



Upper Columbia Basin Network Trip Report - Kettle River Mussel Survey

Lake Roosevelt National Recreation Area (LARO)

Natural Resource Data Series NPS/UCBN/NRDS—2015/780



ON THE COVER

Kettle River near Barstow, Washington, 21 August 2013, Lake Roosevelt National Recreation Area
NPS Photo

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Abstract

In August 2013, the Upper Columbia Basin Network (UCBN) conducted a brief survey of the Kettle River at Lake Roosevelt National Recreation Area (LARO) to determine the location and extent of western pearlshell (*Margaritifera falcata*) populations (i.e. mussel beds). Four mussel beds were described and documented, only one of which had been previously described (Roscoe and Redelings 1964). Timed searches were conducted within each mussel bed to determine species richness and relative abundance. Only two species were found during the course of the survey, the western pearlshell mussel (*Margaritifera falcata*) and the Oregon floater (*Anodonta oregonensis*). Only one live Oregon floater was encountered. Live western pearlshell mussel catch per unit effort (CPUE) ranged from 466.25 to 1,771.00. Shell measurements were obtained from 85 individual western pearlshell taken from a single mussel bed. These shell measurements serve as a proxy for age and indicated a mix of size/age classes within the most upstream site. It is intended that this report will serve as the foundation for future inquiry into mussel beds in the Kettle River area of LARO.

Introduction

In July 2012, staff at Lake Roosevelt National Recreation Area (LARO) found an isolated population of western pearlshell mussels (*Margaritifera falcata*) in the Kettle River near the Barstow bridge (15 miles north of Kettle Falls, WA off state highway 395). The lack of current information about mussels from the Kettle River, and especially on NPS administered lands, warranted a survey of this and downstream potential habitat areas and populations.

In North America, there are 297 freshwater mussel taxa (species and subspecies) in the families Margaritiferidae and Unionidae (Williams et al. 1993). Of the 297 taxa evaluated by Williams et al. (1993) 71.7% are considered endangered, threatened, or of special concern. Master (1990) estimated that 55% of North American mussel species were extinct or imperiled; in contrast, only 7% of birds and mammals are characterized as such. Factors frequently cited as contributing to the decline of freshwater mussels include: stream channel modification, gravel dredging, inundation by dams, siltation, introduced species, loss of required host fish, point and non-point source pollution, and over harvest (Bogan 1993, Williams et al. 1993, Ricciardi and Rasmussen 1999, Lydeard et al. 2004, Strayer et al. 2004, Schloesser and Metcalfe-Smith 2006, Strayer 2006).

As noted in Turgeon et al. (1998) and Nedeau et al. (2009) the Pacific Northwest is depauperate of mussel diversity (8 native species) relative to the eastern two-thirds of North America, yet these species face many shared threats and stressors. Of the 8 species found in the Pacific Northwest, the western pearlshell is widely distributed from northern California to Alaska and eastward to Montana and Wyoming. Shell middens and historic accounts indicate that western pearlshell abundance has been greatly reduced across the entire extent of its range (Hastie and Toy 2008, Nedeau et al. 2009). Despite substantial population declines, relatively little information is available about the status of western pearlshell mussels. This is especially true for streams in north-east Washington state. One notable exception is Roscoe and Redelings 1964, which describes the ecology of pearlshell mussels found near the Barstow bridge. While Roscoe and Redelings provide life history information, their description of population density is an estimate that can only be used for cursory comparison. The Xerces Society for Invertebrate Conservation has recently reviewed existing information about the western pearlshell and the online profile is a useful reference for conservation status and life history information (Jespen et al. 2012)

Freshwater mussel populations are considered an indicator of aquatic ecosystem health. Their presence has been shown to have a significant positive influence on benthic macroinvertebrate assemblage composition and density (Vaughn and Spooner 2006). This positive effect is in part due to the role of mussels in nutrient cycling within streams. In addition, it has been shown that native Pacific lamprey (*Entosphenus tridentate*) benefit from the presence of the western pearlshell, likely due to a shift in available nutrients, bioturbation, and changes to stream bed characteristics (Limm and Power 2010). Historically, Pacific lamprey migrated up to and over Kettle Falls in the Columbia River. Construction of the Chief Joseph and Grand Coulee Dams blocked upstream migration of Pacific lamprey and resulted in their extirpation from the Upper Columbia Subbasin (Wydoski and Whitney 2003, Northwest Power and Conservation Council 2004).

Objectives

- Determine the location and extent of western pearlshell (*Margaritifera falcata*) populations in the segment of the Kettle River within Lake Roosevelt National Recreation Area.
- Delineate mussel populations (mussel beds) on a map to facilitate future surveys.
- Assess species richness and relative abundance in each mussel bed using a timed search for individual mussels.
- Estimate age structure within a single mussel bed based on shell length.
- Evaluate the viability of using randomly placed quadrats for future investigations.

Study Area

Overview of Lake Roosevelt National Recreation Area (LARO)

LARO was established as a unit of the national park system in 1946 by the Secretary of the Interior. With the Secretary's approval, an agreement between the Bureau of Reclamation, the Bureau of Indian Affairs, and the NPS designated the NPS as the manager for the Coulee Dam National Recreation Area. The area included Franklin D. Roosevelt Lake, the reservoir formed behind Grand Coulee Dam, and the "freeboard" lands that were purchased at and above 1,310 foot elevation (Figure 1). Through over 65 years of changes, including a name change to Lake Roosevelt National Recreation Area in 1997, the NPS now manages approximately 47,438 acres of the 81,389 acres of total water surface and associated shoreline, and 12,936 acres of the 19,196 acres of total freeboard land. Also, in 1990, two adjacent Indian Tribes were included in the Lake Roosevelt Cooperative Management Agreement. The Colville Confederated Tribe and the Spokane Tribe of Indians manage the remaining water surface and freeboard land associated with their individual reservations.

The LARO General Management Plan (NPS 2000) defines the 3 major purposes for the recreation area:

- Provide opportunities for diverse, safe, quality, outdoor recreation experiences for the public.
- Preserve, conserve, and protect the integrity of natural, cultural, and scenic resources.
- Provide opportunities to enhance public appreciation and understanding about the area's significant resources.

LARO offers a variety of recreation opportunities in a diverse natural setting on a 154- mile-long lake bordered by 312 miles of publicly owned shoreline. Visitation at the park has fluctuated between a high of 1,784,420 (1990) to a low of 1,081,112 (1996) and has averaged 1,374,797 between 1990 and 2004. LARO has 3 marinas, 24 boat launches, and numerous overnight and day-use campgrounds and other points of access around the lake. The recreation area includes the lower reaches of many rivers and streams including the Colville, Kettle, Sanpoil, and Spokane Rivers.

The NPS managed portion of the Kettle River was the focus of this mussel survey since freshwater mussels still commonly occur in portions of the upper watershed. Prior to creation of the reservoir, it is thought that freshwater mussels, especially western pearlshell, would have been abundant throughout the Columbia, Spokane and Kettle Rivers.

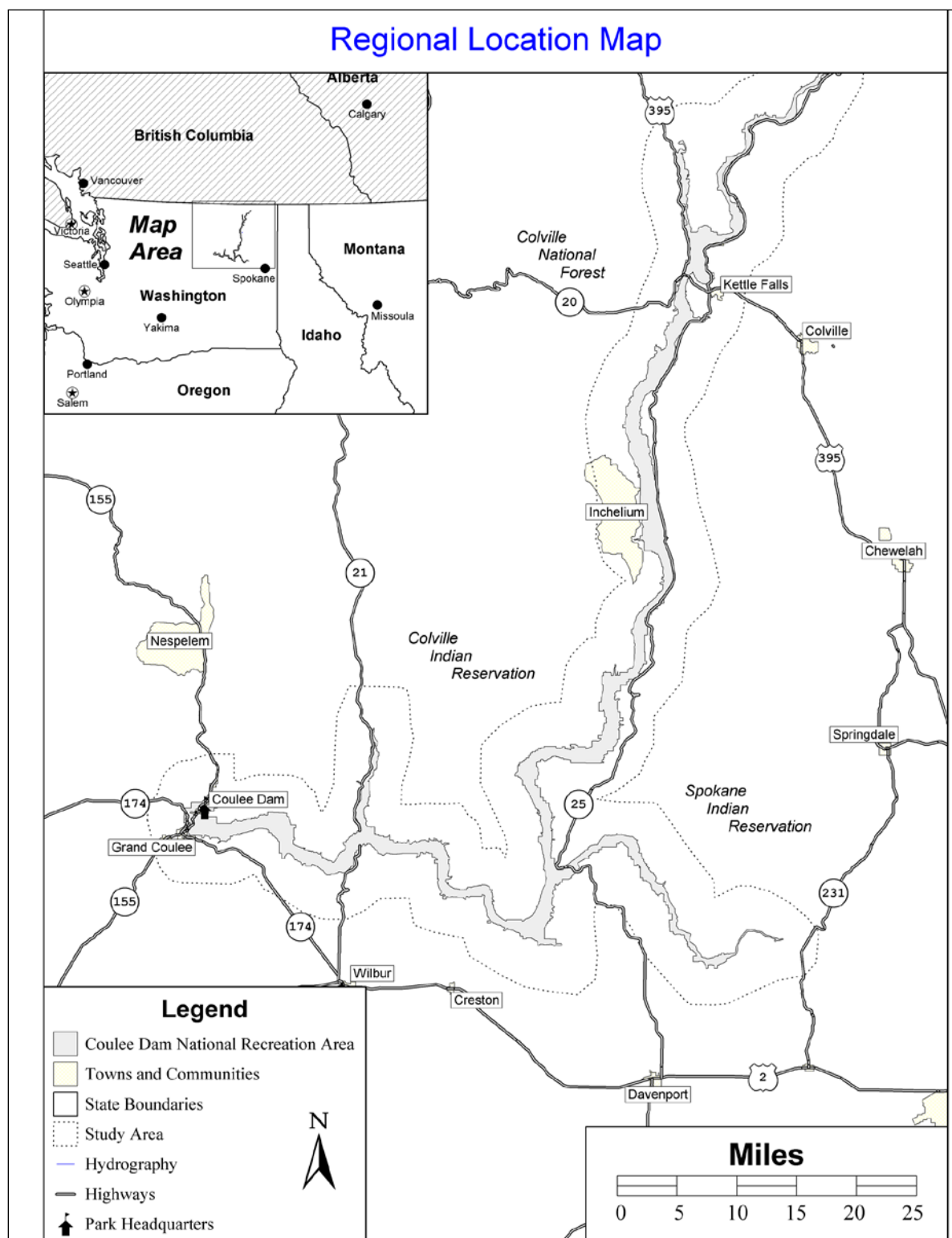


Figure 1. Regional location of Lake Roosevelt National Recreation Area (previously Coulee Dam NRA). Note that the western pearlshell mussel population of interest is North of Kettle Falls along Highway 395.

Overview of the Kettle River Watershed

The following description of the Kettle River watershed has been excerpted from the Kettle River Watershed Management Plan (Regional District of Kootenay Boundary 2010). “The Kettle River lies between the Okanogan and Columbia River valleys in the central part of southern British Columbia and northern Washington. The Kettle River is a 282 km (175 mile) tributary of the Columbia in the southern interior of British Columbia and northeastern Washington State. Its drainage basin is 11,000 km² (4,200 miles²), of which 8,230 km² (3,177 miles²) are in Canada and 2,650 km² (1,023 miles²) are in the United States.

In British Columbia, the Kettle River basin is divided into two large sub-basins by the Midway Range of the Monashee Mountains. The large western sub-basin is divided into two smaller sub-basins by the Beaverdell Range into the West Kettle River Valley and the Christian Valley. From its source at the outlet of Holmes Lake in the Monashee Mountains, the Kettle River flows through the Christian Valley and is joined by the West Kettle River at Westbridge. The Kettle River continues to flow south until it crosses the Canada/U.S. border at Midway, BC and Ferry, Washington.

The eastern large sub-basin of the Kettle River is drained by the Granby River. This sub-basin is located between the Midway Range to the west and the Selkirk Trench, which holds the Columbia River, to the east. Below Midway, the river loops south into the United States, through Ferry County, Washington, before flowing north back into Canada, passing through Grand Forks, BC where the Granby River joins. After flowing east for approximately 18 kilometers, the river turns south again at its confluence with Christina Creek. From there, the river crosses the Canada/U.S. border for a third time near the Laurier, Washington border crossing on Highway 395. It then flows south, joining the Columbia River near Kettle Falls, Washington. The Columbia River at this point is a large reservoir impounded behind Grand Coulee Dam, called Lake Roosevelt (Regional District of Kootenay Boundary 2010).”

Survey Location

Lake Roosevelt National Recreation Area’s segment of the Kettle River extends from just upstream of the Barstow Bridge (river mile 11) downstream to its confluence with the Columbia River/Lake Roosevelt. This survey of the river was focused between the Barstow Bridge (river mile 11) and the Napoleon Bridge (river mile ~5.7). Between these bridges, the river is relatively free flowing with minimal influence of the reservoir except when it is at full pool (1290’ msl), or when water backs up in the Kettle River during high spring runoff. Downstream of the Napoleon Bridge the water depth and influence of the reservoir are not conducive to visual observation of mussels nor is it considered optimal habitat. As a result no surveys were conducted downstream of the Napoleon Bridge.

During the survey (08/20/2013-08/22/2013), lake levels were between 1,279.97’ and 1,280.22’ msl. Figure 2 shows lake levels for water year 2012 and 2013. Note that the lake was at full pool (1,290’ msl) prior to the survey (July 2013). For consistency in observations, survey of LARO’s segment of the Kettle River should ideally occur when lake elevation is no greater than 1,280’ msl. During the survey dates, stream discharge in the Kettle River near Laurier, WA (USGS #12404500) was between 508 cfs and 543 cfs (Figure 3).

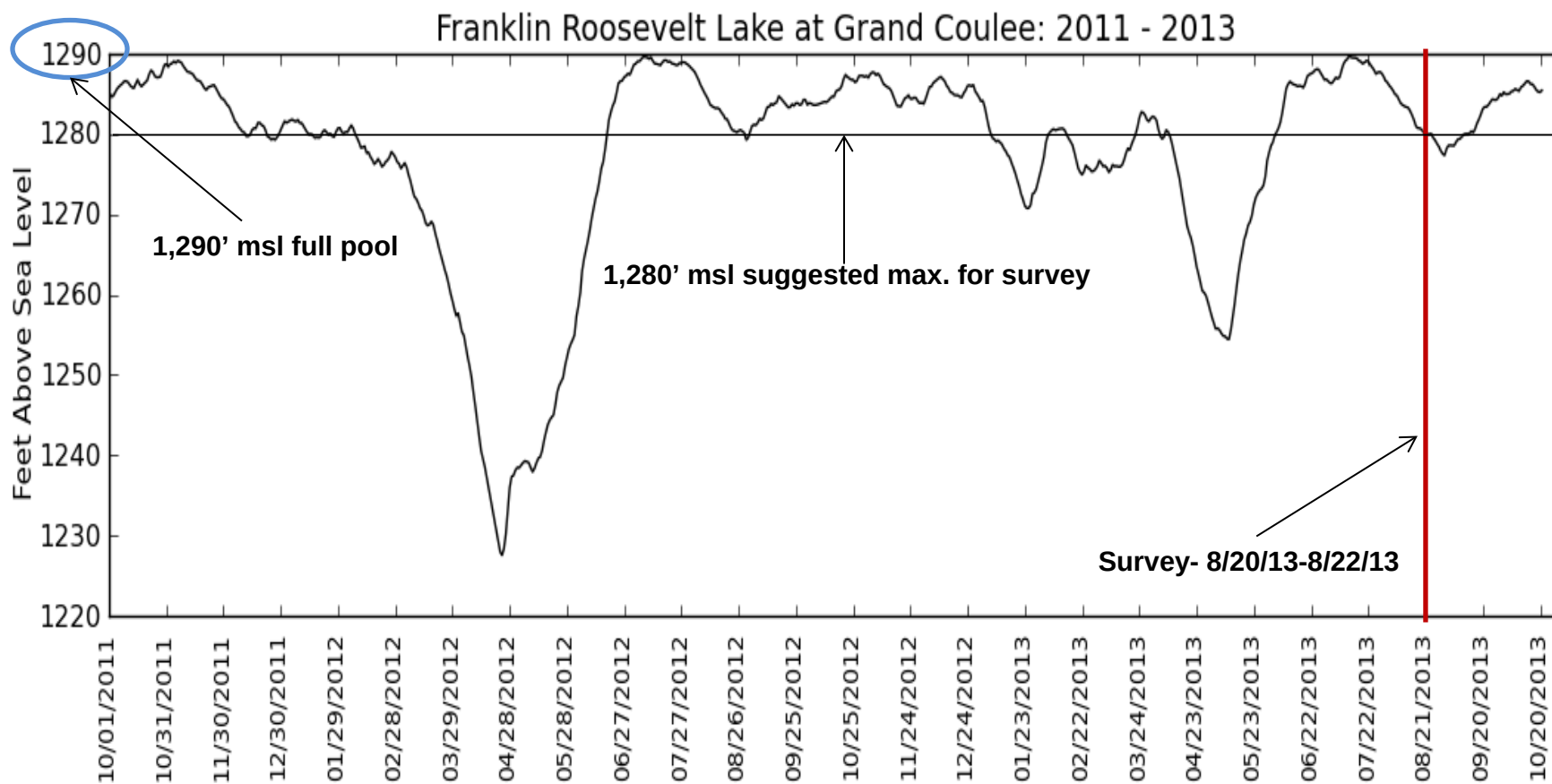


Figure 2. Lake elevations at LARO for water years 2012 and 2013.



USGS 12404500 KETTLE RIVER NEAR LAURIER, WA

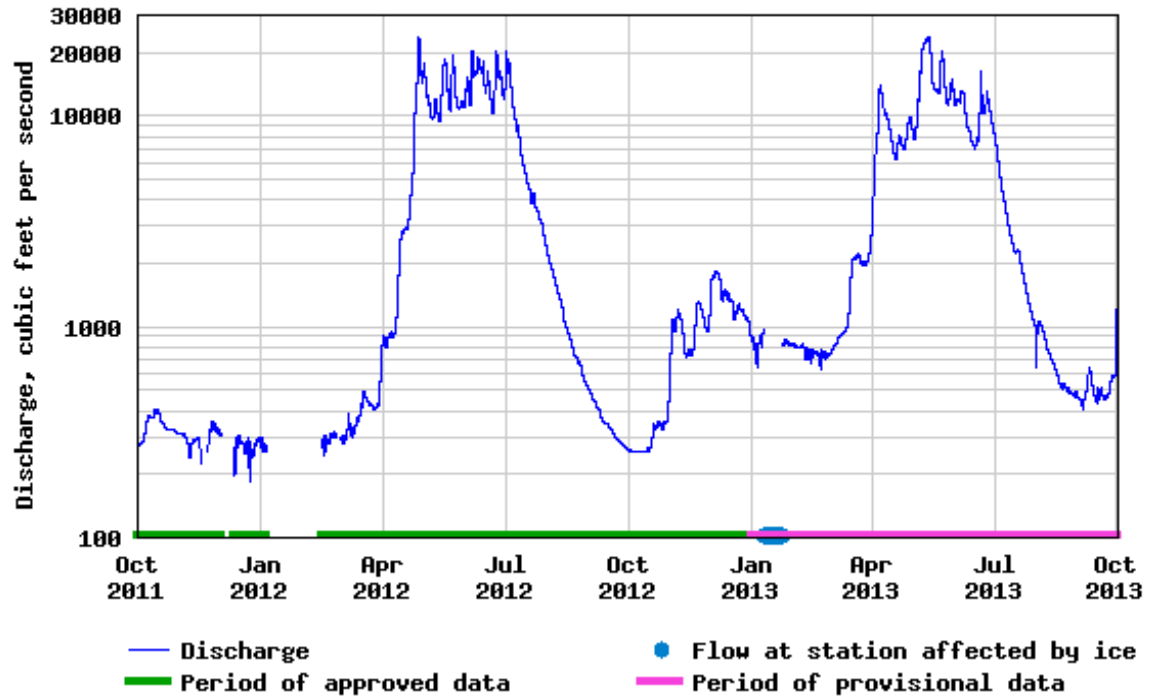


Figure 3. Stream discharge in the Kettle River near Laurier, WA for water years 2012 and 2013.

Methods

Determination of location and extent of mussel beds

A two-person crew launched a canoe near the Barstow Bridge and floated/walked down stream to the Napoleon Bridge. In route, viewing buckets and snorkels were used to search the substrate for mussels. The viewing buckets were made from black 3 gallon buckets with a Plexiglas bottom. When mussels were found, the area upstream was searched until no other individuals were encountered. This was considered the upstream boundary of the mussel bed. The stream was then searched left to right and downstream until no individuals were found. In this way the remaining margins of the mussel bed were determined. GPS waypoints were collected at the upstream and downstream ends of the bed and, along with field notes, were later used to map each bed location.

Timed search

Timed searches of each mussel bed were conducted by slowly walking through a mussel bed while identifying and counting the number of live and relic mussels. The substrate and mussels were viewed using viewing buckets and snorkels. Following the survey, catch per unit effort (CPUE) was calculated by dividing the number of individuals encountered by the total man hours searched.

Estimation of age structure

During the timed search 85 individual mussels were removed from the river so that the field crew could measure shell height, width and length. Measurements were taken using dividers and a ruler, and were recorded in mm. The mussels were then immediately placed back in the river at the collection point. Measurements taken were later entered into MS Excel and graphed.

Five mussels (left and right valves) were sent to Fort Hays State Department of Biological Sciences to be thin sectioned for age determination. These mussel shells were found along the stream bottom and, due to tissue still attached to the shell, considered to be recently deceased. Once these valves were thin sectioned using a low speed saw and attached to microscope slides, annuli were counted by multiple observers. Observer estimates were then considered and reconciled for a final estimate of age. Due to shell erosion along the umbo and shell margin, age determination was sub-optimal; therefore, ages represent the maximum number of visible annuli.

Quadrat search

Within a single mussel bed, a 0.25 m² quadrat was randomly placed to evaluate use of this method in the Kettle River. It is common to use a 0.25m² quadrat to evaluate mussel density and abundance; however, it was unknown if this would be feasible in the Kettle River due to large substrate, moderately swift currents, water depths >1.0 m, and cool water temperatures.

Results and Discussion

This section presents results and discussion organized by mussel bed. Descriptions are from the most upstream population near Barstow Bridge (01), to the most downstream population near the Napoleon Bridge (04) (Figure 4). Overall, 4 mussel beds were evaluated; 3 of which are considered previously un-documented. Close up maps of each mussel bed can be found in Appendix A and GPS locations can be found in Appendix B.

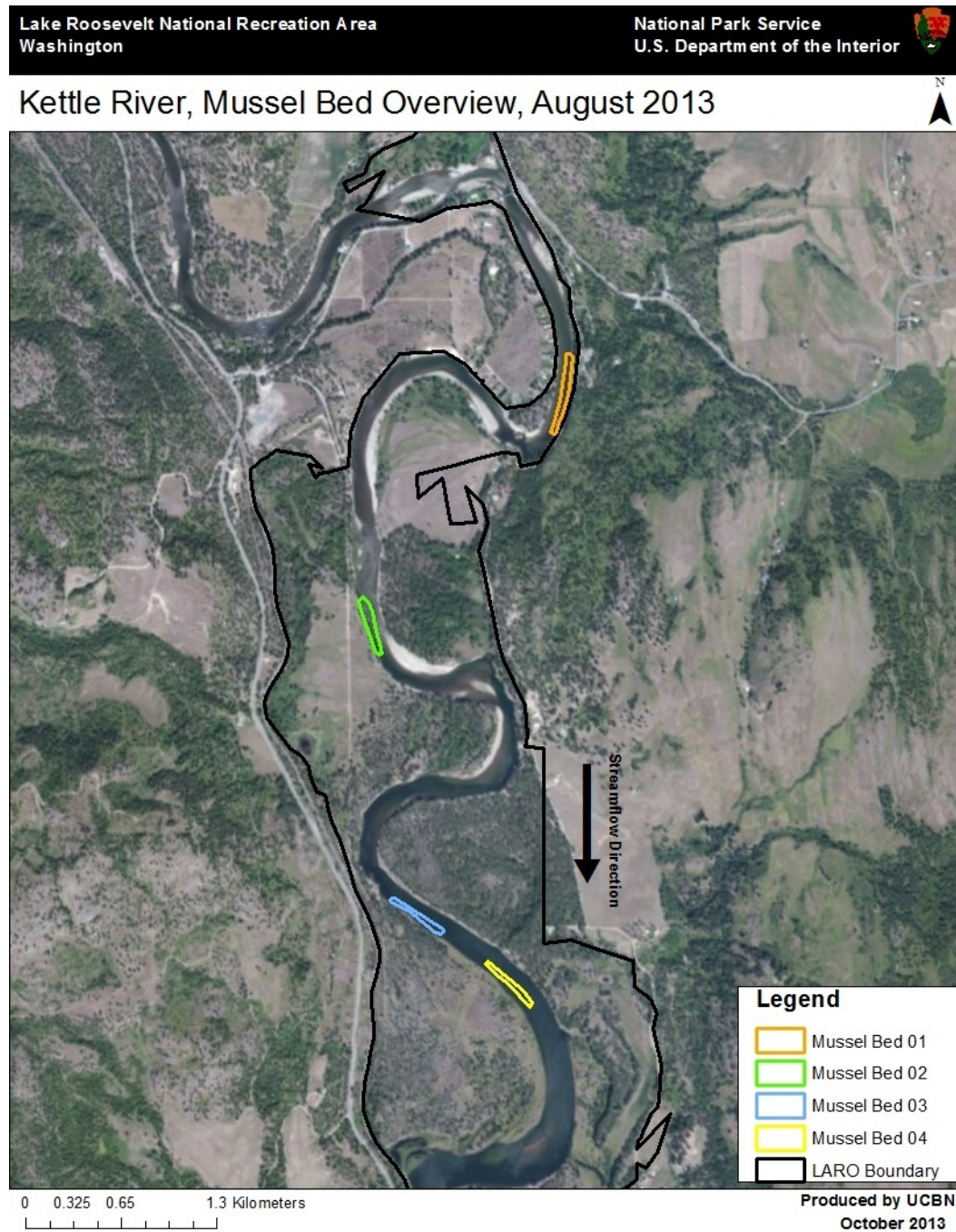


Figure 4. Lake Roosevelt National Recreation Area, Kettle River mussel bed locations.

Mussel bed 01 – Near Barstow Bridge

Individual mussels were found starting approximately 740 m downstream of Barstow Bridge, along the left bank (looking downstream). Population density increased moving downstream. The most downstream end of the mussel bed occurred just before the river bends back to the west (1.7 km downstream of bridge) and prior to the deep pool (Appendix A). Water depth varied from <0.5 m to 1.5 m. Access to this site is from the Napoleon-Barstow County Road along the East side of the stream. Individual mussels were generally found on the downstream side of boulders and cobble in stable sand/gravel substrate (Figures 5-6).

During a timed search (2.74 man hrs) 3,807 live and 7 relic *Margaritifera falcata* were found. In addition, 1 live and 2 relic *Anodonta oregonensis* (Oregon floater) were encountered. Catch per unit effort (CPUE) was 1,389.78 individual live mussels. Ten 0.25 m² quadrats were surveyed for a total of 57 live and 1 relic *Margaritifera falcata*. A more thorough survey is needed to obtain a better estimate of population density.

During the course of the timed search, it was noted that a high proportion of small individuals were found in the upper reaches of this mussel bed (Figure 7). On August 21st, eighty-five individual mussel shells were measured (length, height and width) from the middle and upper reaches of this mussel bed (n=42 and n=43 individuals respectively). Smaller individuals were collected almost exclusively from upstream, while larger individuals were found in the middle of the reach. Shell lengths are plotted in Figure 8 and are considered a proxy for age. At least 2 age classes exist within mussel bed 01 with older individuals appearing to be more numerous in the middle of the bed.

The smallest valve evaluated for age was 61 mm long and was confidently 8 years old when it died (Figure 9). The largest individual (146 mm) was estimated to be at least 68 years old. Due to the small sample size and eroded valves, additional age and growth data are needed to more accurately determine age structure for this mussel bed.



Figure 5. Lake Roosevelt National Recreation Area, Kettle River mussel bed 01, looking upstream.



Figure 6. Lake Roosevelt National Recreation Area, Kettle River mussel bed 01, western pearlshell mussels in situ.



Figure 7. Lake Roosevelt National Recreation Area, Kettle River mussel bed 01, small western pearlshell mussels.

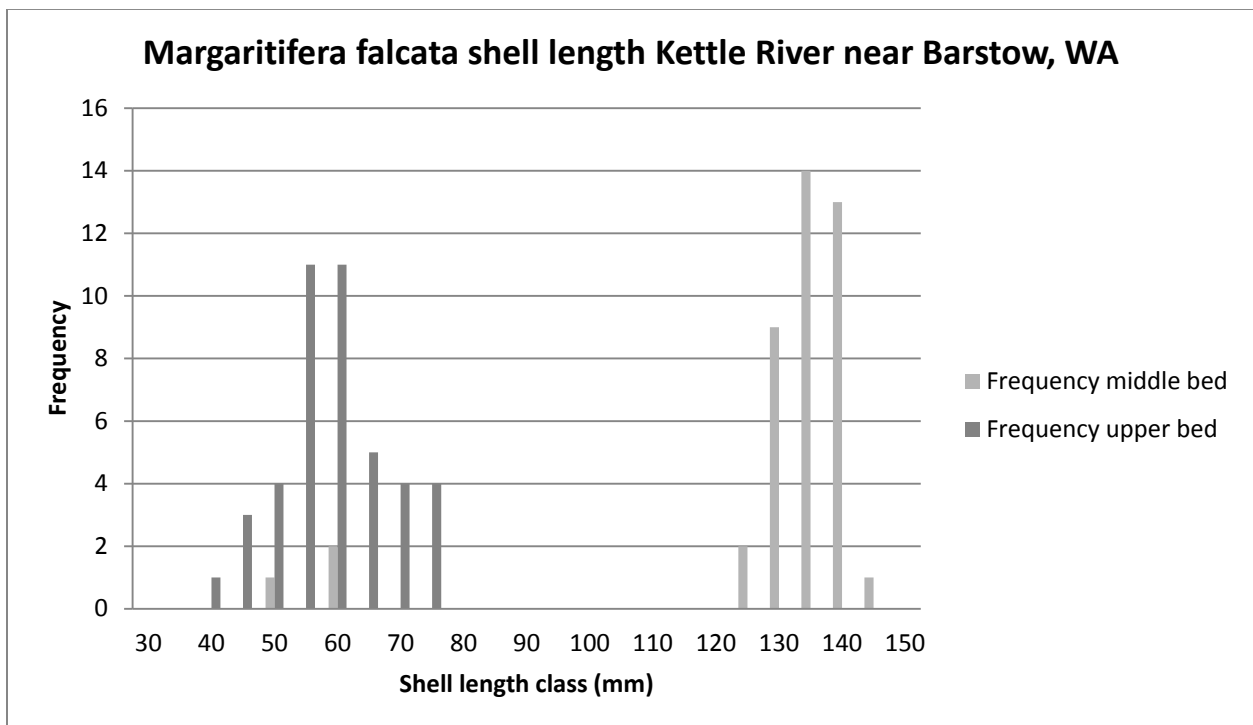


Figure 8. *Margaritifera falcata* shell length from the middle and upper portions of mussel bed 01 in the Kettle River.

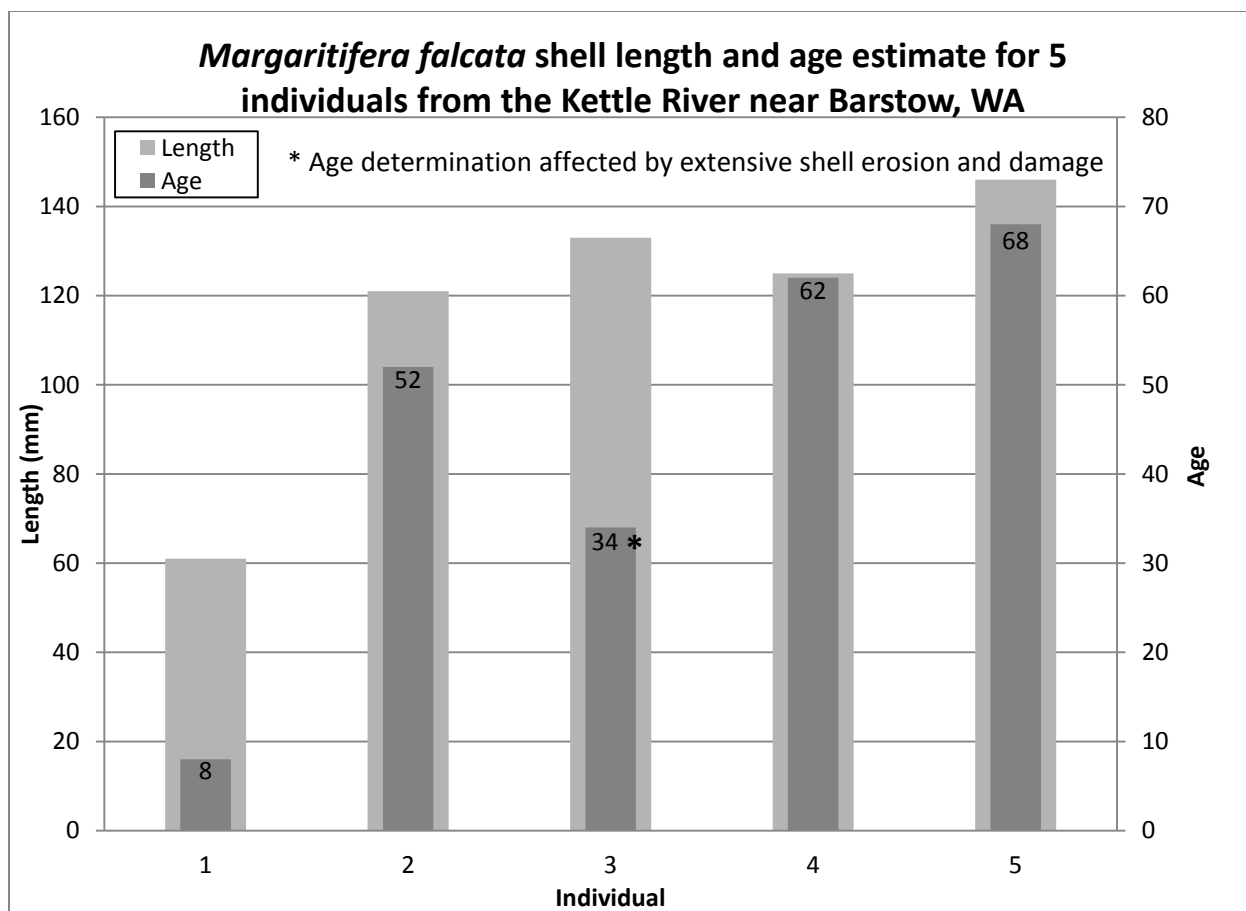


Figure 9. Shell length and estimated age of five *Margaritifera falcata*. Ages were based on the maximum number of visible annuli observed in thin sectioned valves.

Mussel bed 02- Barstow Bridge Spur Road

Access to this site is from the Barstow Bridge Spur Road. The best parking is approximately 1.91 km from Barstow Bridge Rd. This mussel bed is 5.0 km downstream of mussel bed 01 and is along the west side of the stream (right bank facing downstream) (Appendix A, Figure 10). It extends from near shoreline out to about mid-stream. Water depth varied from <0.2 m to over 2 m. Density appeared to be highest in ~2 m of water. Substrate was smaller than in mussel bed 01 and consisted of cobble with interstices generally filled with sand/silt substrate (Figure 11). A fine layer of silt and algae coated the substrate and mussels. In addition, Eurasian watermilfoil (*Myriophyllum spicatum*) was found growing throughout the mussel bed and, along a narrow band, prevented the field crew from seeing the bottom (Figure 12).

During a timed search (1.3 man hours) 1392 live and 15 relic *Margaritifera falcata* were found. Of the live mussels found only 10 were small individuals (~ 40 mm). Catch per unit effort (CPUE) was 1,070.77 individual live mussels. No other mussel species were encountered. Due to time constraints and water depth no quadrat search was conducted.

The abundance of fine sediment, presence of Eurasian watermilfoil and aged population may all pose a threat to this mussel bed. Follow up assessment of population age structure and density is advisable; however, water depth may prevent extensive sampling at this location without the use of scuba equipment.



Figure 10. Lake Roosevelt National Recreation Area, Kettle River mussel bed 02 looking upstream.



Figure 11. Lake Roosevelt National Recreation Area, Kettle River mussel bed 02. Note that mussels and substrate are coated with algae and sediment.

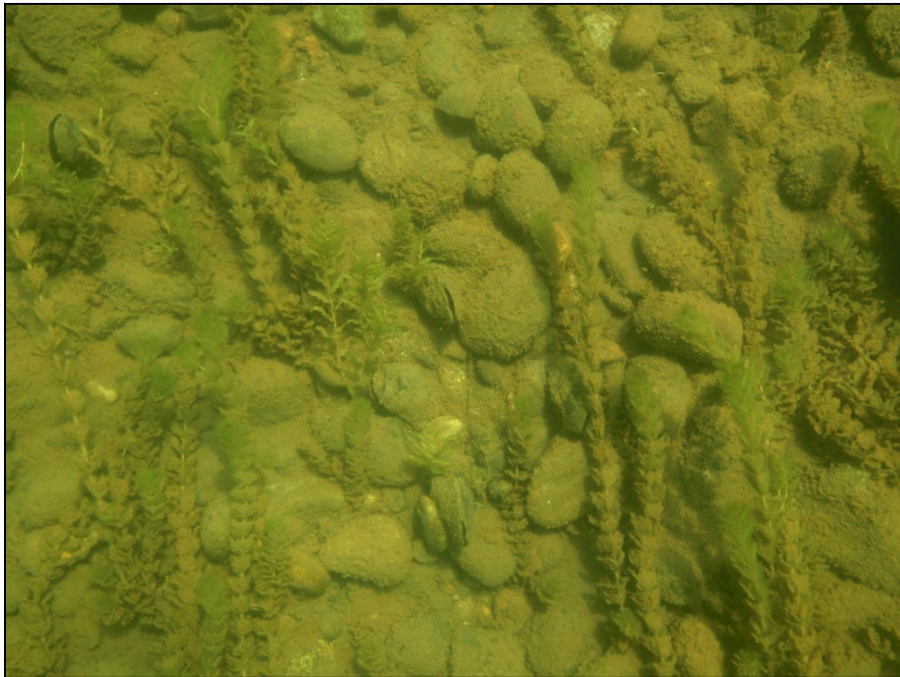


Figure 12. Lake Roosevelt National Recreation Area, Kettle River mussel bed 02, western pearlshell mussels amongst Eurasian watermilfoil.

Mussel bed 03- Barstow Bridge Spur Road

Access this site by driving south from Barstow Bridge Road ~4.4 km on the Barstow Bridge Spur Road, turn left onto a dirt 2 track and follow it ~500 m to the river. An all wheel drive vehicle with high clearance is recommended. Continue on foot ~100 m downstream of the rocky outcrop on the right bank (facing downstream). Mussel bed 03 is ~3.1 km downstream of mussel bed 02. The mussel bed is along the west side of the stream and in August began approximately 1 m out from the right wetted bank (Appendix A and Figure 13). Mussels can be found in a narrow band 3-5 meters wide and in water 1-1.5 m in depth. Due to the fact that these mussels are in a narrow band, this population is easy to overlook or miss if in a canoe. Substrate was cobble and fine gravel to sand coated by a fine layer of silt and algae (Figure 14). Eurasian watermilfoil (*Myriophyllum spicatum*) was found to be growing throughout the mussel bed; however, in general it was less dense than in mussel bed 02.

During a timed search (1.0 man hours) 1,771 live and 14 relic *Margaritifera falcata* were found. Of the live mussels no small individuals were found. Catch per unit effort (CPUE) was 1,771 individual live mussels. No other mussel species were encountered. Due to time constraints no quadrat search was conducted.

The abundance of fine sediment, presence of Eurasian watermilfoil and aged population may all pose a threat to this mussel bed. Follow up assessment of population age structure and density is advisable.



Figure13. Lake Roosevelt National Recreation Area, Kettle River mussel bed 03 looking downstream towards mussel bed 04.



Figure 14. Lake Roosevelt National Recreation Area, Kettle River mussel bed 03, western pearlshell mussels amongst Eurasian watermilfoil.

Mussel bed 04- Barstow Bridge Spur Road

Access this site by driving south from Barstow Bridge Road ~4.4 km on the Barstow Bridge Spur Road, turn left onto a dirt 2 track and follow it ~500 m to the river. An all wheel drive vehicle with high clearance is recommended. Continue on foot ~880 m downstream of the rocky outcrop on the right bank (facing downstream). Mussel bed 03 is ~350 m downstream of mussel bed 03. The mussel bed is along the west side of the stream and in August began approximately 1-2 m out from the right wetted bank (Appendix A and Figure 13). Mussels can be found in a narrow band 3-5 meters wide and in water 0.5-1.5 m in depth. Due to the fact that mussels are in a narrow band, this population is easy to overlook or miss if in a canoe.

Note that this was delineated as a separate mussel bed from 03 because no individuals were found between beds 03 and 04. If mussels are found in between these locations, it should be considered a single mussel bed. Substrate was coble and fine gravel/sand and was coated with a fine layer of silt and algae (Figure 15). Eurasian watermilfoil (*Myriophyllum spicatum*) was found growing in parts of the mussel bed and in areas was thick enough to prevent the observation of mussels.

During a timed search (0.8 man hours) 373 live and 10 relic *Margaritifera falcata* were found. Catch per unit effort (CPUE) was 466.25 individual live mussels. No other mussel species were encountered. Due to time constraints no quadrat search was conducted.

The abundance of fine sediment, presence of Eurasian watermilfoil and aged population may all pose a threat to this mussel bed. Follow up assessment of population age structure and density is advisable.



Figure 15. Lake Roosevelt National Recreation Area, Kettle River mussel bed 04, western pearlshell mussels amongst Eurasian watermilfoil.

Summary

In summary, mussel bed 01 exhibited the highest CPUE of western pearlshell mussels, followed by bed 03, 02 and 04 (Table 1). Habitat quality, based on the presence of clean fine gravel/sand and lack of aquatic vegetation, appeared to decline moving from upstream to downstream. This observation was not unexpected given the increasing influence of the reservoir as one proceeds downstream. It is important to note that the influence of Lake Roosevelt on these mussel populations is largely dependent on lake levels (Figure 2). Full pool (1,290' msl) conditions in July likely contributed to the amount of fine sediment and algal growth encountered in each bed.

The notable absence of small individuals from mussel beds 03 and 04 may indicate that these are senescent populations dominated by old individuals unable to successfully reproduce. Ideally, this cursory observation should be confirmed with more intensive quantitative methods such as quadrat searches. Additionally, an accurate assessment of individual ages within each bed may shed light on each population's status.

The presence of Eurasian watermilfoil in all but one mussel bed (01) is concerning and likely poses a risk to the continued existence of western pearlshell in this portion of the Kettle River.

Table 1. Summary results of timed search of mussel beds 01-04.

Mussel Bed #	Timed Search Man Hours	# of live <i>M. falcata</i>	# of relic <i>M. falcata</i>	Catch per unit effort (CPUE)
01	2.74	3,807	7	1,389.78
02	1.3	1,392	15	1,070.77
03	1.0	1,771	14	1,771.00
04	0.8	373	10	466.25

Data about populations upstream of the park would be useful to LARO when considering management/monitoring priorities for Eurasian watermilfoil and freshwater mussels within the Kettle River. Collaboration with tribal, state, and federal agencies should be considered in order to understand how LARO's Kettle River mussel populations fit within the context of the watershed.

Future Considerations

Access

Unless field crews are searching for new mussel beds, access to each site can be accomplished with a high clearance vehicle and on foot.

Timing

Future surveys and sampling should occur in late August to coincide with minimum stream flow and lake levels near 1,280' mls. Even during low flow some portions of each mussel bed were difficult to evaluate due to water depth and swift current. An additional consideration is water temperature. Even in August the field crew became cold after only 30 minutes in the water. Not only do cold water temperatures pose a safety threat, it can negatively influence data quality. Wetsuits are advisable for extended wet-wading and visual timed searches.

Use of Quadrats

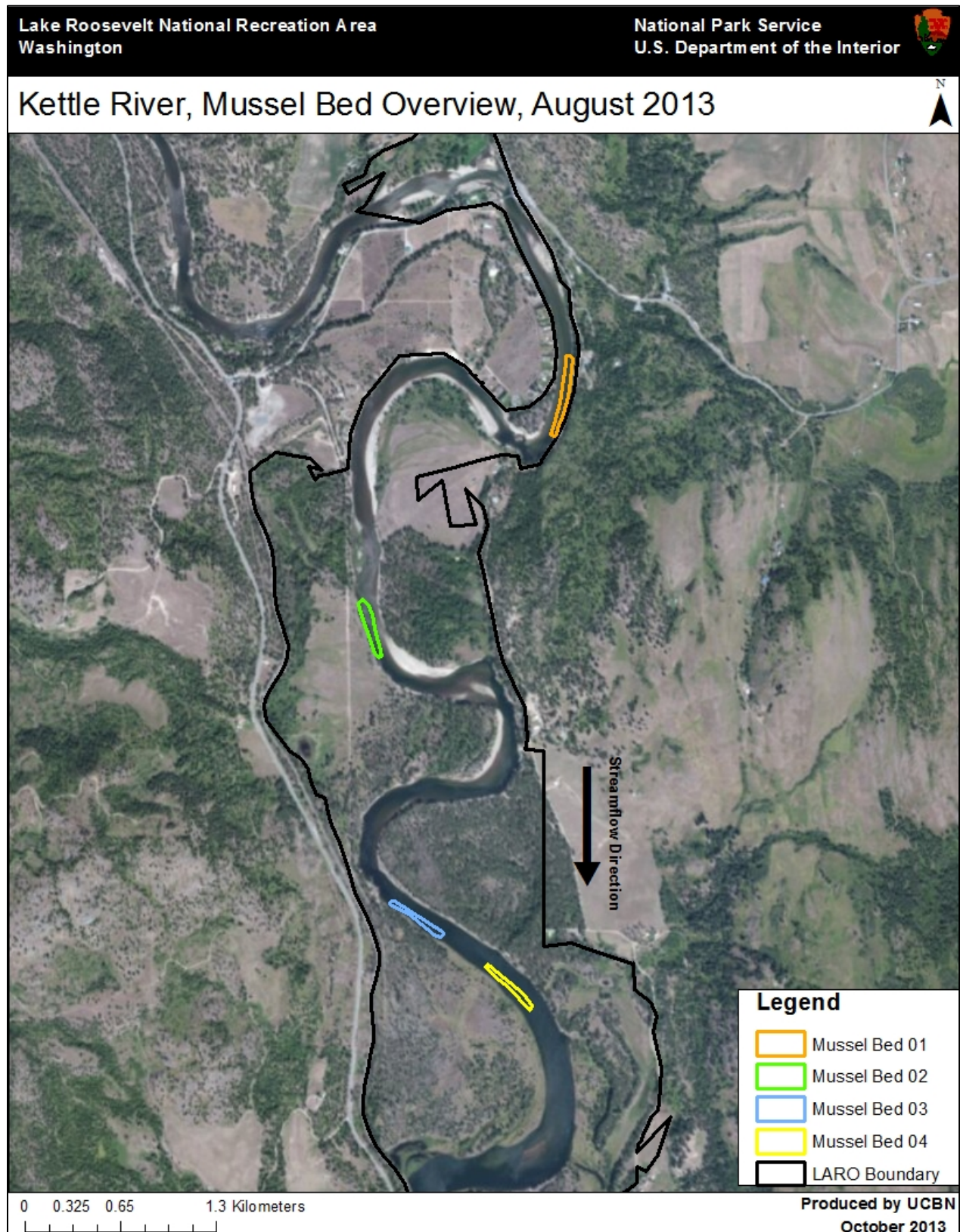
The use of 0.25m² quadrats is advisable in order to obtain more accurate population abundance estimations. The largest substrate encountered (small boulder) rarely prevented placement of the quadrat; however, quadrat placement might be hindered by water depth. A successful quadrat search requires that a field technician can reach the substrate and dislodge individual mussels. This would not be possible in parts of mussel bed 01 and the majority of mussel bed 02.

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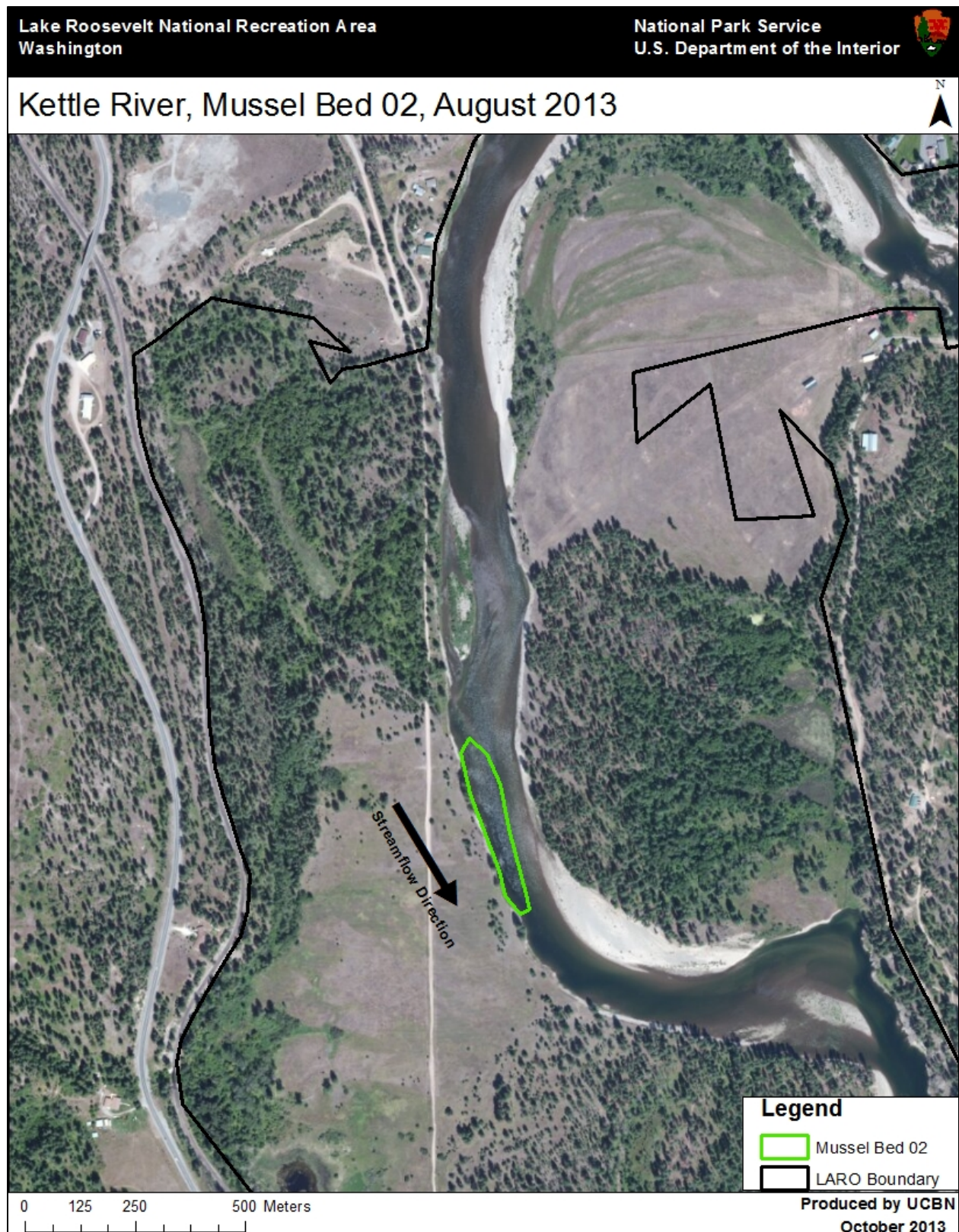
Appendix A LARO- Kettle River Mussel Bed Maps



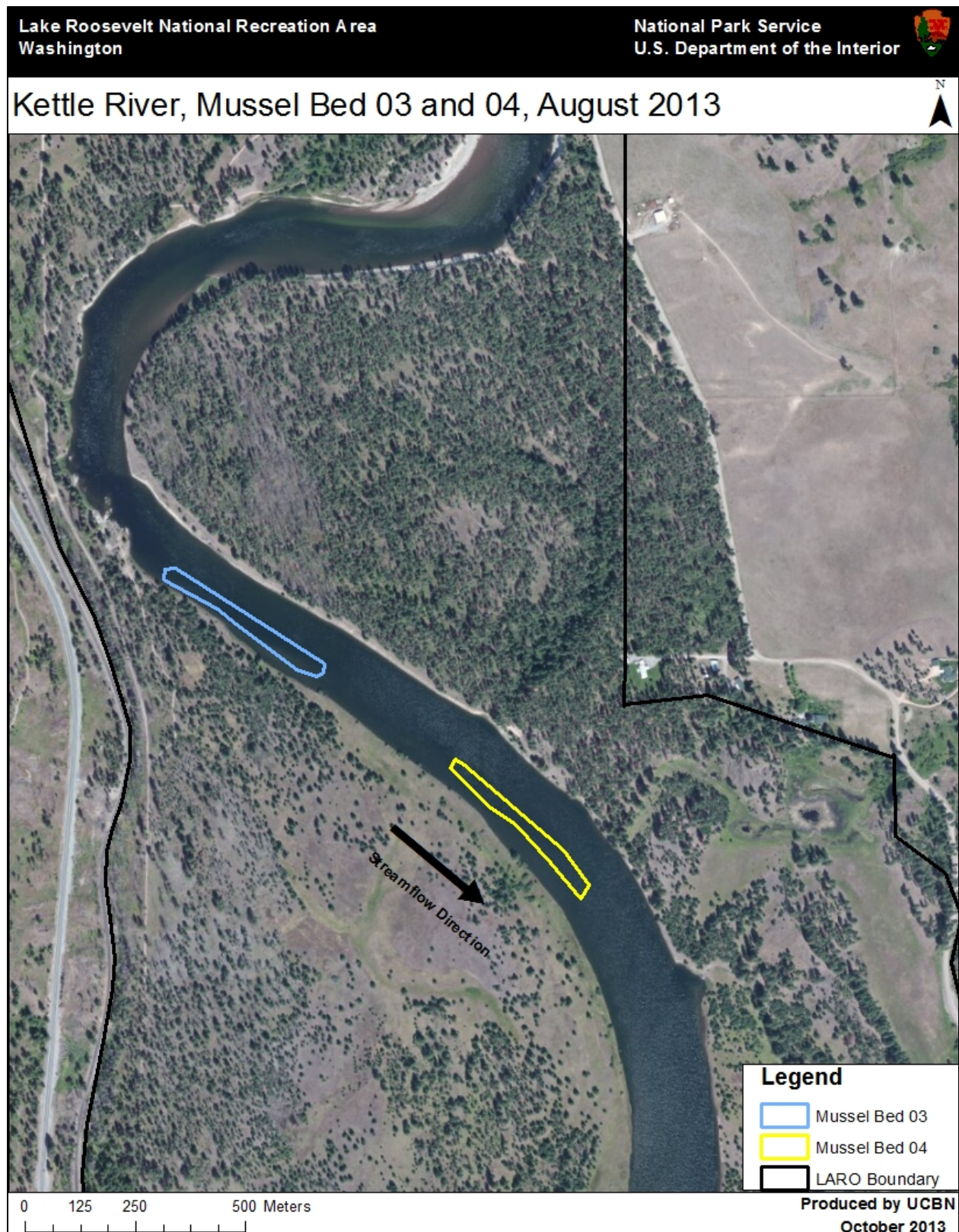
Appendix A LARO- Kettle River Mussel Bed Maps (continued)



Appendix A LARO- Kettle River Mussel Bed Maps (continued)



Appendix A LARO- Kettle River Mussel Bed Maps (continued)



Appendix B: Mussel Bed GPS Waypoints

The GPS locations for the up and downstream edge of mussel beds 01 through 04 are presented in the table below. The projected coordinate system is NAD_1983_UTM_Zone_11N.

Mussel bed # and location	lat	long	y_proj	x_proj
01-UP	48.78071700000	-118.12243500000	5403687.15875100000	417543.15891500000
01-DWN	48.77504200000	-118.12256700000	5403056.47905500000	417524.16459500000
02-UP	48.76815700000	-118.13438400000	5402304.01896000000	416644.57802700000
02-DWN	48.76617400000	-118.13323300000	5402082.33400000000	416725.87386200000
03-UP	48.75612200000	-118.13247800000	5400964.15067000000	416764.74362700000
03-DWN	48.75496900000	-118.12948400000	5400832.71936000000	416982.89400400000
04-UP	48.75359900000	-118.12663200000	5400677.32979000000	417190.26078200000
04-DWN	48.75195400000	-118.12409000000	5400491.71581000000	417374.40219700000

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