

Exploratory Surveys of Rocky Mountain Ridged Mussel (*Gonidea angulata*) in Okanagan Lake, British Columbia, in 2018 and 2020

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2021

**Canadian Data Report of
Fisheries and Aquatic Sciences 1333**

Canadian Data Report of Fisheries and Aquatic Sciences

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2021

**EXPLORATORY SURVEYS OF ROCKY MOUNTAIN RIDGED MUSSEL (*Gonidea angulata*)
IN OKANAGAN LAKE, BRITISH COLUMBIA, IN 2018 AND 2020**

by

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Cat. No. Fs97-13/1333E-PDF ISBN 978-0-660-37134-4 ISSN 1488-5395

Correct citation for this publication:

Dealy, L., MacConnachie, S., Wade, J., and Grant, P. 2021. Exploratory Surveys of Rocky Mountain Ridged Mussel (*Gonidea angulata*) in Okanagan Lake, British Columbia, in 2018 and 2020. Can. Data Rep. Fish. Aquat. Sci. 1333: vi + 9 p.

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ABSTRACT

Dealy, L., MacConnachie, S., Wade, J., and Grant, P. 2021. Exploratory Surveys of Rocky Mountain Ridged Mussel (*Gonidea angulata*) in Okanagan Lake, British Columbia, in 2018 and 2020. Can. Data Rep. Fish. Aquat. Sci. 1333: vi + 9 p.

Rocky Mountain Ridged Mussel (*Gonidea angulata*) is one of only a few freshwater mussel species in British Columbia, restricted in Canada to the Okanagan Basin. In 2005 this species was listed under the *Species at Risk Act* (SARA) as Special Concern, and in 2010 it was reassessed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as Endangered. Between 2011 and 2020, Fisheries and Oceans Canada (DFO) conducted surveys of *G. angulata* at index sites in the Okanagan Basin. In addition, exploratory surveys were conducted in 2018 and 2020 to gain insight into the distribution of the species in Okanagan Lake. In 2018 six publicly accessible sites were searched by wading into shallow water and visually scanning the substrate for live mussels or empty shells, but no live mussels or shells were observed at these sites. In 2020 a boat survey was conducted to search remote shorelines of Okanagan Lake with limited public access. Mussels were observed at only a few sites, and at low densities, likely due to the available substrate type. Within the area sampled, the majority of mussel observations, outside of where populations are known to persist, occurred on the south west shore of the lake north of Penticton. Surveying for mussel beds via boat allowed access to remote sites with limited public access. Only in high winds was it difficult to see the substrate from the boat. Additional exploratory surveys using small vessels to access shoreline near private docks or in very shallow water should be considered to identify locations of previously unreported mussel beds.

RÉSUMÉ

Dealy, L., MacConnachie, S., Wade, J., and Grant, P. 2021. Exploratory Surveys of Rocky Mountain Ridged Mussel (*Gonidea angulata*) in Okanagan Lake, British Columbia, in 2018 and 2020. Can. Data Rep. Fish. Aquat. Sci. 1333: vi + 9 p.

La gonidée des Rocheuses (*Gonidea angulata*), l'une des quelques espèces de moules d'eau douce en Colombie-Britannique, est limitée au Canada au bassin de l'Okanagan. En 2005, l'espèce a été inscrite à titre d'espèce préoccupante à la *Loi sur les espèces en péril* (LEP). En 2010, toutefois, le Comité sur la situation des espèces en péril au Canada (COSEPAC) l'a réévaluée et l'a désignée « espèce en voie de disparition ». De 2011 à 2020, Pêches et Océans Canada (MPO) a mené des relevés dans des sites repères du bassin de l'Okanagan. De plus, des relevés exploratoires, réalisés en 2018 et en 2020, visaient à obtenir des données sur la répartition de l'espèce dans le lac Okanagan. En 2018, six sites accessibles au public ont fait l'objet de relevés à gué en eaux peu profondes et de relevés par balayage visuel du substrat en vue d'y repérer des moules vivantes ou des coquilles vides, mais aucune moule vivante n'a été observée. En 2020, un relevé par bateau a été réalisé dans les sites isolés à accès limité sur les berges du lac Okanagan. Des moules ont été observées dans quelques sites, mais à de faibles densités, probablement en raison du type de substrat. Dans la zone d'échantillonnage, la majorité des observations de moules à l'extérieur des sites où des populations persisteraient ont été réalisées sur la rive sud-ouest du lac, au nord de Penticton. L'utilisation d'un bateau dans le cadre de relevés destinés à trouver des moulières a permis d'accéder à des sites isolés à accès limité au public. Seules les périodes à forts vents ont empêché de voir le substrat depuis le bateau. Il est donc recommandé de mener d'autres relevés exploratoires au moyen de petites embarcations pour accéder aux berges à proximité de quais privés ou à des eaux très peu profondes pour repérer des moulières.

INTRODUCTION

Rocky Mountain Ridged Mussel, *Gonidea angulata* (Lea, 1838), is a freshwater bivalve in the family Unionidae. It is morphologically and taxonomically unique as the only extant member of the genus *Gonidea* (Graf 2002). *G. angulata* is a large, trapezoidal-shaped mussel, with a sharp and prominent posterior ridge (DFO 2010) (Figure 1).

The species reaches the northern limit of its global range in southern British Columbia (BC). In Canada, live *G. angulata* have only been observed within the Okanagan Basin (COSEWIC 2010, BC Conservation Data Centre 2020). Populations within the Okanagan Basin account for approximately 5% of the current global distribution (COSEWIC 2010). Throughout its North American range, this species is found within both lacustrine and riverine habitat, and within Canada, predominantly in lakes where soft substrate is present with a low slope (0–20%) (COSEWIC 2010, Snook 2018). Both habitats require sufficient food, suitable water quality, and particular substrate sizes, depending on the energy of the site (Snook 2018). While *G. angulata* are typically observed in shallow waters, specimens have been recorded at depths of 10–20 m in Washington and Oregon (COSEWIC 2003). However, few surveys in BC have been conducted at depths greater than 3 m and to date most surveys have focused on shallow shoreline along the littoral zone. *G. angulata* also have a distinctive life cycle, which includes a parasitic larval stage (glochidia) that requires a fish host to complete their reproductive cycle (Neves et al. 1985). Therefore, host fish must also be available within potential suitable habitat (COSEWIC 2010, Snook 2018).

Within Okanagan Lake, Fisheries and Oceans Canada (DFO) efforts have primarily focused on annual density and abundance surveys (2011–2020 inclusive) of known aggregations of mussels (i.e., index sites) (MacConnachie et al. 2021a; MacConnachie et al. 2021b; Wade et al. 2020). The goal of the exploratory surveys reported here was to identify locations of previously unreported mussel beds which could further inform the distribution and help inform the management of the species.



Figure 1. Rocky Mountain Ridged Mussel (*Gonidea angulata*) from Okanagan Lake, British Columbia (September 2020). Photograph by L. Dealy.

METHODS

WADING SURVEY

In August 2018 six publicly accessible sites on Okanagan Lake were chosen to survey for mussel beds or suitable mussel habitat. Sites included Okanagan Lake Provincial Park (North and South campgrounds), Peachland Information Centre boat launch, Boyce-Gyro Park (Kelowna), Cedar Creek Park (Kelowna), and Okanagan Mountain Provincial Park (Table 1). Sites were explored on foot by wading into the water to approximately waist-high level to observe and record substrate type and to search for live mussels, empty shells, and potential fish hosts, particularly sculpins (spp.).

Table 1. Public access sites around Okanagan Lake explored in August 2018 for presence of Rocky Mountain Ridged Mussels (*Gonidea angulata*) and mussel habitat.

Site Access	Latitude	Longitude
Okanagan Lake Provincial Park South Campground, boat launch	49.680553	-119.715833
Okanagan Lake Provincial Park North Campground, beach	49.689342	-119.727105
Peachland Information Centre boat launch	49.776814	-119.733974
Boyce-Gyro Beach Park, Kelowna	49.854850	-119.491820
Cedar Creek Park, Kelowna	49.797135	-119.532419
Okanagan Mountain Provincial Park	49.776945	-119.625913

SMALL VESSEL SURVEY

In September 2020, a portion of the nearshore area of Okanagan Lake was surveyed using a small, shallow (<1 m draft) vessel (Boston Whaler 17' Guardian with 90-hp Yamaha outboard motor). Due to time constraints only the lower third portion of the lake was surveyed. To ensure that it was possible to see mussels from the boat, index sites with known mussel beds were included in the transects.

From September 10 to 15, two observers and one driver departed from the Penticton Yacht Club northward to either the east or west side of the lake. At each survey location, the boat was kept in shallow water (0.5–2 m deep) and close to the shoreline. Track lines were recorded using the onboard vessel GPS (Navionics GPS Plotter). The driver attempted to maintain a slow speed (<1 knot) to allow the two observers, sitting or lying on the bow of the boat, to scan the substrate for evidence of mussels; this may include exposed mantle or empty shells. If a mussel was suspected, a float attached via string to a brick was launched to mark the location (Figure 2). One or both observers would enter the water to confirm the detection by snorkeling down to the mussel to confirm in situ, and occasionally, remove the mussel from the substrate for identification. Any live mussels removed from the substrate were reburied where they were found. Once a mussel was determined to be *G. angulata* in a particular area, mussels were identified visually from the vessel to avoid any harm or disturbance to other animals. Observations of mussels were marked with a handheld GPS (Garmin inReach Explorer+).

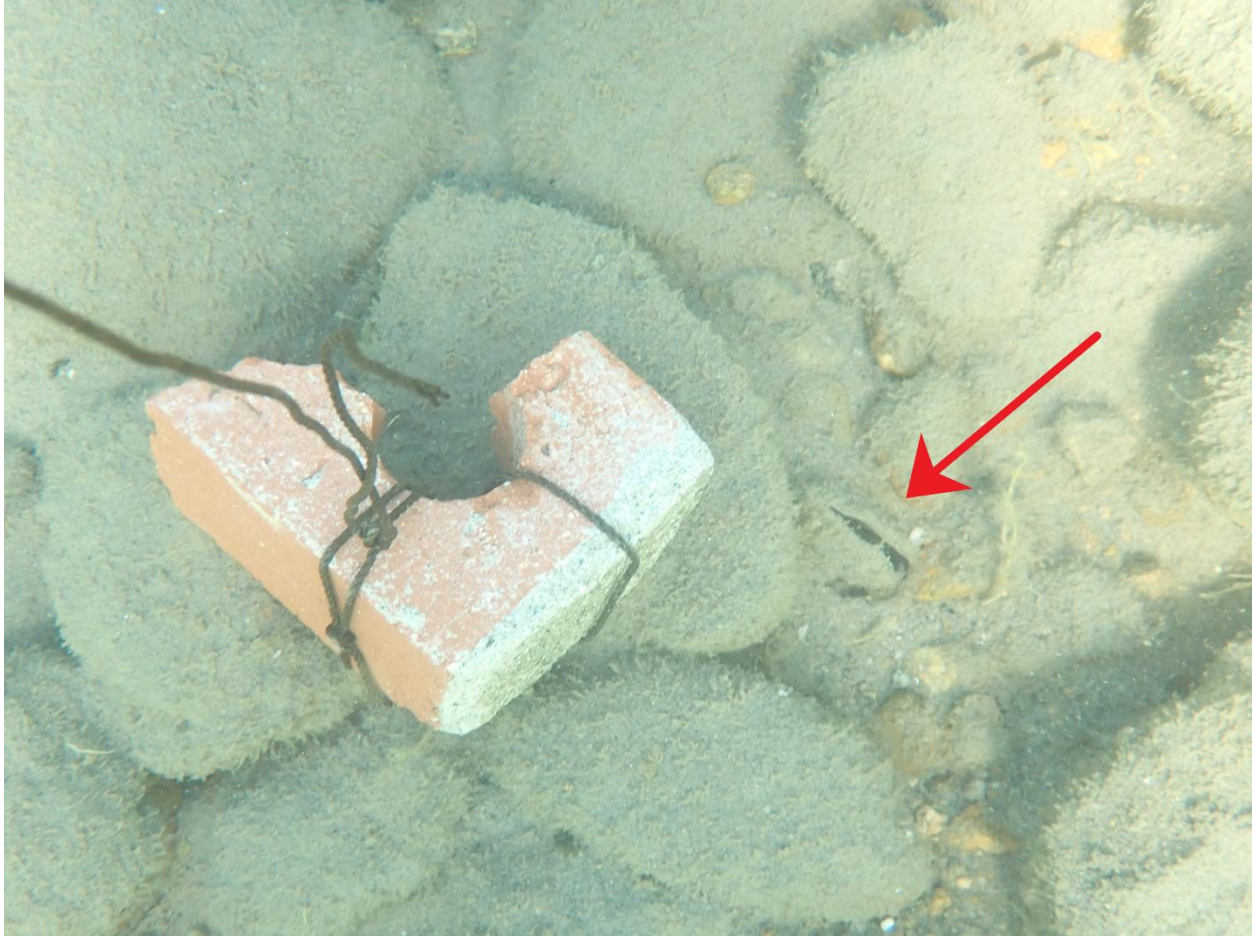


Figure 2. A brick attached to a string and float marks the location of a suspected mussel (*Gonidea angulata*) indicated here with a red arrow. Photograph by L. Dealy.

RESULTS

WADING SURVEY

Observations from wading surveys at the six public access sites on Okanagan Lake are provided in Table 2. No live mussels or empty mussel shells were found at any of the locations. The shoreline could not be accessed at Okanagan Mountain Provincial Park as it was a sheer cliff face. Sculpins were only observed at one location, Cedar Creek Park. Substrate at this location seemed suitable for mussels although none were found.

Table 2. Results of August 2018 wading survey at six public access sites on Okanagan Lake, British Columbia, with descriptions of the substrate and presence or absence of live mussels, empty shells, and sculpins.

Site Access	Substrate	Comment
Okanagan Lake Provincial Park South Campground, boat launch	Compact sediment, unsuitable for mussels	
Okanagan Lake Provincial Park North Campground, beach	Rocky substrate, compact, unsuitable for mussels	
Peachland Information Centre boat launch	Large rocks, compact substrate on North side of dock. Small rocks, looser substrate in dog swim area on south side of dock	No live mussels, no mussel shells, no sculpins (spp.) observed
Boyce-Gyro Beach Park, Kelowna	Sand, unsuitable for mussels	
Cedar Creek Park, Kelowna	Small rock, sand, loose sediment, suitable mussel habitat	No live mussels, no mussel shells. Sculpins (spp.) observed
Okanagan Mountain Provincial Park	Unknown	Inaccessible from our location

SMALL VESSEL SURVEY

Between September 10 and 15, 2020, 83.6 km of shoreline was surveyed by boat, approximately one third of the perimeter of Okanagan Lake (Figure 3; Table 3). Daily survey tracklines, positions of live mussels, and positions of index sites (Dog Beach, Kinsman Park and Three Mile Beach) are depicted in Figure 3. The northeastern section of shoreline surveyed on September 12 and 13 (Figure 3) was generally sheer cliff and deep water (estimated > 3 m) therefore presence of *G. angulata* was unlikely and would have been very difficult to observe from the vessel. Aside from the index sites, the majority of mussels were observed on the western side of the lake just north of Dog Beach on September 15, 2020 (Figure 3).

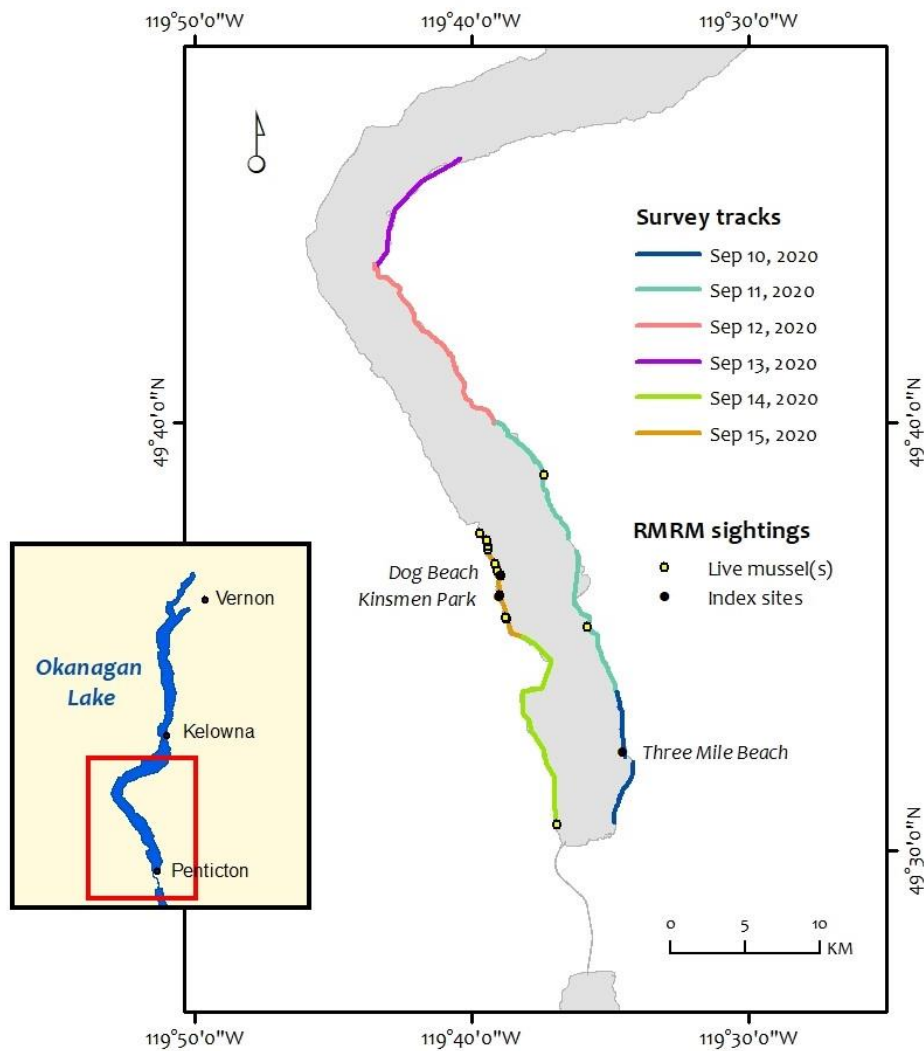


Figure 3. Map of Okanagan Lake small vessel survey (September 10–15, 2020) with survey tracklines and positions of live Rocky Mountain Ridged Mussel observations.

Table 3. Lengths of survey tracklines from the Okanagan Lake small vessel survey (September 10–15, 2020).

Date	Length of survey (km)
Sep 10, 2020	11.0
Sep 11, 2020	22.9
Sep 12, 2020	16.1
Sep 13, 2020	9.9
Sep 14, 2020	15.4
Sep 15, 2020	8.3
Total	83.6

DISCUSSION

Rocky Mountain Ridged Mussel (*G. angulata*) which has been assessed as Endangered, is one of only a few freshwater mussel species in BC, and is restricted to the Okanagan Basin in Canada. In this watershed *G. angulata* has been impacted by historical loss and degradation of habitat (COSEWIC 2010) and the survival or recovery of this species may continue to be jeopardized by current threats ranging from the potential impacts of Zebra (*Dreissenia polymorpha*) and Quagga (*D. bugensis*) mussels, ongoing foreshore and riparian development, and the potential impact of some Eurasian Watermilfoil (*Myriophyllum spicatum*) control methods. Although freshwater mussels play an important role in aquatic ecosystems as filter feeders, affecting nutrient dynamics and water chemistry, as components of food webs, and as indicators of freshwater ecosystem health (Grabarkiewicz and Davis 2008), a large number of knowledge gaps remain for *G. angulata* and other freshwater mussel species. Therefore, it is imperative that surveys are conducted to characterize the presence and distribution of *G. angulata* in BC and other investigations continue to elucidate its role in the ecosystem and the continued impacts of threats on this population (DFO 2010). Within Okanagan Lake, DFO studies have primarily focused on known aggregations of mussels (MacConnachie et al. 2021a; MacConnachie et al. 2021b; Wade et al. 2020). Exploratory surveys were undertaken in 2018 and 2020 to search for new mussel aggregations and to test alternative techniques for detecting mussel populations.

The surveys reported in this study focused on the nearshore area at a depth of approximately 0.5–2 m. While the depth distribution of *G. angulata* in the Okanagan Basin is still uncertain (DFO 2011), at index sites in Okanagan Lake between 2011 and 2016 mussels were detected more frequently in water depths greater than 0.5 m, and detections typically declined with increasing depth (MacConnachie et al. 2021a). Detection error could be slightly higher at greater depths due to reduced visibility, but elsewhere *G. angulata* are also typically observed in shallow waters (COSEWIC 2003). In the Okanagan specimens have, however, been observed at depths of ~7.5 m in

Vaseux Lake and 2.4 m in Okanagan Lake (Stanton et al. 2012). Therefore, *G. angulata* can occur at greater water depths than surveyed in this study, but likely in much lower densities. Conversely, *G. angulata* have also been detected in shallower water <0.5 m in Okanagan Lake, including 0.02 m at Three Mile Beach (MacConnachie et al. 2021a). Mussels in water <0.5 m would have been detected by wading surveys but likely not visible by boat.

In the wading survey, no mussels and few locations of suitable habitat were found. During the small vessel survey, individual live mussels were seen and the method was shown to be suitable at depths ranging from 0.5–2 m. With the exception of the index sites, there were no areas which could be defined as high density mussel beds, and only a small number of individuals in close proximity to each other were ever observed.

Knowing where mussels beds are located within Okanagan Lake is becoming increasingly important with both the disturbance of substrate through removal of Eurasian Watermilfoil and continued pressure from lake shore development and habitat alteration. These surveys, and the boat survey in particular, reinforced the importance of field work to determine where beds can be found and importantly, where they are not. This will help prioritize efforts to preserve habitat for the continued survival of the species in an increasingly urbanizing area.

REFERENCES

- BC Conservation Data Centre. 2020. BC Species and Ecosystems Explorer. B.C. Minist. of Environ. Victoria, B.C. Available:<http://a100.gov.bc.ca/pub/eswp/> (accessed November 20, 2020).
- COSEWIC. 2003. COSEWIC assessment and status report on the Rocky Mountain Ridged Mussel *Gonidea angulata* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vii + 29 pp.
<http://publications.gc.ca/collections/Collection/CW69-14-370-2004E.pdf>
- COSEWIC. 2010. Updated COSEWIC status report on Rocky Mountain Ridged Mussel *Gonidea angulata*. Committee on the Status of Endangered Wildlife in Canada. Ottawa. viii + 55 pp.
http://publications.gc.ca/collections/collection_2012/ec/CW69-14-614-2011-eng.pdf
- DFO. 2010. Management Plan for the Rocky Mountain Ridged Mussel (*Gonidea angulata*) in Canada. [Final]. *Species at Risk Act* Management Plan Series. Fisheries and Oceans Canada, Vancouver. iv + 52 pp.

- DFO. 2011. Recovery Potential Assessment for Rocky Mountain Ridged Mussel (*Gonidea angulata*) in British Columbia. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2011/053.
- Grabarkiewicz, J. and W. Davis 2008. An introduction to freshwater mussels as biological indicators. EPA-260-R-08-015. U.S. Environmental Protection Agency, Office of Environmental Information, Washington, D.C. 108 pp.
- Graf, D.L. 2002. Molecular phylogenetic analysis of two problematic freshwater mussel genera (*Unio* and *Gonidea*) and a re-evaluation of the classification of nearctic Unionidae Bivalvia: Palaeoheterodonta: Unionida). J. Moll. Stud. 68:65–71.
- MacConnachie, S., Dealy, L., Wade, J., Nield, L., Flostrand, L and Grant, P. 2021a. Rocky Mountain Ridged Mussel (*Gonidea angulata*) Index Site Surveys in the Okanagan Basin, British Columbia, 2011–2016. Can. Manuscr. Rep. Fish. Aquat. Sci. 3210: vi + 22 p.
- MacConnachie, S., Dealy, L., Wade, and Grant, P. 2021b. Rocky Mountain Ridged Mussel (*Gonidea angulata*) Index Site Surveys in the Okanagan Basin, British Columbia, 2017–2020. Can. Manuscr. Rep. Fish. Aquat. Sci. 3211: v + 9 p.
- Neves, R.J., Weaver, L.R., and Zale, A.V. 1985. An Evaluation of host fish suitability for *Villosa vanuxemi* and *V. nebulos* (Pelecypoda: Unionidae). Am. Midl. Nat. 113: 13–19.
- Snook, R. 2018. Information in support of the identification of critical habitat for the Rocky Mountain Ridged Mussel (*Gonidea angulata*). DFO Can. Sci. Advis. Sec. Res. Doc. 2018/040. viii + 56 p.
- Stanton, L., Lauzier, R., MacConnachie, S., Nield, L., Pollard, S., Heron, J., and Davies, S. 2012. Exploratory surveys and directed studies of Rocky Mountain Ridged Mussel (*Gonidea angulata* Lea, 1839) in British Columbia. Can. Manuscr. Rep. Fish. Aquat. Sci. 3003: viii + 63 p.
- Wade, J., Stephen, C., and Robertson, C. 2020. Mapping Rocky Mountain ridged mussel beds with preliminary identification of overlapping Eurasian watermilfoil within the Canadian range. Nature Conservation 42: 19–31. <https://doi.org/10.3897/natureconservation.42.51081>.