Filename: Lower Jordan River Mollusk Survey as it Relates to South Davis Sewer District South Plant Effluent

Version: 1.0

Lower Jordan River Mollusk Survey as it Relates to South Davis Sewer District South Plant Effluent

Progress Report 2019

By

David C. Richards, Ph.D.

OreoHelix Ecological, Vineyard UT 84059

Phone: 406.580.7816

Email: oreohelix@icloud.com

and

Jordan Holcomb, Hannah Finely, Frank Fluckiger

Wasatch Front Water Quality Council, Salt Lake City

January 2, 2020

Table of Contents

Introduction

Freshwater mollusk diversity is depauperate in the western USA with the exception of waters in the Bonneville Basin, including the Jordan River drainage, UT (Richards 2015, 2017a, 2017b, 2018, 2019, Miller and Richards 2019). No intensive mollusk surveys have been conducted in the Jordan River other than by Richards (2017a, 2017b) and Richards and Miller (2019) in upper sections of the Jordan River and no surveys have been conducted in the lower Jordan River.

In addition to the importance of understanding the status of mollusks in the lower Jordan River, native mussel surveys documenting presence/absence are critical for ammonia criteria development and regulation. Two species of native mussels, *Anodonta* sp. and *Margaritifera falcata* may have occurred in the lower Jordan River, UT in the past. Unfortunately, severely degraded conditions, host-dependent, dispersal- limited metapopulation dynamics, and absence of past monitoring, legal protection, and adequate management have likely removed the possibility of their continued existence in these waters (Richards 2017a and b, USEPA 2013a, Miller and Richards 2019). There are no historical records of *M. falcata* occurring in the lower Jordan River and only one historical record of *Anodonta* sp. potentially occurring at a single location in the Jordan River, in 1942 (UDWQ 2017b). Richards (2017a, b) and Richards and Miller (2019) conducted the most extensive native mussel surveys in the Jordan River to date, but did not find any live or recently dead native mussels, although several highly weathered *Anodonta* sp. shell fragments were found indicating that this species could have occurred in these or nearby waters in the past. Even though Richards and Miller (2019) concluded that native mussels were likely absent in Mill Creek and upper portions of the Jordan River and likely did not occur downstream, absolute determination of absence is not possible without a complete and thorough examination of the entire creek and river beds (Richards 2017, USEPA 2013a, 2013b). However, probability of detection and survey efficiency statistical models in conjunction with knowledge of native mussel ecology and population dynamics can be employed to help justify a presence or absence conclusion for the lower Jordan River (UDWQ 2017a, Richards and Miller 2017, Richards 2017).

The USEPA published updated Clean Water Act § 304 (a) recommended water quality criteria for ammonia in 2013. The calculation of these criteria included new toxicity data for members of the Mollusca phylum. Results of these new tests and incorporation into criteria calculations and particularly for mussels of the superfamily, Unionoidea, resulted in much more stringent ammonia criteria (USEPA 2013a). Recognizing that these species may be absent from many of the nation's waters, EPA published a supplemental technical support document (TSD; Technical support document for conducting and reviewing freshwater mussel occurrence surveys for the development of site-specific water quality criteria for ammonia, August 2013, EPA 2013b), that outlines survey procedures to determine presence or absence of native mollusks on a site-specific basis. In turn, this may allow site-specific criteria modification of the ammonia criteria. Consequently, the Wasatch Front Water Quality Council and Utah Division of Water Quality (UDWQ) concluded that a site-specific survey of lower Jordan River be performed to determine if mussels are currently present or if the presence of unweathered or weathered empty shells indicate that they were extant in the recent or historic past.

Objectives

The specific objective of this study was for us to provide site-specific survey data sufficient to determine a likelihood estimate of presence or absence of mussels near the South Davis Sewer District South Plant discharge (ammonia zone of influence) using the most appropriate EPA approved survey methods including Eckman and Ponar grabs (dredges). Our objectives were to also perform recommended probability statistical analyses following that of Smith et al. (2001) and Smith (2006) as adopted by UDWQ (2017a) and then provide a detailed report of survey methods used, summary statistics, data interpretation and recommendations to UDWQ and USEPA. It is intended that the final report contain sufficient quality data and analysis for UDWQ/USEPA to make a regulatory determination of the presence or absence of native mussels in the survey area.

Rationale

The primary rationale for this project was to determine if and how many live native freshwater mussels, specifically *Anodonta sp.*, were present in the lower Jordan River. A secondary goal was to establish a historical account of the mollusks of the lower Jordan River

Methods

Study Area

Mollusk surveys were conducted in the lower Jordan River beginning at the State Canal diversion (latitude = 40.871337°; longitude = -111.964996°) and continued every 100 m upstream to the 700 N bridge crossing in northern Salt Lake City (40.784495°; 40.784495°) (N = 127 transects) (Figure 1). Surveys were conducted in late summer and early autumn 2019.

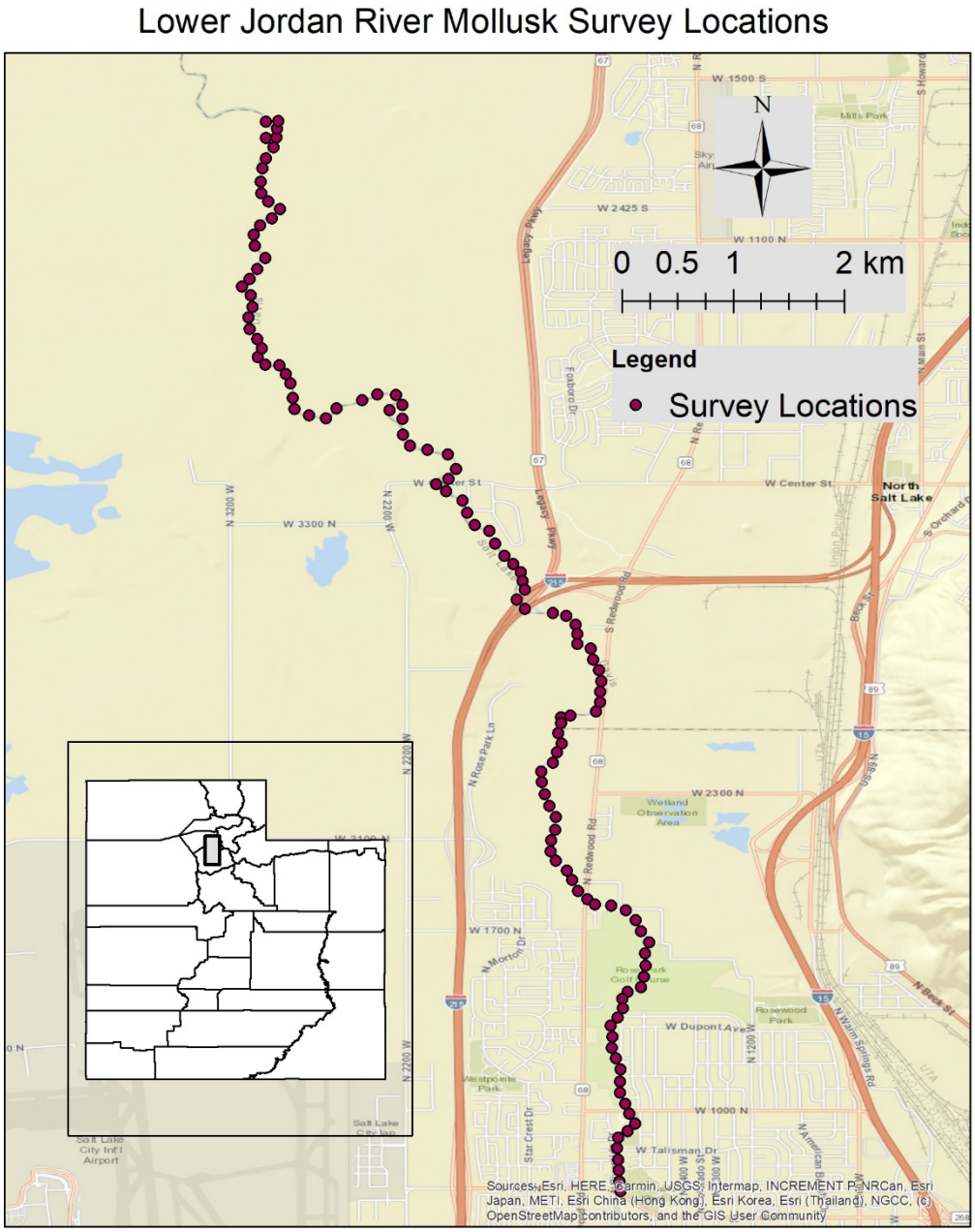

Figure 1. Mollusk survey locations in lower Jordan River 2019. Red circles are transect locations. South Davis Sewer District South Plant is located at just north of W. Center St river crossing. N = 127 transects, nine dredge samples collected at each transect.

Mollusk Surveys

Mollusks were sampled using a long handled 15.24 x 15.24 cm Ekman Dredge operated from a small john boat. Nine dredge samples were taken at each site: 3 near the left descending bank, 3 in approximately the center of the channel, and 3 near the right descending bank for a total of 1,143 samples processed, which accounted for approximately 26.3 m^2 of substrate sampled. Occasionally the water exceeded the depth of the Ekman Dredge handle and a 15.24 x 15.24 cm Ponar Grab was used instead. Spoil from each dredge sample was processed independently by sieving through a 3.2 mm mesh

dip net. Material retained in the dip nets was examined from presence of live, fresh dead, and relict empty shell mollusks. Presence of relict mollusk shells was noted and relict mollusk vouchers were taken at nearly every site in the Jordan River between ~200 m downstream of the Interstate 215-Legacy Parkway crossing (site # JR57 in data file) upstream to the 700 N bridge crossing (site # 127 in data file) in northern Salt Lake City. Non-native Asian Clam (*Corbicula fluminea*) were counted and recorded. Relict mollusk vouchers were identified to the lowest practical taxon with a dissecting microscope following taxonomy of *Mollusks of Utah a Simple Guide*, and a UDWR unpublished draft gastropod key (Kathryn Holcomb and Eric Wagner pers comm). Due to taxonomic uncertainty of certain groups (e.g. Physidae, Sphaeriidae), some were not identified to species. Processed vouchers are stored at the Utah Lake Research Lab at Timpanogos Special Service District Water Reclamation Facility in Pleasant Grove, UT. Because taxonomic keys for Utah mollusks are being revised and there is no consensus on species level taxonomy based solely on morphological characteristics, taxonomic identifications used in this report may be subject to change. Also, our protocol was in development during the course of this study, and as such, all pieces of data were not simultaneously and consistently recorded until about halfway through the survey season. Consequently, final identification of mollusk vouchers is ongoing.

Substrate Evaluation

Dominant and subdominant substrate types in each dredge sample were also recorded. Substrate categories included combinations of silt, sand, detritus, clay, gravel, concrete, cobble, large woody debris, and smaller wood fragments (e.g. twigs and branches). Substrate analysis will be provided in an additional pending report.

Probability of Detection and Search Efficiency as Related to Density Estimates

Estimating search efficiencies given known or assumed densities with probability of detection (POD) estimates is problematic when mussel population densities are at critically low levels or when mussels are expected to be absent based on historical data and literature review (Richards 2017). However, UDWQ (2017a) recommends using methods such as those proposed by Smith (2006) for estimating these values. UDWQ recommends surveying enough area with 100% search efficiency at 0.1 m^{-2} to obtain a 90% POD based on formulas presented by Smith (2006). We used the Smith (2006) formula (equation 4 page 703):

$$POD = 1\text{-}e^{-\beta\alpha\mu}$$

where POD = probability of detecting at least on individual mussel; β =search efficiency (SE), α =search area = 26.3 m^2; and μ = density m^{-2} to develop a probability of detection (POD) model as a function of density m^{-2} at six search efficiency of 1.00.

Results

No live native mussels were encountered and only one highly weathered *Anodonta* sp. shell fragment was found. Of the bivalves, only live non-native Asian Clams, *Corbicula fluminea* (N=904) were found. Additionally, relict mollusk vouchers yielded potentially 22 taxa including potentially seventeen snail taxa, and the fingernail clam, *Pisidium* sp. (Family Sphaeriidae) (Table 1).

Table 1. List of relict mollusk taxa and total abundance of each species. Final taxonomic identification is ongoing pending revisions in the literature.

Amnicola limosus	1
Anodonta sp.	1
Ferrissia rivularis	83
Fluminicola coloradoensis	42
Gastropod sp.	3
Galba obrussa	9
Gyraulus parvus	41
Heliosoma sp.	6
Lymnaea stagnalis	1
Lymnanea sp.	1
Planorbidae sp.	2
Menetus/Promenetus sp.	1
Physella sp.	609
Pisidum sp.	17
Potamopyrgus antipodarum	7
Pyrgulopsis sp.	41
Sphaeriidae	45
Stagnicola elodes	79
Stagnicola utahensis	4
Valvata humeralis	122
Valvata utahensis	3

Control vs. Impacted Sites

No native mussels were found in the control site in lower Jordan River upstream of SDSD South Plant. This apparent absence strongly suggests that factors other than SDSD South Plant discharge have reduced native mussel populations to non-detect levels. See Richards (2017) for a detailed discussion of likely factors affecting native mussel declines and absence in the drainage.

Probability of Detection, Search Efficiency, and Density Models

Mussel densities only had to be 0.087 m^{-2} to obtain a POD of 0.90 (UDWQ recommended POD value) using the Smith (2006) model (Figure 2). The excavation methods (i.e. Eckman and Ponar grabs) are considered the most effective sampling methods used to detect an entire mussel community (USEPA 2013b) and when sieved materials are thoroughly examined; survey results are considered at 100% search efficiency. Based on the Smith (2006) model (Figure 2), we should have observed at least one mussel if they occurred in the survey area at densities > 0.087 m^{-2} which is less than UDWQ's recommended density = 0.1 m^{-2}. Thus, our mussel survey results clearly exceed UDWQ recommendations for a determination of 'absence' of live or recently dead native mussels in the lower Jordan River.

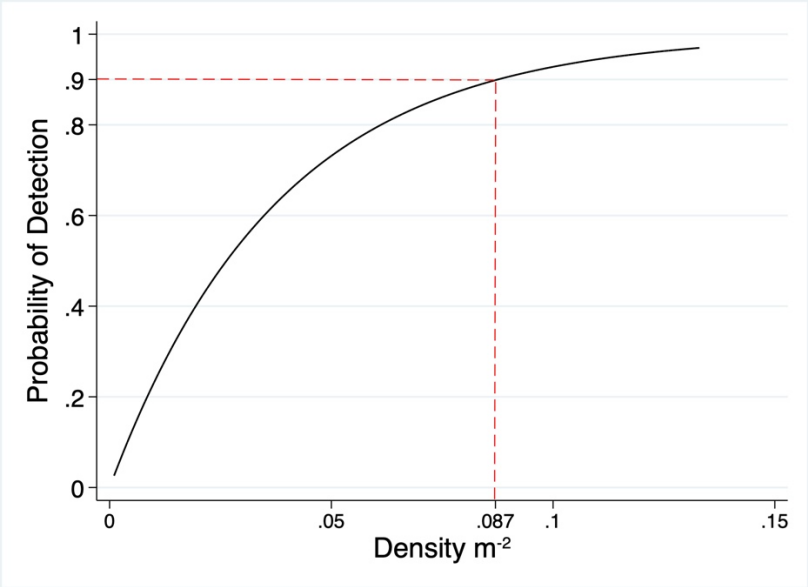

Figure 2. Mussel probability of detection (POD) in the lower Jordan River as a function of density (m^{-2}) at 1.00 search efficiency and search area = 26.3 m^2. POD equates to a density estimate of 0.087 m^{-2} at DWQ recommended POD = 0.90 (red dashed lines). Based on Smith (2006).

Discussion

Multiple Lines of Evidence from Other Native Mussel Surveys

Even though this intrusive survey produced no native mussels and our POD, search efficiencies, and density estimate models strongly support a UDWQ regulatory decision of live or recently dead mussels 'absent', results from other mussel surveys on Mill Creek and Jordan River provided multiple- lines- of-evidence support. Richards (2017) included multiple lines of evidence surveys from several agencies including UDWQ and USU/USGS that showed 'absence' of native mussels in the Jordan River. These lines of evidence are applicable to the lower Jordan River and enforce our conclusion of 'absence'. In addition, the lower Jordan River is highly impaired, more so than upper sections. Most of the substrate is composed of hard pan clay that is poor mussel habitat (pending report). Potential fish host densities are very low, as well (Richards 2019).

We also found very few live or recently dead mollusk taxa given our substantial efforts, including finding no other non-pulmonate snails. We found weathered empty shells of the prosobranch, *Fluminicola coloradoensis* and two heterobranchs, *Valvata humeralis* and *Valvata utahensis,* which suggests that until relatively recently (<100 ybp) the lower Jordan River, including upstream of SDSD South Plant was in much better health than it is now.

Conclusion

Results of this native mollusk survey combined with other surveys provide a multiple-lines-of-evidence that clearly show that native mussels in lower Jordan River are extinct or are so extremely rare that as far as is known, no live individuals have ever been documented, at least since 1942. Other native mollusks including clams and non-pulmonate snail populations are either in sharp decline or also extinct. This is a Utah natural heritage travesty. Reasons for their rapid decline, decreased metapopulation

viability, and potential complete demise throughout the drainage are numerous and have been discussed at length by Richards (2017).

Literature Cited

Miller, T. and D. Richards. 2019. An Ecological Assessment of the Jordan River: 2013-2018. Volume II. Biological Integrity. Prepared for Wasatch Front Water Quality Council. Salt Lake City, UT.

Mueller, R. P., B.L. Tiller, M. D. Bleich, G. K. Turner, and I. D. Welch. 2011. Assessment of the species composition, densities, and distribution of native freshwater mussels along the Benton County shoreline of the Hanford Reach, Columbia River, 2004. Pacific Northwest Laboratory. Richland WA. PNNL-19933.

Richards, D. C. 2017a. Lower Mill Creek and Mid-Jordan River native mussel survey 2017: As it relates to the Central Valley Water Reclamation Facility discharge. Report to Wasatch Front Water Quality Council, Salt Lake City, UT.

Richards, D. C. 2017b. Native Unionoida Surveys, Distribution, and Metapopulation Dynamics in the Jordan River-Utah Lake Drainage, UT. Report to: Wasatch Front Water Quality Council. Salt Lake City, UT. OreoHelix Consulting, Vineyard, UT. Version 1.5 May, 26, 2017. Available at: http://wfwqc.org/wp-content/uploads/2017/04/Native-Unionoida-Surveys-and-Metapopulation-Dynamics-in-the-Jordan-River-Utah-Lake-drainage-UT-Version-1.5-compressed.pdf. With supporting documentation at: http://wfwqc.org/wp-content/uploads/2017/10/Appendix-8-Native-Mussels-Spreadsheet-FINAL-read-only.xlsx.

Richards, D.C. 2019. Two Invasive Mollusks Redistribute Nutrients and Primary Production in the Analog Jordan River, UT. Technical Note to Wasatch Front Water Quality Council. Salt Lake City, UT. OreoHelix Ecological, Vineyard, UT.

Richards, D. C. 2018. A snail, a clam, and the River Jordan. Technical Report to Wasatch Front Water Quality Council. Salt Lake City, UT. OreoHelix Ecological, Vineyard, UT.

Richards, D. C. 2015. Unionoida Mussel and Non- Pulmonate Snail Survey and Status in the Jordan River, UT, 2014. Final Report. OreoHelix Consulting, Moab, UT. Prepared for: Central Valley Water Reclamation Facility and Central Davis Sewer District. 113 pages.

Richards, D. C and T. Miller. 2017. Lower Mill Creek and Jordan River Native Mussel Surveys. Scope of Work (SOW) and Sampling and Analysis Plan (SAP), Draft Final. Version 2.0. August 14, 2017.

Richards, D.C. and T. Miller. 2019. Apparent extinction of native mussels in Lower Mill Creek and Mid-Jordan River, Utah. Western North American Naturalist. 79(1): 72-84.

Smith, D. R. 2006. Survey design for detecting rare freshwater mussels. J. N. AM. Benthol. Soc. 25(3):701-711

Smith, D. R., R. F. VILLELLA, D. P. LEMARIE´ , AND S. VON OETTINGEN. 2001b. How much excavation is needed to monitor freshwater mussels? Pages 203–218 in R. A. Tankersley, D. I. Warmolts, G. T. Watters, B. J. Armitage, P. D. Johnson, and R. S. Butler (editors). Freshwater Mollusk Symposium Proceedings. Ohio Biological Survey, Columbus, Ohio.

UDWQ. 2017a. Adoption of USEPA 2013 ammonia criteria for the protection of aquatic life in Utah. March 12. Review Draft v.0.1

UDWQ et al. 2017b. Utah and Colorado Water Survey for Mussels and Snails. Final Report. Original Draft-July 1, 2017. Revised Draft-.

USEPA. 2013a. Aquatic life ambient water quality criteria for ammonia-freshwater 2013. USEPA, Office of Water, Office of Science and Technology, Washington, DC. EPA-822-R-13-001

USEPA 2013b. Technical Support Document for Conducting and Reviewing Freshwater Mussel Occurrence Surveys for the Development of Site-specific Water Quality Criteria for Ammonia. U.S. Environmental Protection Agency Office of Water Office of Science and Technology Standards and Health Protection Division National Water Quality Standards Branch Washington, DC. August 2013. EPA 800-R-13-003.