Effects of aquatic plants on water quality in Willamette River off-channel habitats

Rich Miller and Mark Sytsma, Portland State University

State of the Willamette: River Habitat Restoration Practice Science and Funding Workshop

Trillium Historic Old School Event Center, Corvallis, Oregon, January 15, 2020

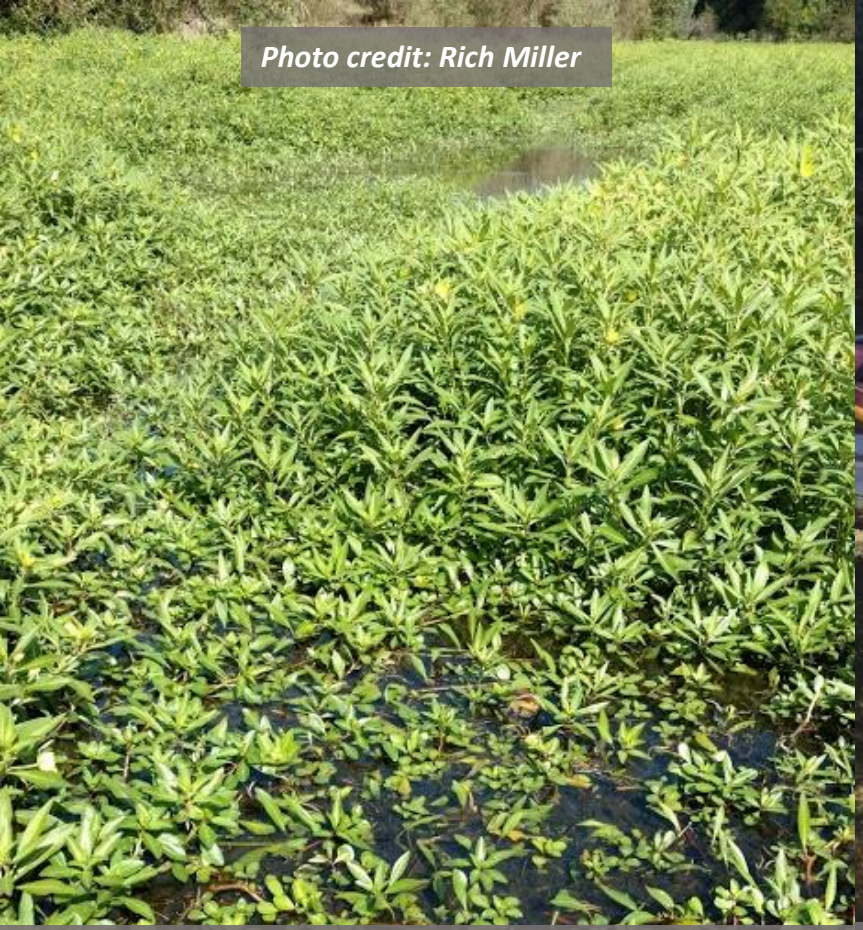
Willamette River aquatic plants are not all new or harmful

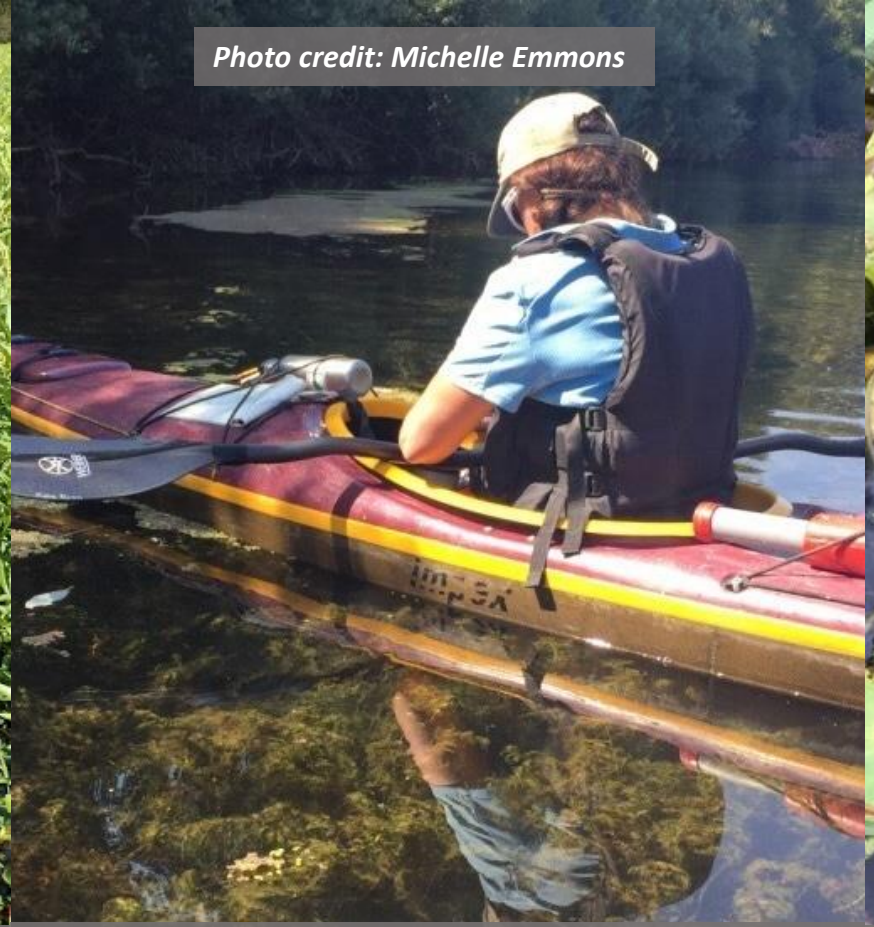
Willamette River oxbow clogged with lilies and weeds, Aug. 1956.
Oreg. State Univ. Libr., Ext. and Exp. Sta. Comm., P120:5730

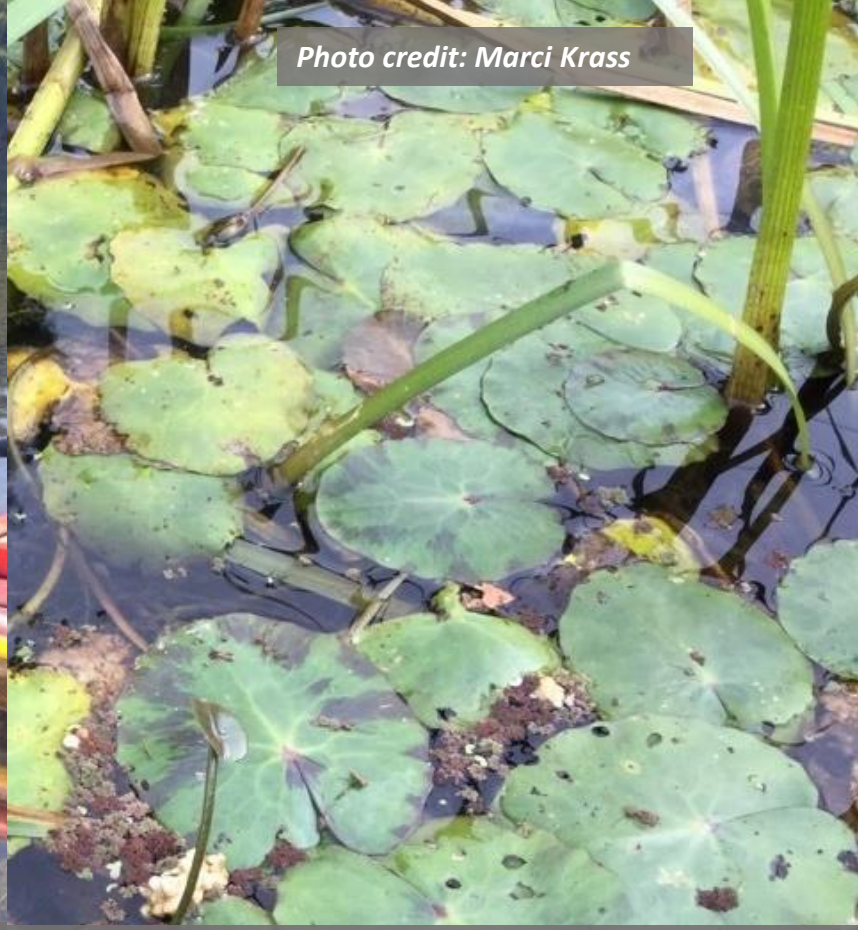
But: Mission Lake, July 1976, no evidence of submerged aquatic vegetation.

Rinella, J. F. 1977. Lakes of Oregon: Volume 5. Marion County. Open-file report. Pages 1–99. US Geological Survey and Oregon Water Resources Department

Windsor Island Slough, Marion County, 2017 (side channel)
Mixture of non-native and native aquatic plants and algae







Emergent species

Water primroses (*Ludwigia* spp.)
Parrotsfeather (*Myriophyllum aquaticum*)
Wapato (*Sagittaria latifolia*)
Bur-reeds (*Sparganium* spp.)
Cattail (*Typha latifolia*)
Bulrushes (*Schoenoplectus* spp.)

Submerged species

Brazilian waterweed (*Egeria densa*)
Curly leaf (*Potamogeton crispus*)
Eurasian watermilfoil (*M. spicatum*)
Pondweeds (*Potamogeton* spp.)
Coontail (*Ceratophyllum demersum*)
Elodeas (*E. canadensis & E. nuttallii*)

Floating leaf species

Yellow floating heart (*Nymphoides peltata*)
Yellow pond lily (*Nuphar polysepala*)
Watershield (*Brasenia schreberi)*
Waterpenny (*Hydrocotyle ranunculoides*)
Duckweeds (*Lemna* spp.)
Water ferns (*Azolla* spp.)

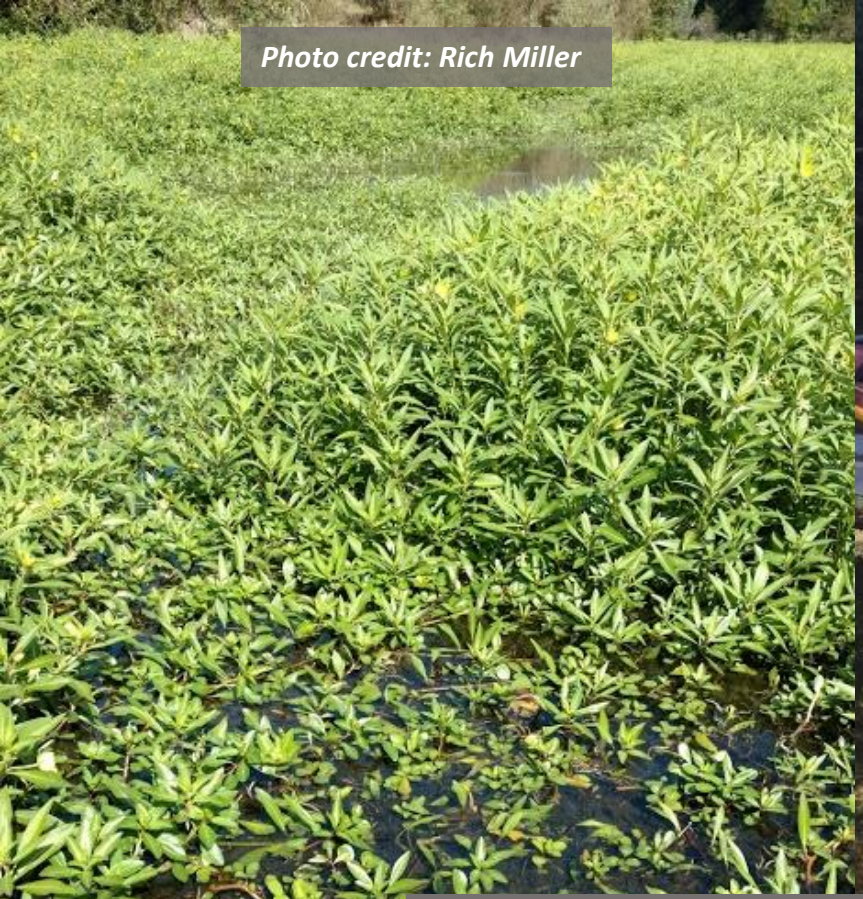


Photo credit: Rich Miller

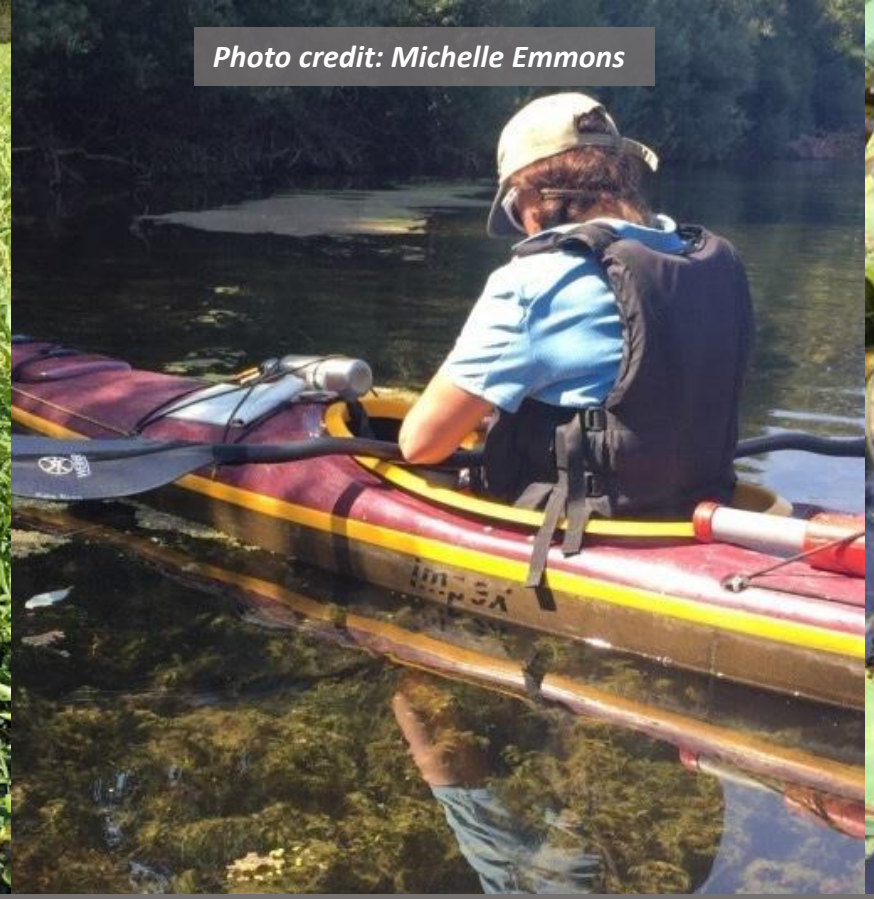


Photo credit: Michelle Emmons

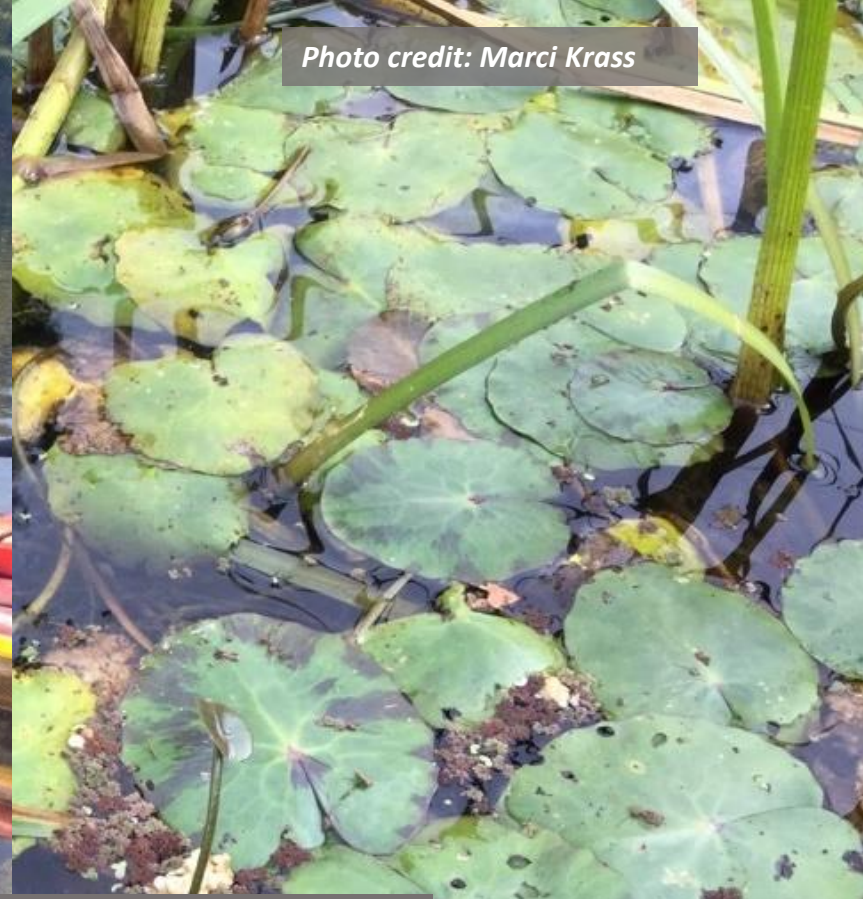
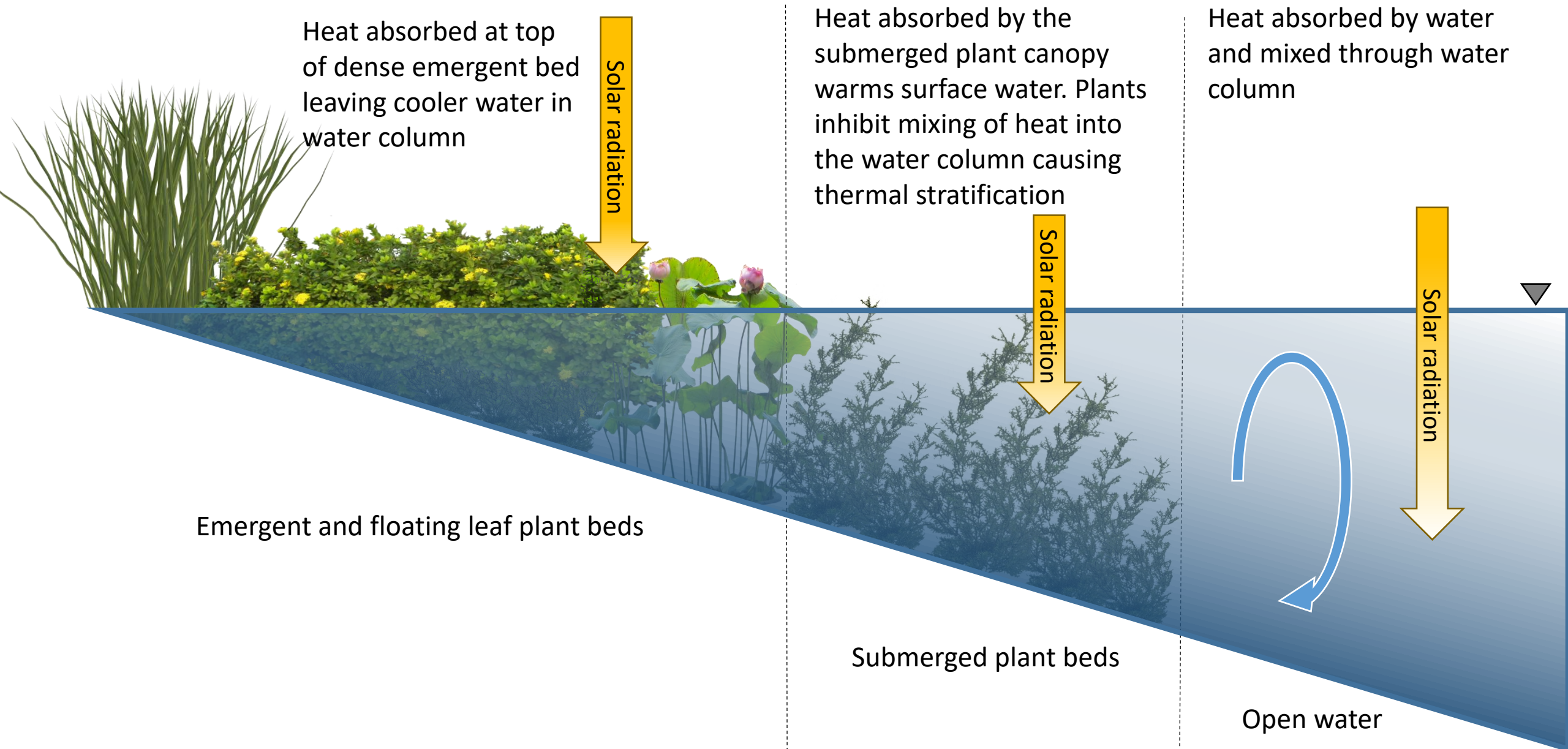


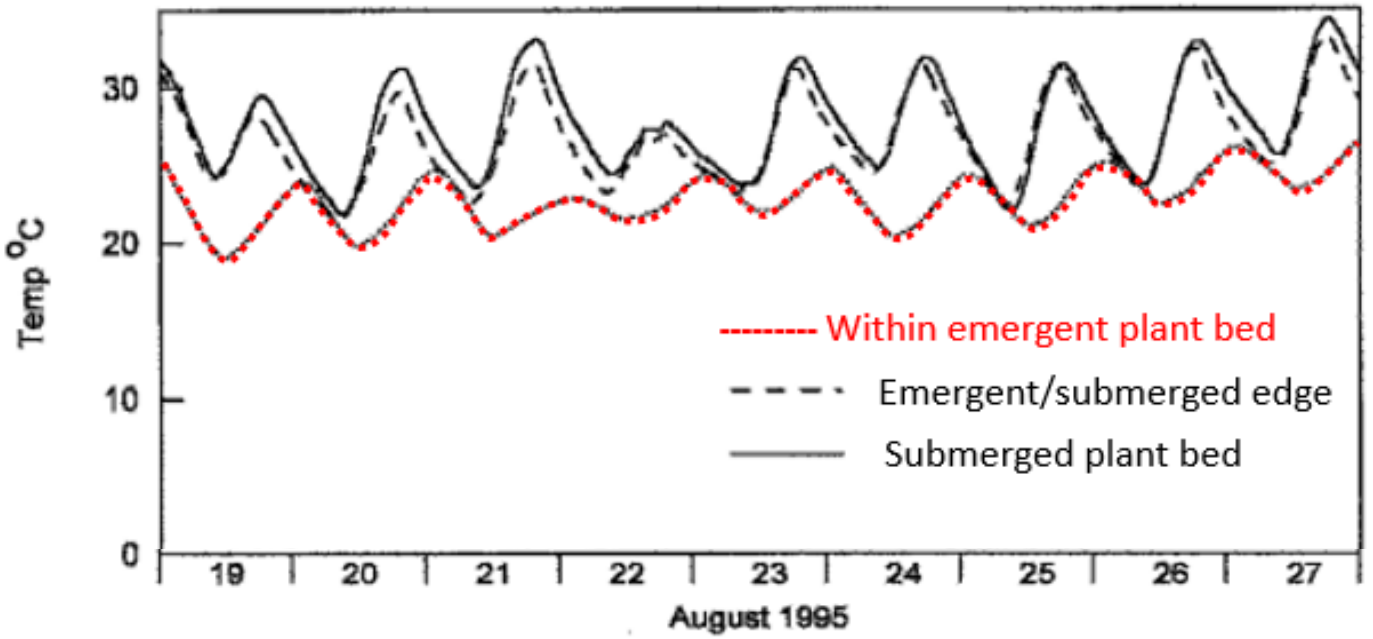
Photo credit: Marci Krass

Aquatic plant growth forms and plant density affect water quality in different manners. Particularly temperature, dissolved oxygen, and pH

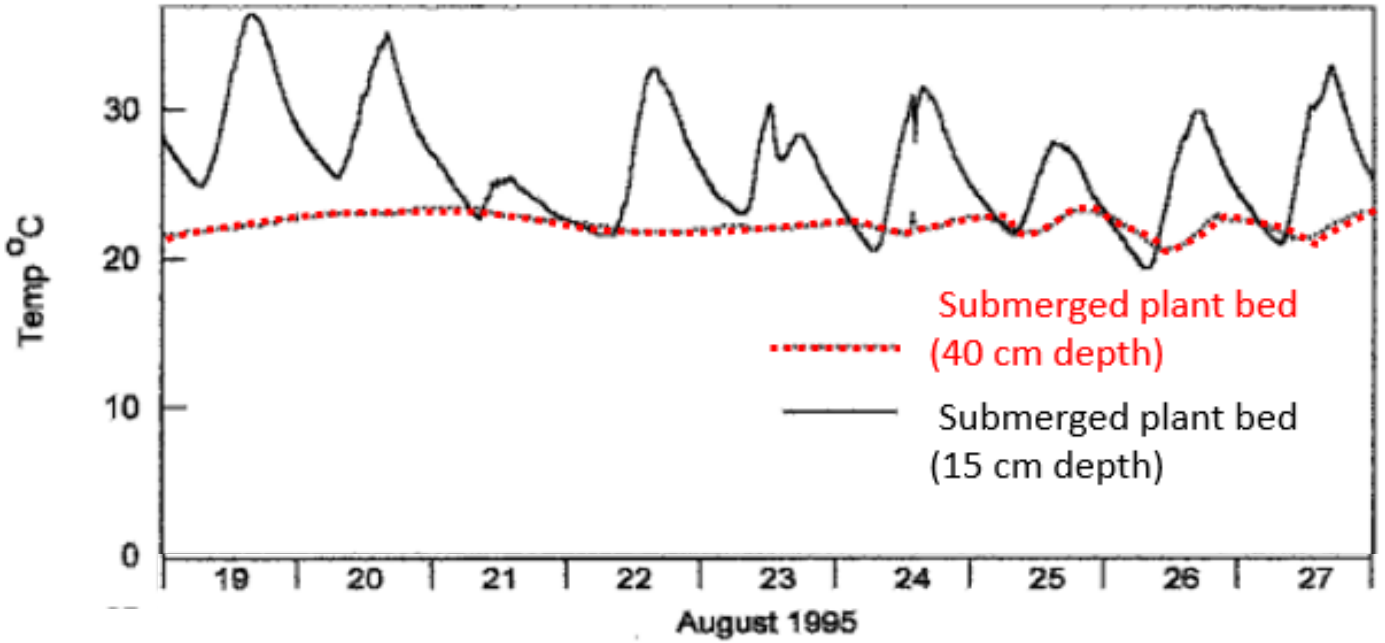
Effects of plant bed types on water temperature



Diel variation in temperature near surface across plant bed types

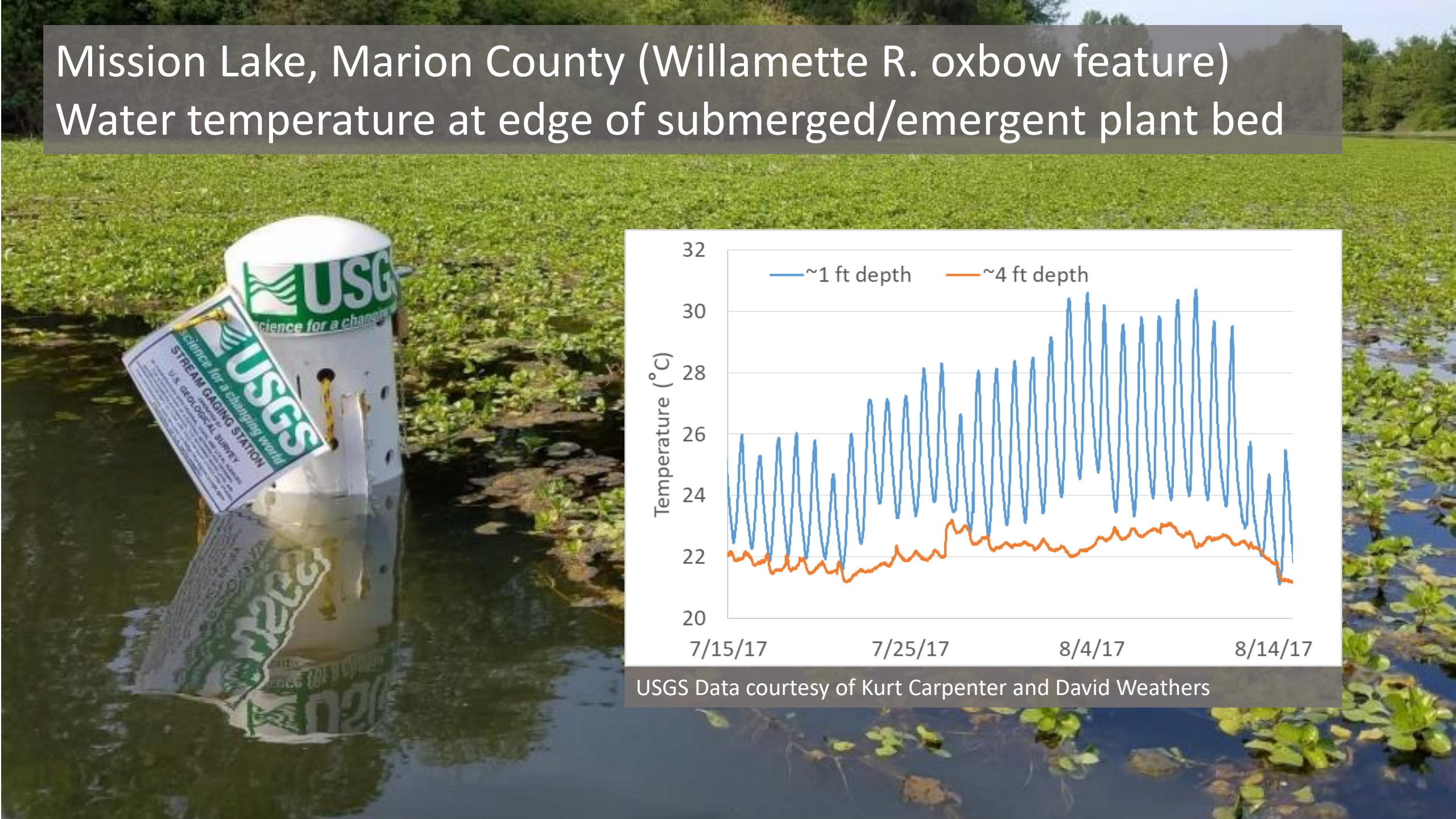


Diel variation in temperature in submerged plant beds across depth



Rose, C., and W. G. Crumpton. 2006. Spatial patterns in dissolved oxygen and methane concentrations in a prairie pothole wetland in Iowa, USA. Wetlands 26(4):1020–1025.

Mission Lake, Marion County (Willamette R. oxbow feature)
Water temperature at edge of submerged/emergent plant bed

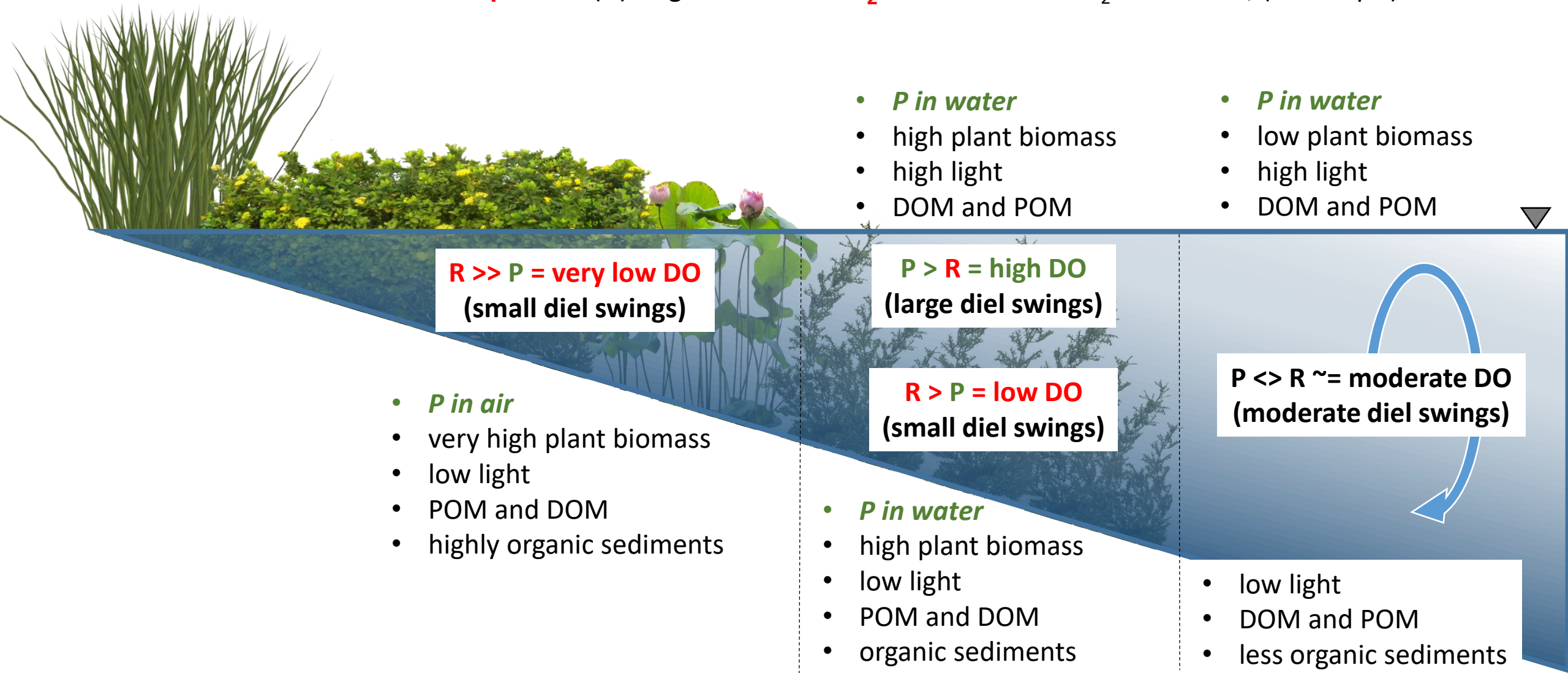


USGS Data courtesy of Kurt Carpenter and David Weathers

Effects of plant bed types and depth on dissolved oxygen

Primary production (**P**): CO_2 + water + light + nutrients ------> O_2 + organic matter, (raises pH)

Respiration (**R**): organic matter + O_2 ------> water + CO_2 + nutrients, (lowers pH)



- ***P in air***
- very high plant biomass
- low light
- POM and DOM
- highly organic sediments

R >> P = very low DO
(small diel swings)

- ***P in water***
- high plant biomass
- high light
- DOM and POM

P > R = high DO
(large diel swings)

R > P = low DO
(small diel swings)

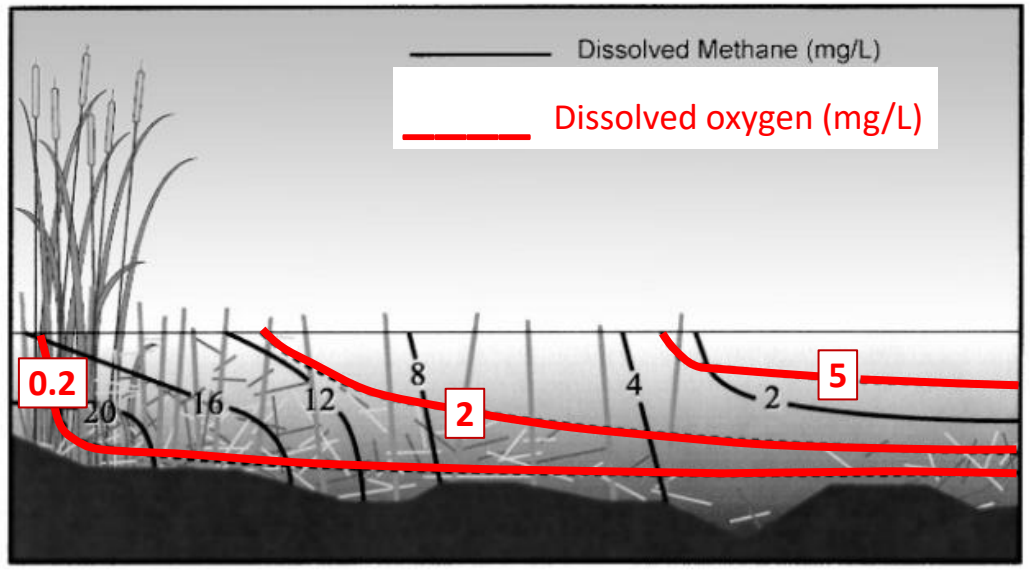
- ***P in water***
- high plant biomass
- low light
- POM and DOM
- organic sediments

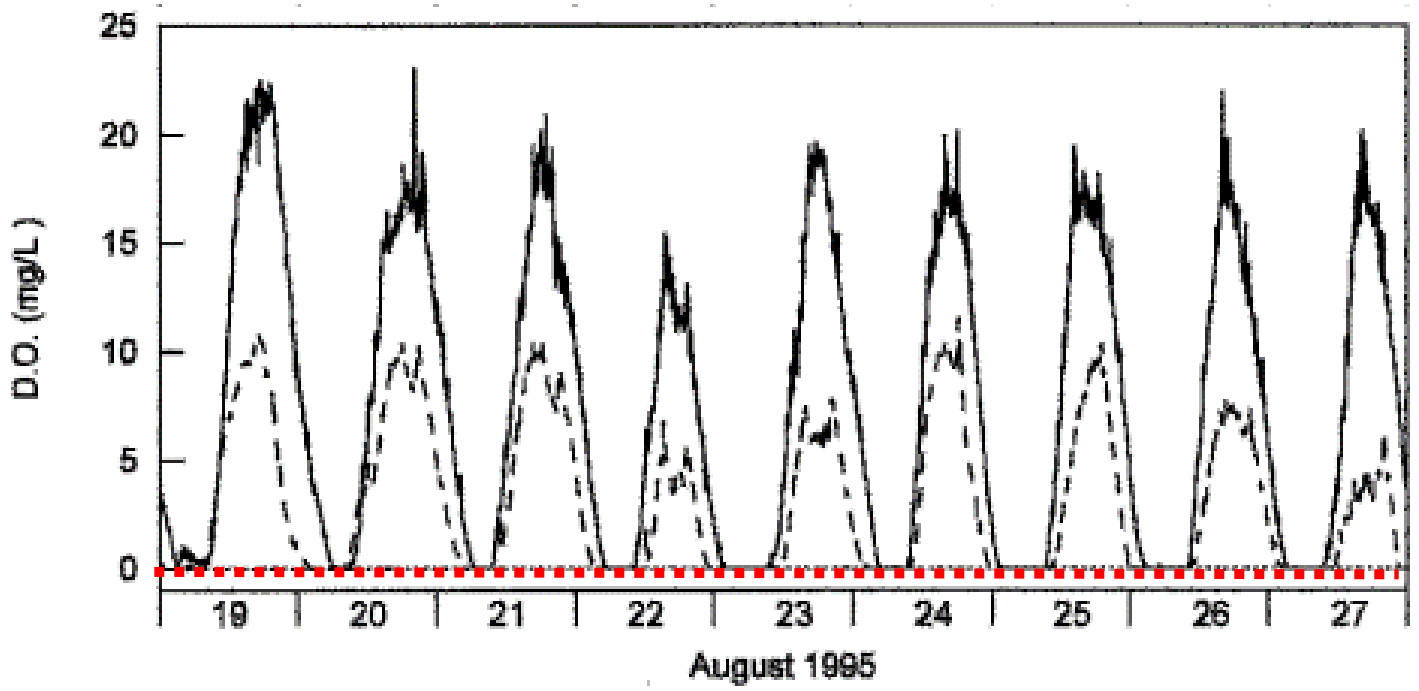
- ***P in water***
- low plant biomass
- high light
- DOM and POM

P <> R ~= moderate DO
(moderate diel swings)

- low light
- DOM and POM
- less organic sediments

Spatial and temporal variation in dissolved oxygen across plant bed types

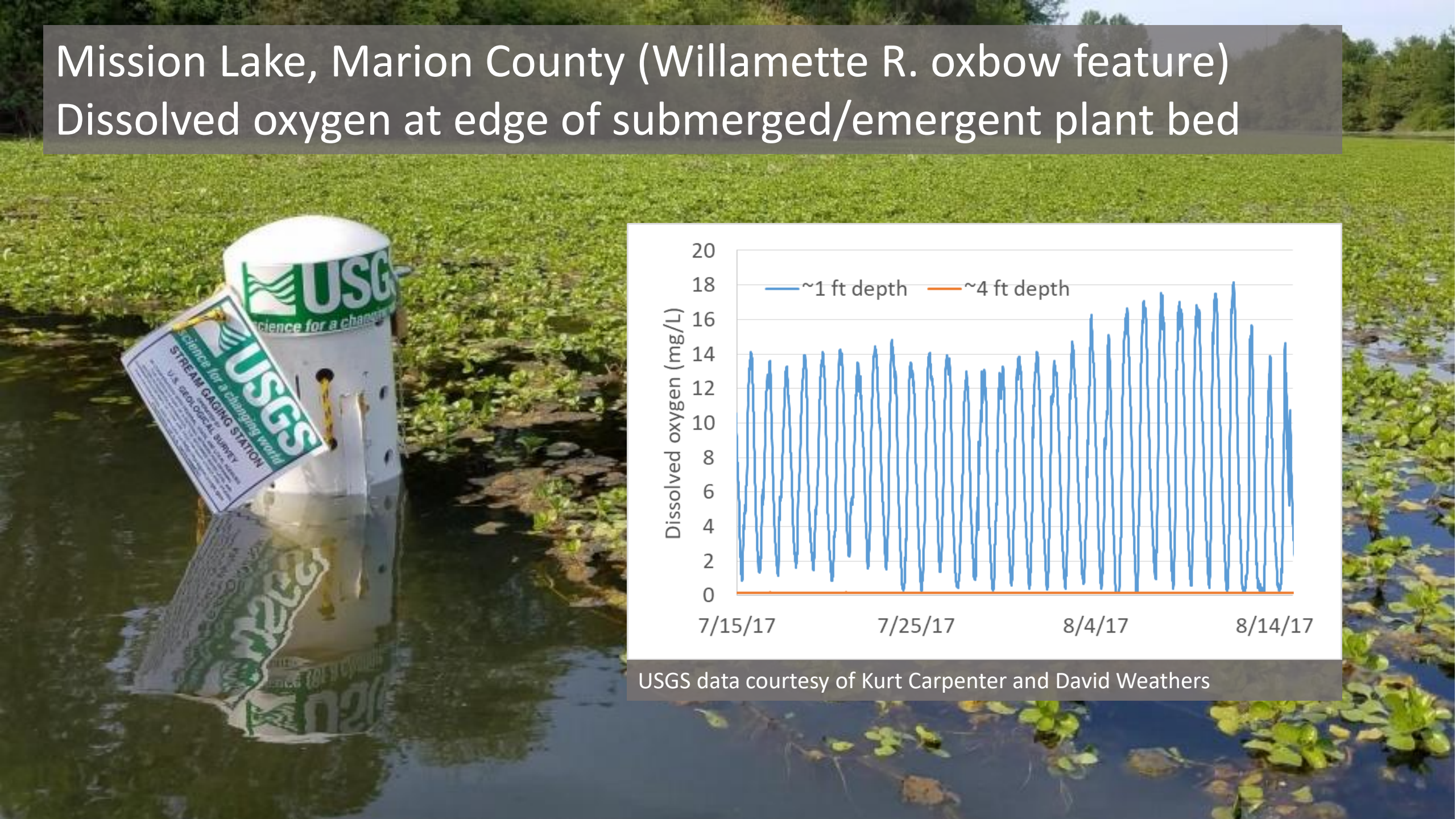




___Submerged plant bed - - - - edge - - - - Emergent plant bed

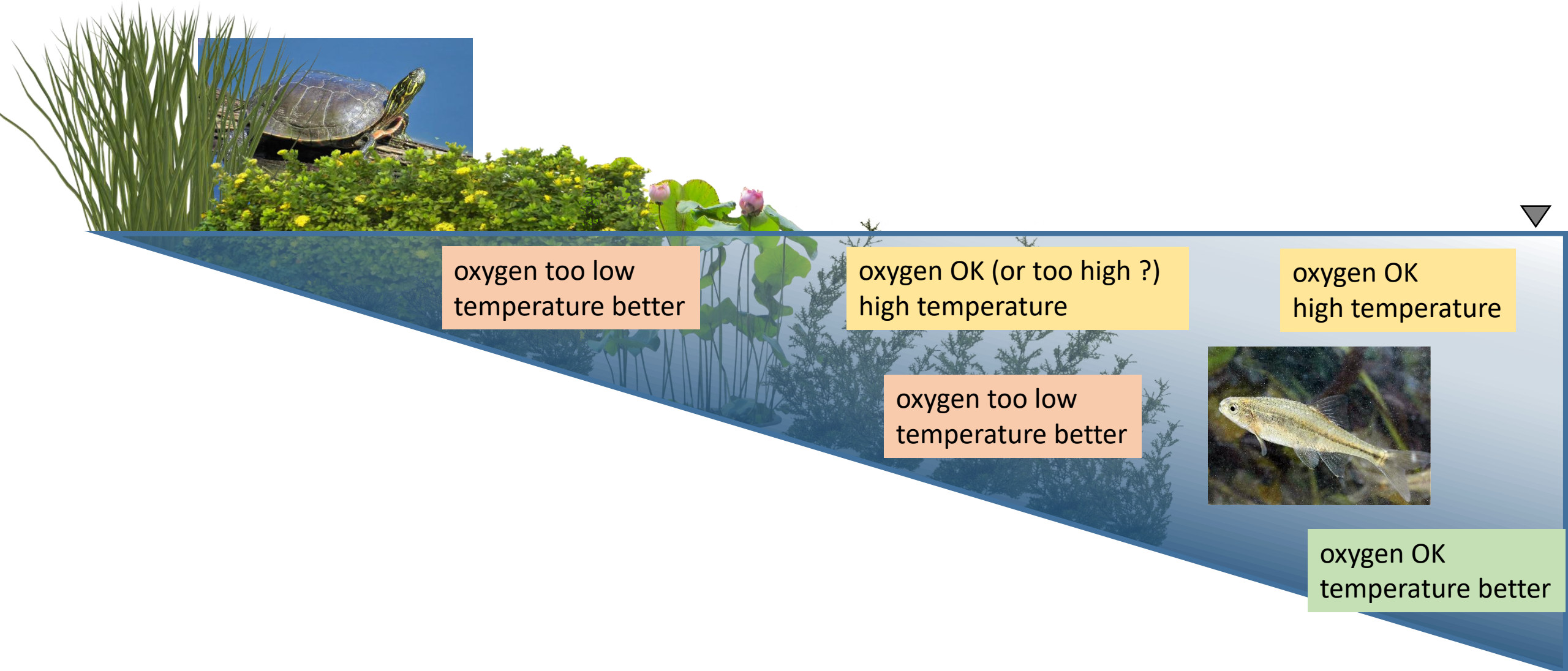
Rose, C., and W. G. Crumpton. 2006. Spatial patterns in dissolved oxygen and methane concentrations in a prairie pothole wetland in Iowa, USA. Wetlands 26(4):1020–1025.

Mission Lake, Marion County (Willamette R. oxbow feature)
Dissolved oxygen at edge of submerged/emergent plant bed



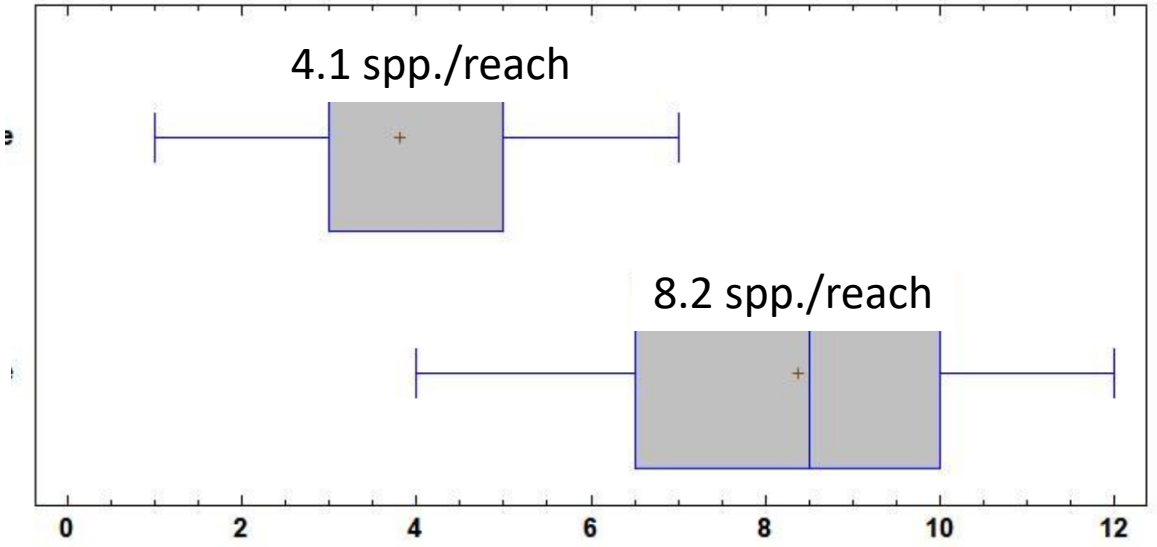
USGS data courtesy of Kurt Carpenter and David Weathers

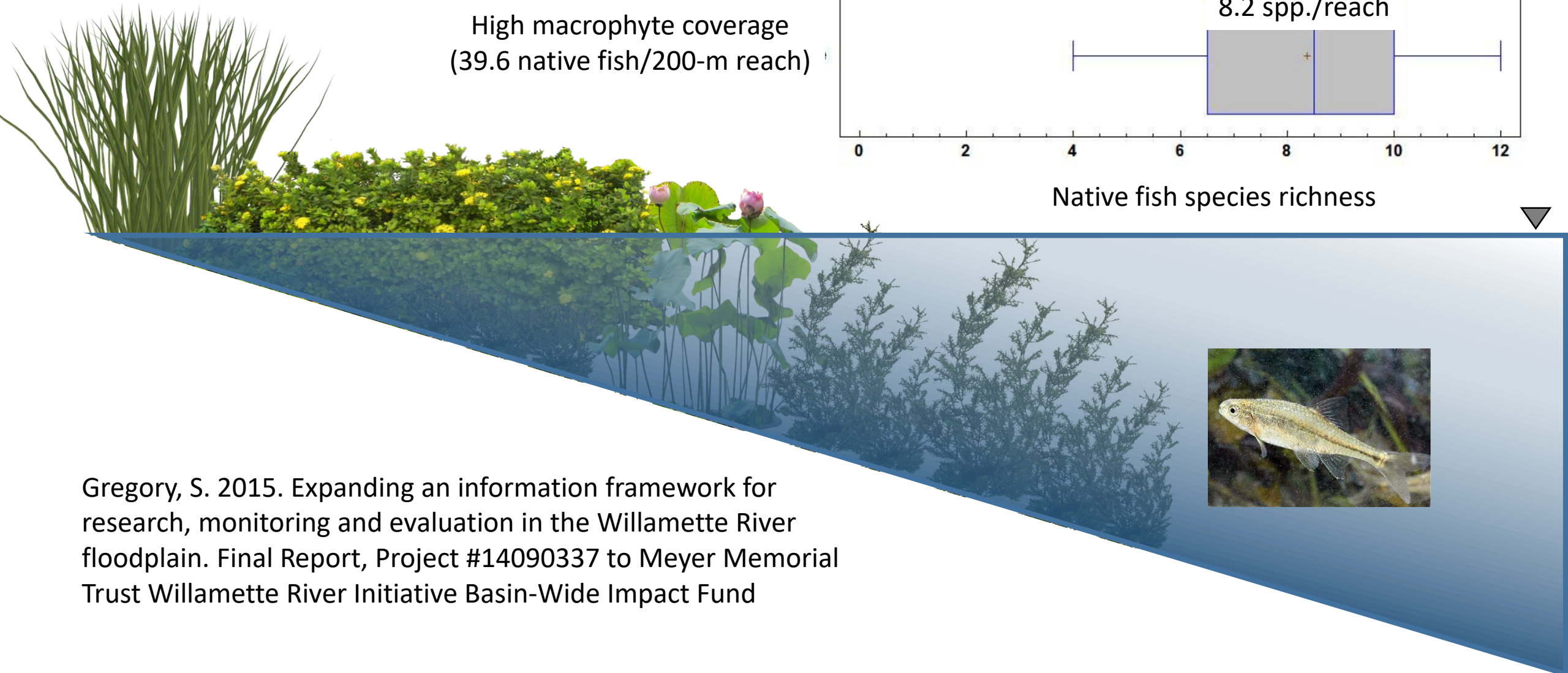
Results in spatial and temporal microhabitats suitable for many types of aquatic organisms



Low macrophyte coverage
(10.6 native fish/200-m reach)

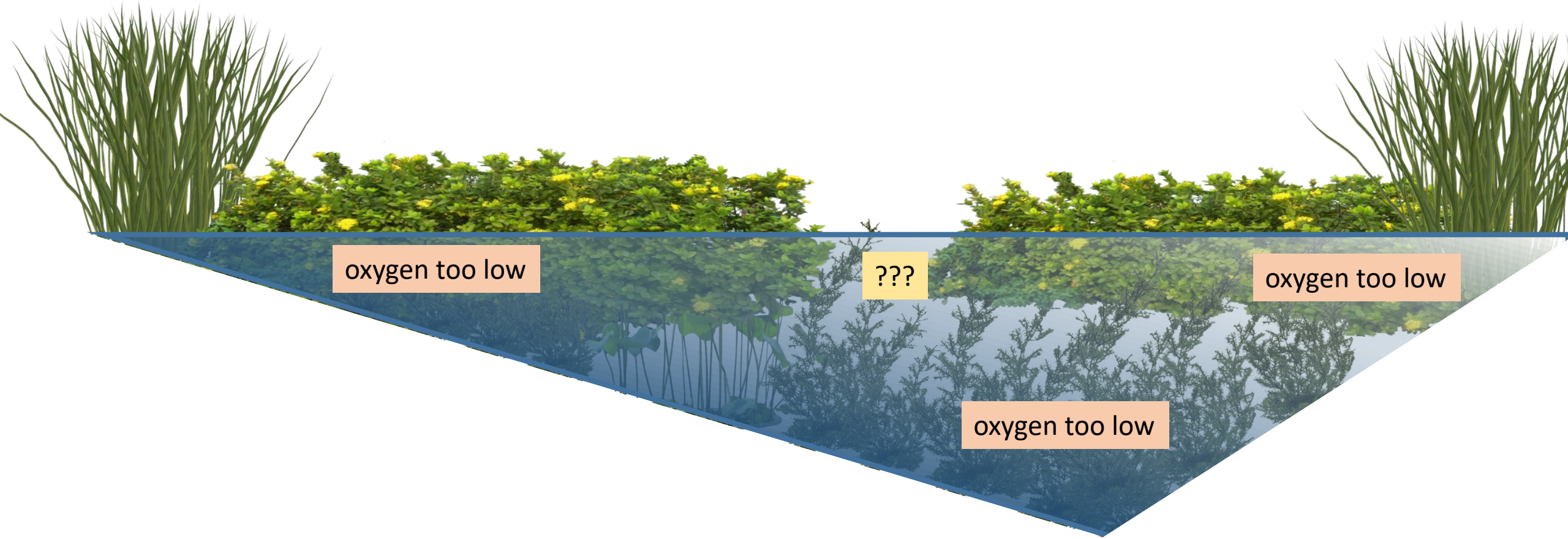
High macrophyte coverage
(39.6 native fish/200-m reach)

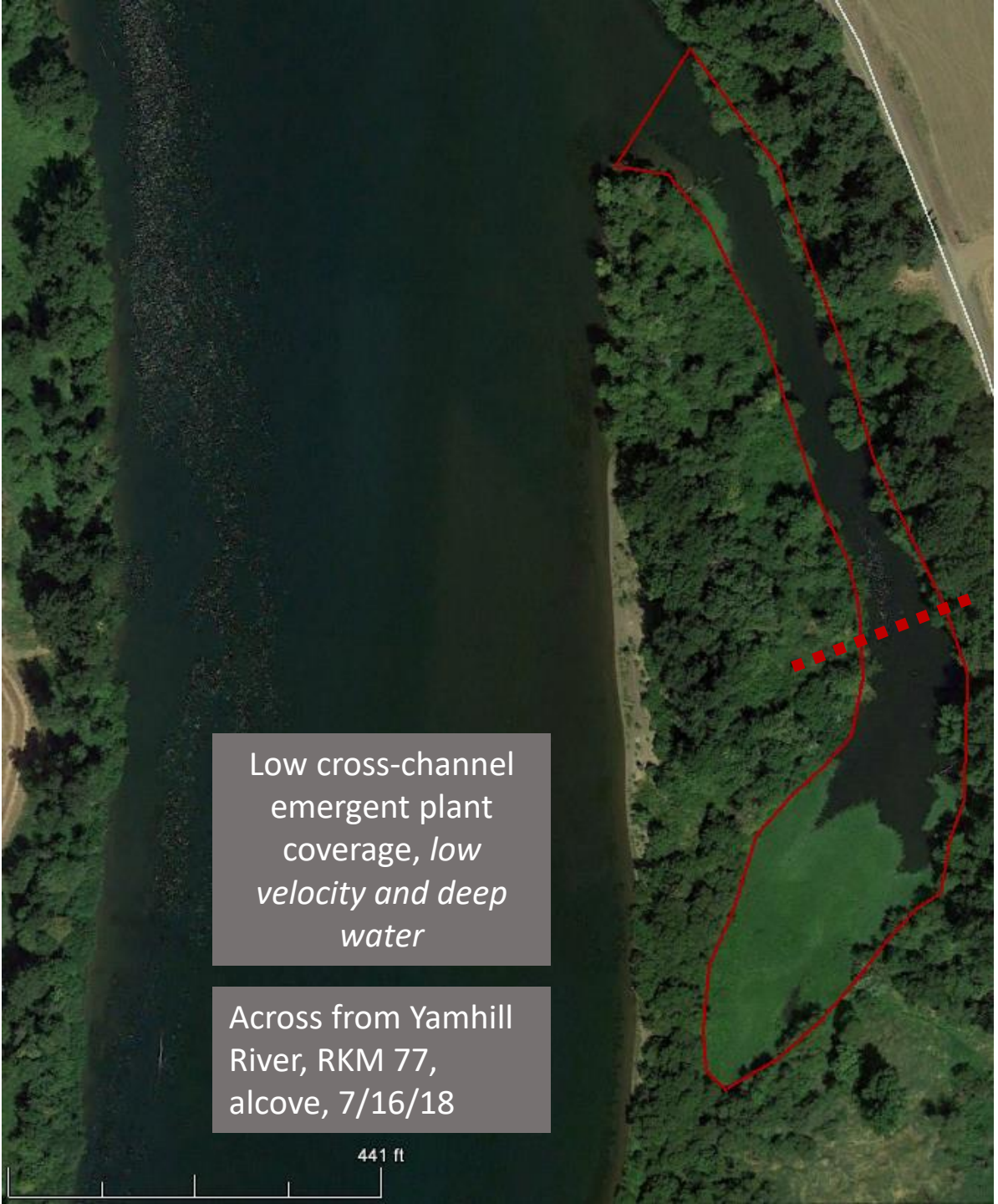




Gregory, S. 2015. Expanding an information framework for research, monitoring and evaluation in the Willamette River floodplain. Final Report, Project #14090337 to Meyer Memorial Trust Willamette River Initiative Basin-Wide Impact Fund

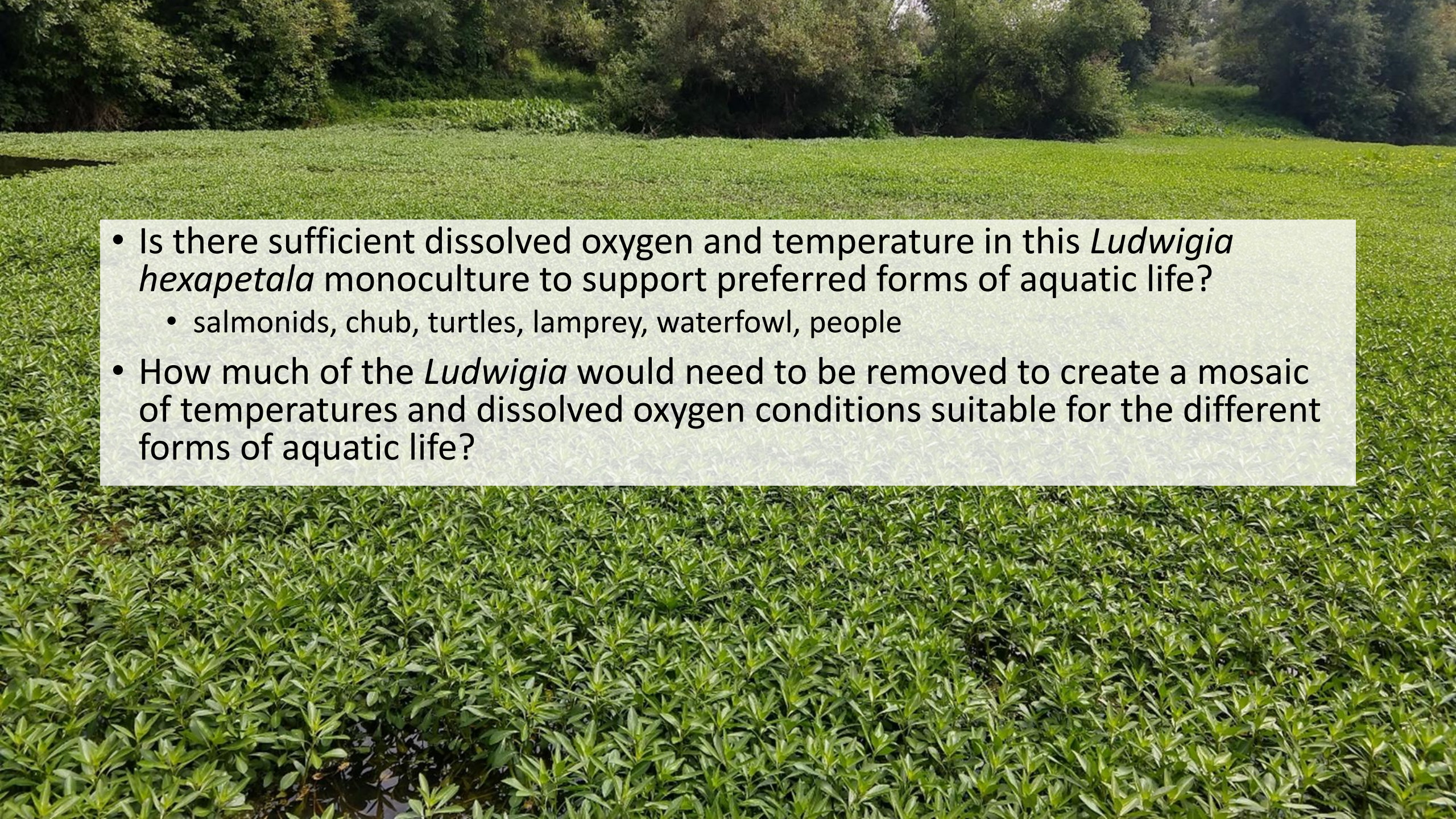
What if emergent plants dominate an off-channel feature?




Low cross-channel emergent plant coverage, *low velocity and deep water*
Across from Yamhill River, RKM 77, alcove, 7/16/18
441 ft

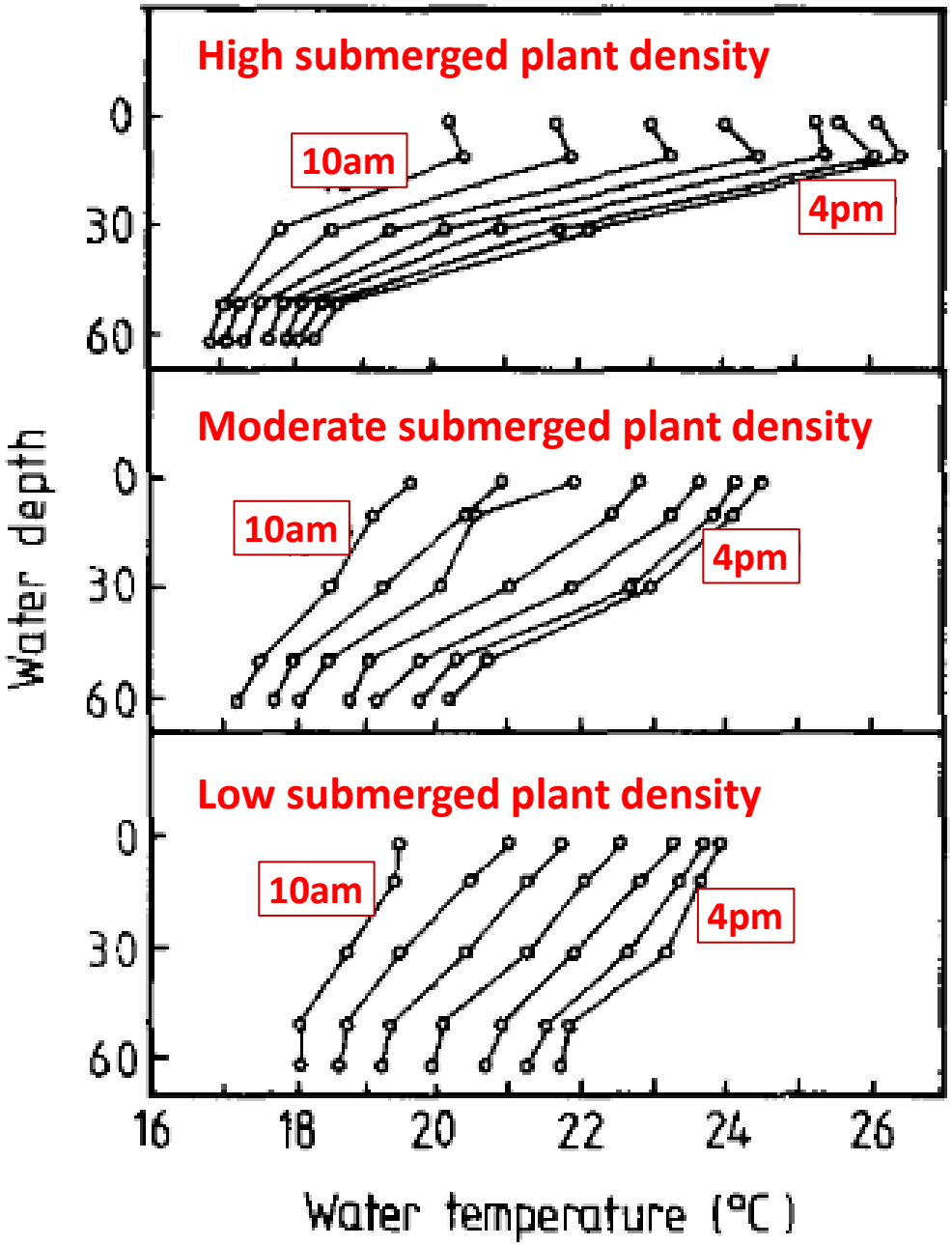

Medium cross-channel emergent plant coverage, *higher velocity and shallow water*
Windsor Island Slough, RKM 97, side-channel, 7/26/18
1122 ft


High cross-channel emergent plant coverage, *low velocity and shallow water*
Black Dog Landing, RKM 142, alcove, 7/26/18
Black Dog Rd NE
1160 ft



- Is there sufficient dissolved oxygen and temperature in this *Ludwigia hexapetala* monoculture to support preferred forms of aquatic life?
  - salmonids, chub, turtles, lamprey, waterfowl, people
- How much of the *Ludwigia* would need to be removed to create a mosaic of temperatures and dissolved oxygen conditions suitable for the different forms of aquatic life?

Rich Miller | richm@pdx.edu



3-8°C difference over 60 cm depth

3-4°C difference over 60 cm depth

1-2°C difference over 60 cm depth

Submerged plant density and time of day affect temperature profiles

Dale, H. M., and T. J. Gillespie. 1978. Diurnal temperature gradients in shallow water produced by populations of artificial aquatic macrophytes. Canadian Journal of Botany 56(9):1099–1106.