



Title	The effects of endangered freshwater pearl mussels on channel morphology and flow in a low-gradient sandy river
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Citation	Hydrobiologia, 848(21), 5119-5134 https://doi.org/10.1007/s10750-021-04696-6
Issue Date	2021-12
Doc URL	http://hdl.handle.net/2115/87364
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Type	article (author version)
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Online Resource 1

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Author names

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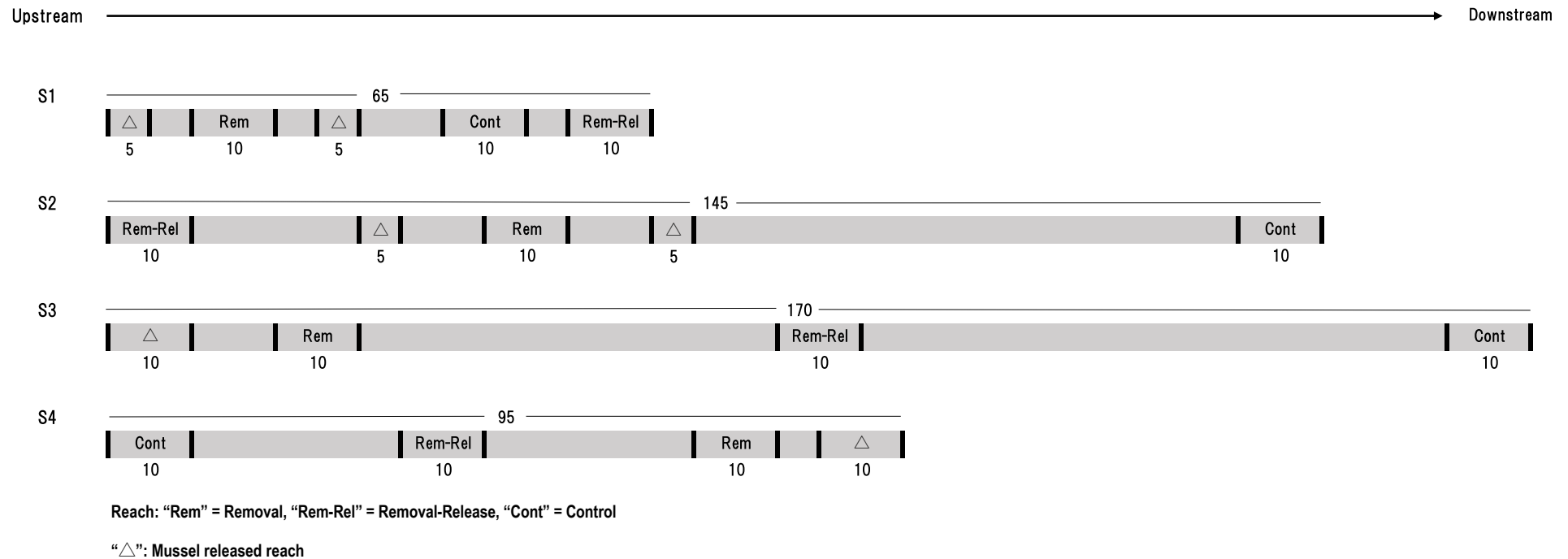


Figure S1 A conceptual diagram demonstrating the positional assignments of the study reaches for three manipulative treatment levels as well as the locations of areas where mussels were released from "Removal" reaches in four study sections. The arrow on the top indicates the flow direction of the study river and all the numbers indicate the section or reach lengths in meters. The length of reaches that were not used in the experiment is proportionate to their actual length.

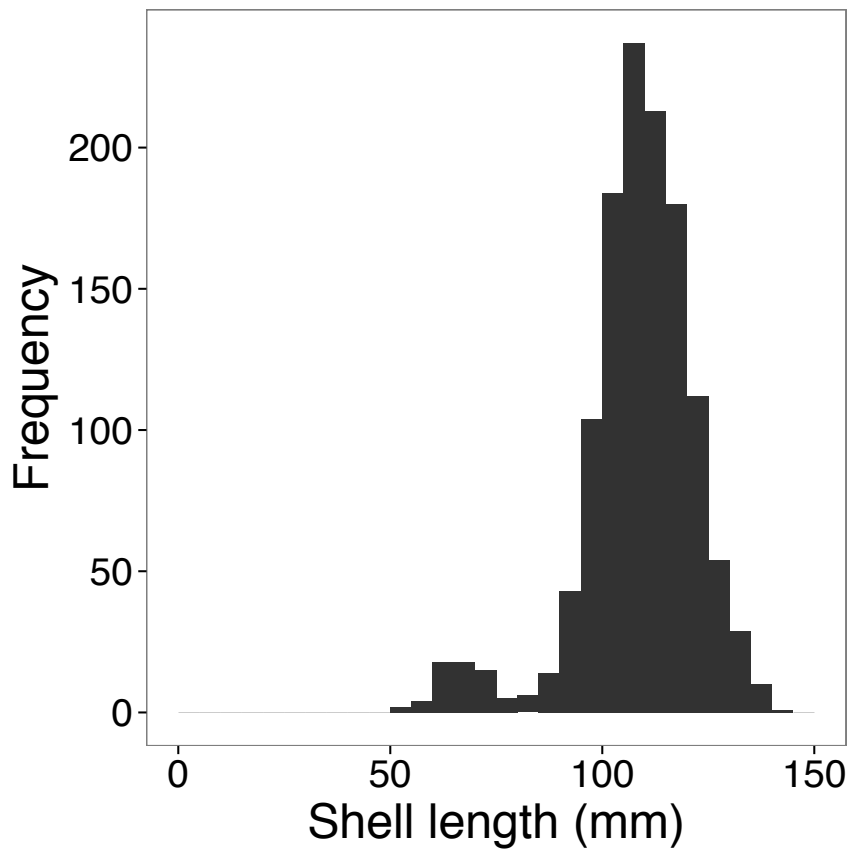


Figure S2 Length-frequency distribution of *Margaritifera laevis* and *M. togakushiensis* collected from the study segment.

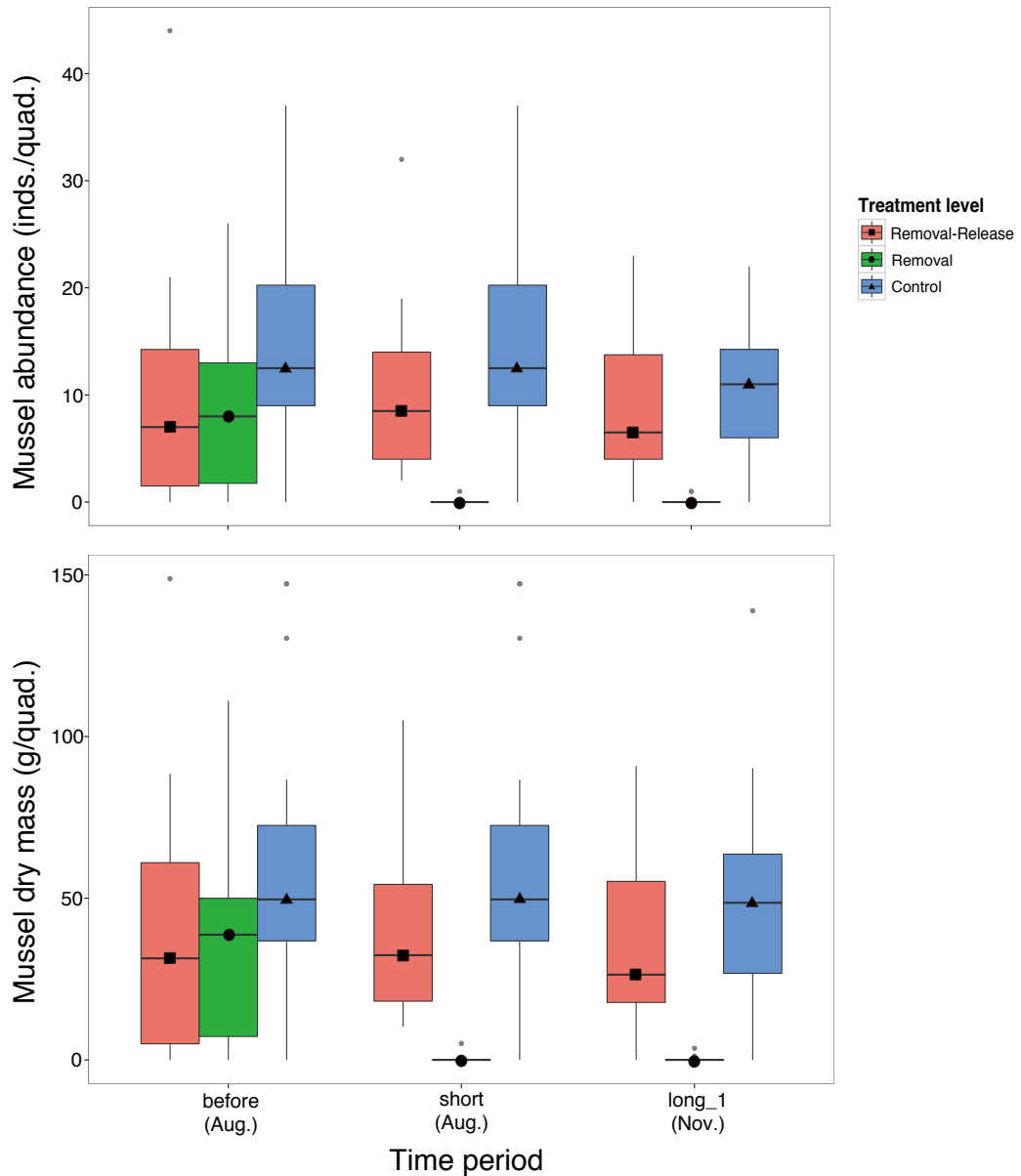


Figure S3 Boxplots showing the mussel abundance (top) and mussel dry mass (bottom) in reaches for each treatment (“Removal–Release,” “Removal,” and “Control”) on each time period (“before,” “short,” and “long_1”) in 2015. The lower ends, top ends, and central thick lines of boxes represent 25% and 75% quartile ranges, and medians, respectively. Error bars indicate a maximum value within 1.5 times of the box height, with outliers as gray circles. The values of mussel abundance and biomass of the “Control” group in the “short” time period were absent because of the reason mentioned in the main text (see [Mussel abundance, biomass, and physical variable measurements](#) in the “Materials and Methods” section). In this figure, an assumption was thus made that the mussel abundance and biomass values in the “short” time period to be the same as those in the “before” time period (within five days) in the “Control” group the mussel abundance and biomass values in the “Control” on “before” time period.

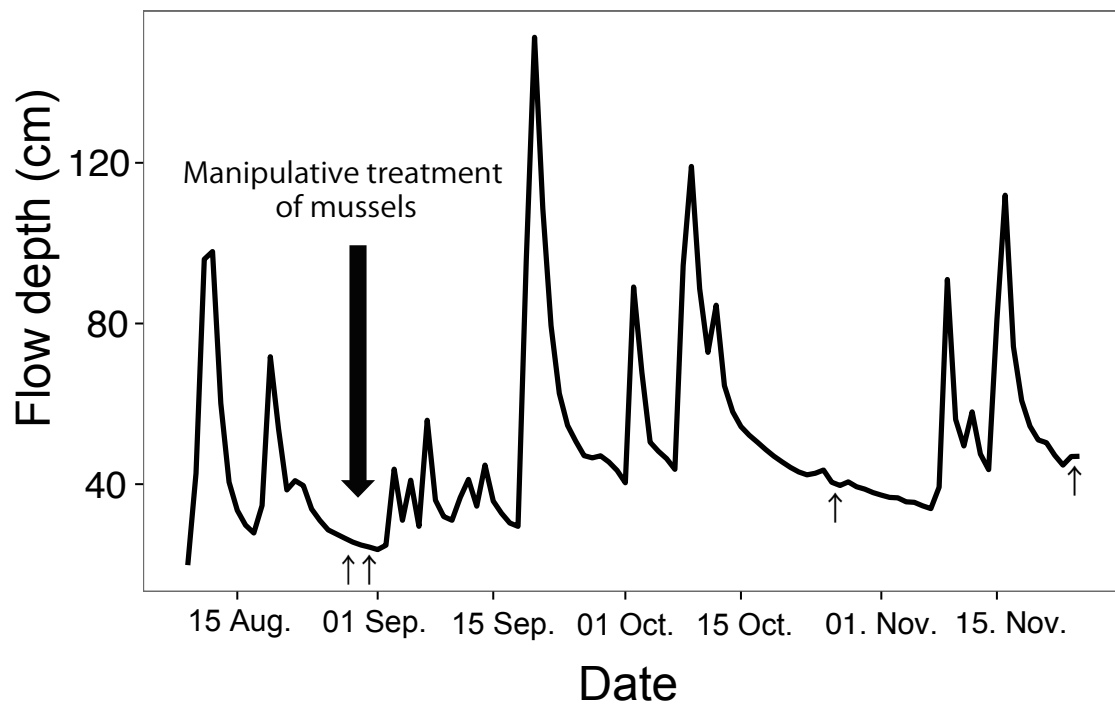


Figure S4 Observed changes of flow depth at the water level monitoring point in the study river during the field experiment period. The downward thick arrow indicates the time point the mussels were subjected to manipulative treatment. The small upward arrows denote the time points when mussel abundance and/or physical variables were measured (“before,” “short,” “medium,” and “long_1” starting from the left).

Online Resource 2

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Construction of the formula for the estimation of the pearl mussel biomass

A total of 42 *Margaritifera laevis* individuals with a shell length range of 9.6–117.3 mm were used. They were collected in June 2013 from the Shubuto River in Hokkaido, northern Japan (42°40'N, 140°18'E), where small pearl mussels are abundant (Terui et al., 2011). Shubuto River specimens were specifically chosen to avoid exerting pressure on the population size in the study river, which lacked small individuals (shell size <50 mm), thus resulted in recent recruitment failures of pearl mussels (Fig. S3).

The soft tissues were removed from the mussels immediately after measuring the shell length (mm) of each individual and were dried for at least 12 h at 60 °C to obtain the dry mass (g). The best-fitting linear regression model was obtained using a residual sum of squares (RSS) for the ln-transformed shell length and dry mass as follows (Fig. A) (Kryger & Riisgård, 1988):

$$\ln(\text{dry mass [g]}) = 2.96 \times \ln(\text{shell length [mm]}) - 12.49, r^2 = 0.98, p < 0.01$$

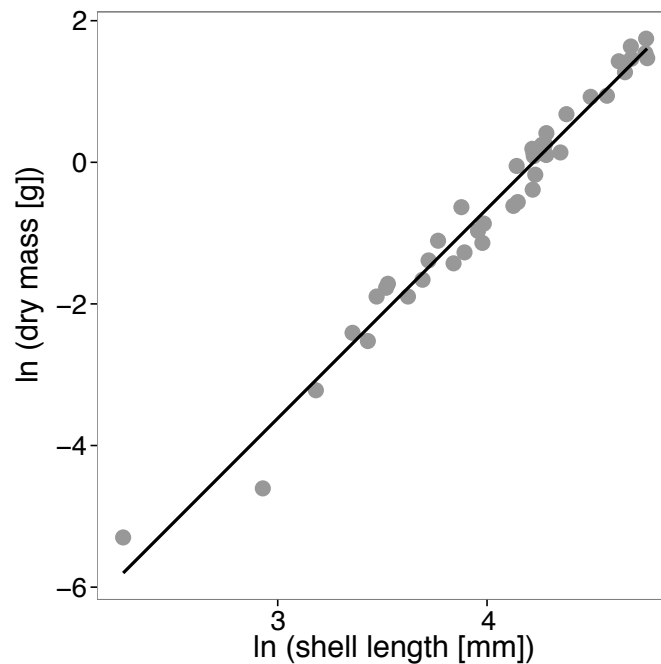


Fig. A The relationships between ln-transformed dry mass and shell length of pearl mussel individuals. Black straight line derived from the linear regression model established in the present study: $\ln(\text{dry mass [g]}) = 2.96 \times \ln(\text{shell length [mm]}) - 12.49$

The present study estimated the biomass of each collected mussel from the study tributary using the above regression model on the basis of the shell length of each mussel individual measured in the field study. This regression model was constructed for the estimation of the dry mass of *M. laevis* individuals. Although the study river included *Margaritifera togakushiensis* as well, it was believed that negligible errors in biomass estimates occurred because *M. laevis* was numerically dominant (only 10% of pearl mussels were considered *M. togakushiensis*) and the two species were similar in terms of their shell morphologies.

References

- Kryger, J., & H. U. Riisgård, 1988. Filtration rate capacities in 6 species of European freshwater bivalves. *Oecologia* 77: 34–38.
- Terui, A., Y. Miyazaki, S. Matsuzaki, & I. Washitani, 2011. Population status and factors affecting local density of endangered Japanese freshwater pearl mussel, *Margaritifera laevis*, in Shubuto river basin, Hokkaido. *Japanese Journal of Conservation Ecology* 16: 149–157.

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Table S1 Summary of mussel abundance and mussel dry mass values [mean (\pm SD)] in reaches for each treatment (“Removal–Release,” “Removal,” and “Control”) on each time period (“before,” “short,” “long_1”) in 2015.

Variable	Removal- Release	Removal	Control
<i>"before"</i>			
Mussel abundance (inds./quad.)	9.80(\pm 10.79)	8.00(\pm 6.89)	15.30(\pm 10.53)
Mussel dry mass (g/quad.)	38.26(\pm 38.92)	33.17(\pm 27.96)	59.03(\pm 42.46)
<i>"short"</i>			
Mussel abundance (inds./quad.)	10.00(\pm 7.55)	0.05(\pm 0.22)	15.30(\pm 10.53)
Mussel dry mass (g/quad.)	41.10(\pm 27.88)	0.25(\pm 1.14)	59.03(\pm 42.46)
<i>"long_1"</i>			
Mussel abundance (inds./quad.)	8.80(\pm 7.05)	0.10(\pm 0.31)	10.35(\pm 6.29)
Mussel dry mass (g/quad.)	37.51(\pm 28.41)	0.24(\pm 0.83)	48.61(\pm 34.36)