

Identification of Alaskan *Elodea* species and small-scale treatment of *Elodea* on the Copper River Delta

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Populations of the non-native aquatic plants in the genus *Elodea* are known from five regions across the state. Identifying *Elodea* to the species level can be difficult, especially when flowers are not present. In an effort to identify which species occur in Alaska and potentially infer introduction vectors, samples of *Elodea* from several water bodies in each of the five regions were collected and the ITS DNA regions were sequenced and analyzed by Dr. Thum's lab at Montana State University. Sequences were used to determine species identifications, which revealed that *Elodea canadensis* is found in the Anchorage area, Cordova area and Alexander Lake infestations, *Elodea nutallii* occurs in the Fairbanks area infestations, and a hybrid of *E. nutallii* x *E. canadensis* occurs in the Kenai Peninsula area infestations.

Elodea was first documented in Alaska in Eyak Lake near Cordova in 1982. Since then, it has spread to Bering, Martin, and McKinley lakes as well as numerous small ponds and sloughs across the Copper River Delta. Due to the widespread distribution and the ecological sensitivity of the Delta, a small-scale treatment project has begun to determine the feasibility and some implications of large-scale treatment or eradication of this species from the Copper River Delta. Concurrently, vegetation data from several different pond types and lakes across the delta are being collected each month to determine effects of *Elodea* introduction on native plants, aquatic invertebrates, water chemistry, and fish.

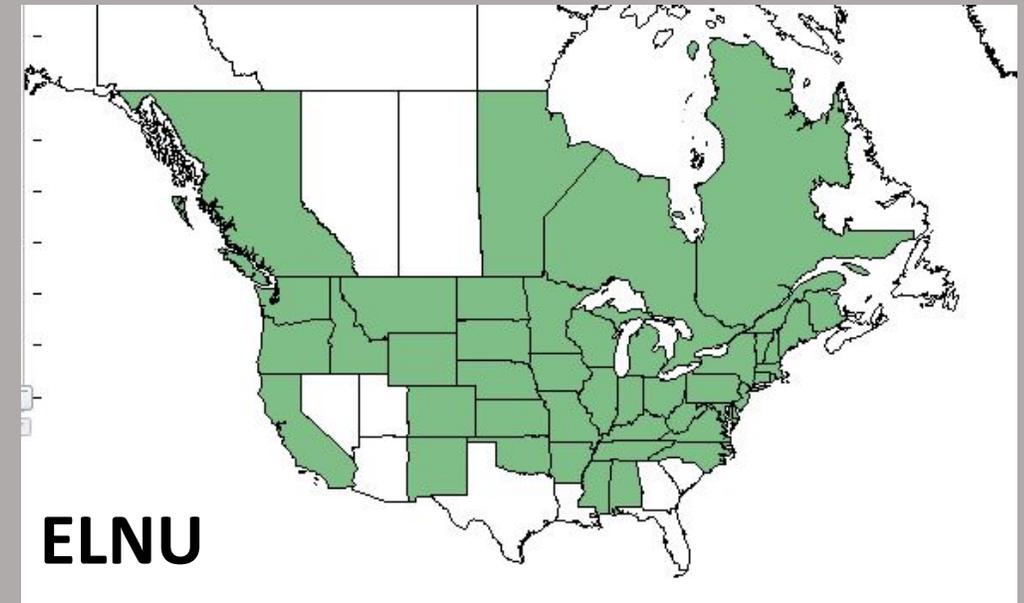
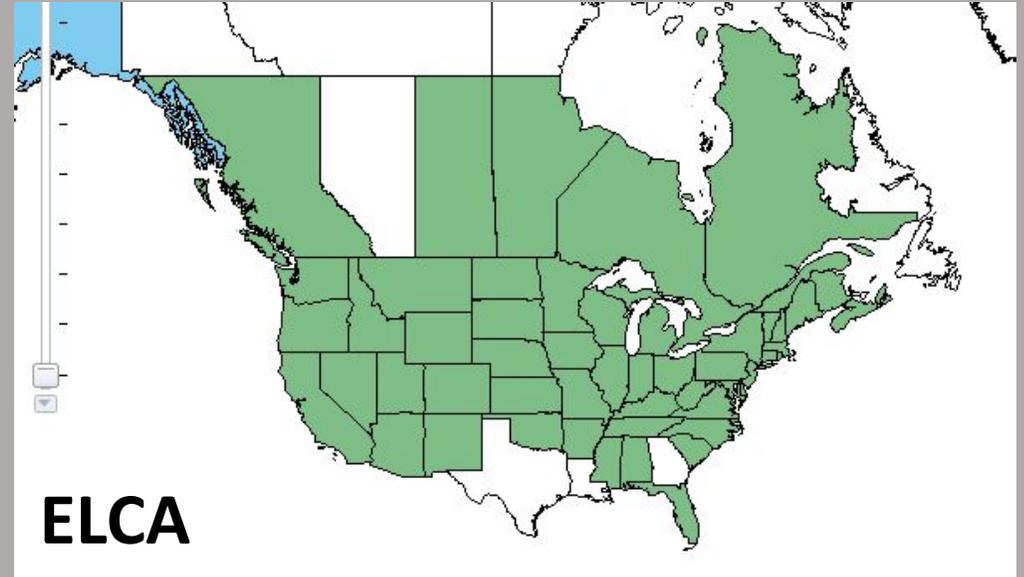


Identification of Alaskan *Elodea* species and Small Scale Treatment on the Copper River Delta

USDA Forest Service
CNIPM Fairbanks 2016

The Genus *Elodea* (waterweeds):

- *Elodea bifoliata* - “twoleaf”
 - *Elodea canadensis*
 - *Elodea nuttallii*
 - *Elodea schweinitzii* – NY and PA
 - *Elodea callitrichoides*
 - *Elodea potamogeton*
 - *Elodea granatensis*
- } South American Species





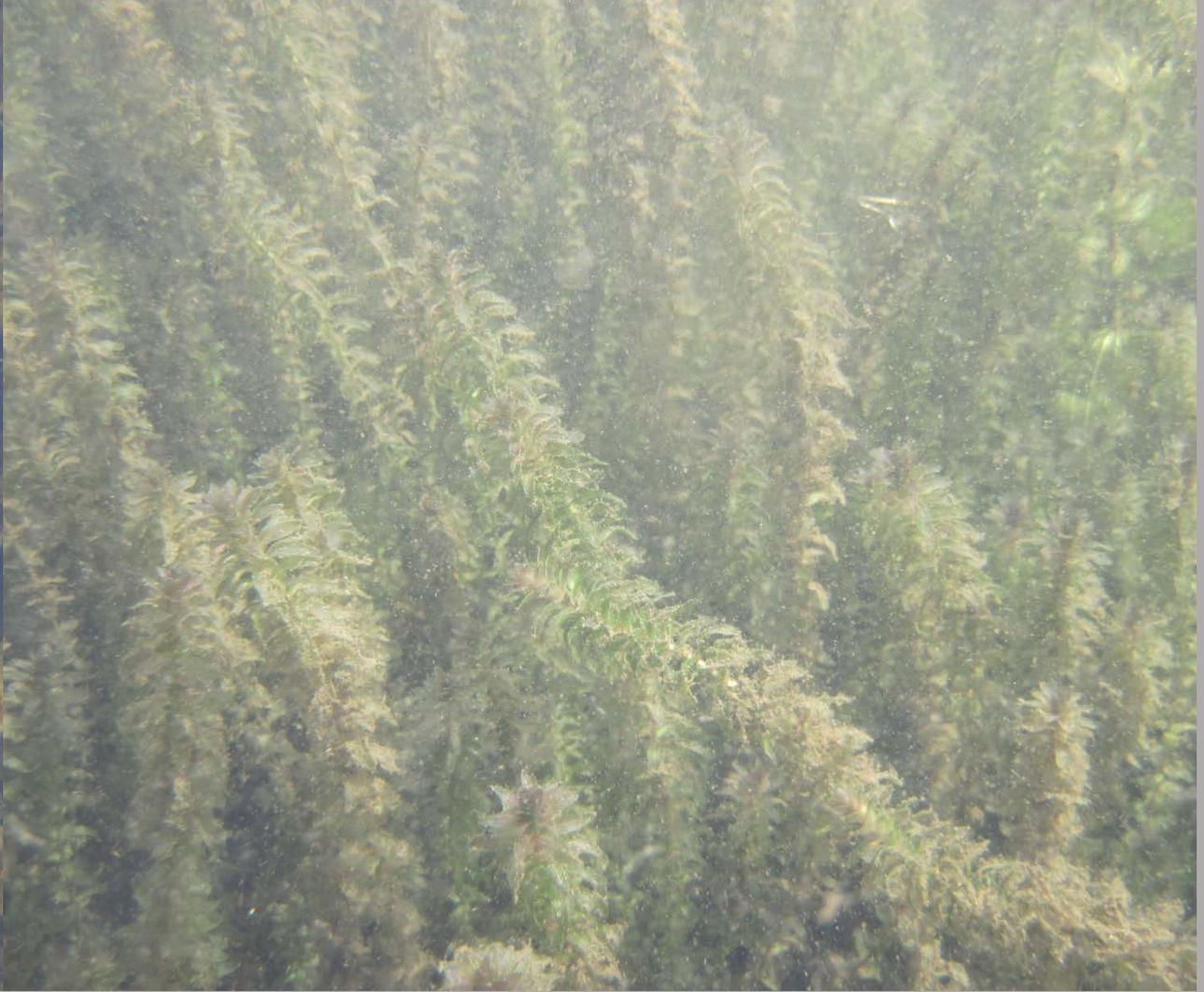
Elodea canadensis



Elodea nuttallii



Elodea nuttallii



Elodea canadensis

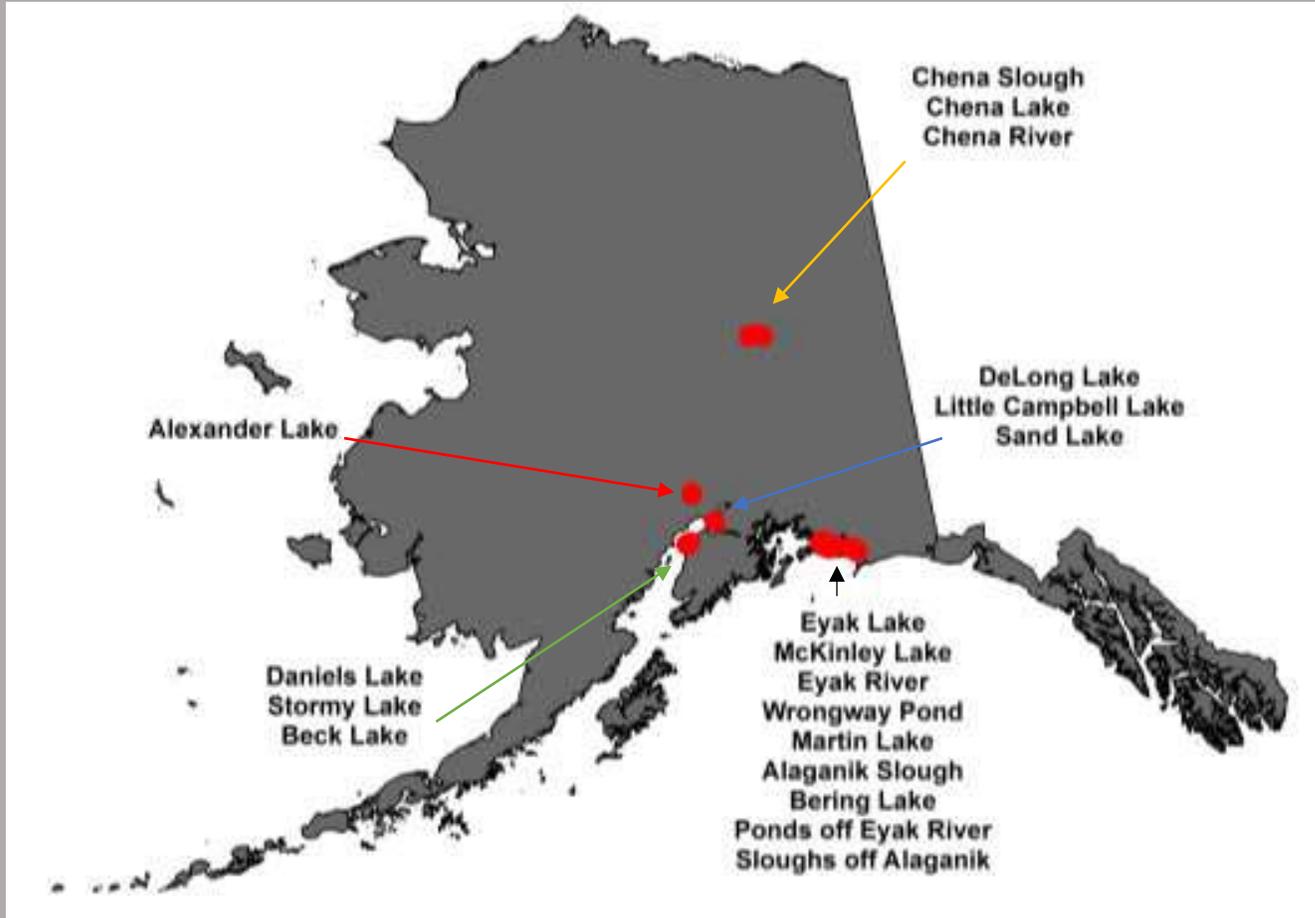


Elodea canadensis



Elodea nuttallii

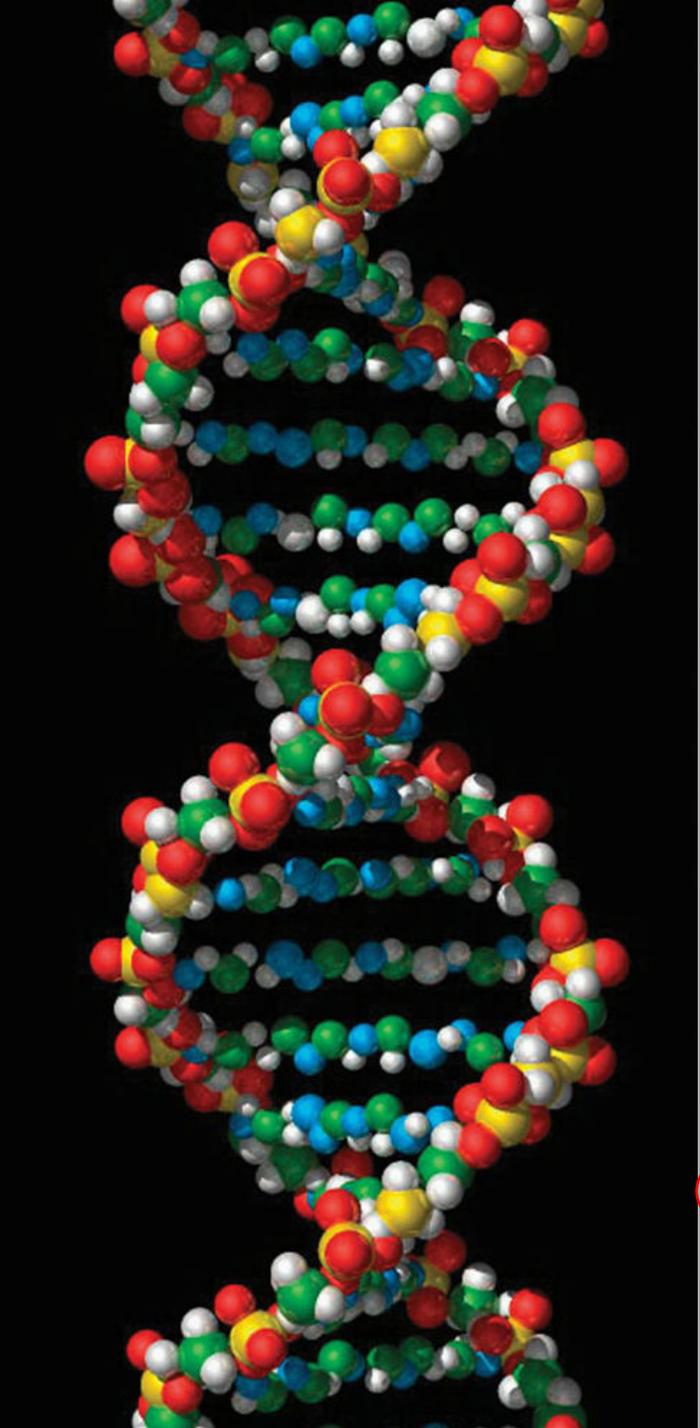
Distribution of *Elodea* in Alaska



- What species do we have?
- What sort of genetic diversity does each infestation exhibit?



- Introduction, possible timing, and vectors
- Treatment implications
- eDNA development



Elodea genetics

- *Elodea* in Alaska is suspected to reproduce vegetatively only (clones)
- Markers to characterize genetic diversity in populations have been identified, but yielded unclear results for native *Elodea* populations (Huotari et. al. 2011)
- Rybicki et. al. (2013) developed rapid RFLP analysis of ITS region- can distinguish *E. canadensis* from *E. nuttallii* but cannot distinguish hybrids of these two species
- Sequencing of the ITS region can readily distinguish species *and* hybrids of *Elodea* and is becoming more affordable

Samples were collected from:

- Chena Slough and Chena Lake in Fairbanks (Trish and Nick)
- Little Campbell Lake, Delong Lake, and Sand Lake in Anchorage (Heather)
- Alexander Lake (Heather)
- Stormy Lake on the Kenai (Libby)
- Martin, Bering, Eyak lakes, and Alaganik Slough near Cordova



Ryan Thum, Assistant Professor
Montana State University
Bozeman

Genetics and Ecology of
aquatic plants and weeds



```
TGCTAATATGTTGCGAATGCTATTAATATCTTCGTGGGTTGATAGCATGCCTTCCTGGTTGCTGC
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```

BLAST® » blastn suite

blastn blastp blastx tblastn tblastx

Enter Query Sequence

Enter accession number(s), gi(s), or FASTA sequence(s) [Clear](#)

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Query subrange [Clear](#)From To

Or, upload file

Browse... [Clear](#)

Job Title

Enter a descriptive title for your BLAST search [Clear](#) Align two or more sequences [Clear](#)

Choose Search Set

Database

 Human genomic + transcript Mouse genomic + transcript Others (nr etc.)Nucleotide collection (nr/nt) [Clear](#)

Organism

Optional

 Enter organism name or id—completions will be suggested Exclude [+](#)Enter organism common name, binomial, or tax id. Only 20 top taxa will be shown [Clear](#)

Exclude

Optional

 Models (XM/XP) Uncultured/environmental sample sequences

Limit to

Optional

 Sequences from type material

Entrez Query

Optional

 [YouTube](#) [Create custom](#)Enter an Entrez query to limit search [Clear](#)

Program Selection

Optimize for

- Highly similar sequences (megablast)
 More dissimilar sequences (discontiguous megablast)
 Somewhat similar sequences (blastn)

Choose a BLAST algorithm [Clear](#)

BLAST

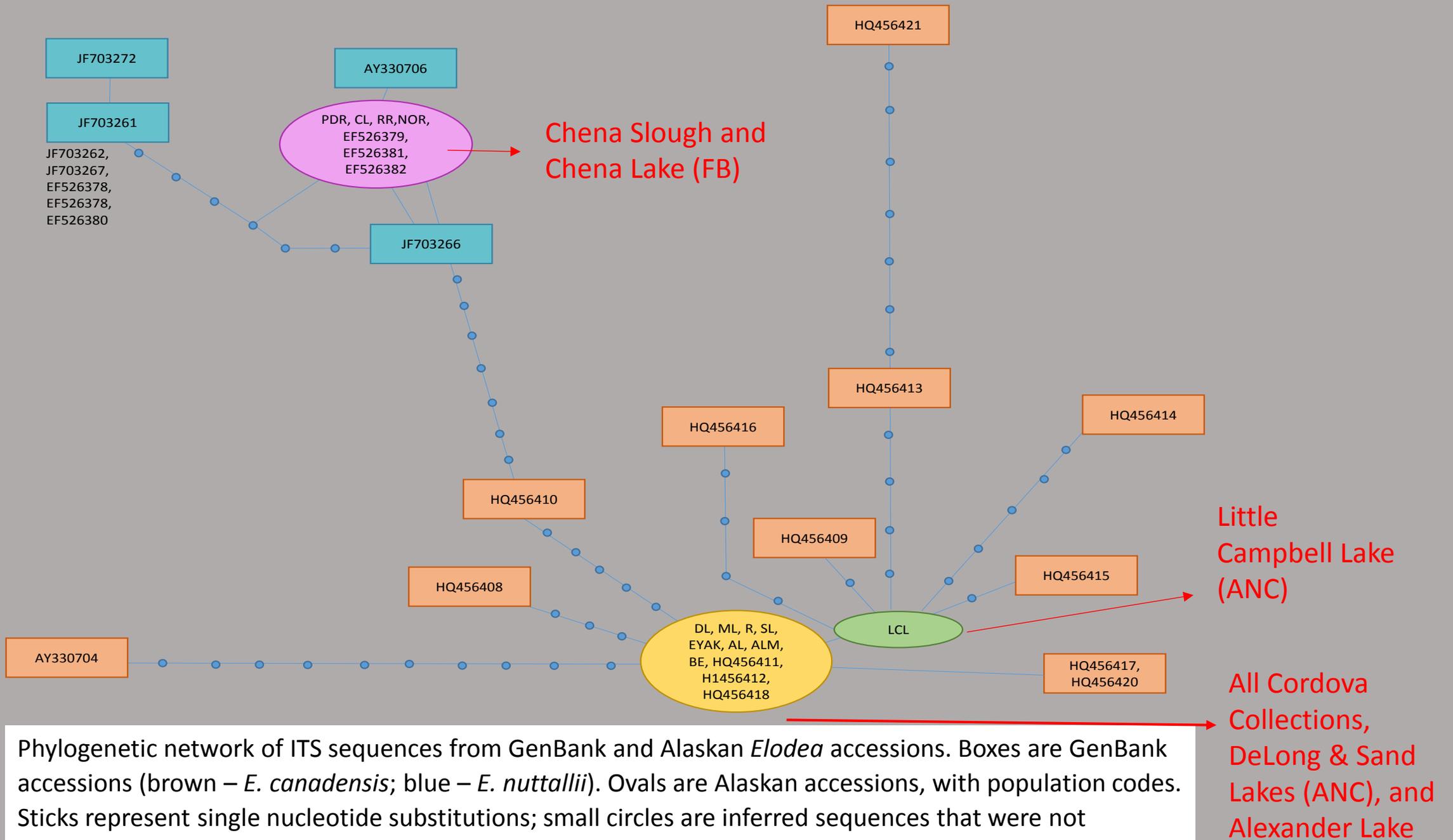
Search database Nucleotide collection (nr/nt) using Megablast (Optimize for highly similar sequences)

 Show results in a new window[+ Algorithm parameters](#)

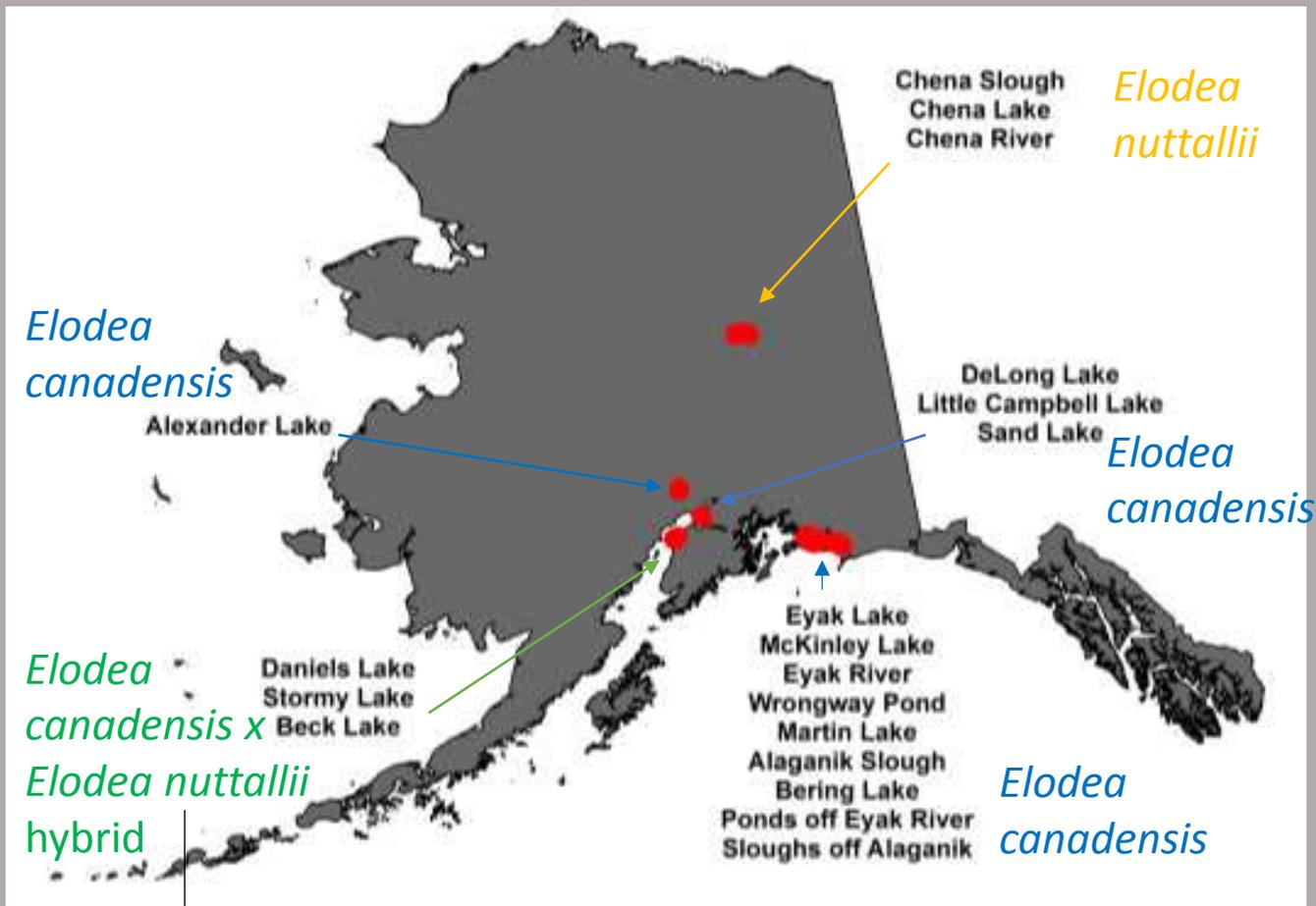
Sequences producing significant alignments:

Select: [All](#) [None](#) Selected:0[Alignments](#) [Download](#) [GenBank](#) [Graphics](#) [Distance tree of results](#)

	Description	Max score	Total score	Query cover	E value	Ident	Accession
<input type="checkbox"/>	Elodea nuttallii isolate 3a 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, complete sequence; and 26S ribosomal RNA gene, parti	1192	1192	100%	0.0	100%	EF526379.1
<input type="checkbox"/>	Elodea nuttallii 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene and internal transcribed spacer 2, complete sequence; and 26S ribosomal RNA gene, partial sequenc	1186	1186	100%	0.0	99%	AY330706.1
<input type="checkbox"/>	Elodea nuttallii isolate SAV85 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1 and 5.8S ribosomal RNA gene, complete sequence; and internal transcribed spacer 2, partial sequence	1182	1182	100%	0.0	99%	JF703266.1
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<input type="checkbox"/>	Elodea nuttallii isolate SAV109 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene, complete sequence; and internal transcribed spacer 2, partial sequence	1151	1151	100%	0.0	99%	JF703272.1
<input type="checkbox"/>	Elodea canadensis isolate 8 voucher Les 813 (CONN) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, complete sequence; and 2	1147	1147	100%	0.0	99%	HQ456421.1
<input type="checkbox"/>	Elodea canadensis isolate 5 voucher Les 803 (CONN) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, complete sequence; and 2	1136	1136	99%	0.0	99%	HQ456410.1
<input type="checkbox"/>	Elodea canadensis isolate 8 voucher Les 803 (CONN) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, complete sequence; and 2	1134	1134	100%	0.0	98%	HQ456413.1
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<input type="checkbox"/>	Elodea canadensis isolate SAV22 internal transcribed spacer 1, partial sequence; 5.8S ribosomal RNA gene, complete sequence; and internal transcribed spacer 2, partial sequence	1110	1110	99%	0.0	98%	JF703257.1
<input type="checkbox"/>	Elodea canadensis isolate 5 voucher Les 813 (CONN) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, complete sequence; and 2	1109	1109	99%	0.0	98%	HQ456418.1
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<input type="checkbox"/>	Elodea canadensis isolate 7 voucher Les 813 (CONN) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1, 5.8S ribosomal RNA gene, and internal transcribed spacer 2, complete sequence; and 2	1103	1103	99%	0.0	98%	HQ456420.1
<input type="checkbox"/>	Elodea canadensis isolate 4 voucher Les 813 (CONN) 18S ribosomal RNA gene, partial sequence; internal transcribed spacer 1 and 5.8S ribosomal RNA gene, complete sequence; and internal transcribed spacer 2, pa	1103	1103	99%	0.0	98%	HQ456417.1



Phylogenetic network of ITS sequences from GenBank and Alaskan *Elodea* accessions. Boxes are GenBank accessions (brown – *E. canadensis*; blue – *E. nuttallii*). Ovals are Alaskan accessions, with population codes. Sticks represent single nucleotide substitutions; small circles are inferred sequences that were not observed.



- DNA from Stormy Lake did not sequence well, but two partial sequences showed strong evidence that they were a hybrid of the two species.

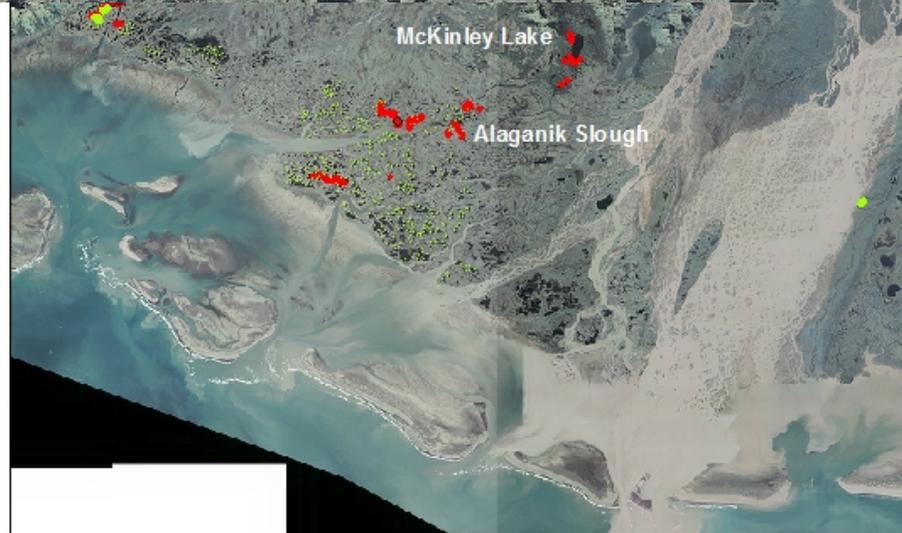
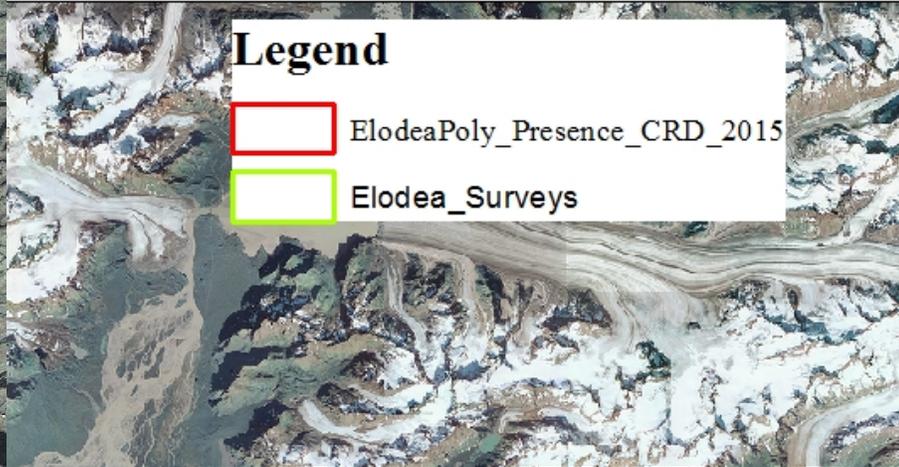
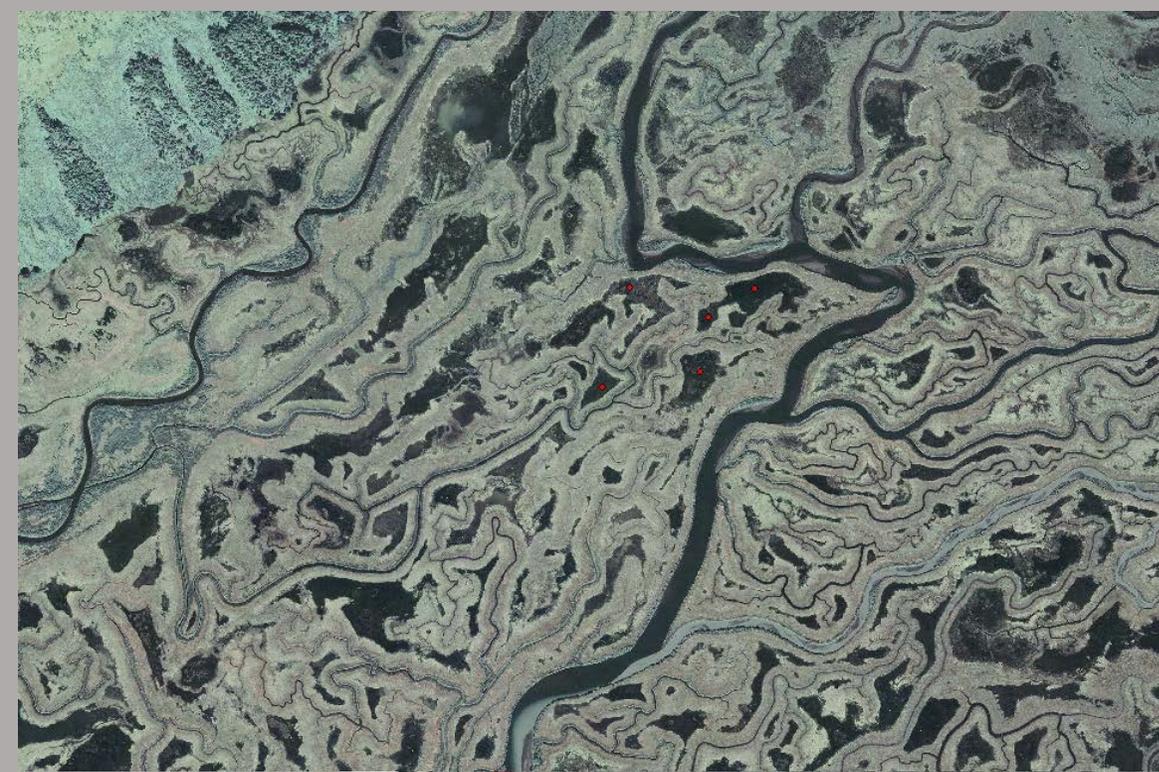
Conclusions

- ITS Sequences from 45 samples collected at 12 locations in 5 geographic areas revealed clear evidence that Alaska has *Elodea canadensis*, *E. nuttallii*, and their hybrid.
- Using additional molecular markers (microsatellites, AFLP's) may detect further variations within and among populations in AK.

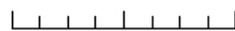
Usefulness

- Management strategies may differ between species (i.e. fluridone rate effectiveness)
- Tracking spread
- eDNA development

ent on the Copper River Delta

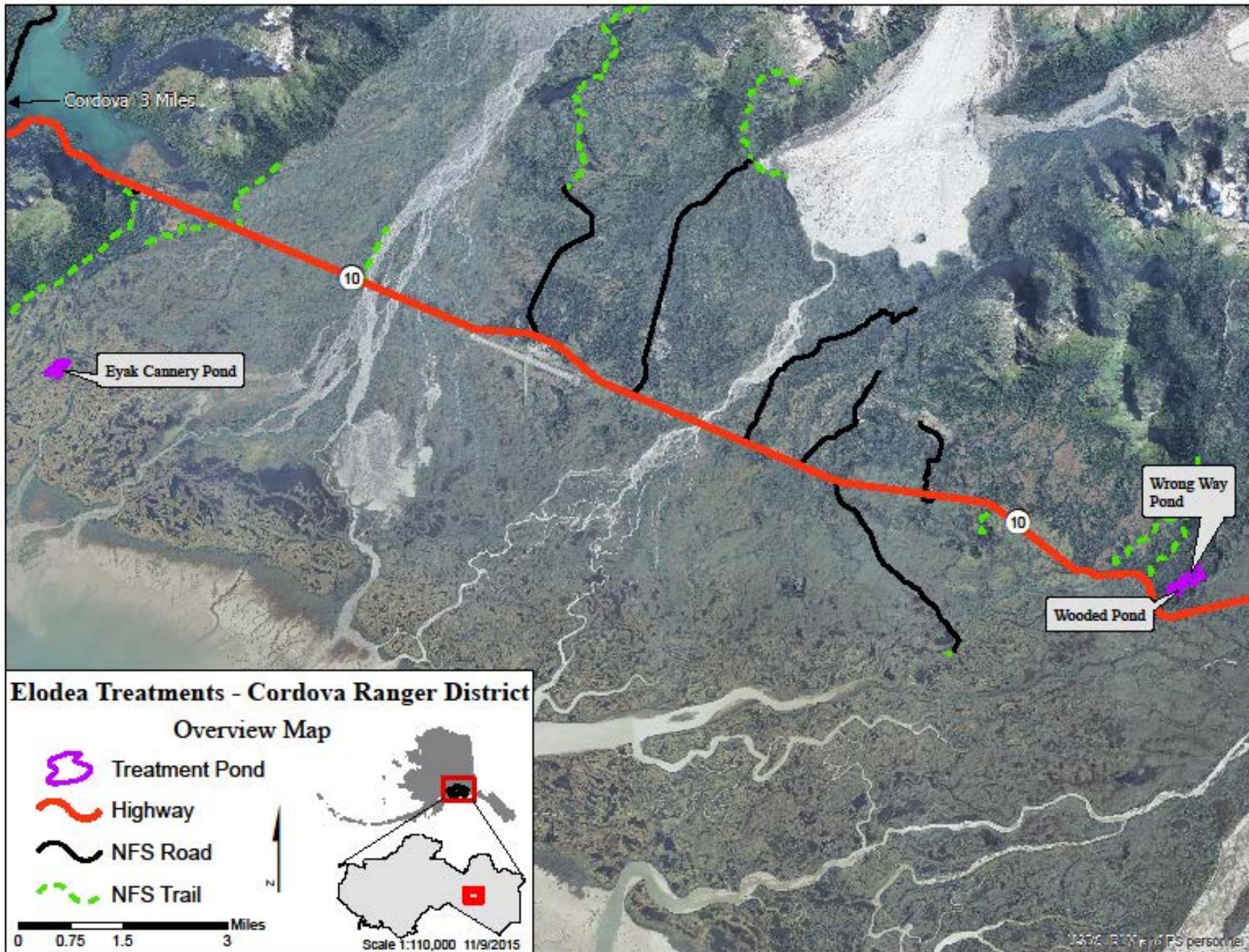


0 3.25 6.5 13 Kilometers



Copper River Delta Elodea





Why small scale treatment:

- Elodea infestation on the CRD is large and complex, requiring many millions for full scale treatment
- Fluridone effects on native macrophytes not fully understood
- Impacts to the food web from fluridone (i.e. macroinvertebrates) not well documented
- Feasibility and probability of success of large scale treatment on the CRD unknown



2016 Treatment Ponds- “Cannery Pond Complex”



- Closed System
- 40 acres total, 22 acres treatment
- No salmonids
- High diversity of native macrophytes
- Several comparable ponds nearby with/wo Elodea

Treatment #1: June 28, 2016



United States Department of Agriculture
Forest Service

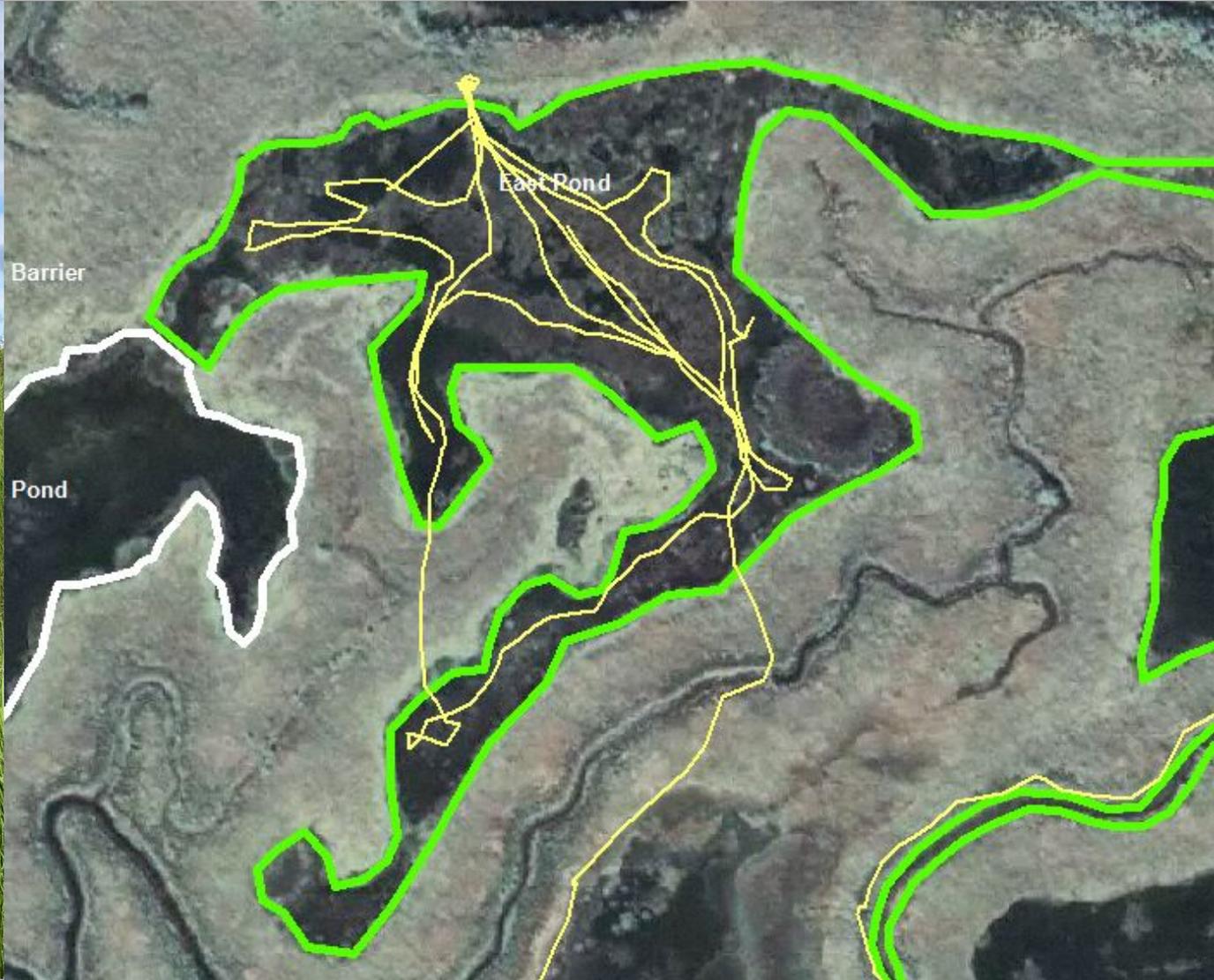
Elodea Herbicide Treatment Environmental Assessment

Cordova Ranger District, Chugach National Forest, Alaska

June 10, 2016



<http://www.fs.usda.gov/project/?project=48044>





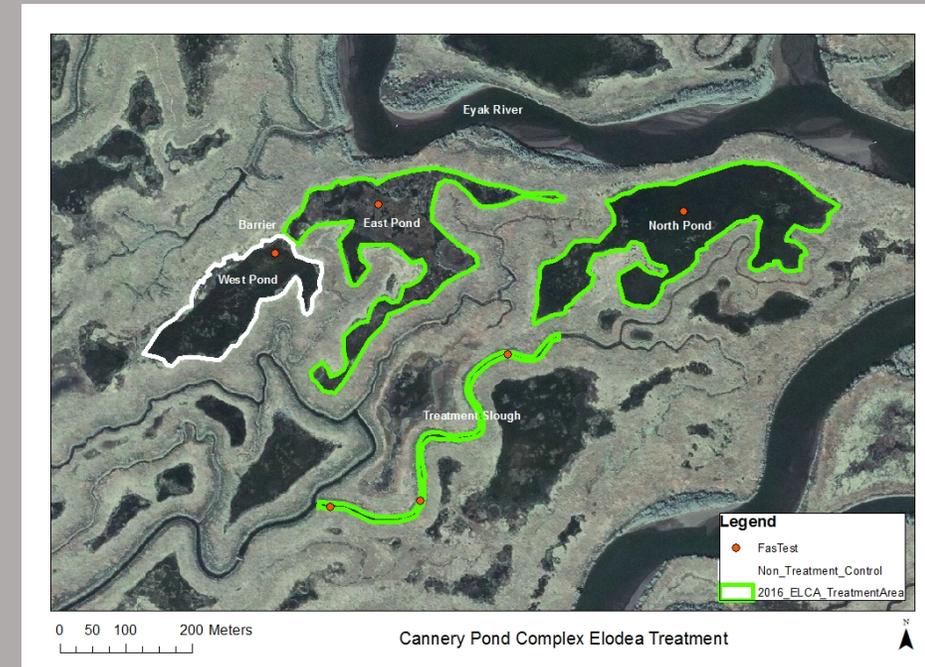
Lessons Learned

- Ponds too shallow, remote and vegetated to apply herbicides from boat
- SonarOne application rate too low to use vortex blower/applicator, hand spreaders only
- Applying the herbicides afoot added additional disturbance to the treatment area

FasTest Results:

Location	7/19/16	8/08/16	8/31/16
Cannery West Control Pond (#1)	<1 ug/L	<1 ug/L	<1 ug/L
Cannery West Infested Pond (#2)	4 ug/L	1.7 ug/L	1.1 ug/L
Cannery East Pond (#3)	5.3 ug/L	2.3 ug/L	1.1 ug/L
Cannery Complex Slough North	not tested	<1	<1
Cannery Complex Slough (#4) Middle	<1 ug/L	<1	<1
Cannery Complex Slough South	not tested	<1	<1

- Could not maintain fluridone in slough (flow issue?)
- Barrier works!



Treatment # 2: September 20th, 2016



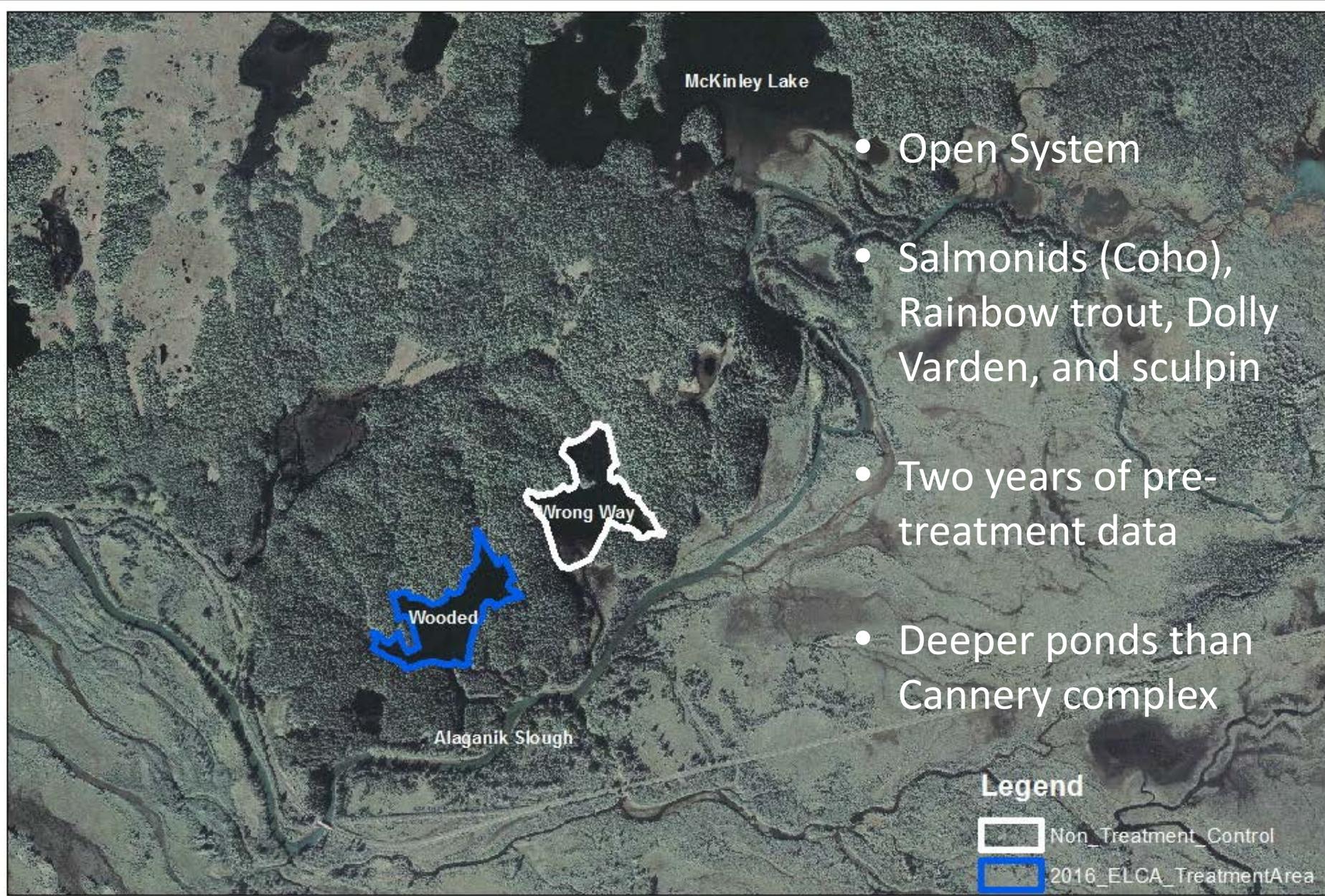
Chugach NF - 2016 Pond Treatments				
		Sep-16		
East Pond		Treatment 2	PPB	Fl.oz./#
Size (ac)	6	Sonar Genesis	-	-
Mean depth (ft)	1.6	SonarOne	10.0	5.0
Volume (ac-ft)	9.4			
North Pond		Treatment 2	PPB	Fl.oz./#
Size (ac)	13	Sonar Genesis	-	-
Mean depth (ft)	2.0	SonarOne	10.0	14.0
Volume (ac-ft)	25.9			
Slough		Treatment 2	PPB	Fl.oz./#
Size (ac)	2.6	Sonar Genesis	-	-
Mean depth (ft)	5.5	SonarOne	15.0	11.5
Volume (ac-ft)	14.3			
			SonarOne Total (#)	30.6

Results-

Sample Location	Test	Method	Results	Sampling Date / Time
Slough Middle	Sonar/Fluridone (ug/L)	FAST 10	1.5	10/05/2016
Slough North	Sonar/Fluridone (ug/L)	FAST 10	1.5	10/05/2016
Cannery East Treatment	Sonar/Fluridone (ug/L)	FAST 10	3	10/05/2016
Cannery West Treatment	Sonar/Fluridone (ug/L)	FAST 10	1.5	10/05/2016
Cannery West Control	Sonar/Fluridone (ug/L)	FAST 10	<1	10/05/2016
Slough South	Sonar/Fluridone (ug/L)	FAST 10	1.6	10/05/2016



Plans for 2017 and beyond



- Open System
- Salmonids (Coho), Rainbow trout, Dolly Varden, and sculpin
- Two years of pre-treatment data
- Deeper ponds than Cannery complex

- Continue cannery ponds treatment until 2018, treat Wrong-way/Wooded until 2019
- Monitor, compile, analyze data and make decision in 2020.

Acknowledgements

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