Contrasting Restoration Histories of the Williamson and Wood River Fluviodeltaic Systems, Upper Klamath Lake

Blow-and-go

Michael L. Hughes[1]
David Thaemert[2]
Daniel King[1]

[1] Department of Natural Sciences
[2] Department of Civil Engineering

Oregon Institute of Technology
Klamath Falls, OR

Acknowledgements

BLM PNW Cooperative Ecosystem Studies Unit (CESU)

Nature Conservancy

Store-and-grow

Two science facets:

- How should wetlands (with organic soils) that have been diked and drained be restored? I.e., How to deal with the levees?

  Results have implications for potential levee removals (along UKL and tributary floodplain systems)

- More broadly, highlighted case studies demonstrate importance of monitoring and adaptive management…but lack synthesis

  Case studies reflect unusually high levels of monitoring effort

  Both studies have conducted monitoring as part of project implementation

  Synthesis of restoration monitoring results and development of adaptive management approaches is at forefront of restoration as a profession and an applied science (e.g., understanding tradeoffs)

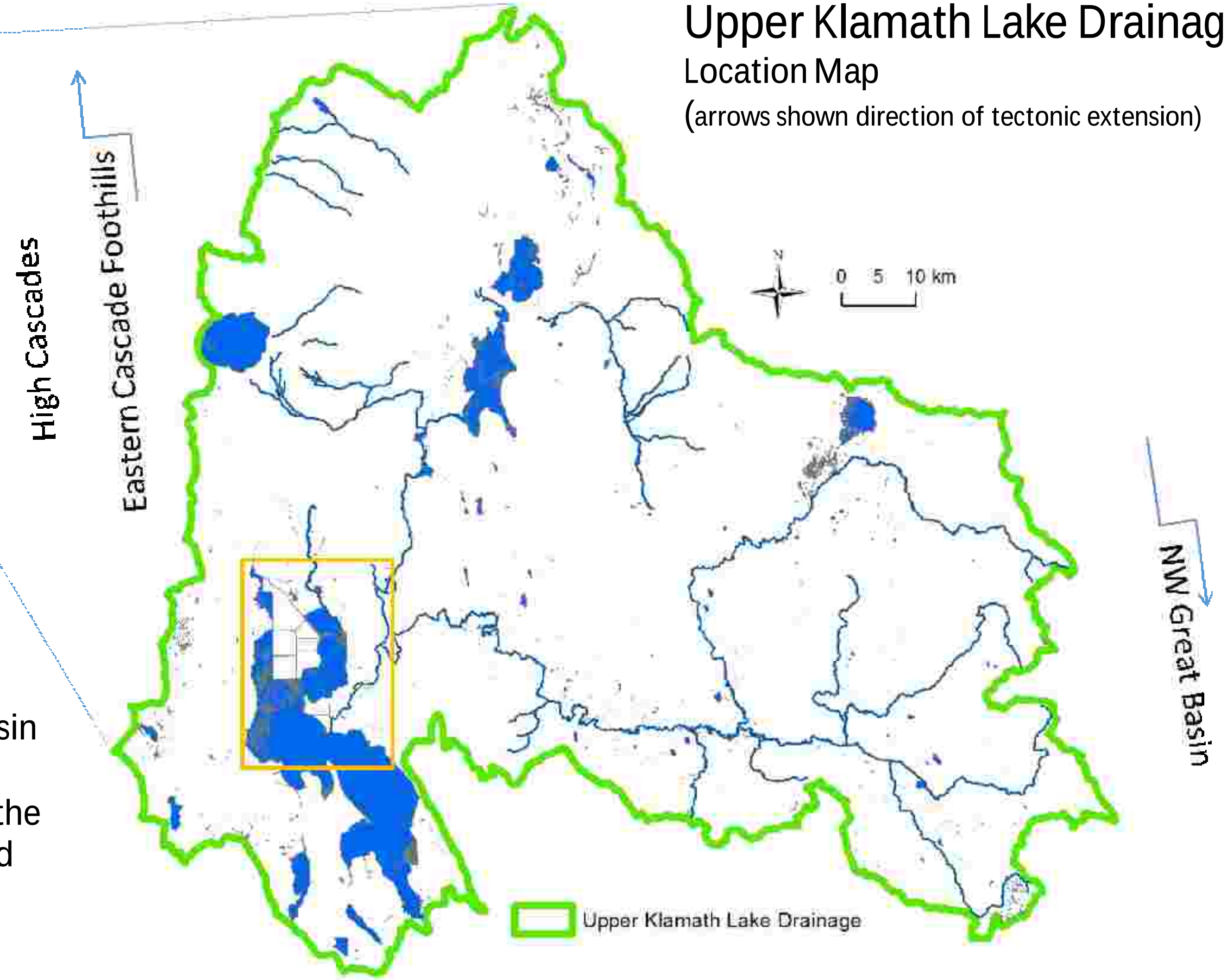

Image courtesy of TNC


GIS data courtesy of BLM

Upper Klamath Lake Drainage

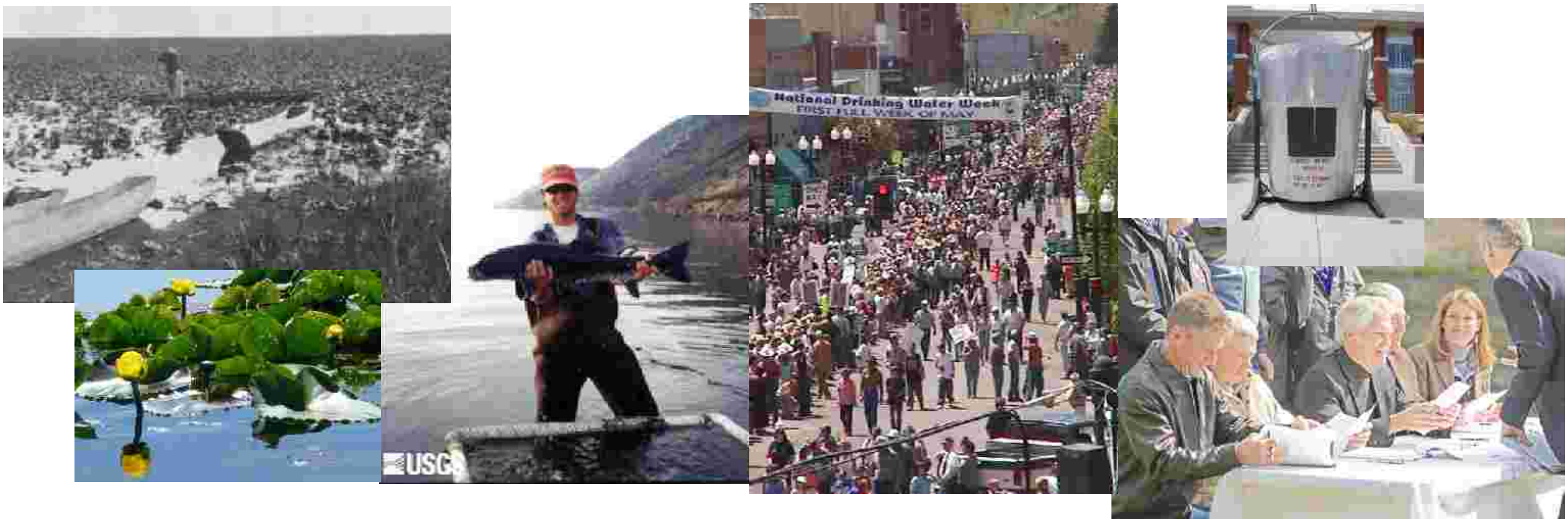
Location Map

(arrows shown direction of tectonic extension)



Klamath Basin occupies faulted “seam” that separates the Cascades from the Great Basin

Tectonic extension has opened the lake/wetland basins and allowed deposition of a fluvial deltas



Treaty with Native Americans 1864

Reclamation 1905 - 1960s

NEPA, CWA, ESA 1970 - 1973

Suckers listed 1988

Drought 1992, 1994

Ecosystem restoration emerges mid-1990s

Water crisis, bucket brigade 2001

Restoration accelerates, settlement talks begin Mid-2000s

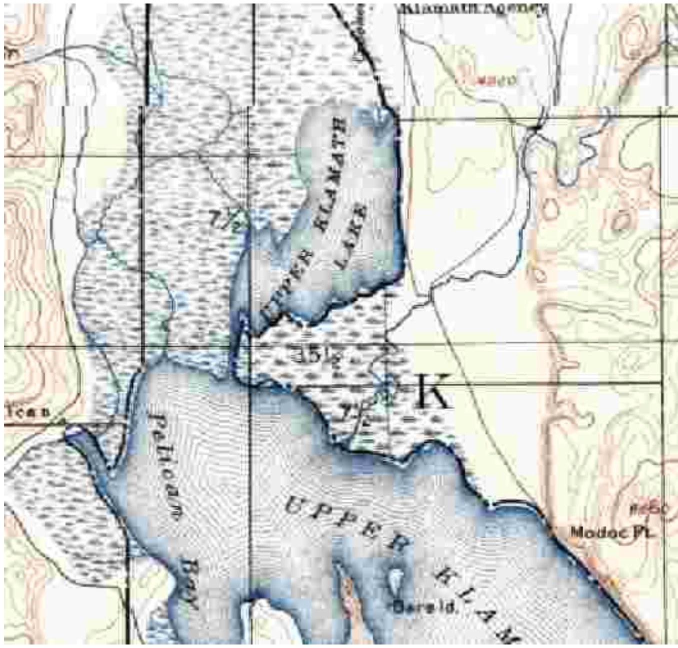
KBRA/KHSA signed 2010

Klamath water rights adjudicated 2013

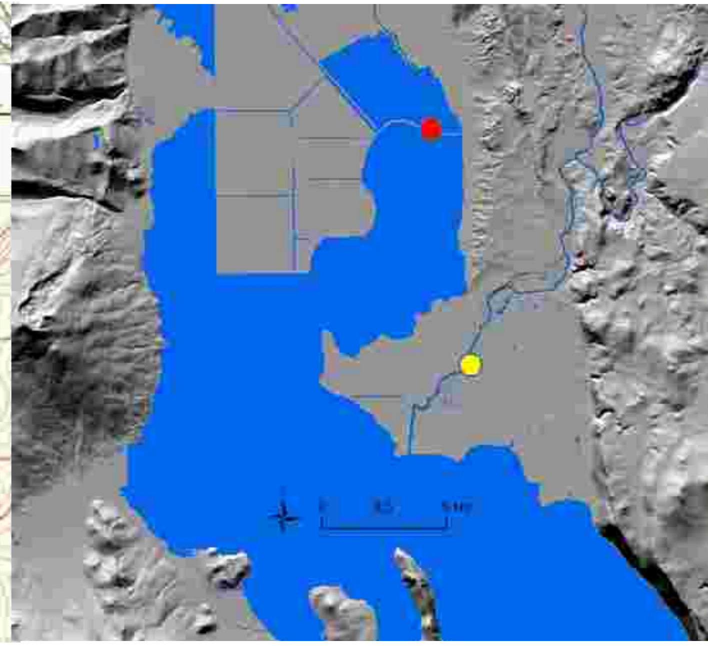
Settlement agreements signed 2014

Congressional Authorization ???

Klamath Basin Timeline



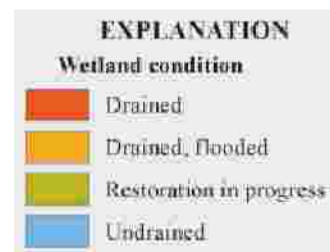
USGS 1905



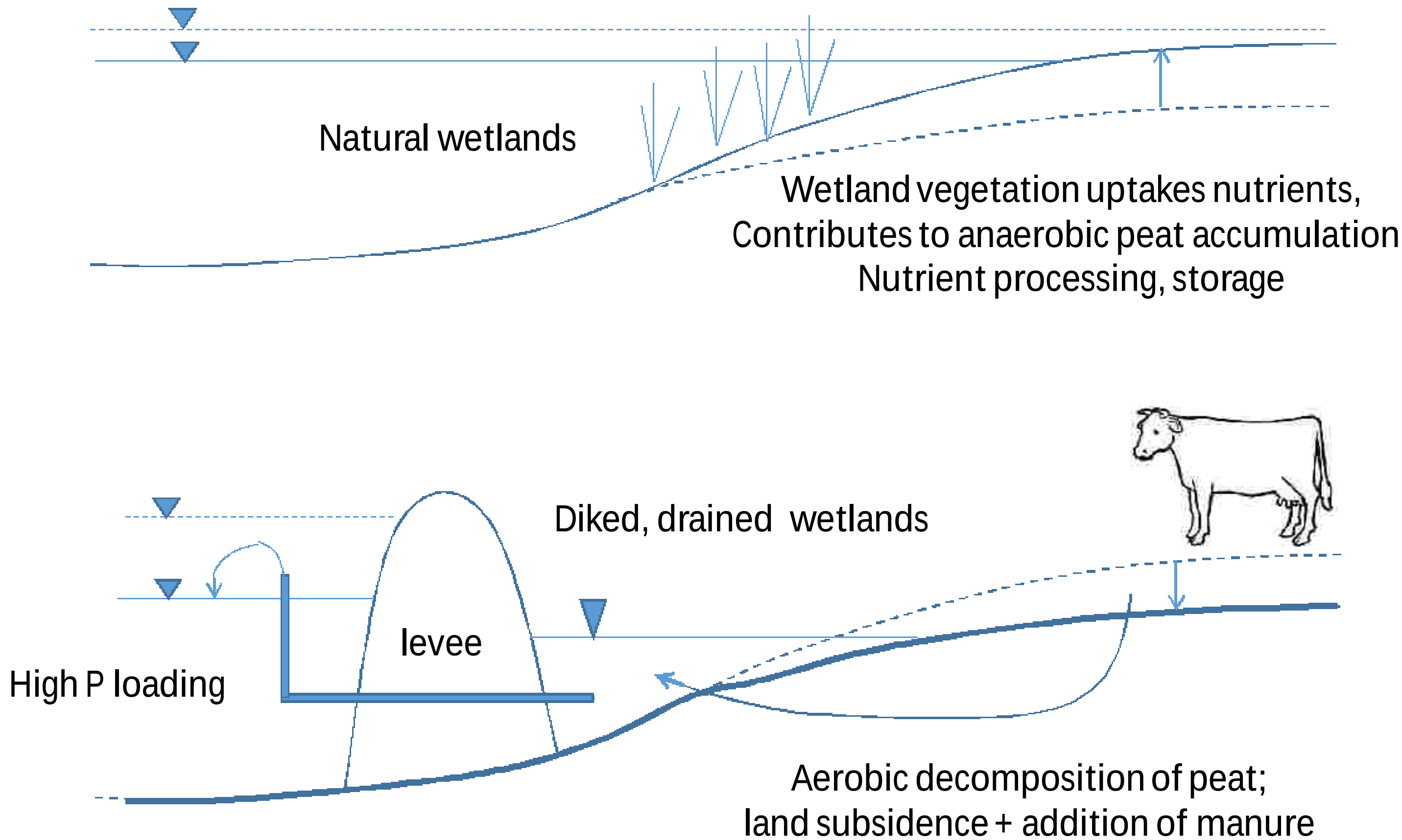
Circa 2006

USGS 2009

- Wood River: Channel Restoration and Treatment Wetland (red dot)
- Williamson River: Levee Breaching and Wetland Restoration (yellow dot)



Conceptualized effects of wetland diking and draining



Drainage of diked agricultural wetlands contributes disproportionally to nutrient loading, hypereutrophication, cyanobacterial impacts on Upper Klamath Lake

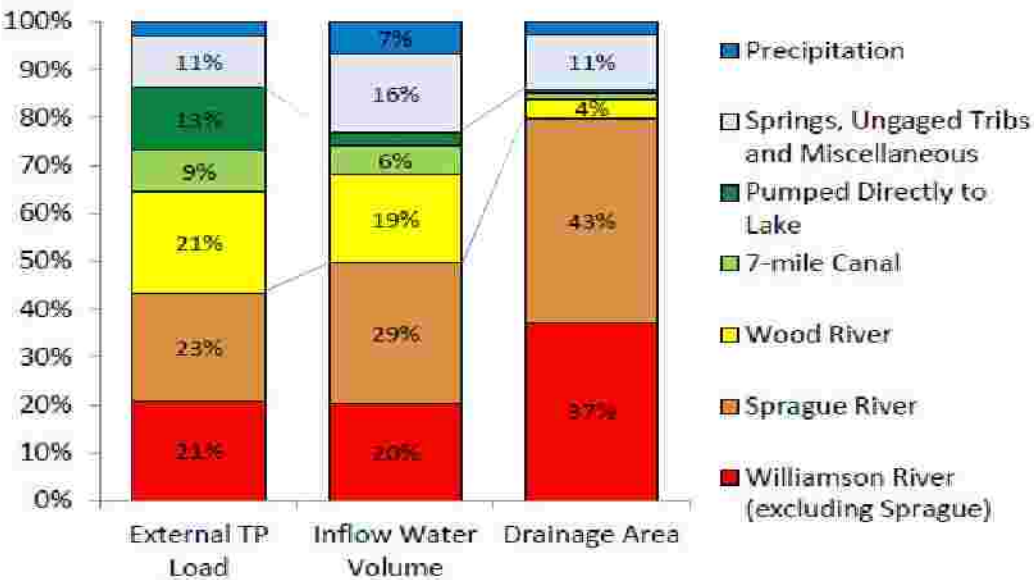


Figure 13. Relative contributions of tributaries and other sources to external total phosphorus (TP) load, inflow water volume, and drainage area to Upper Klamath Lake for hydrologic years 1992-2010. Data from Walker et al. (2012) Appendix E.

	Williamson River	Wood River
Motivation	Decline in native fish populations	Degraded water quality
Goals	Habitat improvement / provision	Water quality treatment Habitat improvement / provision
Strategy	Hydrologic reconnection (Channel-wetland-lake) Wetland restoration	Treatment wetland Subsidence reversal Channel and floodplain restoration
Methods	Blasting Excavation	Divert, treat, pump Excavation and fill
	"Blow and Go"	"Store and grow"

6-16-2006

8-1-2011

Williamson River Delta Restoration, 2006-2008

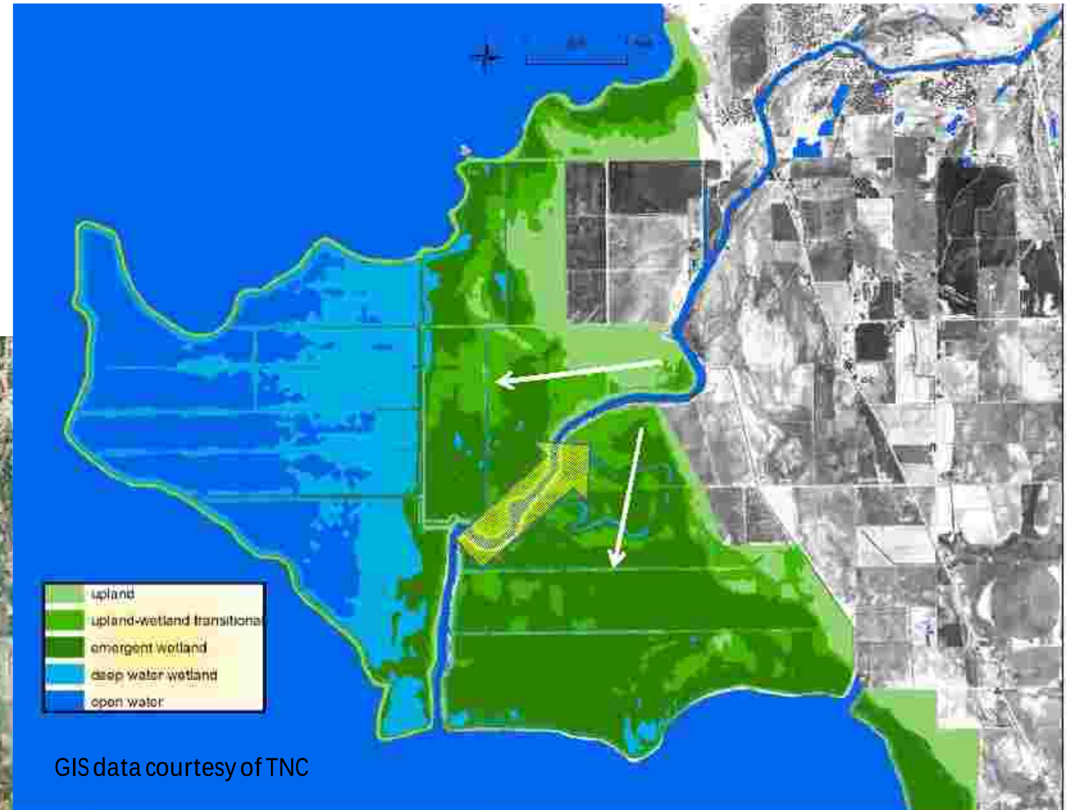
Recommended by National Research Council

Excavation and levee blasting

Excavation: ~1.7 million cubic yards, ~$7 million

Levee breaching resulted in restoration of a variety of vegetative communities and open water habitats

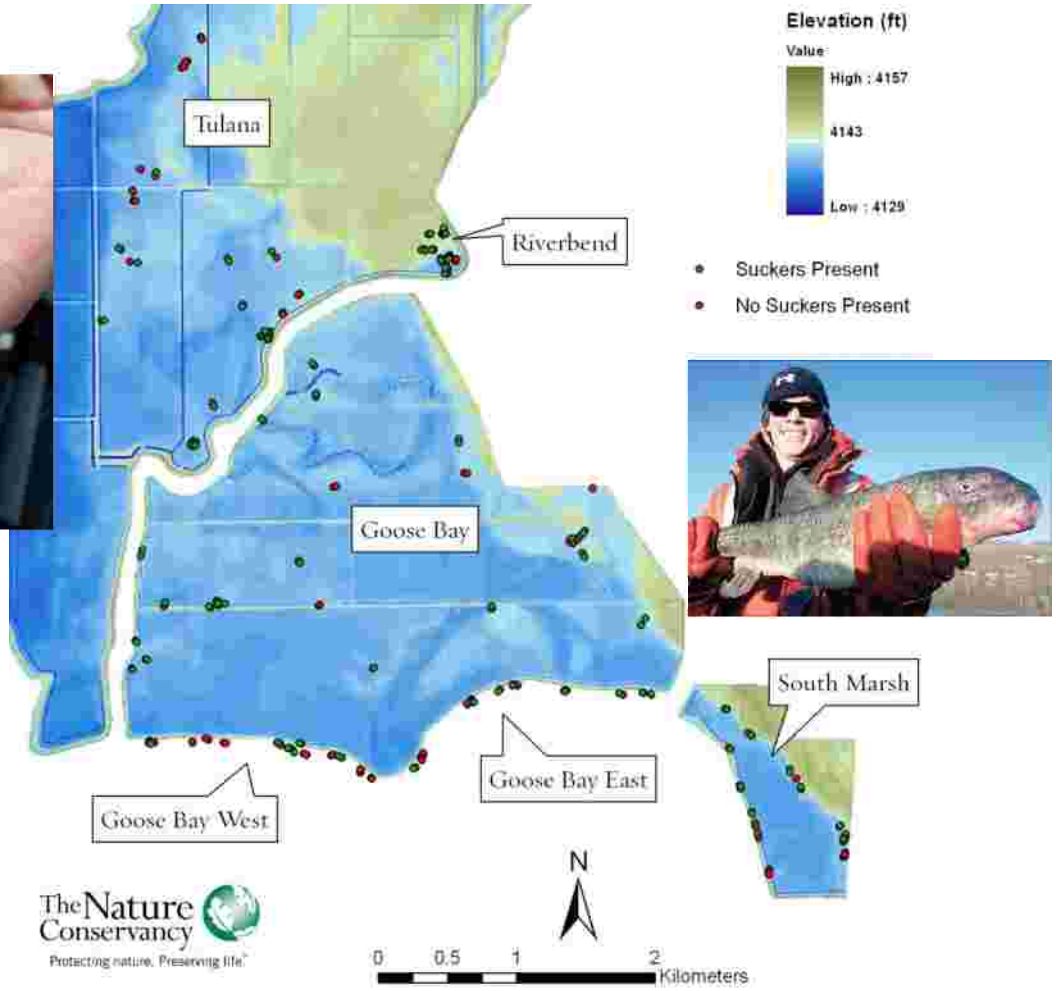
Emergent communities especially important to native sucker that spawn in Williamson-Sprague Rivers

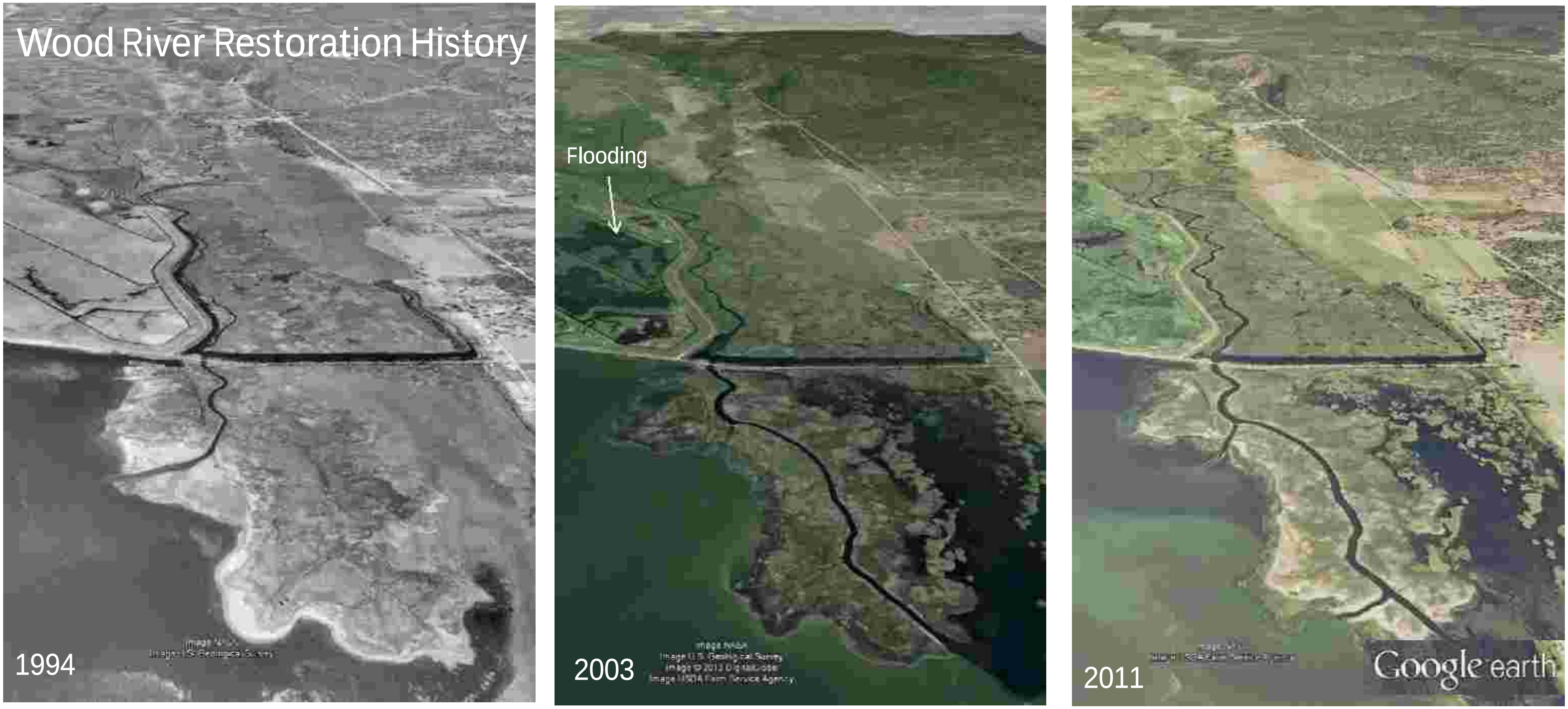


GIS data courtesy of TNC

Suckers well distributed in 2009 survey and other surveys , but to date no evidence of adult recruitment

Image and map courtesy of TNC





Channelization
Wetlands Drained

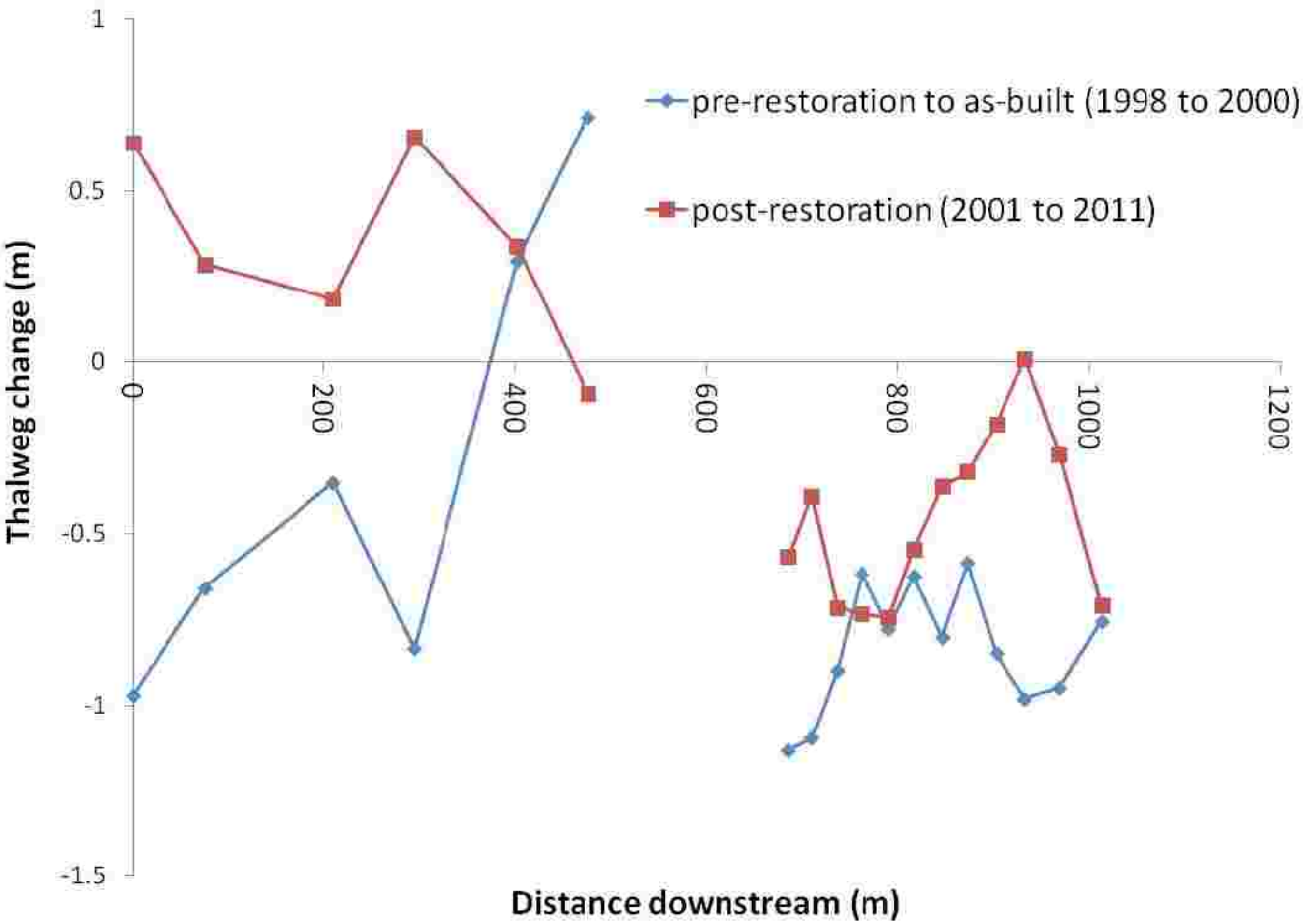
→ 1998-2000

Re-sectioning
Re-meandering
Floodplain reconstruction
Delta extension

→ 2009-2010

Birdfoot excavation
Floodplain supplemented

Thalweg elevation change of the Wood River, 1998 - 2011



Cross sections taken every 3-4 years

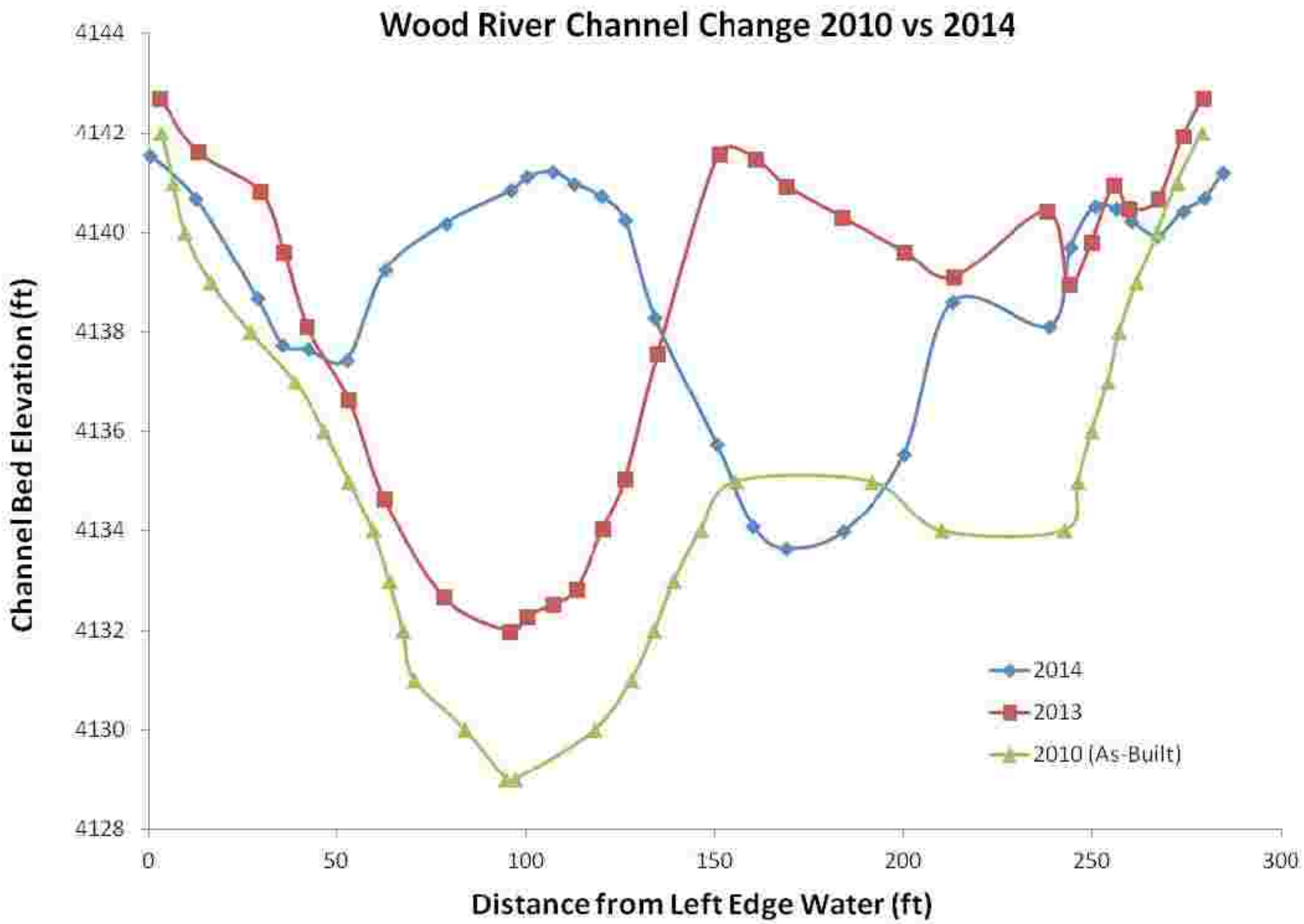
Upstream and downstream data interrupted by boating access channel

Upstream and downstream responses are varied

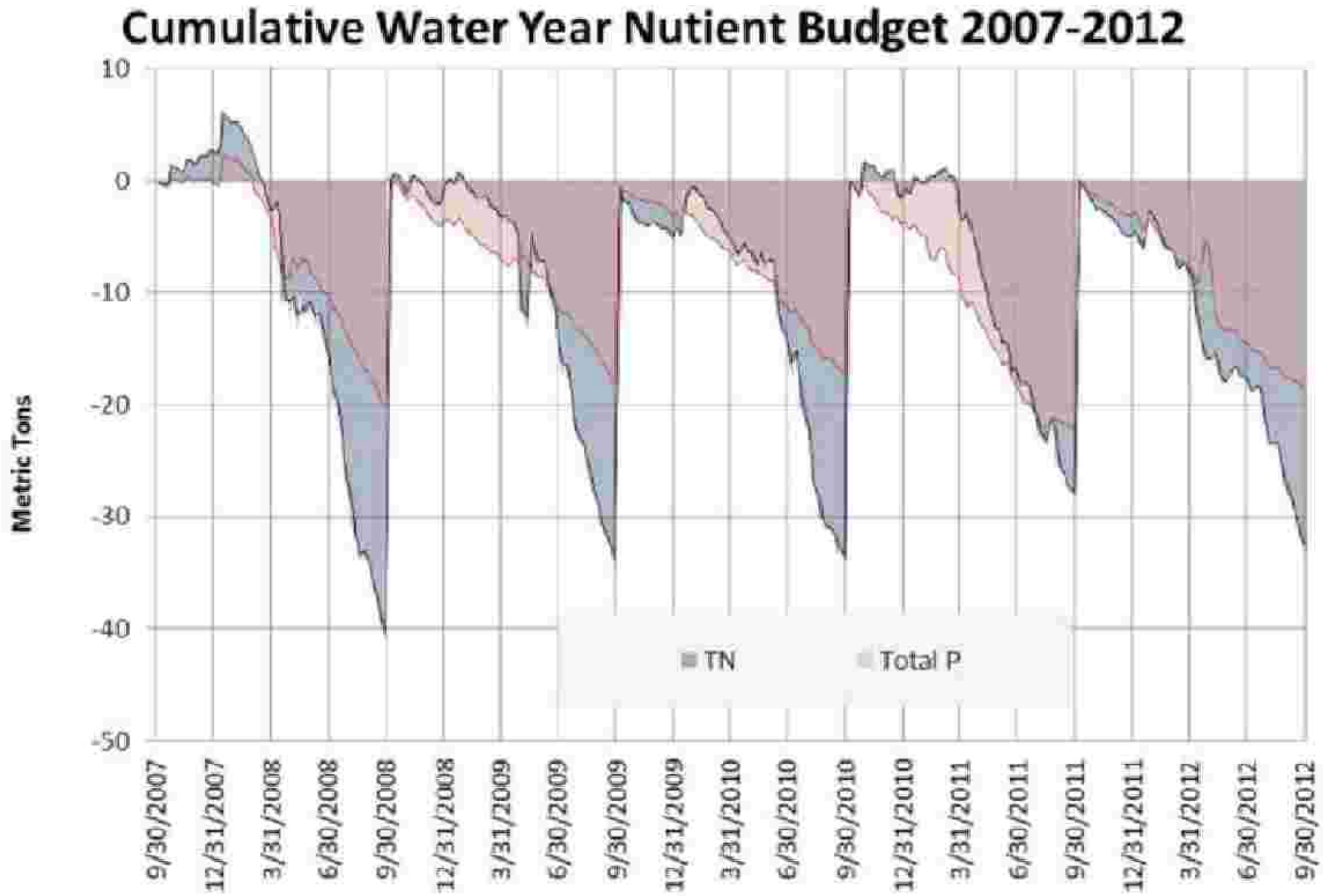
Upstream:
Excavation followed by aggradation

Downstream:
Excavation followed by degradation

Intersection of Wood River and boat access channel is especially dynamic



Wood River Channel Change 2010 vs 2014
Channel Bed Elevation (ft)
4144
4142
4140
4138
4136
4134
4132
4130
4128
0
50
100
150
200
250
300
Distance from Left Edge Water (ft)
2014
2013
2010 (As-Built)

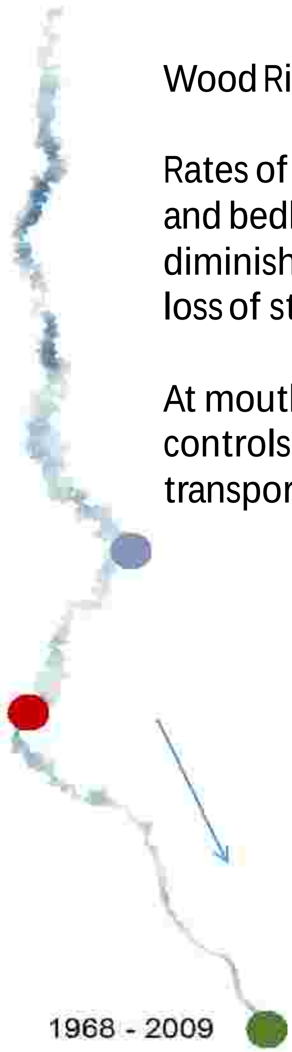


Cumulative Water Year Nutient Budget 2007-2012
Metric Tons
10
0
-10
-20
-30
-40
-50
TN
Total P
9/30/2007
12/31/2007
3/31/2008
6/30/2008
9/30/2008
12/31/2008
3/31/2009
6/30/2009
9/30/2009
12/31/2009
3/31/2010
6/30/2010
9/30/2010
12/31/2010
3/31/2011
6/30/2011
9/30/2011
12/31/2011
3/31/2012
6/30/2012
9/30/2012

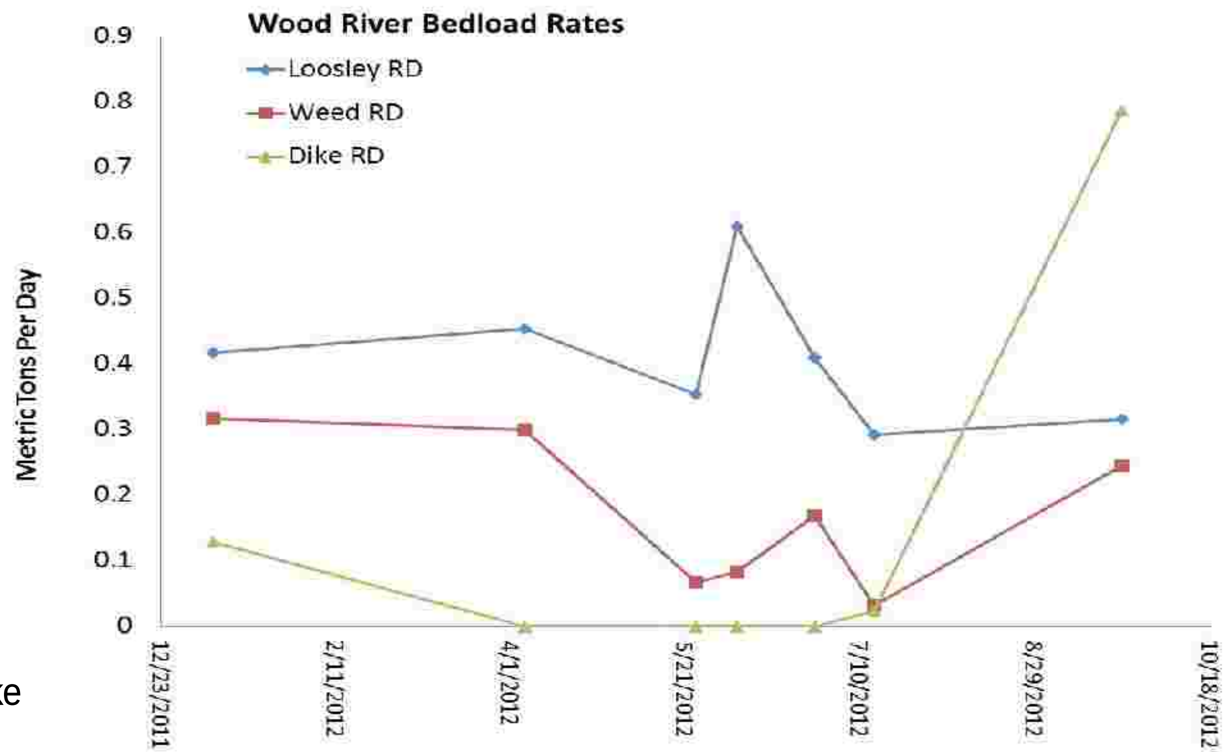
Wood River Corridor

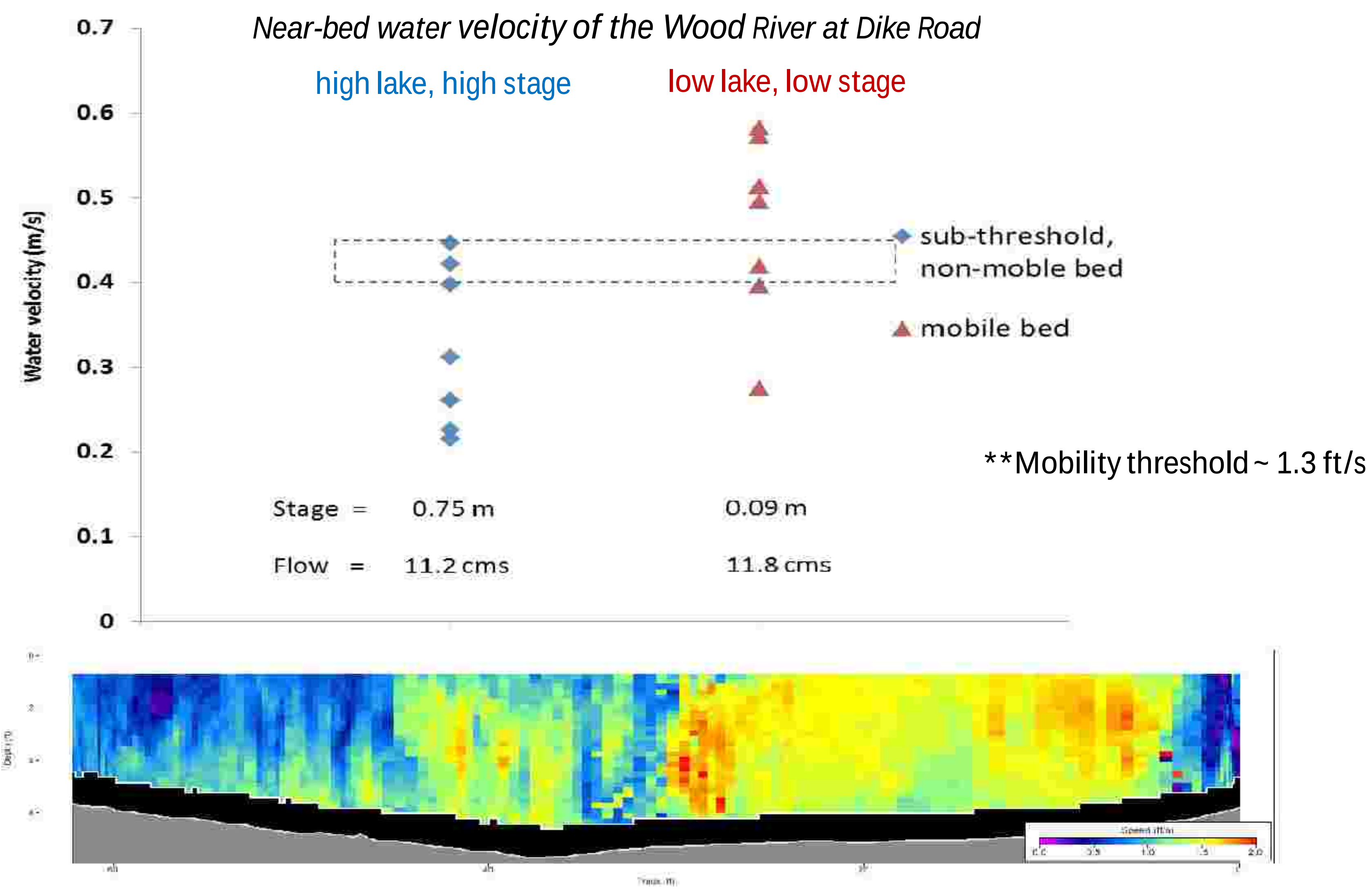
Rates of channel change and bedload transport diminish downstream with loss of steam power

At mouth, lake level controls sediment transport



Upper Klamath Lake





Near-bed water velocity of the Wood River at Dike Road
high lake, high stage
low lake, low stage
Water velocity (m/s)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
sub-threshold, non-moble bed
mobile bed
**Mobility threshold ~ 1.3 ft/s
Stage = 0.75 m
0.09 m
Flow = 11.2 cms
11.8 cms

Synthesis…

	Williamson River	Wood River
Motivation	Decline in native fish populations	Degraded water quality
Goals	Habitat improvement / provision	Water quality treatment Habitat improvement / provision
Strategy	Hydrologic reconnection (Channel-wetland-lake) Wetland restoration	Treatment wetland Subsidence reversal Channel and floodplain restoration
Methods	Blasting Excavation "Blow and Go"	Divert, treat, pump Excavation and fill "Store and grow"
Results	Provision of fish habitat but no increase in adult sucker population Wetland accretion of organic material	Improvement in water quality discharging to lake but no significant impacts on lake quality and/or eutrophication Improvement of channel habitat Wetland accretion of organic material
Adaptive Mgt	Re-excavation Experimental planting of native veg	Shift in flooding period Addition of channel structures

Conclusion

Case studies of the Williamson and Wood Rivers illustrate two contrasting approaches to restoration of fluviodeltaic wetland systems

Each has demonstrated ecological benefits, some similar and others dissimilar

Each has benefited from adaptive management

Tradeoffs in costs and benefits are evident

Future projects to restore fluviodeltaic wetland systems, remove levees , or develop treatment wetlands in the UKB and beyond can benefit from these monitoring efforts

Restoration projects are natural experiments

We must monitor in order to know and we must know in order to improve

We must push to have monitoring included in implementation plans and/or to collaborate in monitoring efforts