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Natural Resource Stewardship and Science

Status of mussels in the Belle Fourche and Laramie Rivers at Devils Tower National Monument and Fort Laramie National Historic Site

Natural Resource Data Series NPS/XXXX/NRDS—2015/XXX

ON THIS PAGE
The native mussel crew from the Wyoming Game and Fish Department (left to right, Meghann Karsch, Phil Mathias, and Jon Mageroy) and Lusha Tronstad of the Wyoming Natural Diversity Database at Fort Laramie National Historic Site.
Photograph courtesy of Sheila Muhlenkamp of Fort Laramie National Historic Site.

ON THE COVER
White heelspliter in the Belle Fourche River at Devils Tower National Monument
Photograph courtesy of Lusha Tronstad, Wyoming Natural Diversity Database, University of Wyoming

Status of mussels in the Belle Fourche and Laramie Rivers at Devils Tower National Monument and Fort Laramie National Historic Site

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Abstract

Native mussels are declining across the United States and the status of mussels in Wyoming is currently being studied. We surveyed the Belle Fourche River at Devils Tower National Monument and the Laramie River at Fort Laramie National Historic Site to discover what mussels live in these rivers and assess their status. We surveyed the entire length of the rivers flowing through each park by snorkeling, viewing the river bottom with glass-bottomed view buckets and visual surveys depending on conditions. We discovered that the Belle Fourche River at Devils Tower National Park has an abundant population of white heelsplitters (*Lasmigona complanata*). The sizes of mussels that we found suggested that white heelsplitters are reproducing within the river. We found a few live cylindrical papershells (*Anodontoides ferussacianus*) in the Laramie River, but not enough individuals to assess if these mussels are reproducing at Fort Laramie National Historic Site. We found shells of plain pocketbook (*Lampsilis cardium*) but no live individuals in the Laramie River. Surveying these populations every five to 10 years to assess their status and abundance will help manage the native mussels in these parks.

Acknowledgments

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Introduction

Freshwater mussels are declining worldwide due to impacts from invasive species, polluting aquatic ecosystems, reorganizing fish faunas, overharvesting, damming streams and channelizing waterways. North America (north of Mexico) had the highest historic diversity of freshwater mussels in the world, with 297 taxa (Bogan 1993). Eighty-nine of those taxa are currently listed Threatened or Endangered in the United States, and six are Candidate species under the Endangered Species Act (ESA; NatureServe 2015, www.explorer.natureserve.org). Several life history traits make freshwater mussels vulnerable. First, freshwater mussels reproduce by releasing glochidia (larval mussels) into the water. To survive, glochidia must attach to the gills or fins of a suitable host fish species. After a short time of being parasitic on fish, glochidia drop off the fish and remain in the sediment, if suitable, where they grow into adult mussels. Because mussels depend on specific fish species for survival, the disappearance of native fish can cause local extirpation of mussel species. Second, mussels are long lived invertebrates; individuals can live up to 130 years depending on the species (Bogan 1993). Because mussels are long lived, individuals can accumulate high levels of pollutants and are often used as bioindicator species. Further, adult mussels may persist at a location for a long period of time without reproducing, giving the illusion of population persistence when in fact the population is fated to disappear.

Little is known about freshwater mussels in Wyoming, especially in the eastern part of the state. Seven mussel species are known to inhabit rivers and lakes of Wyoming (Cvancara 2005), and none of these species are currently petitioned or listed under the ESA. However, seven species are listed as Endangered in neighboring states (*Cumberlandia monodonta*, *Epioblasma triquetra*, *Lampsilis higginsii*, *Leptodea leptodon*, *Pleurobema clava*, *Potamilus capax*, and *Quadrula fragosa*; www.natureserve.org). Freshwater mussels are declining in surrounding areas, thus understanding the status of Wyoming species and monitoring their populations is critical to avoid similar declines and their consequent management crises in the near future.

We surveyed the Belle Fourche and Laramie Rivers to estimate the status of native mussels on National Park lands. Our specific questions were: 1.) What species live in the rivers, 2.) What is the size distribution of the populations, and 3.) How abundant are the mussels? Potential threats to native mussels exist in eastern Wyoming, including increased silt and altered stream channel stemming from upstream reservoirs, and pollution from urban and agricultural runoff. Our study establishes a baseline of information on which future surveys can be compared to assess the population status of these mussels.

Methods

Surveying for Native Mussels

We surveyed the entire lengths of the Belle Fourche and Laramie Rivers within park boundaries (Figure 1). We began by walking the banks looking for hazards in and out of the water and evidence of shells along the banks. Many times, native mussel shells are deposited on the banks from high water flows and/or predators (e.g., muskrats or raccoons; Grabarkiewicz and Davis 2008). Deposited shells were collected as evidence that the species found are or were present in that section of stream.

Based on our observations of the site (i.e., water clarity, depth, etc.), we used the most appropriate sampling technique: snorkeling, glass-bottomed view buckets, and/or polarized sunglasses. We would often use a variety of methods along each reach to increase our efficiency of detecting mussels. Each method was performed as a timed search; we recorded the total time sampled and the number of surveyors to calculate the overall person-hours and catch per unit effort (CPUE, number of live mussels per person-hour).

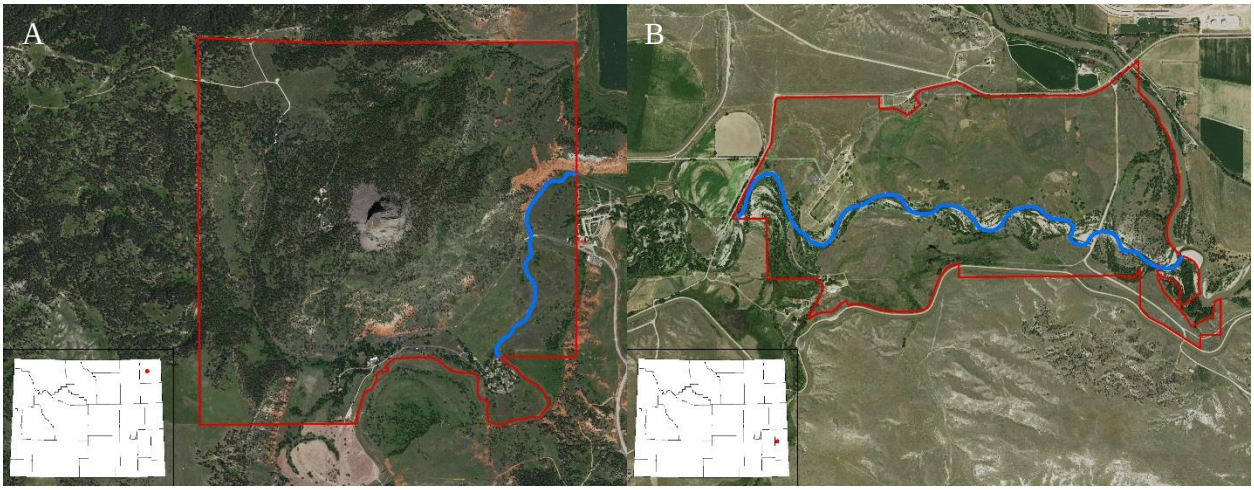

Figure 1. We surveyed the A.) Belle Fourche River (blue line) at Devils Tower National Monument and B.) the Laramie River at Fort Laramie National Historic Site. Blue lines show the length of the river we surveyed.

We divided the length of the river within the parks into sections (usually 600 m long each). Surveys began at the downstream portion of the park and we worked upstream to reduce turbidity. Substrates were not excavated to find buried mussels, so our surveys were bias to less cryptic, larger and older individuals and species (Hornbach and Deneka 1996, Obermeyer 1998, Metcalfe-Smith et al. 2000). We measured the total length (TL, mm) of all live mussels observed. Measuring live mussels for TL gave a relative population age structure. If we measured a large range of sizes, especially the presence of small individuals, we confirmed that recruitment was occurring as TL is relative to age. After live mussels were measured, they were returned to their approximate original location in the river.

Habitat Measurements

We measured the rivers for basic habitat parameters. Each section of the river was divided into 11 equally spaced transects. We measured the wetted width, bankfull width and approximate bankfull depth. Bankfull depth was approximated by estimating the stream elevation at the greenline (first line of perennial vegetation), suspending the measuring tape across the stream at the greenline and measuring the vertical distance downward to the bottom of the wetted-channel at five positions across the stream (left bank, left-center, center, right-center, and right bank; directions are when the surveyor faces downstream). Bankfull width and bankfull depth were used in our analysis because

we assumed these measurements to be the maximum hydrologic pressure a site would regularly experience (Gangloff and Feminella 2007). Substrate was also categorized at each position across the river. Substrate was categorized as: fines (silt, clay, muck, not gritty), sand (< 2 mm, gritty, up to ladybug size), fine gravel (2-16 mm, ladybug to marble size), coarse gravel (16-64 mm, marble to tennis ball size), cobble (64-250 mm, tennis ball to basketball), boulder (250-4,000 mm, greater than basketball), hardpan, bedrock (> 4,000 mm, larger than car), wood, and other (Lazorchak et al. 2006). Between transects, we identified the dominant habitat type as a pool, riffle or run. We also recorded basic site information, including location (decimal degrees, NAD83) at the upstream and downstream extent of each reach, elevation, date, surveyors and data recorders.

Results

We surveyed about 1500 m of the Belle Fourche River at Devils Tower National Monument on 10 to 12 September 2014. The wetted width of the river was 11.9 m on average and depth averaged 26.6 cm. We found 383 white heelsplitters (*Unionidae: Lasmigona complanata*) in the river that varied from 37 to 174 mm in length. We found 9 mussels per person hour in the survey on average.

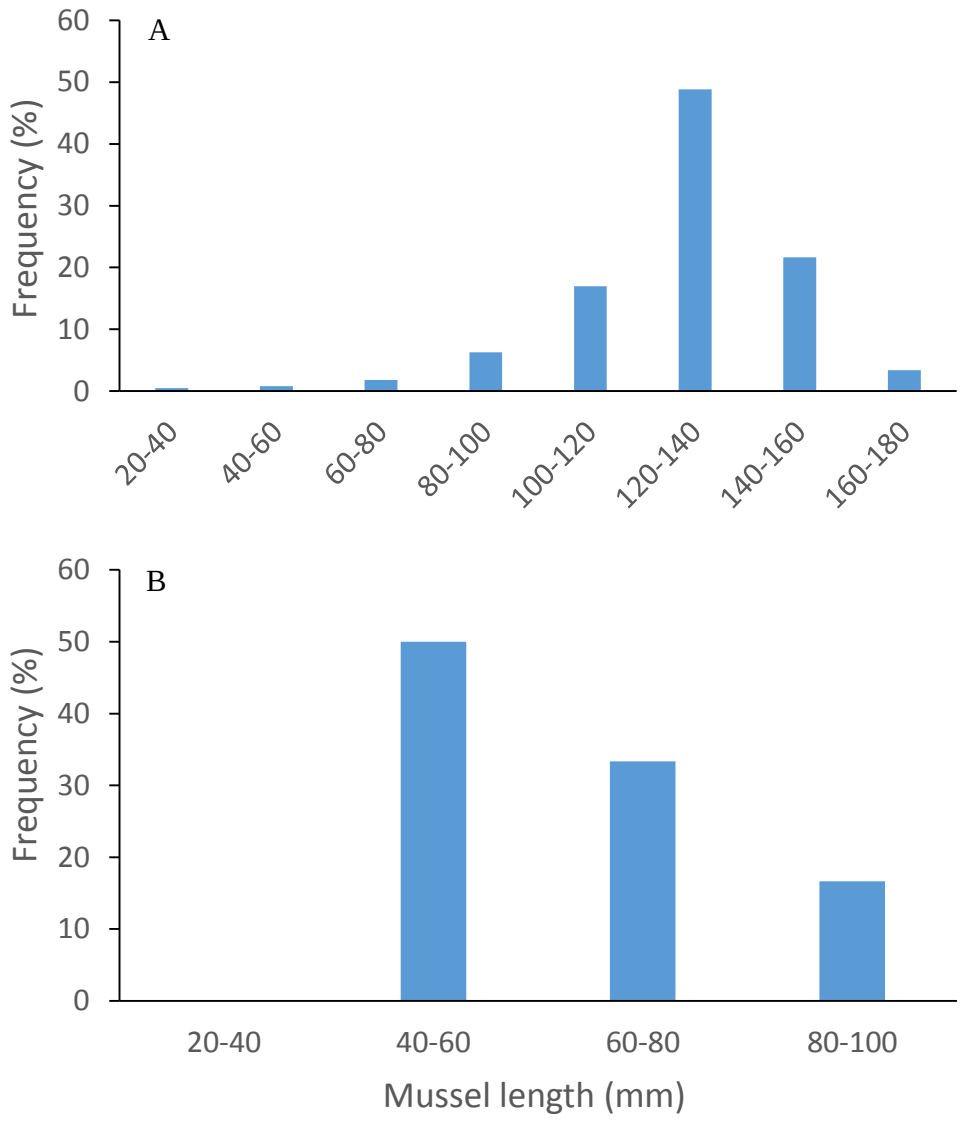

Figure 2. Shell length frequencies for A.) white heelsplitters in the Belle Fourche River at Devils Tower National Monument (*n* = 383) and B.) cylindrical papershells in the Laramie River at Fort Laramie National Historic Site (*n* = 12).

We surveyed about 4100 m of the Laramie River at Fort Laramie National Historic Site on 12 to 14 August 2013 and 8 to 10 October 2014. The wetted width of the river was 15.4 m on average and depth averaged 31.7 cm. We found 12 live cylindrical papershells (*Unionidae: Anodontoides ferussacianus*) at a rate of 1.6 mussels per person hour in the Laramie River. The cylindrical papershells varied in length between 54 and 87 mm. We only found shells of plain pocketbook (*Unionidae: Lampsilis cardium*).

Table 1. Habitat and mussel characteristics in the Belle Fourche and Laramie Rivers. Mussel lengths are averages and the range of sizes are in parentheses. We calculated catch per unit effort (CPUE) as the number of live mussels found per person hour.

Location	**Belle Fourche River**	**Laramie River**
Starting location	44.593°N -104.700°W	42.199°N -104.529°W
Ending location	44.583°N -104.706°W	42.202°N -104.565°W
Length of river surveyed (m)	1500	4100
Number live	383	12
Mussel length (mm)	128 (37-174)	67 (54-87)
CPUE (mussels per person hour)	9.0	1.6
Average wet width (m)	11.9	15.4
Average greenline width (m)	12.4	15.5
Average depth (cm)	26.6	31.7
Dominant substrate	Fines, gravel, cobble	Fines, sand, gravel, cobble

Discussion

The white heelsplitter is a moderately short-lived mussel species that rarely lives more than 12 years. These mussels grow rapidly during their first three years and reach a maximum length of 190 mm (7.48 in; Watters et al. 2009). The longest white heelsplitter we found in the Belle Fourche River was 174 mm, which is near the largest known length for the species. The native range for these mussels includes the Great Lakes drainages and the Mississippi River from Saskatchewan to Ontario and south to Texas and Georgia (Watters et al. 2009). White heelsplitters have fairly general habitat requirements and they can tolerant poor water quality. The mussel is commonly found in sandy mud and silt in large and small creeks, rivers and lakes and can be found below sewage outfalls and impoundments (Watters et al. 2009). Natural hosts that are known for the white heelsplitter and from Wyoming are Sauger (*Sander canadensis*). Another potential host is Shorthead Redhorse (*Moxostoma macrolepidotum*), which is the same genus as the proven host River Redhorse (*M. carinatum*). Other hosts for this mussel include Common Carp (*Cyprinus carpio*), Green Sunfish (*Lepomis cyanellus*), Largemouth Bass (*Macropterus salmoides*), White Crappie (*Pomoxis annularis*), Pumpkinseed (*Lepomis gibbosus*), Bluegill (*Lepomis cyanellus*), Yellow Perch (*Perca flavescens*), Gizzard Shad (*Dorosoma cepedianum*), and Freshwater Drum (*Aplodinotus grunniens*). These mussels currently have a NatureServe rank of G5/N5 at the global and national scales (USA

and Canada) and state ranks vary between S1 (critically imperiled) to S5 (secure; www.natureserve.org).

Figure 3. White heelsplitter nestled in the Belle Fourche River at Devils Tower National Monument.

Both white heelsplitters and giant floaters (*Pyganodon grandis*) are native to the Belle Fourche River drainage, but abundance had not been previous recorded. We discovered very high abundances of white heelsplitters in the Belle Fourche River at Devils Tower National Monument and they often blanketed the bottom of the river. Previous studies have shown that white heelsplitters seem to thrive in waters with high nutrient loading, such as streams downstream of sewer outfalls (Watters et al. 2009). The Belle Fourche is listed under the 303(d) impaired list for the state of Wyoming as unsafe for drinking water and contact recreation because concentrations of fecal coliform bacteria exceeded the standard (WYDEQ 2012). This classification and the large abundances of white heelsplitters, may indicate that the Belle Fourche River has high productivity due to high nutrient loads and pollution from animal feces. Currently, three stream segments in the Belle Fourche drainage (Donkey Creek, Arch Creek and the Belle Fourche River from the confluence with Donkey Creek downstream to Keyhole Reservoir) are listed as impaired for contact recreation (WYDEQ 2012). Fecal coliform concentrations have not been recently measured to estimate if the Belle Fourche River

downstream of Keyhole Reservoir (including the reaches flowing through Devils Tower National Monument) exceeds the criteria (WYDEQ 2012).

The cylindrical papershell is a relatively short-lived mussel species that rarely exceeds seven years of age or 100 mm length (3.94 in; Watters et al. 2009). Their native range includes the Great Lakes drainages, upper Mississippi River (Missouri, Ohio, and upper Cumberland rivers, but not the Tennessee River), and east to New York and Pennsylvania in the United States (Watters et al. 2009). In Canada, its native range includes the James and Hudson Bay drainages (Watters et al. 2009). The cylindrical papershell is generally a headwaters species and can live in intermittent streams (Watters et al. 2009). These mussels can live in various substrate types from the crevices of bedrock to packed cobble to fine silts, mud and clay (Watters et al. 2009). Cylindrical papershells are considered a host fish generalist and can use a multitude of hosts, including White Sucker (*Catostomus commersonii*), Mottled Sculpin (*Cottus bairdii*), Iowa Darter (*Etheostoma exile*), Bluegill, Common Shiner (*Luxilus cornutus*), Largemouth Bass, Fathead Minnow (*Pimephales promelas*), and Black Crappie (*Pomoxis nigromaculatus*) in Wyoming (Watters et al. 2009). The cylindrical papershell currently has a NatureServe rank of G5/N5 at the global and national scales (USA and Canada) and state ranks between S1 (critically imperiled) to S5 (secure; www.natureserve.org). Only 14 cyclindrical papershells were discovered in the Laramie River during surveys in 2011 to 2014 and 12 of these individuals were from the reach within Fort Laramie National Historic Site (Mathias 2015).

The plain pocketbook grows quickly during their first three to four years before reaching sexual maturity (Watters et al. 2009). Their maximum shell length can reach 140 to 150 mm (5.51 in to 5.90 in; Parmalee and Bogan 1998). Individuals rarely exceed 30 years of age (Watters et al. 2009). Shell length can be difficult to correlate with age for this species. For example, an individual that is 90 mm in length (3.54 in) can be 5 to15 years of age (Watters et al. 2009). Their native range includes Great Lakes drainages and the Red River of the North drainage. In the Mississippi River drainage, the mussel extends south to northern Louisiana; west to Missouri, Arkansas and Wyoming, and east to Pennsylvania (Watters et al. 2009). The plain pocketbook tolerates a wide assortment of water flows and substrate types (Watters et al 2009). The mussel typically occurs in moderate to strong current with a substrate of coarse gravel and sand, but also thrives in stable substrate rich in mud and silt (Parmalee and Bogan 1998). They can be found in small to large streams, lakes and ponds (Watters et al. 2009; Parmalee and Bogan 1998). The plain pocketbook mostly uses centrarchids and has many potential hosts in Wyoming, such as Tiger Salamander (*Ambystoma tigrinum*), Pumpkinseed (*Lepomis gibbosus*), Green and Bluegill Sunfish, Largemouth and Smallmouth Bass (*Micropterus dolomieu*), Black and White Crappie, Yellow Perch, Sauger and Walleye (*Sander vitreus*; Watters et al. 2009). Sauger is the only host fish native to Wyoming, but there may be undocumented host fish native to Wyoming that plain pocketbook can use.

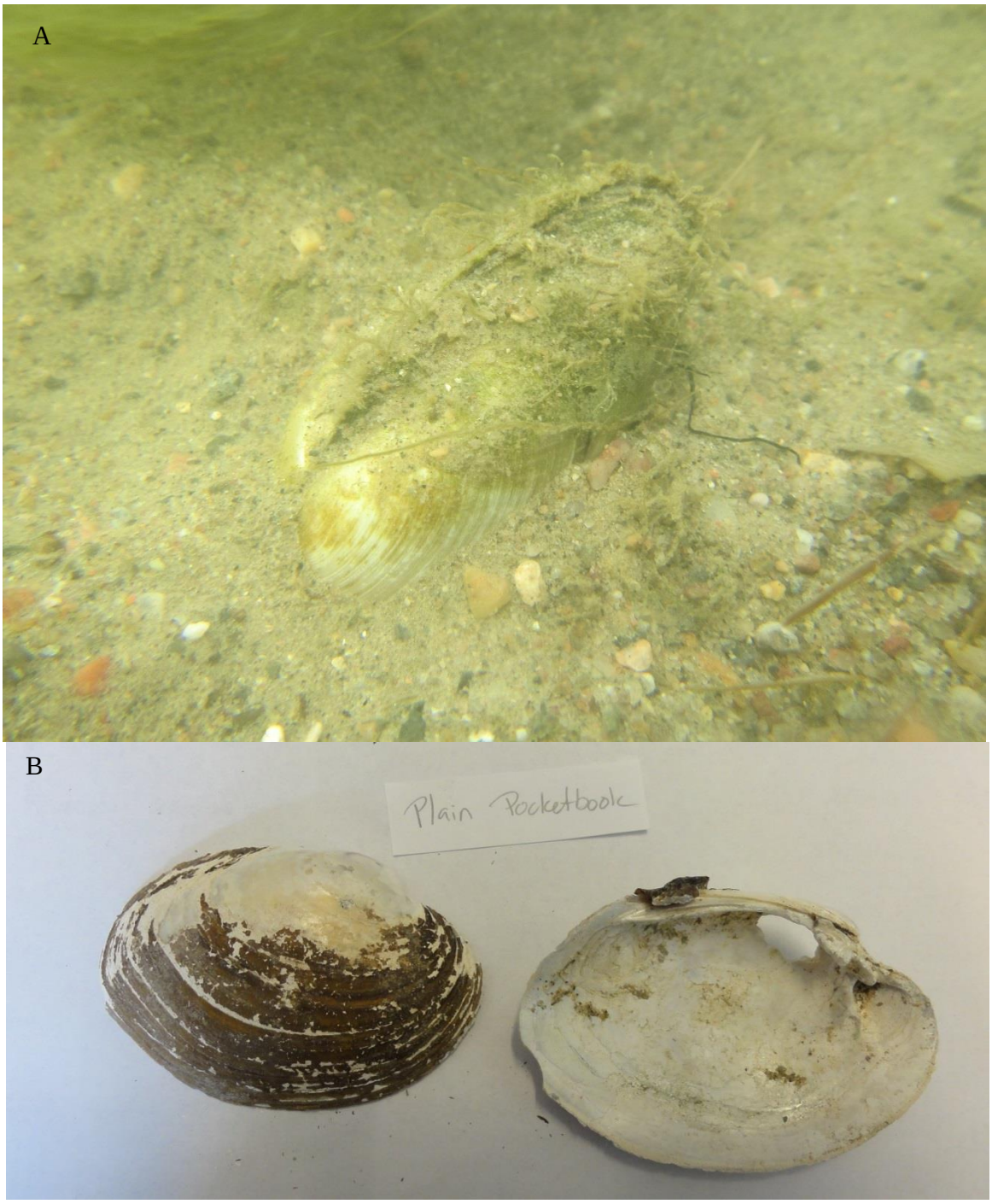

Figure 4. A. Cylindrical papershell at Fort Laramie National Historic Site. B.) Shell of plain pocketbook found in the Laramie River.

The plain pocketbook may be extirpated in Wyoming. We only found shells in the Laramie River during our surveys at Fort Laramie National Historic Site. Since native mussel surveys began in Wyoming, only one live plain pocketbook has been found during prairie stream fish surveys in 2008 (Edwards 2009). The mussel was located upstream of Grayrocks Reservoir in the Laramie River. Surveys were performed near this occurrence point in 2013, but no live plain pocketbooks were

found (Mathias 2015). The large number of plain pocketbook shells found throughout the Laramie River suggests that the species was once fairly common. Observations of the Laramie River over time may help explain what caused the low number of cylindrical papershell and the possible extirpation of plain pocketbook. The Laramie River has run dry in the past which is difficult for mussels to survive. Large floods may also move individuals downstream into unsuitable habitat or leave them stranded on banks. A large flash flood occurred in the Laramie River a day prior to our survey at Fort Laramie National Historic Site in 2013. We found native mussels lying on top of the substrate at the edge of the river. As the water receded after the flood, these individuals would have likely been stranded and died. These mussels were likely washed out of their habitat downstream with the flood. We also observed many plain pocketbook shells high on the river banks that were also likely placed there during floods.

Native mussels were more abundant in the Belle Fourche River at Devils Tower National Monument compared to the Laramie River at Fort Laramie National Historic Site. White heelsplitters appear to be reproducing and thriving in the Belle Fourche River. Cylindrical papershell had much lower abundance in the Laramie River; however, the most cylindrical papershell found in the Laramie River were at Fort Laramie National Historic Site. Live plain pocketbook have not been recently found in Wyoming and we only found shells at Fort Laramie National Historic Site indicating that this species was once abundant in the river. We are only beginning to study the status of native mussels in Wyoming and we do not know why mussels are abundant in the Belle Fourche River and scarcer in the Laramie River. Differences may be attributed to changes in the fish assemblages, pollution, drying, water withdrawals, regulating streams, river inputs and invasive species; however, we do not know the specific impacts that are affecting these rivers. Surveying mussels within the parks every five to 10 years to monitor these populations would help managers address any changes in their abundance or size structure.

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