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2014 Aquatic Weed Surveys in Timothy Lake, Lake Harriet, North Fork Reservoir, Faraday Lake, and Estacada Lake

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FINAL REPORT

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TABLE OF CONTENTS

FIGURES

TABLES

INTRODUCTION

The Clackamas River Hydroelectric Project No. 2195 (Project) is located on the Oak Grove Fork of the Clackamas River and the mainstem of the Clackamas River in Clackamas County, Oregon. Reservoirs included in the Project include Timothy Lake, Lake Harriet, North Fork Reservoir, Faraday Lake, and Estacada Lake. The operator of the Project, Portland General Electric (PGE), was issued a license on December 21, 2010 by the Federal Energy Regulatory Commission (FERC) for continued operations and maintenance. The Final Environmental Impact Statement (FEIS) for the license noted that regular surveys for invasive aquatic weed species would be conducted as part of the Project's Vegetation Management Plan (PGE 2006).

The term "aquatic weed" is used here to refer to any non-native aquatic plant species. Information from repeated aquatic surveys will help determine native species distributions and the need for treatment of problematic aquatic weed species, particularly hydrilla (*Hydrilla verticillata*), Brazilian elodea (*Egeria densa*), and Eurasian watermilfoil (*Myriophyllum spicatum*).

Surveys conducted for PGE by Portland State University (PSU) in Timothy Lake, Lake Harriet, and North Fork Reservoir in 2011 did not locate any problematic submerged or floating leaved aquatic weed species (Sytsma and Morgan 2011). Earlier surveys of Timothy Lake (Heaton et al. 1996), and Timothy Lake and Lake Harriet (Pfauth and Sytsma 2004), also indicated the reservoirs were free of aquatic weeds. Heaton et al. (1996) noted that the native species *Bidens beckii* was present and had the potential to become weedy, however, this species was not found during the 2004 or 2011 surveys.

This report covers the results of follow up aquatic vegetation surveys conducted in Lake Harriet, Timothy Lake, and North Fork Reservoir between August 14 and August 21, 2014, as well as new surveys of Faraday Lake and Estacada Lake. Shoreline surveys for emergent invasive species such as yellow flag iris (*Iris pseudacorus*) and purple loosestrife (*Lythrum salicaria*) were included in surveys for the first time.

STUDY AREA

Timothy Lake, Lake Harriet, North Fork Reservoir, Faraday Lake, and Estacada Lake are located in Clackamas County, Oregon (Figure 1). Timothy Lake is a 572-ha impoundment of the Oak Fork of the Clackamas River located within the Mt. Hood National Forest an elevation of about 973 m. The lake is drawn down during the winter by about 6-8 m; drawdown typically begins in early September. Summer water levels range between 0.3-0.6 m of full pool (92.3-972.9 m); the lake is usually full by Memorial Day weekend. Summer water depths exceed 80 feet (24 m) in the center of the lake. Macrophytes are infrequent and sparse through much of the lake. The North Arm of the lake is shallower, generally less than 20-feet (6 m) deep, and macrophytes are more common and dense.

Lake Harriet is an 8-ha impoundment of the Oak Fork Clackamas River downstream from Timothy Lake in the Mt. Hood National Forest at an elevation of 619 m. The lake is relatively shallow throughout with a maximum depth of about 9 m. Water levels are relatively stable throughout the year and suitable plant habitat is found throughout much of the lake.

North Fork Reservoir, an impoundment of the main stem of the Clackamas River, is 142 ha at the normal high water surface elevation of 202.6 m. Water levels fluctuate daily by over 1 m and shorelines have steep relief. While portions of the reservoir's shoreline is undeveloped private property, most of the North Fork is situated within the Mt. Hood National Forest and is used heavily for recreational pursuits such as boating, water-skiing and fishing.

Faraday Lake, is the 20-ha forebay for the Faraday Powerhouse located downstream of North Fork Reservoir. Estacada Lake, created by the River Mill Dam, is located further downstream and adjacent to the City of Estacada.

Each lake has picnic sites open to the public from May through September. Timothy Lake has four public boat ramps, each of which is located within a public campground. Lake Harriet has public camping sites and only one primitive boat ramp. North Fork Reservoir has public camping, two boat ramps and a small marina.

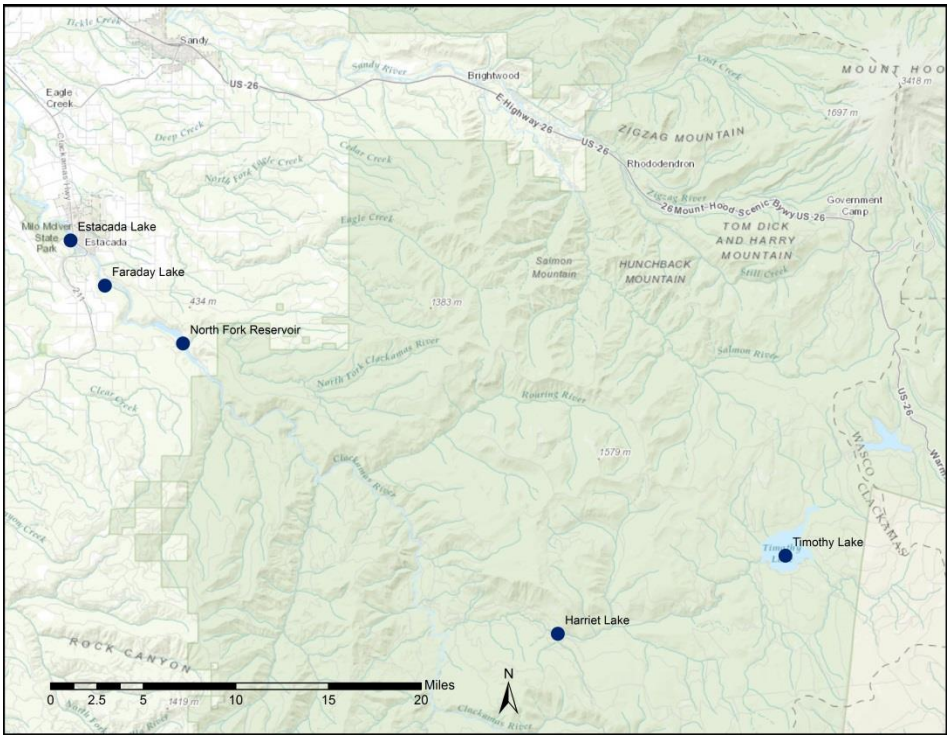

Figure 1. Location of Timothy Lake, Lake Harriet, North Fork Reservoir, Faraday Lake, and Estacada Lake along the Oak Fork and mainstem Clackamas River.

METHODS

Surveys of Timothy Lake, North Fork Reservoir, Faraday Lake, and Estacada Lake were conducted from a motorized boat and the survey of Lake Harriet was conducted by canoe. Submersed aquatic plants were collected using a double sided thatch rake fixed to an aluminum pole. At each sampling site, the rake was lowered to the bottom, the depth recorded to the nearest decimeter, then the rake was turned one full rotation and retrieved. The total area sampled by each rake grab was approximately 0.15 m^2. All plants retrieved on the rake were identified and estimates of relative abundance were made for each species. Supplemental sampling was employed when sparse plant cover did not afford good capture with the plant rake. Such sampling typically involved repeated dragging of the plant rake to dislodge visible plants and collection as material floated to the surface.

Sampling sites in the deeper waterbodies; Timothy Lake, North Fork Reservoir, and Estacada Lake; were located on transects roughly perpendicular to the shore from the shore to the maximum depth of macrophyte colonization. A minimum of one sampling point was collected for every two meter increase in depth or 10 m along each transect. Transects in Timothy Lake were located in similar

areas surveyed during prior surveys in 2004 and 2011 and transects in North Fork Reservoir were in similar areas surveyed during 2011. Sampling sites in Lake Harriet were along transects across the entire width of the reservoir in the upper shallow end; and along short, steep transects in the deep end of the reservoir. Sampling sites in Faraday Lake were throughout the waterbody covering the depth range of the littoral zone. Sample locations and shoreline survey tracklogs were recorded using a Trimble Juno 3B GPS unit which has a real-time positional accuracy as good as 2 m depending on satellite visibility. Positional dilution of precision (PDOP) was used to evaluate the quality of GPS location data. PDOP values less than 2 are considered to be of excellent quality, 2-5 are considered good quality. GPS locations with PDOP values between 5 and 10 should be used with caution, and values greater than 10 are fair to poor quality and should only be used as a rough estimate of location. Low positional quality GPS data is expected in areas of steep terrain like near Lake Harriet.

Submersed and floating leaf plants were surveyed at 91 sites along 20 transects throughout Timothy Lake (Figure 2). GPS location quality was good or excellent though most of the lake with the exception of moderate quality locational data in parts of the north arm of the lake. Sites were located at approximately the same locations as during the 2004 (Pfauth and Sytsma 2004), 2011 (Sytsma and Morgan 2011), and 1996 surveys (Heaton et al. 1996). Samples were collected at 60 sites along 20 transects within Lake Harriet (Figure 3). GPS location quality in much of the western portion of the lake was moderate to poor so those locations should be considered approximate. This is evident from the map as some sites appear to be on shore although they were in the lake. In North Fork Reservoir, 87 sites were sampled along 27 transects in the narrow littoral band found in the mid-to-lower reaches of the reservoir, the North Fork of the Clackamas arm, and shallow upper reservoir (Figure 4). At Faraday Lake, 40 sites were sampled along the north, south, and west ends of the waterbody (Figure 5). In Estacada Lake, 55 sites were sampled (Figure 6). GPS positional quality in North Fork Reservoir, Faraday Lake, and Estacada Lake was good to excellent in most areas.

The shoreline of each waterbody was visually inspected for emergent invasive species while slowly motoring or paddling along each waterbody perimeter. Oregon Department of Agriculture designated noxious aquatic weeds (2014) including purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis* ssp. *australis*), and yellow flag iris (*Iris pseudacorus*) were targeted during shoreline surveys. Locations were automatically logged once per second along survey paths with the Trimble Juno 3B GPS unit. When emergent or shoreline invasive species were encountered,

GPS locations were recorded along with percent coverage estimates within nested 5 m^2, 10 m^2, 0.5 ha areas. Although terrestrial invasive weeds and invasive aquatic animals were not a focus of the surveys, they were noted when observed.

Species were identified according to Brayshaw (2000), Crow et al. (2006), Crow and Hellquist (2006), Hamel and Parsons (2001), Jepson Flora Project (2014), and Flora of North America Editorial Committee (1993). Example specimens were pressed, labeled and archived at PSU.

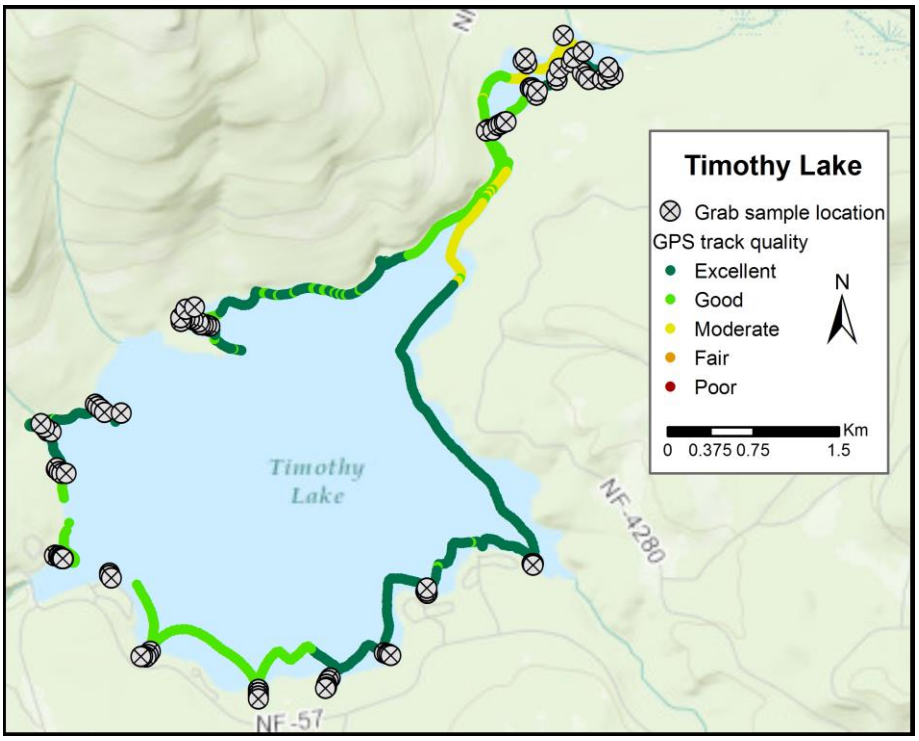

Figure 2. Timothy Lake grab sample location (91 sites) and shoreline survey paths. GPS paths are colored according to measured position dilution of precision quality.

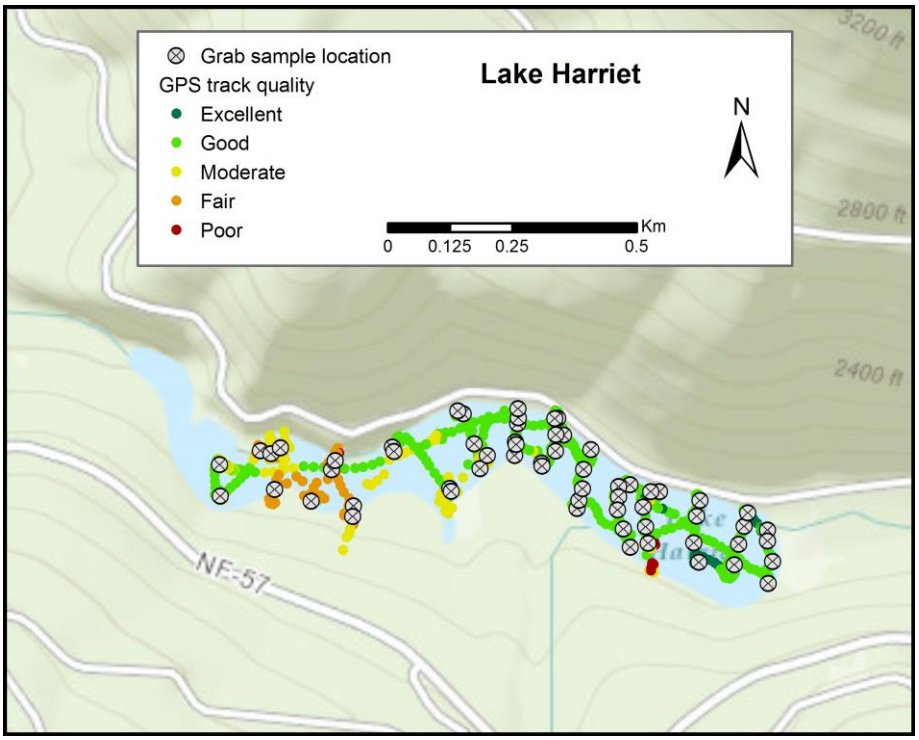

Figure 3. Lake Harriet grab sample locations (60 sites) and shoreline survey paths. GPS paths are colored according to measured position dilution of precision quality.

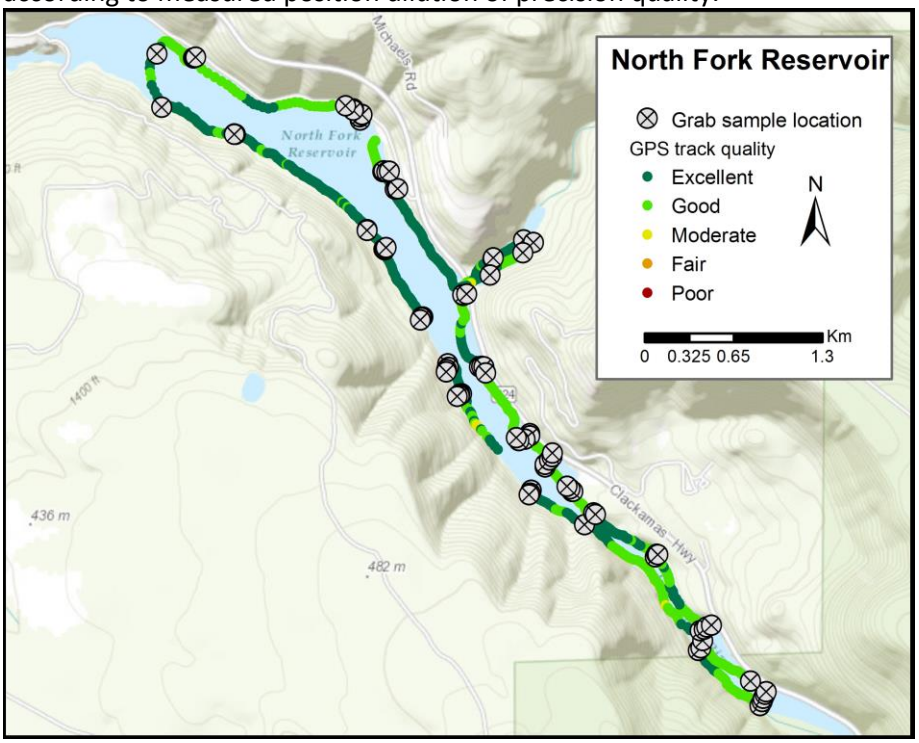

Figure 4. North Fork Reservoir grab sample locations (87 sites) and shoreline survey paths. GPS paths are colored according to measured position dilution of precision quality.

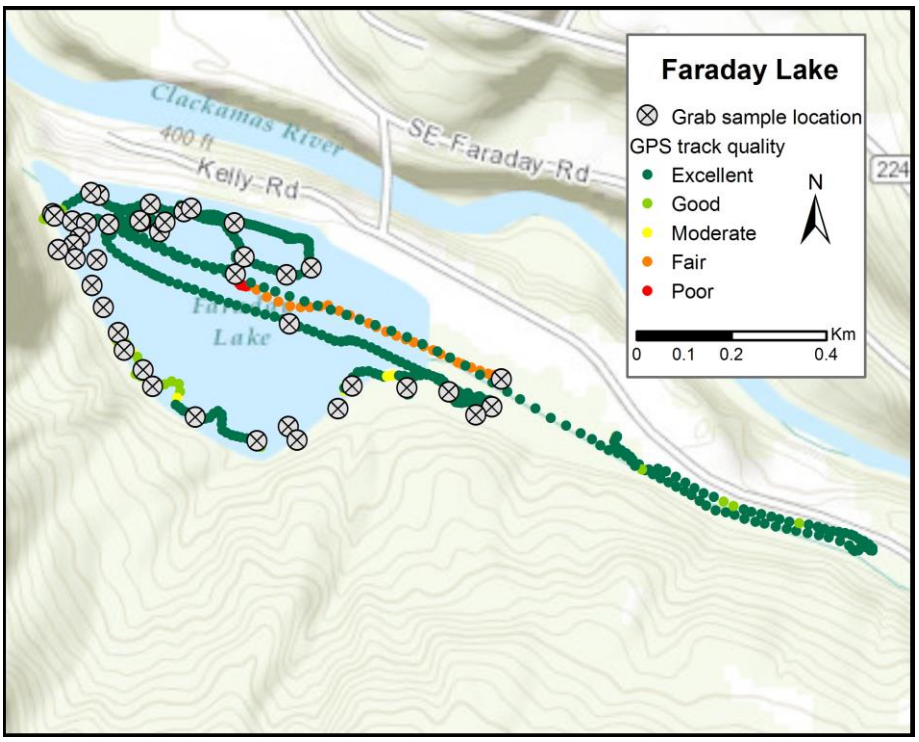

Figure 5. Faraday Lake grab sample locations (40 sites) and shoreline survey paths. GPS paths are colored according to measured position dilution of precision quality.

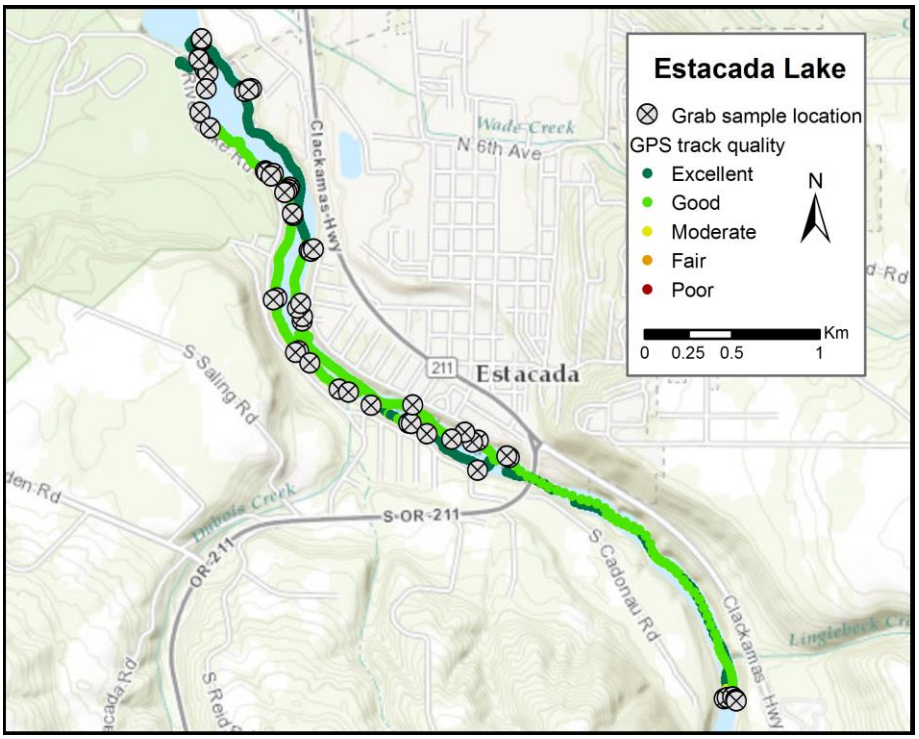

Figure 6. Estacada Lake grab sample locations (55 sites) and shoreline survey paths. GPS paths are colored according to measured position dilution of precision quality.

RESULTS

SUBMERSED AND FLOATING LEAF AQUATIC PLANT SURVEYS

A total of 19 different submerged or floating leaf aquatic plant species were identified in the five waterbodies sampled (Table 1). No non-native aquatic plants were found at any of the sites. Fifteen of the species were angiosperms, two were bryophytes, and two were macroalgae. No species was observed in all study lakes, but three species were observed in four of the five lakes (*Elodea canadensis, Nitella* sp., and *Potamogeton pusillus).*

Fifteen species were present in Timothy Lake, by far the highest species richness of the survey lakes. Similar to previous surveys, the greatest abundance and diversity of aquatic plants in was located in the shallow north arm of the lake. Plants occurred in 22 of 30 (73%) samples collected in the north arm and included 11 of the 15 species. Sample depths within the north arm ranged from 0.6 to 4.2 m with plants occurring across the entire depth range. The maximum depth sampled in the lake was 6.3 m and no plants were observed below a depth of 4.5 m. Dominant taxa in the lake included *Callitriche hermaphroditica, Eleocharis acicularis, Potamogeton alpinus, Potamogeton pusillus,* and *Sparganium angustifolium*. *C. hermaphroditica* occupied the shallowest range (0.3-1.4 m) while *P. pusillus* occupied the deepest range (0.6-4.5 m). Three native species were detected in Timothy Lake that were not observed during the 2004 and 2011 surveys: *Potamogeton gramineus, Sagittaria* sp. (likely *S. cuneata*) and *Utricularia ochrolenca*. *U. ochrolenca* (northern bladderwort), had also been detected in Timothy Lake during a 2002 survey (EDAW Inc. 2003). *U. ochrolenca* is a rare species that is listed as secure but with cause for long term concern at a global scale (NatureServe 2014) and threatened with extinction in Oregon (Oregon Biodiversity Information Center 2013, NatureServe 2014).

Four native submerged plant species were present in Lake Harriet. At least one species was present in 90% of the samples and the maximum depth of colonization was 6.5 m. Suitable plant habitat was more common in the shallow eastern half of the lake compared to the western portion of the lake where steep gradients only allowed a narrow littoral band for macrophyte colonization. Similar to results from the 2011 surveys, *Elodea canadensis* was the most common and abundant species. The plant was gathered in all sites where vegetation was detected and composed over 96% of the species

composition at each site. *Nitella* sp. and *Ranunculus aquatilis* were the next most commonly encountered plants, found in 15 and 6.7% of the samples respectively.

Table 1. Aquatic plant species found in Timothy Lake, Lake Harriet, North Fork Reservoir, Faraday Lake, and Estacada Lake between August 14 and August 21, 2014.

Genus and species	Native species?	Timothy Lake	Lake Harriet	North Fork Reservoir	Faraday Lake	Estacada Lake
Angiosperms						
Callitriche hermaphroditica	Y	X				
Eleocharis acicularis	Y	X				
Elodea canadensis	Y		X	X	X	X
Lemna sp.	Y			X		
Persicaria amphibia	Y	X				
Potamogeton alpinus	Y	X				
Potamogenton gramineus	Y	X				
Potamogeton pusillus	Y	X		X	X	X
Ranunculus aquatilis	Y	X	X	X		
Limosella aquatica	Y	X				
Schoenoplectus subterminalis	Y	X				
Sagittaria sp. (either *S. cuneate or S. latifolia*)	Y	X				
Sparganium angustifolium	Y	X				
Typha latifolia	Y	X				
Utricularia ochrolenca	Y	X				
Macroalgae						
Chara sp.	Y					X
Nitella sp.	Y		X	X	X	X
Bryophytes						
Sphagnum sp.	Y	X	X	X		
Fontinalis sp.	Y	X				

Six submerged species were found in North Fork Reservoir. Plants were present at 57% of sites and at depths ranging up to 5 m. Areas with suitable plant habitat were concentrated around the marina, the North Fork Clackamas arm, and upper reaches of the reservoir. Similar to Lake Harriet, *Elodea canadensis* was the most common and abundant species by far in this waterbody. *E. canadensis* was found in 50% of the samples and comprised over 79% of the species composition at those sites. Other common species in North Fork Reservoir included *Nitella sp.* and *P. pusillus* which were found in 10 and 24% of the samples respectively. The remaining three species were rare and observed at less than 5% of sites.

Only three native submerged aquatic plant species were detected in Faraday Lake: *P. pusillus*, *Nitella sp.*, and *E. canadensis*. The three species were observed at 39, 63, and 58% of the sites respectively. At least one species was present at 90% of the sites at depths up to 3.6 m.

Four native submerged aquatic plant species were present in Estacada Lake. At least one species was present at 61.4% of the sites up to a maximum depth of 5.6 m. *E. Canadensis* and *P. pusillus* were dominant and occurred at 47 and 14% of the sites sampled respectively.

SHORELINE EMERGENT PLANT SURVEYS

Shoreline surveys for non-native plants were conducted at all five waterbodies. No non-native shoreline shoreline emergent plant species were detected along the shores of any of the lakes. Non-native terrestrial plants, however, were observed near the shorelines of Timothy Lake, North Fork Reservoir, Reservoir, and Estacada Lake (

Table 2). Five of the taxa are ODA Class B listed weeds (Oregon Department of Agriculture Noxious Weed Control Program 2014), all five of which are widespread in western Oregon. Most of the species were detected near Estacada Lake which is surrounded by residential areas. The most common plant was Himalayan blackberry with ten observations at Estacada Lake and two observations at the North Fork Reservoir. English ivy was the second most common species with nine observations at Estacada Lake and one observation at the North Fork Reservoir.

Table 2. Non-native terrestrial species found near the shores of Timothy Lake, Lake Harriet, North Fork Reservoir, Faraday Lake, and Estacada Lake in 2014.

Taxa	Common name	ODA weed class.	Timothy Lake	Lake Harriet	North Fork Reservoir	Faraday Lake	Estacada Lake
Buddleja davidii	butterfly bush	B					X
Clematis vitalba	old man's beard	B					X
Convolvulus arvensis	field bindweed	B					X
Cytisus scoparius	Scotch broom	B					X
Hederx helix	English ivy	B			X		X
Jacobaea vulgaris	tansy ragwort	-	X				
Persicaria hydropiper	marshpepper knotweed	-					X
Rubus armeniacus	Himalayan blackberry	B			X		X
Solanum dulcamara	bittersweet nightshade	-					X

DISCUSSION

As was the case during previous surveys of Clackamas River Hydroelectric Project impoundments, no submerged or floating leaf non-native aquatic weeds were detected during the 2014 surveys. First-time surveys of Faraday Lake and Estacada Lake revealed similar, low diversity native submersed plant communities that are present upstream in North Fork Reservoir and Lake Harriet. Initial detailed shoreline surveys also indicated the waterbodies were free of emergent non-native species.

Documentation of two native species in Timothy Lake that had not been detected during three previous surveys, *Potamogeton gramineus*, *Sagittaria* sp., does not necessarily indicate that they have been newly introduced into the lake. These species may have been missed during the prior surveys due to the patchy distribution, low abundance, and seasonal changes in abundance

Several native species that were detected are of particular interest due to their rarity in Oregon. In addition to the aforementioned *U. ochroleuca* that was observed in Timothy Lake, *Schoenoplectus subterminalis* is on the Oregon Natural Heritage Programs list of imperiled species (Oregon

Biodiversity Information Center 2013). Specifically *S. subterminalis* is considered "imperiled because of rarity or because other factors demonstrably make it very vulnerable to extinction (extirpation), typically with 6 to 20 occurrences".

There are numerous vectors for aquatic weeds introduction to these lakes such as trailered boats, fishing equipment, aquarium releases and natural vectors such as wildlife. The heavy recreational use of all Clackamas Hydroelectric Project waterbodies, their proximity to waterbodies with existing populations of aquatic weeds (e.g. *Egeria densa* in the Willamette River), relatively high population density and disturbance near Estacada Lake suggest introduction of one or more undesirable plant species is likely. The high density and diversity of non-native terrestrial species such as English ivy and Himalayan blackberry around Estacada Lake highlights the risk of highly populated, highly disturbed areas for the invasion of non-native species.

Timothy Lake is particularly vulnerable to introductions on non-native plants since it has four public boat ramps and high usage by boaters. The natural topography and water-level fluctuations at Timothy Lake and North Fork Reservoir may serve as an impediment to successful establishment through much of the lake, although this does not limit the relatively high species richness present in the north arm of the lake. Lake Harriet is at higher risk for successful establishment if aquatic invasive species are introduced due to fairly stable water levels, ample littoral habitat, and clear water.

Species of concern that were not detected include *Myriophyllum spicatum* (Eurasian watermilfoil) and *Potamogeton crispus* (curlyleaf pondweed), *Egeria densa* (Brazilian egeria), *Cabomba caroliniana* (Fanwort), *Myriophyllum aquaticum* (parrotfeather), *Myriophyllum heterophyllum* (variableleaf milfoil), *Nymphoides peltata* (yellow floatingheart), *Ludwigia* spp. (floating water primrose) and *Hydrilla verticillata* (Hydrilla). Some of these are well established in the Columbia River or Willamette River basins. Several of these species of concern are capable of prolific vegetative reproduction and can rapidly overwhelm a waterbody.

RECOMMENDATIONS

Early detection coupled with eradication of pioneer infestations has been shown to be the most cost effective way to deal with invasive species (Rejmánek and Pitcairn 2002). Repeat surveys in The Clackamas River Hydroelectric Project impoundments are required to allow for rapid response to newly introduced species. Ideally aquatic plant surveys should be conducted every two to three years and should generally follow methods used in this survey. Surveys at Timothy Lake should focus effort on the north arm of the lake where there is much more habitat suitable for the establishment of new species, although high use areas near boat launches should continue to be monitored. Education of visitors to the waterbodies, as well as PGE staff, on high-risk aquatic plants that are likely to be introduced and established in the waterbodies would help with early detection efforts between more extensive surveys. Of course, signs instructing boaters to clean their trailers and boats before and after launching should be maintained at all boat ramps.

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