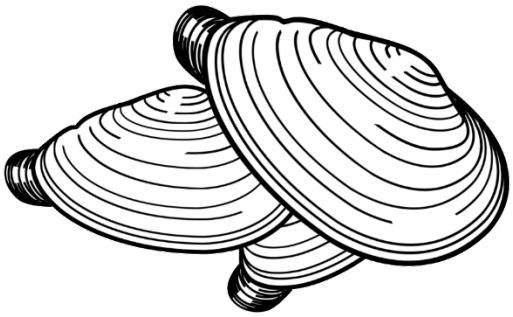
Fatmucket Mussel Response to a 7 foot drawdown of Black Eagle Reservoir, Missouri River, Montana July 2019



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Introduction

In July 2019, NorthWestern Energy conducted a drawdown of Black Eagle Reservoir to repair a dam waste gate damaged by the June 2019 high water event and to seal flash boards that were replaced in 2018. The current Missouri River and Reservoirs Fisheries Monitoring Agreement (2018-2026) between NorthWestern Energy (NWE) and Montana Fish, Wildlife & Parks lists the objectives for the Great Falls Reservoirs and their tailwaters which include "…2) conducting periodic evaluations of aquatic organisms and habitat in Black Eagle Reservoir during maintenance drawdowns…" As such, NWE conducted this evaluation to determine the likely influence a 7 foot drawdown would have on mussel (clam) behavior and survival in Black Eagle Reservoir.

Study Area

NorthWestern Energy uses historic Montana Power data to reference reservoir elevations. The base elevation for this drawdown was 3,284 feet which exposed river bed upstream from Black Eagle Dam approximately 2.72 miles. (Figure 1). A survey was conducted in three sections of the exposed river bed that totaled 1.85 miles. Time for this survey was 5 hours, 1 minute (Table 1).

Table 1. Mussel survey locations, distance and time. Black Eagle Reservoir, Missouri River, Montana. July 24, 2019.

Bank	Survey reach	Distance (mi)	Time (h:m)
Right	10th Street Bridge to Central Ave W. Bridge	1.26	3:41
Left	Downstream 10th St. Br. to waste water plant effluent	0.41	1:01
Left	Black Eagle Dam to deposition bar upstream	0.18	0:19

The prescriptions for reservoir drawdown are filed with FERC as a condition of License 2188, Article 403. Black Eagle Reservoir standard operating elevation is 3,291 feet. The drawdown plan for Black Eagle Reservoir stipulates between 3,289 and 3,285 feet the rate is 0.10 foot per hour and below 3,285 is 0.05 foot per hour. The July 2019 drawdown base elevation was 3,284.

Methods

A turbidity meter in the powerhouse intake at Black Eagle Dam measured turbidity on 15 minute intervals during the process. Reservoir forebay elevation was measured by a pressure transducer in a stilling well located near the powerhouse intake on 5 minute intervals and mean nephelometric turbidity (NTU) values were measured at penstock intake lines on 15 minute intervals using a Hach - Surface Scatter 7 sc turbidity meter.

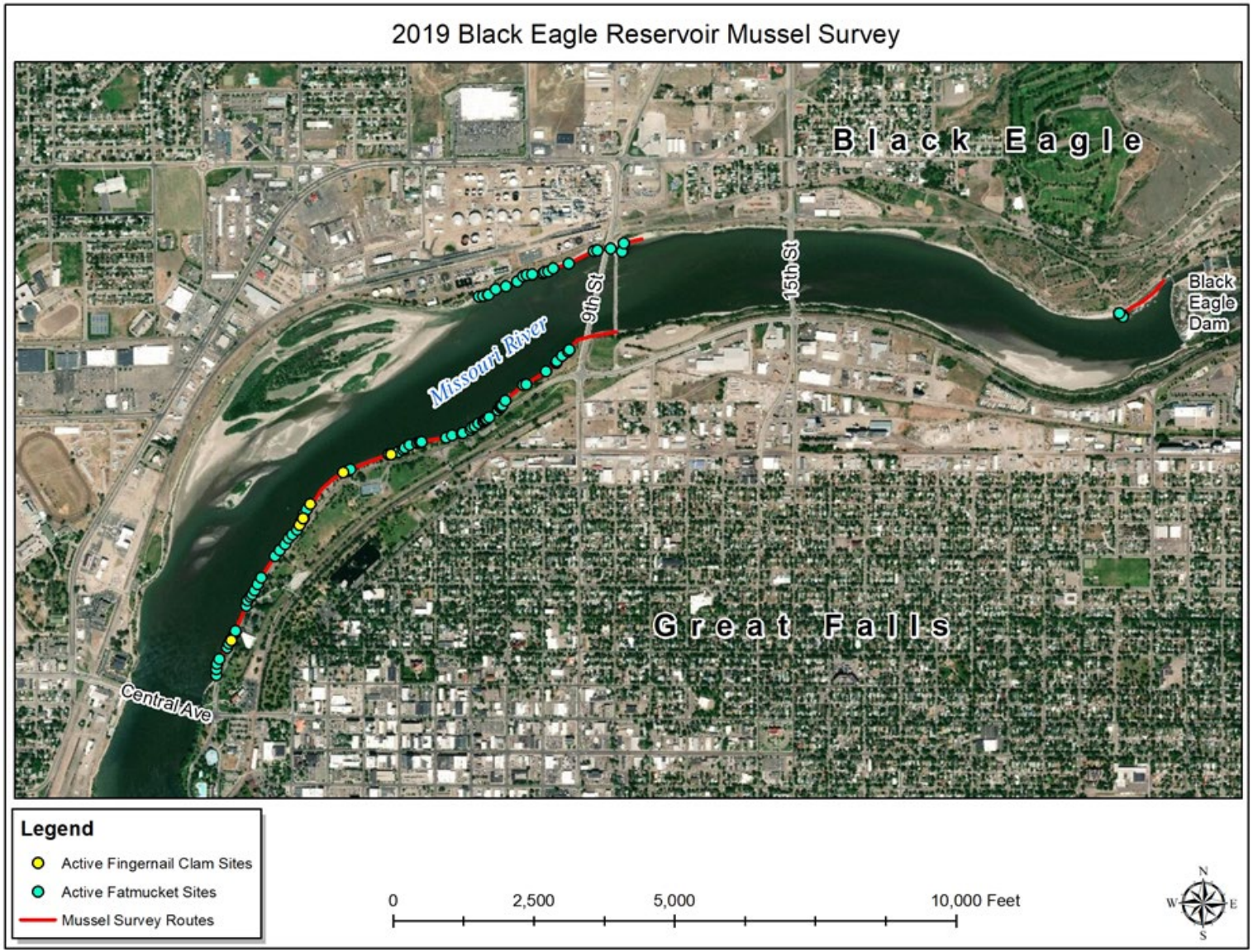

Figure 1. Black Eagle Reservoir mussel survey locations July 24, 2019. Missouri River, Montana.

Given the uncertainty in the amount of river bed exposed during this drawdown, NWE staff was prepared to follow one of two protocols to describe mussel status, behavior and response. The quantitative method uses a systematic random sampling design with defined grid areas where sampling effort (area/m2) increases with stream size (Piette 2005). With this method a surveyor would walk the exposed shoreline and count the number of mussels present at 50 randomly selected $1m^2$ sites. Randomness would have been established by a surveyor throwing a $1m^2$ PVC pipe square to a random location and counting the number of mussels in the area where it landed (Scheaffer et al. 1990, Smith et al. 1999). The qualitative method uses a given amount of sampling effort (person-hours or distance) to establish a species list, presence and condition (Piette 2005). The July 2019 drawdown exposed a band of river bed along the littoral zone (shore line) ranging ~5-40 feet, depending on slope of the river bed. As such, the amount of riverbed exposed during this drawdown provided conditions most suited for a qualitative survey. The survey was conducted on July 24, approximately 58 hours after the drawdown began. A surveyor walked the shoreline and recorded the number of live and dead mussels, evidence of motility (track length), sessile or burrowed and size (length in mm). A GPS coordinate was taken at each site, and the number of mussels within a ~10 foot radius were counted as one GPS location. Relic mussel shells were also counted and measured.

A large portion of the dead mussels were eaten by raccoons or gulls as evidenced by tracks of both animals and the mantle/foot removed from the shell with reasonably fresh tissue remaining. In such cases, death by dewatering was the likely cause because it would be difficult for a raccoon or gull to pry apart a live mussel with a retracted mantle. Relic mussels showed evidence of no fresh tissue remaining, periphyton on the shell, and shell halves. Relic mussel shells were sampled to compare their size with live and recently-live shells. The hypothesis was that relic shells likely died of old age, natural causes or previous drawdown events.

Statistical pre-tests showed the data were normally distributed and sample means were similar with unequal variances. A Welch's t-test for unequal variances was used to determine if size was a factor in whether a mussel was alive or dead, burrowed, or showed motility. These tests were performed on data within this sampling period, and not across habitats or time. The level of significance was $\alpha=0.05$.

Results

The drawdown below 3,289 feet began on Sunday July 21, 2019 at 20:45 and followed the prescribed rate of 0.10 foot per hour (based on a 4 hr running average) for 38 hours until forebay elevation reached 3,285 on July 23 at 11:25 (Figure 2) .Over the next 11 hrs 50 min, elevation dropped at the rate 0.001 foot per hour until reaching 3,284. Mean NTU value measured during the drawdown was 46.8 (range 32-80) and mean value outside the drawdown was 34.1 (21.3-96.0) (Figure 3). Mean daily NTU value during the drawdown ranged 5-41% of the pre drawdown values (Figure 4).

The total amount of linear bank effected by the drawdown was 5.70 miles (not including islands). The survey was conducted on 32% of the affected area and identified two mussel species; fatmucket (*Lampsilis siliquoidea)* (Figure 5) and the grooved fingernail clam (*Sphaerium simile)* (Figure 6).

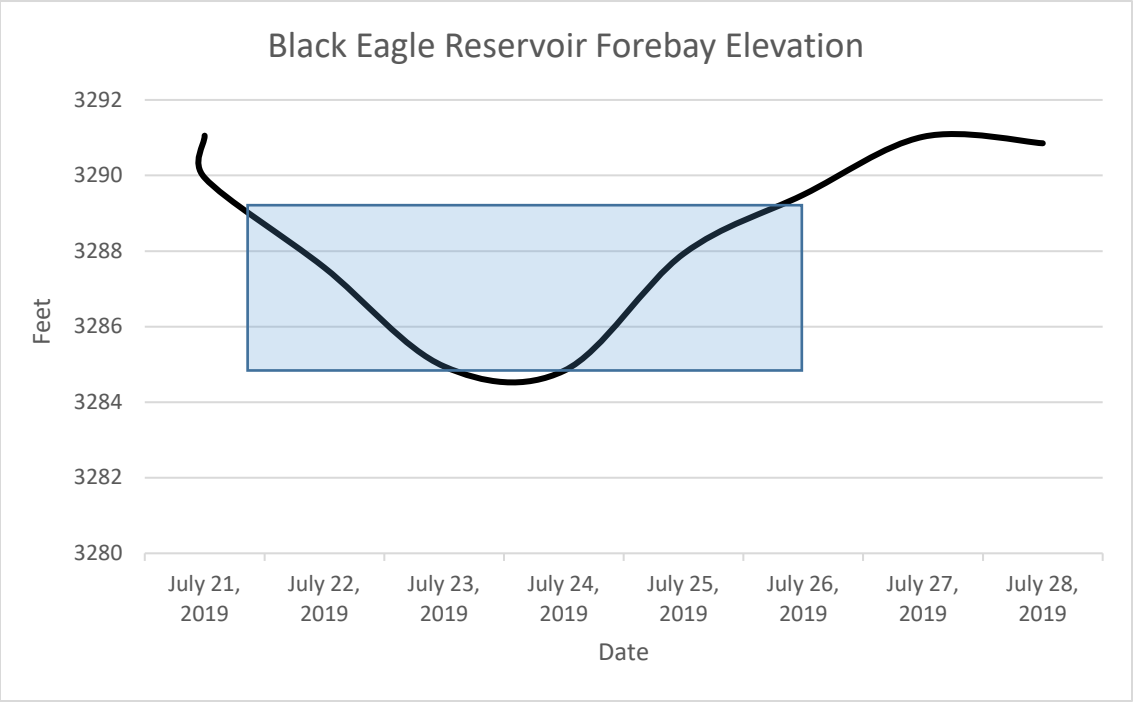

Figure 2. Black Eagle Reservoir forebay elevation during the July 21-26, 2019 maintenance drawdown. Note; the drawdown plan was in effect durign the time period and elevation hilighted in the blue box. Missouri River, Montana.

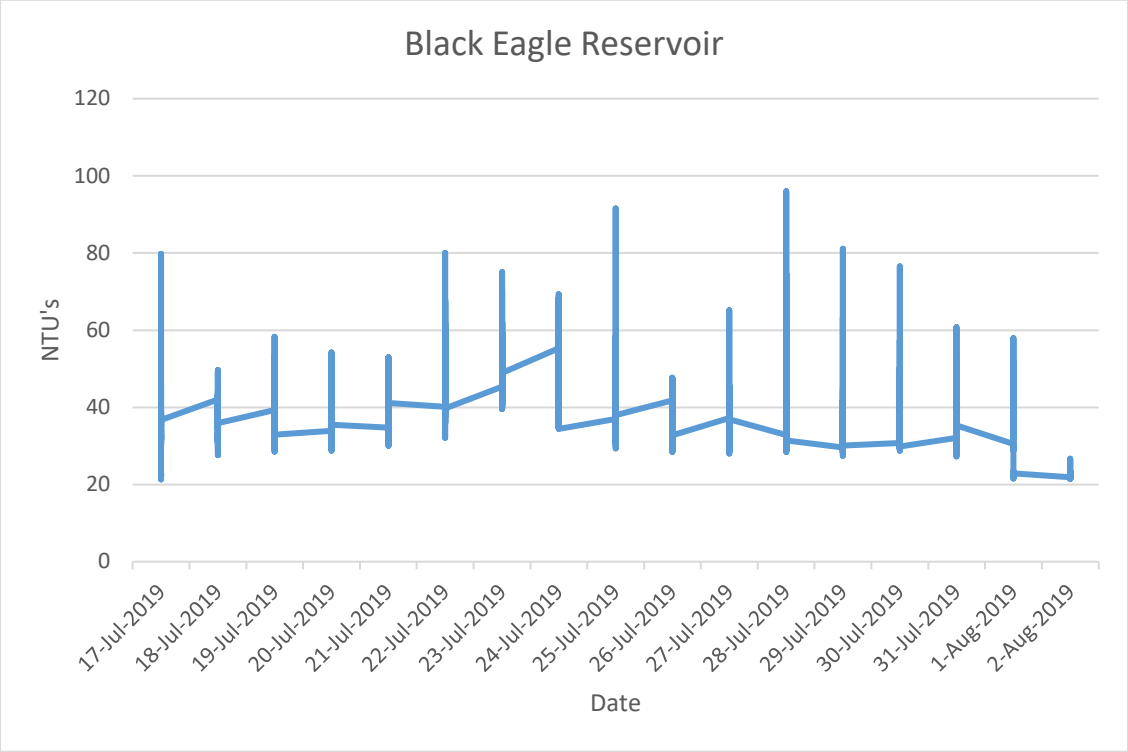

Figure 3. Fifteen minute interval NTU data gathered before, during and after the July 21-23 drawdown at Black Eagle Reservoir, Missouri River, MT.

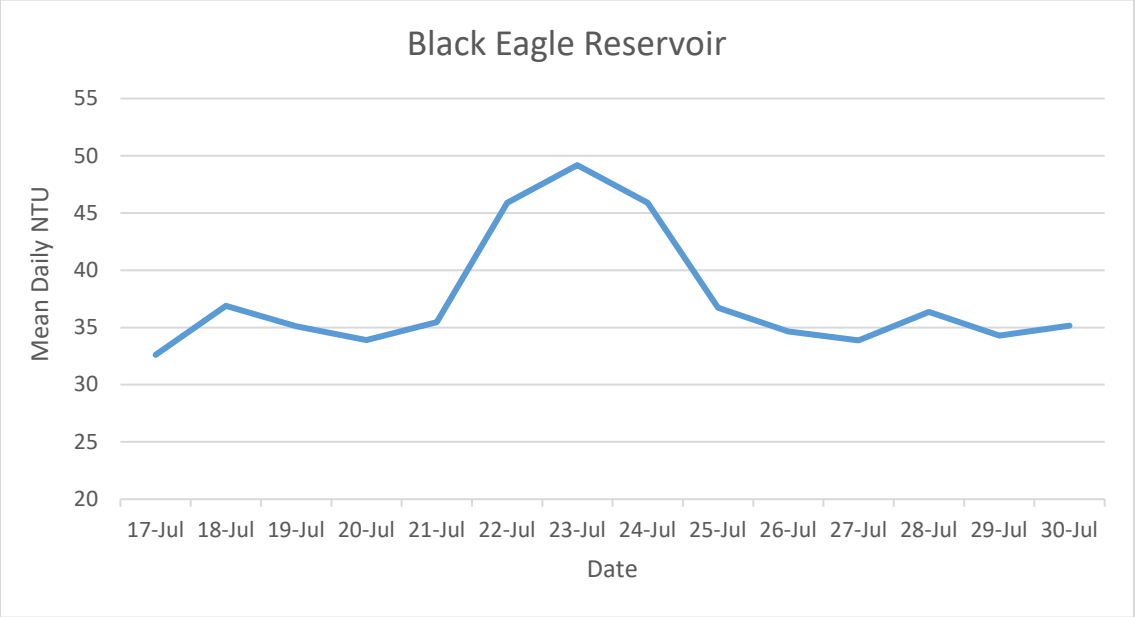

Figure 4. Mean daily NTU values before, during and after the July 21-23 drawdown at Black Eagle Reservoir, Missouri River, MT.

Figure 5. Fatmuckets (*Lampsilis siliquoidea)* sampled during Black Eagle Reservoir drawdown survey. Missouri River, Montana. July 24, 2019.

Figure 6. Grooved fingernail clams (*Sphaerium simile)* sampled during Black Eagle Reservoir drawdown survey. Missouri River, Montana. July 24, 2019.

Because fingernail clams are very abundant in this reach of river, and difficult to quantify with limited time, only fatmuckets were included in the analysis. Nevertheless, six areas within the survey area had very high abundance of fingernail clams that were considered "beds" (Figure 1). Visual estimates on the number of grooved fingernail clams at these sites ranged from ~200-1000.

A total of 135 fatmuckets were sampled. At the time of the survey 47% were alive and 53% were dead (Table 2). Dead mussels that were preyed upon by raccoons or gulls were included in the survey because they likely died as a result of stranding during the drawdown (Figure 7).

Table 2. Number and disposition of fatmuckets surveyed in Black Eagle Reservoir. Missouri River, Montana. July 24, 2019.

	# of fatmuckets	Sessile	Motile	Buried	Buried and Motile
Alive	63	41	3	12	7
Dead	72	61	9	2	0
Total	135	102	12	14	7

Figure 7. A fatmucket with residual mantle tissue, presumably preyed upon by a gull or raccoon. Black Eagle Reservoir, Missouri River, Montana. July 24, 2019.

Evidence of fatmucket motility was demonstrated as a track in the mud created by the mantle/foot (Figure 8). Some dead mussels showed evidence of motility before dying. Overall, 14% of the fatmuckets observed showed signs of motility. There was no significant difference in size between live and dead fatmuckets ($t(115) = 0.875$, $p = 0.38$) or for motile ($t(2)=0.43$, $p=0.71$) or buried ($t(11) =-0.45$, $p=0.65$) sub groups. A subsample (42%) of motile fatmuckets showed the mean length of a track was 5.0 feet (range=1.7-11.0). For live fatmuckets, mean track length was 4.5 feet (range 1.7-8.1) and for dead fatmuckets it was 5.8 feet (range 2.9-11.0). Approximately 90% of the fatmuckets that buried/burrowed were alive (Figure 9).

Figure 8. Example of a motile fatmucket that is partially buried and alive. Note the gull tracks in the mud. Black Eagle Reservoir, Missouri River, Montana. July 24, 2019.

Figure 9. A sessile live fatmucket partially buried in mud. Black Eagle Reservoir, Missouri River, Montana. July 24, 2019.

Overall 55 relic shells were sampled. Mean length was 89 mm (range 64-126) which is slightly larger than live or recently dead fatmuckets.

Discussion

Mussels exhibit at least two major behaviors in response to dewatering that include burrowing vertically into the substrate and moving short distances horizontally (Galbraith et al. 2014).

In this survey, we found slightly more than half (53%) of the fatmuckets exposed were vulnerable to stranding and death by dehydration, overheating or predation. The ability of a fatmucket to move and burrow improved chances of survival up to 9 times. Mean distance traveled by motile fatmuckets was 5 feet and the ability to travel up to 11 feet suggests that some of the fatmuckets could have moved far enough to reach the water before the survey occurred, which means they could have left the survey area and survived.

The survey occurred 58 hours after the drawdown from 3,291 feet began. Maximum air temperature recorded by the National Weather Service in Great Falls was 88ºF on July 24, 2019 and it was 90 and 98ºF for the two preceding days, respectively. During this period, daily minimum and maximum air temperatures were as much as 41ºF apart. Archembald et al. (2014) reported the 96-hr acute median lethal temperature (LT50) values in watered and dewatered exposures for juvenile mussels of two species (*Lampsilis abrupta and Lampsilis radiate*) was 91.0ºF (range 85.8-96.0). In 96-hr dewatering experiments, the median lethal temperature that caused 50% mortality to *L. abrupta* was 96.0ºF. Some mussel species can reportedly survive up to 60 days out of water when relative humidity is ≥60%, and can survive 6-10d in air

temperatures up to 77°F at 45-44% relative humidity (Bartsch et al. 2000). According to the University of Utah Department of Atmospheric Sciences MesoWest data base, from July 22-26, 2019 the daily mean relative humidity for Great Falls ranged 32-58.5% which suggests mussel survival could have been improved slightly by the atmospheric conditions at the time of the July 2019 drawdown.

The air temperature conditions during this survey represented some of the harshest conditions expected for mussel survival. Factors that could lessen the impact of a reservoir drawdown on fatmucket mussels include: 1) moderate to high relative humidity, 2) daily temperature swings of 41°F and 3) the short duration (<3d) of the drawdown which allowed moisture in the river bed to facilitate burrowing and provided a sufficient amount of moisture for fatmuckets.

The observation of live mussels at this time of the survey suggests these factors combined to facilitate survival by about half of the fatmuckets exposed by a 7 foot drawdown of Black Eagle Reservoir.

References

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