Grant Cycle 30-7 – Application Due Date: December 15, 2016

Project title: (Using 6 words or less give your project a descriptive title)
Willamette River Aquatic Weed Management, Phase 4
County or Counties project is located in:
Benton County, Linn County

Type of Organization: A grant applicant must be a **legal entity** identified below and have a FEIN number. A state or federal agency may apply for funding only as a co-applicant with an eligible entity.

☒Cooperative Weed Management Area ☐Not-For-Profit Organization
☐Watershed Council ☐Local or tribal government
☐Soil & Water Conservation District ☐Institution for Higher Education
☐Individual (not eligible for indirect or administrative costs)

OSWB dollars requested: $ 31,980 **Total cost of project: $** 59,135

Name of Applicant or Organization: Benton County Cooperative Weed Management Area

Contact: Melissa Newman **email:** mnewman@bentonswcd.org

Address: 456 SW Monroe Ave., Suite 110

City: Corvallis **State: OR** **Zip:** 97333

Phone: 541-753-7208 **Fax:** 541-753-1871

Project Manager for Applicant or Organization: Benton Soil and Water Conservation District

Contact: Melissa Newman **email:** mnewman@bentonswcd.org

Address: 456 SW Monroe Ave., Suite 110

City: Corvallis **State:** OR **Zip:** 97333

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Payee for Organization: Benton Soil and Water Conservation District

Contact: Holly Crosson **email:** hcrosson@bentonswcd.org

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City: Corvallis **State:** OR **Zip:** 97333

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Project Information

1.Weed Species: (List all state listed noxious weeds pertaining to this project. Use common name plus genus and species. If your project has more weeds than the allowable space please duplicate this table on a separate sheet and attach to this application)

*Habitat	**Method of treatment	*Weed species	Net/treatment acres	Gross/survey acres	Herbicide(s)	Define the timing of treatment
Wetland	*Bio-Control*	*Purple loosestrife, Lythrum salicaria*	*1*	*13*	*N/A*	*Late June*
Instream (Lake)	Herbicide	Yellow floating heart (Nymphoides peltata)	0.5	16.5	Imazapyr, Imazamox, Triclopyr	June/July, and Sept./Oct.
Instream (River side-channels)	Herbicide	Uruguayan primrose-willow (*Ludwigia hexapetala*	12.75	18	Glyphosate	June/July and Sept./Oct.
Instream	Manual	Uruguayan primrose-willow (*Ludwigia hexapetala*	<1 acre	5	N/A	May through September
Instream	Manual	Yellow floating heart (*Nymphoides peltata*)	<1 acre	5	N/A	May through September

*Choose the primary habitat the weed exist – Upland, Riparian, Wetland, Instream, Estuary. It is recognized that some projects have mixed habitat types, chose only one habitat per weed per line. Habitats are described within the instructions. Use only state listed noxious weeds as described within the Instructions Exhibit B.**see question 5. below for treatment type

Total estimated project acreage: net: 15.25 gross: 44.50
(see appendix c with Instructions for understanding calculation of your total project net/gross project acreage)

2. Project location: (directions to the site)

Horseshoe Lake, Benton County (*Nymphoides peltata* site): From Hwy 20, head north onto NW N. Albany Rd, right onto NW Quarry Rd, left onto NW Cacade Heights Dr, and right onto NW Horseshoe Lake Cir. Parking area is on the right. Landowner permission required to park and walk down to lake.

Collins Bay (*Ludwigia hexapetala* site – 10.5 acres): Heading east on Hwy 20, take the first right after intersection of HWY 20 & Independence Hwy, onto private road. Park at bridge and walk along ag field edge towards Willamette River. For both sites, call Benton SWCD to get landowner permission before entering private land.

Greenbelt Land Trust (GLT)'s Scatter Bar Pond at Horseshoe Lake, Linn County site (formerly referred to as "Oxbow") (*Ludwigia hexapetala* site – 5.25 acres): From downtown Corvallis, head east on OR-34. Turn left onto Riverside Drive. Turn left onto

Stellmacher Dr, head towards river and park along ag field edge. Landowner permission required to access site.

Wapato Cove (*Ludwigia hexapetala* site - 1 acre): On the mainstem Willamette River downstream from Corvallis, 1 mile downstream from Tripp Greenway Island on river right. Accesible by boat, or by vehicle with landowner permission. From Hwy 34 head north on Riverside Dr. Turn left on Stellmacher Dr. and follow to river. Private road, need permission to enter.

Several small patches of Ludwigia and yellow-floating heart will be hand pulled on the Willametter River between Corvallis and Albany.

Latitude: (Horseshoe Lake Site: W -123.112806), (Collins Bay Site: W -123.173201), (Scatter Bar Pond: -123.180446) (Wapato Cove Site: W -123.1756) Longitude: (Horseshoe Lake Site: N 44.660760), (Collins Bay Site: N 44.634964) (Scatter Bar Pond: 44.612357) (Wapato Cove Site: N 44.6192) – (at least one lat/long reading is mandatory)

3. Does this project exist within a designated weed control district?
(Refer to ORS 569.360)

☐Yes ☒No If Yes, provide district name:

4. Is this part of an established Cooperative Weed Management Area? ☒
Yes ☐No If Yes provide name: Benton County Cooperative Weed Management Area

****5. Identify your integrated pest management methods:** (all activities must be directly related to the proposed project)**:**

☒Assessment/Management Plan Development
☐Biological control
☒Herbicide control
☐Mechanical control
☒Prevention
☐Other – Explain:
☒Education and outreach
☒Manual control
☒Monitoring
☒Restoration
☒Survey – Describe the method of survey planned: Survey Ludwigia and yellow floating heart populations by boat using GPS. The use of Fulcrum software will allow us to quickly map aquatic invasive data along the river during surveys and instananeously share the data with other practitioners through a shared database.

6. Have you consulted with ODA staff? ☒Yes ☐No

If yes who? Glenn Miller and Tristen Berg

7. Is this a landowner reimbursement (cost share) project? ☐Yes ☒ No
Remember to attach a list of landowners with acreage by weed species. Updated landowner lists are required with your progress reporting.

8. Project summary: In 200 words – give a statement about your overall project. Provide a summary in 200 words (1000 characters) or less describing what the project will accomplish and what problems will be addressed. The information you provide will be used for project review, OWEB reporting purposes and will be displayed to the general public.

The Willamette River Aquatic Weed Management Phase 4 (WRAWMP) is the continuation of a project started by Benton County Cooperative Weed Management Area in 2014 with Oregon State Weed Board funding. The focus of the project is the control of Uruguayan primrose-willow (*Ludwigia hexapetala*) and yellow floating heart (*Nymphoides peltata*): two aggressive, invasive aquatic plants that pose a threat to fish and wildlife habitat in fresh water systems. N. peltata is an A-listed Oregon State Noxious Weed. The project area spans the reach of the Willamette from Corvallis to Albany, and covers about 15 river miles. WRAWMP consists of three main components:

1. Management of aquatic weed species:

    a. A-rated *Nymphoides peltata* at Horseshoe Lake, North Albany.

    b. B-rated Ludwigia at Collins Bay, Oxbow, and other river inlets (e.g., Wapato Cove).

    c. Restoration of areas following years of Ludwigia treatments (e.g., Collins Bay)

    d. Volunteer weed pulls for small patches of Ludwigia and yellow floating heart on the mainstem Willamette River.

2. Targeted community outreach about aquatic invasive plant species, consisting of workshops on aquatic invasive plants and distribution of the Water Weeds Guide for Benton County.

3. Effectiveness and water quality monitoring at project sites before and after treatments.

9. What are you proposing to do? Give an overview of the project (1,300 words which is approximately 8,000 characters) This should include: is this an extension of a previously funded project if so, include details of past treatments such as successes and failures • estimated acreage for treatment • method of control • restoration component • how this project relates to other projects within the area. It is important be concise and keep this to the 1,300 word limit, but give the details outlined above, this portion is essential in the overall review process.

Was this project previously funded by OSWB? ☒Yes ☐No

If yes what year(s) and provide the grant number? In 2014 (2014-27-400), 2015 (2015-28-501), 2016 (2016-29-601)

Proposal details:

The Willamette River Aquatic Weed Management Phase 4 (WRAWMP) is the continuation of an existing project to control key invasive aquatic plants to prevent further spread and reinfestation, restore habitat, monitor treatment efficacy, and perform outreach on the Willamette River. For this project the Benton County CWMA proposes the following activities:

1. Management of Aquatic Weed Species:

One goal of this project component is to increase the quantity and quality of open water habitat in the Willamette River system through control of invasive aquatic weeds. Specifically, we will continue to reduce the ecological impacts of Ludwigia on the river system through control treatments and the reduction of its spread, as well as the promotion of native plant recovery through restoration plantings. Another component of this project is to conduct a follow-up treatment and eventually eradicate yellow floating heart from Horseshoe Lake, the first reported population of this species in Benton County. We will also reduce the ecological impacts of yellow floating heart on the river system. In the summer of 2016 we saw the first observed yellow floating heart occurrence along the mainstem of the Willamette river in the Corvallis to Albany reach (at a side channel at Upper Kiger). Our volunteer groups hand pulled the small population. We will continue to visit this area to pull any new plants, as well as survey for this species along the river and hand pull any small populations we observe. New observations will be GPS'd and included in a shared mapping database.

a. *Nymphoides peltata*:

One component of this project is the continued control of A-rated *N. peltata* at Horseshoe Lake, North Albany. (**Appendix A: Map and Photos of Yellow Floating Heart Treatment Area at Horseshoe Lake, Benton County**). This population was treated during summer, 2014, 2015, and 2016 with OSWB funds. Further treatments are needed to eradicate these plants as the glyphosate treatment method is not as effective as we had hoped. It may be that the glyphosate treatments are producing only a top burn of the yellow floating heart plants, where the root system still remains and reproduces for the next season.

There is also an existing yellow floating heart seed bank at the site which contributes to the conintued plant growth.

We have been consulting with Glenn Miller of ODA as well as other partners and research scientists (i.e., Dr. Mark Systma, Director of the Center for Lakes and Reservoirs and Co-Director of the Aquatic Bioinvasion Research and Policy Institute; Dr. Michael Netherland, U.S. Army Engineer Research and Development Center, University of Florida Center for Aquatic and Invasive Plants) to explore additional options for treatment of *N. peltata* that have been successful for other organizations. We have also been meeting with landowners surrounding Horseshoe Lake to discuss possible alternative treatment options and their potential irrigation and water needs/restrictions.

We plan to use the most appropriate method to achieve effective plant suppression with minimal impact to the native community. The treatment method we are proposing follows methods used by scientists in Indiana who have successfully eliminated yellow floating heart populations from ponds after regular treatments over the last four to seven years. The successful treatment methods were shared by Dr. Michael Netherland of the University of Florida Center for Aquatic and Invasive Plants.

Treatments will take place in June or July (at first sign of leaf emergence and prior to flower formation), with a second treatment taking place in August or September (as soon as regrowth is observed). A mixture of aquatic label Imazamox or Imazapyr (1 quart per acre) with 0.5-2% surfactant (Agridex) and indicator dye will be used for the early treatment of the plants. The second treatment for plant regrowth will consist of aquatic label Triclopyr (2 quarts per acre) with 0.5-2% surfactant (Agridex) and indicator dye. We will be conducting as much of the applications from the shoreline (instead of from kayaks) as possible, as well as during days with less wind. The research scientists we have spoken with have explained that because of the morphology of floating hearts, any kind of wake (e.g., caused by boats or wind) during herbicide applications causes the leaves of the plant to dip under and reduces the effectiveness of the treatments. In other states, with larger infestations, they have resorted to aerial treatments to minimize disturbance because they had such reduced success from applying by boat.

Concurrent with our proposed treatment regimen for *N. peltata*, the Homeowners Association on the lake will have their detention pond, which drains into the lake, inspected for *N. peltata*, and treated by a contracted professional if any plants are found.

The focus of this project is to significantly reduce, and eventually eradicate, *N. peltata* from Horseshoe Lake and to prevent its spread to the nearby Willamette River. This population was the first observed site in Benton County, making it a prime candidate for targeted removal.

In the summer of 2016 we saw the first occurrence of *N. peltata* on the mainstem of the Willamette river in the Corvallis to Albany reach (at the side channel of

Upper Kiger). Our volunteer groups hand pulled the small population. We will continue to visit this area to pull any new plants, as well as survey for this species along the river and hand pull any small populations we observe. New observations will be GPS'd and included in a shared mapping database.

b. *Ludwigia hexapetala*:

Continued control of B-rated *L. hexapetala* will occur in Collins Bay, a side-channel inlet of the Willamette River. This site was treated in summer 2014, 2015, and 2016 for Ludwigia by professional contractors (see **Appendix B: Maps and pictures of Ludwigia treament areas**). For treatments in 2017 at Collins Bay, we will be requesting a reduced amount of OSWB grant funds, as we will be able to use some Oregon Watershed Enhancement Board Strategic Implementation Plan (SIP) grant funds to help pay for treatment at this site in 2017. Based on results from previous treatments, we expect 70% mortality of the *L. hexapetala* population on this site.

Collins Bay is a river inlet connected to the mainstem of the Willamette River, the entirety of which is infested with Ludwigia (**Appendix B: Maps and pictures of Ludwigia treament areas**). This population was identified and mapped during an assessment of the floodplain along the Willamette River from Corvallis to Albany completed in 2013. In the final report based on this assessment, Ludwigia is identified as a priority for removal from the Willamette River system. Collins Bay is recommended for restoration due to the rarity of open marshland on the mainstem of the river, which is vital habitat for birds, fish, pond turtles, river otters and many other species. (Carex Working Group, Sept. 2013). Ludwigia is also identified as a priority for management in the Five-Year Action Plan for the Willamette Mainstem Cooperative, a group of landowners, natural resource specialists, and other stakeholders who are working to promote, facilitate, and foster long-term stewardship of Willamete River natural resources. (WMC 5-Yr Plan, 2014 with updates).

A new site that we added to last year's grant application (2016-29-601) to be targeted for control of *L. hexapetala*, called Wapato Cove (**Appendix B: Maps and pictures of Ludwigia treatment areas; Appendix C: Wapato Cove Photos**), was not able to be treated in 2016. Prior to a new Benton SWCD grant manager transitioning to the position in summer 2016, the previous Benton SWCD grant manager did not get a chance to get landowner approvals for the work and access or coordinate with the National Marine Fisheries Service (NMFS) to find out if any specific regulatory permits (e.g., Section 7 Endangered Species Act compliance under SLOPES Biological Opinion) were needed from the agency for treatment work at this cove which is directly on the Willamette River.

The new Benton SWCD grant manager has consulted with NMFS, and NMFS has clarified that we do not need an Endagered Species Act permit at this time for herbicide applications for treating aquatic invasive plants along the Willamette River. We have also secured landowner approvals for access and control treatments at the site. We will be requesting an extension of OSWB grant 2016-

29-601 for control of *L. hexapetala* at Wapato Cove in 2017. (No new 2017 OSWB grant funds are being requested for treatments at Wapato Cove as part of this grant application.) This 1 acre site has been identified during numerous river surveys and by the Willamette Aquatic Invasive Network as priority for control based on its location directly on the river, presence of a significant native species (wapato), and the threat of spread of *L. hexapetala* to downstream locations.

One new site targeted for control of *L. hexapetala* is a pond/slough, which is just upstream of Wapato Cove. For the purpose of this application this 5.25 acre site is called Scatter Bar Pond at Horseshoe Lake, Linn County (site was formerly referred to as "Oxbow") (**Appendix B: Maps and pictures of Ludwigia treatment areas; Appendix D: Scatter Bar Pond at Horseshoe Lake, Linn County site Photos**). The site is a pond/slough that formed behind a revetment that was constructed at Scatter Bar Bend in the 1950s (according to the historical U.S. Army Corps of Engineer designs). The site is hydrologically connected to the Willamette River during high flow events. The Ludwigia population at this site was identified and mapped during the 2013 assessment of the floodplain along the Willamette River (Carex Working Group, Sept. 2013) and is also identified as a priority for management in the Five-Year Action Plan for the Willamette Mainstem Cooperative (WMC 5-Yr Plan, 2014 with updates). Our contractor has also been conducting water quality montioring at this site the past two years prior to any control treatments being completed, in order to assess baseline conditions. In 2016 they also completed Ludwigia cover density mapping at the site. Thus, including the site in 2017 treatments will produce a nice comparison of conditions before and after Ludwigia treatments.

Treatments for these sites will consist of herbicide application to thick mats of Ludwigia in open water and the shoreline. To minimize impacts to aquatic non-target plants, backpack sprayers will be used to treat infestations around native plant communities. Contracted applicators will be familiar with native species, and trained in techniques for selective application in aquatic ecosystems. An herbicide mixture of 2 to 3% aquatic label glyphosate, 1-2% surfactant (Agridex), and indicator dye will be used. Applications will take place in early summer, when about half of the plants have flowered, but seed capsules have not yet matured. A follow-up application will take place about six to eight weeks later.

c. Additional restoration plantings at Collins Bay:

Three seasons of treatments at Collins Bay have led to a reduction in Ludwigia cover, with some areas having greatly reduced plant cover to no plant cover (**Appendix B: Maps and pictures of Ludwigia treatment areas**). In Fall 2016 we planted over 500 bulbs of donated wapato (*Sagittaria latifolia*) tubers at the site (0.07 acre) (**Appendix E: Collins Bay Restoration Areas map**). Due to historic high flows in October, which limited access, we added the wapato tubers to an area that was the easiest to access and we knew had limited to no plant cover. We plan to add additional native seed to the site (0.67 acre) once the river height comes down later this winter or in early spring 2017.

Native plant materials were generously donated from a local farmer and wetland restoration practitioner, Marvin Gilmour. Donated native plant materials include: tubers/bulbs (wapato) and native seed (e.g., wapato, softstem bulrush [*Schoenoplectus tabernaemontani*], common spikerush [*Eleocharis palustris*], soft rush [*Juncus effusus*], spike bent grass [*Agrostis exarata*], American slough grass [*Beckmannia syzigachne*], slender rush [*Juncus tenuis*], slough sedge [*Carex obnupta*]). Benton SWCD staff, Marvin and his staff, and Benton SWCD volunteers collected native seed and harvested tubers from Marvin's wetlands in August and September 2016. Seed was cleaned and is being stored in a cool location. Marvin also donated additional native seed that was previously collected and cleaned. A volunteer blog about this effort is included at the Willamette Mainstem Cooperative webpage: https://www.bentonswcd.org/afternoon-dig-duck-potato/.

Sites where native plant materials have been added will be monitored using photo points and GPS mapping, as well as presence-absence surveys of plant species.

Additional areas of the bay (0.81 acre) that have greatly reduced plant cover to no plant cover would benefit from the planting of selected native plants in Fall 2017. (**Appendix E: Collins Bay Restoration Areas map**). See Question 10 Paragraph 3 for a list of proposed native species.

d. Volunteer weed pulls:

In 2017, Benton SWCD, in partnership with Willamette Riverkeeper, will host at least two volunteer weed pulls at locations where volunteers previously pulled Ludwigia and yellow floating heart between Corvallis and Albany, as well as any additional small populations we find during river surveys (**Appendix F: Map of Ludwigia sites for hand pulling between Corvallis and Albany**). One objective of these volunteer events is to increase community awareness about the connection between river health and aquatic invasives. Another objective is to remove target invasives from the river in areas where they are just getting established (satellite populations) before these smaller populations become more significant. Ludwigia and other priority invasives will be manually harvested and secured in heavy duty plastic bags on individual watercrafts. The bags will be sealed and properly disposed of at the end of each pull event. To determine effectiveness of hand pulling, volunteer pull sites will be monitored at least once each year following weed pulls. The sites will be monitored using photo points and GPS mapping. Willamette Riverkeeper will provide boats and assist with coordination, safety, and labor.

2. Targeted community outreach consisting of two workshops:

Benton SWCD, in partnership with Willamette Riverkeeper, will host at least two workshops on the Willamette River, one targeted for the community and the other for members of Willamette Aquatic Invasives Network (WAIN). These workshops will contain information on native and invasive aquatic plant identification, and appropriate response and reporting techniques for priority aquatic weed species.

During the workshops we will distribute the Water Weed Guide for Benton County, developed during the first phase of this project (Benton County Water Weed Guide, BSWCD 2014). Willamette Riverkeeper, Oregon State Parks Department, and Dr. Mark Systma from Portland State University's Center for Lakes and Reservoirs will assist with the workshops.

3. Effectiveness and water quality monitoring:

Monitoring will consist of strategic photo-points throughout the area of infestation and GIS mapping of the pre- and post-treatment extent of Ludwigia. Ludwigia density will be mapped in Collins Bay and Scatter Bar Pond. Monitoring will also include pre- and post-treatment surveys of native plant species and documentation of perceptible changes in plant species density.

We also propose to continue to conduct water quality monitoring to measure pre- and post-treatment changes in dissolved oxygen, specifc conductivity, pH, and temperature. We will hire a contracted professional to conduct water quality monitoring on at least three sites (e.g., two treatment sites and one untreated site). In 2016 we intended to add a fourth site without Ludwigia present for comparison; however, we were not able to add this site to the 2016 monitoring as a relationship still needs to be developed with the landowner of the site. The previous Benton SWCD grant manager accidentally thought this site was owned by a different landowner who Benton SWCD already has an existing relationship with. Benton SWCD will be working on developing a relationship with the landowner to hopefully add this site (or a similar site) for the 2017 water quality monitoring field season.

We will follow the monitoring plan developed during phase two of this project (**Appendix G: Ludwigia Monitoring Plan for Benton Soil and Water Conservation District)**, as well as the recommendations included in the monitoring reports prepared by the contractor for the project. The contractor submitted a monitoring report with recommendations following the 2015 field season (**Appendix H: 2015 Water Quality and Ludwigia Monitoring Report**) and is currently developing the 2016 monitoring report, with recommendations for the 2017 season.

10. Using a bulleted list: Explain the project goals and objectives.
(See Instructions section for specific guidance on goals and objectives)

• The primary goal of this project is to increase the quantity and quality of open aquatic habitat in the Willamette River system through control of invasive aquatic weeds. Specifically, we will continue to reduce the ecological impacts of Ludwigia on the river system through the reduction of the downstream spread of the species through plant fragmentation. We will also promote native plant recovery through restoration plantings following treatments. Sites targeted for control include Collins Bay, Scatter Bar Pond,, Wapato Cove, the side channel of Upper Kiger, and new, small populations of Ludwigia between Corvallis and Albany. We will reduce the populations of Ludwigia in the river using integrated techniques at strategic sites. Treatment methods include hand pulling and herbicide application using updated techniques and equipment (Inteli-spray system with tractor, boat, and hose & reel).

• Another goal of this project is to continue to control and eventually eradicate yellow floating heart at Horseshoe Lake, the first observed population in Benton County. We will also reduce the ecological impacts of yellow floating heart on the river system. In the summer of 2016 we saw the first observed yellow floating heart occurrence along the mainstem of the Willamette river in the Corvallis to Albany reach (at a side channel at Upper Kiger). Our volunteer groups hand pulled the small population. We will continue to visit this area to pull any new plants, as well as survey for this species along the river and hand pull any small populations we observe.

• Another objective of this project is to monitor site changes in response to treatment. We will use density mapping (**Appendix H: 2015 Water Quality and Ludwigia Monitoring Report**) and photo-point monitoring techniques. These techniques will allow us to track changes in post-treatment distribution and abundance of Ludwigia and yellow floating heart, native plant distribution, and non-target impacts. We will also conduct water quality monitoring to record pre- and post-treatment differences in dissolved oxygen, temperature, pH, and specific conductivity at at least three site (e.g., two treatment sites and two controls: one untreated site and one site without Ludwigia) (**Appendix H: 2015 Water Quality and Ludwigia Monitoring Report**).

• Another goal of this project to reach at least 50 people through education and outreach activities including presentations, workshops and volunteer weed pulls. We will provide information on aquatic weed identification and proper early detection and rapid response techniques. Through volunteer weed pulls, Ludwigia and yellow floating heart will be removed from areas where it is just becoming established before it forms significant populations.

• Another objective of this project is to share treatment methodology and results with other land managers and practitioners. The use of Fulcrum software will allow us to quickly map aquatic invasive data along the river during surveys and instananeously share the data with other practitioners through a shared database. All survey data collected for this project will also be entered into iMapInvasives and WeedMapper to

track treatments and map Ludwigia populations. Control techniques and efficacy of treatments will continue to be recorded and shared through meetings, presentations, and workshops. Recent examples of where we have highlighted the work and shared lessons learned include presentations at the Fall 2016 Benton County Cooperative Weed Management Area meeting, the Fall 2016 Willamette Aquatic Invasives Network meeting, and Meyer Memorial Trust's December 2016 Within our Reach Conference.

• Another goal of the project is to continue restoration at Collins Bay. After the first three years of Ludwigia treatments, portions of Collins Bay were ready for replanting with native vegetation. In Fall 2016 we planted over 500 bulbs of donated wapato tubers at the site (0.07 acre) (Appendix E: Collins Bay Restoration Areas map). We plan to add additional native seed to the site (0.67 acre) once the river height comes down later this winter or in early spring 2017. Based on native plants found on site, some of the native species best suited for Collins Bay include wapato, softstem bulrush, common spikerush, and soft rush, broadfruit bur-reed (*Sparganium eurycarpum*), and yellow pond lily (*Nuphar polysepala*). In 2016 we did not have access to broadfruit bur-reed or yellow pond lily stock; however, we will be trying to access some of this seed for the 2017 planting season. Access to native aquatic riverine weltand plant material is extremely limited.

• Another objective of the project is to continue the development of a long-term management plan for Collins Bay. This plan will include clear goals and objectives for this site and integrate work already accomplished with future restoration needs. The plan will also include a timeline for achieving restoration goals, and the associated actions needed to accomplish these goals.

11. Is the project part of an existing weed management plan?
☒Yes ☐No (if yes, provide the plan name, author & date published)
This project fits within the goals and management principles outlined in the Benton County CWMA Five-year Management Plan. Specifically, "projects [should be] designed using an ecosystem management approach based on an understanding of weed biology, weed ecology, and landscape level processes." (Benton County CWMA, 2012; pp. 2-4).

The control of Ludwigia on the Willamette River is listed as a priority in the Willamette Mainstem Cooperative 5-Year Action Plan. The first goal of this plan is to work with willing landowners to protect high quality and unique habitats through management and control of high priority invasive plant species, including water primrose (Ludwigia spp.) (WMC 5-Yr Plan, 2014 with updates).

Control of Ludwigia is also recommended in the "Willamette Mainstem Vegetative Habitat Survey and Assessment Final Report." This report was prepared by Carex Working Group based on invasive plant and habitat assessment and survey work completed in 2012 & 2013 on approximately 2,500 acres of riparian habitat on the Willamette River from Corvallis to Albany. This document was reviewed by the WMC steering committee members, and staff of Oregon Watershed Enhancement Board and

Meyer Memorial Trust (Carex Working Group, Sept. 2013). The abridged version of this report can by found on the WMC webpage on the Benton SWCD website: https://www.bentonswcd.org/assets/Willamette-Mainstem-Assessment-Final-Report-Abridged.pdf.

12. Are there additional partners? ☒Yes ☐No
Who are the additional partners and what are their roles and responsibilities?
Additional partners include Oregon Parks and Recreation Department (OPRD), Willamette Riverkeeper (WRK), Benton Soil and Water Conservation District (BSWCD), Greenbelt Land Trust (GLT), Portland State University Center for Lakes and Reservoirs (PSU), Oregon Department of Fish and Wildlife, Oregon Department of Agriculture (ODA), private landowners within the project area including the Horseshoe Lake Neighborhood Association (HLNA), the Willamette Mainstem Cooperative (WMC), and Willamette Aquatic Invasives Network (WAIN).

Glenn Miller, Integrated Weed Management Specialist with ODA, has been and will continue to provide in-kind support in the form of professional advice, site visits, and consultation on weed control activities. ODA provided photos and GIS shapefiles from aerial surveys for Ludwigia in the Willamette River system conducted during summer 2014. Further survey work is planned, as feasible. This data has helped to assess the extent of Ludwigia populations in the Willamette River system, and is being utilized in the formation of a management plan for this plant (currently being developed by the Willamette Aquatic Invasives Network).

OPRD staff, Scott Youngblood, will continue to participate in outreach activities related to this project. In the past OPRD has participated in similar projects by providing coordination and safety assistance during volunteer activities on the river. OPRD staff have helped control priority invasives on the Willamette. They will continue to provide these services in 2016 and in-kind funding in the form of staff time and equipment use.

WRK staff will continue to work with Benton SWCD to organize at least four river events, including two aquatic invasive workshops and two volunteer weed pulls. WRK will provide in-kind funding in the form of equipment use (boats, vans, and trailers) as well as some staff time. Some funds are requested in this grant proposal for WRK staff time and mileage, which will be disbursed under paid contract.

Greenbelt Land Trust will be partners in this project at the Scatter Bar Pond at Horseshoe Lake, Linn County site through regular contact with Benton SWCD, outreach to neighbors in the area, and some site monitoring.

Staff from PSU Center for Lakes and Reservoirs will continue to participate, as they have for our previous workshops and volunteer events, by offering expertise on aquatic invasives, presentations, and sharing outreach materials.

The Oregon Department of Fish and Wildlife has conducted electrofishing surveys in 2015 and 2016, in coordination with Benton SWCD and the landowners, at several

Ludwigia treatment sites (i.e., Collins Bay, Stewart Slough) to estimate fish species presence and population densities. ODFW staff will continue to conduct electofishing surveys with Benton SWCD in 2017 to provide information on fish species presence. The collection of several consecutive years of survey data will help us understand Ludwigia's effects on fish species composition and density.

Private landowners at Horseshoe Lake and Collins Bay will be partners in this project through site monitoring, regular contact with Benton SWCD, and outreach to neighbors in the area. The Horseshoe Lake Neighborhood Association will continue to monitor and treat yellow floating heart as necessary in a detention pond that drains into the lake. Benton SWCD will continue to provide informational handouts about the project and weeds of concern to interested landowners.

Marvin Gilmour, a local farmer, has offered to provide native plant materials including seeds (e.g., common rush, softstem bulrush) and wapato bulbs for restoration plantings at Collins Bay. Other private landowners will contine to allow access to their properties for treatment of target invasive species.

Both WMC and WAIN focus on management of invasive species on the mainstem of the Willamette River. The WMC is a group of landowners, organizations, volunteers, and other interested parties working towards shared long-term stewardship of Willamette River resources with a focus on the Corvallis to Albany river reach. The Willamette Aquatic Invasives Network, comprised of over 50 participating organizations (local, state, and federal), fosters collaboration to share information, expertise, technologies, scientific data, and best management practices and to develop strategies to protect aquatic resources and restore aquatic and riparian habitat in the Willamette River Basin (Cascade Pacific RC&D, WAIN webpage, 2015). WRAWMP (this project) has benefited from the work and expertise of members of WAIN and the WMC. The BC CWMA will continue to coordinate and work with these groups to share information and lessons learned in the management of Ludwigia.

13. Which elements of the project will OSWB funds be used for? Be specific to activity and specific timing of the activity.

The Benton County CWMA is requesting OSWB funds for the following elements of this proposed project:

1. Salary and Wages:

Funding for Benton SWCD staff will be used for these tasks: project coordination and management (on-going), administration and oversight of all grant activities (on-going), coordination and facilitation of education and outreach activities (April-September 2017), information sharing and reporting (on-going), and beginning development of a long-term management plan for Collins Bay (Dec. 2016-February 2017).

2. Contracted Services:

Survey (May-September 2017) and monitoring (May-October 2017) to determine previous treatment effectiveness and post-treatment of yellow floating heart on 0.5 acres of Horseshoe Lake as needed. Treatments will take place in June or July (at first sign of leaf emergence and prior to flower formation), with a second treatment taking place in August or September (as soon as regrowth is observed). Monitoring will take place before and after treatments and as needed.

Survey and monitoring of Collins Bay to determine treatment effectiveness and other site changes, and continued treatment of *Ludwigia hexapetala* on 11 acres. Concurrent with survey and monitoring, treatment will occur between June-July depending on conditions, and consist of application of herbicide. Secondary control treatments will occur between Aug.-Sept. to spray remaining plants. Monitoring will take place before and after treatments and as needed.

Removal of Ludwigia at Scatter Bar Pond at Horseshoe Lake, Linn County (approximately 5.25 acres) will be an addition to this project. The Ludwigia population at this site was identified and mapped during the 2013 assessment of the floodplain along the Willamette River (Carex Working Group, Sept. 2013) and is also identified as a priority for management in the Five-Year Action Plan for the Willamette Mainstem Cooperative (WMC 5-Yr Plan, 2014 with updates). Concurrent with survey and monitoring, treatment will occur between June-July depending on conditions, and consist of application of herbicide. Secondary control treatments will occur between Aug.-Sept. to spray remaining plants. Monitoring will take place before and after treatments and as needed.

Funding is requested for community outreach including two aquatic weeds trainings, one targeted for the community and the other for members of the Willamette Aquatic Invasives Network.These activities will be led by Benton SWCD staff in partnership with Willamette Riverkeeper and Oregon State Parks Department (OPRD). Workshops will be held in early summer 2017. OSWB funds will pay for a portion of Benton SWCD and Willamette Riverkeeper staff time to coordinate these workshops. OPRD staff time, and much of the Benton SWCD staff time will be in-kind matching services.

OSWB funds are requested for coordination of at least two days of volunteer Ludwigia hand-pull activities on the Willamette from Corvallis to Albany. This effort will be led by Willamette Riverkeeper and Benton SWCD. Funds will cover Benton SWCD and Willamette Riverkeeper staff time for the coordination of these activities. The first weed pull event will take place in early summer (June), and will be followed-up with a pull later in the season (August). Much of the Benton SWCD staff time will be in-kind matching services.

Monitoring of project sites will include pre- and post-treatment photo points and aerial imagery mapping (using ODA survey images). Funding is requested for continued monitoring of water quality parameters, which include pre- and post-treatment measurements of dissolved oxygen, pH, temperature, oxygen reduction potential and specific conductivity at four sites with varying degrees of Ludwigia percent coverage.

Also included in monitoring is density mapping of Ludwigia at three treatment sites. Water quality monitoring data and density mapping was collected in 2015 (**Appendix H: 2015 Water Quality and Ludwigia Monitoring Report**) and 2016, and is also proposed for 2017.

14. How does this project relate to other projects (BLM, USFS or local projects) completed or planned? Is the project related to work funded in part with another grant from OWEB (i.e. restoration, land acquisition, or technical assistance)? List the OWEB grant number and briefly describe the relationship to this proposal.

The Willamette River Aquatic Weed Management Phase 4 (WRAWMP) fits within the mission and guiding principles of the Willamette Mainstem Cooperative (WMC), a group of landowners, organizations, and volunteers who work together to improve stewardship of natural resources across all landownerships on the mainstem, with a focus area of Corvallis to Albany (WMC Programmatic Bylaws, 2015). Ludwigia is listed as a priority species for control in the Willamette River in the WMC 5-Year Action Plan (WMC 5-Yr Plan, 2014; pg. 8). Capacity funding for the WMC is funded by Meyer Memorial Trust, through the Willamette River Initiative program, with Benton SWCD providing leadership and fiscal management.

The Ludwigia sites proposed for treatment in this application were identified and mapped during a landscape scale invasive plant assessment of the floodplain along the Willamette River from Corvallis to Albany. The survey was conducted for the Willamette Mainstem Cooperative by Carex Working Group (CWG). In the final report submitted by CWG, Ludwigia was identified as a priority for removal from the Willamette River system, and specifically Collins Bay and Scatter Bar Pond, due to the rarity of open marshland habitat on the Willamette (Carex Working Group, Sept. 2013).

Benton SWCD has a Five Year Strategic Plan (2015-2020). One of the goals of the Strategic Plan is to deliver programs that inspire stewardship. To fulfill this goal, Benton SWCD coordinates the WMC, which entails management and implementation of several projects that focus on control of *Ludwigia hexapetala* and yellow floating heart on the Willamette River. WRAWMP is one such project, funded through the ODA-OSWB. Another WMC project is funded through the Oregon Watershed Enhancement Board (OWEB) Strategic Investment Partnership (SIP) and Bonneville Power Administraiton (BPA). This four-year project includes the treatment of over four miles of side-channel/slough habitat and over 50 acres of floodplain habitat and gravel ponds heavily infested with Ludwigia. This project is located across the river from Wapato Cove, and less than 0.5 miles upstream from Collins Bay (**Appendix B: Maps and pictures of Ludwigia treatment areas,** see areas “Stewart Slough, “Asbahr Lake”, “Gravel Ponds”).

Ludwigia is currently being controlled at several other locations on the Willamette River. One of the larger projects is being implemented by City of Eugene, which has been working on *Ludwigia hexapetala* control since 2011 at the Delta Ponds Natural Area. The City of Eugene developed the Invasive *Ludwigia hexapetala* Management Plan for the Delta Ponds Natural Area. Delta Ponds Natural Area is a series of gravel extraction

ponds recently reconnected to the Willamette River. This 5-year plan outlines the systematic treatment of *Ludwigia hexapetala* in the Delta Ponds integrating manual and herbicide control methods. WRAWMP proposes to apply successfully implemented techniques for Ludwigia control, as outlined in the Management Plan by the City of Eugene.

The Delta Ponds Natural Area is located upstream from the WRAWMP project area. The WRAWMP project manager has consulted with several experts working on the Delta Ponds Invasive Ludwigia Control Project. Individuals consulted include: Lauri Holts, Resources Coordinator with the City of Eugene; Dr. Brenda Grewell, Delta Ponds project consultant and ecologist with USDA-Agricultural Research Service Exotic & Invasive Weeds Research Unit; Glenn Miller, Integrated Weed Management Specialist with the Oregon Department of Agriculture; Mark Systma, Associate Vice President for Research, Research & Strategic Partnerships at Portland State University; and Matthew Mellenthin, Delta Ponds Ludwigia control contractor with Integrated Resource Management (also current control contractor for WRAWMP).

Calapooia Watershed Council in collaboration OPRD will be removing *Ludwigia hexapetala* from the side-channel system running through Bowers Rock State Park. This work will be funded through a new OWEB - Focused Investment Partnership (FIP) grant, as well as with Meyer Memorial Trust funding. This work will be accomplished summer 2017 prior to side-channel reconnection construction also being proposed on this site in the coming years (**Appendix B: Maps and pictures of Ludwigia treatments areas**).

OPRD and WRK will be collaborating to remove *Ludwigia hexapetala* from 95 acres of aquatic habitat at OPRD's Willamette Mission State Park. Willamette Riverkeeper, OPRD, the U.S. Geological Survey, Portland State University, and Benton SWCD will be collaborating to conduct baseline monitoring of the Ludwigia and controls treatments to learn more about the impacts of Ludwigia and other aquatic invasive species on the off channel habitat at the park. This work will be supported by a new OWEB-FIP monitoring grant.

The Long Tom Watershed Council is currently working with the OSWB to remove *Ludwigia hexapetala* from several locations on the Long Tom River, upstream of the WRAWMP project area. They started work in summer 2015 and plan to continue in 2016.

ODA is currently conducting control treatments for yellow floating heart at approximately River Mile 145/146 near OPRD's Sam Daws/Buckskin site, at the southeast end of Benton/Linn counties.

It is our understanding that the City of Eugene, McKenzie River Trust, and WRK will be applying for 2017 OSWB grant funding for treatment of yellow floating heart along the Willamette River in Lane County.

The WRAWMP project manager has consulted with several experts working on yellow floating heart, as well as other floating heart species such as crested floating heart (*Nymphoides cristata*). Individuals consulted include: Glenn Miller, Integrated Weed Management Specialist with the Oregon Department of Agriculture; Mark Systma, Associate Vice President for Research, Research & Strategic Partnerships at Portland State University and Dr. Michael Netherland, U.S. Army Engineer Research and Development Center.

In summers 2015 and 2016, Willamete Riverkeeper, in partnership with Willamette Aquatic Invasive Network partners, conducted a survey of the Willamete River from north of Eugene to Salem to map high priority aquatic invasive species, including Ludwigia and yellow floating heart, on the river. Portland State University conducted similar surveys on the river around the Portland area in 2015. ODA conducted aerial surveys of the upper Willamette to map Ludwigia in 2014, and plans to continue mapping, as feasible. The data sets from these surveys have been entered into various databases and have been shared with the appropriate partners, who are using this information to develop plans, set priorities, and apply for funding to strategically manage this species. Benton SWCD is one of the groups who has partipated in these surveys and is currently utilizing the resulting data. Benton SWCD will also be participating on the subcommittee for the strategic action plan being developed by WAIN (and led by Willamette River Keeper and OPRD) to prioritize invasive species treatments along the Willamette River.

15. How does this project fit into the statewide and/or local weed management objectives? Identify the county weed listing priority if known.
Oregon State's Noxious Weed Control Strategic Plan outlines ten objectives and associated strategies for implementation. WRAWMP meets the first eight of these as follows:

• Objective One: Leadership and Organization - Strategy One: Provide consistent statewide and local leadership and organization.

The Benton County CWMA provides local leadership and organization to groups, agencies, and landowners related to invasive plant issues around the county. The Benton County CWMA Management Plan outlines management principles for CWMA activities that align with this project such as; "projects are designed using an ecosystem management approach based on an understanding of weed biology, weed ecology, and landscape level processes." (Benton County CWMA, 2012).

The BC CWMA is coordinated by Benton Soil and Water Conservation District. Benton SWCD's current Executive Director has over 30 years of experience managing aquatic invasive species programs and is committed to dedicating the resources necessary to address long-term management needs of this program (WRAWMP) in Benton County (within budget restraints). This will increase the likelihood of long-term success.

• Objective Two: Cooperative Partnerships - Strategy Two: Develop and expand partnerships.

The Benton County CWMA is made up of a broad partnership of agencies, organizations, and landowners. Benton SWCD provides fiscal oversight and coordination of the Benton County CWMA. Benton SWCD has a strong history of developing partnerships and collaborating with other agencies, organizations, and landowners to complete projects and develop programs for the stewardship of natural resources. Another partnership that will be involved in the planning and implementation of this project is the Willamette Mainstem Cooperative, which is supported by a group of stakeholders who represent local agencies and landowners, and is facilitated by Benton SWCD.

For this project Benton County CWMA and Benton SWCD will work with Willamette Riverkeeper, Oregon State Parks and Recreation Department, and other partners to implement workshops, volunteer events, and survey work. Benton SWCD also plans to work closely with Portland State University Center for Lakes and Reservoirs, Oregon Department of Fish and Wildlife, and other interested groups to ensure that it is meeting Ludwigia and yellow floating heart control objectives while minimizing impacts to local fish and wildlife species.

• Objective Three: Planning and Prioritizing - Strategy Three: Develop and maintain noxious weed lists and plans.

The Benton County CWMA has developed and maintains an invasive plant list for Benton County. This list is regularly reviewed and updated by members of the CWMA EDRR Action Team. *Ludwigia hexapetala* is a B-rated weed on the Oregon state noxious weed list and a B-rated weed on the Benton County invasive plant list, and is targeted for outreach and data collection, both of which would be fulfilled through this project. *Nymphoides peltata* is an A-rated noxious weed by the state of Oregon and A-rated in Benton County as well. It is targeted for ODA response and immediate removal.

The species and sites proposed for treatment in this application have been carefully considered and chosen based on survey data and recommendations from several specialists and land managers who operate on the mainstem Willamette River.

• Objective Four: Education and Awareness - Strategy Four: Provide education and awareness.

For this project Benton SWCD in partnership with Willamette Riverkeeper will provide community outreach to land managers, land owners, and the general public through a series of aquatic weed workshops, volunteer weed pulls, and project site tours on the Willamette River. For these events, we will discuss the benefits of identifying, reporting, and removing invasive plant populations before they spread. The objectives for these workshops are to educate targeted audiences on the identification of aquatic invasive

plants, the impact on wildlife, humans and native plant communities and the methods for timely response relative to the species of concern. Benton SWCD will develop outreach materials and distribute them to workshop participants and landowners within the project area. This include distribution of the water weed guide for Benton County: https://www.bentonswcd.org/assets/BSWCDAquaticWeedGuidebklt15.pdf.

An objective of these events is to increase public awareness of aquatic invasives and provide tools to members of the community to make informed decisions for management of aquatic weeds.

• Objective Five: Integrated Weed Management (IWM) - Strategy Five: Continue to support and advocate the principles of IWM.

The Benton County CWMA is dedicated to using tested, integrated approaches in weed management. This project is supportive of integrated weed management principles in the use of manual and chemical control of Ludwigia and yellow floating heart on the mainstem and at each project site. For each site, all appropriate methods for treatment will be thoroughly analyzed and considered based on resources available and existing conditions.

• Objective Six: Early Detection and Control of New Invaders - Strategy Six: Implement early detection and control.

This project includes early detection and control of new invaders as a key element: we plan to control the first observed *Nymphoides peltata* population in Benton County (at Horseshoe Lake), as well as the first observed yellow floating heart occurrence along the mainstem of the Willamette river in the Corvallis to Albany reach (at a side channel at Upper Kiger).

Several experts have indicated that the invasive Ludwigia in the upper reaches of the Willamette River are currently at a level where early detection of new populations and control of established populations may still be effective in significantly reducing, and eventually removing, the plants from the river system.

• Objective Seven: Noxious Weed Information System and Data Collection - Strategy Seven: Upgrade Noxious Weed Information System.

Through the survey and mapping of project sites using GPS technologies, we can contribute to existing state weed information systems such as the Oregon Invasives Hotline and IMap Invasives. Data collected during the course of this project can be made available for reference by other land management agencies, to inform the development of other projects or management plans, such as the Strategic Plan the Willamette Aquatic Invasives Network is currently developing.

• Objective Eight: Monitoring and Evaluation - Strategy Eight: Monitor noxious weed projects to evaluate effectiveness.

Regular monitoring will be integrated into this project to determine the short and long-term effectiveness of control activities. Photo-points will be strategically placed at each site to collect information before and after each treatment occurs. Populations will be mapped and updated throughout the duration of the project and in subsequent years as funding allows. Sites will also be monitored for changes in water quality parameters over time, and population density will continue to be mapped on at least three sites.

16. How will restoration be a part of your project? If restoration is not a component of this project please explain.
An objective of the project is habitat restoration work at Collins Bay. Collins Bay is recommended for restoration due to the rarity of open marshland on the mainstem of the river, which is vital habitat for birds, fish, pond turtles, river otters and many other species. (Carex Working Group, Sept. 2013).

Three seasons of treatments at Collins Bay have led to a reduction in Ludwigia cover, with some areas having greatly reduced plant cover to no plant cover (**Appendix B: Maps and pictures of Ludwigia treatment areas**). Seasonally disconnected from the river, these areas have shallow water and are exposed during the summer months.

In Fall 2016 we planted over 500 bulbs of donated wapato tubers at the site (0.07 acre) (**Appendix E: Collins Bay Restoration Areas map**). We plan to add additional native seed to the site (0.67 acre) once the river height comes down later this winter or in early spring 2017. Additional areas of the bay (0.81 acre) that have greatly reduced plant cover to no plant cover would benefit from the planting of selected native plants in Fall 2017. (**Appendix E: Collins Bay Restoration Areas map**). After surveying the site and considering native plants growing in similar habitats, as well as access to local native aquatic plant materials, we have selected the following species for replanting: wapato, softstem bulrush, common spikerush, soft rush, spike bent grass, American slough grass, slender rush, slough sedge). In 2016 we did not have access to broadfruit bur-reed or yellow pond lily stock; however, we will be trying to access some of this seed for the 2017 planting season. Access to native aquatic riverine weltand plant material is extremely limited.

Other areas treated during this project will be assessed for restoration potential as treatments continue.

17. Does this project protect a high priority species or habitat? Please give a brief description of the species or habitat/land use designation for this project.
1. Anchor Habitat for Anadromous Fish: Collins Bay and Scatter Bar Pond are within the areas identified in OWEB's Willamette River Habitat Protection and Restoration Program 2010-2015 Habitat Technical Team Proposal as part of the priority anchor habitats for anadromous fish along the Willamette River mainstem (OWEB 2010). Collins Bay and Scatter Bar Pond also within ODFW’s designated essential salmon habitat (ODFW 2011).

2. Open Water Marsh Habitat: Collins Bay was also listed as a special habitat by Carex Working Group during the 2012-1013 invasive plant and habitat assessment by stating that the open water marsh habitat was rarely encountered during survey work and that the site is worth noting for preservation/restoration work. They also recommended the use of integrated methods to remove Ludwigia along the Willamette mainstem to reclaim infested habitats and prevent further spread (Carex Working Group, Sept. 2013).

3. Western Pond Turtles: Western pond turtles are considered a sensitive species by the State of Oregon and are one of the strategy species listed in the Oregon Conservation Strategy (OR Dept. of Fish and Wildlife 2006). While there are no official surveys on record, property owners Stanley and Louise Snyder spoke of the pond turtles and large fish once found in Collins Bay. They have witnessed more wildlife species (turtles, wood ducks) using the inlet since the Ludwigia has been treated. Prior to the treatments they did not observe any pond turtles or large fish in the inlet since Ludwigia had become pervasive. Other landowners from properties nearby have corroborated the Snyder's account of the progression of Ludwigia and subsequent changes to the river.

Western pond turtles require open water habitat with native emergent vegetation to feed, bask, reproduce, and hide from predators. Infestations of aquatic weeds, such as Ludwigia, result in thick vegetation mats that limit movement of aquatic and semi-aquatic species, such as turtles, amphibians, fish, waterfowl and mammals, severely limiting their ability to navigate, feed, and reproduce. In addition, these dense mats of vegetation die off at the end of the growing season and the process of decay can drastically reduce dissolved oxygen in the water. These areas of low dissolved oxygen may create a barrier for the movement of aquatic organisms through a waterway, or cause the fatality of aquatic organisms that can become trapped in areas without sufficient dissolved oxygen. Furthermore, the thick mats of vegetation formed by Ludwigia capture sediment, potentially altering the floodplain capacity and side-channel characteristics of waterways such as Collins Bay.

We are also working with ODFW and the Oregon Native Turtle Working Group to develop a landowner handout on the effects invasive aquatic plant species such as Ludwigia and yellow floating heart have on native turtles and their habitats. The handout is currently in draft form (**Appendix I: Draft Landowner Handout, Native Turtles and Invasive Aquatic Plants**), and is being reviewed by partners at the local, state, and federal levels. When the handout is finalized it will be added to the Oregon Native Turtle Working Group's newly launched website: https://www.oregonturtles.com/, which is for both the public and practitioners in Oregon.

Benton SWCD and the WMC are also currently in discussions with ODFW on the development of a possible Oregon Native Turtle workshop in Spring 2017 for the public/landowners. The workshop would integrate classroom discussion (e.g., overview of our native turtles, general Best Management Practices for conserving native turtles, overview of aquatic invasive animals and plants overtaking turtle habitat, techniques on

creating and enhancing habitat for turtles on landowner properties, etc.) and a field component (e.g., site visit to restored/enhanced wetland site).

4. Wapato (*Sagittaria latifolia*), also known as broadleaf arrowhead, is considered a significant native plant for its cultural value. This plant was once widely harvested by Native Americans in the Willamette Valley, such as the Kalapuyan people. It has an edible, potato-like tuber, which is valued for its high nutritional value. Many species of ducks, mammals, and other wildlife also feed on the leaves and tubers of these plants, and all parts are considered edible. All sites proposed for treatment in this project contain wapato. The Willamette Aquatic Invasive Network considers wapato to be an indicator of high quality habitats, and are recording habitats containing wapato during surveys.

18. Salmon/Steelhead Populations Targeted and Expected Benefits to Salmon/Steelhead

The information provided will be used by OWEB to better meet federal and state reporting requirements. Completion of this section is required but will not be used to evaluate this application for funding.

☐ This project is NOT specifically designed to benefit salmon or steelhead.

- If you check this box do not answer supplemental question 18(A)

Targeted Salmon/Steelhead Populations: Select one or more of the salmon ESUs (Evolutionary Significant Unit) or steelhead DPSs (Distinct Population Segment) that the project will address/benefit. Additional information on the designation and location of the salmon/steelhead populations can be found at http://www.nwr.noaa.gov/ESA-Salmon-Listings/Salmon-Populations/Maps/Index.cfm

Chinook Salmon (Oncorhynchus tshawytscha)		**Coho Salmon (O. kisutch)**	
☐	Deschutes River summer/fall-run ESU	☐	Lower Columbia River ESU
☐	Lower Columbia River ESU	☐	Oregon Coast ESU
☐	Mid-Columbia River spring-run ESU	☐	Southern Oregon/Northern California ESU
☐	Oregon Coast ESU		
☐	Snake River Fall-run ESU	**Steelhead (O. mykiss)**	
☐	Snake River Spring/Summer-run ESU	☐	Klamath Mountains Province DPS
☐	Southern Oregon and Northern California Coastal ESU	☐	Lower Columbia River DPS
☐	Upper Klamath-Trinity Rivers ESU	☐	Middle Columbia River DPS
☒	Upper Willamette River ESU	☐	Oregon Coast DPS
		☐	Snake River Basin DPS
Chum Salmon (O. keta)		☐	Washington Coast DPS (SW Washington)
☐	Columbia River ESU	☒	Upper Willamette River DPS
☐	Pacific Coast ESU	☐	Steelhead/Trout unidentified DPS

18(A). Expected Benefits: Write a brief description of the goals and purpose of the project and how it is expected to benefit salmon/steelhead habitat.

One goal of this project is to remove aquatic invasive plants from side-channels, ponds, and sloughs within the Willamette River system. Aquatic weeds such as Ludwigia act as sediment traps, and can fill in open water habitat and side-channel systems over time. These plants reduce the amount of available dissolved oxygen in the water with the rapid growth and decay of large biomasses. Removal of these weeds will improve water quality and reduce habitat degradation caused by these plants, thus improving habitat for fish and other wildlife (Sears et. al., 2006).

19. How will success be determined? What elements will be monitored/evaluated and by whom, how often and for how long?

Monitoring and evaluation of this project is currently being led by Benton SWCD, with the aid of contracted professionals, and will continue for as long as needed, provided funding is available. To determine success for this project, photo-points, which have already been established, will continue to be used for monitoring purposes. Data on the extent of native and invasive plants present at each site will be recorded and mapped. Each plot will be monitored to evaluate the response of the plant communities to each treatment method. Monitoring will take place before and after each treatment, and annually after that to assess the extent of Ludwigia and Nymphoides at each waterbody.

Success will be determined by comparing the post-treatment distribution and abundance of Ludwigia, yellow floating heart, and native plants to pre-treatment abundance and distribution. We will also measure and record water quality parameters and compare pre-and post-treatment findings with those found on other sites containing Ludwigia that have not been treated. This will help us to determine the water quality impacts of controlling dense to sparse Ludwigia populations. Mapping of Ludwigia population density will be continued in 2017 to better determine post-treatment changes.

This project includes the fourth year of treatment for Ludwigia at Collins Bay and yellow floating heart at Horseshoe Lake. Collins Bay is expected to require several more years of treatment to adequately reduce plant densities to levels where the habitat can stabilize. The first year was the most intensive for control work at the site. With the reduction in plant densities, treatments now require less labor and time, which means yearly maintanance should continue to decrease in cost.

An adjusted treatment plan will be needed for yellow floating heart at Horseshoe Lake to achieve eradication of the plants, as the glyphosate treatment method is not as effective as we had hoped.

20. What is the long term plan for this project? Who will maintain the project after the grant and for how long?

Benton SWCD is developing a long-term management plan for Collins Bay, which will include at least a five-year plan for restoration, maintanance, monitoring, and funding options. Other sites will eventually be included as part of this management plan, or as part of a larger plan for invasives management on the Willamette River, which is being developed by WAIN. Benton SWCD will continue to maintain these projects for as long as funding can be obtained. Many funding and maintenance options will be (or have been) considered, including discussion with landowners on the contributions they are willing and able to make. As indicated earlier, current Benton SWCD leadership is committed to the long-term success of this project. To the extent budgets allow, the organization is dedicated to continuing its role in providing the expertise and oversight of an aquatic invasive plant management program in Benton County.

RACIAL AND ETHNIC IMPACT STATEMENT

This form is used for informational purposes only and must be included with the grant application.

Chapter 600 of the 2013 Oregon Laws require applicants to include with each grant application a racial and ethnic impact statement. The statement provides information as to the disproportionate or unique impact the proposed policies or programs may have on minority persons[1] in the State of Oregon if the grant is awarded to a corporation or other legal entity other than natural persons. "Minority persons" are defined in SB 463 (2013 Regular Session) as women, persons with disabilities (as defined in ORS 174.107), African-Americans, Hispanics, Asians or Pacific Islanders, American Indians and Alaskan Natives.

1. ☐ The proposed grant project policies or programs could have a disproportionate or unique positive impact on the following minority persons:

Indicate all that apply:

_____ Women
_____ Persons with Disabilities
_____ African-Americans
_____ Hispanics
_____ Asians or Pacific Islanders
_____ Alaskan Natives
_____ American Indians

2. ☐ The proposed grant project policies or programs could have a disproportionate or unique negative impact on the following minority persons:

Indicate all that apply:

_____ Women
_____ Persons with Disabilities
_____ African-Americans
_____ Hispanics
_____ Asians or Pacific Islanders
_____ Alaskan Natives
_____ American Indians

3. ☑ The proposed grant project policies or programs <u>will have no</u> disproportionate or unique impact on minority persons.

If you checked numbers 1 or 2 above, on a separate sheet of paper, provide the rationale for the existence of policies or programs having a disproportionate or unique impact on minority persons in this state. Further provide evidence of consultation with representative(s) of the affected minority persons.

I HEREBY CERTIFY on this 14th day of December, 2016, the information contained on this form and any attachment is complete and accurate to the best of my knowledge.

Signature Holly Crosson

Printed Name: Holly Crosson

Title Executive Director

Project Partners

List agencies/organizations from which funding is anticipated for the proposed project.

The Oregon State Weed Board requires 25% match for projects. If you have questions with this requirement please contact Tristen Berg, ODA Grant Program Coordinator at 503-986-4622.

Show all anticipated funding sources, and indicate the dollar value for cash and in-kind contributions. For all funding please state within the "use of contribution" column exactly what the cash/in-kind will be used for- include a separate line for volunteers, labor, or materials. This helps the OSWB gain a better understanding of the roles and responsibilities the partners will have with the project. Check the appropriate box to denote if the funding status is secured or pending. In the Amount/Value Column, provide a total dollar amount or value for each funding source. Match should be directly related to the noxious weed project. **Other OWEB funding is not eligible for match toward OSWB grants.**

NOTE: If your project is selected for funding your organization will be asked to provide signatures for 25% match as a component of agreement procedures.

Funding Source (Name the Partner)	Use of Contribution	Cash	In-kind	Secured (x)	Pending (x)	Amount/Value
Sample Agency	***GIS mapping, and ATV use***		***$2,500***	*X*		***$2,500***
OSWB	**Planning and project coordination for aquatic invasives control, restoration planting, survey, and monitoring (WQ and effectiveness), and targeted outreach**	$31980	**N/A**	☐	☒	$31980
Oregon Dept. of Agriculture	**Project consultation, aerial and boat survey and data interpretation**	**N/A**	$1425	☐	☐	$1425
Meyer Memorial Trust Willamette Mainstem Cooperative Capacity Grant	**Benton SWCD Project Coordination and mileage**	$6081	**$**	☒	☐	$6081
Meyer Memorial Trust Willamette Mainstem Cooperative Capacity Grant	**River workshops and surveys**	$2800	**$**	☒	☐	$2800
Benton Soil and Water Conservation District	**Project staff assistance**	**$**	$1680	☒	☐	$1680

Willamette Riverkeeper	**Staff assistance with restoration work parties, surveys, community outreach, and ecological monitoring and equipment**	**$**	$2920	☐	☐	$2920
Marvin Gilmour	**Plant materials for restoration planting, and labor for seed harvest/processing**	**$**	$3016	☐	☐	$3016
Greenbelt Land Trust	**Project coordination and planning, contractor oversight**	**$**	$1440	☐	☐	$1440
OWEB-SIP funds (non-matchable)	**Ludwigia treatments at Collins Bay**	$4973	**$**	☐	☐	$4973 (non-matchable)
Benton SWCD volunteers	**Native seed and bulb collection and planting**	**$**	$1319	☐	☐	$1319
Oregon Parks and Recreation Department	**Control, monitoring, and outreach activities**	**$**	$1500	☐	☐	$1500
		$	**$**	☐	☐	**$**
		$	**$**	☐	☐	**$**
Total Estimated Funds (add all amounts in the far-right Column):	(The total should equal the total cost of the project on page 1 of the application)					***$59135**
Have any conditions been placed on matching funds that may affect completion? ☐ Yes ☒ No If Yes , Explain:						

NOTICE of Grant Award Conditions

Initial each category below and be sure this page is submitted along with your completed proposal.

☒ If this proposal is funded, you will be required to:

- Sign a Grant Agreement containing the terms and conditions for the project implementation, release of funds, and documentation of completion.
- Payments will be made only for work started after the effective date of the grant agreement, unless special conditions have been placed by ODA/OWEB.

☒ Before ODA/OWEB releases the Grant Agreement, you will be required to:

- Resolve any and all outstanding issues from your previous grants with ODA/OWEB.

☒ Upon signing the Grant Agreement, you will be required to:

- Certify in the Grant Agreement that prior to starting work on private land, you have or will obtain cooperative agreements with the private landowner(s). Exhibit D of the ODA/OWEB Grant Agreement may also require you to submit copies of those agreements to ODA/OWEB prior to the release of funds.
- Agree that monitoring information resulting from projects are public domain.
- Determine what permits and licenses are required.

☒ Before ODA/OWEB releases any payments, you will be required to:

- Document that 25% match funding has been secured.
- Submit an OWEB Metrics Form.
- Submit copies of all applicable permits and licenses from local, state, or federal agencies or governing bodies, or certify that permits and licenses are not needed.

☒ Upon completing the project, you will be required to:

- Submit a Project Completion Report as required in the Grant Agreement, including maps, and photos. OGMS Online Project Completion Reporting can be completed at http://apps.wrd.state.or.us/apps/oweb/fiscal/default.aspx.
- Submit your Oregon Watershed Restoration Inventory report(s) electronically at http://apps.wrd.state.or.us/apps/oweb/owrio/default.aspx. New weed site data will be pulled from OWRI to meet Weedmapper requirements.

CERTIFICATION:

I certify that this application is a true and accurate representation of the proposed project and that I am authorized to sign as the Applicant or Co-Applicant. By the following signature, the Applicant certifies that they are aware of the requirements (***see Application Instructions***) of an OSWB/OWEB grant and are prepared to implement the project if awarded. **I have read and initialed the NOTICE of Grant Award Conditions**

Applicant Signature: Holly Crosson Date: 12/14/16

Print Name: Holly Crosson Title: Executive Director

Co-Applicant Signature: _____ Date: _____

Print Name: _____ Agency: _____

All appendices are housed within the application instructions section and can be downloaded at:
http://www.oregon.gov/ODA/programs/Weeds/Pages/GrantProgram.aspx

Mandatory attachments:

- **Oregon State Weed Board Project Budget.**
- **Project Partner Form.**
- **Racial and Ethnic Statement.**
- **Maps highlighting specific area of project activities.**
- **Photos (please use the same photo points you will use on interim progress reporting and project completion reports should this project be awarded).**
- **For landowner reimbursement projects – landowner list with acreages listed by weed species.**

Oregon State Weed Board Project Budget

Oregon State Weed Board Project Budget

IMPORTANT: Read the application instructions and the current OWEB Budget Categories Document. http://www.oregon.gov/OWEB/forms/2015_Budget_Category_Definitions_Policies.pdf

Add additional lines, if necessary. All costs must be directly associated with project.

Totals automatically round to the nearest dollar.

A	B	C	D	E	F		G
Itemize projected costs under each of the following categories:	**Unit Number** (e.g. # of hours)	**Unit Cost** (e.g. hourly rate)	**OWEB Funds**	**Cash Match**	**In-Kind Match**	**OWEB-SIP Funds (Non-matchable)**	**Total Costs** (add columns)
SALARIES, WAGES AND BENEFITS. List position titles for in-house staff/applicant employees for whom payroll taxes are paid. Include only costs charged to this grant.							
Project Coordination	320 hrs	$ 32.00	4,380	5,860			**10,240**
Staff Assistance	40 hrs	$ 42.00			1,680		**1,680**
(1)		**SUBTOTAL**	4,380	5,860	1,680		**11,920**
CONTRACTED SERVICES. Labor, supplies, materials and travel to be provided by *non-staff* for project implementation.							
Collins Bay (10.5 acres) - Aquatic veg. control (herbicide) with Intelli-spray and tractor and backpack, early summer and early fall treatment (IRM)	3 days (6-7 crew)	2324.47	2,000			4,973	**6,973**
Scatter Bar Pond at Horseshoe Lake, Linn County (5.25 acres) - Aquatic veg. control (herbicide) with Intelli-spray and tractor and backpack, early summer and early fall treatment (contractor)	5 days (5-6 crew)	1113.71	5,569				**5,569**
Horseshoe Lake, Benton County - Aquatic veg control (herbicide) with backpack, early summer and early fall treatment (IRM)	3 days (3 crew)	326.67	980				**980**
Restoration work parties, surveys, community outreach, and ecological monitoring (Willamette Riverkeeper contract)	160 hrs	40	1,600	2,800	2,000		**6,400**
Mileage reimbursement (Willamette Riverkeeper, Portland)	1100	0.54	594				**594**
Canoes, paddling equip., dry bags, trailer & other equip. (Willamette Riverkeeper)	46 units	20			920		**920**
Third year of water quality monitoring (pre and post treatment) and Ludwigia density mapping (Mosaic Ecology contract)	216 hrs	$35/$70	13,020				**13,020**
Mileage reimbursement (Mosaic Ecology, Portland)	1000	0.54	540				**540**
Project consultation, river survey (aerial and boat) and data interpretation (ODA, Glenn Miller)	3 days	$475			1,425		**1,425**
Control, monitoring, and outreach activities (Oregon State Parks Dept., Scott Youngblood)	3 days	$500			1,500		**1,500**

Oregon State Weed Board Project Budget

A	B	C	D	E	F		G
Itemize projected costs under each of the following categories:	**Unit Number** (e.g. # of hours)	**Unit Cost** (e.g. hourly rate)	**OWEB Funds**	**Cash Match**	**In-Kind Match**	**OWEB-SIP Funds (Non-matchable)**	**Total Costs** (add columns)
Native plant materials for restoration planting; wapato, bur-reed, common rush & soft-stem bulrush (local farmer, Marvin Gilmour)	3 lbs seed; 1,000 bulbs	various			2,696		**2,696**
Processing seed and harvesting bulbs (Marvin Gilmour)	8 hrs	40			320		**320**
Collecting seeds and bulbs (volunteers)	24 hrs	23.56			565		**565**
Restoration planting, seeds and bulbs (volunteers)	32 hrs	23.56			754		**754**
Project coordination and planning, contractor oversight (Greenbelt Land Trust)	40 hrs	36			1,440		**1,440**
							0
(2)		**SUBTOTAL**	24,303	2,800	11,620	4,973	**43,697**
TRAVEL. Mileage, per diem, lodging, etc. Must use current State of Oregon rates.							
Mileage for project (BSWCD staff) through MMT grant	410	0.54	0	221	0	0	**221**
							0
(3)		**SUBTOTAL**	0	221	0	0	**221**
MATERIALS and SUPPLIES. Refers to items that are purchased by, or invoiced to, the applicant, and are "used up" in the course of the project. Costs must be directly related to the implementation of this grant.							
							0
							0
(4)		**SUBTOTAL**	0	0	0	0	**0**
EQUIPMENT/SOFTWARE. List portable equipment costing **$300** or more per unit. Must remain property of a governmental entity, tribe, watershed council, SWCD, institution of higher learning or school district.							
Fulcrum software - for ability to map aquatic invasive data along the river during surveys			300				**300**
							0
(5)		**SUBTOTAL**	300	0	0	0	**300**
OTHER. Grantee-owned equipment costs, small equipment repair, project-specific printing, and items that do not fit other categories.							
Disposal of bagged hand pulled aquatic invasive plants at landfill site	3 visits	30	90				**90**
							0
(6)		**SUBTOTAL**	90	0	0		**90**
(7)	**MODIFIED TOTAL DIRECT COSTS: Add all subtotals (1-6) above.**		29,073	8,881	13,300	4,973	**56,228**
INDIRECT COSTS. Not to exceed **10% of Modified Total Direct Costs (7)**. Choose **ONE** of the indirect cost methods below.							
10% "*de minimis*" indirect rate requested.	X	10%	2,907				**2,907**
No reimbursement for indirect costs requeste	☐	0%	0				**0**
(8)		**SUBTOTAL (8)**	**2,907**	**0**	**0**	**0**	**2,907**
GRAND BUDGET TOTAL: Add Totals (7), and (8). Totals automatically round to the nearest dollar.*			**31,980**	**8,881**	**13,300**	**4,973**	**59,135**

* The totals for these two columns must mirror the match totals provided on the Match Funding form..

December 14, 2016

Oregon State Weed Board
635 Capital St. NE
Salem, Oregon 97301-2532

Dear Oregon State Weed Board Grant Review Members,

On behalf of the Willamette Aquatic Invasive Network and Willamette Riverkeeper I would like to express our strong support of the Benton County Cooperative Weed Management Area (CWMA) grant proposal for "Willamette River Aquatic Weed Management Project Phase 4" in the Corvallis to Albany Reach of the Willamette River. This project will treat target noxious weeds, restore biologically diverse habitat, and allow for much needed community outreach about the importance of protecting and enhancing floodplain habitat in the Willamette Valley.

The Willamette Aquatic Invasive Network (WAIN) is a group of natural resource and conservation professionals working to foster collaboration, share information, and develop strategies to restore riparian habitat in the Willamette River basin. Willamette Riverkeeper is a non-profit organization dedicated to protecting and restoring the Willamette River. Willamette Riverkeeper will work with Benton SWCD to help recruit volunteers and engage community members in hands-on stewardship activities. In partnership, we will co-facilitate two aquatic weeds trainings one targeted for the community and the other for members of WAIN. We will also facilitate two community restoration work party events during the summer season. The work party events will focus on hand pulling target invasive plants and providing community outreach and hands on education.

Willamette Riverkeeper plans to dedicate $2,920 in kind match toward this project to leverage resources for the aquatic weed workshops, aquatic invasive surveys, project coordination, and use of canoes to support the Benton County CWMA efforts in the Corvallis to Albany river reach. Willamette Riverkeeper will also be surveying for data gaps on the mainstem Willamette River downstream of Albany (outside of the jurisdiction of the Benton County CWMA). Knowledge gained from on the ground surveys related to this project proposal will help WAIN with the development of a prioritized treatment plan for invasive species such as *Ludwigia* along the mainstem Willamette River in the Peoria to Albany Reach.

Thank you for your careful consideration of this grant proposal.

Sincerely,

Marci Krass
Restoration Coordinator

Oregon
Kate Brown, Governor

Parks and Recreation Department
Southern Willamette Mgmt Unit
570 N Moss St
Lowell, OR 97452
541 937-1173

Oregon State Weed Board
635 Capital St. NE
Salem, Oregon 97301-2532

December 13, 2016

Subject: Support for the BC CWMA OSWB application entitled "*Willamette River Aquatic Weed Management Phase 4*"

Dear Oregon State Weed Board Grant Review Team Members,

I am writing to express the Oregon Department of Parks & Recreation's (OPRD) support for the Benton County Cooperative Weed Management Area's (BC CWMA) grant proposal for aquatic weed management. Partnerships between private and public landowners, local and state agencies, and non-profit conservation organizations have formed in recent years to address critical habitat needs along the Corvallis to Albany Reach of the Willamette. The Willamette Mainstem Cooperative (WMC) is one such partnership and has conducted a landscape scale weed assessment of the floodplain between Corvallis and Albany. One outcome of the assessment process is that *Ludwigia hexapetala* has been identified as a priority species for control in the Willamette River. The BC CWMA proposes to conduct follow-up treatments of *Ludwigia* in Collins Bay, and to add an additional site locally known as Oxbow. Several *Ludwigia* sites have been the focus of volunteer hand-pulling in previous years, and will continue to be monitored and targeted for hand-pulling during this project phase.

The control of target invasive plants will contribute significantly to improving ecological function of the Willamette River, and protecting unique and high quality habitats. In order to support the next phase of these efforts, OPRD staff will assist in volunteer and outreach activities on the river including weed pulls and aquatic weed workshops. OPRD will contribute $1500 in staff time for control, monitoring, and outreach activities related to this project.

The control of aquatic invasive plants will contribute significantly to the overall goal of improving ecological function of the Willamette River habitats.

Thank you for your consideration of this proposal.

Sincerely,

Julie Whalen

Julie Whalen
OPRD Park Manager

OSWB Grant Program
Oregon Dept. of Agriculture
635 Capitol St NE
Salem, OR 97301

December 14, 2016

Subject: Support for the OSWB application entitled "*Willamette River Aquatic Weed Management Phase 4*"

Dear Members of the Review Team:

I am writing to express great support of Benton County Cooperative Weed Management Area (CWMA) grant proposal for invasive plant control at Greenbelt Land Trust's "Scatter Bar Pond" site along the Willamette River in Linn County. Partnerships between private and public landowners, local and state agencies, and non-profit conservation organizations have formed in recent years to address critical habitat needs along this reach. Greenbelt Land Trust is looking forward to working with Benton Soil and Water Conservation District (SWCD) on this project. Benton SWCD has taken a lead role by conducting a landscape scale weed assessment of the floodplain between Corvallis and Albany. This proposal is an outcome of that assessment and it builds on Benton SWCD's and Benton County CWMA's ongoing restoration efforts occurring along the river.

Greenbelt Land Trust is actively working on invasive plant control and floodplain restoration on 376 acres at two sites (Horseshoe Lake [in Linn County[1]] and Little Willamette) in this same reach of the river. Approximately 80 acres of agricultural fields within the floodplain have been planted to forest and more will be completed in the next few years. Control of Himalayan blackberry, bull and Canada thistle, English ivy, false brome, old man's beard, Scotch broom and other species are part of larger habitat restoration efforts at these two sites.

Greenbelt can contribute up to $1,440.00 as match funds (through Meyer Memorial Trust) in staff time for project and landowner coordination and monitoring for Benton SWCD's project.

The weed assessment and control efforts of Benton SWCD combined with restoration efforts at Horseshoe Lake (in Linn County) and Little Willamette will not only provide tremendous ecological benefits but will likely lead to more conservation opportunities in the vicinity of each project.

Please feel free to contact me if you have any questions.

Sincerely,

Matt Blakeley-Smith
Willamette Restoration Coordinator

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1 Please note that Greenbelt Land Trust's Horseshoe Lake property (in Linn County) is a different site than the Horseshoe Lake site discussed in Benton County CWMA's 2017 ODA OSWB grant application.

References

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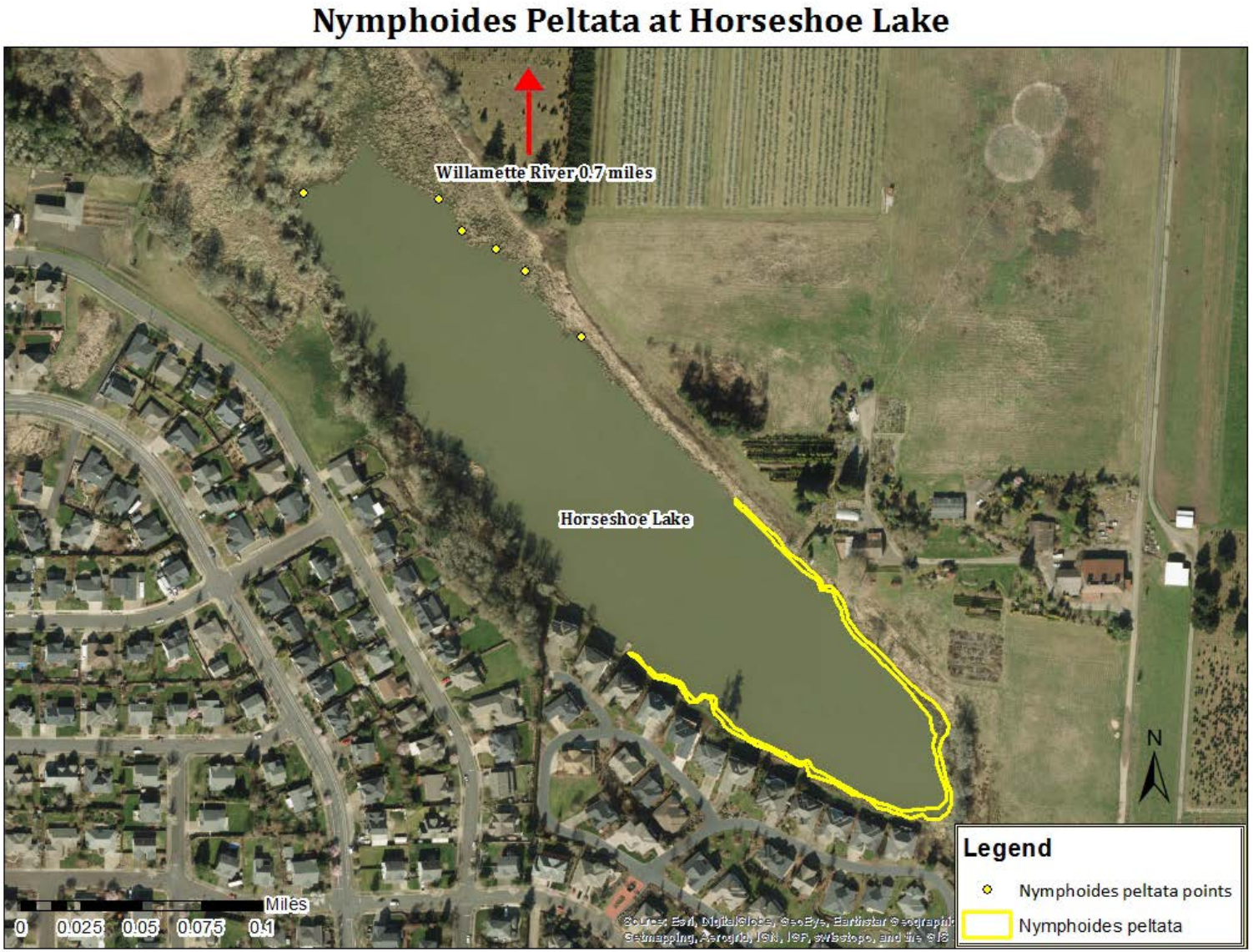
Appendix A: Map and Photos of Yellow Floating Heart Treatment Area at Horseshoe Lake, Benton County



Map 1: Location of yellow floating heart (*Nymphoides peltata*) at Horseshoe Lake, Benton County. Points mark small populations or single plants.

Appendix A (*continued*): Map and Photos of Yellow Floating Heart Treatment Area at Horseshoe Lake, Benton County

Photo Monitoring at Horseshoe Lake: Yellow Floating Heart (*Nymphoides peltata*)

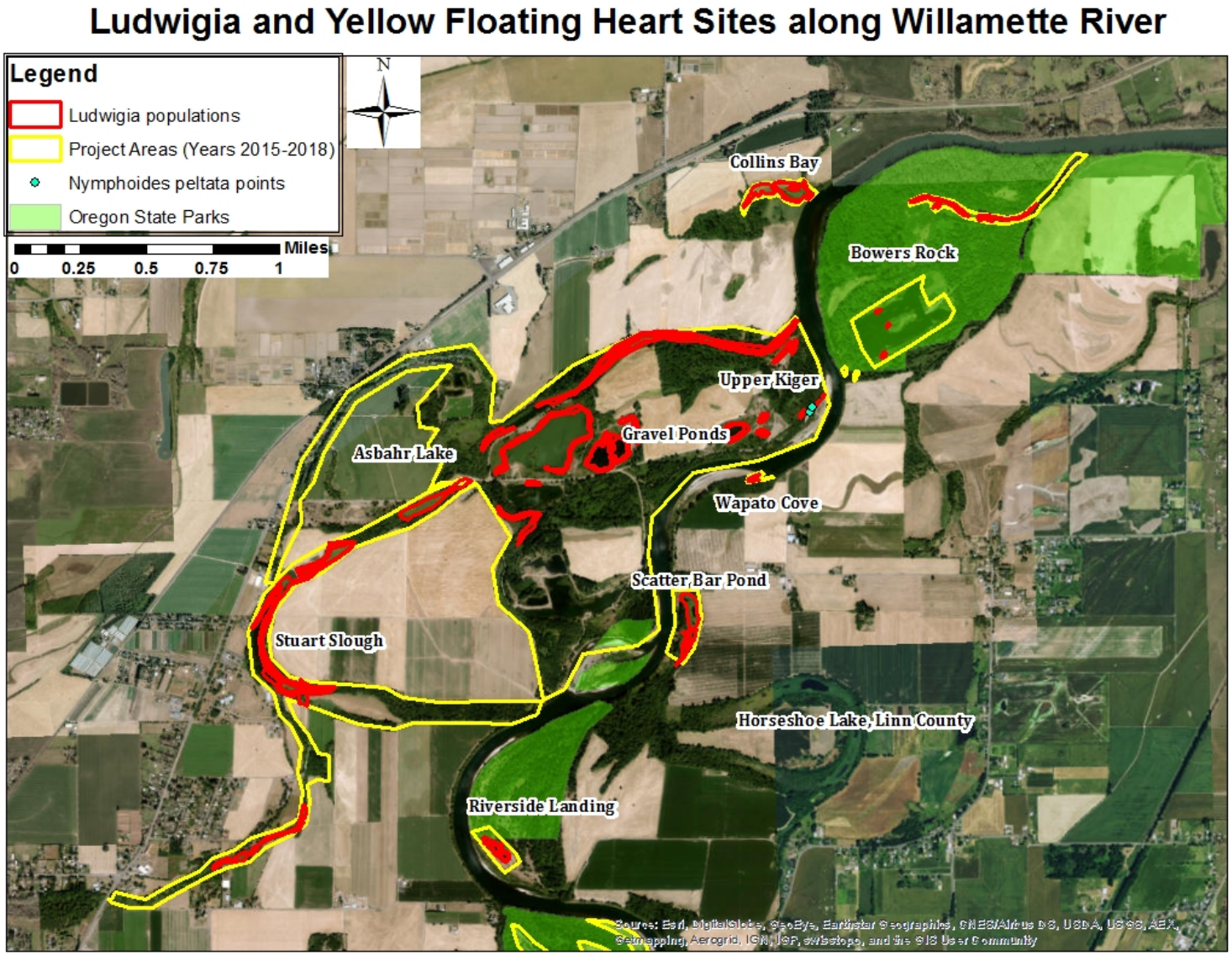
Yellow floating heart at Horseshoe Lake - June, 2014

Yellow floating heart at Horseshoe Lake - July 11, 2016

Before third year of treatment - July 11, 2016

After third year of treatment - August 26, 2016

Appendix B: Maps and Pictures of Ludwigia and Yellow Floating Heart Treatment Areas along River



Map 2: Location of invasive water primrose species (*Ludwigia* ssp.) and yellow floating heart (*Nymphoides peltata*) on the Willamette River between Corvallis and Albany.

Appendix B (*continued*): Maps and Pictures of Ludwigia and Yellow Floating Heart Treatment Areas along River

Photo Plot Monitoring at Collins Bay: Before and After *Ludwigia* Treatments

Photo Point 1— July 7, 2014, before Ludwigia treatment

Photo Point 1— June 27, 2016, before third year of Ludwigia treatment

Photo Plot 1— Sept. 29, 2016, after third year of treatment

Appendix B (*continued*): Maps and Pictures of Ludwigia and Yellow Floating Heart Treatment Areas along River

Photo Plot Monitoring at Collins Bay: Before and After *Ludwigia* Treatments

Photo Point 4— July 7, 2014, before Ludwigia treatment

Photo Point 4— July 25, 2016, before third year of Ludwigia treatment

Photo Plot 4— Sept. 29, 2016, after third year of treatment

Appendix B (*continued*): Maps and Pictures of Ludwigia and Yellow Floating Heart Treatment Areas along River

Willamette River Aquatic Weed Management Project Pictures

Aquatic weed workshop on the Willamette between Corvallis & Albany. PSU professor Mark Sytsma discussing parrotfeather. June 28, 2016.

Aquatic weed workshop on the Willamette between Corvallis & Albany. June 28, 2016.

Volunteer Ludwigia weed pull & workshop on the Willamette River (Upper Kiger Side Channel). July 16, 2016.

Volunteer Ludwigia weed pull & workshop on the Willamette River. July 16, 2016.

Appendix B (*continued*): Maps and Pictures of Ludwigia and Yellow Floating Heart Treatment Areas along River

Northwest Youth Corps Ludwigia weed pull on the Willamette River (East Channel Willamette River). September 1, 2016.

Wapato tuber collection at local landowner's property who donated native plant materials for Collins Bay restoration. September, 14, 2016

Water quality monitoring at Scatter Bar Pond at Horseshoe Lake, Linn County site ("control site" with no *Ludwigia* herbicide treatment). July 21, 2016.

Appendix C: Wapato Cove Photos

Ludwigia (and wapato) at Wapato Cove - August 12, 2016

Ludwigia (and wapato) at Wapato Cove - scouting trip July 13, 2016

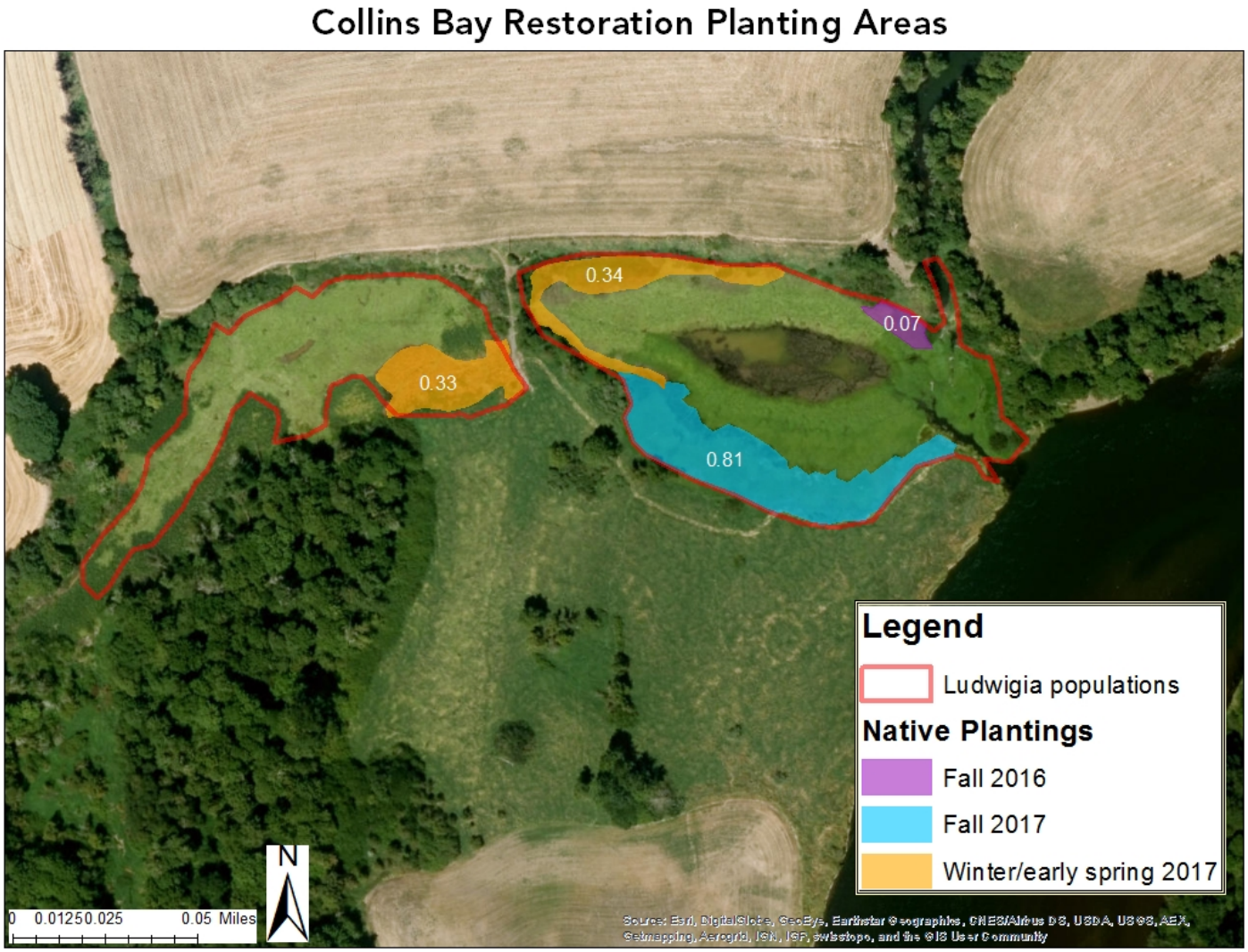
Ludwigia (and wapato) at Wapato Cove - scouting trip July 13, 2016

Appendix D: Scatter Bar Pond at Horseshoe Lake, Linn County Photos

Ludwigia at Scatter Bar Pond at Horseshoe Lake, Linn County – July 2016

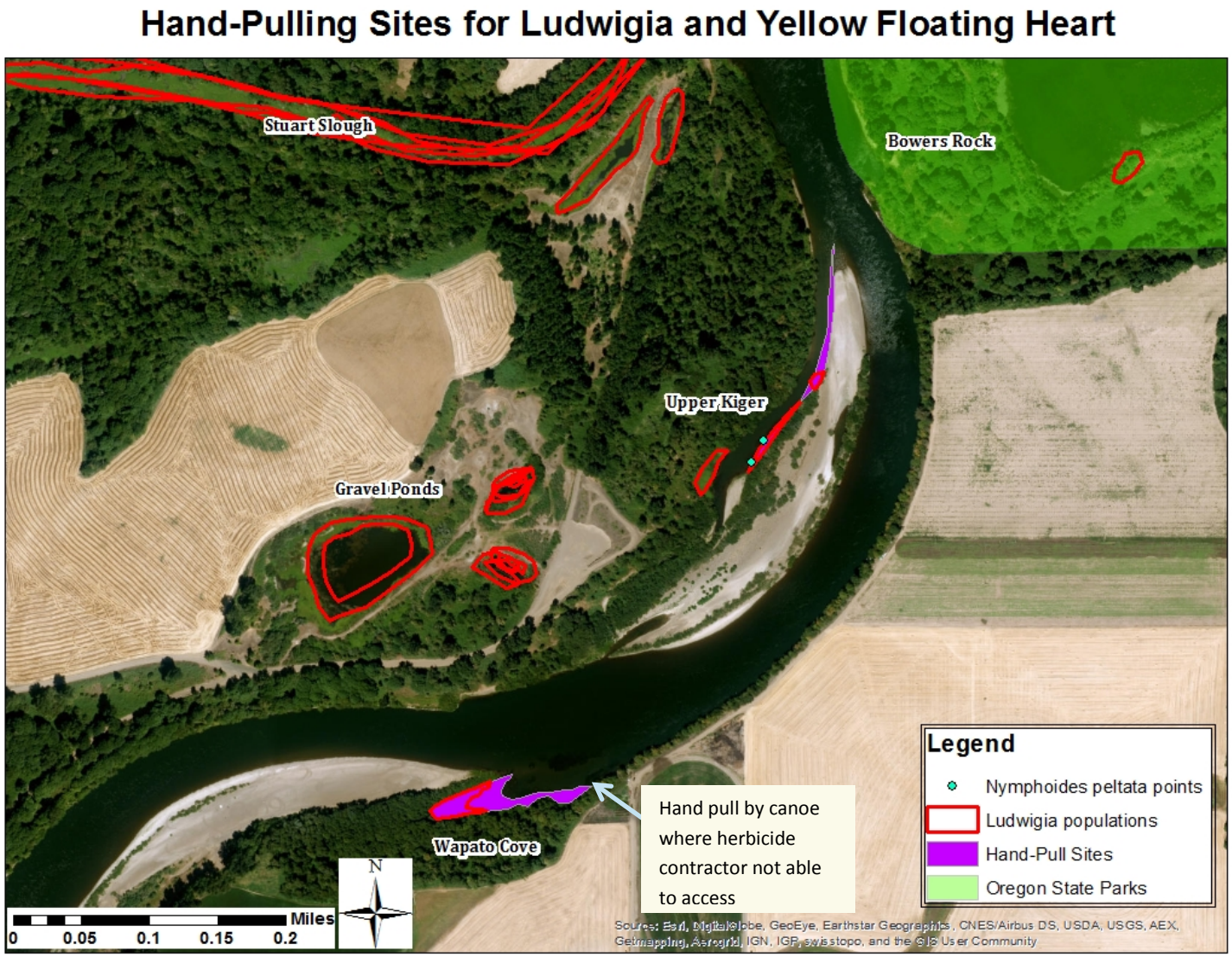
Water quality monitoring at Scatter Bar Pond at Horseshoe Lake, Linn County – July 2016

Appendix E: Collins Bay Restoration Areas Map



Map 3: Restoration planting areas at Collins Bay.

Appendix F: Map of Ludwigia and Yellow Floating Heart Sites for Hand Pulling



Map 4: Sites for hand-pulling Ludwigia and Yellow Floating Heart., including Wapato Cove and Upper Kiger side-channel.

Appendix G: 2015 Ludwigia Monitoring Plan for Benton Soil and Water Conservation District

Ludwigia Monitoring Plan for Benton Soil and Water Conservation District

Created by Mosaic Ecology LLC
June 29, 2015
Contact: Alex Staunch, restoration technician
Stau9723@gmail.com, 585.315.6926

Overview

In connection with the on-going control of *Ludwigia* spp. within the Willamette River system of Benton County, Oregon, a long-term monitoring program will be established within the Stuart Slough Project Area. Data collection in 2015 will create baseline measurements for water quality and *Ludwigia* abundance within four bodies of water. Monitoring locations were selected to represent the diverse environments and varied water body types that are targeted for *Ludwigia* control (gravel pit, slough, oxbow, bay). Water quality monitoring will assess impacts of large scale eradication efforts on water chemistry (dissolved oxygen, pH, temperature, conductivity) and mapping will show annual shifts in range and density of large *Ludwigia* infestations. Monitoring will begin on July 1, 2015 and the written report will be completed by 2/1/2016. The proposed monitoring plan for 2015 is meant to generate data that can be replicated and compared to future years' monitoring within the project area.

Benton SWCD Project Prescription (Appendix I)

Monitoring Goals

1. Assess impact to water quality of large masses of decaying *Ludwigia* in response to control.
2. Measure pre-treatment *Ludwigia* range and density values to allow annual comparisons.
3. Create and improve repeatable methods in order to duplicate data collection for following years.

Monitoring Sites

A total of 4* locations were selected within the project area to provide detailed information regarding water quality and shifts in *Ludwigia* abundance (Appendix II). Sites represent some of the diverse water body types that have been targeted for control. Baseline water quality and GPS data will be collected within the Oxbow, Stuart Slough and Gravel Pit sites where control has yet to be administered. The Oxbow site is targeted for removal in 2016 or 2017, thus will act as a control for *Ludwigia* infested waterbodies. The Collins Bay site experienced chemical control in 2014 and will be mapped in 2015 to provide an estimate of current *Ludwigia* abundance. The 2014 Collins Bay infestation will be estimated, from previous site notes and picture monitoring to produce a comparison that can be produced this coming year.

* *Number of sites may be adjusted in accordance with time and funding.*

Methods Summary: *Detailed data collection methods available upon request.*

Range & Density Mapping: The 4 target locations will be mapped by hand-held GPS instruments to create cover classes and quantify total infestation acreage. Methods and deliverables will be similar to those used for the Blue Heron Wetland Restoration Project (Appendix III). Cover classes will be generated to represent Sparse (<5%), Moderate (5 – 50%) and Heavy (>50%) cover classes. Polygons will be generated by tracing infestation densities by foot and watercraft.

Water Quality: Data will be collected by hand, using YSI Professional Pro Plus Multiparameter Water Quality Meter (https://www.ysi.com/proplus). The instrument was retrofitted with additional probes to collect the variables of dissolved oxygen, temperature, pH and conductivity. All 4 variables will be collected at a minimum of 4 points within each location. At each site, depth and average percent cover of *Ludwigia* within a 5 foot radius will be assessed. At each point, sub-surface samples will be collected directly below the water surface, within the *Ludwigia* biomass and directly below the floating mass (or 6 inches above bottom).

Appendix I. Prescription and timeline for monitoring *Ludwigia* within the Stuart Slough Project Area for the Benton SWCD.

Mosaic Ecology LLC
Alex Staunch
3355 NE 74th Ave
Portland, OR 97213
585.315.6926

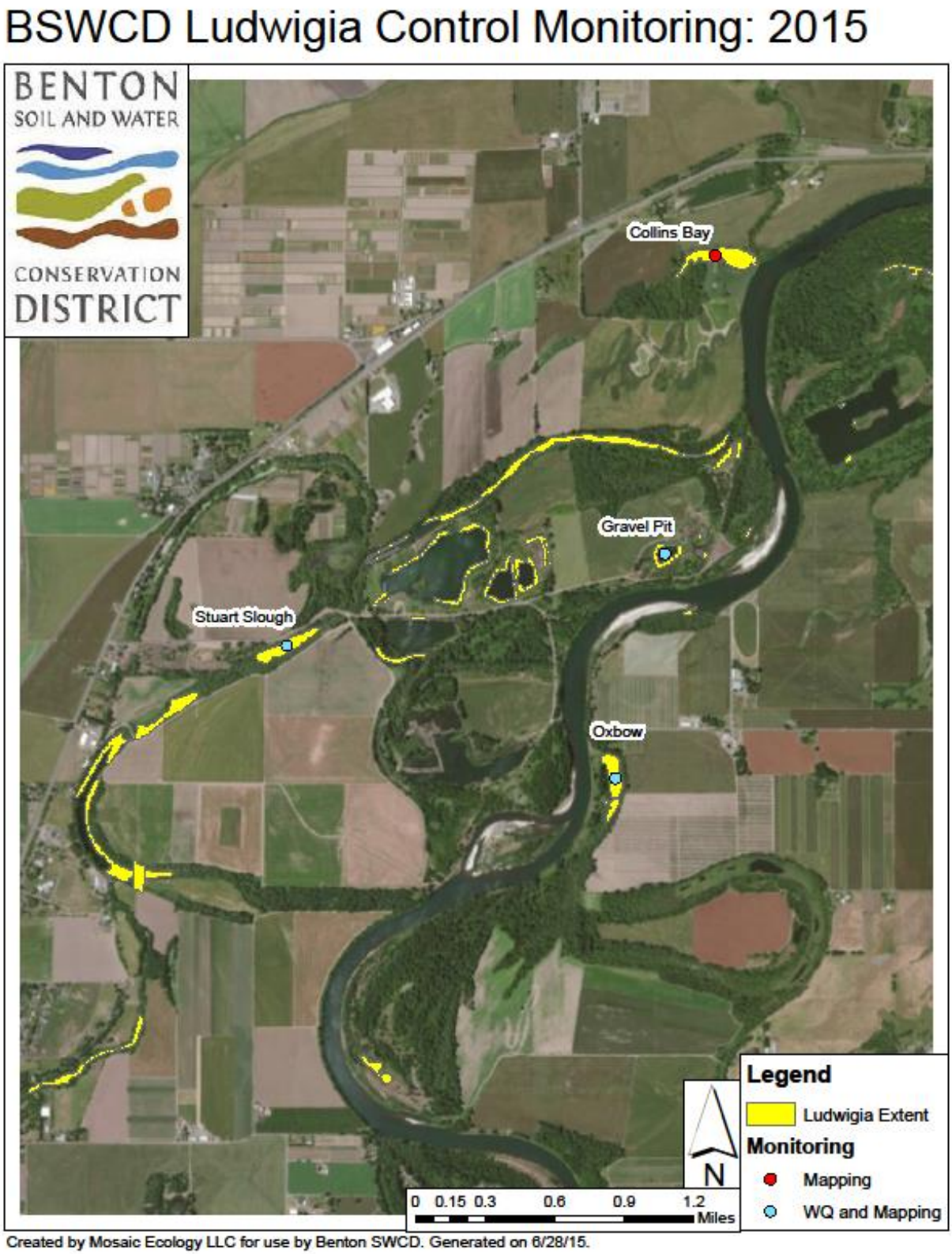
Prescription for: Benton Soil & Water Conservation District

Project Name: *Ludwigia* Monitoring

Description	Number	Unit	Date*	Cost per Unit	Total	Notes
Monitoring Protocol Creation (Alex Staunch)	15	hr	Jun-15	$ 65.00	$ 975.00	Site visit (6/19/15), purchasing of instruments, monitoring design creation, consultation, etc.
Pre-Treatment Data Collection: GPS Mapping (Alex Staunch)	12	hr	7/2/15	$ 65.00	$ 780.00	Pre-treatment maps for range and density of *Ludwigia* will be collected at up to 4 locations
Pre-Treatment Data Collection: Water Quality (Alex Staunch)	12	hr	7/6/15	$ 65.00	$ 780.00	Collect baseline samples for water quality at 3 locations
Pre-Treatment Assistant: Water Quality (Chris Holmes)	12	hr	7/6/15	$ 35.00	$ 420.00	Assist Alex Staunch to collect samples for water quality
GIS Analyses and Map Generation (Alex Staunch)	15	hr	7/31/15	$ 65.00	$ 975.00	Create range and density maps of up to 4 locations
Post Treatment (1) Data Collection: Water Quality (Alex Staunch)	12	hr	7/15/15	$ 65.00	$ 780.00	Collect samples for water quality at 1 week to 10 days after initial treatment
Post Treatment (1) Assistant: Water Quality (Chris Holmes)	12	hr	7/15/15	$ 35.00	$ 420.00	Assist Alex Staunch to collect samples for water quality
Post Treatment (2) Data Collection: Water Quality (Alex Staunch)	12	hr	8/7/15	$ 65.00	$ 780.00	Collect samples for water quality 1 month after initial treatment
Post Treatment (2) Assistant: Water Quality (Chris Holmes)	12	hr	8/7/15	$ 35.00	$ 420.00	Assist Alex Staunch to collect samples for water quality
Post Treatment (3) Data Collection: Water Quality (Alex Staunch)	12	hr	11/1/15	$ 65.00	$ 780.00	Collect samples for water quality during natural winter senescence
Post Treatment (3) Assistant: Water Quality (Chris Holmes)	12	hr	11/1/15	$ 35.00	$ 420.00	Assist Alex Staunch to collect samples for water quality
Data Analyses Water Quality (Alex Staunch)	30	hr	1/1/16	$ 65.00	$ 1,950.00	Organize, statistically analyse and create presentable figures of water quality data
Report Writing (Alex Staunch)	40	hr	2/1/16	$ 65.00	$ 2,600.00	Create document summarizing monitoring program and collected data
Mileage	1200	miles	-	$ 0.57	$ 678.00	Accounts for a total of 6 trips to Corvallis from Portland, OR. 100 miles each way.
TOTAL					**$ 12,758.00**	

*Dates are approximate and are subject to change

Appendix II. Proposed sites for monitoring and data collection.



Appendix III. Example of proposed map to be created for Benton SWCD.

L. peploides Range & Density within Blue Heron Wetlands
Pre and Post Chemical Application

September 3rd, 2012

August 5th, 2013

Ludwigia Coverage (Acreage)

Percent Cover	2012	2013
Sparse (< 5%)	0.508	1.577
Light (5% - 50%)	0.820	0.322
Heavy (> 50%)	1.031	0.401

0 100 200 Feet

Map created for Blue Heron Wetland Restoration Project on 9/20/2013. Aerial imagrey was provided by the City of Portland Bureau of Planning and Sustainability.
All other data obtained from RLIS. For additional information contact Alex Staunch at staunch@pdx.edu.

Appendix H: 2015 Water Quality and Ludwigia Monitoring Report

2015 Water Quality and *Ludwigia* Monitoring Report for Stewart Slough Project Area, Benton County




BENTON SOIL AND WATER CONSERVATION DISTRICT

Prepared by Mosaic Ecology LLC
For Benton Soil & Water Conservation District
February 2016

mosaic ECOLOGY

This report is meant to be utilized by staff of Benton Soil & Water Conservation District as well as interested members of the natural resource community

Overview

In July of 2015, in association with the on-going control of Uruguayan primrose-willow (*Ludwigia hexapetala*) within the Willamette River system of Benton County, Oregon, Benton Soil & Water Conservation District (BSWCD) developed a pilot monitoring program. Monitoring was conducted in order to track annual population shifts of *Ludwigia* in response to control efforts and to assess the effect of herbicide treatments for the control of *Ludwigia* on water quality.

Aquatic plants are known to affect water quality. Dense populations of aquatic plants alter diurnal fluctuations of dissolved oxygen (DO) and large-scale die-offs can create anoxic conditions detrimental to aquatic life. Monitoring compared DO within open water and *Ludwigia* infested areas of waterbodies within the Stewart Slough Project Area. Monitoring occurred before and after herbicide treatment from July to November in an attempt to capture the rapid reduction of DO in response to *Ludwigia* decay. Range and density of *Ludwigia* within three distinct water bodies were mapped to record baseline *Ludwigia* cover. Generated maps will assist applicators to target areas of regrowth and adjust management methods accordingly. Water quality data was collected by a handheld YSI meter in four distinct water bodies up to four times during the 2015 growing season. Presented data focused on dissolved oxygen with an emphasis on the effect to aquatic organisms.

Ludwigia infested sampling sites possessed lower DO than open water environments even prior to herbicide application. The presence of *Ludwigia* resulted in DO values exceeding thresholds that impair aquatic organisms, in some cases low enough to cause acute mortality. Open water areas contained elevated DO levels, providing refuge for fish in water bodies containing *Ludwigia.* A clear reduction of DO resulting from mass decay was not observed across all sites. Due to varying physical variables between sampled water bodies, sites showed varying baseline DO values and trends over time.

The monitoring effort was conducted to inform BSWCD of the possible impacts the *Ludwigia* control may have on water quality in the Stewart Slough Project Area. Monitoring was not required by Oregon Department of Environmental Quality (DEQ) or the US Environmental Protection Agency (EPA), though a Pesticide General Permit was required and obtained through DEQ for treatment of *Ludwigia* infestations. Field and data analysis methods from the 2015 monitoring effort were evaluated and recommendations for the following years have been made.

Monitoring Goals

1. Measure pre-treatment *Ludwigia* range and cover values for annual comparisons.
2. Assess how the presence of *Ludwigia* affects water quality with or without herbicide treatment.
3. Develop a replicable monitoring methodology that can be used for data collection in future years.

Background

Ludwigia in Stewart Slough Project Area

Native to Central and South America, *Ludwigia hexapetala* and *L. peploides* ssp. *montevidensis* are invasive aquatic plants that are rapidly increasing in prevalence in Oregon, most notably in the Willamette River Valley (ODA 2015). In the past 10 to 15 years, *Ludwigia* populations have occupied high profile sites such as Delta Ponds Park of Eugene, leading to an increased local awareness and the discovery of established *Ludwigia* populations throughout the Willamette River Valley (City of Eugene 2013). From 2012 to 2015, surveys by boat and remote sensing showed that *Ludwigia* had become "widespread" within Linn, Benton and Marion Counties, and was expanding the its range in Oregon to the north and south (ODA 2011; ODA 2015) Listed as a Class B noxious weed in the State of Oregon, intensive management is encouraged on a case-by-case basis (ODA 2014).

After initial surveying showed extensive infestations within side channels, oxbows, riverine wetlands and other water bodies of the Willamette River, BSWCD acquired funding from the Oregon State Weed Board, the Oregon Watershed Enhancement Board and other sources in an attempt to eradicate or greatly reduce *Ludwigia* in over 4 miles of infested habitat in the Stewart Slough Project Area of Benton County. Collins Bay, located north of the Stewart Slough Project Area, was initially chemically treated in 2014 for *Ludwigia*. Collins Bay was mapped in 2015 to assess the efficacy of the previous year's control methods. The first year of full scale treatment within the Stewart Slough Project Area occurred in late-June to early-July of 2015, with follow up applications occurring in August and October of 2015. Contractors applied a formulation of aquatic label Rodeo (glyphosate) at a concentration of 3%, with dye and Agri-dex surfactant. Herbicide formulations were selected for their known effectiveness in treating *Ludwigia* and relatively low toxicity to fish, mammals and invertebrates in comparison to other formulations. Due to the large scale of the project area, sections of the four mile slough system were treated over a period of 15 application days. Roughly four weeks after the July 2015 chemical application, large masses of *Ludwigia* were observed dying as leaf and stem tissue browned, curled and sank to decay at the water bottom (Figure 1.).

Figure 1. *Ludwigia* within Stewart Slough #1 Site (Asbahr Lake) of project area, 7/6/2015 (A) prior to chemical application and four weeks after chemical application, 8/11/2015 (B).

Effects of Plants to Dissolved Oxygen

Water chemistry is greatly affected by the abundance and composition of plant life in aquatic systems. Aquatic plants exchange gases with the water column, affect water temperature, can reduce turbidity, alter evapotranspiration rates, and influence microbial communities. This monitoring effort was intended to assess how large-scale herbicide treatments and the resulting decay of high *Ludwigia* densities affects DO within the Stewart Slough Project Area.

Major sources of DO within aquatic systems include: direct diffusion from the atmosphere, wind and wave action, and photosynthesis. Photosynthesis from plant and algal species exchange CO_2 for O_2 within the water column when sunlight is available, while respiration from animals, including microbial organisms remove O_2 from the aquatic system through respiration (Francis-Floyd 2003). Although plants are known for photosynthesis, which produces oxygen, they also consume oxygen through respiration. In the absence of light respiration in plants occurs at a higher rate compared to photosynthesis. Temperature also greatly affects DO as higher temperatures reduce the capacity of water to hold gases such as O_2 and CO_2 (ODFW 1999) There is a large amount of conflicting information supporting both the increase and reduction of DO caused by aquatic plants (Frodge et al. 1990; Caraco & Cole 2002; Francis-Floyd 2003; Tanner & Headley 2011). A plant's influence on DO is largely dependent on plant growth habit (submerged, floating, emergent, etc.). Submerged plants can more efficiently exchange CO_2 directly with O_2 increasing oxygen in the water column and floating-leaved plants release O_2 to the atmosphere, depleting DO (Caraco et al. 2006). But how exactly emergent plants such as *Ludwigia* affect DO can be unclear.

In communities dominated by emergent aquatic plants, zones of dense vegetation provide significant submerged structure, but result in nearly or completely anoxic water conditions (Rose & Crumpton 1996). Reduction of DO in emergent plant beds have been attributed to large quantities of decaying leaf litter and reduced diffusion of oxygen from the atmosphere (Caraco & Cole 2002; Rose & Crumpton 2006;). Even more directly related to the Stewart Slough WQ Pilot Study, anoxic zones have been found in emergent plant communities of *Ludwigia palustris* and *L. hexapetala* within the backwater channels and bays of a major riverine system in the southeast United States (Miranda & Hodges 2000). Besides direct influences to DO, seasonal or human caused plant die-offs pose the risk of reducing DO as respiration rates of microbes increase during the decay process (CDBW 2001; Jewell 1971; ODFW 1999).

The degree of oxygen consumption in decaying plant communities varies in regards to plant densities, species, and microbial community composition. Oxygen demand, or depletion of DO is directly related to the initial biomass of plant communities (Tang et al. 2013). Numerous *in-situ* and *ex-situ* experiments have showed hypoxic conditions result from plant die-offs related to both chemical and mechanical control of aquatic plants (Hellsten et al. 1999; Jewell 1971; Tang et al. 2013). Hypoxia related to weed control can occur locally within regions of a larger waterbody or occur throughout the entirety of a small waterbody. One study in particular showed a reduction of DO to zero within a small pond four days after Canadian elodea (*Elodea canadensis*) was chemically treated (Owens and Maris, cited from Jewell 1971).

It is clear that *Ludwigia* has the potential to greatly reduce available oxygen in aquatic environments of the Stewart Slough Project Area. With evidence of anoxic conditions being present in areas of both living and decaying plant material, it is important to assess how *Ludwigia* affects the varying waterbody types within the Stewart Slough System before and after treatment. Waterbodies may possess system wide anoxic conditions or contain open water areas that provide refuge for fish species. Thresholds have been established to indicate the minimum concentration of DO within water that results in detrimental impact to fish.

Effects of Dissolved Oxygen to Fish

Within scientific literature, there are numerous thresholds of minimum DO for both salmonid and non-salmonid fish species. The generally accepted threshold for most fish species is 5 mg/L of DO (Yeakley et al. 2013; Francis-Floyd 2003). At a concentrations below 5 mg/L, embryonic and larval development can be greatly impaired, weight loss can occur, avoidance may take place, and survivorship of certain species is decreased. In a study of non-salmonid fish, a majority of species tested experienced zero survivorship in water less than 2.4 mg/L of DO (EPA 1986). Coldwater species or members of the family *Salmonidae* (salmonids) are even more sensitive to reduced DO.

In the State of Oregon, criteria for minimum DO in water bodies is administered by DEQ. For water bodies identified by DEQ as providing cold-water life, the absolute minimum for DO may not be less than 8.0 mg/L (OAR 340-041-0016(2)). In waters identified as providing cool-water aquatic life, DO may not be less than 6.5 mg/L at any given time (OAR 340-041-0016(3)). The absolute minimum is increased to 11.0 mg/L in water bodies identified as active spawning areas during designated times (OAR 340-041-0016 (1)). Standards set by DEQ are based on criteria established by the EPA (EPA 1986).

Ludwigia infested areas within the Willamette River Valley include ponds, bays, oxbows and sloughs that may or may not have connectivity to the main channel of the Willamette River. It is important to gauge how DO within infested water bodies such as those monitored in the Stewart Slough Project Area could affect both salmonid and non-salmonid species present. Two DO thresholds will be applied to the results of WQ monitoring to assess suitability for fish development and survivorship. Although more imperative to stream environments, the cool-water criterion of 6.5 mg/L of DO will be applied to account for possible salmon or trout rearing and migration in the "Willamette River and Tributaries Gallery Forest" ecoregion, which the Stewart Slough Project Area is located within (DEQ 2010). A threshold of 5 mg/L will be used as reference for non-salmonid species where moderate to slight production impairment is known to occur based on life stage (EPA 1986). These thresholds have been applied to the figures simply as a reference for data interpretation and do not identify impaired waters of the State.

Methods

Site Selection

A total of five sites within the project area were selected for monitoring (Figure 2.). Selected sites represent the diverse water body types that persist within the project area (gravel pit, slough, oxbow lake, bay). Access, perennial water presence, permission of entry, distance from one another and degree of infestation were taken into account to select sites. In total, three sites

were mapped by GIS and four sites were sampled for water quality. Originally, four sites were selected for density and range mapping, but due to time constraints, the Oxbow site was not mapped. Due to an uncharacteristically dry and warm water year, the sampling location of Stewart Slough #1 completely dried for the first time in local memory. The Stewart Slough #2 site was added to maintain data collection within the immediate Stewart Slough Project Area and preserve the number of sites being sampled during each sampling period. Collins Bay is the only site that was chemically treated in 2014. All sites except for Oxbow were chemically treated in summer of 2015.

Figure 2. Sites within Stewart Slough Project Area that were mapped and/or monitored for water quality.

Range & Cover Mapping

Stewart Slough #1, Gravel Pit and Collins Bay were mapped on July 2, 2015 before chemical application took place at the three sites. Mapping was carried out by a research technician on foot using a hand held GPS instrument (Garmin Oregon 450). Percent cover estimates of *Ludwigia* were used to generate cover class polygons within surveyed sites: Light (<5%), Moderate (5 – 50%) and Heavy (>50%). Total range of *Ludwigia* was measured first by GPS and polygons of Moderate and Heavy cover were then collected within the population extent.

GPS data was projected and analyzed within ArcGIS 10.3 to calculate acreage of individual polygons and total acreage of each cover class. All data was projected in the NAD_1983_UTM_Zone_10N coordinate system. Maps were generated to provide comparisons for future treatment years as it is expected that range and density mapping will occur within the three sites on an annual basis. Variables affecting *Ludwigia* density patterns within mapped sites were summarized.

Water Quality Monitoring

Water quality was monitored within the Stewart Slough Project Area on 7/6, 8/11, 9/21, and 11/2/2015. Dates were selected in an attempt to capture the seasonal fluctuations of WQ conditions in response to widespread *Ludwigia* die-off (Table 1). Monitoring occurred at roughly the same time on each date to minimize daily variations in WQ values. Monitoring at specific sites did not vary more than 1.5 hours from other sampling dates. On specific sampling dates, some sites were not monitored for WQ due to uncharacteristically dry conditions or in one case, instrument error (Table 1).

Table 1. Sampling dates at sites within Stewart Slough Project Area. Successful sampling periods indicated by "Yes", otherwise restrictions to WQ monitoring are indicated.

	Sampling dates and relation to herbicide treatment			
	July 6	**Aug 11**	**Sept 21**	**Nov 2**
Site	Before Treatment	2 Weeks After	2 Months After	Fall Senescence
Gravel Pond	Yes	Yes	Yes	Yes
Stewart Slough #1	Yes	Dry Conditions	Dry Conditions	Limited Sampling
Stewart Slough #2	Not yet selected	Yes	Yes	Yes
Oxbow (No Chemical Treatment)	Instrument Error	Yes	Yes	Yes

Two technicians collected data by foot or boat using a YSI Professional Pro Plus Multiparameter Water Quality Meter (https://www.ysi.com/proplus). The WQ variables of temperature, DO, pH, conductivity, and oxidation reduction potential (ORP) were measured. Prior to each monitoring date, temperature, pH, conductivity and ORP were calibrated and DO was calibrated prior to each site. For each sample, depth, max depth and percent cover of *Ludwigia* were collected. Sampling points were recorded by GPS (Garmin Oregon 450). Samples were collected in areas of open water and >50% *Ludwigia* cover. Percent cover was assessed for the total area within one meter of the sample. As plants began to die back after herbicide application, the GPS was used to reference previous monitoring points infested with *Ludwigia* and utilized the range and

cover data from the July 2nd mapping effort. Readings were collected at the surface (0.13 meters) and slightly above the water bottom (0.10 to 0.25 meters from bottom surface). Data was logged within the YSI meter and recorded manually by technician simultaneously. Both electronic generated and written data have been provided to BSWCD with calibration data.

Data was summarized to account for four distinct categories: Surface/Open Water, Surface />50% *Ludwigia* Cover, Bottom/Open Water, and Bottom/>50% *Ludwigia* cover. Technicians attempted to collect at least four readings within all categories, but was not possible at all times due to absence of open water areas, access restrictions or time constraints. Comparisons of WQ were made between categories within the same site. Inter-site comparisons would be difficult to make since each site represents varying physical and hydrologic conditions.

Results

Data collected by GPS, YSI meter and manually have been supplied to BSWCD staff. Range and density of *Ludwigia* within the three mapped sites have been presented in map form with calculated acreage. The six measured WQ variables have been summarized and provided to BSWCD for further analyses and interpretation. Within the report only DO (mg/L) and temperature (°C) have been graphically displayed and summarized.

Oxbow

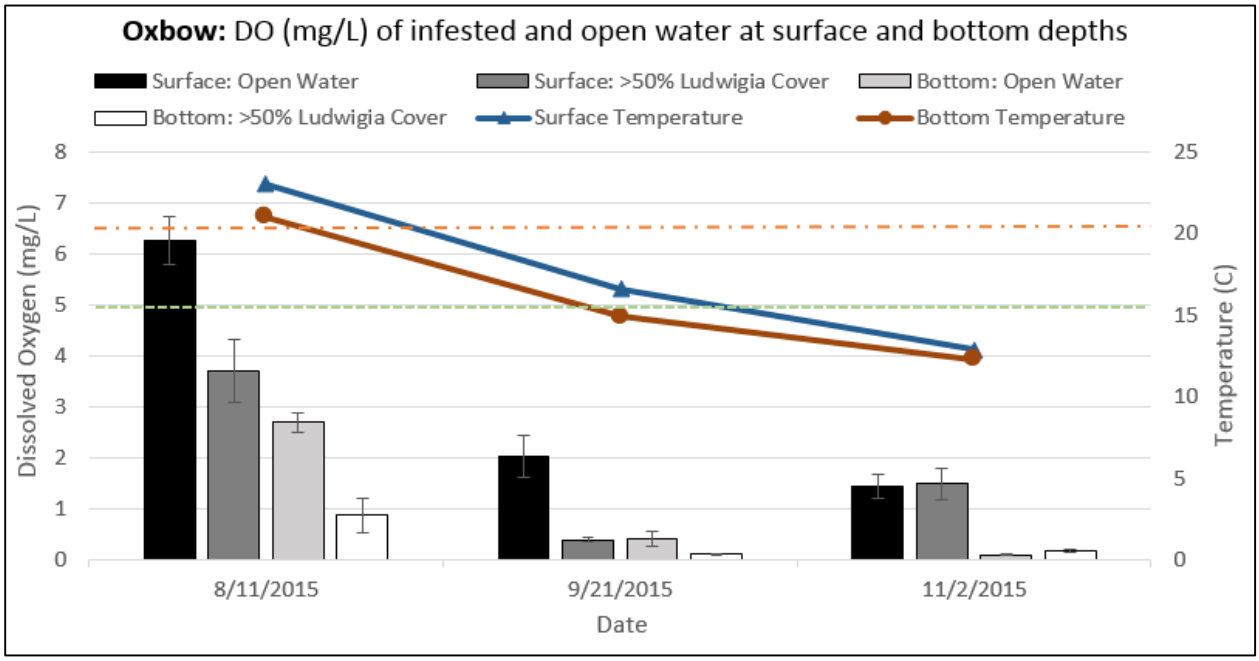


Figure 3. DO comparison between surface and bottom layers in open water and *Ludwigia* infested areas of Oxbow Site. Oxbow acted as a control and **no herbicide application occurred**. Dashed lines represent cool-water criterion (orange) and moderate impairment for non-salmonid species (green).

Acting as the control site, the Oxbow was heavily infested with *Ludwigia* in roughly 90% of the water body except for an open water area adjacent to an irrigation pump and some areas <10m^2 in which no cause was attributed. In August, surface values of DO in open water possessed an average value of 6.25 mg/L in comparison to 3.70 mg/L in infested areas (Figure 3). Surface

values of DO remained lower in infested sample sites compared to open water sites in September. By November, surface DO was similar in infested and open water areas. Values of DO decreased in open water as the season progressed with the lowest DO occurring within open water areas in November. Temperature measurements each month decreased from August to November in both surface (23.0 ºC to 12.9 ºC) and bottom readings (21.0 ºC to 12.3 ºC) supporting evidence that reduced DO was not attributed to temperature decrease. DO and temperature were lower within bottom samples for both open water and infested samples when compared to surface readings. The largest difference in temperature between surface and bottom samples was 2.0 ºC which occurred in August.

Average DO in the Oxbow was below both cool-water criterion and non-salmonid thresholds in all sampling categories except for surface readings in open water during the August sampling date. In August only the non-salmonid threshold was met. However, one open water surface sample and one sample with 60% *Ludwigia* cover exceeded the 6.5 mg/L cool-water criterion with DO of 6.72 mg/L and 8.73 mg/L respectively. Across all sampling dates, only five surface samples exceeded 5.0 mg/L of DO, all in August.

Gravel Pond

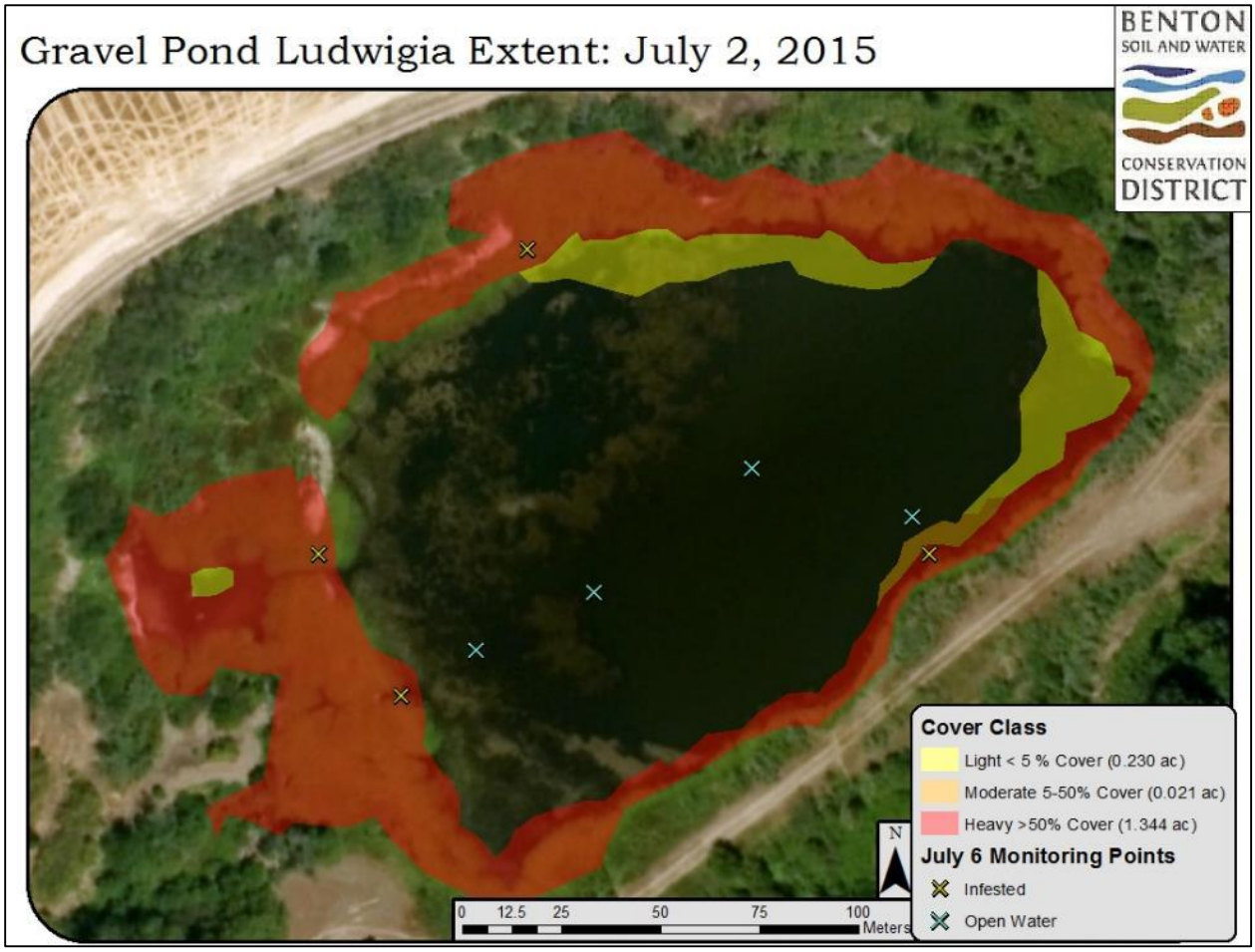


Figure 4. Range and cover class summary of *Ludwigia* within Gravel Pond before first herbicide application with sampling points for July 6 monitoring.

In the Gravel Pond, *Ludwigia* was limited to heavy cover along the perimeter due to soil saturation, water depth, and substrate type (Figure 4). The Gravel Pond has historically been mined for gravel, creating a steep drop off along the bank. The open water area accounted for 4.401 acres in comparison to the 1.595 acres of *Ludwigia* present. Max depths during WQ sampling exceeded 2.5 meters in July. Banks and water bottom were dominated by course gravel with minimal organic matter visible. Although the extent of water at flood stage was not measured, a distinct line existed between bare ground and heavy *Ludwigia* infested areas, indicating where soils are saturated for at least part of the year. The extension of heavy *Ludwigia* cover to the southwest portion of the pond is due to a depression where water was present until July. The light and moderate densities of *Ludwigia* were attributed to stolons or "runners" extending from the dense bank populations with few individuals rooting within the aquatic environment. Brazilian elodea (*Ergeria densa*) was the other dominant aquatic plant species occurring at high densities in the western portion of the site.

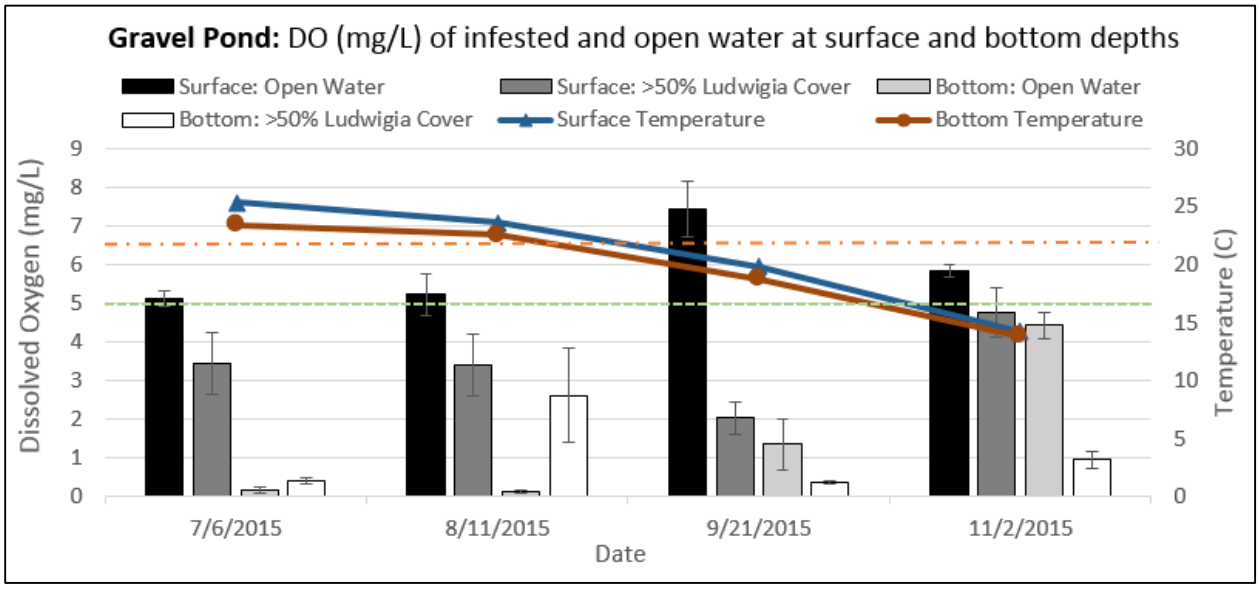


Figure 5. DO comparison between surface and bottom layers in open water and *Ludwigia* infested areas of Gravel Pond. Herbicide application occurred during the week of August 2nd. Dashed lines represent cool-water criterion (orange) and moderate impairment for non-salmonid species (green).

There was not a pronounced decrease in surface DO over time within the Gravel Pond as seen in the Oxbow Site (Figure 5). However from August to September, surface DO within infested sampling sites decreased from 3.41 mg/L to 2.03 mg/L, while open water surface values increased substantially from 5.22 mg/L to 7.41 mg/L. In November, all sampling categories increased except for open water surface values which decreased to 5.83 mg/L. Temperature decreased over time in both surface (25.3 ^{o}C to 14.2 ^{o}C) and bottom readings (23.3 ^{o}C to 13.9 ^{o}C). Temperature could be partially attributed to the elevated values of DO in November, but cannot necessarily account for the decrease of DO within *Ludwigia* infested sampling sites from August to September.

Average DO within open water surface samples met the non-salmonid threshold of 5 mg/L on all four sampling dates, exceeding the cool-water criterion threshold only in September. One individual open water surface sample exceeded the cool-water criterion threshold in August, with

7 of 11 samples exceeding the 6.5 mg/L DO threshold in September. The trend was similar in relation to the non-salmonid threshold with 6 of 10 open water samples exceeding 5 mg/L in August and 11 of 11 samples exceeding the threshold in September. *Ludwigia* infested areas had a much lower frequency of samples exceeding either threshold at the surface. Only 1 of 5 samples exceeded the non-salmonid threshold in August with no sample exceeding 4.0 mg/L in September. In November, surface values in *Ludwigia* infested areas exhibited a broader range of DO values (0.58 to 9.72 mg/L) in comparison to open water areas (4.95 to 6.50 mg/L). The open water surface samples only met 6.5 mg/L DO once in 10 samples, with 4 of 16 samples exceeding the cool-water threshold in infested areas. However, open water areas contained conditions less harmful to non-salmonid fish species with 9 of 10 samples exceeding the non-salmonid threshold in comparison to the 7 of 16 samples exceeding the threshold in infested areas. The large range in DO values within infested areas could have been caused by varying levels of *Ludwigia* decay. Since initial herbicide treatments occurred over 3 months prior, with follow up herbicide treatments in August and October, there may have been sampling areas that decay had ceased and other areas in which decay was still occurring from the October herbicide treatment. Regardless of the lower DO average compared to open water areas, it is promising that the frequency of DO values >5 mg/L and total average greatly increased in infested sites three months after initial herbicide treatment.

Stewart Slough #1

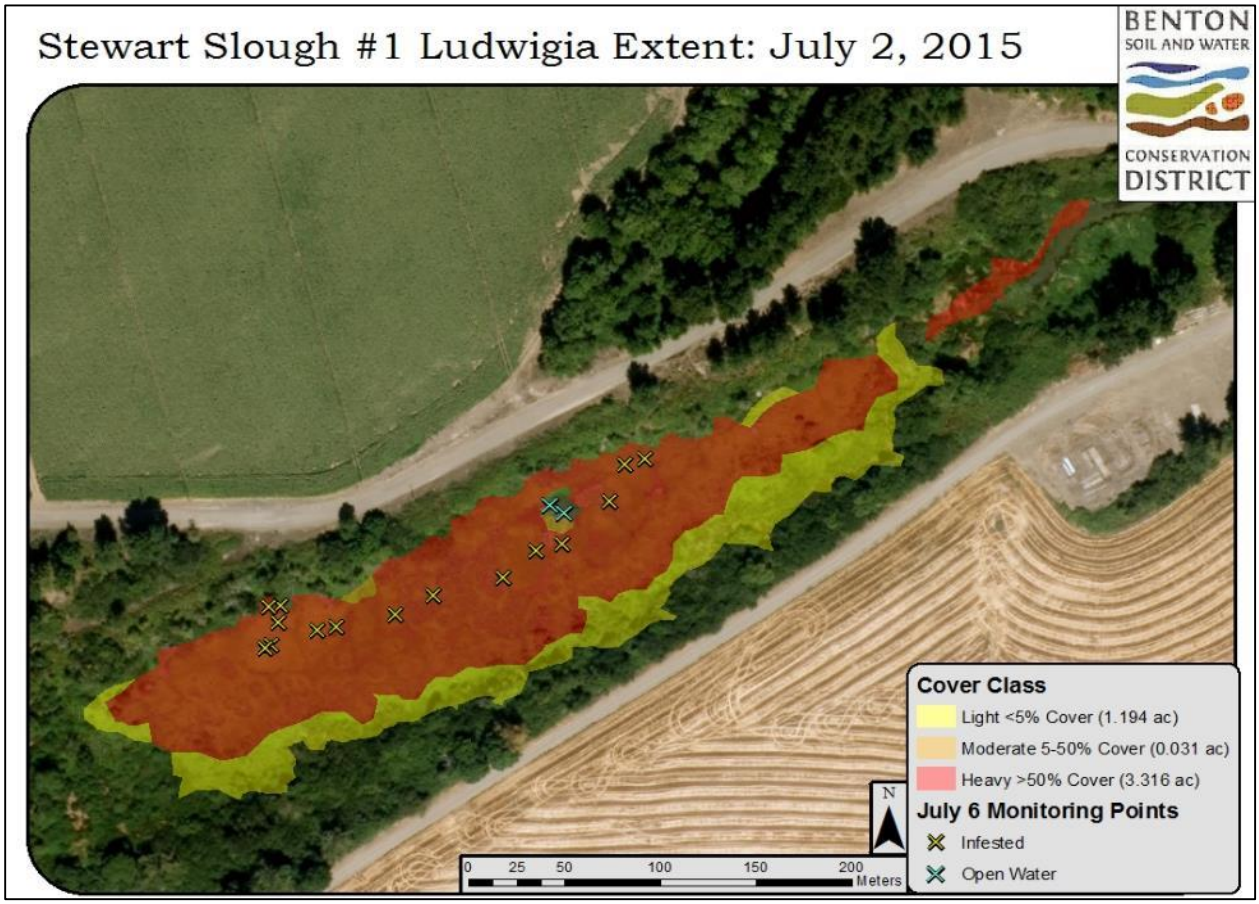


Figure 6. Range and cover class summary of *Ludwigia* within Stewart Slough #1 before first herbicide application with sampling points for July 6 monitoring.

The Stewart Slough #1 site demonstrated heavy *Ludwigia* cover throughout the entire waterbody (Figure 6). At the time of GPS collection, the entire system was walkable, not exceeding depths of 1 meter. Different from the Gravel Pond, the site contained local populations of Western pond lily (*Nuphar polysepela*) and bur-reed (*Sparganium eurycarpum*) species which competed with *Ludwigia*. The areas of moderate cover were associated with populations of *N. polysepela* while the extent of light cover along the southeastern edge of the site can be partially contributed to a healthy stand of *S. eurycarpum.* Areas where trees extended over the water surface and provided shade had reduced cover and in some cases no *Ludwigia* cover.

Of the sites surveyed for mapping or WQ, the Stewart Slough #1 Site had the highest presence of channels created through burrowing activity of aquatic mammals such as nutria and beaver, throughout the water body. Channels of deeper water provided cover to *Ludwigia* during chemical application. Regrowth of healthy individuals were observed within the channels by August as water subsided.

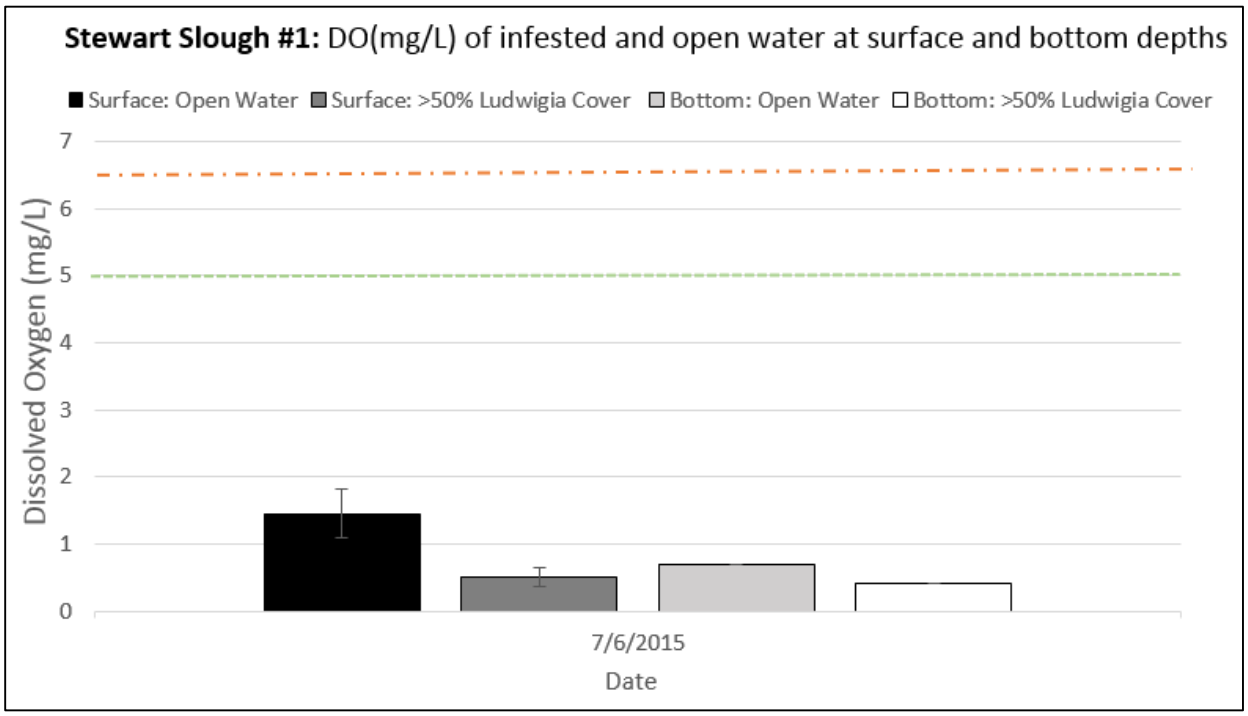


Figure 7. DO comparison between surface and bottom layers in open water and *Ludwigia* infested areas of Stewart Slough #1 prior to treatment. Dry conditions in summer months made WQ monitoring not possible. Dashed lines represent cool-water criterion (orange) and moderate impairment for non-salmonid species (green).

The Stewart Slough #1 location provided very few opportunities for open water samples (n = 2). Nearly the entirety of the water body with >0.2 m depths was infested with heavy cover making it difficult to find sampling sites representative of open water environments (Figure 6). Average depth of samples were 0.33 meters providing optimal environments for *Ludwigia* growth. The shallow depths made it difficult to collect bottom samples independent of surface samples. Open water samples were taken in areas of thick *N. polysepela* growth. The shallow nature of the water body lead to rapid drying in the months after July data collection occurred.

Regardless of challenges in collecting diverse categories of data, the Stewart Slough Site #1 represented a waterbody type that is relatively common in the Stewart Slough Project Area. July sampling provided an insight to DO conditions within these infested water bodies. The shallow, stagnant nature of the site, with dense *Ludwigia* growth resulted in low DO values (Figure 7). It is important to note however that water temperature was surprisingly low (19.4^{o}C) in comparison to Gravel Pond Site (25.3 ^{o}C) indicating possible groundwater recharge or immediate runoff from adjacent irrigation activity.

Within infested sample sites, surface DO ranged from 0.06 mg/L to 2.03 mg/L, averaging 0.50 mg/L. Of the 17 samples collected, only five exceeded 0.50 mg/L DO. Although only two open water samples were collected, DO values were 1.05 and 1.78 mg/L. A larger sample size for open water samples is needed, but there is support that even small open water areas can result in increased DO within heavily infested water bodies.

In November, about a third of the Stewart Slough #1 Site contained standing water due to recent rains. Samples were collected in a restricted region of the water body. All samples were collected where large mats of decaying *Ludwigia* were still observed. Samples in *Ludwigia* infested areas exhibited a similar pattern in November as *Ludwigia* infested areas of the Gravel Pond. Average DO was 2.89 mg/L with a large range of 0.24 to 8.25 mg/L. In total 4 of 16 samples exceeded the non-salmonid threshold, with two values exceeding the cool-water criterion.

Stewart Slough #2

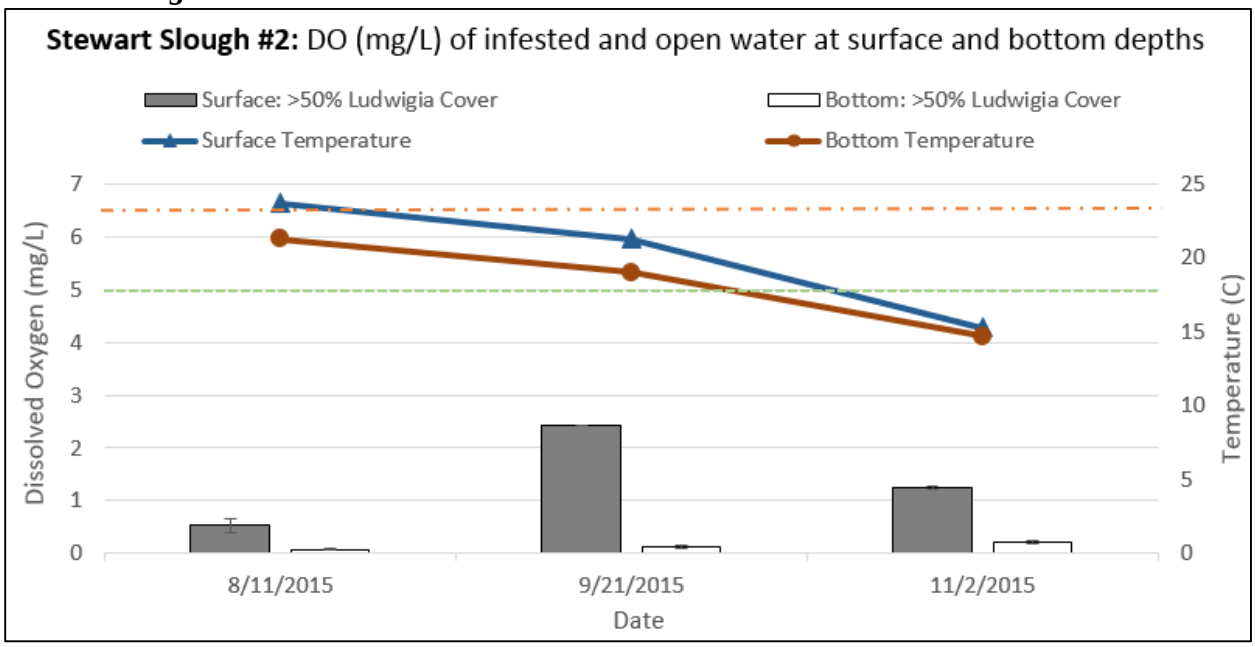


Figure 8. DO comparison between surface and bottom layers in *Ludwigia* infested areas of Stewart Slough #2 after herbicide application. Herbicide application occurred during the week of July 19th. Dashed lines represent cool-water criterion (orange) and moderate impairment for non-salmonid species (green).

The Stewart Slough #2 Site was added to the monitoring sites after attempted sampling at the dried Stewart Slough #1 Site was not possible. Due to time constraints and access issues, only *Ludwigia* infested areas were sampled with a target sample number of 3. Samples further demonstrate the relatively low DO within thick beds of *Ludwigia*. The population of *Ludwigia* at

sample sites within Stewart Slough #2 were exceptionally dense, with technicians breaking through thick mats of stem and root matter to access bottom samples. Observationally, August surface readings were carried out in decaying leaf and stem tissue that was resting on the dense root mass. DO values in August ranged from 0.31 mg/L to 0.80 mg/L. Surface values of DO increased substantially in September as values ranged from 2.41 mg/L to 2.43 mg/L. The technician noted that by September the *Ludwigia* had sunken into the water column. The open water above the dense root and stem system contained DO values well above the August readings. When the probe was lowered below the root mass, average DO values did not exceed 0.21 mg/L during any sampling date. Neither threshold was exceeded by individual samples.

Collins Bay

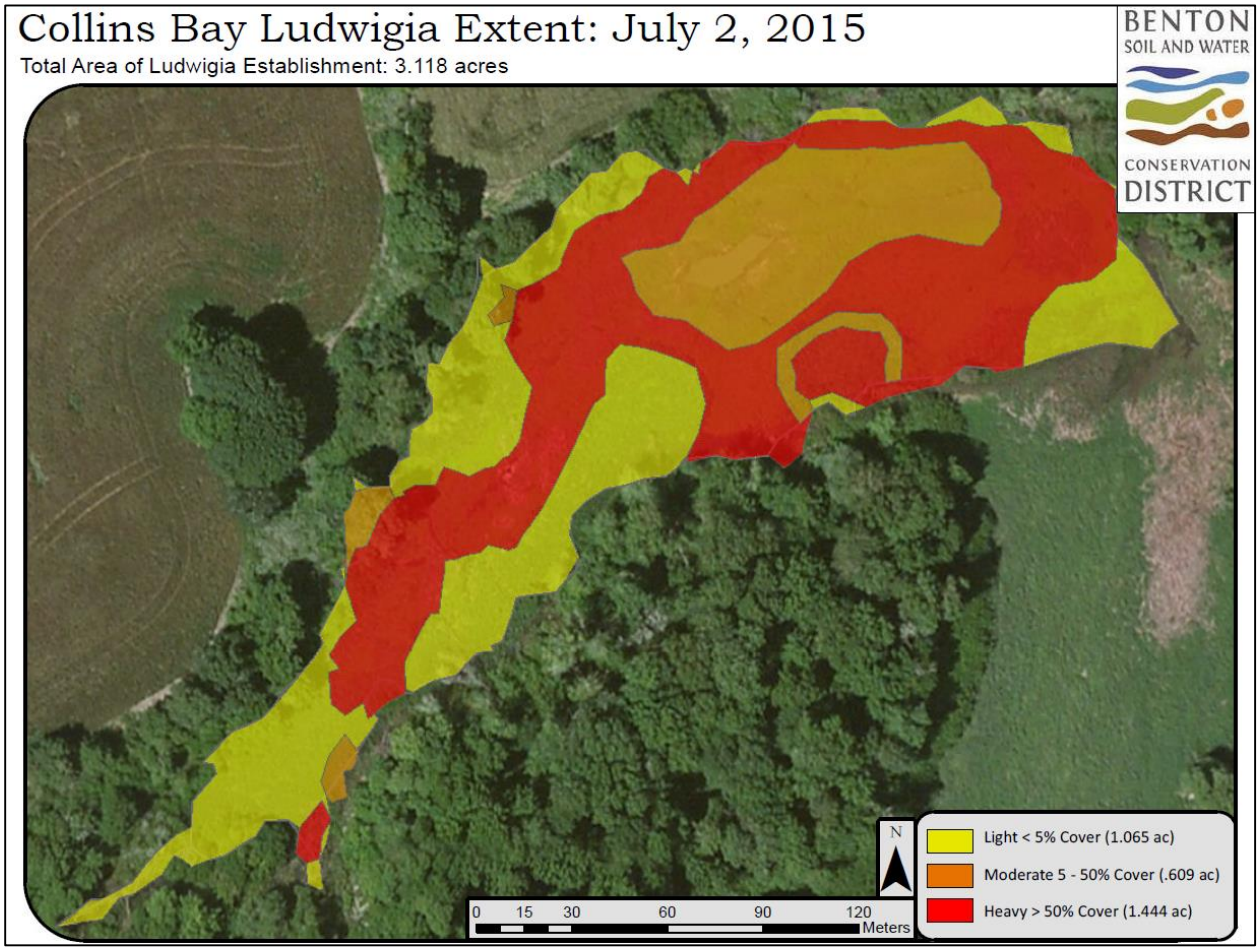


Figure 9. Range and cover class summary of *Ludwigia* in Collins Bay, before second year of treatment.

Collins Bay provided a preview of the possible regrowth that may occur in the numerous sites within the slough system to be treated in 2015 (Figure 9). Observations from BSWCD staff indicated that the Collins Bay site was dominated by heavy *Ludwigia* cover prior to herbicide treatment in 2014. There was no evidence during the mapping effort that range of *Ludwigia* had decreased substantially. Dense regrowth was observed through the central portion of the water body. Moderate or light-cover occurred in areas that contained *N. polysepala* and *S. Eurycarpum*, such as the horseshoe shaped polygon observed in the southeastern portion of the surveyed area. Dense mats of dead *Ludwigia* were observed with fresh growth occurring from underneath. This

pattern of regrowth was most apparent in the large moderate-cover polygon in the northeastern portion of the site.

Regrowth of *Ludwigia* in Collins Bay highlighted the benefits of native species such as *N. polysepela* and *S. eurycarpum* in reducing local densities of *Ludwigia.* The map product and observations by Mosaic Ecology technicians show that dense populations of *Ludwigia* could shield individuals in the lower water column from herbicide treatment. Regrowth within the dense mats could have come from the nodes of plants not entirely killed through the treatment process or possible recruitment from an established seedbank.

Data Summary and Discussion

Only one site, the Gravel Pond was sampled on all four target dates. Therefore, before/after comparisons regarding the response of DO to *Ludwigia* die-off in response to herbicide treatment can only be made from data collected within that site. However, valuable insight related to how *Ludwigia* can affect DO and subsequently aquatic life at a large scale has been gained from comparing all four sites and dates.

Because all four water bodies possessed varying physical characteristics, hydrologic regimes and degree of *Ludwigia* infestation, initial values and trends of DO varied at each sampling site. In July, the Stewart Slough #1 Site contained anoxic conditions in nearly the entirety of the system prior to massive *Ludwigia* die-off, while the Gravel Pond possessed an average DO value of 3.44 mg/L in infested areas. In July, prior to a potential further reduction in DO due to microbial respiration, the Stewart Slough #1 Site had already exceeded the acute mortality limit for salmonids, non-salmonids and aquatic invertebrates (USEPA 1986).

Even without chemical application, *Ludwigia* infested surface waters contained less DO on average than open water in all comparisons except for the November sampling in the Oxbow Site. Results of reduced DO and anoxic conditions within emergent beds of *Ludwigia* adhere to findings from previous studies focused on emergent vegetation (Caraco & Cole 2002; Miranda & Hodges 2000; Rose & Crumpton 1996). The presence of *Ludwigia* in waterbodies of the Willamette River Valley greatly reduce available DO within non-treated plant beds.

A clear and obvious “DO crash” in response to herbicide application cannot be clearly observed due to difficulty in collecting WQ data across all dates and sites. It is possible that *Ludwigia* at sampled sites decayed at a rate in which our sampling intervals did not capture. Decay rates vary by species and are related to physical, chemical and biological variables of the environment. The time between herbicide application and DO crashes have varied in previous studies (Owens and Maris, cited from Jewell 1971; Wells et al. 2014). It is possible that due to varying characteristics of water bodies sampled and differences in *Ludwigia* distribution, cover, and density, decay rates were different within each sampling site. Furthermore, the Gravel Pond Site received chemical application roughly two weeks after Stewart Slough #1 and Stewart Slough #2 sites. On the August WQ monitoring date, technicians noted that *Ludwigia* within the Stewart Slough #2 location exhibited a more progressed form of herbicide damage. In the Stewart Slough #2 Site large patches of *Ludwigia* possessed brown leafless stems (Figure 10A). On the same date within the Gravel Pond, the first signs of herbicide damage with chlorosis beginning to yellow the leaves was observed (Figure 10B).

Figure 10. Two sites exhibited different degrees of herbicide damage on monitoring date of 8/11/15. *Ludwigia* within the Stewart Slough #2 Site exhibited defoliation, browning, and curling stems (A), while *Ludwigia* within the Gravel Pond possessed yellowing and curling leaves (B).

After the chemically applied plant tissue dies, the structural integrity of *Ludwigia* weakens and the plant mat sinks into the water column, opening the water surface to wind action and increased oxygen diffusion from the atmosphere. Microbial respiration and oxygen consumption may be highest as leaves and stems decay followed by a release of surface water from dense vegetative cover. This pattern may explain why the Gravel Pond and Stewart Slough #2 Sites displayed low DO values followed by a DO increase at different sampling dates. Also of interest is that a similar pattern was observed in the Oxbow Site which did not receive herbicide application. Natural senescence and plant decay may have been occurring during the September sampling period with a natural thinning of the canopy cover by November. Other possible causes of the DO increase within infested areas during the November sampling period are the increased precipitation rates and cooler water temperatures.

The Gravel Pond Site was the only location with significant open water. In September, the open water area experienced a substantial increase in DO two months after chemical treatment. DO within open water environments has been found to be inversely related to the overall vegetative cover of the water body and negatively affected by distant plant beds (Miranda & Hodges 2000). It is possible that the open water area of the gravel pond was no longer being affected by dense populations of functioning *Ludwigia* and subsequently DO within the open water area increased. The presence of *E. densa* may have also increased DO due to the ability of submerged plants to increase O_2 more efficiently than plants with other growth habits (Coraco et al. 2006).

Across all sites and dates, average DO values in *Ludwigia* infested areas were below the 5 mg/L threshold that would moderately impair non-salmonid fish. Only open water surface readings in the Gravel Pond during September resulted in average DO above the 6.5 mg/L cool-water threshold. Even then, numerous samples possessed DO values well below the cool-water criterion for absolute minimum. Even more alarming were the average DO values that fell below the 3.0 mg/L limit of acute mortality for salmonids, non-salmonids and invertebrates. Within the

Oxbow Site during November sampling, only 1 of 20 surface samples were above the 3.0 mg/L threshold for acute mortality of the three major categories of aquatic organisms. Waterbodies in the Stewart Slough Project Area heavily infested with *Ludwigia* such as the Oxbow and Stewart Slough #1 Sites may be unable to maintain annual populations of fish species. The Stewart Slough #2 Site requires sampling across a larger area to properly assess the capacity to maintain fish populations. During monitoring only the Western Mosquito Fish (*Gambusia affinis*), able to tolerate waters as low as 1.0 mg/L DO was observed at each site (Hubbs 2000). The only sampled site known to possess a diverse fish population is the Gravel Pond (BSWCD 2015). The fish present within the Gravel Pond are predominantly game fish, native to the eastern United States. The large open water area of the Gravel Pond provides refuge from anoxic conditions within *Ludwigia* infested areas. The presence of *Ludwigia* within waters of the Stewart Slough Project Area may result in fish kills and inhabitable environments for both native and game species.

In relation to management decisions, it appears that elevated DO values after herbicide treatment can occur. Although more data must be collected in coming years for annual comparisons, both the Stewart Slough #1 and Gravel Pond Sites experienced increases in average DO in *Ludwigia* infested sites by November compared to pre-herbicide values in July. Meanwhile, the Oxbow Site, acting as a control experienced a decrease in DO values in both infested and open water areas from August to November.

Conclusions

Weaknesses exist in the collected data which include non-uniform sample sizes, failure to sample sites during all four dates, varied dates of herbicide application and the absence of accessible open-water. Weaknesses of the pilot study will be addressed in upcoming monitoring years based on experience gained by the project managers and technicians. The preliminary findings must be corroborated by further data collection and more comprehensive study.

Range & Cover Mapping

1. Physical variables such as gravel substrate, steep banks and canopy cover acted as barriers to *Ludwigia* establishment.
2. *Ludwigia* was not found root in water depths >1.9 meters.
3. *Ludwigia* cover decreased in the presence of native *N. polysepela* and *S. eurycarpum.*
4. Dense mats of *Ludwigia* provided adequate cover to underlying individuals for regrowth in the year after initial herbicide application.

Dissolved Oxygen Monitoring

1. A “DO crash” related to herbicide treatment of *Ludwigia* was not observed.
2. Regardless of herbicide application, *Ludwigia* infested areas possess lower DO.
3. Heavy *Ludwigia* infestations can reduce DO concentrations resulting in acute mortality to salmonids, non-salmonids and aquatic invertebrates.
4. Water quality varies substantially between different water body types in the Stewart Slough Project Area.
5. Infested waterbodies treated with herbicide may experience a more rapid increase in DO compared to non-treated *Ludwigia* infested waterbodies.

Question Formation

With different methods of WQ monitoring able to provide a diverse array of data to be analyzed and communicated in various ways, BSWCD will work with Mosaic Ecology to further clarify existing goals and answerable questions. By doing so, the scientific method can be better applied to study design, Quality Assurance Project Plans (QAPPs) can be implemented, and resources can be better preserved if only necessary data is collected and analyzed. It is important that posed questions meet the needs of BSWCD. This could involve gathering data in regards to the detrimental impacts to fish species or providing information to change Best Management Practices in relation to herbicide treatment.

There is also a need to better finalize the deliverables of the collected data. Data collected for BSWCD can be used for numerous purposes such as: community presentations, grant reporting, detecting water quality issues, permit or compliance purposes, and scientific publications. Based on the deliverables, methods can be adjusted to meet necessary quality assurance (QA) standards. By adhering to certain QA standards, data can meet specific quality levels which select agencies require for reporting (DEQ 2009).

Site Selection

Due to variable and unpredictable seasonal weather patterns, some waterbodies within the Stewart Slough Project Area experienced unprecedented fluctuations in seasonal water levels. Of the monitored sites, Stewart Slough #1 dried completely in most areas after July 2015 sampling. It is recommended that the Stewart Slough Site #1 is not sampled for WQ in the future throughout the entirety of a monitoring season (July to November). However, data collected in July of 2015 can be used to compare WQ data collected in July of the coming years. An increase in sampling points should occur within the Stewart Slough #2 site to account for dropping Stewart Slough #1. Depending on proposed question and study design, it is recommended that a water body is chosen as a sampling site where *Ludwigia* has never known to be present. By doing so, infested water bodies similar in physical characteristics may be compared to the non-infested water body. Specific micro-habitats and select variables can be measured and compared.

Changes to Water Quality Study Design

The 2015 pilot study has many aspects to improve upon to increase systematic data collection and adhere to DEQ standards. As mentioned in the beginning of this section, posing a specific question will lead to the ability to better design a systematic study and assist in project planning and QAPPs. Regardless of the question to be answered, certain aspects of study design can be improved upon. There were challenges involving access and site selection that prevented such parameters from being applied in 2015. Mosaic Ecology technicians and staff at BSWCD will use experience of the 2015 pilot study to make target methods possible for upcoming data collection periods. Adjusted methods will better adhere to QA protocols of DEQ and increase the efficiency in data analysis.

Samples within sites will occur at the same location throughout the monitoring season. In 2015, samples were collected haphazardly where the most representative sampling points existed (infested/open water) and access was possible. In 2016, technicians will repeatedly return to

sampled areas by use of GPS. In addition to GPS points, PVC markers will be placed in areas less than 1 meter in depth to help insure technicians of sample locations.

Contingent on the independent variable(s) to be compared in 2016, 12 samples for each comparable variable will be collected at each site with a target sample size of 10. This differs from the 2015 methods of 4 samples per variable. By increasing the sample size, the measured variable will be better represented, normalization of the data is more likely to occur, and anomalies can be discarded if necessary. Also, by attempting to have the same number of samples for each independent variable measured, statistical tests to detect significant differences are easier to complete and statistical power increases. Adhering to DEQ quality standards, at least 10% of the sample locations will be duplicated to act as an audit to measure precision (DEQ 2009). In 2015 no duplicate samples were collected to evaluate precision.

Measurement depths will be adjusted to adhere to DEQ standards (DEQ 2009). Depth of each sample will be adjusted for both "surface" and "bottom" measurements. In waters <2 m in depth, measurements will be taken at 0.5 m from the surface and 0.5 m from the bottom. In waters >2m, measurements will be taken at depths of 0.5 m from the surface, 1.0 m, then at 1.0 m intervals until a final depth of 0.5 m from the bottom. If proposed question involves depth as a measurable variable, depth will be collected at 0.5 m intervals.

Continuous Monitoring Considerations

The current methods used by Mosaic Ecology involve the use of a YSI meter that collects discrete samples in the presence of an observer. These methods are able to provide comparisons of different variables (Open Water/*Ludwigia* infested, July/September, etc.) between water bodies or within water bodies. Yet, it may be in the interest of BSWCD to look into collecting continuous data by using "permanent" dissolved oxygen data loggers to witness trends in DO as *Ludwigia* decays in mass quantities over time.. Such data collection can account for diurnal fluctuations by averaging days together. One such product that is relatively affordable to collect continuous DO and temperature data is the miniDOT logger (http://pme.com/products/minidot). An example of temperature data collected with a similar type of logger is presented in Figure 11.

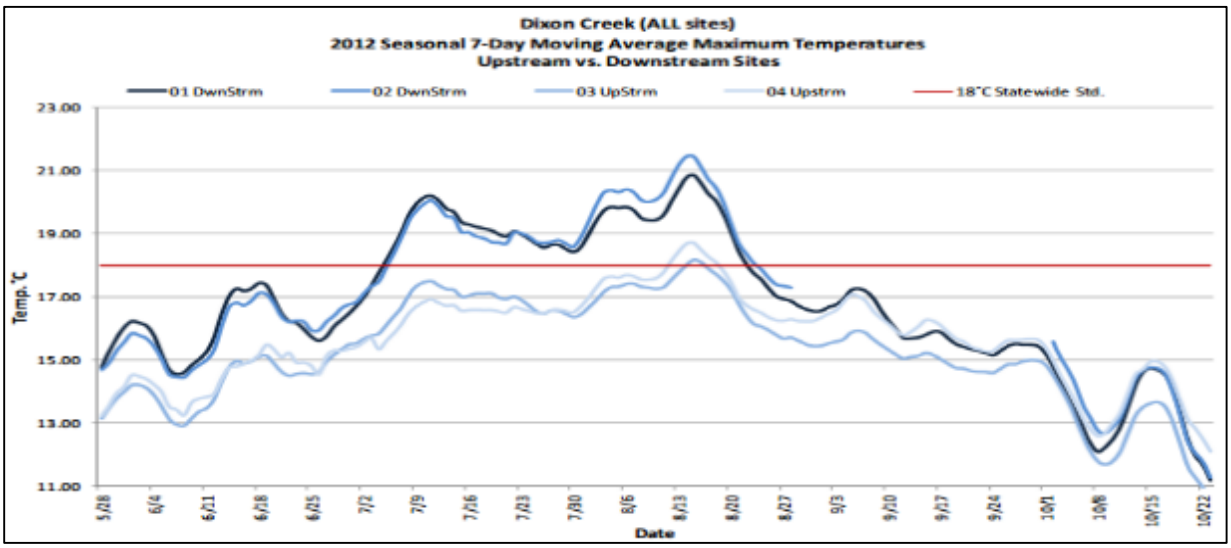


Figure 11. An example of continuous data collected from an instream temperature logger employed by the City of Corvallis, OR (Payne 2012).

Recently, there has been discussion with U.S. Geological Survey (USGS) to collaborate through sharing equipment and utilizing recent water quality data collected on the Willamette. Resources could include stationary water quality data loggers, staff time, and analysis of water samples.

It is important to carryout research before utilizing unsupervised monitoring probes as there are many challenges. Such problems that exist include: stolen probes, detached probes, depth fluctuations over time, algal fouling, or instrument error (Payne 2012; Suplee 2011). Mosaic Ecology is willing to assist in the formation of methods, contacts or even acquire the ability to carry out continuous water quality monitoring ourselves. But at this time, Mosaic Ecology does not possess the monitoring equipment to do so.

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Appendix I: Draft Landowner Handout, Native Turtles and Invasive Aquatic Plants

Help Protect Oregon's Native Turtles from Invading Aquatic Plant Species!

Oregon has two native turtles: the western pond turtle (*Actinemys marmorata*) and the western painted turtle (*Chrysemys picta bellii*). Both species depend on open water areas in riparian, wetland, and pond habitats to complete their life cycle. They use these open water habitats for foraging and basking, and use shallower open water areas for rearing of hatchlings and juveniles.

Top: western pond turtle (*Actinemys marmorata*) adults. Bottom: western painted turtle (*Chrysemys picta bellii*) adult and juvenile. Photos courtesy of Gary Nafis and CaliforniaHerps.com.

Oregon's native turtles need your help. Aggressive non-native aquatic weeds, such as Uruguayan water primrose (*Ludwigia hexapetala*), creeping water primrose (*Ludwigia peploides*), and yellow floating heart (*Nymphoides peltata*) are invading the Willamette River Basin. These aquatic weeds are spreading to shallow, slow moving water bodies along the Willamette River and its tributaries including sloughs, channels, alcoves, and nearby ponds.

Uruguayan water primrose (*Ludwigia hexapetala*): left photo is plant form over water, right photo is plant form on land. The invasive water primrose species have alternate leaves. No wetland native plant has showy yellow flowers like this. Please note the look-alike: The native water purselane (*Ludwigia palustris*) has inconspicuous green flowers and opposite leaves.

Yellow floating heart (*Nymphoides peltata*): plant leaves in left photo; flowering plant in right photo. (Photo on left courtesy of Holly Crosson, Benton SWCD.) Please note the look-alikes: The native yellow pond-lily (*Nuphar polysepala*) has ball-shaped yellow flowers and large, heart-shaped leaves that are held out of the water as the water recedes. The native watershield (*Brasenia schreberi*) has oval leaves with no slit, stem attached at the center of the leaf, and lower leaf surface and stem covered in a slippery gelatinous substance.

Why are these Invading Aquatic Plant Species a Problem?

Invasive water primrose and yellow-floating heart grow rapidly and form dense monoculture mats of vegetation that crowd out native plant species and other vegetation. The mats extend below the water surface, across the surface, and extend to the immediate shoreline. These plants have the ability to completely take over shallow, slow moving water, and the dense mats that form severely reduce habitat for species that depend on open water, such as native turtles.

Native turtles and other wildlife species (beavers, muskrats, mink and river otters) have a hard time swimming through or utilizing waters infested with these invasive aquatic plants, which limits the habitat native turtles have available to use. Aquatic animals such as fish and amphibians are also impacted by these invasive aquatic plants; the thick mats of vegetation limit these animals' ability to navigate, feed and reproduce.

Other impacts of the invasive water primrose and yellow-floating heart include:

- Thick floating mats reduce recreational activities (e.g., swimming, canoeing, kayaking)
- Mats reduce oxygen exchange and levels in water bodies, disrupting aquatic food chain
- Mats stagnate water; stagnate water is favorable to mosquitos
- Mats shade and limit native bottom vegetation
- Dominance of these plants reduce species diversity and exclude native species
- Traps sediment which reduces deep water habitats
- Potential negative impacts on property values

Photo monitoring Uruguayan primrose-willow (*Ludwigia hexapetala*) in open marsh habitat on the Willamette River (pre-treatment on left (July 2014); before third year of treatment at same site on right (June 2016). It takes many years of control treatments to even begin to see the return of open water habitat.

How do these Invading Aquatic Species Spread?

It's possible these plants were originally introduced to the basin from one or multiple persons dumping the contents of a fresh-water aquarium into local waterways. Once introduced, invasive water primrose and yellow floating heart easily spread by plant fragments (such as leaves, stems) and by seed over great distances throughout watersheds. Waterfowl and recreationists can also accidentally and unknowingly spread the plants from existing invasion sites to new areas.

How can you Help Prevent the Spread of these Invading Aquatic Species?

- Follow noxious weed laws and quarantines.
- Never put non-native plants or aquarium contents into a natural water body.
- Choose non-invasive species for gardens.
- Clean boats, trailers, boots, and other equipment before moving between water bodies.
- Properly dispose of noxious weeds. Do not add these plants to compost piles or yard waste where seeds can still spread to new sites.
- In Benton County, contact Benton SWCD if you are unsure what to do.
- Report invasive aquatic weeds to the OregonInvasivesHotline.org or 1-866-INVADER.
- To learn more about aquatic plants and invasive aquatic weeds, please see the Guide to Aquatic Weeds for Benton County and the Oregon Department of Agriculture's Noxious Weed Profiles.

What are we doing to Prevent and Control the Spread of these Invading Aquatic Species?

We are working with local landowners, organizations, and volunteers to raise awareness about invasive aquatic plants and address aquatic weed control priorities. More information on this effort can be found at the **Willamette Mainstem Cooperative** webpage: https://www.bentonswcd.org/programs/willamette-main-stem/.

Resources for Additional Information

Benton Soil & Water Conservation District Invasive Plants Database, www.bentonswcd.org/programs/invasive-species/weed-profiles/

King County Noxious Weed Control Program, www.kingcounty.gov/weeds

On The Lookout for Aquatic Invaders: Identification Guide by Oregon Sea Grant, http://seagrant.oregonstate.edu/sgpubs/H14001-on-the-lookout

Oregon Department of Agriculture Noxious Weed Control Program, www.oregon.gov/ODA/PLANT/WEEDS/Pages/index.aspx

Oregon Invasive Species Council, http://www.oregoninvasivespeciescouncil.org/

Washington State Department of Ecology, Aquatic Plants, Algae and Lakes, http://wdfw.wa.gov/licensing/aquatic_plant_removal

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