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Aquatic Invasive Species Surveys of Pacificorp's North Umpqua River Impoundments

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2012 Report

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Table of Contents

1. Abstract

Ten North Umpqua Hydroelectric Project impoundments were surveyed for aquatic invasive species during the summer of 2012. One non-native submersed aquatic vegetation species (*Potamogeton crispus*) and one non-native snail species (*Radix auricularia*) was detected. No crayfish or mussel veligers were collected and no non-native zooplankton species were encountered.

2. Introduction

Pacificorp Energy's North Umpqua Hydroelectric Project includes 11 impoundments within the North Umpqua River watershed in the Umpqua National Forest (UNF) of southwestern Oregon. The impoundments are managed by Pacificorp under the Federal Energy Regulatory Commission License Number 1927 in cooperation with the UNF. Pacificorp and the UNF contracted with the Center for Lakes and Reservoirs at Portland State University (CLR) to survey the waterbodies for aquatic invasive species (AIS) including invasive submersed aquatic plants, crayfish, gastropods and adult bivalves, planktonic bivalve veligers, and zooplankton.

Ten of the 11 waterbodies were surveyed between July 30 and August 10, 2012: Lemolo Reservoir, Lemolo No. 1 Forebay, Lemolo No. 2 Forebay, Toketee Lake, Stump Lake, Clearwater No. 1 Forebay, Clearwater No. 2 Forebay, Fish Creek Screen Ponds, Fish Creek Forebay, and Slide Creek Reservoir (Figure 1). The most downstream impoundment, Soda Springs Reservoir, was not surveyed due to limited access.

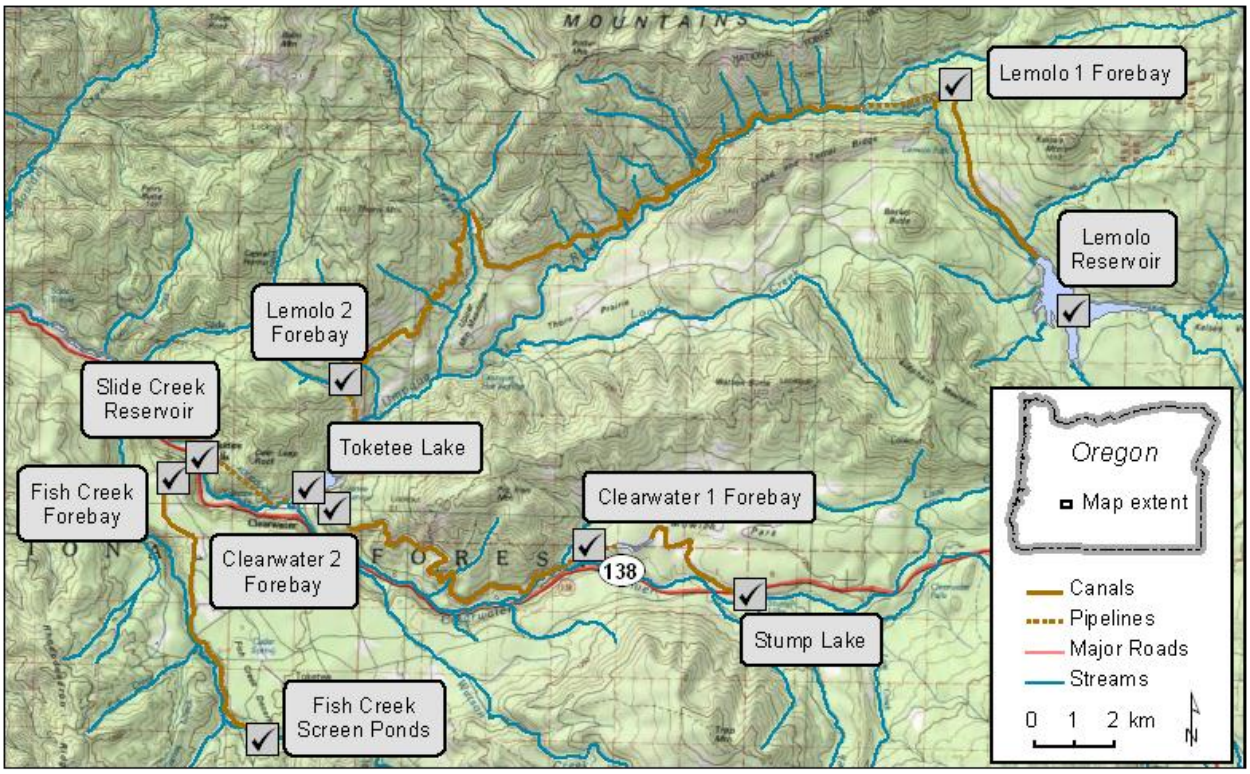

Figure 1. North Umpqua Hydroelectric Project impoundments surveyed for AIS during July and August, 2012.

3. Methods

3.1 Submersed Aquatic Vegetation

The species composition of submersed aquatic vegetation (SAV) was assessed at 100 sampling sites in Lemolo and Toketee Lakes and 50 sites in each of the smaller impoundments with the exception of Lemolo 1 Forebay, which had a plastic liner and no apparent SAV (Figure 2 through Figure 5). Sampling sites were haphazardly distributed throughout each impoundment and focused on areas likely to have a high diversity of SAV species such protected bays or areas with low slope.

SAV samples were collected at each site from a boat or from shore with a double-sided thatch rake attached to a graduated pole or with a thatch rake attached to a throw rope. The graduated pole was lowered vertically to the sediment surface, rotated 180 degrees, and attached material was retrieved. Alternatively, the thatch rake was thrown, drug along the sediment for approximately one meter, and retrieved. The total area sampled was approximately 0.15-m^2 for each pole sample and 0.22-m^2 for each rake drag. GPS location, sample depth, and preliminary species identifications were noted on field datasheets. Voucher specimens were placed in labeled plastic bags and placed on ice for verification. Field species identification were verified using Crow and Hellquist (2000; 2006), Hamel and Parsons (2001), and Brayshaw (2001). Selected specimens were pressed and archived in the herbarium at Portland State University.

3.2 Bivalve Veligers

Samples for the detection of zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena rostriformis bugensis*) veligers were collected and inspected according to Wells and Sytsma (2011). Samples were collected from a boat at a minimum of fifteen sites distributed throughout each impoundment (Figure 2 through Figure 5). Vertical, oblique, or horizontal tows were collected depending on the depth. Tows were collected with a decontaminated 20-cm diameter, 64-µm mesh plankton net with a removable cod-end piece. The multiple tow samples were composited into a single 500-mL HDPE bottle. Total sample volume of approximately 125-mL was preserved by adding 95% ethanol to a final concentration of approximately 70% ethanol. Samples were inspected for veligers at the Portland State University using cross-polarized light microscopy.

3.3 Gastropods and Adult Bivalves

Gastropods and adult bivalves were collected using three methods: sediment dredging, SAV sampling, and shallow water observations. Sediment dredge samples (225-cm^2 sample area) were collected at 10 sites within each impoundment using a Petit Ponar dredge (Figure 2 through Figure 5). SAV samples were collected with either a Petit Ponar dredge or a rake as described in Section 3.1. Sediment and SAV samples were rinsed onto a 250-µm mesh screen and inspected for suspected invasive snails and bivalves. For the shallow water observations, rocks and woody debris were inspected every few meters along 30-m transects near the shore of primary access points. Suspected invasive species were placed in labeled vials and preserved in ethanol. AIS identifications were verified by Robyn Draheim at Portland State University.

3.4 Crayfish

Crayfish surveys were conducted based on the protocols outlined by Larson and Tait (2011). Briefly, modified Gee minnow traps were placed at five sites at least 10-m apart in each of the impoundments (Figure 2 through Figure 5). Traps were baited with dry dog food and deployed from late evening to early morning in shallow areas (< 2 m) with hard substrate. Trap locations, deployment length, deployment depth, substrate type, and numbers and species of crayfish trapped were recorded on field data sheets. Crayfish encountered during SAV and benthic surveys were collected if captured. Specimens were photographed and preserved in ethanol.

3.5 Zooplankton and Epi-benthos

Zooplankton and epi-benthos samples were collected with a 64-um mesh, 20-cm diameter, Wisconsin-style net. Samples were collected at the deepest location in Lemolo Lake, Lemolo No. 2 Forebay, Clearwater Forebays No. 1 and 2, Toketee Reservoir, and Fish Creek Forebay (Figure 2 through Figure 5). Fish Creek Screen Ponds and Lemolo No. 1 Forebay were not surveyed for zooplankton because they were drawn down at the time of survey. Slide Creek Reservoir was not surveyed for due to lack of boat access. Samples were not collected from Stump Lake. Zooplankton were enumerated to the lowest possible taxonomic level by ZPs Taxonomic Service of Olympia, WA.

3.6 Water Quality

Temperature, dissolved oxygen, pH and specific conductivity were measured near the deepest location in each of the impoundments (Figure 2 through Figure 5) using a Eureka Manta^{TM} or Hydrolab Quanta^{TM} water quality multiprobe. Accuracy of specific conductivity and pH sensors was assured by calibration at the start of each sampling day using NIST certified 500-µS/cm, pH-7, and pH-10 standards. At each impoundment, accuracy of dissolved oxygen was assured by calibration to 100% saturation based on in situ barometric pressure measurements. Accuracy of temperature probes was assured through factory calibration. Measurements were conducted at 0.1-m depth, 1-m depth, and at 1-m depth increments thereafter to within 1-m of the sediment. Probes were held at each depth for at least one minute for equilibration with conditions at each depth. Precision was assessed by repeating the 1 or 2-m measurements after profiles were completed.

Water transparency was measured by observing the depth of disappearance of a 20-cm Secchi disk lowered off the shaded side of the boat. All water quality measurements were recorded on waterproof field datasheets.

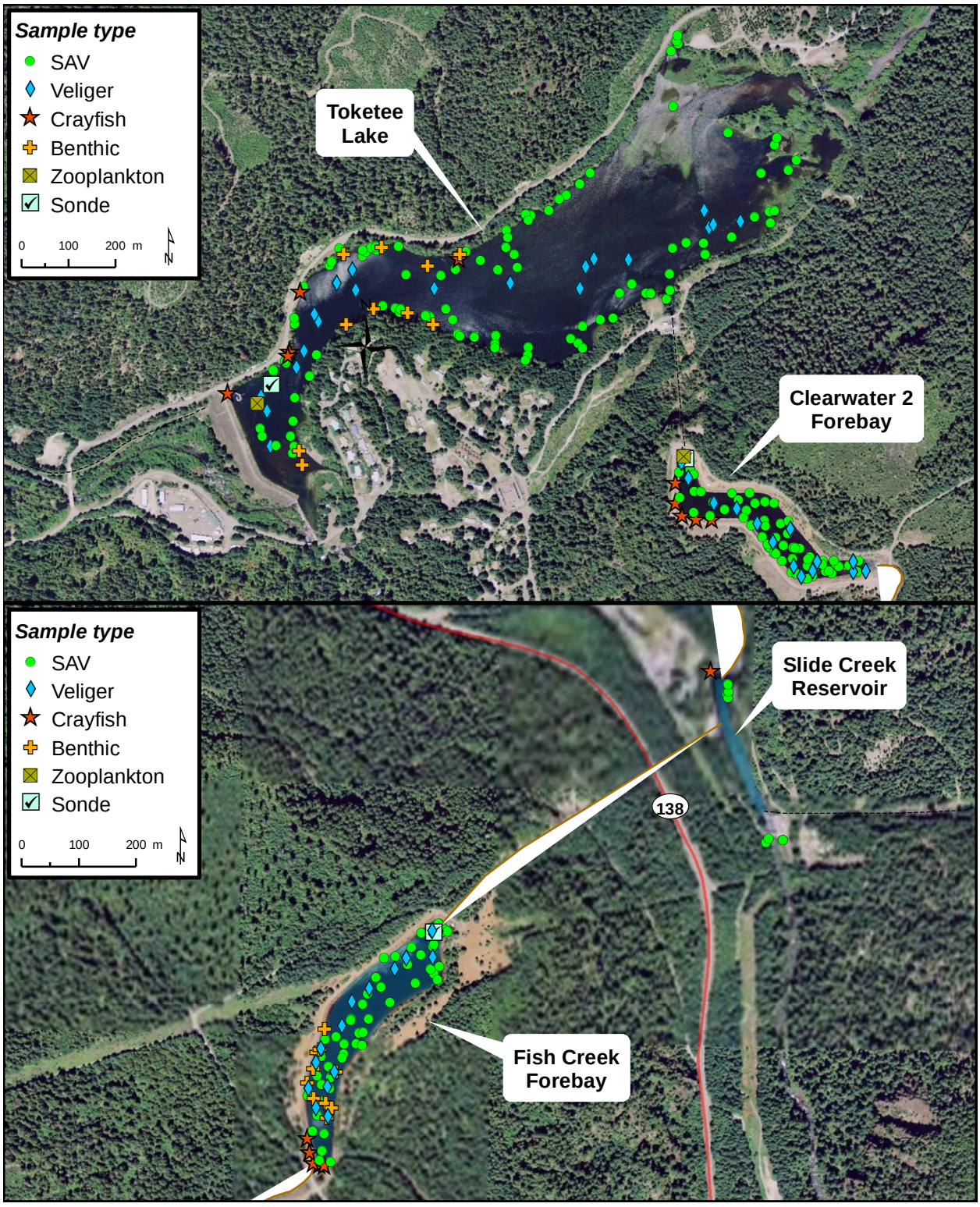

Figure 2. Toketee Lake, Clearwater No. 2 Forebay, Fish Creek Forebay and Slide Creek Reservoir sites sampled for AIS during 2012.

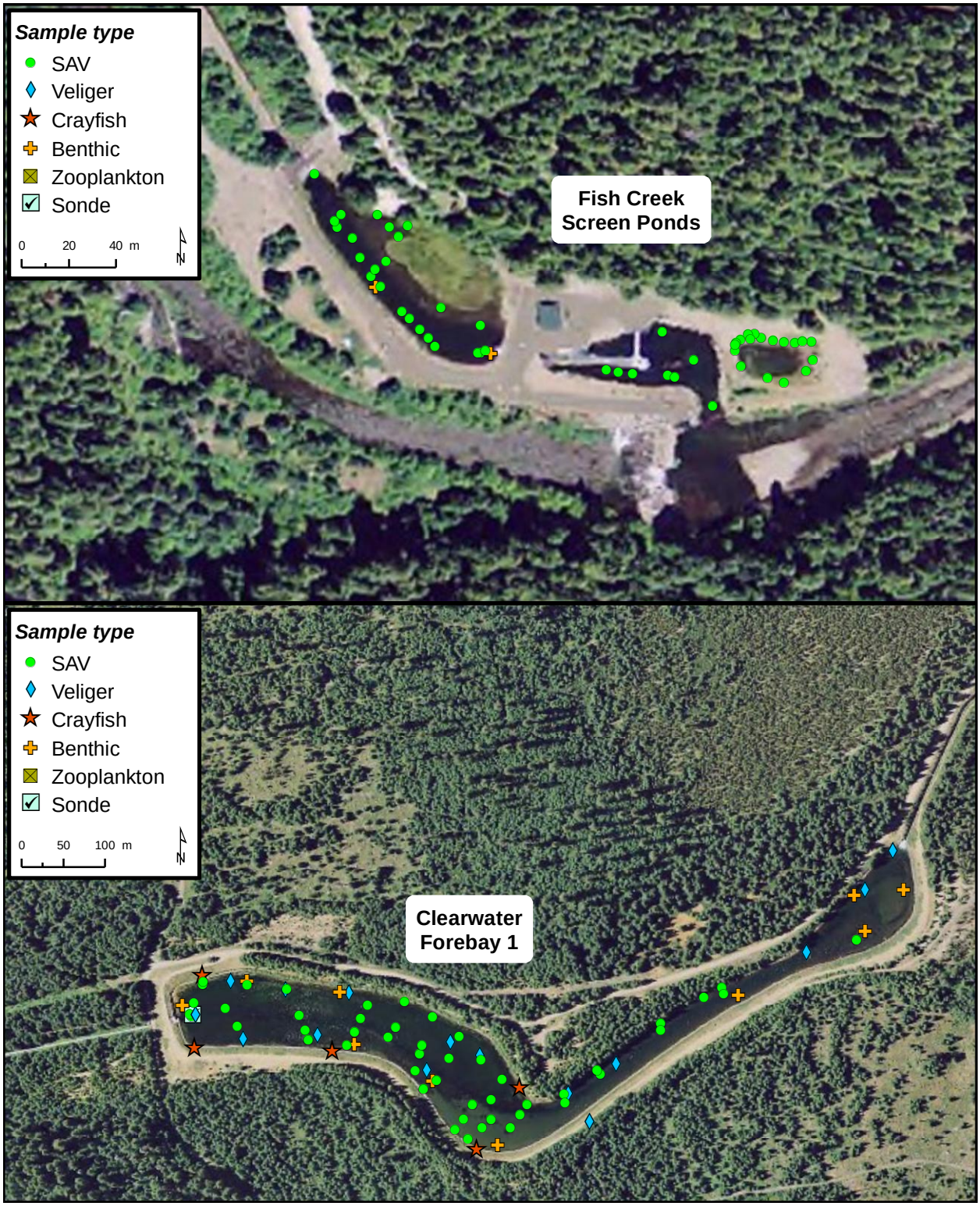

Figure 3. Fish Creek Screen Ponds and Clearwater No. 1 Forebay sites sampled for AIS during 2012.

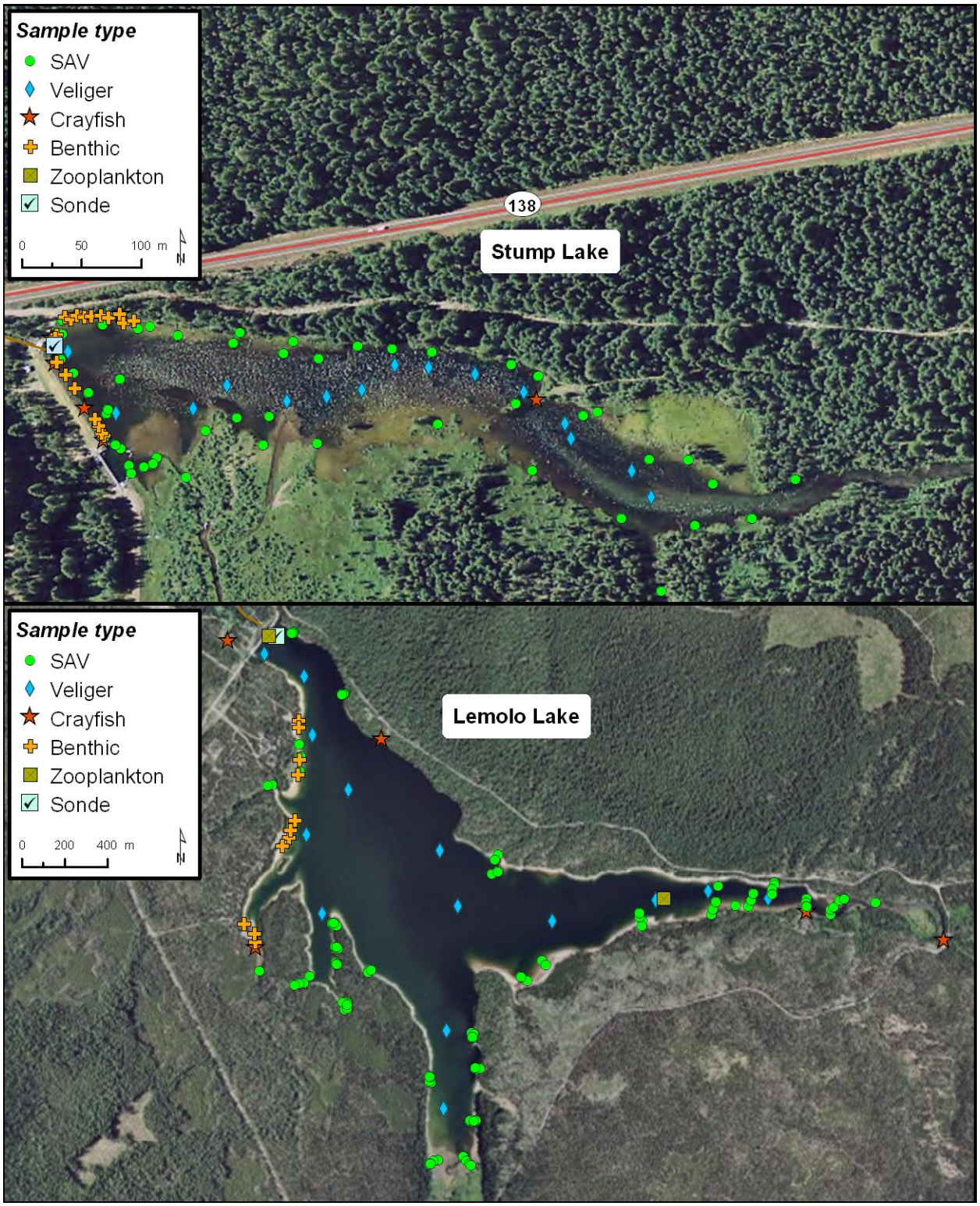

Figure 4. Stump Lake and Lemolo Lake sites sampled for AIS during 2012.

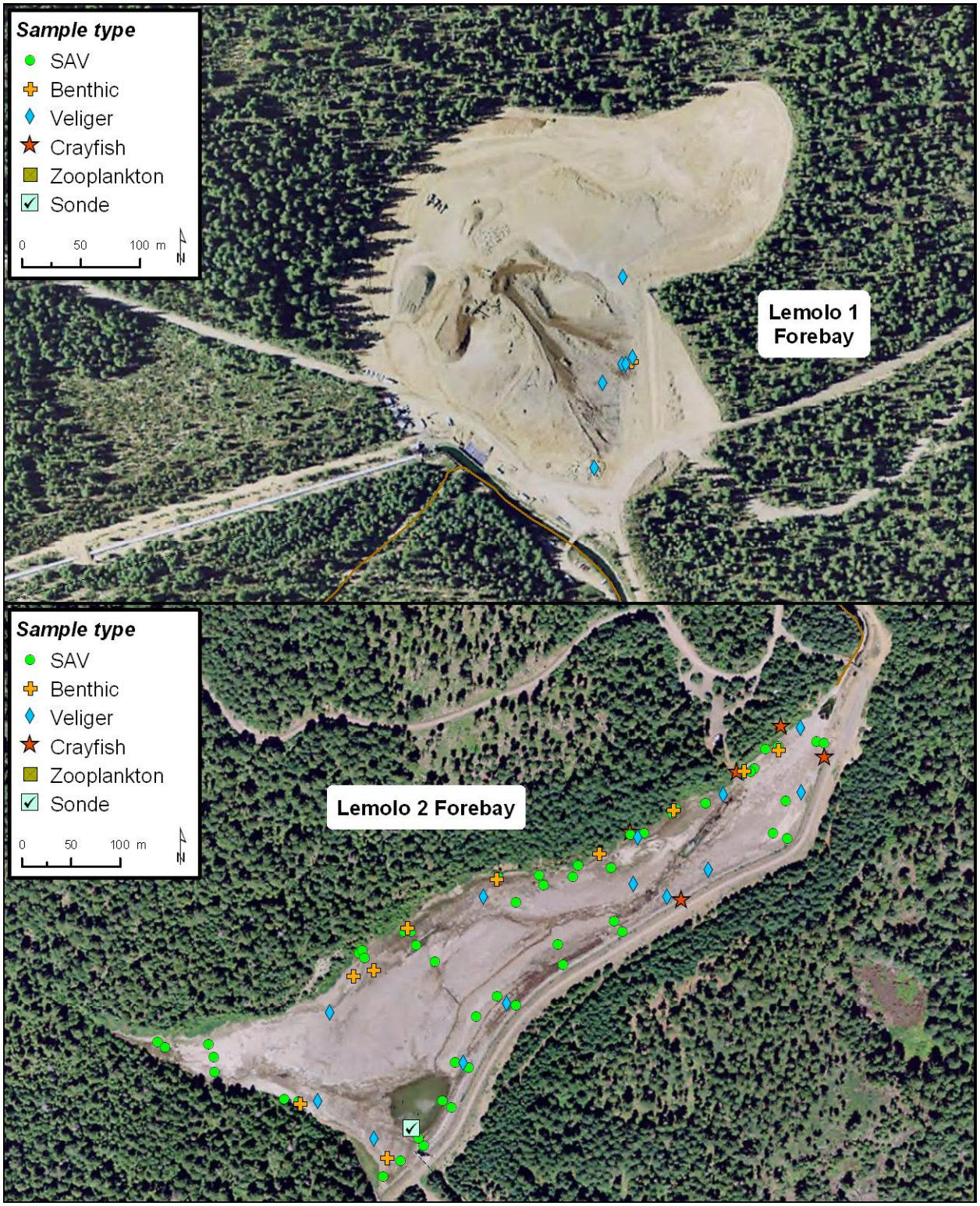

Figure 5. Lemolo No. 1 Forebay and Lemolo No. 2 Forebay sites sampled for AIS during 2012.

4. Results

4.1 Submersed Aquatic Vegetation

Only one nonnative, submersed aquatic plant was found in the impoundments, *Potamogeton crispus* (curly-leaf pondweed) (Table 1). *P. crispus* was detected in Clearwater River impoundments and Toketee Lake, but not North Umpqua River impoundments upstream from Toketee Lake (Lemolo Lake, Lemolo No. 1 and 2 Forebays) or the Fish Creek impoundments. It is likely that P. *crispus* has been introduced to Lemolo Lake and Forebays and may be present at low densities since *P. crispus* has been present in Diamond Lake (located upstream of Lemolo Lake) since at least the mid 1990s (R. Helliwell, USFS, personal communication).

Several submersed plant specimens collected were not identified to species (e.g. the mosses, liverworts and stoneworts); however, none of these groups contain species considered invasive in Oregon.

Shoreline plants were surveyed with a focus on detecting Oregon Department of Agriculture class "A" and "B" designated noxious weeds such as class "B" purple loostrife (*Lythrum salicaria*) and yellow flag iris (*Iris pseudacorus*) (ODA 2012). No ODA designated weeds were observed along the shorelines of the systems surveyed (Table 2).

4.2 Bivalve Veligers

No bivalve veligers were detected in the samples collected from the impoundments. Although zebra mussels (*Dreissena polymorpha*) are established as close as central California (Benson et al. 2013a) and quagga mussels (*Dreissena bugensis*) are established in southern Nevada and California (Benson et al. 2013b), extensive monitoring has not detected either species in the Northwest (Steve Wells, Portland State University, personal communication).

4.3 Gastropods and Adult Bivalves

Several *Radix auricularia* (big-eared radix) specimens were collected in Fish Creek Forebay (Table 3). *R.auricularia* have previously been detected in Toketee Reservoir (Kipp et al. 2013), but were not collected during the current survey. All other gastropods collected were native species (e.g. *Stagnicola elodes*) or unidentified species that belong to taxonomic groups that have many native species and few AIS. No adult dreissenid mussels were detected in any of the impoundments. Other AIS gastropods that were not detected, but are present in the Northwest US include New Zealand mudsnails (*Potamopyrgus antipodarum*) and Chinese mystery snails (*Cipangopaludina chinensis malleata*).

Table 1. Submersed and floating-leaf aquatic vegetation collected from North Umpqua Hydroelectric Project impoundments (P = sample pressed; X = present but not pressed).

Species	Common name	Status	Clearwater 1 Forebay	Clearwater 2 Forebay	Fish Creek Forebay	Fish Creek Screen Ponds	Lemolo 1 Forebay	Lemolo 2 Forebay	Lemolo Lake	Slide Creek Reservoir	Stump Lake	Toketee Reservoir
Callitriche hermaphroditica	Autumn water starwort	Native				P		X		X		P
Callitriche sp.	water starwort	Native		P	P	P						
Eleocharis acicularis	needle spikerush	Native				P		X	X			P
Elodea canadensis	Canadian waterweed	Native	X	P				X			X	P
Equisetum sp.	horsetail	Unknown			P							
Lemna sp.	duckweed	Native										P
Myriophyllum quitense	Andean milfoil	Native										P
Potamogeton amplifolius	big-leaf pondweed	Native			P							P
Potamogeton crispus	**curly leaf pondweed**	**AIS**	**X**	**P**								**P**
Potamogeton pusillus	small pondweed	Native				P			X			
Potamogeton sp.	thin leaf pondweed	Native							X			
Potamogeton sp.	floating leaf pondweed	Native							X			
Ranunculus aquatilis	white water buttercup	Native	X	P	P	P		X		X	X	P
Ranunculus flammula var. reptans	greater creeping spearwort	Native							X			P
Sagittaria cuneata	duck potato	Native							P			
Sparganium angustifolium or emersum	narrow leaf or European bur reed	Native			P	P			X			
Stuckenia filiformis	slender leaf pondweed	Native										P
Bryophytina sp.	moss species 1	Unknown						X	P	X		
Bryophytina sp.	moss species 2	Unknown						X	P			
Fontinalis sp.	fontinalis moss	Unknown		X		P		X				P
Marchantiophytina sp.	liverwort	Unknown		P								
Chara sp.	muskgrass	Unknown	X									P
Nitella sp.	brittlewort	Unknown	X	P	P			X			X	P

Table 2. Shoreline plants collected from North Umpqua Hydroelectric Project impoundments (P = sample pressed; X = present but not pressed).

Species	Status	Clearwater 1 Forebay	Clearwater 2 Forebay	Fish Creek Forebay	Fish Creek Screen Ponds	Lemolo 1 Forebay	Lemolo 2 Forebay	Lemolo Lake	Slide Creek Reservoir	Stump Lake	Toketee Reservoir
Carex sp. 1	Unknown		P	X	P		X	X	X		X
Carex sp. 2	Unknown		P	X							
Dicot (opposite leaf)	Unknown								X		
Eleocharis sp.	Unknown				P						
Juncus effusus	Native						X				
Juncus sp.	Unknown							X			
Mentha sp.	Unknown		P						X		
Myosotis laxa	Native		P								P
Myosotis sp.	Native							X	X		
Plantain like leaves	Unknown			X							
Poacea sp. 1	Unknown			X	X				X		
Poacea sp. 2	Unknown			X							
Prunella sp.	Unknown			X							
Rumex sp.	Unknown								X		
Small green opposite leaf	Unknown										X
Veronica sp.	Unknown				P						
Gratiola sp.	Unknown				P			X			
Typha latifolia	Native						X				X

Table 3. Gastropods and bivalves collected from Project impoundments.

Species	Common Name	Status	Clearwater 1 Forebay	Clearwater 2 Forebay	Fish Creek Forebay	Fish Creek Screen Ponds	Lemolo 1 Forebay	Lemolo 2 Forebay	Lemolo Lake	Stump Lake	Toketee Lake
Radix auricularia	big-eared Radix	AIS			X						
Stagnicola elodes		native						X			
Lymnaidae sp., possibly *S. elodes*	pond snails	likely native					X	X			X
Planorbidae sp.	ramshorn snails	likely native	X	X	X	X				X	X
Physidae sp.	bladder snails	likely native									X
Sphaeridae sp.	pea clams	likely native	X	X	X	X				X	X

4.4 Crayfish

No crayfish were collected in traps deployed in the impoundments. One crayfish was observed in Slide Creek Reservoir, however, it was not captured and the species was not determined.

Although non-native crayfish were not been detected in Pacificorp's North Umpqua Project impoundments, there are several species present nearby. Red swamp crayfish (*Procambarus clarkii*) are present in the Willamette, lower Umpqua, and Rogue River drainages; and ringed crayfish (*Orconectes neglectus*) are present in the Rogue and lower Umpqua drainages (Larson and Olden 2011; Pearl et al. 2011). Other crayfish species of concern include rusty crayfish (*Orconectes rusticus*) and northern Crayfish (*Orconectes virilis*), which are present in eastern Oregon and Washington State, respectively.

4.5 Zooplankton and Epi-benthos

No known non-native zooplankton or epi-benthic species were identified in the six waterbodies surveyed (Table 4). A total of 15 cladoceran species, 6 copepod species, 15 rotifer species and several other miscellaneous species were identified.

AIS zooplankton of concern for the Project area include the water flea *Daphnia lumholtzi* (native to Africa, Australia, and Asia) and the spiny water flea (*Bythotrephes longimanus*) (native to Northern Europe and Asia) and the opossum shrimp (*Mysis relicta*). *D. lumholtzi* is most firmly established in the South and Midwest but populations have been detected in California and Utah (Frisch et al. 2012). *B. longimanus* establishment has been restricted to the upper Midwest and Northeast (Liebig et al. 2012). Although both species can compete with native species, *B. longimanus* is an especially voracious predator that can have a major effect on zooplankton and fish community structure. *M. relicta* is a large zooplanktor that can have major impacts on foodwebs and has been introduced into Lake Tahoe, Flathead Lake, Priest Lake (Foster et al. 2013), and Wallowa Lake (ODFW 2010).

4.6 Water Quality

Surface water temperatures in the impoundments ranged from 9.5˚C in Stump Lake to 23.7˚C in Fish Creek Forebay (Table 5). Fish Creek Forebay was considerably warmer than the other water bodies, most likely because the inflow from Fish Creek Canal had been turned off for maintenance. Lemolo Lake was thermally stratified with a 2-m deep upper mixed layer and Toketee Lake was weakly stratified with a 1-m deep upper mixed layer. The other impoundments were completely vertically mixed. Surface water dissolved oxygen concentrations in all impoundments were greater than saturation with the atmosphere and ranged up to 138% of saturation. pH values ranged from 7.8 in Clearwater No. 1 Forebay to 9.0 in Lemolo Lake. The high pH values and dissolved oxygen concentrations were primarily a result of algal production in the case of Lemolo Lake and SAV production in the other more shallow impoundments.

Table 4. Zooplankton collected from Project impoundments.

Group	Species	Lemolo Lk. (2 samples)	Lemolo No. 2 Fore.	Clearwater No. 2 Fore.	Clearwater No. 1 Fore.	Toketee Reservoir	Fish Creek Forebay
Cladocera	*Daphnia pulicaria*	X	X			X	
	Daphnia rosea	X	X				
	Daphnia mendotae	X	X	X		X	
	Immature *Daphnia*		X				
	Simocephalus vetulus						X
	Scapholeberis armata						X
	Ceriodaphnia quadrangula						X
	Bosmina longirostris		X			X	X
	Macrothrix sp.	X					
	Chydorus sphaericus	X	X			X	X
	Alona (B.) affinis	X					
	Alona costata					X	
	Alonella nana					X	
	Graptoleberis testudinaria	X	X				X
	Eurycercus lamellatus		X			X	
	Leptodora kindti	X					
Copepoda	*Epischura nevadensis*	X					
	epischurid copepodites	X	X	X			
	Macrocyclops albidus		X		X		X
	Diacyclops thomasi						X
	Cyclops vernalis	X	X				
	Microcyclops varicans	X	X				
	Eucyclops agilis					X	
	cyclopoid copepodites	X	X			X	X
	harpacticoid copepods	X	X	X			X
	copepod nauplii	X	X		X		X
Rotifera	*Asplanchna priodonta*	X	X				
	Keratella cochlearis	X	X			X	X
	Euchlanis dilatata	X	X			X	
	Notholca acuminata		X				
	Kellicottia longispina	X	X			X	
	Mytilina ventralis		X			X	
	Monostyla lunaris	X	X				
	Cephalodella sp.		X	X			
	Polyarthra vulgaris	X	X			X	X
	Synchaeta sp.	X	X			X	X
	Ploesoma truncatum		X				
	Trichocerca cylindrica	X	X			X	
	Trichocerca similis					X	
	Conochiloides dossuarius						X
	Philodina sp.		X			X	X
Other	*Difflugia sp.*		X	X	X	X	X
	water mites	X	X	X		X	X
	Cypridopsis vidua	X	X			X	X
	chironomid larvae	X	X	X	X	X	X
	mosquito pupae					X	
	mayfly larvae		X			X	X
	Hydra sp.		X				
	Oligochaete		X				
	tardigrade		X				

Table 5. Water quality measurements at Project impoundments.

Impoundment	Date	Depth (m)	Temp. (˚C)	Sp. Cond. (µS/cm)	pH (S.U.)	D.O. (mg/l)	D.O. (% sat.)
Toketee Lake	8/2/2012	0.1	13.9	54	8.1	10.9	115
		1.0	13.7	54	8.0	10.8	114
		2.0	11.8	59	8.1	11.5	116
		3.0	11.1	62	8.2	11.8	117
		4.0	11.0	64	8.2	11.7	116
		5.0	10.9	64	8.2	11.7	115
		6.0	10.9	64	8.9	13.0	127
Stump Lake	8/2/2012	0.5	9.5	61	8.2	11.4	115
Lemolo No. 2 Forebay	8/10/2012	0.1	11.3	56	8.0	11.7	120
		1.0	11.0	56	8.0	11.6	118
		2.0	10.9	56	8.1	11.6	118
		3.0	10.9	56	8.1	12.6	128
		4.0	10.8	57	8.2	12.6	124
		5.0	10.8	57	8.2	11.7	119
Clearwater No. 2 Forebay	8/3/2012	0.1	10.6	60	8.1	11.0	112
		1.0	10.1	59	8.1	11.3	112
		2.0	9.9	59	8.1	11.4	113
		2.5	9.9	59	8.2	11.4	113
Clearwater No. 1 Forebay	8/10/2012	0.1	9.7	67	7.8	13.7	138
		1.0	8.2	67	7.9	13.9	135
		2.0	7.8	67	7.9	13.2	128
		2.5	7.8	66	7.9	12.8	124
Fish Creek Forebay	8/4/2012	0.1	23.7	51	8.5	8.8	116
		1.0	23.1	50	8.4	8.9	116
		2.0	22.9	50	8.4	8.9	115
		3.0	20.4	53	8.7	10.1	125
Lemolo Lake	8/8/2010	0.1	19.3	47	9.0	10.7	134
		1.0	19.0	48	9.0	10.4	129
		2.0	18.8	47	9.0	10.3	128
		3.0	14.3	52	8.9	11.8	133
		4.0	13.2	54	8.8	11.7	120
		5.0	12.8	54	8.8	11.5	125
		6.0	12.4	54	8.7	11.2	122
		7.0	12.1	54	8.7	10.9	117
		8.0	11.8	55	8.6	10.5	112
		9.0	11.5	55	8.5	10.4	110
		10.0	11.2	55	8.4	10.2	108
		11.0	11.0	55	8.3	10.2	107
		12.0	10.5	56	8.2	10.2	105
		13.0	10.1	56	8.1	10.3	105
		14.0	9.8	56	8.0	10.1	103
		15.0	9.7	56	8.0	9.9	100
		16.0	9.7	57	7.9	9.7	98
		17.0	9.6	57	7.9	9.6	97
		18.0	9.6	56	7.9	9.5	97
		19.0	9.6	57	7.9	9.5	96
		20.0	9.6	57	7.9	9.4	95

5. Discussion

Despite intensive surveys in ten North Umpqua River Project impoundments, only two aquatic invasive species were detected. Both species, *Potamogeton crispus* and *Radix auricularia*, were detected in only a subset of the impoundments. In addition, populations appeared to be at relatively low densities and were mixed with native species assemblages.

Given that no crayfish were trapped in five traps deployed in each impoundment, we assume that populations are low. Low and non-detect population densities are consistent with similar surveys of Puget Sound lowlands lakes (Larson and Olden 2012). Larson and Olden (2012) used the same trap type, bait, and deployment time as the current survey, but deployed 20 traps per lake. They detected crayfish in 63% of the lakes surveyed, and mostly at very low densities with a catch per unit effort of 0.8 crayfish per trap excluding lakes where crayfish were not detected.

There are several other high risk AIS that could potentially have a more negative impact on native biota and the beneficial uses of the impoundments. The floating leaf aquatic plant *Nymphoides peltata* (yellow floating heart) can form a dense surface canopy which shades out native species, can cause water quality problems (low dissolved oxygen concentrations can occur below dense canopies of floating leaf species), and is very difficult to eradicate or control. *N. peltata* is present in a nearby pond in the Umpqua National Forest and several other locations in Western Oregon. *Myriophyllum spicatum* (eurasian water milfoil) can also displace native species and lead to water quality problems such as high pH. It also forms hybrids with native northern water milfoil (*Myriophyllum sibricum*) which can be more invasive and less sensitive to some herbicides than *M. spicatum* (Larue et al. 2012). *M. sibiricum x spicatum* hybrid populations are present in several Southern Oregon Lakes and *M. spicatum* populations are relatively common in western Oregon, especially in the Willamette Valley.

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