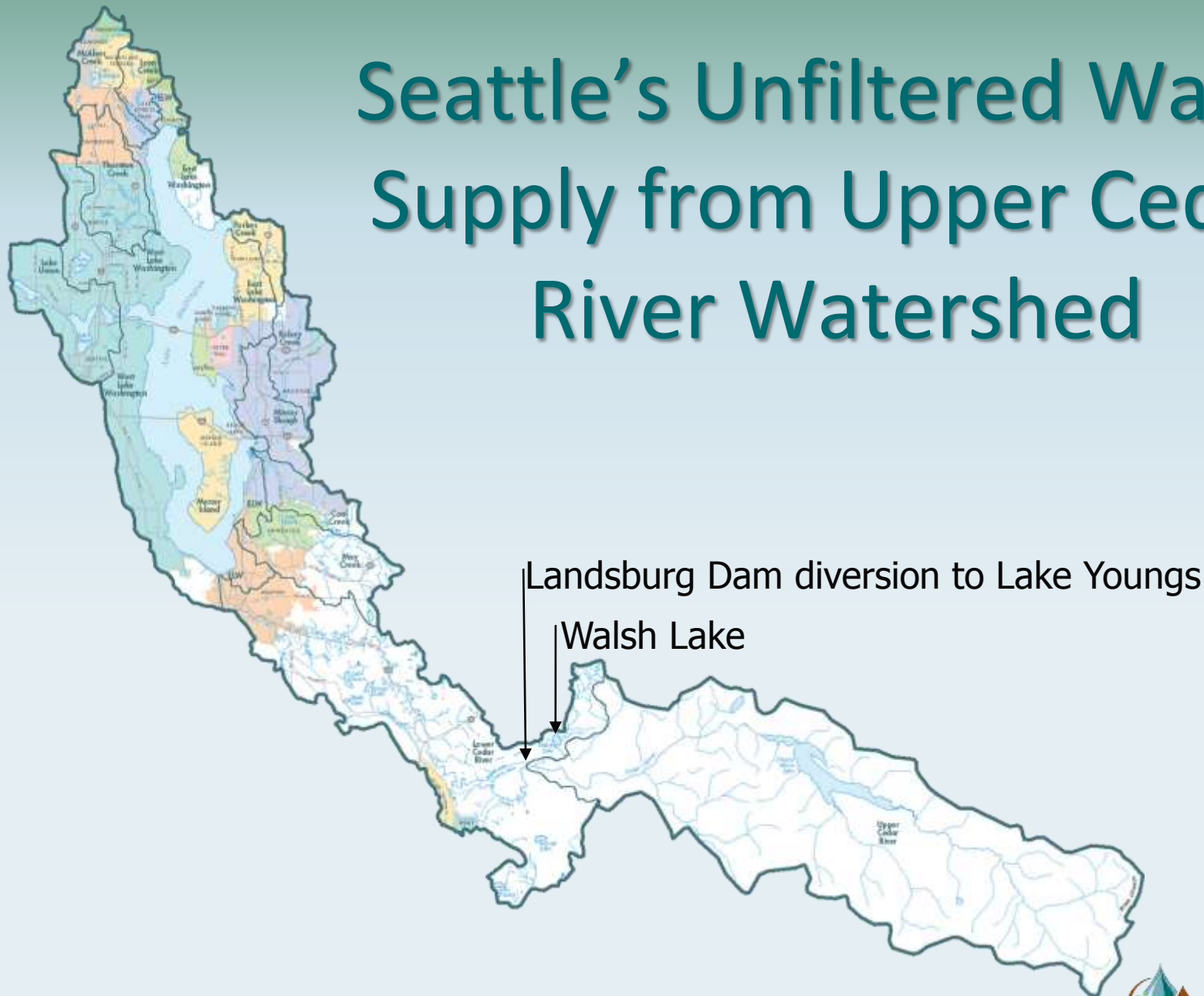


Milfoil Eradication by Diver Hand Pulling in Walsh Lake, Washington

Rob Zisette and Josh Wozniak

Herrera Environmental Consultants, Seattle, WA

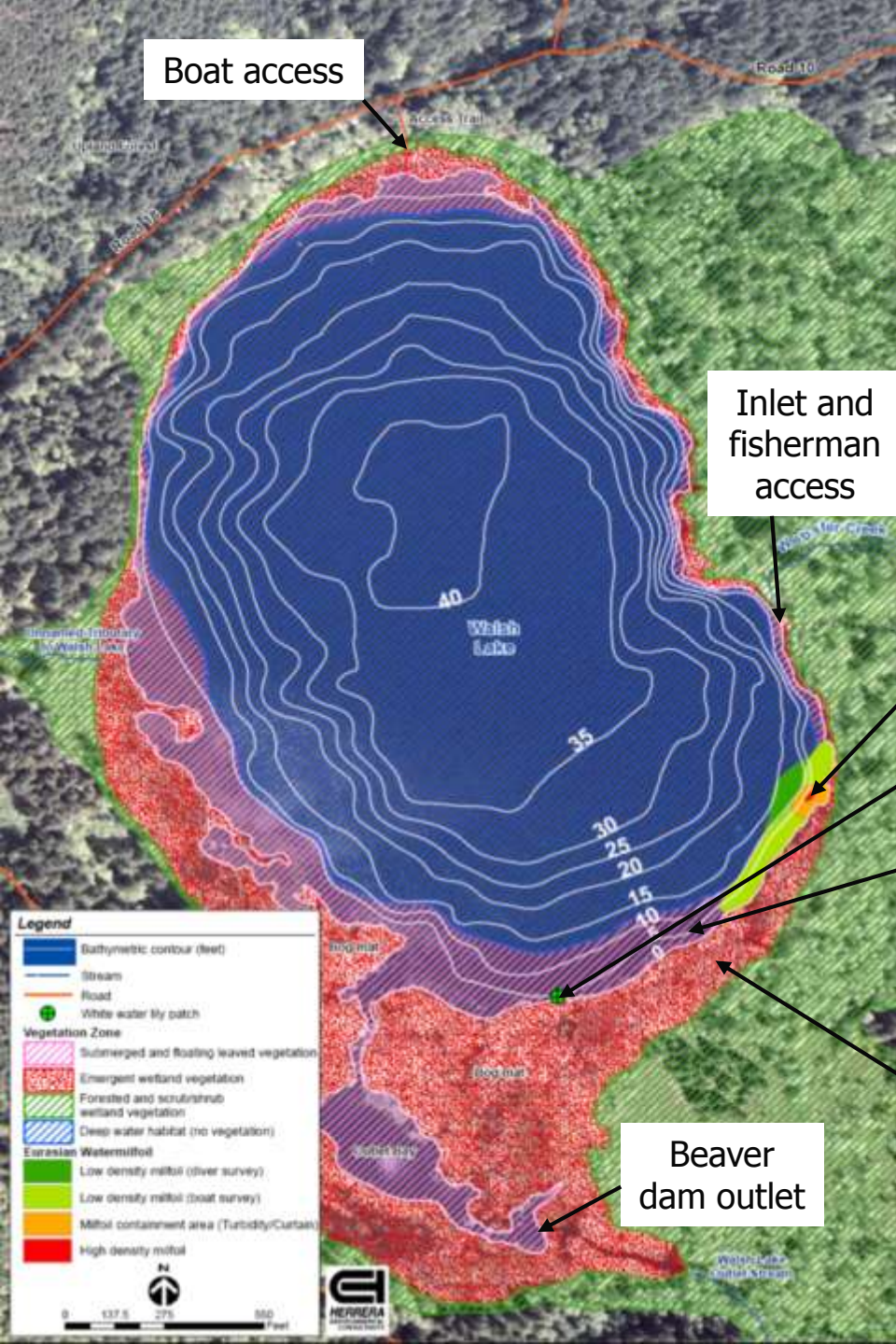
Seattle's Unfiltered Water Supply from Upper Cedar River Watershed





- Originally, SPU constructed Walsh Ditch to divert Walsh Lake Outlet out of upper watershed due to water quality concerns
- Since Landsburg fish ladder construction in 2003, SPU planned to reconnect Walsh Lake Outlet with Rock Creek to enhance chinook salmon habitat in upper watershed
- SPU discovery of Eurasian watermilfoil in lake in 2005 raised concern that reconnection would provide vector to Cedar River and Lake Youngs

2005 Aquatic Plant Map



- Lake = 74 acres, 19 ft mean depth, 41 ft max depth
- 122 native plant species
- 0.6 acres of water lily
- One patch of water lily
- 13.8 acres with 26 native submerged/ floating plant species (hatch)
- 28.1 acres with 71 native emergent plant species (stipple)

Scientific Name	Common Name	Scientific Name	Common Name	Scientific Name	Common Name
<i>Agrostis hyemalis</i>	winter bentgrass	<i>Hydrocotyle ranunculoides</i>	water pennywort	<i>Polystichum munitum</i>	sword fern
<i>Agrostis scabr</i>	tickle-grass	<i>Hypericum anagalloides</i>	bog St. John's wort	<i>Potamogeton amplifolius</i>	big-leaf pondweed
<i>Athyrium filix-femina</i>	lady fern	<i>Isoetes echinospora</i>	bristle-like quillwort	<i>Potamogeton epihydrus</i>	ribbon-leaf pondweed
<i>Bidens cernua</i>	nodding beggar-ticks	<i>Isoetes occidentalis</i>	western quillwort	<i>Potamogeton friesii</i>	flat-shelled pondweed
<i>Blechnum spicant</i>	deer fern	<i>Juncus acuminatus</i>	tapered rush	<i>Potamogeton gramineus</i>	grass-leaved pondweed
<i>Boykinia elata</i>	coast boykinia	<i>Juncus balticus</i>	Baltic rush	<i>Potamogeton pectinatus</i>	Sago pondweed
<i>Brasenia schreberi</i>	water-shield	<i>Juncus bufonius</i>	toad rush	<i>Potamogeton robbinsii</i>	fern-leaf pondweed
<i>Callitriche heterophylla</i>	water starwort	<i>Juncus bulbosus</i> var. <i>gerardii</i>	mud rush	<i>Potamogeton zosteriformis</i>	flat-stem pondweed
<i>Cardamine oligosperma</i>	few-seeded bittercress	<i>Juncus effusus</i>	soft rush	<i>Potentilla palustris</i>	marsh cinquefoil
<i>Carex aquatilis</i> var. <i>dives</i>	water sedge	<i>Juncus ensifolius</i>	dagger-leaf rush	<i>Pteridium aquilinum</i>	bracken fern
<i>Carex canescens</i>	gray sedge	<i>Juncus supinus</i> (<i>Juncus bulbosus</i> var. <i>supinus</i>)	bulbous rush	<i>Ranunculus aquatilis</i> var. <i>capillaceus</i>	white water-buttercup
<i>Carex deweyana</i>	Dewey's sedge	<i>Juncus tenuis</i>	slender rush	<i>Ranunculus repens</i>	creeping buttercup
<i>Carex echinata</i>	prickly sedge	<i>Leersia oryzoides</i>	rice cutgrass	<i>Rorippa nasturtium-aquaticum</i>	water cress
<i>Carex lenticularis</i> var. <i>lipocarpa</i>	Kellogg's sedge	<i>Lemna minor</i>	duckweed	<i>Rumex crispus</i>	curled dock
<i>Carex mertensii</i>	Merten's sedge	<i>Ludwigia palustris</i>	water purslane	<i>Sagina procumbens</i>	bird's-eye pearlwort
<i>Carex obnupta</i>	slough sedge	<i>Luzula parviflora</i>	small-flowered wood-rush	<i>Scirpus acutus</i>	hardstem bulrush
<i>Carex viridula</i>	little green sedge	<i>Lycopus uniflorus</i>	bugleweed	<i>Scirpus cyperinus</i> var. <i>brachypodus</i>	wool grass
<i>Ceratophyllum echinatum</i>	spineless hornwort	<i>Lysichiton americanum</i>	skunk cabbage	<i>Scirpus microcarpus</i>	small-fruited bulrush
<i>Chara oregana</i>	Oregon muskgrass	<i>Maianthemum dilatatum</i>	wild lily-of-the-valley	<i>Sparganium emersum</i>	narrow-leaved bur-reed
<i>Circaea alpina</i>	enchanter's nightshade	<i>Mentha arvensis</i>	field mint	<i>Stachys cooleyae</i>	Cooley's hedgenettle
<i>Cirsium arvense</i>	Canada thistle	<i>Mimulus guttatus</i>	monkey flower	<i>Stachys rigida</i>	rigid hedgenettle
<i>Drosera rotundifolia</i>	sundew	<i>Myosotis laxa</i>	small-flowered forget-me-not	<i>Stellaria calycantha</i>	northern starwort
<i>Dulichium arundinaceum</i>	three-way sedge	<i>Myosotis scorpioides</i>	common forget-me-not	<i>Trillium ovatum</i>	western trillium
<i>Eleocharis ovata</i>	ovoid spikerush	<i>Myriophyllum spicatum</i>	Eurasian water-milfoil	<i>Trisetum cernuum</i>	nodding trisetum
<i>Eleocharis palustris</i>	creeping spikerush	<i>Najas flexilis</i>	slender water-nymph	<i>Typha angustifolia</i>	narrow-leaved cattail
<i>Elymus glaucus</i>	blue wildrye	<i>Nitella</i> sp.	nitella	<i>Typha latifolia</i>	cattail
<i>Epilobium angustifolium</i>	fireweed	<i>Nuphar polysepala</i>	yellow waterlily	<i>Utriculata vulgaris</i>	greater bladderwort
<i>Epilobium watsonii</i>	Watson's willow-herb	<i>Nymphaea odorata</i>	white waterlily	<i>Vallisneria americana</i>	tapegrass
<i>Equisetum fluviatile</i>	water horsetail	<i>Oenanthe sarmentosa</i>	Pacific water-parsley	<i>Veronica americana</i>	American brooklime
<i>Equisetum telmateia</i>	giant horsetail	<i>Phalaris arundinacea</i>	reed canarygrass	<i>Veronica officinalis</i>	common speedwell
<i>Galium trifidum</i>	small bedstraw	<i>Poa annua</i>	annual bluegrass	<i>Veronica serpyllifolia</i>	thyme-leaved speedwell
<i>Geum macrophyllum</i>	large-leaved avens	<i>Poa trivialis</i>	roughstalk bluegrass	<i>Viola palustris</i>	marsh violet
<i>Glyceria borealis</i>	northern mannagrass	<i>Polygonum amphibium</i>	water swartweed		

Shading indicates a non-native plant species.

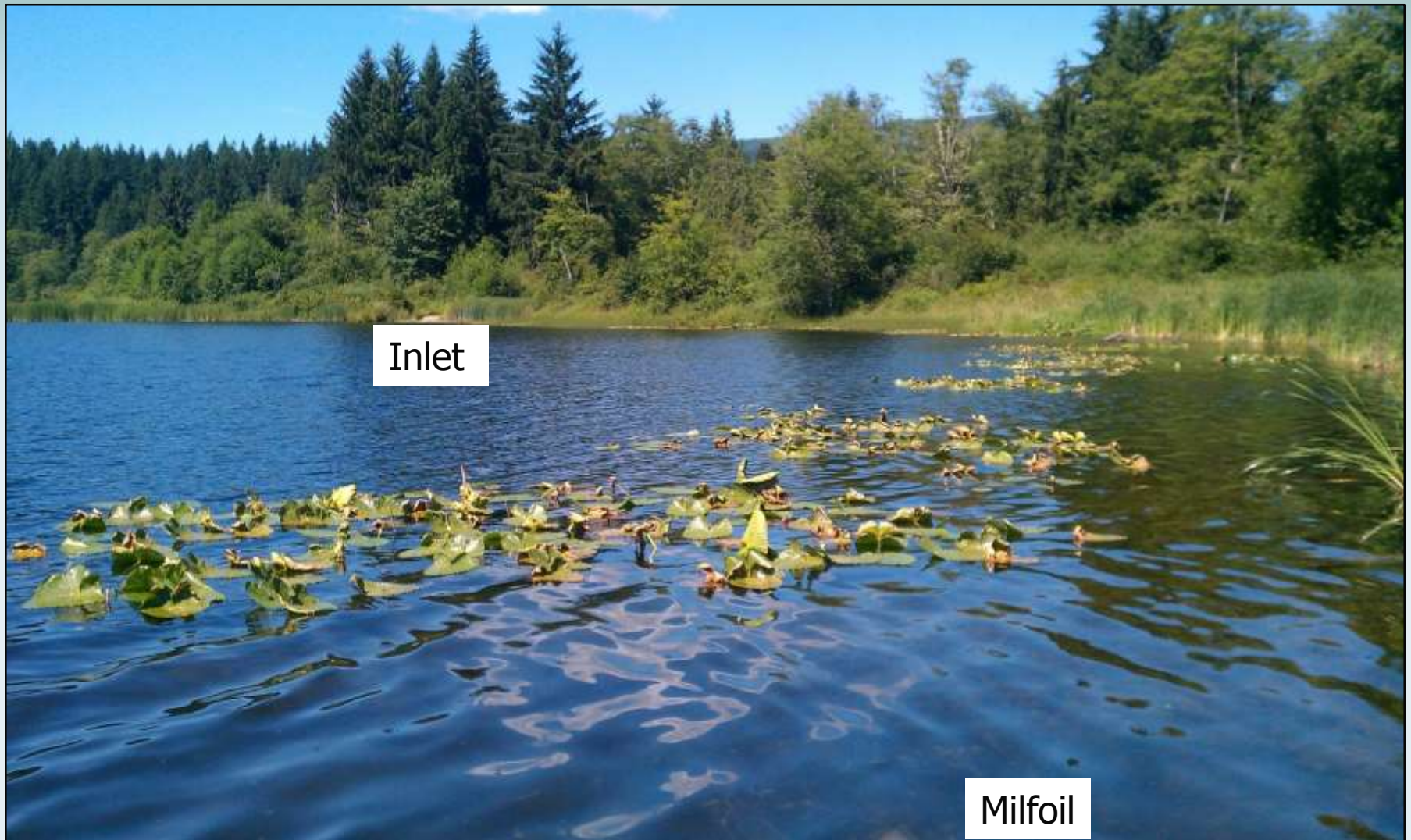
Diverse Submerged Community



Complex Cattail and Peat Mats



Milfoil Core 540 Feet South of Inlet



Inlet

Milfoil

Fisherman Vector

2005 Milfoil Control Approach

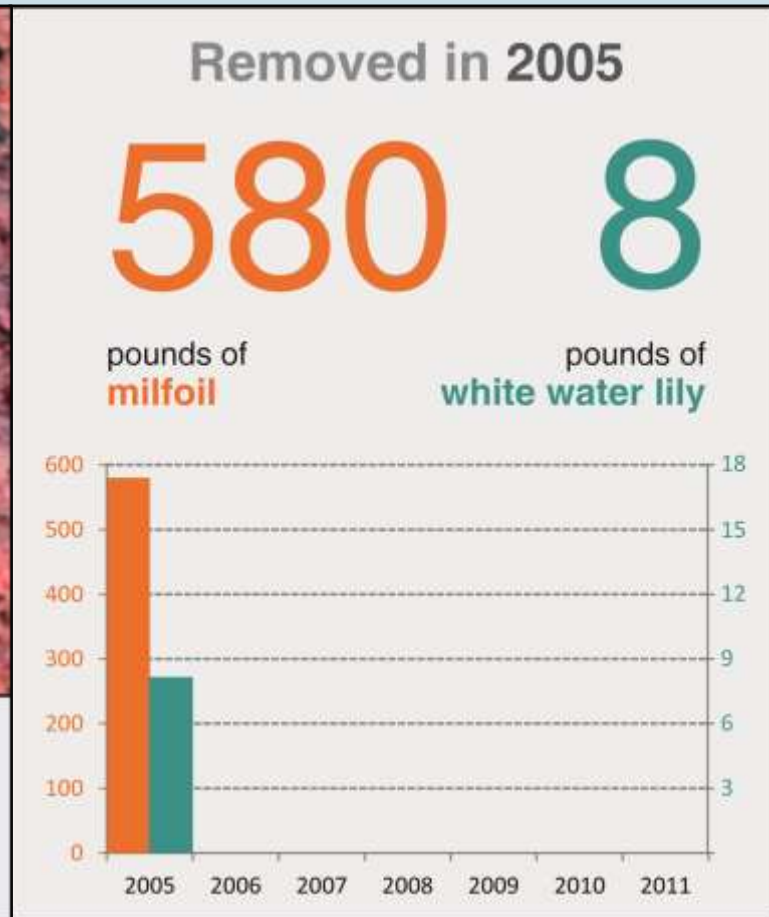


1. Pull milfoil outside dense milfoil core
2. Install curtain around core
3. Pull milfoil inside/outside of curtain

2005 Survey and Removal



- Low density milfoil
- High density milfoil
- Containment area



*5-Day Effort

2006 Survey and Removal



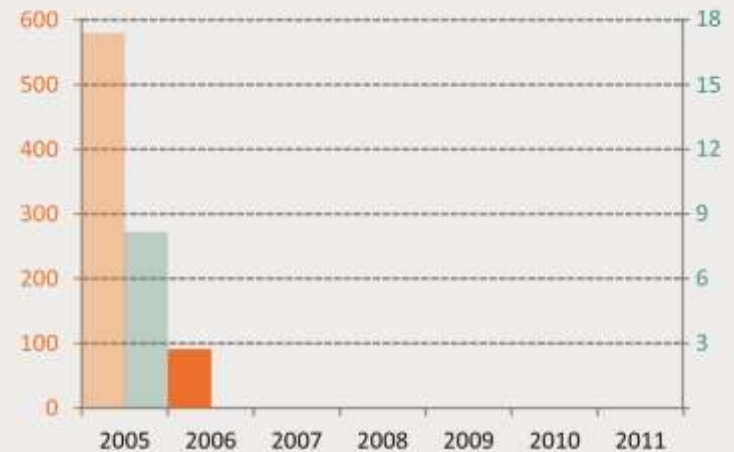
Removed in 2006

91

pounds of
milfoil

0

pounds of
white water lily



*4-Day Effort

2007 Expanded Search and Control



Expanded search deep within cattails
Found milfoil at beaver dam outlet



Hand pulling water lily patch

2007 Survey and Removal



New milfoil site at outlet dam built by beaver vector

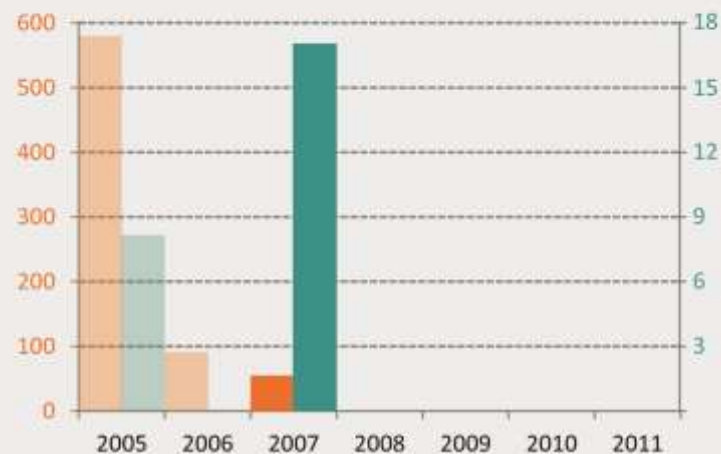
Removed in 2007

55

pounds of
milfoil

17

pounds of
white water lily



*7-Day Effort



2008 Survey and Removal



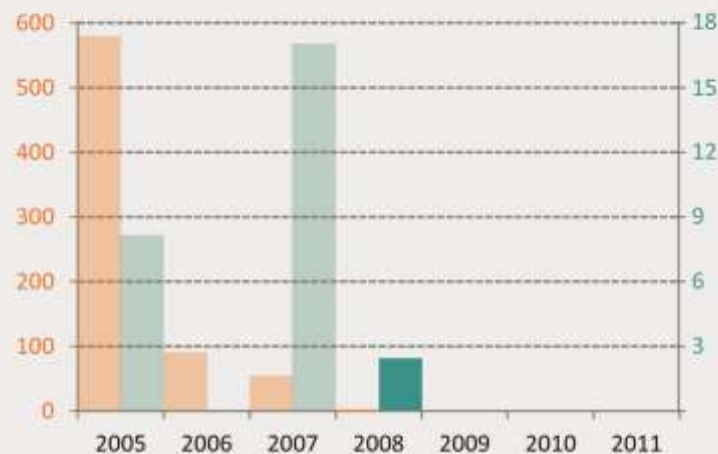
Removed curtain and laid small bottom barrier
Two new lily patches

Removed in 2008

0.2 2.5

pounds of
milfoil

pounds of
white water lily



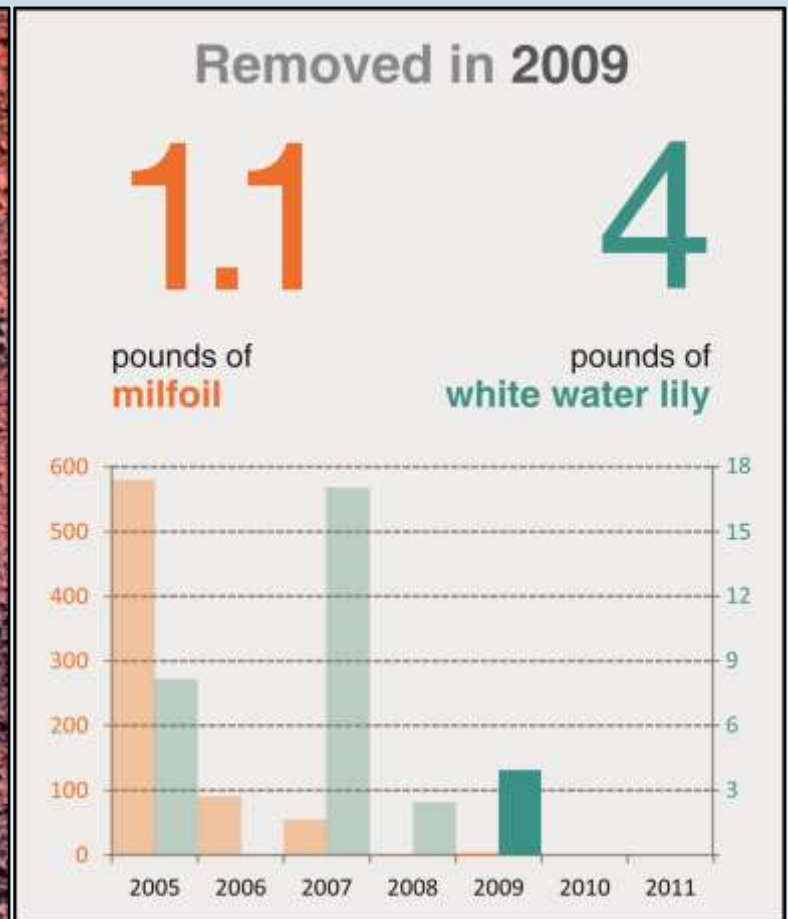
*4-Day Effort



2009 Survey and Removal



Small amounts of milfoil and lily removed



*4-Day Effort

2010 Survey and Removal



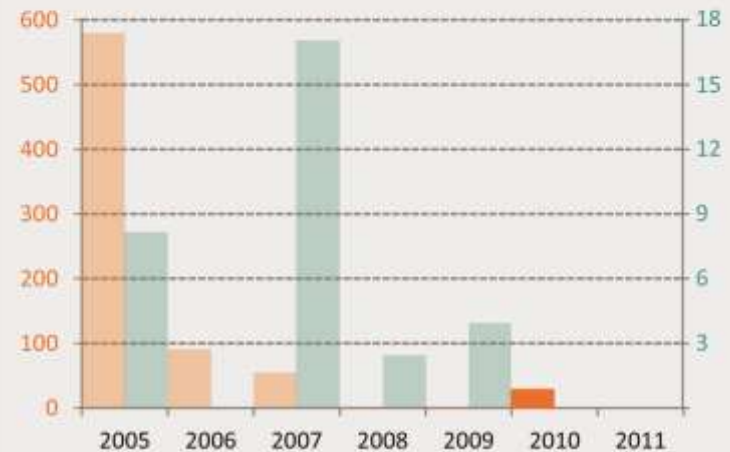
Removed in 2010

28

pounds of
milfoil

0

pounds of
white water lily



New milfoil site in cattails by beaver lodge

*3-Day Effort

2011 Survey and Removal



Only 8 short milfoil plants in cattails by beaver lodge

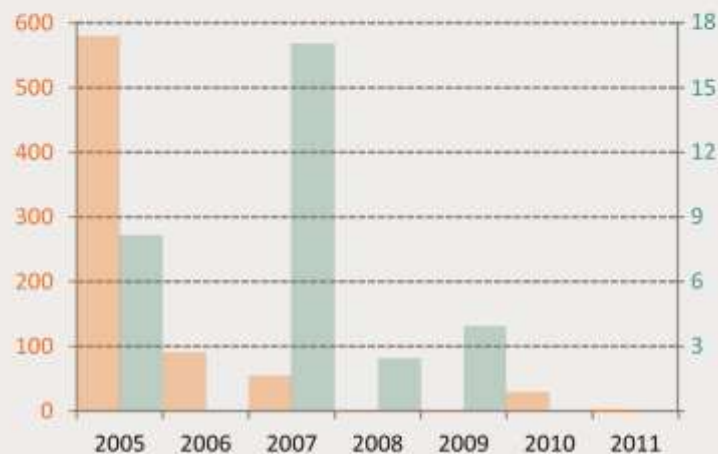
Removed in 2011

0.5

pounds of
milfoil

0

pounds of
white water lily



*4-Day Effort



HERRERA

2012 - 2014 Surveys



2012 (3 Days)
No milfoil
No water lily



2013 (1 Day)
No milfoil
No water lily



2014 (1 Day)
No milfoil
One water lily

Project Costs

Year	Cost
2005	\$43,416
2006	\$15,136
2007	\$31,358
2008	\$20,480
2009	\$11,111
2010	\$7,327
2011	\$9,429
2012	\$6,236
2013	\$2,917
2014	\$2,728
Total	\$150,138



Keys to Success



Last milfoil plant removed
in September 2011

- Early detection
- Immediate action
- Intensive diver survey
- Multiple surveys per year
- Sufficient budget
- Outsmart the beavers!

Questions?



Josh and Julia at beaver lodge in August 2014

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206-787-8262

