Protocol for the Prevention & Control of Reed Canarygrass *(Phalaris arundinacea)*

10,000 Years Institute

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Contents

Purpose

This protocol for the prevention and control of invasive reed canarygrass (*Phalaris arundinacea*) has been developed by 10,000 Years Institute to support inclusion of reed canarygrass in salmon recovery and habitat restoration project proposals, and in response to lessons learned during implementation of these prevention, control, and effectiveness monitoring practices. The practices are based on adaptive Early Detection/Rapid Response (ED/RR) and Integrated Pest Management (IPM) strategies practiced in watersheds on Washington State's Olympic Peninsula. Input from practitioners in other regions is sought and included (e.g., Woodward et al. 2011). The protocol is applicable across a range of riparian and aquatic habitats.

About Reed Canarygrass

General Description

Reed canarygrass is a perennial grass with creeping rhizomes that form a dense sod layer raising bed elevation in wetlands and other aquatic habitats (Thurston Co. EHD 2009). In the Pacific Northwest, reed canarygrass (RCG) emerges between late winter and early spring and exhibits a range of growth rates depending on light availability, substrate, and moisture level. Reed canarygrass is often identified by rigid and hollow stems, flat and wide (up to 2 cm) leaf blades, and membranous ligules (*Photos 1 and 2*).

Photo 1: A membranous ligule is present where the leaf blade attaches to the stem. (Photo: Sarah Watkins, 10KYI)

Photo 2: The flat leaf blades on new RCG growth. (Photo: Sarah Watkins, 10KYI)

Identification

- **Stems:** Rigid and hollow that grow up to 3 m from the rhizomes
- **Leaf Blades:** Broad, flat blades up to 0.5 m long and 2 cm wide
- **Ligules:** Membranous and distinct
- **Inflorescence:**
    - Immature – Green compact spike, 'boot stage'

- Full bloom (May to June) – Green to dark purple with an open formation
- Fruiting/Seeds dispersed – Straw-colored with an open formation

Propagation & Dispersal

Reed canarygrass propagates by seed and vegetatively through creeping rhizomes, rhizome fragments, and stem fragments.

Seeds

Reed canarygrass seeds are small, dense, and naked (*Photo 3*). While each reed canarygrass stem produces up to 600 seeds per year, seed germination rates are reported to be low (Tu 2004). RCG seed production is limited in the first year of growth but increases with colonization. In the Pacific Northwest, reed canarygrass seeds mature between July and August, and are dispersed by:

- Gravity
- Wind
- Water (e.g., streams, wetlands, stormwater in ditches)
- Humans (e.g., boots, vehicles, boats, ATVs, mowers)
- Animals (e.g., livestock, pack animals, beaver, elk, bear – transporting seeds in fur and hooves, not by seeds passing through digestive scarification)

Photo 3: RCG seeds collected in July. (Photo: Sarah Watkins, 10KYI)

Rhizomes

Cloned reed canarygrass plants grow from rhizomes and tillers (Waggy 2010) (*Photo 4*). Rhizomes may grow over three meters per year and form dense deep mats (*Photo 5*). While reed canarygrass favors full sun, the rhizomes enable the plant to spread and persist in heavily shaded areas. When reed canarygrass stems are grazed, cut, mowed, or otherwise injured, regrowth occurs from the rhizomes, and has been observed moving underground up wet slopes in native shrub communities (10KYI obs.).

Photo 4: RCG stems growing from a single rhizome. (Photo: Sarah Watkins, 10KYI)

Photo 5: Dense mats of rhizomes establish and build up on instream wood and beaver dams. (Photo: Devin Chastain, 10KYI)

Vegetative Fragments

Reed canarygrass stem and rhizome fragments resulting from high flow events, river scour, mowing, and beaver-cutting produce cloned reed canarygrass plants, contributing to the success of reed canarygrass in riverine zones of disturbance and deposition. On the upright stem, roots and stems grow from stem nodes (*Photo 6*). Stem and rhizome fragments and clumps of eroded RCG float and will root and sprout when deposited on damp soil or anchored under stream cobble, or catch on instream woody debris, and root in stream substrates below (*Photo 7*).

Photo 6: RCG root growing from a stem node. (Photo: Raena Anderson, 10KYI)

Photo 7: RCG caught on woody debris, rooting in stream substrate. (Photo: Jill Silver, 10KYI)

Impacts of Reed Canarygrass

Reed canarygrass is a highly invasive species that outcompetes and displaces native vegetation (Laverge et al. 2019). As RCG spreads to form monotypic stands, native plant diversity is reduced and habitat structure and functions are altered (Weilhoefer et al. 2016; Spyreas 2010). Stream and wetland hydrology is altered as stems and rhizomes decrease water velocity and trap sediment, filling wetlands and riverine side channels; reducing access to juvenile salmon rearing and refuge (Lestelle 2011; Antieau 2008; Tu 2004). Water temperatures rise and dissolved oxygen is lowered as a result of decreased flow and decomposition of plant biomass. Aquatic prey species production is reduced in RCG-dominated stands (Weilhoefer et al. 2016; Borde et al. 2015), and amphibian reproductive success is lower (Hallock 2013). In agricultural settings, RCG results in conversion from wet to dry pasture, and has historically been recommended and utilized for that purpose (Stanndard & Crowder 2001). Water flowing through pastures into wetlands and tributaries to mainstem rivers carries seeds that are observed to establish new populations far from the original agricultural setting (Kercher & Zedler 2004, 10KYI obs.).

Prevention and Control Methods

Preventing spread and successfully controlling reed canarygrass requires multiple years of persistent effort. A variety of methods specific to management goals, site type, extent and density of infestation, environmental impact, and available resources are often required.

Prevention and control methods are adapted and layered over time in response to treatment efficacy and resulting reduction of an infestation, continuing inflow of propagules from upstream or upslope sites, and for retreatment of regrowth from the seed bank or rhizomes that survive earlier treatment.

Recommended Strategies and Methods

- Prevention & Early Detection/Rapid Response (ED/RR)
- Manual control
- Chemical control

Prevention & Early Detection/Rapid Response

Early action on small populations is the most effective action to reduce reed canarygrass, locally and across watersheds. The combination of preventing dispersal of RCG seeds during regular surveys and eradicating small populations reduces long-term management costs and effort and supports the maintenance of healthy native riparian and aquatic habitats.

Photo 8: Treating small clumps of RCG along rivers and roads is the highest priority, as seeds travel in river and ditch flow. Don't walk by - remove those seeds. (Photo: Raena Anderson, 10KYI)

Regularly survey and treat sources, pathways, and vectors of reed canarygrass seeds, stems, and rhizome fragments (see *Table 1*). Roadsides, boat launches, roads and road crossings over streams, wetlands and tributaries where reed canarygrass populations are confined to discrete patches or individual plants are ideal sites to implement early detection and rapid response protocols. Eliminate sources of seeds and propagules which can be transported by water or human activities (boots, vehicles, boat trailers, mowing equipment) into ditches and streams, and from there, settle into low gradient riverine and wetland habitats. From these locations, seeds and stem fragments can be further distributed by animals (Tu 2004). Beaver dams and ponds are covered and filled by reed canarygrass in in the Upper Quinault watershed, the Hoh and Clearwater rivers, Goodman Creek, and many other locations (10KYI obs.).

Collect all florets and seeds prior to mowing, road construction or maintenance, and treat all patches on all road systems to prevent seeds and propagules from spreading to new sites. Be prepared to track seed migration in seasonal flow events to downstream or downslope sites, and to the outer extent of water flow across floodplains. Even under full shade of red alder or mixed deciduous and coniferous floodplain forests, reed canarygrass is found to produce seed, carried in water out of flooded wetlands and wet swales across floodplains; into new wet sites such as shallow channel margins, where some will germinate, forming a new source site.

Additional ED/RR activities include:

- Require RCG-free hay and straw for use in sediment or flow mitigation on all projects and

monitor all sites where hay and straw have been used for possible RCG introductions.

- Re-seed with native regionally appropriate grass species to encourage competition (this will add effort protecting native plants when re-treating growth from seed bank or rhizomes).
- Install educational signs at boat launches to inform the recreational public of risk of moving RCG by trailers, ATVs, and boots – and treat RCG in the pathways of vehicles, trailers, and boats.
- Incorporate equipment and boot washing protocols (per WDFW and WISC).
- By the third year of successful treatment, plant willows, red alder, Sitka spruce, and western red cedar or other species to create shade and competition where needed, and where beaver are not active.

Table 1: Reed Canarygrass Sources, Pathways, and Vectors

	Consider	Common Sources
Sources	*Where are reed canarygrass seeds, stems, and rhizome fragments originating?*	• Tributaries • Upstream mainstem sites • Stream crossings • Road approaches • Boat launches • Infested hay or straw for livestock or erosion control
Pathways	*How are reed canarygrass seeds, stems, and rhizome fragments moving?*	• Rivers and streams, wetland outflow • Outer edges of high flow (Ordinary High Water) • Roadways • Flooded pastures
Vectors	*Is something moving reed canarygrass seeds, stems, and rhizome fragments?*	• Water and wind • Boots and clothing • Tires (e.g., cars, trucks, boats, trailers, ATVs) • Mowing, construction, and snow removal equipment • Animals (e.g., beaver, elk, livestock, waterfowl)

Manual Control

Hand-pulling can be effective when removing individual stems in water, wet uncompacted, or sandy soils, as long as the entire rhizome is removed. Small, shallowly rooted clumps in water are generally able to be successfully removed (Lyons 1998). These are often fragments anchored under cobble or a piece of wood. Removing the rock and wood anchors enables easier pulling. If the plant does not come loose freely, chemical control will be a more effective method than leaving fragments of rhizome to form new plants. Remove and collect loose stem fragments from water bodies to avoid rooting and relocation by water. Hand-pulling is labor-intensive and ineffective for dense deeply-rooted patches, and all plant material must be transferred to a dry disposal site where no possible contact with damp soil, water flow carrying seeds, animals or equipment; making it infeasible for most applications or locations.

Cut, bag, and dispose of all reed canarygrass florets and seed heads (*Photos 8-9*). Pay special attention to reed canarygrass florets in 'boot stage' (*Photo 9*), as they can be difficult to spot. Sites may need to be

revisited after reed canarygrass florets are cut, as they often reform during the growing season. If reed canarygrass florets are actively releasing seeds, tip and cut seed heads directly into a bag for capture and disposal. Paper bags can be composted or burned, but must be kept dry. Wet bags tear and spill seeds. To avoid additional spread, always check for and remove seeds from boots, clothing, and gear prior to moving to an uninvaded area.

Photo 8: Reed canarygrass florets cut and placed into a heavy paper bag inside a tree planting bag, prior to disposal by burning. (Photo: Raena Anderson, 10KYI)

Photo 9: Reed canarygrass florets cut in 'boot stage' with a seatbelt cutter tool. (Photo: Raena Anderson, 10KYI)

Chemical Control

Reed canarygrass can be safely and effectively controlled with aquatic herbicides. Herbicide applications are most effective later in the growing season, when plants translocate nutrients to the rhizomes. Using 1-1.5% aquatic glyphosate (Aquaneat) or 0.5% aquatic imazapyr (Polaris) herbicide spray, herbicide can also be applied early in the growing season when stems are in 'boot stage'. Plants in different site types reach this stage asynchronously, requiring multiple surveys. Treating plants before flowering and seed production reduces the effort of collecting florets; but treating earlier when the plants are actively growing may not kill all rhizomes; requiring a second herbicide application later in the season. Despite application of the two low environmental risk aquatic herbicides recommended here, seeds can ripen in the time the herbicide is processed in the plant; so, when present, florets should be clipped, bagged, and disposed of by burning, burying, in a hot-composting facility, or landfill. Large monocultures generally require too much effort for floret and seed removal, and with continued seed rain, will require a longer treatment timeframe.

Herbicide Application Methods

1. Mix herbicide spray:
    a. 1 - 1.5% aquatic glyphosate (*Aquaneat*) or 0.5-1% aquatic imazapyr (*Polaris*) depending on growth stage and degree of saturation of soil (more saturated, more aquatic herbicide)
    b. 1-2% aquatic surfactant
    c. 1% marker dye

    d. Water (glyphosate requires municipally-sourced water due to sensitivity to pH and suspended sediment of any concentration)
2. Cut and bag reed canarygrass florets and seed heads.
3. Separate reed canarygrass stems from native vegetation (see recommended methods below).
4. Lift all stems out of water, and where possible, push stems onto banks to spray.
5. Bundle small clumps for targeted spray.
6. Spray herbicide directly onto RCG leaf-blades at a minimum of 80% coverage, using a finely calibrated backpack or hand sprayer, aimed up from base to top of stems to protect soil from spray.

Precautions

- Follow all label directions and federal and state herbicide regulations.
- Practice extreme care to avoid off-target and other environmental impacts.
- Wear Personal Protective Equipment (PPE) when handling and applying herbicide: Gloves, long sleeves, long pants, and rubber boots. Check herbicide label for additional PPE requirements.

Mechanical Control

Mowing or cutting alone will not eradicate reed canarygrass unless repeated for numerous seasons in dry sites. Mowing only once or twice per year may stimulate stem and leaf production; instead, mow large infestations five or more times per year prior to seed production for 5-10 years to deplete the existing seed bank (Lyons 1998). Once the seed bank is no longer viable, eliminate mature reed canarygrass with chemical control. 10KYI advises against excavation as a management tool for RCG. The rhizome mats and seeds present a hazard wherever they are deposited, and heavy equipment causes soil compaction, crushes biota, and must be washed regularly to avoid moving seeds and propagules. Instead, consider that after herbicide application and degradation, the mats of treated and composting biomass could provide a medium from which native plants might recover, although reported allelopathic properties may be present in decomposing RCG. More research is needed on allelopathy and planting in treated beds.

Biological Control

Other than grazing, there are no reported biological controls for reed canarygrass. While cattle may consume young stems and leaves, due to its high silica content, livestock will not graze it once the stems become rigid. Grazing alone will not eliminate reed canarygrass infestations due to both above and below-ground growth response (Lyons 1998).

Management Considerations & Best Practices

Timing – Surveys, Manual and Chemical Control

Surveys

Reed canarygrass surveys can be conducted year-round. During late fall to winter, dead reed canarygrass stems and blades generally remain standing, and are pale blonde (*Photo 10*). Early spring surveys are more challenging, as other grass species look similar until it grows over a meter. The florets provide the easiest verification. Inventory and flag questionable patches and return during late spring to early summer to verify species. Grass identification takes practice!

Manual Control

Manual control of reed canarygrass florets is most effective between late spring to early fall, to be completed before seeds have ripened. Site condition and exposure to sun influence reed canarygrass growth and treatment timing. Reed canarygrass in direct sunlight will grow, flower, and produce seed earlier than in shade, such as the roadside population shown below.

Photo 10: Roadside reed canarygrass inventoried during the winter for future treatment. The blonde color is clearly visible in other site types. (Photo: Raena Anderson, 10KYI)

Chemical Control

Chemical control of reed canarygrass is most effective as RCG begins to senesce (late summer to early fall). During this life stage, nutrients and water are actively flowing from blades to the root system, and herbicide is most effectively translocated to the rhizomes. Early chemical control of reed canarygrass can also be effective when the plant is in 'boot stage' (late spring to early summer, see Photo 9 above) but often requires another late summer treatment to control the regrowth from unaffected rhizomes.

Table 2: Reed Canarygrass Survey and Treatment Calendar

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Survey	X	X	X	X	X	X	X	X	X	X	X	X
Manual					X	X	X	X	X	X		
Chemical					X	X	X	X	X	X		

Invasion Density & Area Considerations

Scattered Reed Canarygrass Stems and Clumps

In water, clumps often grow from a single rhizome fragment or free-floating stem lodged under wood or cobble. These clumps can be gently pulled out, removing all rhizomes from the substrate. In other sites with loose soil, very small clumps may be pullable. Remove and dispose of all plant fragments to prevent regrowth. Do not compost. If manual treatment is not feasible, bundle clumps and treat with herbicide (*Photo 11)*. Take extra care to spray up from the base to the top to avoid spraying soil or surface water.

Photo 11: Scattered reed canarygrass bundled prior to spot treatment. (Photo: Raena Anderson, 10KYI)

Mixed with Native Plants

If reed canarygrass is growing in or alongside native vegetation avoid herbicide overspray by untangling and bundling reed canarygrass (*Photos 12 and 13)*. To bundle reed canarygrass, gather stems by gently pulling out of native plants, starting from the base of the RCG clump. Twist the stems to form a loose knot. Avoid breaking stems, as herbicide will be less able to translocate to the roots. Spray bundles with herbicides as described above. Spray the exterior of the bundle, the top of the bundle, and with the wand inside the bundle. Native plants can be protected if they are pushed aside by stepping on the stem, pushed outward and held down by fallen branches, or bent or cut away before spray treatment (*Photo 13)*. Unsprayed native plants return the following season, reducing impact and replanting costs.

Photo 12: Reed canarygrass is untangled from a native sword fern patch.
(Photo: Breyanna Waldsmith, 10KYI)

Photo 13: Reed canarygrass is bundled and pushed away from a native sword fern for treatment.
(Photo: Raena Anderson, 10KYI)

Photo 14: Native rush is bent away from a reed canarygrass patch to protect from spray – so the rush will regrow, and the RCG will be controlled. (Photo: Raena Anderson, 10KYI)

Dense Patches

Dense patches of reed canarygrass are most effectively treated with herbicide. Removal of florets and seed heads is encouraged to prevent four additional years of viable seed spread, however, across large and dense infestations, requires too much effort to be feasible. An alternative is to gently push stems, florets, and seed heads toward the middle of the patch to be able to spray just the RCG. Branches may be placed across the stems during treatment and removed after or left in place. Remember to avoid breaking RCG stems, as broken stems do not successfully translocate herbicide to the rhizomes.

Large Monocultures

Larger, dense monoculture populations will require multiple years of treatment, and often a combination of treatment types. As above, removing reed canarygrass florets across large monocultures is overly labor-intensive and generally infeasible except by regular mowing (conducted prior to seed production). Instead, focus on removing florets and seed heads along the edges of the site, along roadsides, and where water may flow. If the site is being treated with herbicide, and not mowed - push flowering stems into the center of patches and spray, so that when seeds ripen and drop, they are captured inside the dense stems of the patches. Where no new seed or propagule introduction is present, monitor for three to four years to assess regrowth from the seed bank, and retreat new infestations. Where continued introductions via water, equipment, animals, or boots occur, repeat treatments will be necessary. See below for discussion about when to consider revegetation.

Photo 15: Spray treatment of a RCG clump, after manual floret and seed removal.
(Photo: Raena Anderson, 10KYI)

Prevention and Control Practices by Habitat Type

Pastures

- Inventory all reed canarygrass sites on mowing tracks, wet swales, pasture and edges
- Identify sources where possible, and avoid reintroduction of seeds and propagules
- Treat all stems, clumps, patches at the same time
- Remove and bag all florets and seed heads from small clumps and along roadsides, streams, and fences
- Gather and bundle small clumps, and treat in place
- Mow before seed development, or push stems into large clumps
- If mowed, regrow until just before florets form
- Spray with herbicide
- Monitor for regrowth and retreat new infestations

Roadsides

- Inventory and flag reed canarygrass sites
- Remove and bag all florets and seed heads
- Gather and bundle small clumps
- Push stems into large clumps
- Spray with herbicide
- Monitor for regrowth and retreat new infestations

Stream Crossings- Bridges and Culverts

- Survey for and treat all infestations along approaches to road stream crossings (*Photo 16*)
- Survey up and downstream for distributed plants and sites
- Remove and bag all florets and seed heads, even when other treatments are not possible
- Inventory and flag reed canarygrass sites
- Gather and bundle small clumps (do not bundle unless herbicide is applied at the same time)
- Spray with herbicide
- Monitor for regrowth and retreat new infestations

Photo 16: Reed canarygrass invasion along a roadside, extending to the river's bank, and acting as a source to downstream reaches, wetlands, and riparian floodplains. (Photo: Raena Anderson, 10KYI)

Instream and Riparian Habitats

- Survey small side channels, tributary mouths and estuaries, off-channel habitats, vegetated islands, and gravel bars within floodplains, wetlands, and channel migration zones
- Inventory and flag reed canarygrass sites
- Remove and bag all florets and seed heads
- Untangle and separate RCG from native vegetation to prepare for treatment
- Carefully remove all plants (and their rhizomes) growing in water where possible, remove all floating clumps or stems from water, and place on top of riparian clumps to be sprayed
- Gather and bundle small clumps and spray with herbicide
- Remove stems from water, and push over RCG clump as above, and spray with herbicide
- Monitor for regrowth and retreat new infestations

Photo 17: Reed canarygrass is pulled out of water and placed on the streambank prior to herbicide treatment. (Photo: Raena Anderson, 10KYI)

Photo 18: Reed canarygrass is pulled up from the river for de-heading, using a fallen branch. (Photo: Raena Anderson, 10KYI)

Boat Launches

- Survey all parking areas, boat launch sites, and surrounding trails
- Inventory and flag reed canarygrass sites
- Remove and bag all florets
- Gather and bundle small clumps, and push stems into center of large clumps
- Spray with herbicide (and post a public notice as required)
- Monitor for regrowth and retreat new infestations

Revegetation

Native species revegetation may be necessary in areas where dense reed canarygrass infestations are eliminated and where a robust native seed bank or seed source is not available (Adams & Galatowitsch 2008). Revegetation methods include seeding, planting stakes, planting plugs and potted plants, and installing pre-vegetated coir mats. When selecting a revegetation method, consider site access, available resources, genetic stock, and site maintenance. Site maintenance will be required for a minimum of three to five years after planting, and longer if a reed canarygrass seed source is present upstream or upslope, or to ensure planting success in general. Avoid damaging desirable plants when applying herbicide by pruning, clipping, or temporarily pushing them aside (Miller et al. 2008).

Does Shade Eliminate Reed Canarygrass?

The restoration of native trees and shrubs, including red alder and willow species, has been recommended to shade and control reed canarygrass. Practitioners report planting willow as live stakes can reduce RCG vigor and density (Kim et al. 2006).

On the coast, we observe that these early successional species are vulnerable to disturbance events that eliminate the shade (wind, erosion, or beavers), and when a seed source is present (upstream or adjacent seed-producing population), reed canarygrass moves in to reinvade the treated and planted area. RCG can grow even under completely closed canopies of 30-year-old Sitka spruce, so dense that native shade-tolerant understory plants cannot thrive. This condition is counter to the goal of restoring a biodiverse native plant community and doesn't support the off-channel aquatic habitats so critical to

Pacific salmon and other coldwater species. As such, 10KYI recommends and practices treatment at the scale of stream basins and watersheds, focused on all sources and pathways as outlined above.

Can Reed Canarygrass Really Be Stopped?

We believe it can! Following these methods, 10KYI is demonstrating they are effective in three watersheds on the coast – in Goodman Creek, the Hoh River, and the lower Queets River. One important strategy is to identify and protect all places which have not yet been invaded, and work on small sources along pathways to these uninvaded sites, to 'hold space' where native species can thrive and spread their seeds until an effective program can be developed to address the spread of RCG.

While labor-intensive, stopping seed production is a simple and highly effective component of preventing RCG spread, especially by stream and ditch flow, and less laborious than tracking a new invasion down miles of stream, and out into floodplains.

Integrating seed control into a robust watershed-scale prevention and treatment plan, reed canarygrass can be controlled and eliminated – albeit, continued introductions require continued ED/RR of sources, vectors, and pathways. The larger populations and continued introductions from adjacent watersheds demand a more robust and coordinated approach, to be developed.

Watershed-Scale Coordination and Programmatic Development

Cross-landowner partnerships are essential to effective prevention at the watershed scale, to respond to the sources, pathways, and vectors of spread. Long term programs will be most effective in responding to new plants found at sites with a high prevalence of spread – e.g., roadsides leading to flowing ditches.

- **Notify and coordinate** with all land managers, road management and restoration entities to end the spread of seeds through various activities including mowing, in erosion control materials and seed, by vehicles, and industrial and recreational equipment. The following are entities with whom 10KYI works, and to whom we offer and provide prevention and control services:
    - Olympic and other National Parks, US Forest Service (USFS), Olympic National Forests (ONF), Tribes, Washington State Departments of Transportation (WSDOT), Fish and Wildlife (WDFW), Natural Resources (WDNR), and Agriculture (WSDA), City and County Public Works Departments, Lead Entities, Regional Fisheries Enhancement Groups, Quileute Tribe, Hoh Indian Tribe, and Quinault Indian Nation, restoration project sponsors, local non-profit organizations, timberland owners and managers, and private landowners.
- **Offer treatment support** when possible - do the work for the partners to stop the spread.
- **Promote reed canarygrass awareness** by developing outreach materials, workshops, and leading field tours to demonstrate practices and successes.

Projects are needed in every watershed. We look forward to supporting you in this critical work, and are currently able to provide training, site assessments, and assistance for project planning at no cost.

Call us!

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References

Adams, C. R. and Galatowitsch, S. M. (2008). **The transition from invasive species control to native species promotion and its dependence on seed density thresholds**. *Applied Vegetation Science,* 11, 131-138. DOI: https://doi.org/10.1111/j.1654-109X.2008.tb00211.x

Antieau, C. J. (1998). **Biology and Management of Reed Canarygrass, and Implications for Ecological Restoration.** *Washington State Department of Transportation*, Seattle, WA.

Borde, A., Cullinan, V., Thom, R., Hanson, A. and Corbett, C. (2015). ***Phalaris arundinacea* vs. *Carex lyngbyei*: A comparison of the food web contribution between non-native and native wetland species.** *Pacific Northwest National Laboratory and Lower Columbia Estuary Partnership*. Olympia, WA. Presentation to the Society of Wetland Scientists, PNW Chapter Meeting. URL: http://www.clallam.net/weed/doc/2016BordeRCGinColumbiaRiver.pdf

Hallock, M. (2013). **Draft State of Washington Oregon Spotted Frog Recovery Plan.** *Washington Department of Fish and Wildlife*, Olympia, WA. 93 pp. URL: https://wdfw.wa.gov/publications/01505

Kercher, S. M. and Zedler J. B. (2004). **Multiple disturbances accelerate invasion of reed canary grass (*Phalaris arundinacea* L.) in a mesocosm study**. *Oecologia,* 138, 455-464. DOI: https://doi.org/10.1007/s00442-003-1453-7

Kim, K. D., Ewing K., and Giblin, D. E. (2006). **Controlling *Phalaris arundinacea* (reed canarygrass) with live willow stakes: A density-dependent response.** *Ecological Engineering,* 27, 219–227. DOI: https://doi.org/10.1016/j.ecoleng.2006.02.007

Laverge, S. and Molofsky, J. (2019). **Control Strategies for the Invasive Reed Canarygrass (Phalaris arundinacea L.) in North American Wetlands: The Need for an Integrated Management Plan.** Natural Areas Journal, 26(2): 208-214. URL: https://doi.org/10.3375/0885-8608(2006)26[208:CSFTIR]2.0.CO;2

Lestelle, L. (2011). **WRIA 21 Queets/Quinault Salmon Habitat Recovery Strategy**. *Quinault Indian Nation Lead Entity*. URL: https://www.coastsalmonpartnership.org/wp-content/uploads/2019/02/WRIA-21-Salmon-Habitat-Restoration-Strategy-June-2011-Edition.pdf

Lyons, K. E. (1998). **Element Stewardship Abstract for Phalaris arundinacea.** *The Nature Conservancy*. University of California-Davis, CA. Web-accessed Jan. 13, 2019. URL: http://www.clallam.net/weed/doc/2016BordeRCGinColumbiaRiver.pdf

Miller, T. W., Martin, L.P., and MacConnell, C. B. (2008). **Managing Reed Canarygrass (*Phalaris arundinacea*) to Aid in Revegetation of Riparian Buffers.** *Weed Technology*, 22, 507–513. DOI: https://doi.org/10.1614/WT-06-194.1

Spyreas, G., Wilm, B.W., Plocher, A.E., Ketzner, D. M., Matthews, J.W., Ellis, J.L., and Heske, E. J. (2010). **Biological consequences of invasion by reed canary grass (*Phalaris arundinacea*)**. *Biological Invasions 12,* 1253-1267. DOI: https://doi.org/10.1007/s10530-009-9544-y

Reinhardt, C. and S. M. Galatowitsch. (2004). **Best Management Practices for the Invasive Phalaris arundinacea L. (reed canary grass) in Wetland Restorations.** *Minnesota Department of*

Transportation, St. Paul, MN. [Final Report]. URL: https://www.shorebirdplan.org/wp-content/uploads/2013/01/ReedCanaryGrassReport2004.pdf

[Thurston Co. EHD] Thurston County Environmental Health Division. (2009). Integrated Pest Management Prescription: Reed Canarygrass. Web accessed Jan. 13 2019. URL: https://www.co.thurston.wa.us/health/ehipm/pdf/RCG.pdf

Tu, Mandy. (2004). **Reed Canarygrass: Control and Management in the Pacific Northwest.** *The Nature Conservancy*, Portland, OR. URL: https://www.invasive.org/gist/moredocs/phaaru01.pdf

Stanndard, M. and Crowder, W. (2001). **Biology, History, and Suppression of Reed Canarygrass (Phalaris arundinacea L.).** *USDA-NRCS (US Department of Agriculture-National Resource Conservation Service): Plant Materials Cen*ter, Pullman. Plant Material Technical Notes #43. URL: https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmstn400201.pdf

Waggy, M. A. (2010). **Phalaris arundinacea.** *U.S. Department of Agriculture, Forest Service. Rocky Mountain Research Station, Fire Sciences Laboratory*. URL: https://www.fs.fed.us/database/feis/plants/graminoid/phaaru/all.html

Wisconsin Reed Canary Grass Management Working Group. (2009). **Reed Canary Grass (*Phalaris arundinacea*) Management Guide: Recommendations for Landowners and Restoration Professionals.** U.S. Department of Agriculture, PUB-FR-428 2009. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_035064.pdf

Weilhoefer, C. L., Williams, D., Nguyen, I., Jakstis, K., Fischer, C. (2016)**. The effects of reed canary grass (Phalaris arundinacea L.) on wetland habitat and arthropod community composition in an urban freshwater wetland.** *Wetlands Ecol Manage*, 25, 159-175. DOI: https://doi.org/10.1007/s11273-016-9507-x

Woodward, A., Torgersen, C., Chenoweth, J., Beirne, K., and Acker, S. (2011), **Predicting spread of invasive exotic plants into de-watered reservoirs following dam removal on the Elwha River.** *Olympic National Park*, Washington: U.S. Geological Survey Open-File Report 2011-1048, 64 pp. http://pubs.usgs.gov/of/2011/1048/