Improved management of Rocky Mountain ridged mussel in the Okanagan Valley, B.C.:

2014-2015 Technical report to the Environment Canada Habitat Stewardship Program.

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Photo: Roxanne Snook

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Summary

There were three main activities planned for the project, Improved management of Rocky Mountain ridged mussel in the Okanagan Valley, B.C. (2014HSP6695), during the 2014-2015 fiscal year:

1. Surveying associated with the development of a habitat model for Rocky Mountain ridged mussel (RMRM; *Gonidea angulta*). 44 locations were surveyed to establish baseline data on differences in habitat measures between locations with and locations without RMRM. To achieve this, 22 known RMRM locations and 22 locations not known to have RMRM were chosen. During the surveying, the presence or absence of RMRM was re-assessed. RMRM were found at three of the sites that were not known to contain the mussel. In addition to forming the baseline for the model, these data will be used by the British Columbia Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO) to protect the RMRM sites from in-lake developments.

2. Development of a habitat model. A habitat model was developed for Rocky Mountain ridged mussel in Okanagan Lake. This model shows that the most important factors in determining habitat suitability for the mussel are, in order of decreasing importance: Embededness of the substrate, total fetch, amount of sand present, amount of boulders present, and the slope at the location. The habitat model was subsequently used to predict suitable RMRM habitat and possible RMRM locations. The possible mussel locations were surveyed and the mussel was found at two of these locations. This model will be used by the British Columbia Ministry of Environment and MFLNRO in the development and application of management guidelines for the protection of RMRM.

3. Development and production of interpretive signage on Rocky Mountain ridged mussel biology and conservation needs. An interpretive sign describing RMRM biology and conservations needs were developed through collaboration between the University of British Columbia – Okanagan, MFLNRO, and Lime Design Inc. The signs are in production and will be placed at six high density RMRM sites in the Okanagan Valley, during April and/or May 2015. They will inform the public users of the lakes and rivers of the Okanagan about the mussel and hopefully mitigate any negative impact of such use on the mussel.

Introduction

The project, Improved management of Rocky Mountain ridged mussel (RMRM; *Gonidea angulata*) in the Okanagan Valley, B.C. (2014HSP6695), is a two year project. It is a collaboration between the University of British Columbia – Okanagan (UBCO), the British Columbia Ministry of Forests, Lands, and Natural Resource Operations (MFLNRO), and the British Columbia Ministry of Environment (MOE). Over the entire project period, a wide variety of activities are planned to improve the management and conservation of the mussel. However, during the 2014-2015 fiscal year, only three activities were planned: 1. Surveying for RMRM associated with the development and testing of a habitat model for the mussel. 2. Development of the habitat model. 3. Development and production of interpretive signage on RMRM biology and conservation needs (Walker and Mageroy 2013). The completion and results of those activities are described in the three next sections of this report.

Surveying

A total of 44 sites in Okanagan Lake were surveyed with respect to habitat measures and for Rocky Mountain ridged mussels (Fig. 1). From known RMRM locations, 22 locations were randomly selected to represent the mussel's preferred habitat. In addition, an additional 22 sites were selected that were not known to contain RMRM, but varied in their habitat suitability from very high to very low (based on the model described below). Given these selection criteria, GIS (ESRI 2012) was used to select the sites randomly. A wide variety of habitat measures were collected during the surveying. With respect to RMRM, only presence vs. absence was recorded. The habitat measures for sites with and without RMRM formed the baseline data for the development of the habitat model for the mussel, described in the section below. The surveying for mussels revealed that RMRM were present at three of the non-RMRM sites. The updated data on RMRM presence will be used, by MFLNRO to protect those sites from in-lake developments. For further details, see Snook (2015).

Habitat Model Development

Methods

The selection of habitat measures, to collect, was initially based on the measures already collected through the Foreshore Inventory Mapping (FIM) dataset. This dataset was chosen as it is a standardized method of characterizing aquatic habitat in the lakes in the Okanagan Valley (Schleppe & Mason 2009). Which measures from the FIM to include in the model development, was chosen with the help of expert opinion. Based on this expert opinion a few habitat measures, which are not included in the FIM, were also included in the model development. This resulted in 12 habitat measures being included in the initial model.

To improve the initial model, a couple of steps were taken. To remove highly correlated predictor variables from the model, a sensitivity analysis was undertaken. This resulted in five predictor variables being retained in the final model. Subsequently, a variable importance analysis was undertaken and each variable's effect on the probability of Rocky Mountain ridged mussel being present was determined. The final model was produced from the FIM data (Schleppe & Mason 2009) as a vector map in ArcMap10.1 (ESRI 2012). Layers within the FIM that were used included the most favourable habitat ranges of for the most important habitat measures. In addition, for these overlapping sites with favourable variables, any important non-FIM variables were included in the model. For further details on the development of the model, see Snook (2014, 2015). These references have been attached to the online application form as "Midterm Report on Habitat Model for BC MFLNRO" and "Draft of Master of Science Thesis", respectively.

Results/Discussion

The model selection resulted in a model with these five habitat measures, in order of decreasing importance in determining habitat suitability for the Rocky Mountain ridged mussel:

1. Embededness of the substrate. This measures describes to what extent coarser substrate, such as cobbles and bolders, are surrounded by finer sediments, such as silt and sand

(Sylte & Fischenich 2002). The suitability of the habitat for Rocky Mountain ridged mussel increases with increasing embededness, although the difference between medium and high embededness is not very great (see Fig. 2). The increased suitability of habitat with medium or high embededness may be explained by increased ability of the mussel to bury within the substrate (Vannote & Minshall 1982) and increased food availability (Brim Box *et al.* 2002).

2. Total fetch. This measure describes how far wind can travel unimpeded, by land, over water (e.g., Håkanson & Jansson 1983). The suitability of the habitat for Rocky Mountain ridged mussel is the lowest at a fetch of approximately 5 km (see Fig. 2). From 5 km the habitat suitability increases substantially until the fetch reaches 11 km. At this distance the suitability of the habitat stabilizes, before declining after the fetch reaches approximately 16 km. There is also an increase in habitat suitability at a fetch below 5 km. However, this increase is minimal compared to the increases observed for longer distances. Note that total fetch is the only one the five most important measures, for predicting RMRM habitat suitability, that is not a part of the FIM data (Schleppe & Mason 2009). Fetch affects water and nutrient movement, which will affect the availability of food and oxygen to mussels. In addition, increased fetch can create unstable substrates and dislodge mussels (Cyr 2009). Therefore, it is not surprising that it affects the habitat suitability for RMRM in a complex manner.

3. Percentage of sand present. The model shows that habitat without sand is unsuitable for Rocky Mountain ridged mussel and that the suitability of the habitat increases with the percentage of sand. However, the increase in habitat suitability from low to very high percentages of sand is not very great (see Fig. 2). The necessity of some sand being present for a location to be suitable RMRM habitat is not surprising, since sand allows mussels to bury within the substrate (e.g. Vannote and Minshall 1982, COSEWIC 2003).

4. Percentage of boulders present. The habitat suitability for Rocky Mountain ridged mussel is highest when the percentage of boulders is low and lowest at a medium percentage, before increasing again at high and very high percentages (see Fig. 2). Boulders provide stable substrate, and reduces scouring and shearing (e.g. Vannote and Minshall 1982, Cyr 2009, Davis *et al.* 2013). Further, they create currents that result in providing nutrients, plankton, and dissolved oxygen, and fine sediments to organisms that live at their base (Davis *et al.* 2013). Therefore, they alter the habitat in ways to benefit mussels. However, this does not explain why no boulders also favour RMRM.

5. The slope. This measure describes the near-shore slope and shape of the lake bottom. The habitat suitability for Rocky Mountain ridged mussel is the highest when the near-shore slope forms a bench like structure and declines with an increase in the slope (see Fig. 2). However, the difference in suitability between a bench and a low slope is not very great. Further, the habitat suitability for RMRM seems to be minimal when the slope is steep or very steep. That habitat suitability decreases with the steepness of the slope is not surprising, as steeper slopes may prevent mussels from anchoring themselves in the substrate (e.g., Davis *et al.* 2013).

The model has been used to predict suitable RMRM habitat and possible RMRM locations. The possible mussel locations were surveyed and the mussel was found at three of these locations (see surveying described in the previous section). This model will be used by MOE and MFLNRO in the development and application, respectively, of management guidelines for the protection of RMRM. More specifically, it will be used by MFLNRO to predict suitable RMRM habitat and possible RMRM locations throughout the lakes in the Okanagan Valley. These predictions will be used in determining whether mussel surveys are required in association with in-lake developments and whether such developments should be allowed on suitable RMRM habitat.

For further details on the results and discussion, with respect to these measures or the other measures included in the original model, see Snook (2014, 2015).

Signage

An interpretive sign describing RMRM biology and conservations needs were developed through collaboration between the UBCO, MFLNRO, and Lime Design Inc (see Fig. 3). To more easily study the design of the sign, see the pdf of the sign that has been attached to the online application form as “RMRM Interpretive Sign.” The signs are in production and will be placed at six high density RMRM sites in the Okanagan Valley (see Fig. 4), during April and/or May 2015. They will inform the public users of the lakes and rivers of the Okanagan about the mussel and hopefully mitigate any negative impact of such use on the mussel.

Figure 3. Rocky Mountain ridged mussel interpretive sign. Designed by Matthias Reinicke with Lime Design. Inc., illustrated by Briony Penn, and developed in cooperation by Matthias Reinicke, Jamie Leathem (MFLNRO), Jon Mageroy (UBCO), and Lora Nield (MFLNRO). To more easily study the design of the sign, see the pdf of the sign that has been attached to the online application form as "RMRM Interpretive Sign."

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