Unintended Entrainment of Western Pond Turtle (*Actinemys marmorata*) during Algae Control on a Newly Restored Wetland

Jeff A. Alvarez (corresponding author: The Wildlife Project, P.O. Box 188888, Sacramento, CA 95818, Jeff@thewildlifeproject.com), Rodrigo Gaitan (2761 Costa Court, West Sacramento, CA), Mary Shea (1143 Second Street, Suite A-172, Brentwood, CA), Sarah M. Foster (Foster Wildlife Surveys, Sacramento, CA)

A relatively recently proposed taxonomic split in the *Actinemys marmorata* (Western pond turtle) created two named species, the *A. marmorata* (Northwestern pond turtle) and *A. pallida* (Southwestern pond turtle) (Spinks et al. 2010, 2014, 2016, Iverson et al. 2017). Both species are recognized as California species of concern and have been in steady decline in California (Bury et al. 2012, Thompson et al. 2016). Bury et al. (2012) considered the decrease in these species strongly associated with loss or alteration of habitat, among other causes. Both species appear to utilize anthropogenic habitat created for cattle stock ponds, drinking water reservoirs, sewage detention basins, and other aquatic habitats (Germano 2010, Bury et al. 2012, Riensche et al. 2019, pers. obs.). This level of habitat plasticity may contribute to an overall benefit to the species (Bury et al. 2012). However, management and maintenance activities associated with aquatic refuge sites can alter turtle behavior and their ability to persist (Alvarez 2006, Alvarez et al. 2017). Here we report on the collection of two pond turtles by a mechanical algae removal machine during habitat restoration activities.

Moorhen Marsh (hereafter, the Marsh) is part of the Peyton Slough Marsh Complex and is a 21-acre constructed freshwater wetland associated with and owned and operated by the Mt. View Sanitary District (MVSD) in Martinez, California. The ponds are the outfall point for treated effluent and create a natural buffer between treated water and the San Francisco Bay Estuary, into which the Marsh waters eventually flows. We monitored co-occurring populations of Northwestern and Southwestern pond turtles at the Marsh from 2013 to 2019. Baseline monitoring (i.e., nesting activity, upland habitat use, and movement patterns) created a source of data used for avoidance and minimization measures related to restoration activities and designed to restore habitat for both species in the Marsh. In 2017 a large-scale restoration project, including draining six ponds, rebuilding levees, recontouring pond bottoms, creating islands, and restoring native vegetation was undertaken in the Marsh. Construction activity occurred over a two-year period, through which turtle behavior was closely monitored.

During the first year after restoration activities were completed and ponds were refilled, a substantial filamentous algal bloom (likely one or more of the genera *Mougeotia*, *Spirogyra*, or *Zygnema*) occurred within the ponds. Algae covered approximately 80 to 90% of all pond surfaces and extended from the surface down into the water column at least 0.5 m. Consideration of the suitability of the habitat for pond turtles, planted native fishes (*Archoplites interruptus* [Sacramento perch] and *Orthodon micropidotus* [Sacramento blackfish]), and nesting water birds contributed to the decision to remove a majority of the algae.

A contractor, using a floating mechanical vegetation removing device (here after, algae harvester), was hired to remove as much algae as possible. The device was operated by a single person who rode on the machine as it moved through the water body. The unit was placed in a pond with the use of a crane and operated under its own power. It was directed in parallel lines throughout each water body. The algae harvester had a conveyor on the front of the unit, which lifted and collected algae from the surface and approximately 0.5 meters below the surface (Figure 1). Algae was then moved on the conveyor to the rear of the machine, where it was deposited into a hopper for later disposal. When the machine was at maximum capacity, it was directed to the shoreline where the hopper dumped the algal load into a single pile, and then returned to removing algae.

On 9 May 2019, a juvenile (3 years old) *Actinemys* sp. was found within the algae deposition pile immediately after the spoils were dumped from the algae harvester. The pond turtle was collected from among the algae pile, processed, and immediately released. On 10 May 2019, a monitoring biologist observed a pond turtle on the conveyor belt of the algae removal machine (Figure 1). The algae harvester was followed to the disposal location where the algae was unloaded. Monitoring biologists searched through the algae by hand until they encountered the live turtle. The turtle was identified as an adult male *A. pallida* and was found approximately 0.3 m deep in the pile. Monitoring biologists checked the remainder of the disposal pile and found no additional pond turtles.

Our observations during monitoring of algal removal activities suggest that turtles occupying the same pond as the algae removal machine appeared to flee (i.e., dive) at the approach of the machine. We speculated that the turtle may have been collected by the machine either after rising near the machine from an earlier dive, or perhaps the turtle was not able to dive fast enough to avoid the harvester, likely due to a repressed swimming ability associated with the filamentous nature of the agal bloom.

Color version of this article is available through online subscription at: http://er.uwpress.org

Ecological Restoration Vol. 39, No. 4, 2021
ISSN 1522-4740 E-ISSN 1543-4079

Figure 1. Algae removal machine working in pond B in Moorhen Marsh, Martinez, California. Arrow indicates a pond turtle collected under a layer of algae, 10 May 2019. *Photo by Jeff A. Alvarez.*

Because we were closely monitoring this activity, we were able to rescue the pond turtles from the disposal pile. We contend that without human intervention, the turtles within the disposal pile may not have escaped under their own power. This type of algal composition, particularly when removed from the water, is heavy, slippery, and entangled, and would likely have precluded any ability to escape.

We contend that this type of algal bloom may increase in the future (Posch et al. 2012, Griffith and Gobler 2020). If this occurs there may be an increased need to conduct mechanical algae removal to restore marsh or waterway functions and habitat suitability, with a corresponding increase in the potential to entrain turtles in similar types of machines. We suggest that mechanical algae removal activities be accompanied by one or more monitoring biologists who may be able to collect turtles that are entrained. This is particularly important when algae removal occurs in areas where declining species like *A. marmorata* and *A. pallida* are extant.

Acknowledgments

We are very grateful to the Mt. View Sanitary District and its Board of Directors for continued support to study turtles at Moorhen Marsh. Work conducted herein was permitted under a Lake and Streambed Alteration Agreement (1600-2016-0347-R3).

References

Alvarez, J.A. 2006. *Actinemys marmorata* (Pacific Pond Turtle). Refugia. *Herpetological Review* 37:339–340.

Alvarez, J.A., G.A. Kittleson, K.A. Davidson and L. Asseo. 2017. Potential injury and mortality in *Actinemys* (*Emys*) *marmorata* during restoration and maintenance activities. *Western Wildlife* 4:81–85.

Bury, R.B., H.H. Welsh, D.J. Germano and D.T. Ashton (eds). 2012. Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation and Management. *Northwest Fauna* 7:1–128.

Germano, D.J. 2010. Ecology of Western Pond Turtles (*Actinemys marmorata*) at sewage treatment facilities in the San Joaquin Valley, California. *Southwestern Naturalist* 55:89–97.

Griffith, A.W. and C.J. Gobler, 2020. Harmful algal blooms: A climate change co-stressor in marine and freshwater ecosystems. *Harmful Algae* 91:101590. doi.org/10.1016/j.hal.2019.03.008.

Iverson, J.B., P.A. Meylan and M.E. Seidel. 2017. Testuidines—turtles. in B.I. Crother (ed.), Scientific and Standard English Names of Amphibians and Reptiles of North America North of Mexico, with Comments Regarding Confidence in Our Understanding. *SSAR Herpetological Circular* 43:1–102.

Posch, T., O. Köster, M.M. Salcher and J. Pernthaler. 2012. Harmful filamentous cyanobacteria favoured by reduced water turnover with lake warming. *Nature Climate Change* 2:809–813.

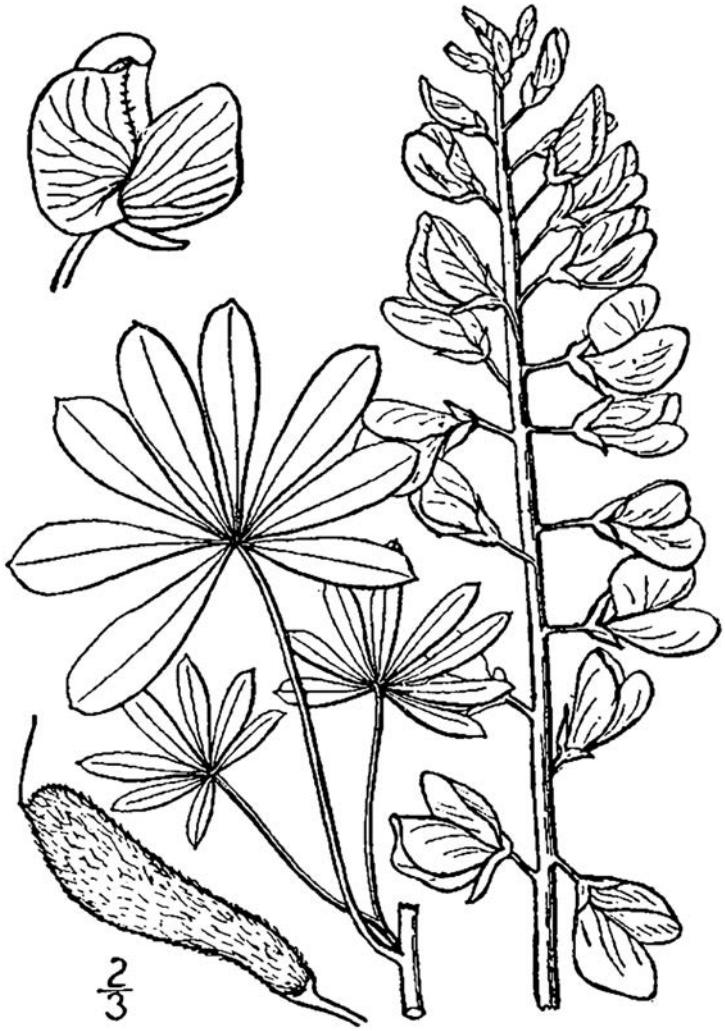
Spinks, P.Q., R.C. Thompson and H.B. Shaffer. 2010. Nuclear gene phylogeography reveals the historical legacy of an ancient inland sea on lineages of the western pond turtle, *Emys marmorata* in California. *Molecular Ecology* 19:542–556.

Spinks, P.Q., R.C. Thompson and H.B. Shaffer. 2014. The advantages of going large: genome-wide SNPs clarify the complex population history and systematics of the threatened western pond turtle. *Molecular Ecology*. 23:2228–2241.

Spinks, P.Q., R.C. Thompson, E. McCartney-Melstad and H.B. Shaffer. 2016. Phylogeny and temporal diversification of the New World pond turtles (Emydidae). *Molecular Phylogenetics and Evolution.* 103:85–97.

Thompson, R.C., A.N. Wright and H.B. Shaffer. 2016. California Amphibians and Reptile Species of Special Concern. Berkeley, CA: University of California Press.

Riensche, D.L., S.K. Riensche and R.E. Riensche. 2019. Habitat use, movement patterns, and nest site selection by Western Pond Turtles (*Actinemys marmorata*) in a managed central California rangeland pond. *Northwestern Naturalist* 100:90–101.



***Lupinus perennis*. USDA-NRCS PLANTS Database. Britton, N.L. and A. Brown. 1913. *An Illustrated Flora of the Northern United States, Canada and the British Possessions*. New York, NY: Charles Scribner's Sons.**