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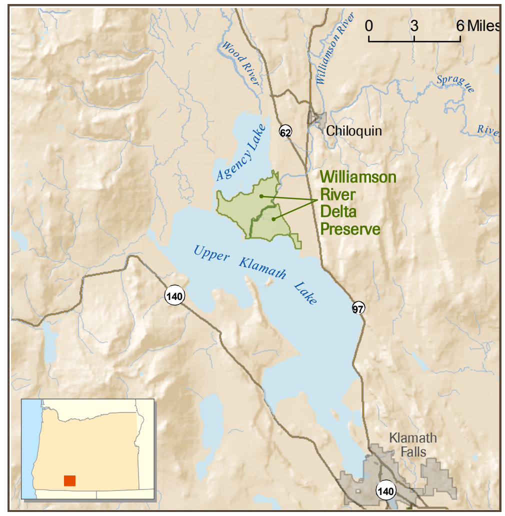
Minimizing phosphorus loading through wetland restoration in the Klamath Basin



The Williamson River Delta in southern Oregon's Klamath Basin (map) was once a vast expanse of floodplain and lake-fringe wetland habitat that formed where the Williamson River entered Upper Klamath Lake. In the mid-twentieth century, the Delta was leveed from the river and lake and converted to agricultural production. These actions eliminated important emergent marsh habitat historically utilized by endemic and endangered Lost River and shortnose suckers. Agricultural practices on the delta included pumping water from the property into the lake to drain the fields before planting. This pumped water contributed about 21-25 tons of phosphorus (P) per year to Upper Klamath Lake (Snyder and Morace 1997), which suffers from poor water quality conditions due to excessive P levels. The high P concentrations support extensive cyanobacterial blooms that deplete oxygen critical for suckers.

Beginning in 1996, The Nature Conservancy acquired the Williamson River Delta and initiated wetland restoration. The goal of the project was to reconnect the delta with the lake and river, to restore the lake-fringe wetland habitat for the benefit of native species and to reduce agricultural P exports to the lake. However, there was concern that breaching levees and reconnecting former agricultural fields would release a large amount of stored P into the lake, further degrading water quality.

Extensive research and modeling was conducted to predict what would happen when these former wetland soils were flooded following reconnection. Soil core experiments indicated that as much as 64 tons of P would be released from soils after flooding. Most of the P would be released during the first several days, after which P levels would decline and stabilize (Aldous et al. 2005, 2007; Stevens and Tullos 2011).

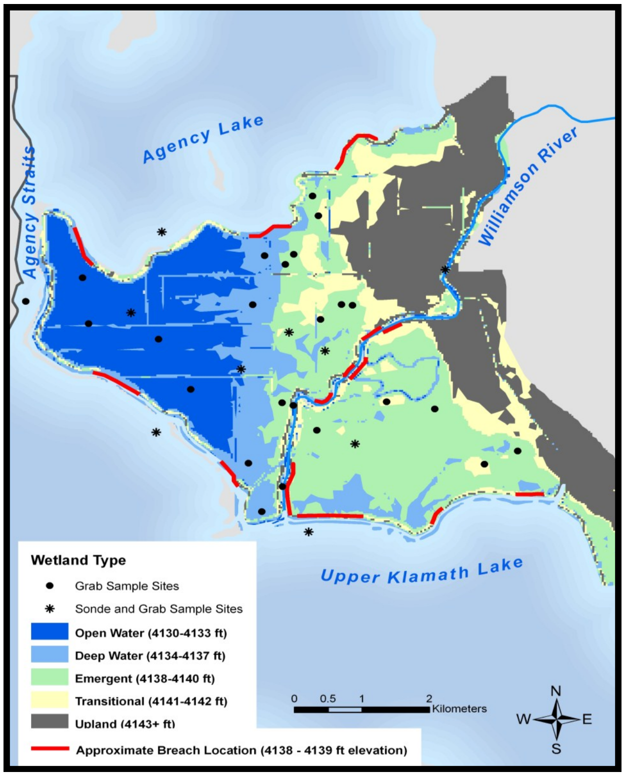


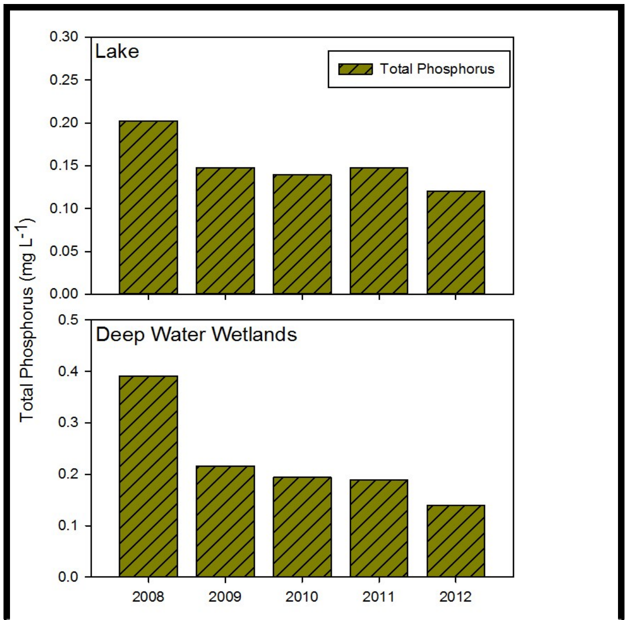

Conservation benefits from restoration, particularly an increase in habitat for suckers, were expected to offset the initial export of P, so the decision was made to breach the levees and monitor the results. Levees were breached on the west side of the delta in 2007, inundating approximately 3,500 acres, and on the east side of the delta in 2008, inundating approximately 2,000 acres (see map; back page). From March 2008–November 2012 The Nature Conservancy collected surface water grab samples for nitrogen (N) and phosphorus (P) at 27 sites. Data were collected in a variety of wetland types, as well as in the river and lake.

Photo credits: Delta before breach, © Scott Nelson; Delta wetlands post-breach, © Rick McEwan; collecting soil cores, © Allison Aldous; soil core experiment, © Allison Aldous

Far less phosphorus was released into the lakes and wetlands following restoration than modeling and experiments had predicted.

- At three weeks, 2.47 tons of Total Phosphorus (TP) was estimated to have been released, versus the predicted 64 tons (Wong et al. 2010).
- Overall P concentrations from the restored wetlands are approaching surrounding (lake) concentrations and are significantly less than P exports from historic management practices
- Following the initial pulse, seasonally averaged TP concentrations progressively became more stable and lower at lake and wetland sites from 2008–2012 (Hayden and Hendrixson 2013) (see graph).
- TP concentrations were 3-4 times lower compared to the first year of monitoring in open water, deep water (permanently-flooded) wetland and lake sites from mid-August through early October, the time period in which peak algal blooms historically occur in Upper Klamath and Agency Lakes.
- TP concentrations in shallow water (emergent and transitional) wetlands decreased by approximately 2.5 times during June–August from 2008 to 2012. These shallow water habitats, which are naturally nutrient rich, are seasonally inundated and usually remain flooded until sometime between late June and early August depending on the water year.





Graphs show the decline in P over time in deep water wetland and lake sites.

Wetland restoration and reconnection at the Williamson River Delta has reduced nutrient loading to the lake. During the last five years, overall total phosphorus has leveled off to surrounding concentrations. In addition to water quality benefits, restoration has the added benefits of:

- Providing critical rearing habitat for larval and juvenile shortnose and Lost River suckers
- Adding more than 5,500 acres of lake fringe and permanently flooded wetlands
- Allowing natural processes to determine wetland hydrology and connectivity

Literature cited: Aldous, A., P. McCormick, C. Ferguson, S. Graham, and C. Craft. 2005. Hydrologic regime controls soil phosphorus fluxes in restoration and undisturbed wetlands. Restoration Ecology 13: 341-347.; Aldous, A. R., C. B. Craft, C. J. Stevens, M. J. Barry, and L. B. Bach. 2007. Soil phosphorus release from a restoration wetland, Upper Klamath Lake, Oregon. Wetlands 27:1025–1035.; Hayden, N.J. and H.A. Hendrixson. 2013. Water quality conditions on the Williamson River Delta, Oregon: Five years post-restoration. 2012 annual report. The Nature Conservancy, Portland, OR.; Snyder, D.T. and J.L. Morace. 1997. Nitrogen and phosphorus loading from drained wetlands adjacent to Upper Klamath and Agency Lakes, Oregon. US Geological Survey, Water-Resources Investigations Report 97–4059.; Stevens, C.J. and D.D. Tullos. 2011. Effects of temperature and site characteristics on phosphorus dynamics in four restored wetlands: implications for wetland hydrologic management and restoration. Ecological Restoration 29: 279-291.; Wong, S.W., M.J. Barry, A.R. Aldous, N.R. Rudd, H.A. Hendrixson, and C.M.Doehring. 2011. Nutrient release from a recently flooded delta wetland: comparison of field measurements to laboratory results. Wetlands. 31:433-443.

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