenish Creek fan.

$650,000 from the RCPP for wetlands enhancement on the Satus North Drain and floodplain restoration on lower Satus Creek. This project will re-route the Satus North Drain into the Satus Wildlife Area with benefits for wetlands and for steelhead habitat in Satus Creek.

Wildlife Surveys

The Yakama Nation Wildlife Resource Management Program (YNWRMP) conducts wildlife surveys in the valley portion of the Yakama Reservation. These surveys provide an index to wildlife populations. They also provide information on wildlife responses to our restoration efforts. Although most surveys are conducted through the whole valley, wildlife trends on or near properties managed by the YNWRMP show a positive trend in wildlife numbers.

Waterfowl Breeding Pair Counts

We conduct waterfowl breeding pair annually during the second week of May. These counts are conducted at 14 different sites. These counts allow us to monitor duck responses to our restoration efforts and make proper management decisions. Results from these counts indicate that the total number of breeding pairs of dabbling ducks has increased since 1955 (Figure 6). This increase has been evident in teal (Figure 2) and Gadwall (Figure 3). Wood Ducks (Figure 1) and Mallard (Figure 5) numbers have remained relatively constant.

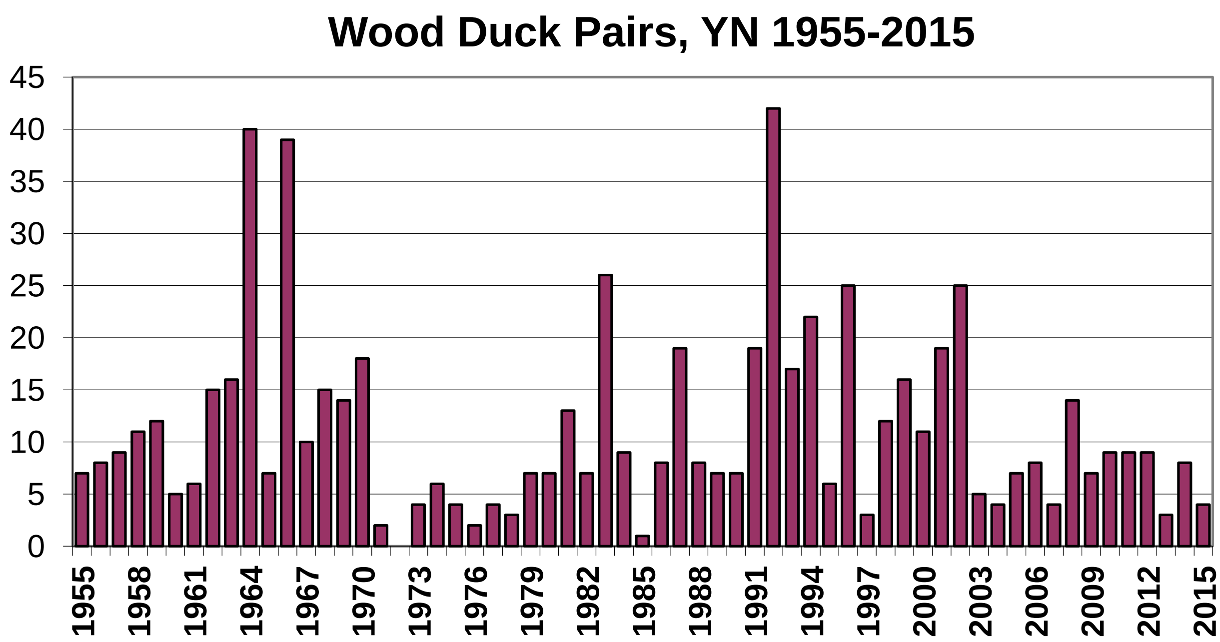


Figure 5: Number of breeding pairs of Wood Duck observed during counts conducted from 1955-2015 on the Yakama Reservation.

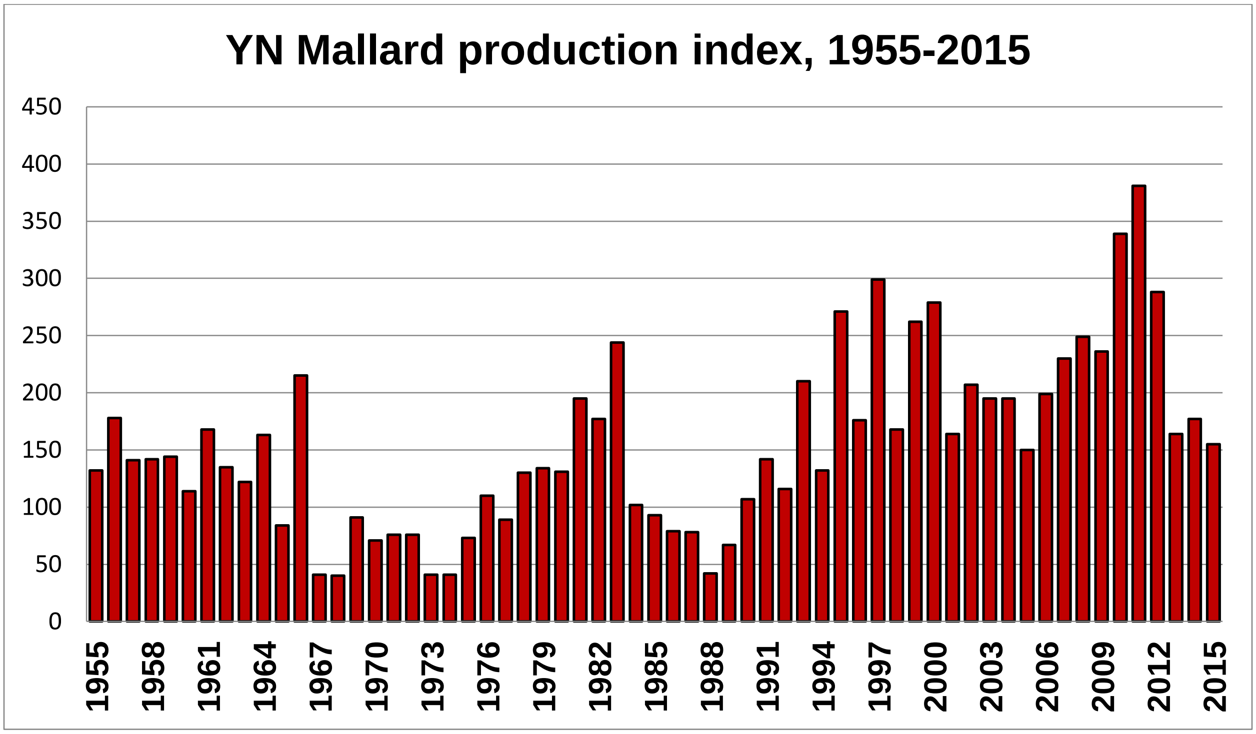


Figure 6. Number of breeding pairs of Mallards observed during counts conducted from 1955-2015 on the Yakama Reservation

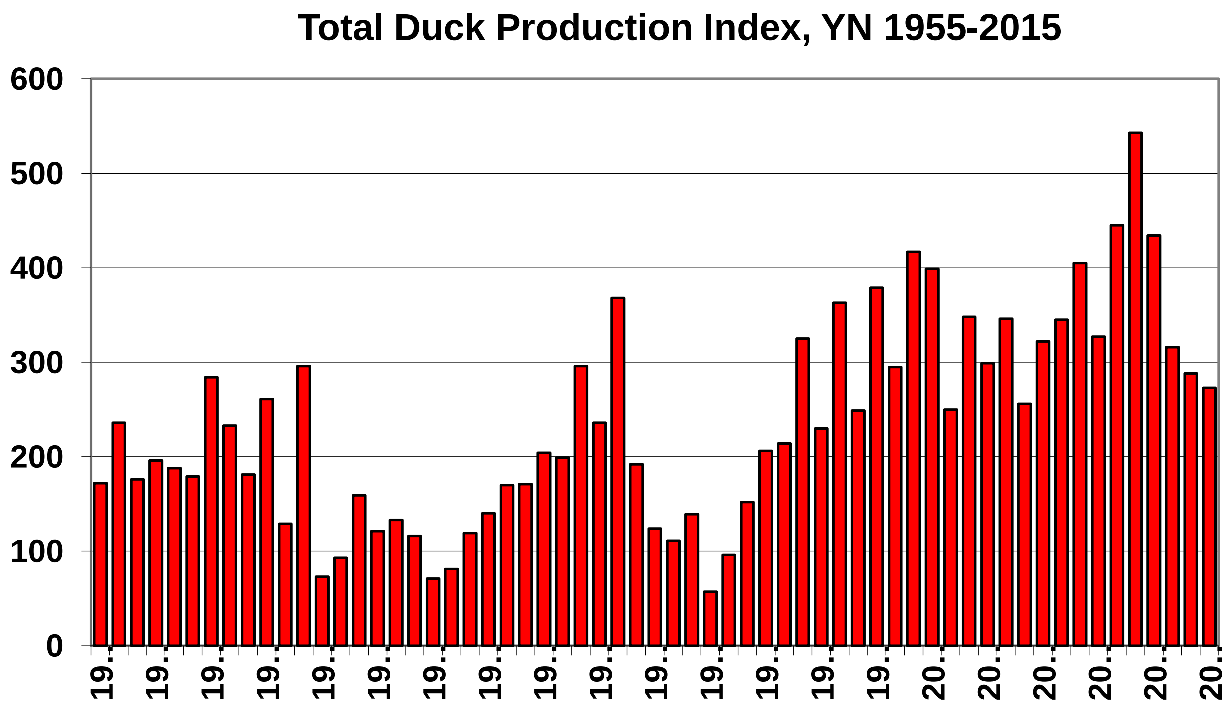


Figure 7. Number of breeding pairs of dabbling ducks observed during counts conducted from 1955-2008 on the Yakama Reservation

<u>Upland Game Bird Brood Counts</u>

During the last 2 weeks of July and the first week of August, we conduct annual counts of ring-necked pheasant, and California quail broods to index population levels. These counts are done on 4 standardized routes once a week. Quail counts indicate that populations dropped from the highs of the previous years; however the population estimate is still higher than the 1990's (Figure 9). The number of doves seen per mile also dropped from the previous year but still numbers are relatively high (Figure 10). The number of pheasants seen per mile have remained relatively stable (Figure 11). Pheasant population estimates have been declining since we began monitoring the populations. Reasons for the decline are unclear however changes in agricultural practices may have detrimental impacts on pheasant populations.

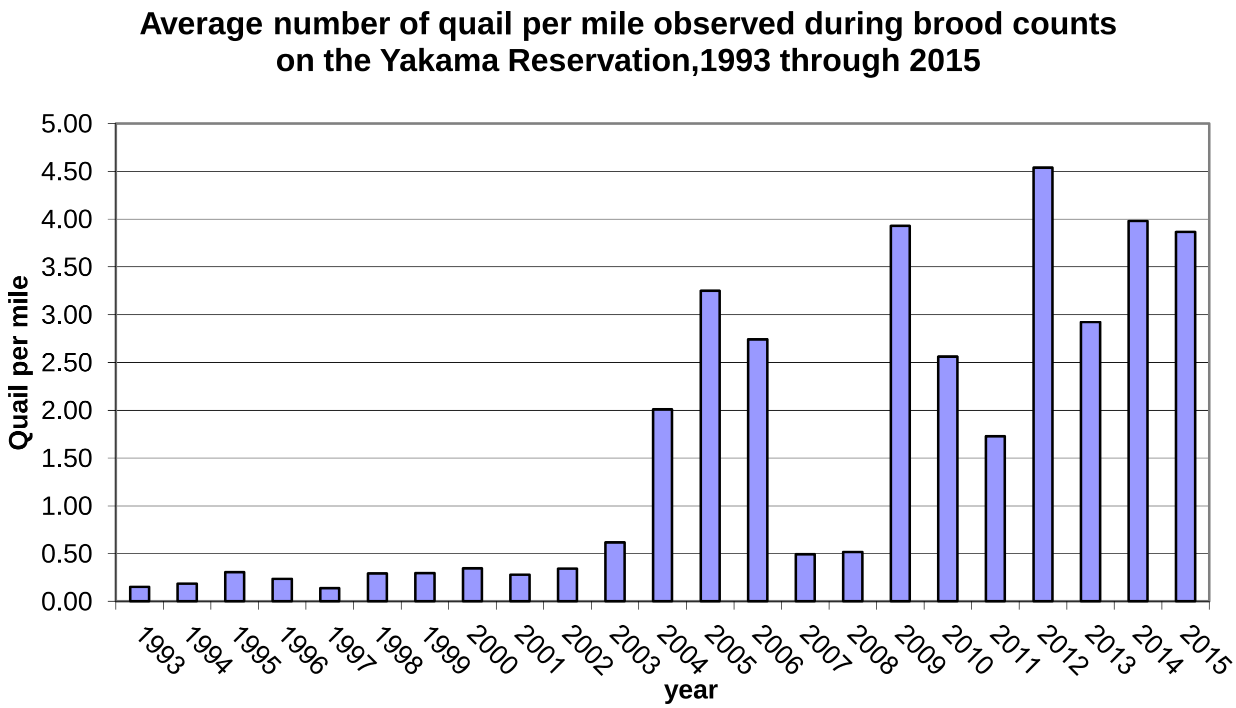


Figure 8. Average number of California Quail seen per mile on the Yakama Reservation in Washington from 1993 through 2008.

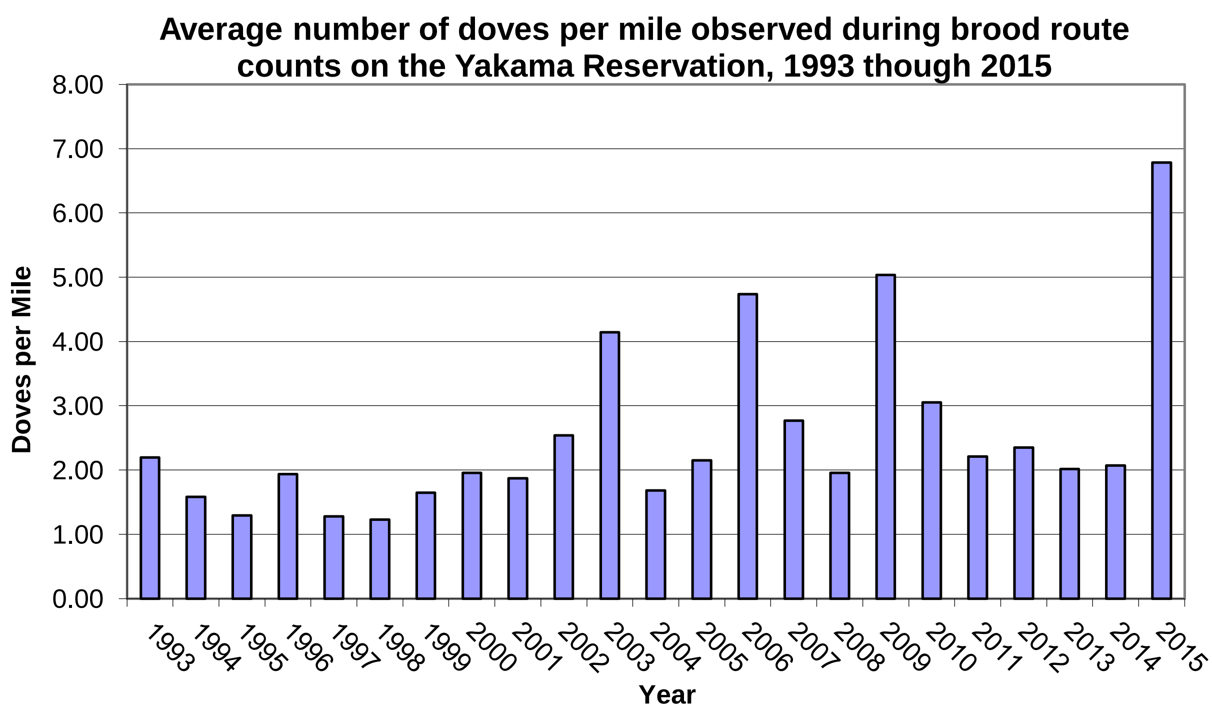


Figure 9. Average number of mourning doves seen per mile on the Yakama Reservation in Washington from 1993 through 2008.

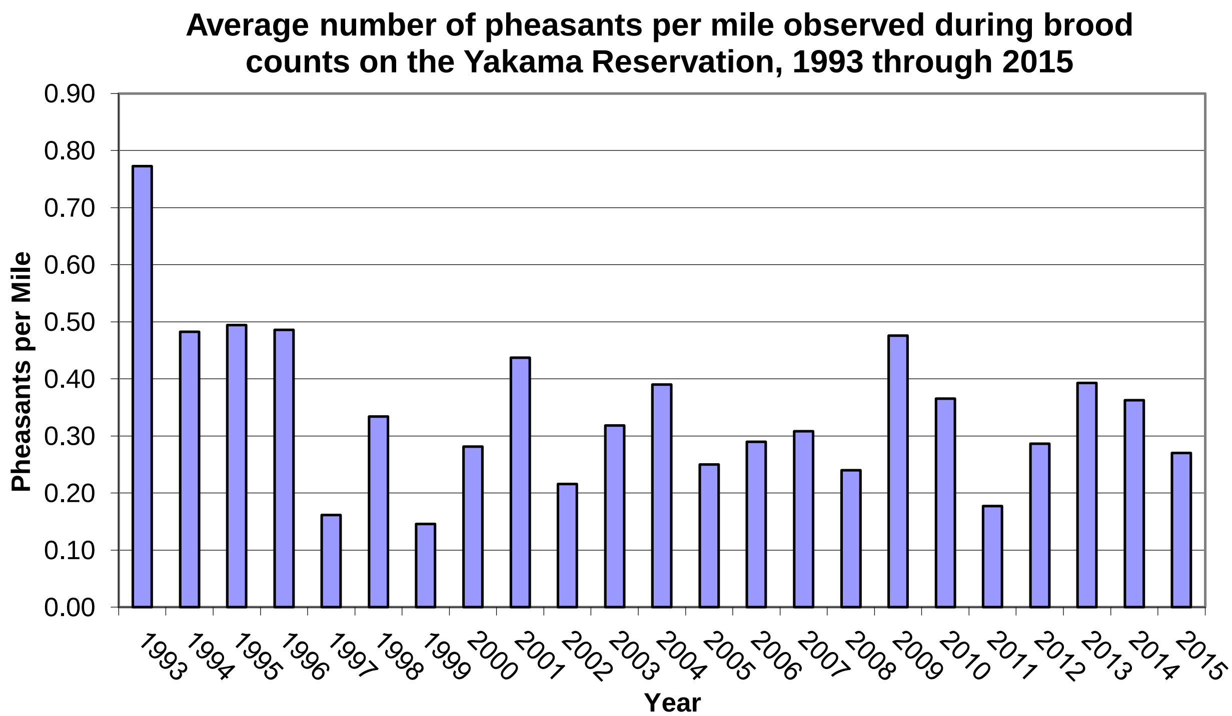


Figure10. Average number of pheasants seen per mile on the Yakama Reservation in Washington from 1993 through 2008.

Vegetation Monitoring

See Appendix A.

Appendix A. Vegetation Monitoring Report

Monitoring of Yakama Nation Riparian Restoration Sites
Phase 7
Final Report Summary (Draft)
April 2016

Anthony Gabriel, David Cordner, and Luke Stilwater
Geo-Ecology Research Group, Center for Spatial Information
Central Washington University, Ellensburg, WA

Introduction

Monitoring the successes and failures of riparian restoration techniques is rarely conducted even though millions of dollars are spent annually on these activities (Bernhardt et al. 2005). The overall goal of this project is to provide the Yakama Nation with the tools necessary to better make these management decisions. Crucial to the development of effective riparian and wetland restoration projects is an inventory and assessment of critical physical processes, biological features, and land use alterations. However, conservation planners are often overwhelmed by the sheer mass of information available, confounded by the inconsistent formats and spatial scales of the data, and uncertain of the appropriate analytical approaches to employ.

This year's project addressed three related objectives, including:

1) conducting baseline characterizations of the plant communities found at the Pumphouse/Island Road Restoration Project west and east units, using a combination of remotely sensed imagery and field assessment;

2) continuing GIS analysis of the distribution of riparian vegetation species and communities on four Yakama Nation Wetlands and Riparian Restoration Project properties along Toppenish Creek, including the Pumphouse/Island Road, Xapnish, Campbell Road, and Old Goldendale properties, based on a comparison of previously collected and classified field data, LiDAR imagery, and digital datasets of surface hydrology and depth-to-groundwater.

3) further exploring the feasibility of conducting a systematic survey of stream channel cross-sections along sections of the lower Toppenish Creek corridor, using a HiPer Lite + RTK survey grade GPS mapping unit.

Objective 1: Ecological Characterization of the Pumphouse/Island Road Restoration Project.

In 2010-11, a systematic field vegetation survey was conducted to identify and quantify the spatial extent of the types and kinds of emergent vegetation found at the Yakama Nation Wetlands and Riparian Restoration Project's Pumphouse/Island Road restoration site (Fig. 1). Over two years, 830 polygons were mapped, encompassing 22 species, 42 plant communities, and over 1.4 million m^2. A digital GIS vegetation database of field data and associated maps was developed using ArcMap GIS software. In addition, upon completion of the vegetation survey, descriptions of dominant plant communities were written to highlight their major characteristics, including species associations between dominant plant species. The goal of the initial study was to use remotely sensed imagery to characterize the emergent vegetation on the Pumphouse/Island Road restoration site, thereby developing baseline information to monitor the changes in vegetation that are expected to occur due to a series of hydrologic restructuring projects and reconnections to Toppenish Creek.

One of the objectives of this year's study was to begin characterizing the emergent wetland vegetation on both the west and east units of the Pumphouse/Island Road Restoration Project units, thereby providing baseline information to identify the changes in vegetation that occurred on the west unit since the last set of surveys, as well as baseline information for the east unit to assess future changes due to ongoing vegetation management practices and hydrologic reconnections. Beginning June 2015, the study encompassed the emergent wetland vegetative communities covering the riparian portion of the 1836 acre restoration site, which is located in the Toppenish Creek riparian corridor (Fig. 2).

Based on previously developed methods (Gabriel and Sainsbury, 2009, Hu et al., 2000), this study addressed the following objectives:

1) identified plant communities and habitats, including their location, general attributes and their spatial relationships to each other;
2) developed digital vegetation databases showing the spatial distribution of the plant communities as well as their characteristics; and
3) conducted Geographic Information System (GIS) spatial analysis for assessing habitat characteristics.

Remote sensing technologies have many applications in wetland vegetation analysis (e.g. Cowardin and Meyers, 1974; Hodgson et al., 1987; Jensen et al., 1991; Mead and Gammon, 1981; Ossinger, et al., 1993; Scarpace et al., 1981; Stewart et al., 1980; Welch, et al., 1995). With remotely sensed data such as aerial photographs as input of a geographic information system (GIS), the vegetation and habitat can be located and characterized as to type (Hu et al, 2000). A GIS vegetation database derived through the interpretation of large scale aerial photographs to date can provide current inventory of vegetation on the ground.

The timely development of an accurate, detailed vegetation GIS database requires the use of remotely sensed data of sufficient resolution to identify and delineate vegetation classes to an accuracy of approximately 90 percent or better on 10 m by 10 m plots. The primary sources for the development of the GIS vegetation database were low-altitude digital orthorectified 2013 National Agriculture Imagery Program aerial photographs. The use of these low-altitude aerial photographs of less than1 m resolution was essential for this project. Vegetation classes were delineated manually on screen using ArcMap GIS software, creating polygons where boundaries between vegetation patches, potentially representing different plant communities, determined based on differences in color.

A systematic field vegetation survey was conducted to identify and quantify the spatial extent of the types and kinds of emergent wetland vegetation found at the Pumphouse/Island Road restoration site. This was done by field surveying and ground truthing individual polygons identified through the initial aerial photo interpretation, including the identification of dominant plant communities and associated plant species. The field survey was conducted using a Trimble Juno SB GPS datalogger displaying the delineated vegetation polygons and 2013 aerial photography, thereby expediting data collection and verification in the field by allowing field researchers to know exactly which vegetation polygon they were field checking. The Juno GPS unit also allowed the use of ArcPad 8.0 software to annotate vegetation polygons in the field, assigning attribute information (i.e., proportions of dominant plant communities and associate plant species) for each vegetation polygon. Coverage of individual species within a polygon were visually estimated using 5% increments, with lower coverages recorded as 1-2%

A total of 366 polygons were mapped, encompassing 54 species, 61 community types, and over 3.0 million m^2 (Figs. 3-4; Table 1). As a proportion of the area surveyed, native plant communities are dominated by greasewood (*Sarcobatus baileyi)* (12.1%), tule *(Shoenoplectus acutus)* (7.4%), and basin wild rye *(Leymus cinereus)* (3.0%), while invasive and exotic communities are dominated by Russian olive *(Elaeagnus angustifolia)* (8.1%), perennial pepperweed *(Lepidium latifolium)* (7.0%), and cheat grass (*Bromus tectorum*) (4.4%). Approximately 22% of the site was also classified as mixed, with no dominant species identified. In addition, descriptions of 30 dominant plant communities (based on species with coverages of 35% or more in a polygon) were written to highlight their major characteristics, including species associations between dominant plant species (see appendix). These descriptions can be combined with representative digital ground photographs of each plant community type included in the GIS database.

A digital GIS vegetation database of field data collected as well as associated maps were developed using ArcMap GIS software (see Fig. 5 for example). Hyperlinked photos of each community may be viewed in ArcGIS 10.0 using HTML popup dialogs (Fig. 6). With this feature, both data and photos are viewable in a window with a 'spatial' callout to the hyperlinked feature. Both the photomonitoring points and the field-truthed vegetation polygon layers are set up for using the HTML popup dialog. The data set created by this study provides a baseline to monitor the future changes in emergent wetland vegetation as a result of hydrologic reconnection as well as target further management activities at the Old Goldendale riparian restoration site.

As a percentage of the area surveyed in both time periods, relative proportions of several dominant plant communities have changed since 2010-11, while species (+17) and community diversity (+6) have also increased. Of the 22 communities present during both sampling periods, the greatest decreases have occurred in those dominated by perennial pepperweed (-95%), greasewood and either basin wild rye or perennial pepperwood (-73.0 to -85.9%), and Russian olive/perennial pepperweed (-86.7%)(Table 2). The greatest increases have occurred in the mixed (+833.9.0%), perennial pepperweed/salt grass *(Distichlis spicata)*(+533.2%), and thick-spike wheatgrass *(Elymus lanceolatus)* or thick spike wheatgrass/perennial pepperweed communities (+472.5 to +638.1%). Two other communities dominated by non-native invasive species have increased as well, including Russian olive (+18.4%) and reed canarygrass *(Phalaris arundinacea)*(+14.5%). Results are mixed for other communities dominated by species commonly found in wetlands or riparian zones, including decreases in willow (-81.3%) broad-leaved cattail (-65.8%), broad-leaved cattail/tule (-45.0), and soft rush *(Juncus effusus)*/three square (*Scirpus americanus*) communities (-78.9%), while both tule and soft rush communities increased (+15.0 to +80.7%).

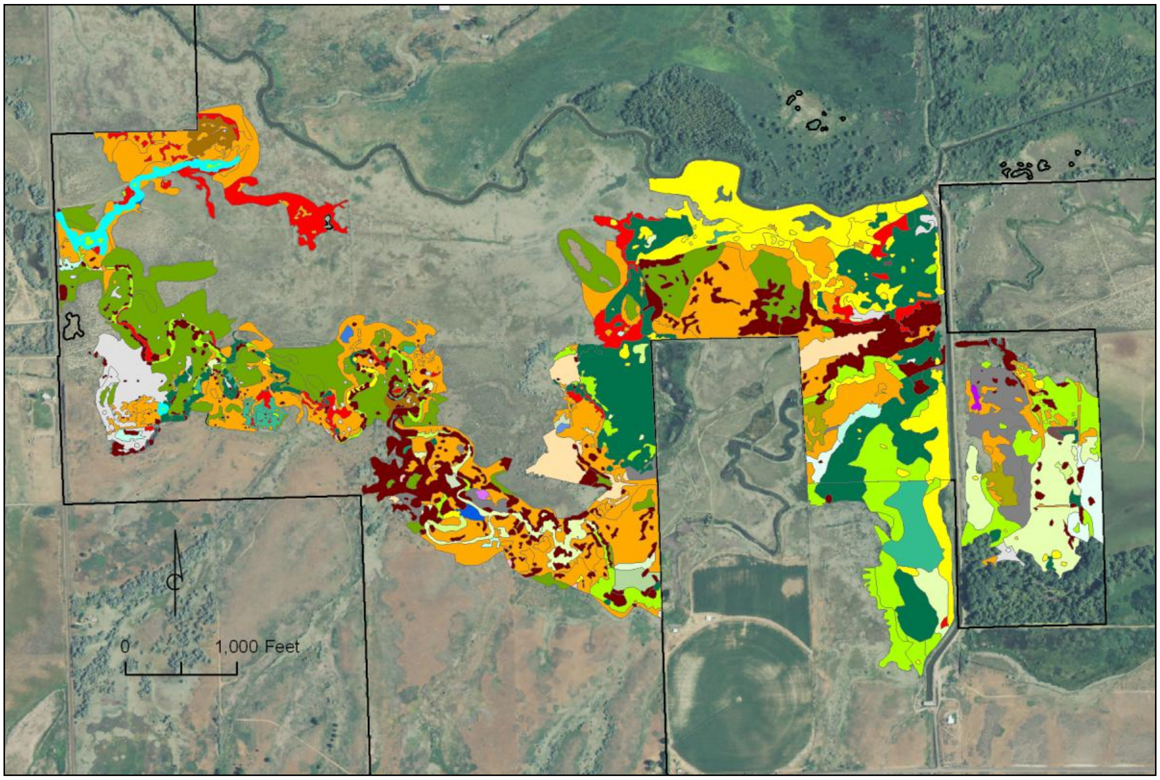


Fig. 1. Pumphouse/Island Road riparian restoration site (east unit) vegetation community map, Summer, 2010-11.

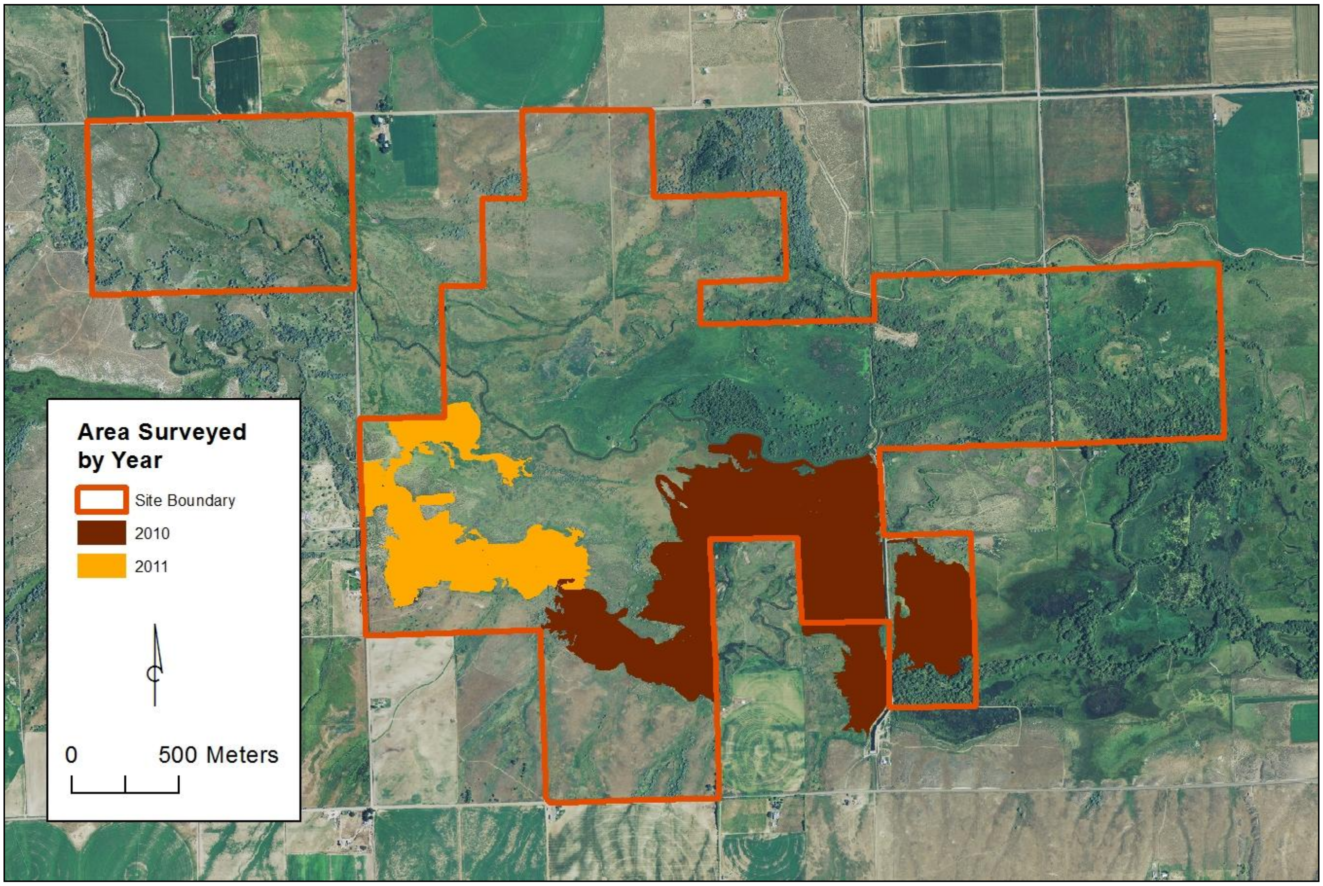


Fig. 2. Pumphouse/Island Road riparian restoration site, west and east units.

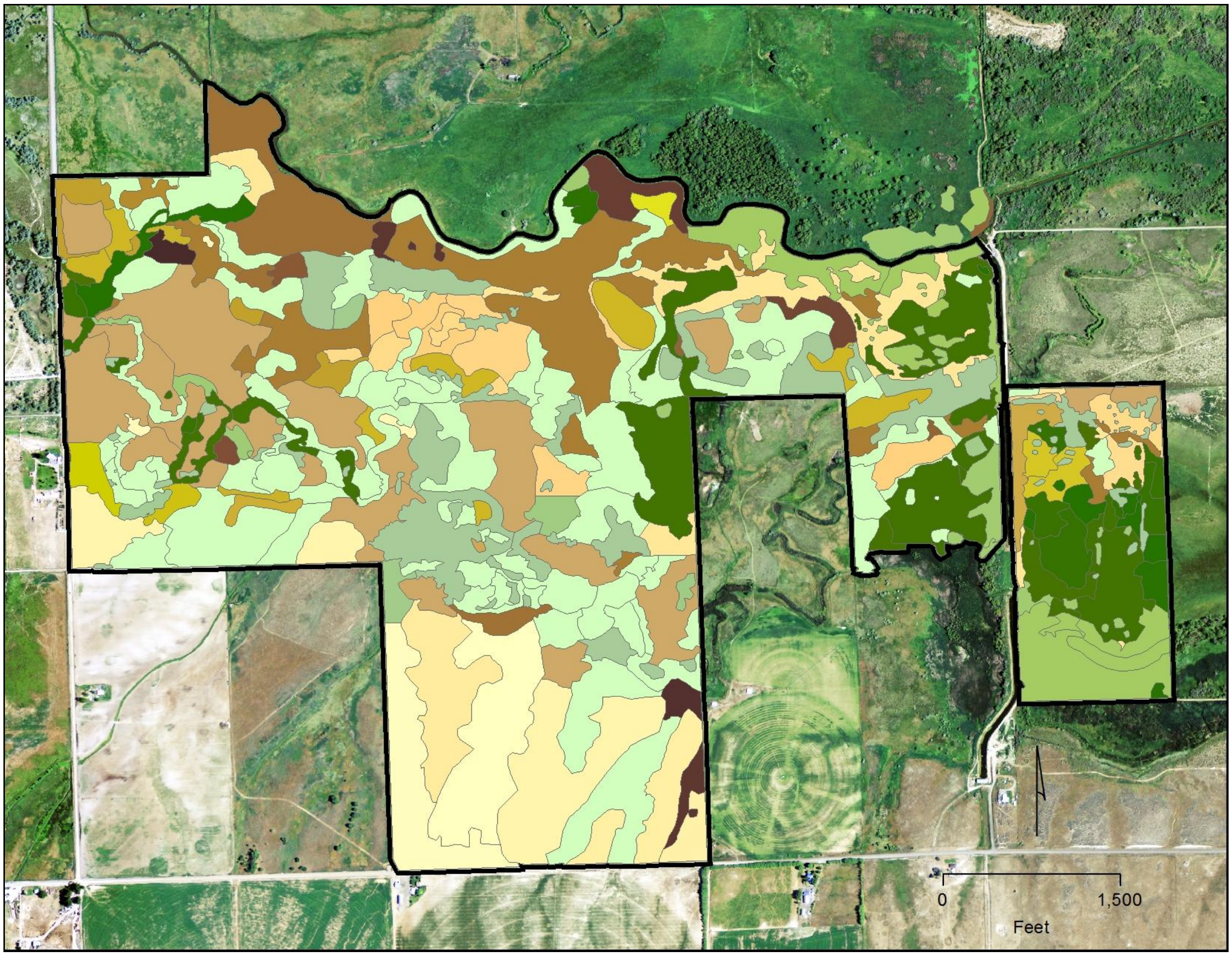


Fig. 3. Vegetation communities identified on the Pumphouse/Island Road Riparian Restoration Project, 2015 (see detailed legend, Fig. 4).

Fig. 4. Legend for map of vegetation communities identified on the Pumphouse/Island Road Property Riparian Restoration Project, 2015 (see Fig.3)

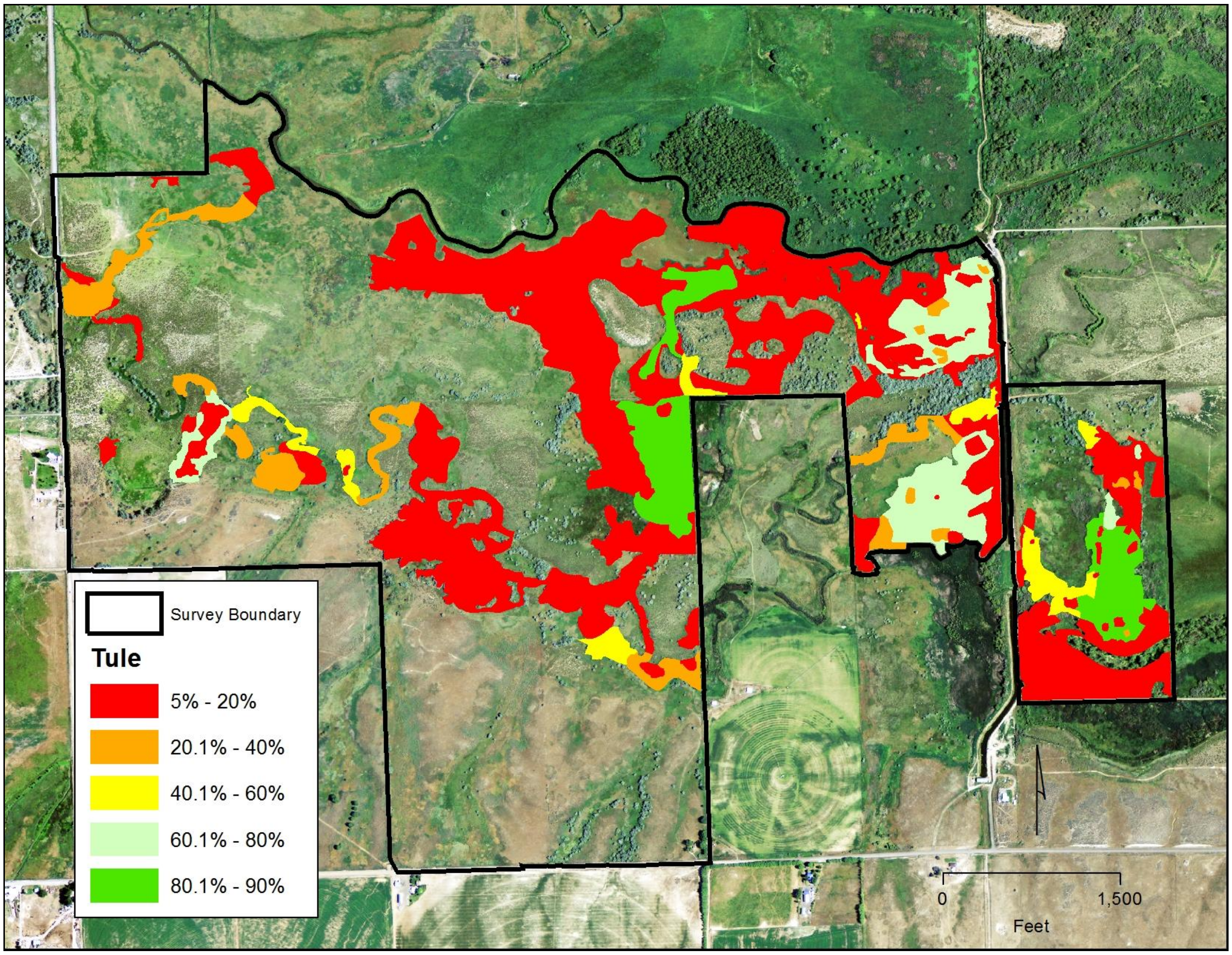


Fig. 5. Example of vegetation maps for Pumphouse/Island Road Property Riparian Restoration Project that can be created using the GIS database.

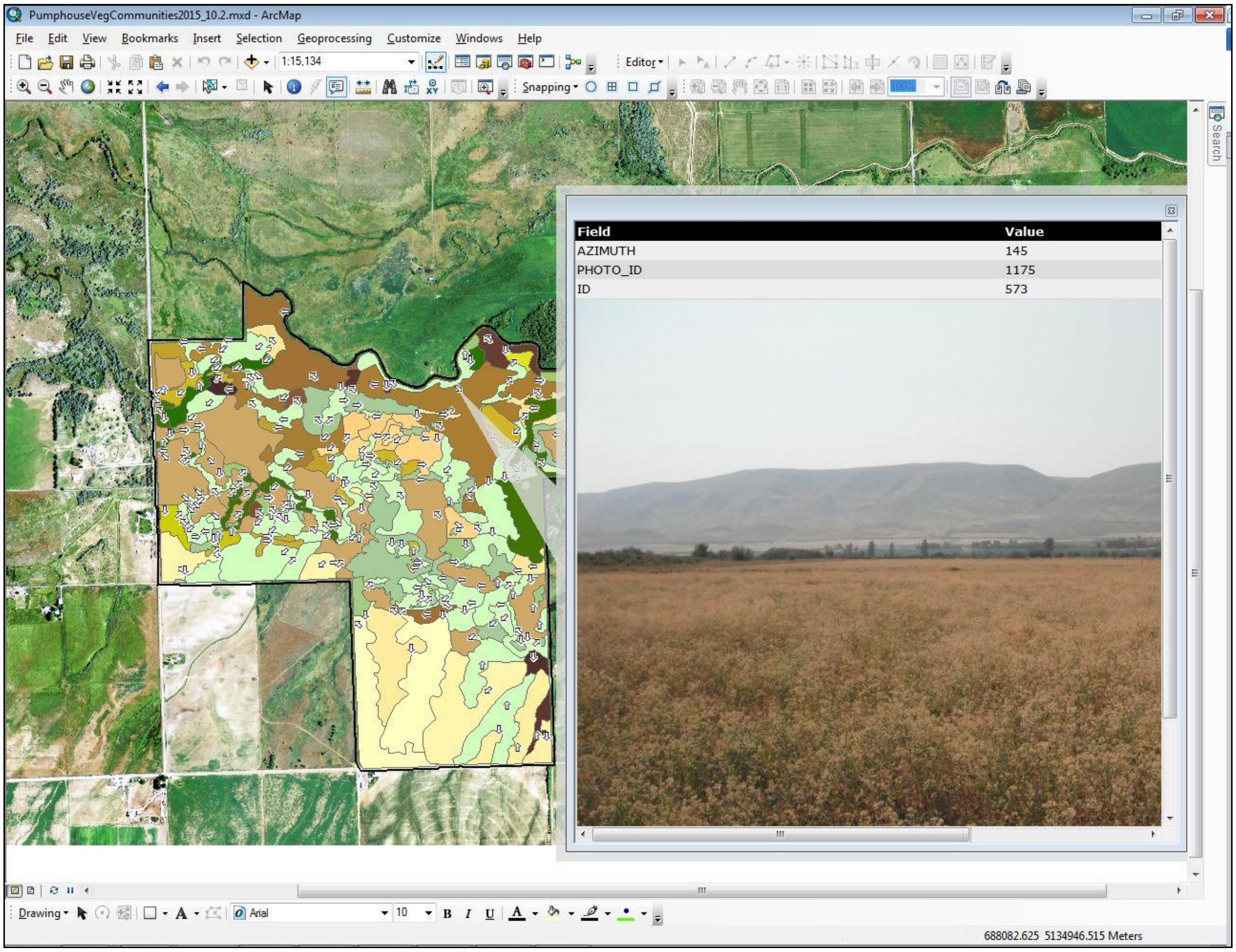


Fig. 6. Example of HTML popup window when viewing photomonitoring points in ArcGis 10.1.

Objective 2: Geospatial Analysis of Riparian Vegetation Species

The second objective of this year's study was to continue a GIS-based analysis of the distribution of riparian vegetation communities on four Yakama Nation Wetlands and Riparian Restoration Project properties along Toppenish Creek, including the Pumphouse/Island Road, Xapnish, Campbell Road and Old Goldendale properties (Fig. 7). From 2008-2014, the riparian vegetation communities were assessed on these properties, using the methods noted above in Objective #1. During a six year period, a total of 2064 polygons were mapped, encompassing 22-52 species, 42-52 community types, and over 6.4 million m^2 at the four sites. Coverage of individual species within each community polygon were visually estimated using 5% increments, with lower coverages recorded as 1-2%. Last year, the vegetation community types at the four sites, including changes at the Old Goldendale site between 2008 and 2014, were spatially analyzed relative to elevation, surface hydrology, and depth-to-groundwater, using LiDAR imagery and other geospatial datasets.

This year, the distribution of the previously collected and classified vegetation species data (based on proportions of select species) were spatially analyzed for specific species relative to elevation, Euclidean distances to Toppenish Creek, and depth-to-groundwater, using LiDar imagery and other geospatial datasets and the methods developed in last year's contract. (Analysis was not conducted relative to soils due to a very small number of soil types which were primarily differentiated on the basis of slope differences that did not correspond to LiDAR data downloaded from the Puget Sound LiDAR Consortium.) The analysis focused on vegetation species of management concern, chosen in consultation with Yakama Nation Wildlife staff (e.g. tule, wapato, broad-leaved cattail, sedges, reedcanary grass, and yellow flag iris). In addition, using field data collected this year, changes in vegetation communities at the Pumphouse/Island Road site between 2010-11 and 2015 were similarly analyzed relative to elevation, surface hydrology, and depth-to-groundwater. These additional analyses also used depth-to-groundwater data recently collected and processed for the Pumphouse/Island Road property.

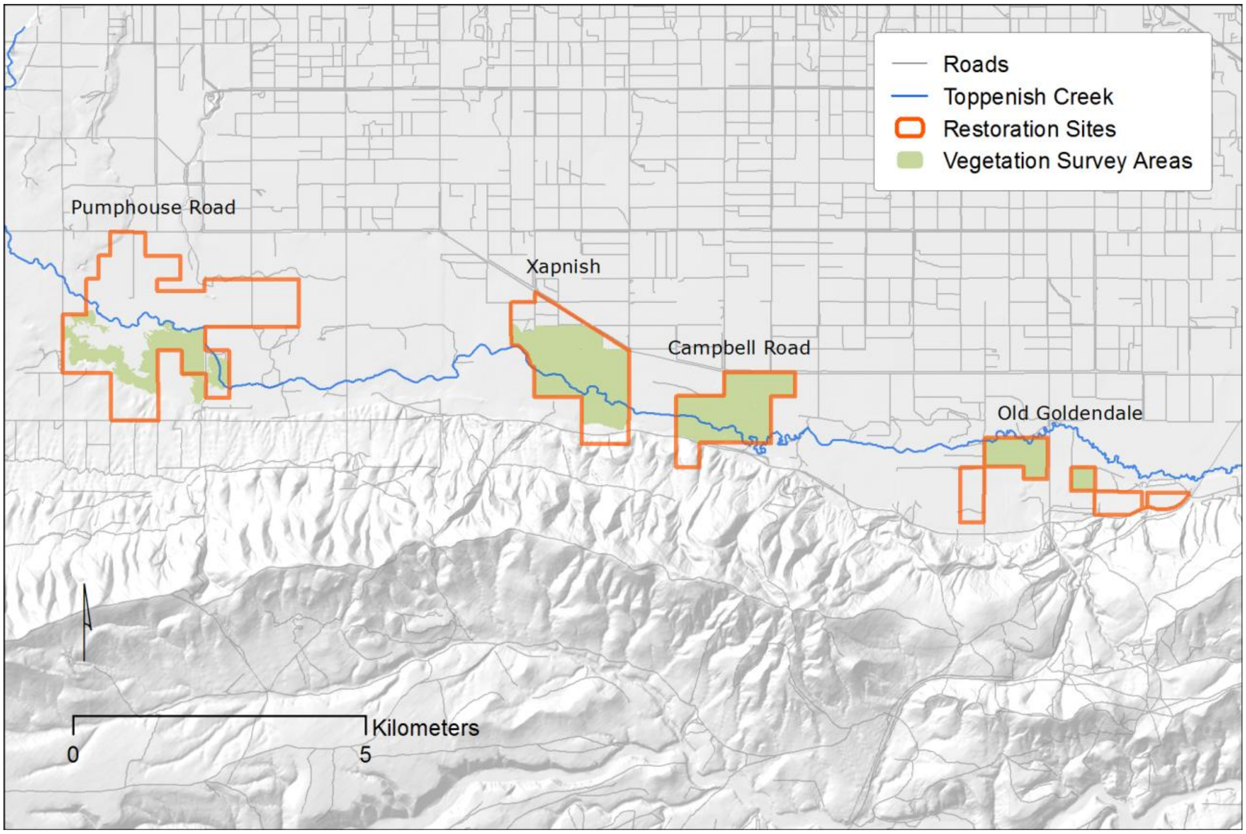


Fig. 7. The four riparian restoration study sites located along the Toppenish Creek.

Methods

Average Elevation

LiDAR elevation data was downloaded from the Puget Sound LiDAR Consortium and transposed into 10 x 10 foot cells (Fig. 8). Elevation models derived from Lidar data were used to calculate the mean, minimum, and maximum elevation of each vegetation community as well as selected species of interest, as a proxy for depth to groundwater. The elevations were adjusted to remove the downward sloping trend and values were normalized in relation to the mean elevation of Toppenish Creek at each individual restoration site. The trend in the elevation data was removed using the Trend Tool in ArcGIS. Ten meter gridded point datasets were derived from the Lidar elevation models for each site. These points were used to interpolate a trend surface using the Trend Tool. Using Raster Calculator, the trend surface elevation values were subtracted from the Lidar elevation data to create a new elevation model.

The elevation models were normalized to the mean elevation of Toppenish Creek at each site using the elevation model that had the trend removed. The mean elevation of all raster cells that intersected Toppenish Creek was used to recalculate the elevation values. A digitized creek polyline was buffered by 1.5 meter to create a 3 meter wide polygon feature class used to calculate the mean elevation of the creek. The elevation model values were recalculated by subtracting the mean elevation of the creek from each raster cell value resulting in elevation models for each site that are zeroed to the creek elevation.

The mean, minimum, and maximum elevations for each vegetation community and species of interest were calculated from the normalized elevation model using the Zonal Statistics Tool. The statistics were derived from the raster cells that intersected the polygons representing each vegetation type.

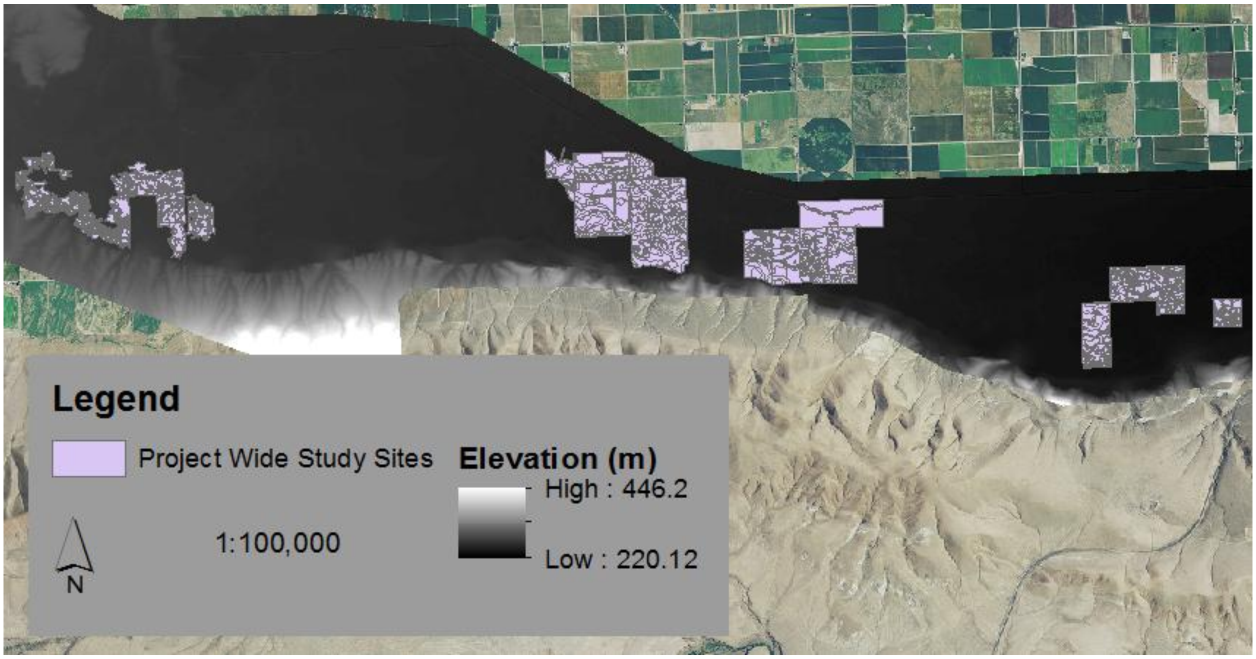


Fig. 8. Elevation based on LiDAR from the Puget Sound Lidar Consortium and all four study sites that comprise the project wide study area.

Average Distance to Stream

A Euclidean distance raster layer was created measuring continuous distances from the stream, which was used to calculate zonal statistics for each vegetation community and proportions of select species. A zonal statistics analysis was performed on the vegetation classes to summarize the minimum, maximum, and the average distance of each community and species type to the stream. This process was repeated for each study site and the entire project area.

Average Depth to Ground Water

Depth to groundwater was analyzed for the Xapnish, Campbell Road, and Pumphouse/Island Road sites due to a limited amount of data. Groundwater depths have been collected by Yakama Nation for these three sites, , representing spring and late summer groundwater levels. This data was combined with elevations based on LiDAR from the Puget Sound LiDAR Consortium to calculate depth to groundwater (Fig. 9).

The zonal statistics tool was run for each site and the interpolated groundwater depth for both seasons. Output tables were edited to display the minimum, maximum and mean depths to groundwater for each vegetation community and proportions of selected species. Values are all based on LiDAR data, and converted to meters.

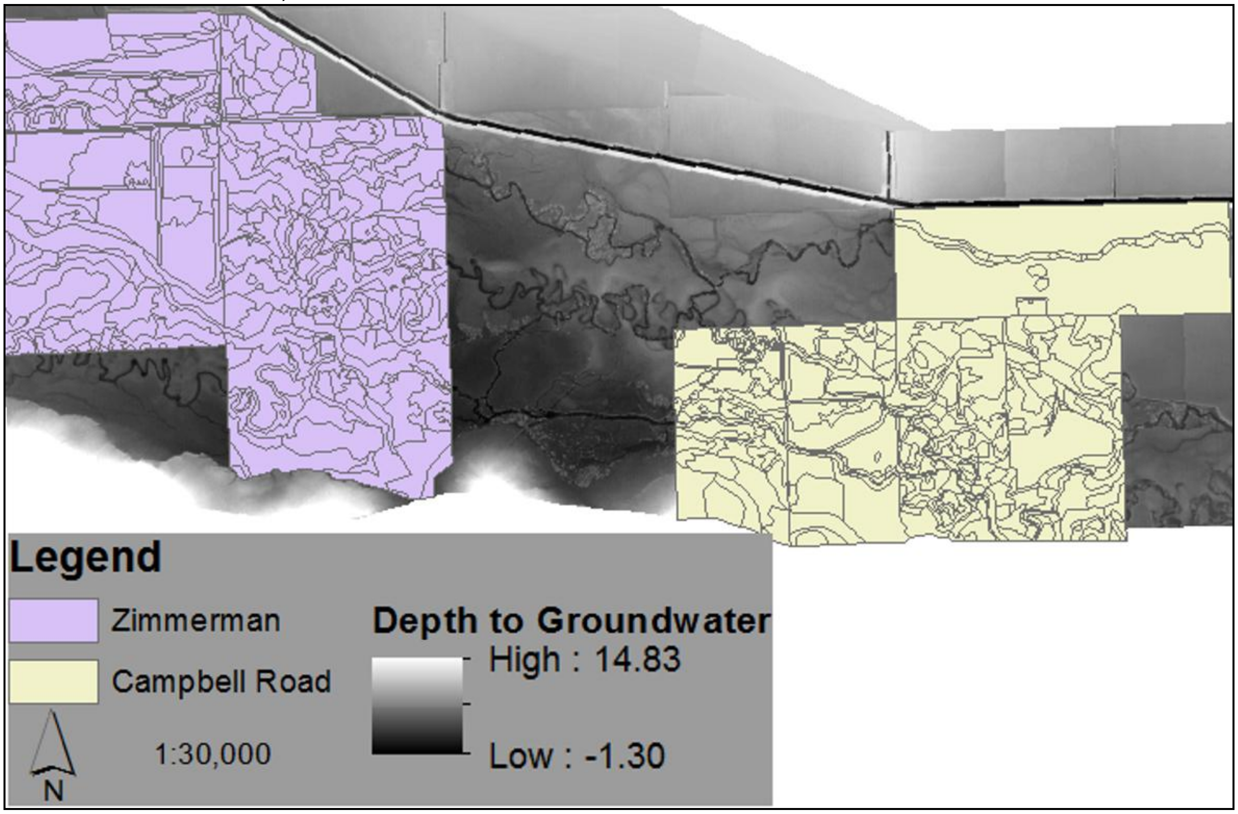


Fig. 9. Example of depth to groundwater raster underlying Xapnish/Zimmerman and Campbell Road study sites.

The final data sets and associated tables created by this study provide a baseline to monitor the future changes in emergent wetland vegetation as a result of hydrologic reconnection as well as target further management activities at the four riparian restoration sites.

Objective 3: Feasibility for Stream-Channel Survey, Lower Toppenish Creek.

The third objective of this year's study was to further test the feasibility of conducting a systematic survey of stream channel cross-sections along the lower Toppenish Creek riparian restoration corridor, using a HiPer Lite + RTK survey grade GPS mapping unit. The resulting geo-referenced datasets of stream channel cross-section elevations along lower Toppenish Creek may be integrated into existing LiDAR datasets of the Toppenish Creek floodplain to assist with hydrologic modelling and the design of in-stream grade structures and side channel elevations for hydrologic reconnection projects.

In a pilot reconnaissance last year, we found surveying by wading into the main channel was not feasible at many riparian restoration projects along Toppenish Creek due to the steepness of the bank and deepness of the water, even during the low flow conditions of late fall. In addition, access to launch sites was very difficult on much of the creek, requiring long portages or impeded by dense shrubs or willows. Also, suitable haul out sites do not generally exist. Many sections or the creek are unnavigable because of downed or overhanging trees, narrow channels, and other obstructions. In some places, swift currents make lashing and securing the boat to a transect rope and conducting the survey too risky, with a high potential for equipment to be submerged in the creek.

Besides field access issues, additional problems stem from using the HiPer Lite + RTK survey grade GPS, which can use a network connection through a wireless data service to receive real-time position corrections while surveying in the field. These position corrections are based on location measurements sent from a network of continuously operating base stations. A field rover unit connects to a nearby base station to receive real-time corrections, which can be used to resolve positions within a centimeter accuracy. However, to achieve centimeter accuracy the field rover GPS unit must be able to view at least four of the same satellites that a nearby base station in the network can view, achieving a fixed position. During preliminary tests in the study area, we could not achieve a fixed position with our GPS rover, which only allowed for operation of the unit in float mode, which varies widely in horizontal accuracy depending on satellite positions (~ 1 m - 5 m), with corresponding vertical accuracy twice that amount. Most likely, the ridge to the south blocks the view of the sky limiting the number of satellites the GPS rover can view in common with the network base station, which is compounded by the dense vegetation along many of the streambanks.

This year we tested whether optimum satellite conditions would allow the survey equipment to view enough satellites to survey a section of Toppenish Creek in the Pumphouse Road restoration property that we previously identified as being potentially surveyable (Fig. 4). The Trimble GNSS Planning Online website was used to determine days that had the optimal satellite configurations for surveying in the study area. In the field, we could not obtain a common view of 4 GPS satellites between our receiver and any base station; therefore we could not operate with the accuracy necessary to collect useful cross-sections. Additionally, we had intermittent connectivity issues with wireless network. With our system, it is possible to set up one of our receivers as a local base station and achieve high positional accuracy in relative to the base station location. Later, in the office the base station location can be differentially corrected and all points collected can be adjusted. To operate in this configuration, a line of site is needed between the roving GPS receiver and the base station. Maintaining line of site for multiple cross-sections is not possible due to the incised nature of the stream and blocking vegetation. We determined that our equipment could not be used to collect steam profile cross-sections.

Literature Cited

Cowardin, L. and V. Myers. 1974. Remote sensing for identification and classification of wetland vegetation. Journal of Wildlife Management, 38 (2), pp.308-314.

Frescino, T. S., G.G. Moisen, L. DeBlander, and M. Guerin. 2007. The investigation of classification methods of high-resolution imagery. *Notes*.

Gabriel, A.O., and B. Sainsbury 2009. Monitoring of Yakama Nation Riparian Restoration Sites. Final Report and Digital Map Portfolio. Ellensburg: Central Washington University. 38 pp.

Hodgson, M. E., J. R. Jensen, H. E. Mackey, Jr., and M. C. Coulter. 1987. Remote sensing of wetland habitat: a wood stork example. Photogrammetric Engineering and Remote Sensing, 53 (8), pp. 1075-1080.

Hu, S., A. Gabriel and C. Lancaster. 2000. An integrated multimedia approach for wetland management and planning for Terrell's Island, Winnebago Pool Lakes, Wisconsin. The Wisconsin Geographer,16, pp. 34-44.

Jensen, J. R., H. E. Mackey, S. Nurumalani, and O. Weatherbee. 1991. Remote sensing offers an alternative for mapping wetlands. Geo Info Systems, 1 (9), pp. 46-53.

Mead, R. A. and P. T. Gammon. 1981. Mapping wetlands using orthophotoquads and 35-mm aerial photographs. Photogrammetric Engineering and Remote Sensing, 47, pp. 649-652.

Ossinger, M. C, J. A. Schafer, and R. F. Cihon. 1993. Method to identify, inventory, and map wetlands using aerial photography and Geographic Information Systems. Transportation Research Records, 1366. pp. 35-40.

Scarpace, F. L., B. K. Quirk, R. W. Kiefer, and S. L. Wynn. 1981. Wetland mapping from digitized aerial photography. Photogrammetric Engineering and Remote Sensing, 47 (6), pp. 829-838.

Stewart, W. R., V. Carter, and P. D. Brooks. 1980. Inland (non-tidal) wetland mapping. Photogrammetric Engineering and Remote Sensing, 46 (5), pp. 617-628.

Welch, R. M. Remillard, and R. F. Doren. 1995. GIS database development for South Florida’s national parks and preserves. Photogrammetric Engineering and Remote Sensing, 61 (11), pp. 1371-1381.

Appendix

Table 1. Dominant vegetation communities at Pumphouse/Island Road Restoration Site, Toppenish, Washington, 2014.

Vegetation Community	*Number*	*Minimum Size (m^2)*	*Maximum Size (m^2)*	*Mean Size (m^2)*	*Total Area (m^2)*	*P S*
Basin wildrye/Lambs' quarters	1	68480.3	68480.3	68480.3	68480.3	
Bent grass	1	528.8	1817.3	1173.0	2346.1	
Bent grass/Greasewood	1	2290.2	2290.2	2290.2	2290.2	
Broad-leaved cattail	8	465.7	24201.5	5212.8	41702.4	
Broad-leaved cattail/Reed canarygrass	2	1201.6	7723.8	4462.7	8925.4	
Canada thistle	1	5616.7	5616.7	5616.7	5616.7	
Canada thistle/Perennial pepperweed	2	6808.0	11164.1	8986.1	17972.1	
Cheatgrass	3	15267.3	91017.8	44365.9	133097.8	
Cheatgrass/Kochia	1	12188.7	12188.7	12188.7	12188.7	
Cheatgrass/Russian knapweed	2	9694.3	28619.6	19156.9	38313.9	
Cheatgrass/Russian thistle	1	59965.4	59965.4	59965.4	59965.4	
Globe podded hoary cress/Prickly lettuce	1	6197.0	6197.0	6197.0	6197.0	
Greasewood	24	2946.0	69082.2	15222.5	365339.1	
Greasewood/Basin wildrye	1	798.9	798.9	798.9	798.9	
Greasewood/Perennial pepperweed	2	644.4	15741.6	8193.0	16386.0	
Greasewood/Sage brush	1	5992.8	5992.8	5992.8	5992.8	
Greasewood/Salt grass	8	2068.7	16379.0	7491.4	59931.3	
Kochia	2	2788.4	2970.8	2879.6	5759.2	
Kochia/Perennial pepperweed	5	656.9	11849.5	5005.3	25026.6	
Kochia/Salt grass	1	5934.2	5934.2	5934.2	5934.2	
Mixed	83	113.2	45190.1	8084.6	671018.3	
Perennial pepperweed	13	519.3	120222.4	16218.9	210845.3	
Perennial pepperweed/Lambs' quarters	4	4360.0	51091.9	22263.1	89052.4	
Perennial pepperweed/Reed canarygrass	3	767.5	1669.7	1156.2	3468.6	
Perennial pepperweed/Salt grass	1	5242.8	5242.8	5242.8	5242.8	
Perennial pepperweed/Spike rush	1	3572.9	3572.9	3572.9	3572.9	
Perrennial Pepperweed/Salt grass	1	11176.0	11176.0	11176.0	11176.0	
Prickly lettuce	1	20765.4	20765.4	20765.4	20765.4	
Reed canarygrass	14	238.0	25768.7	5730.8	80231.6	
Reed canarygrass/Lambs' quarters	1	9499.0	9499.0	9499.0	9499.0	
Reed canarygrass/Softrush	1	8999.1	8999.1	8999.1	8999.1	
Russian knapweed	4	352.4	8571.5	3573.8	14295.2	

Vegetation Community	*Number*	*Minimum Size (m^2)*	*Maximum Size (m^2)*	*Mean Size (m^2)*	*Total Area (m^2)*	*P S*
Russian knapweed/Lambs' quarters	1	7760.8	7760.8	7760.8	7760.8	
Russian olive	68	15.8	50994.6	3587.9	243975.9	
Russian olive/Greasewood	1	4662.1	4662.1	4662.1	4662.1	
Russian olive/Kochia	1	4624.2	4624.2	4624.2	4624.2	
Russian olive/Perennial pepperweed	3	232.9	9099.2	3782.1	11346.3	
Russian olive/Salt grass	2	507.4	2901.7	1704.6	3409.1	
Russian olive/Thickspike wheatgrass	1	9979.7	9979.7	9979.7	9979.7	
Russian olive/Three square	1	1840.8	1840.8	1840.8	1840.8	
Russian olive/Tule	2	3300.3	3787.1	3543.7	7087.4	
Russian thistle/Salt grass	1	6796.8	6796.8	6796.8	6796.8	
Sage brush	1	6852.9	6852.9	6852.9	6852.9	
Sagebrush/Greasewood	1	12808.2	12808.2	12808.2	12808.2	
Salt grass	5	1610.4	10258.3	5100.4	25501.8	
Soft rush	1	814.3	814.3	814.3	814.3	
Soft rush/Sow weed	2	4080.3	17771.3	10925.8	21851.5	
Soft rush/Three square	2	3860.8	7498.6	5679.7	11359.4	
Thickspike wheatgrass	5	1219.7	21194.8	8486.5	42432.6	
Thickspike wheatgrass/Perennial pepperweed	4	7711.3	14535.2	10244.9	40979.7	
Three square	5	333.6	8154.4	3315.6	16578.1	
Three square/Perennial pepperweed	1	1137.7	1137.7	1137.7	1137.7	
Tule	15	432.3	45113.2	14831.1	222465.9	
Tule/Broad-leaved cattail	4	710.7	13664.6	5129.5	20518.2	
Tule/Perennial pepperweed	1	894.9	894.9	894.9	894.9	
Tule/Reed canarygrass	2	1793.6	2366.1	2079.9	4159.7	
Willow	24	79.1	13798.4	1880.9	45141.9	
Willow/Broad-leaved cattail	1	806.6	806.6	806.6	806.6	
Willow/Perennial pepperweed	1	4953.1	4953.1	4953.1	4953.1	
Willow/Reed canarygrass	12	259.0	64380.3	11622.1	139464.7	
Willow/Tule	1	1677.2	1677.2	1677.2	1677.2	

Table 2. Changes in common dominant vegetation communities at Pumphouse/Island Road Restoration Site, Toppenish, Washington, 2010-2015.

Vegetation Communities	**2011 Area (m^2)**	**2015 Area (m^2)**
Broad-leaved Cattail	121830.8	41684.7
Broad-leaved Cattail/Reed Canarygrass	1818.7	1836.2
Broad-leaved Cattail/Tule	73385.6	40343.2
Greasewood	132283.8	165222.1
Greasewood/ Basin Wildrye	5670.2	798.9
Greasewood/Perennial Pepperweed	2382.5	644.4
Greasewood/Salt Grass	51208.8	42669.6
Mixed	42320.2	395210.8
Perennial Pepperweed	364091.3	17742.0
Perennial Pepperweed/Reed Canarygrass	13159.4	14892.3
Perennial Pepperweed/Salt Grass	564.6	3574.7
Reed Canary Grass	63850.4	73122.1
Russian Olive	155718.7	184121.9
Russian Olive/Perennial Pepperweed	1703.6	226.6
Soft Rush	9833.0	17771.3
Soft Rush/Three Square	22106.6	4657.7
Thick Spike Wheatgrass	2539.9	14541.8
Thick Spike Wheatgrass/Perennial Pepperweed	370.1	2732.0
Three Square	12254.2	11502.1
Tule	188012.2	216118.1
Willow	136313.4	25497.2
Willow/Tule	1746.3	1677.2

Dominant Vegetation Communities at the Pumphouse/Island Road Site (2015)

Broad-leaved Cattail *(Typha latifolia)* Community

The broad-leaved cattail community is found in permanently wet locations. These communities are dominated by cover by cattail, and often form dense, exclusive patches. The wetland indicator status of broad-leaved cattail is OBL. It is a perennial, emergent herb that grows 2 meters tall or more. Species communities are often found in marshes, ponds and shallow slow-flowing water, and from sea level to mid-elevations in the mountains on both sides of the Cascades. Cattails provide important habitat and food for many marsh animals, including wrens, blackbirds, waterfowl and muskrats. Historically, cattail has been used to make mats for bedding, kneeling in canoes, as insulation for winter homes, and as blankets or bags. Its rhizomes have been consumed as a source of starch. Cattail can be easily identified by its cattail-like inflorescences.

Broad-leaved Cattail *(Typha latifolia)* – Reed Canarygrass *(Phalaris arundinacea)* Community

The broad-leaved cattail community is found in permanently wet locations. These communities are dominated by cover by cattail, and often form dense, exclusive patches. The wetland indicator status of broad-leaved cattail is OBL. It is a perennial, emergent herb that grows 2 meters tall or more. Species communities are often found in marshes, ponds and shallow slow-flowing water, and from sea level to mid-elevations in the mountains on both sides of the Cascades. Cattails provide important habitat and food for many marsh animals, including wrens, blackbirds, waterfowl and muskrats. Historically, cattail has been used to make mats for bedding, kneeling in canoes, as insulation for winter homes, and as blankets or bags. Its rhizomes have been consumed as a source of starch. Cattail can be easily identified by its cattail-like inflorescences. Reed canarygrass is a non-native perennial grass listed as a class C noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is FACW. It grows up to 1.7 meters tall, and is widespread in Washington at low to mid elevations in marshes, disturbed wetland areas, streambanks and agricultural ditches, and often in areas of agricultural activity. It is a mat-forming rhizomatous plant that negatively impacts wetland biodiversity since it outcompetes native vegetation. Reed canarygrass also displaces wildlife because it provides little food or suitable habitat after forming monocultures. On a larger ecosystem scale, reed canarygrass can alter ecosystem processes and functions by forming thick sod-layers that elevate the surface of the wetland, thereby increasing sedimentation, altering nutrient cycling, and changing wetland hydrology. Historically, this grass has been used to make mats for eating on and drying food, and for rope for binding fish weirs.

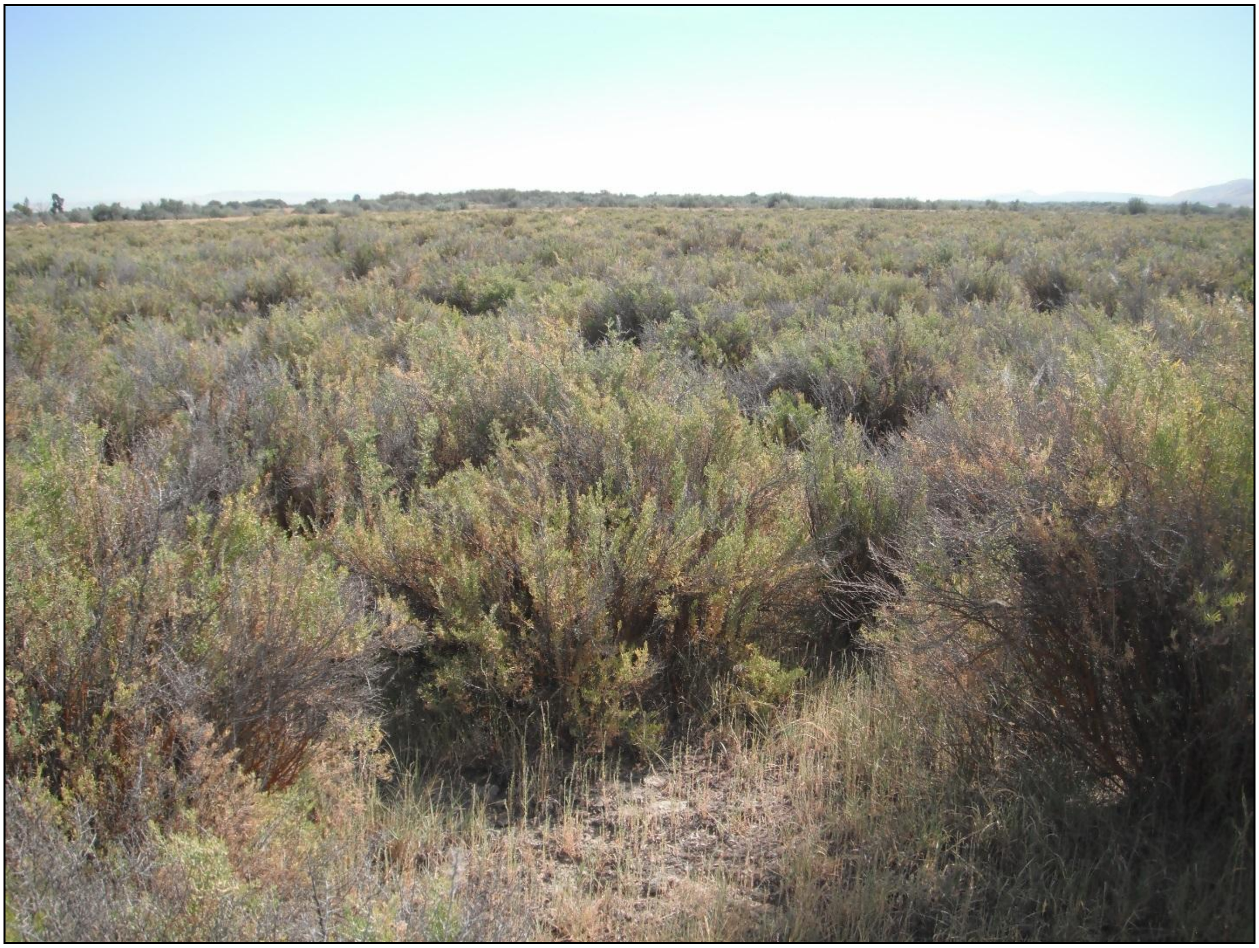
<u>Canada thistle (*Cirsium arvense*) - Perennial Pepperweed *(Lepidium latifolium)* Community</u>
Canada thistle, an invasive perennial herb introduced from Eurasia, is listed as a Class C noxious weed by the WA State Noxious Weed Control Board. It thrives in a variety of habitats ranging from dry to moist soils, and from low to mid elevations on both sides of the Cascades. Small areas of the perennial pepperweed community are found in transitional zones between uplands and wetlands. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed out competes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands.

<u>Cheatgrass *(Bromus tectorum)* Community</u>

Cheatgrass is an annual flowering grass introduced from the Mediterranean region. It grows up to .6 meters tall. It is commonly considered an invasive species and is estimated to infests over 41 million hectares in the western US. It out-competes native grasses and forbs, and often invades neighboring plant communities. Cheatgrass provides some value as forage for livestock early in the season, but may lead to early season depletion of soil moisture during drought years. It may become highly flammable from late spring through early fall following maturation, which can alter natural ecosystem fire occurrence. It is widespread in croplands, haylands, pasturelands, rangelands, and along roadsides.

Cheatgrass *(Bromus tectorum)* Community - Russian Knapweed *(Centaurea repens)* Community

Cheatgrass is an annual flowering grass introduced from the Mediterranean region. It grows up to .6 meters tall. It is commonly considered an invasive species and is estimated to infests over 41 million hectares in the western US. It out-competes native grasses and forbs, and often invades neighboring plant communities. Cheatgrass provides some value as forage for livestock early in the season, but may lead to early season depletion of soil moisture during drought years. It may become highly flammable from late spring through early fall following maturation, which can alter natural ecosystem fire occurrence. It is widespread in croplands, haylands, pasturelands, rangelands, and along roadsides. The Russian knapweed community is found in drier areas of the study site at the margins of wet areas and in uplands. Russian knapweed often forms dense, exclusive patches. Russian knapweed is a nonnative perennial herb found chiefly east of the Cascades in Washington in dry, open areas at low elevations and in foothills. It frequently invades disturbed areas such as roadsides, ditches, pastures, clear-cuts, and croplands in semi-arid areas. It was introduced to this region in the early 1900’s from southern and eastern Europe. This knapweed species is listed as a class B noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is NL. It grows 40-80 centimeters tall, and can spread via well-developed too systems that can reach more than 7 meters. It also spreads via allelopathy by secreting toxic chemicals from their roots, which reduces the growth of many native plants. Russian knapweed is toxic to horses by causing severe neurological damage after being consumed.



Greasewood (*Sarcobatus baileyi)* Community

Greasewood often grows in extensive, nearly pure stands in pluvial desert locations and is most common on fine-grained soils in areas with a relatively high water table. These deciduous shrubs grow to 0.5–3 m tall with spiny branches and succulent leaves, 10–40 mm long and 1–2 mm broad. The leaves are green, in contrast to the grey-green color of most of the other shrubs within its range. The species reproduces from seeds and sprouts and is considered a halophyte, usually found in sunny, flat areas around the margins of playas and in dry stream beds and arroyos. Greasewood is a native perennial shrub commonly found east of the Cascades in saline or alkaline soils and flats in dry regions, and grows up to 2.5 meters tall. Its wetland indicator status is FACU+. It is distributed throughout the sagebrush steppe. Greasewood can tolerate excessive soil salts that draw water out of less well adapted plants. These salts are accumulated in the leaf tissue and root tissue, which can be easily detected in the taste of the fleshy leaves. Greasewood provides wildlife habitat for rabbits and other small animals in these semi-arid landscapes.

<u>Greasewood *(Sarcobatus vermiculatus)* - Perennial Pepperweed *(Lepidium latifolium)* Community</u>

The greasewood – perennial pepperweed community is found in upland areas in the study site either surrounding or intermixed with wetland areas. Greasewood is a native perennial shrub commonly found east of the Cascades in saline or alkaline soils and flats in dry regions, and grows up to 2.5 meters tall. Its wetland indicator status is FACU+. It is distributed throughout the sagebrush steppe. Greasewood can tolerate excessive soil salts that draw water out of less well adapted plants. These salts are accumulated in the leaf tissue and root tissue, which can be easily detected in the taste of the fleshy leaves. Greasewood provides wildlife habitat for rabbits and other small animals in these semi-arid landscapes. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed outcompetes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands.

Greasewood (*Sarcobatus baileyi*) - Saltgrass *(Distichlis spicata)* Community

Greasewood often grows in extensive, nearly pure stands in pluvial desert locations and is most common on fine-grained soils in areas with a relatively high water table. These deciduous shrubs grow to 0.5–3 m tall with spiny branches and succulent leaves, 10–40 mm long and 1–2 mm broad. The leaves are green, in contrast to the grey-green color of most of the other shrubs within its range. The species reproduces from seeds and sprouts and is considered a halophyte, usually found in sunny, flat areas around the margins of playas and in dry stream beds and arroyos. Saltgrass is a native perennial grass commonly found east of the Cascades at low to mid elevations in arid to semi-arid basins and adjacent plateaus in saline or alkaline meadows. It grows 10-30 centimeters tall, and often forms a uniform cover over large areas of wetlands and flats. Its wetland indicator status is FACW.

Kochia (*Kochia scoparia*) Community

Kochia is an annual native to Asia. It has spread across North America after introduction from Europe. Commonly found in fields, ditchbanks, and waste areas throughout the American west. Kochia can grow to be 1-6 feet tall with alternate lance-shaped leaves 0.5-2 inches long. Upper surface is usually smooth while the underside is covered in soft hairs. Kochia is readily eaten by livestock but may contain high nitrate levels that make it toxic to the animals. Mowing or slashing of kochia before flowering can significantly reduce seed production.

<u>Kochia (*Kochia scoparia*) Perennial Pepperweed *(Lepidium latifolium)* Community</u>

Kochia is an annual native to Asia. It has spread across North America after introduction from Europe. Commonly found in fields, ditchbanks, and waste areas throughout the American west. Kochia can grow to be 1-6 feet tall with alternate lance-shaped leaves 0.5-2 inches long. Upper surface is usually smooth while the underside is covered in soft hairs. Kochia is readily eaten by livestock but may contain high nitrate levels that make it toxic to the animals. Mowing or slashing of kochia before flowering can significantly reduce seed production. Small areas of the perennial pepperweed community are found in transitional zones between uplands and wetlands. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed out competes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands.

Perennial Pepperweed *(Lepidium latifolium)* Community

Perennial pepperweed communities are often found in transitional zones between uplands and wetlands. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed out competes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands.

Perennial Pepperweed *(Lepidium latifolium)* - Lambsquarters (*Chenopodium album)* Community

Perennial pepperweed communities are commonly found in transitional zones between uplands and wetlands. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed out competes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands. Lambsquarters is an annual that can range from 1-6 feet tall. It has erect stems that are striped with pink or purple, alternate leaves. Flowers are small, greenish-gray and concentrated in axils at the tips and branches of stem. Lambsquarters is found in cultivated fields, gardens, and waste areas. This competitive weed has high growth and water use rates. Greens of this plant can be can be eaten in salads when young. Lambsquarters is native to Europe but has become widespread throughout North America. Seeds of this species are very long-lived and can survive annual control attempts.

<u>Perennial Pepperweed *(Lepidium latifolium)* - Reed Canarygrass *(Phalaris arundinacea)* Community</u>

Perennial pepperweed communities are often found in transitional zones between uplands and wetlands. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed out competes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands. Reed canarygrass community is often found in both upland and wetland areas due to its ability to grow successfully in both habitats. Reed canarygrass is a non-native perennial grass listed as a class C noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is FACW. It grows up to 1.7 meters tall, and is widespread in Washington at low to mid elevations in marshes, disturbed wetland areas, streambanks and agricultural ditches, and often in areas of agricultural activity. It is a mat-forming rhizomatous plant that negatively impacts wetland biodiversity since it outcompetes native vegetation. Reed canarygrass also displaces wildlife because it provides little food or suitable habitat after forming monocultures. On a larger ecosystem scale, reed canarygrass can alter ecosystem processes and functions by forming thick sod-layers that elevate the surface of the wetland, thereby increasing sedimentation, altering nutrient cycling, and changing wetland hydrology. Historically, this grass has been used to make mats for eating on and drying food, and for rope for binding fish weirs.

Reed Canarygrass *(Phalaris arundinacea)* Community

Reed canarygrass community is often found in both upland and wetland areas due to its ability to grow successfully in both habitats. Reed canarygrass is a non-native perennial grass listed as a class C noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is FACW. It grows up to 1.7 meters tall, and is widespread in Washington at low to mid elevations in marshes, disturbed wetland areas, streambanks and agricultural ditches, and often in areas of agricultural activity. It is a mat-forming rhizomatous plant that negatively impacts wetland biodiversity since it outcompetes native vegetation. Reed canarygrass also displaces wildlife because it provides little food or suitable habitat after forming monocultures. On a larger ecosystem scale, reed canarygrass can alter ecosystem processes and functions by forming thick sod-layers that elevate the surface of the wetland, thereby increasing sedimentation, altering nutrient cycling, and changing wetland hydrology. Historically, this grass has been used to make mats for eating on and drying food, and for rope for binding fish weirs.

Russian Knapweed *(Centaurea repens)* Community

The Russian knapweed community is found in drier areas of the study site at the margins of wet areas and in uplands. These communities are dominated by over 70% cover by Russian knapweed, and often form dense, exclusive patches. Russian knapweed is a nonnative perennial herb found chiefly east of the Cascades in Washington in dry, open areas at low elevations and in foothills. It frequently invades disturbed areas such as roadsides, ditches, pastures, clear-cuts, and croplands in semi-arid areas. It was introduced to this region in the early 1900's from southern and eastern Europe. This knapweed species is listed as a class B noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is NL. It grows 40-80 centimeters tall, and can spread via well-developed too systems that can reach more than 7 meters. It also spreads via allelopathy by secreting toxic chemicals from their roots, which reduces the growth of many native plants. Russian knapweed is toxic to horses by causing severe neurological damage after being consumed.

Russian Olive *(Elaeagnus angustifolia)* Community

The Russian olive community is found in all habitats across the study site in both moist and dry conditions. It occurs as both a shrub and a short tree. These communities often form dense, exclusive patches. Russian olive is an introduced perennial shrub and/or tree from Europe commonly found east of the Cascades in Washington in natural habitats that include open fields, stream banks, marshes, and riparian areas. It was widely promoted in the 1800's as an ornamental and in the 1900's as a wildlife attractant and windbreak. It can reach 14 meters in height and has 2-5 centimeter-long thorns on its branches. Its wetland indicator status is FAC. It is commonly considered an invasive plant because of its ability to outcompete native vegetation through nitrogen-fixing growth strategies and the formation of dense stands. It re-sprouts from its roots and trunk, which enables its quick reestablishment where native vegetation is managed through burning. This dense growth limits the ability of cavity-nesting birds to make nest holes. However, Russian olive fruits are an abundant food source for native wildlife. The plant also provides soil stabilization in riparian and disturbed areas.

<u>Russian Olive *(Elaeagnus angustifolia)* - Perennial Pepperweed *(Lepidium latifolium)* Community</u>

The Russian olive - perennial pepperweed community is frequently found in the study site in both wetland and upland areas. Perennial pepperweed grows in the understory of Russian olive at the margins of the community patches. It is a mixed community whose cover is dominated equally by both species. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed outcompetes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands. Russian olive is an introduced perennial shrub and/or tree from Europe commonly found east of the Cascades in Washington in natural habitats that include open fields, stream banks, marshes, and riparian areas. It was widely promoted in the 1800's as an ornamental, and in the 1900's as a wildlife attractant and windbreak. It can reach 14 meters in height and has 2-5 centimeter-long thorns on its branches. Its wetland indicator status is FAC. It is commonly considered an invasive plant because of its ability to outcompete native vegetation through nitrogen-fixing growth strategies and the formation of dense stands. It re-sprouts from its roots and trunk, which enables its quick reestablishment where native vegetation is managed through burning. This dense growth limits the ability of cavity-nesting birds to make nest holes. However, Russian olive fruits are an abundant food source for native wildlife. The plant also provides soil stabilization in riparian and disturbed areas.

Russian Olive *(Elaeagnus angustifolia)* - Saltgrass *(Distichlis spicata)* Community

The Russian olive community is found in all habitats across the study site in both moist and dry conditions. It occurs as both a shrub and a short tree. These communities often form dense, exclusive patches. Russian olive is an introduced perennial shrub and/or tree from Europe commonly found east of the Cascades in Washington in natural habitats that include open fields, stream banks, marshes, and riparian areas. It was widely promoted in the 1800's as an ornamental and in the 1900's as a wildlife attractant and windbreak. It can reach 14 meters in height and has 2-5 centimeter-long thorns on its branches. Its wetland indicator status is FAC. It is commonly considered an invasive plant because of its ability to outcompete native vegetation through nitrogen-fixing growth strategies and the formation of dense stands. It re-sprouts from its roots and trunk, which enables its quick reestablishment where native vegetation is managed through burning. This dense growth limits the ability of cavity-nesting birds to make nest holes. However, Russian olive fruits are an abundant food source for native wildlife. The plant also provides soil stabilization in riparian and disturbed areas. Saltgrass is a native perennial grass commonly found east of the Cascades at low to mid elevations in arid to semi-arid basins and adjacent plateaus in saline or alkaline meadows. It grows 10-30 centimeters tall, and often forms a uniform cover over large areas of wetlands and flats. Its wetland indicator status is FACW.

Russian Olive *(Elaeagnus angustifolia)* - Tule *(Shoenoplectus acutus)* Community

The Russian olive community is found in all habitats across the study site in both moist and dry conditions. It occurs as both a shrub and a short tree. These communities often form dense, exclusive patches. Russian olive is an introduced perennial shrub and/or tree from Europe commonly found east of the Cascades in Washington in natural habitats that include open fields, stream banks, marshes, and riparian areas. It was widely promoted in the 1800's as an ornamental and in the 1900's as a wildlife attractant and windbreak. It can reach 14 meters in height and has 2-5 centimeter-long thorns on its branches. Its wetland indicator status is FAC. It is commonly considered an invasive plant because of its ability to outcompete native vegetation through nitrogen-fixing growth strategies and the formation of dense stands. It re-sprouts from its roots and trunk, which enables its quick reestablishment where native vegetation is managed through burning. This dense growth limits the ability of cavity-nesting birds to make nest holes. However, Russian olive fruits are an abundant food source for native wildlife. The plant also provides soil stabilization in riparian and disturbed areas. The common tule community is widespread within the most saturated areas within the study site, and in nearly all areas seasonally inundated. These communities are dominated by tule, and often form dense, exclusive patches. Common tule is abundantly located across Washington at mid to low elevations in wetlands with standing water, riparian areas, and lake and pond margins. It is a native perennial herb that grows up to 3 meters tall. Its wetland indicator status is OBL. It can form dense stands that include previous years' litter, which provides cover for various avian and terrestrial wildlife species. The abundant nut-like seeds produced by common tule stands are also an important food source for waterfowl. Historically, common tule has been used to make mats, roofs, and wall-coverings for summer lodges or tents. These mats were also used for drying berries and as ground-covers on which to eat.

Saltgrass *(Distichlis spicata)* Community

Saltgrass is a native perennial grass commonly found east of the Cascades at low to mid elevations in arid to semi-arid basins and adjacent plateaus in saline or alkaline meadows. It grows 10-30 centimeters tall, and often forms a uniform cover over large areas of wetlands and flats. Its wetland indicator status is FACW.

Soft Rush *(Juncus effusus)* - Sow weed (Sonchus arvensis) Community

Soft rush, also known as common rush, is a native perennial herbaceous plant found on both sides of the Cascades in moist areas from coastal tidal flats to mountain meadows. It often grows in standing water of wet prairies, meadows, pastures and fields, and in shallow water edges of pools, ponds and lakes. It can grow to be 20-100 centimeters tall in tufted, thick tussocks, and can form dense stands that exclude other plant species. Its wetland indicator status is FACW. It provides moderate cover for waterfowl, and is a minor food source for small mammals. Sow weed also known as Marsh sow thistle is a perennial with an extensive root system and can grow up to 6 feet tall. Yellow, waxy blooms and 4-10 inch leaves with prickly margins. Upper leaves have less lobes and clasp the stem. Sowthistle was introduced from Europe and can be found in temperate zones world-wide. This plant grows quickly in a wide variety of conditions and have wind-borne seeds that spread easily. Livestock will readily graze on sow thistle in preference to grass as the leafy lettuce-like greens are high in nutrients. Sow thistle also has medicinal properties similar to those of dandelions and succory.

Soft Rush *(Juncus effusus)* - Three square *(Shoenoplectus pungens)* Community

The threesquare – soft rush community frequently occurs in the study site in seasonally inundated areas that are moist to saturated year-round. It is a mixed emergent community whose cover is dominated equally by both species. This community often abuts cattail and/or tule communities, and provides additional wildlife habitat in these localized areas due to the variation in vegetative structure relative to the cattail and tule. Threesquare, also known as American threesquare or common threesquare, is a native perennial herb widespread in Washington in marshes and wetlands, and in shallow water or soil that is saturated to the surface. The species is also tolerant of alkali soils, and can grow up to 1 meter tall. Its wetland indicator status is OBL. Historically, it has been used extensively in basketry. Soft rush, also known as common rush, is a native perennial herbaceous plant found on both sides of the Cascades in moist areas from coastal tidal flats to mountain meadows. It often grows in standing water of wet prairies, meadows, pastures and fields, and in shallow water edges of pools, ponds and lakes. It can grow to be 20-100 centimeters tall in tufted, thick tussocks, and can form dense stands that exclude other plant species. Its wetland indicator status is FACW. It provides moderate cover for waterfowl, and is a minor food source for small mammals.

Thickspike Wheatgrass *(Elymus lanceolatus)* Community

Thickspike wheatgrass is characterized as a long-lived perennial grass commonly found in areas of the northern Great Plains and intermountain west. It persists in areas with annual precipitation ranging from 20 to 51 centimeters. It is drought and frost resistant allowing it to be found between sea level and 3048 meters in elevation. It grows from .3 to 1 meter tall with a maximum seed spike of 25.5 centimeters. This grass species is significantly high in protein during the spring months providing a food source for many wild grazers and livestock. The species is also found in sand dunes in eastern Washington, glacial outwash in Montana, and windblown sediment in Idaho. It is commonly found with Idaho fescue, big sagebrush, juniper, and needlegrasses.

<u>Thickspike Wheatgrass (Elymus lanceolatus) – Perennial Pepperweed *(Lepidium latifolium)*</u>

The thickspike wheatgrass is characterized as a long-lived perennial grass commonly found in areas of the northern Great Plains and intermountain west. It persists in areas with annual precipitation ranging from 20 to 51 centimeters. It is drought and frost resistant allowing it to be found between sea level and 3048 meters in elevation. It grows from .3 to 1 meter tall with a maximum seed spike of 25.5 centimeters. This grass species is significantly high in protein during the spring months providing a food source for many wild grazers and livestock. The species is also found in sand dunes in eastern Washington, glacial outwash in Montana, and windblown sediment in Idaho. It is commonly found with Idaho fescue, big sagebrush, juniper, and needlegrasses. Perennial pepperweed is a perennial herb introduced from Eurasia especially adapted to saturated and salty soils. Its wetland indicator status is FAC. It is a non-native perennial grass listed as a class B noxious weed by the WA State Noxious Weed Control Board. It is commonly considered an invasive species because of its negative impacts on native plants and animals, soil nutrients, agriculture, livestock, and community biodiversity. Perennial pepperweed out competes native vegetation for moisture, nutrients, and light, and forms dense monocultures that reduce biodiversity and available wildlife habitat. It also changes plant community compositions by depositing salts near the soil surface, thereby negatively affecting less salt-tolerant species. Perennial pepperweed is most often found near fresh or salt water at elevations below 3,000 meters east of the Cascades. Common habitats include riparian areas, wetlands, alpine meadows, shrublands, and disturbed areas such as roadsides, pastures, and residential areas. It is abundantly found in moist areas and irrigated land, but also on drier lands.

<u>Three Square (*Scirpus americanus*) Community</u>

Three Square is found in areas that are semi permanently inundated along streams and mash areas in the site. It grows in many types of coastal and inland wetland habitat, as well as sagebrush, desert scrub, chaparral, and plains. This rhizomatous perennial herb easily exceeds two meters in height. The stiff stems are sharply three-angled and usually very concave between the edges. Each plant has three or fewer leaves which are short and narrow. The inflorescence is a small head of several spikelets which may be brown to bright orange, red, purplish, or pale and translucent. They have hairy edges. The fruit is a brown achene.

Tule *(Shoenoplectus acutus)* Community

The common tule community is widespread within the most saturated areas within the study site, and in nearly all areas seasonally inundated. These communities are dominated by tule, and often form dense, exclusive patches. Common tule is abundantly located across Washington at mid to low elevations in wetlands with standing water, riparian areas, and lake and pond margins. It is a native perennial herb that grows up to 3 meters tall. Its wetland indicator status is OBL. It can form dense stands that include previous years' litter, which provides cover for various avian and terrestrial wildlife species. The abundant nut-like seeds produced by common tule stands are also an important food source for waterfowl. Historically, common tule has been used to make mats, roofs, and wall-coverings for summer lodges or tents. These mats were also used for drying berries and as ground-covers on which to eat.

Tule *(Shoenoplectus acutus)* - Broad-leaved Cattail *(Typha latifolia)* Community

The common tule community is widespread within the most saturated areas within the study site, and in nearly all areas seasonally inundated. These communities are dominated by tule, and often form dense, exclusive patches. Common tule is abundantly located across Washington at mid to low elevations in wetlands with standing water, riparian areas, and lake and pond margins. It is a native perennial herb that grows up to 3 meters tall. Its wetland indicator status is OBL. It can form dense stands that include previous years' litter, which provides cover for various avian and terrestrial wildlife species. The abundant nut-like seeds produced by common tule stands are also an important food source for waterfowl. Historically, common tule has been used to make mats, roofs, and wall-coverings for summer lodges or tents. These mats were also used for drying berries and as ground-covers on which to eat. The broad-leaved cattail community is abundantly found through the site in wet areas. These communities are dominated by over 70% cover by cattail, and often form dense, exclusive patches. Its wetland indicator status is OBL. Broad-leaved cattail is a perennial, emergent herb that grows 2 meters tall or more. Species communities are often found in marshes, ponds and shallow slow-flowing water, and from sea level to mid-elevations in the mountains on both sides of the Cascades. Cattails provide important habitat and food for many marsh animals, including wrens, blackbirds, waterfowl and muskrats. Historically, cattail has been used to make mats for bedding, kneeling in canoes, as insulation for winter homes, and as blankets or bags. Its rhizomes have been consumed as a source of starch. Cattail can be easily identified by its cattail-like inflorescences.

<u>Tule *(Shoenoplectus acutus)* – Reed Canarygrass *(Phalaris arundinacea) Community*</u>
Tule is abundantly located across Washington at mid to low elevations in wetlands with standing water, riparian areas, and lake and pond margins. It is a native perennial herb that grows up to 3 meters tall. Its wetland indicator status is OBL. It can form dense stands that include previous years' litter, which provides cover for various avian and terrestrial wildlife species. The abundant nut-like seeds produced by common tule stands are also an important food source for waterfowl. Historically, common tule has been used to make mats, roofs, and wall-coverings for summer lodges or tents. These mats were also used for drying berries and as ground-covers on which to eat. Reed canarygrass is a non-native perennial grass listed as a class C noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is FACW. It grows up to 1.7 meters tall, and is widespread in Washington at low to mid elevations in marshes, disturbed wetland areas, streambanks and agricultural ditches, and often in areas of agricultural activity. It is a mat-forming rhizomatous plant that negatively impacts wetland biodiversity since it outcompetes native vegetation. Reed canarygrass also displaces wildlife because it provides little food or suitable habitat after forming monocultures. On a larger ecosystem scale, reed canarygrass can alter ecosystem processes and functions by forming thick sod-layers that elevate the surface of the wetland, thereby increasing sedimentation, altering nutrient cycling, and changing wetland hydrology. Historically, this grass has been used to make mats for eating on and drying food, and for rope for binding fish weirs.

Willow *(Salix spp.)* Community

Willows are predominantly found in moist to wet areas, and are highly favored by wildlife. Willow buds are eaten by birds and small mammals, deer and elk eat the twigs and leaves, and rabbits and beavers eat the bark. Willows often prevent erosion by stabilizing stream banks, and provide nesting habitat for bird and mammals. Historically, willows have been used for a variety of purposes. Willow bark has been used to make string for fishing lines and nets, and ropes for structures, baskets, mats, and clothing. Willow wood has also been used for drills for starting fires by friction. Willow bark has also been used medicinally for bleeding cuts and wounds, sore throats, alleviating pain, and reducing fever.

<u>Willow *(Salix spp.)* - Reed Canarygrass *(Phalaris arundinacea)* Community</u>
Willows are predominantly found in moist to wet areas, and are highly favored by wildlife. Willow buds are eaten by birds and small mammals, deer and elk eat the twigs and leaves, and rabbits and beavers eat the bark. Willows often prevent erosion by stabilizing stream banks, and provide nesting habitat for bird and mammals. Historically, willows have been used for a variety of purposes. Willow bark has been used to make string for fishing lines and nets, and ropes for structures, baskets, mats, and clothing. Willow wood has also been used for drills for starting fires by friction. Willow bark has also been used medicinally for bleeding cuts and wounds, sore throats, alleviating pain, and reducing fever. Reed canarygrass is a non-native perennial grass listed as a class C noxious weed by the WA State Noxious Weed Control Board. Its wetland indicator status is FACW. It grows up to 1.7 meters tall, and is widespread in Washington at low to mid elevations in marshes, disturbed wetland areas, streambanks and agricultural ditches, and often in areas of agricultural activity. It is a mat-forming rhizomatous plant that negatively impacts wetland biodiversity since it outcompetes native vegetation. Reed canarygrass also displaces wildlife because it provides little food or suitable habitat after forming monocultures. On a larger ecosystem scale, reed canarygrass can alter ecosystem processes and functions by forming thick sod-layers that elevate the surface of the wetland, thereby increasing sedimentation, altering nutrient cycling, and changing wetland hydrology. Historically, this grass has been used to make mats for eating on and drying food, and for rope for binding fish weirs.

Mixed - No Dominants

These community patches did not have any dominants with greater than 35% cover. They are mixed communities consisting of grasses, invasive weeds, herbaceous perennials, and shrubs. They are typically located in transition zones between uplands and wetlands, and include a variety of species adapted to wetland and upland habitats.

Other Communities

31 additional community types were present within the study site, but only occurred once. These included:

- Basin Wildrye (*Leymus cinereus*)
- Basin Wildrye (*Leymus cinereus*) - Lambs Quarters (*Chenopodium album)*
- Bentgrass *(Agrostis spp.)*
- Bentgrass *(Agrostis spp.)* - Greasewood (*Sarcobatus baileyi)*
- Canada thistle (*Cirsium arvense*)
- Cheatgrass *(Bromus tectorum)* - Kochia (*Bassia scoparia)*
- Cheatgrass *(Bromus tectorum)* - Russian Thistle (*Salsola iberica)*
- Globe-podded Hoary Cress (*Lepidium appelianum*) – Prickly Lettuce (*Lactuca serriola*)
- Greasewood *(Sarcobatus vermiculatus)* - Basin Wildrye (*Leymus cinereus*)
- Greasewood *(Sarcobatus vermiculatus)* – Sage Brush (*Artemisa tridentata*)
- Kochia (*Bassia scoparia)* - Saltgrass *(Distichlis spicata)*

- Perennial Pepperweed *(Lepidium latifolium)* - Saltgrass *(Distichlis spicata)*
- Perennial Pepperweed *(Lepidium latifolium)* - Spike Rush *(Eleocharis spp.)*
- Prickly Lettuce (*Lactuca serriola*)
- Reed Canarygrass *(Phalaris arundinacea)* - Lambsquarters (*Chenopodium album)*
- Reed Canarygrass *(Phalaris arundinacea)* - Soft Rush *(Juncus effusus)*
- Russian Knapweed*(Acroptilon repens*) - Lambsquarters (*Chenopodium album)*
- Russian Olive *(Elaeagnus angustifolia)* - Greasewood *(Sarcobatus vermiculatus)*
- Russian Olive *(Elaeagnus angustifolia)* - Kochia (*Bassia scoparia)*
- Russian Olive *(Elaeagnus angustifolia)* - Thickspike Wheatgrass *(Elymus lanceolatus)*
- Russian Olive *(Elaeagnus angustifolia)* - Three Square (*Scirpus americanus*)
- Russian Thistle (*Salsola iberica)* - Saltgrass *(Distichlis spicata)*
- Sage Brush (*Artemisa tridentata*)
- Sage Brush (*Artemisa tridentata*) - Greasewood *(Sarcobatus vermiculatus)*
- Soft Rush *(Juncus effusus)*
- Three Square (*Scirpus americanus*) - Perennial Pepperweed *(Lepidium latifolium)*
- Tule *(Shoenoplectus acutus)* - Perennial Pepperweed *(Lepidium latifolium)*
- Willow *(Salix spp.)* - Broad-leaved Cattail *(Typha latifolia)*
- Willow *(Salix spp.)* - Perennial Pepperweed *(Lepidium latifolium)*
- Willow *(Salix spp.)* - Tule *(Shoenoplectus acutus)*