Guidance for Freshwater Mussels in the Okanagan

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Ministry of Forests, Lands, Natural Resource Operations and Rural Development
Thompson Okanagan Region | Resource Management | Ecosystems Section

102 Industrial Place | Penticton BC | V2A 7C8

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ACKNOWLEDGEMENTS

This document has been prepared by Lora Nield and Greg Wilson by utilizing the existing guidance provided in the *Protocol for the Detection and Relocation of Freshwater Mussels Species at Risk in Ontario-Great Lakes Area (OGLA)* by G. Mackie, T. Morris, and D. Ming (2008). Without that document this would not have been possible as it is key methodology used for this version with only slight modifications made to address the local management concerns and habitats.

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1.0 INTRODUCTION

This document is intended to provide advice to qualified professionals (QPs) undertaking freshwater mussel surveys and relocations within the Thompson Okanagan Region of British Columbia (B.C). Freshwater mussels are among the most imperiled groups of organisms in the world (Metcalfe-Smith and Cudmore-Vokey 2004, Strayer et al. 2004, Lydeard et al. 2004), with only four to seven species in B.C (Gelling 2008, Nedeau 2009). In B.C. there is currently one mussel species, Rocky Mountain Ridged Mussel (*Gonidea angulate*), that is listed as at-risk by the federal *Species at Risk Act* (SARA), and by the provincial government (red-listed). The scope of this document is focused on action needed for Rocky Mountain Ridged Mussel conservation. If other mussel species are detected at a project site this document can be used as guidance; however, the level of mitigation required may be different depending on the species conservation status.

There is a need in the Okanagan area to both detect Rocky Mountain Ridged Mussels and consider impacts to mussels during instream work activities. To date, relocation has been required for projects that have a high risk of impacting mussels. It is recognized however, that relocation efforts are time consuming and may increase a project's expenses. Moreover, there is inherent risk to mussels of relocating populations. As such, relocation should only be considered after various mitigation options have been exhausted. Appropriate mitigation measures include relocating the project out of mussel beds (out of Red or Yellow Zone) and/or reducing the footprint or area disturbed. Please note that in some instances relocation may not be possible, or permitted.

Previously, the *Protocol for the Detection and Relocation of Freshwater Mussel Species at Risk in Ontario Great Lakes Area* (Mackie et al. 2008) was provided as advice to proponents undertaking shoreline development projects. The guidance herein is a modified version of Mackie et al. (2008), which reflects local knowledge of species and habitats. It focuses on direction for detection and relocation of freshwater mussels.

This document will guide the applicant and QP(s) through proposing instream works by providing the required steps to ensure appropriate mitigation is applied to the works, mussel detections are accurate, and relocations are successful and cost effective.

Consideration of other species and habitats that are either at-risk or of concern to management agencies are not within the scope of this document and still need to be considered by proponents and their qualified professionals.

This document must be used in conjunction with the Okanagan Large Lakes Foreshore Protocol (the Protocol) which provides risk rankings for foreshore development activities and outlines foreshore sensitivity zones for Shore Spawning Kokanee, Freshwater Mussels, and Foreshore Plants.

Note: This document is subject to changes and depending on the scope of the project proposed, additional conditions may be added to your works by the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) or Fisheries and Oceans Canada (DFO) to properly mitigate for freshwater mussels.

2.0 USE OF A QUALIFIED PROFESSIONAL

Mussel survey and relocation work must be undertaken by professional biologists (members of the College of Applied Biology) who deem themselves qualified to conduct these works. The biologists should have experience working in the local, aquatic environments, and should be familiar with freshwater mussel biology and be capable of identifying freshwater mussel species. It is recommended, although not mandatory, that the qualified professionals undertaking mussel work attend the Mussels Detection Training Course that has been offered by FLNRORD Ecosystems Section. If you require further information on this training course please contact an Ecosystem Biologist in the Penticton office at 250-490-8200.

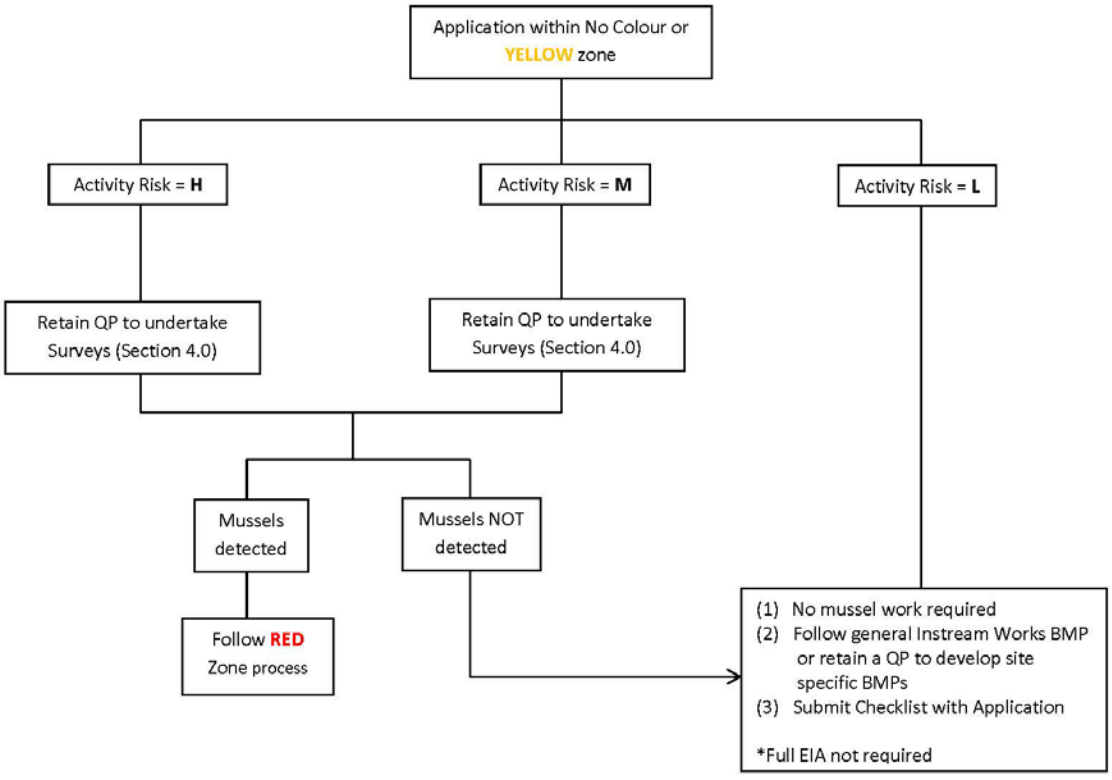
For mussel identification factsheets and detection tricks see Species Fact Sheets.

3.0 DETERMINING THE REQUIREMENTS FOR YOUR PROJECT

Foreshore sensitivity zone determination and risk ranking of your project must be determined using the Protocol. Once you have determined your zone and risk this guidance document will provide you the steps that are needed for the protection and mitigation for mussels.

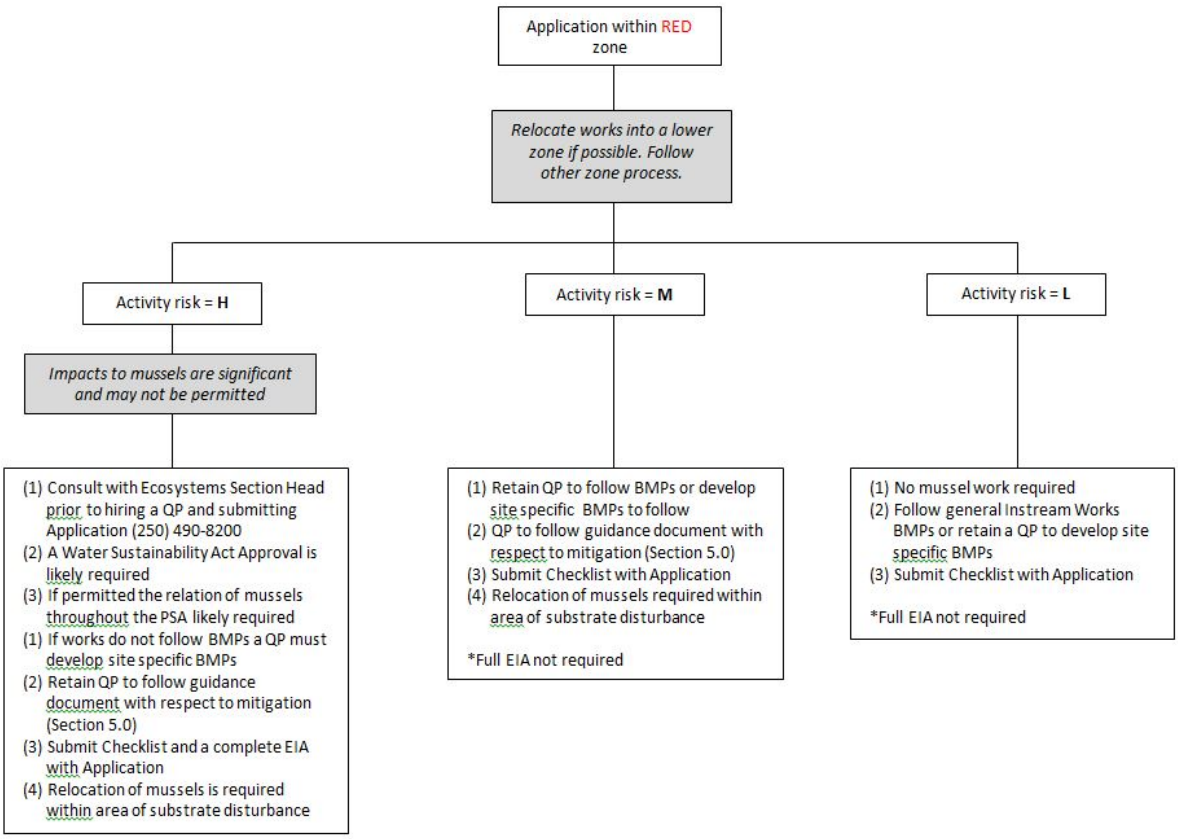
3.1 No Colour and Yellow Zones

Mussel surveys (Section 4.0) are required for all Moderate and High Risk activities within No Colour and Yellow Zones because Rocky Mountain Ridged Mussels may be present and the activity risk may result in the need for mitigative measures. Low Risk activities in No Colour and Yellow Zones can proceed with no additional mussel work.



3.2 Red Zones

Rocky Mountain Ridged Mussel surveys are not required in Red Zones because presence has already been confirmed. For Low Risk activities no further mussel work will be required. For Moderate Risk activities a QP will need to be retained to use this guidance document to relocate all Rocky Mountain Ridged Mussels found within areas where substrate is disturbed. High Risk activities may not be consistent with FLNRORD management direction and therefore may not be approved. Consultation with the Ecosystems Section Head is required before moving forward with your application. The below flow chart depicts this process in more detail.



Note: If works are completed in the dry no mussel detection or relocation surveys will be required.

Note: Before conducting any instream works all field gear must be bleached to prevent the movement of invasive species between water bodies. Freezing is not always an effective method. For guidance refer to the provincial Interim Hygiene Protocols for Amphibian Field Staff and Researchers.

4.0 SURVEY METHODOLOGY

Surveying for mussels is done through visual methods. Beach walkers and snorkelers (possibly divers) will be required to undertake these surveys. Survey methods are described below for beach walkers and snorkelers (divers) separately. This methodology has been designed to ensure a high probability of detection. Mackie et al. (2008) highlights the concerns about surveys that have concluded that no "at-risk" mussel species are present when in fact there was a failure to detect these species. Failure to detect mussels, when present, can result in negative impacts to the local population, and could result in a halt in works if presence is later confirmed.

4.1 Defining the Survey Area

Delineation of the survey area must be done as described in Section 4.2 of Mackie et al. (2008). The search area is defined as the "prescribed search area" (PSA); composed of a zone of influence, risk zone, and an activity zone. The activity zone is the area directly disturbed by the activity. Components of the PSA, including the different zones, substrate types and water characteristics are to be clearly defined and recorded as the information may be required or requested by agency staff.

4.2 Timing of Field Work

4.2.1 Water Clarity

Surveys can only be undertaken in ideal visibility conditions as water clarity must allow for visual detection, therefore, surveys should be postponed in wavy or turbid water conditions. Sunny calm days provide the best visibility.

4.2.2 Temperature

Mussels are mobile, capable of moving both horizontally across the substrate and vertically into the substrate (Nedeau et al. 2009, Mackie et al. 2008, Perles et al. 2003). In some species/populations, 70% of mussels can be found subsurface even in warm water seasons (Mackie et al. 2008). Only preliminary data is currently available on the movement of Rocky Mountain Ridged Mussels in B.C. Adults have been recorded moving 1 m across the substrate in one month (during summer). At the few sites assessed to date, approximately 10% of adults and near 100% of juveniles were found subsurface. Therefore, surveys are to be conducted when water temperatures are >16^{o}C to have the greatest chance of detection. In addition, handling mussels in temperatures <16^{o}C can pose significant risk to the mussels (i.e., reduced ability to reattach to the substrate), therefore, mussels should not be disturbed in waters <16^{o}C (Mackie et al. 2008).

4.3 Laying Out the Survey Area

The visual surveys must be conducted using transects running perpendicular to the shoreline from the high water mark (HWM) to the end of the PSA. Therefore, step one is to set out a guideline along the shoreline (at or just above the HWM) of the PSA (Figure 1(a)). Once the guideline is established run transects perpendicular from the guideline (shoreline) out into the water. Transects should be placed along the guideline every meter (or every 2 m if water clarity and visibility of lake bottom allows), to ensure adequate survey coverage of the PSA (see Figure 1(b) and Figure 2). It is recommended that surveyors swim out on one side of the transect line focusing on the line itself and area to one side of the line and swim in on the opposite side of the line.

Figure 1 Laying out the Survey Area: (a) a guideline along a PSA, (b) snorkelers laying out transects off of guideline

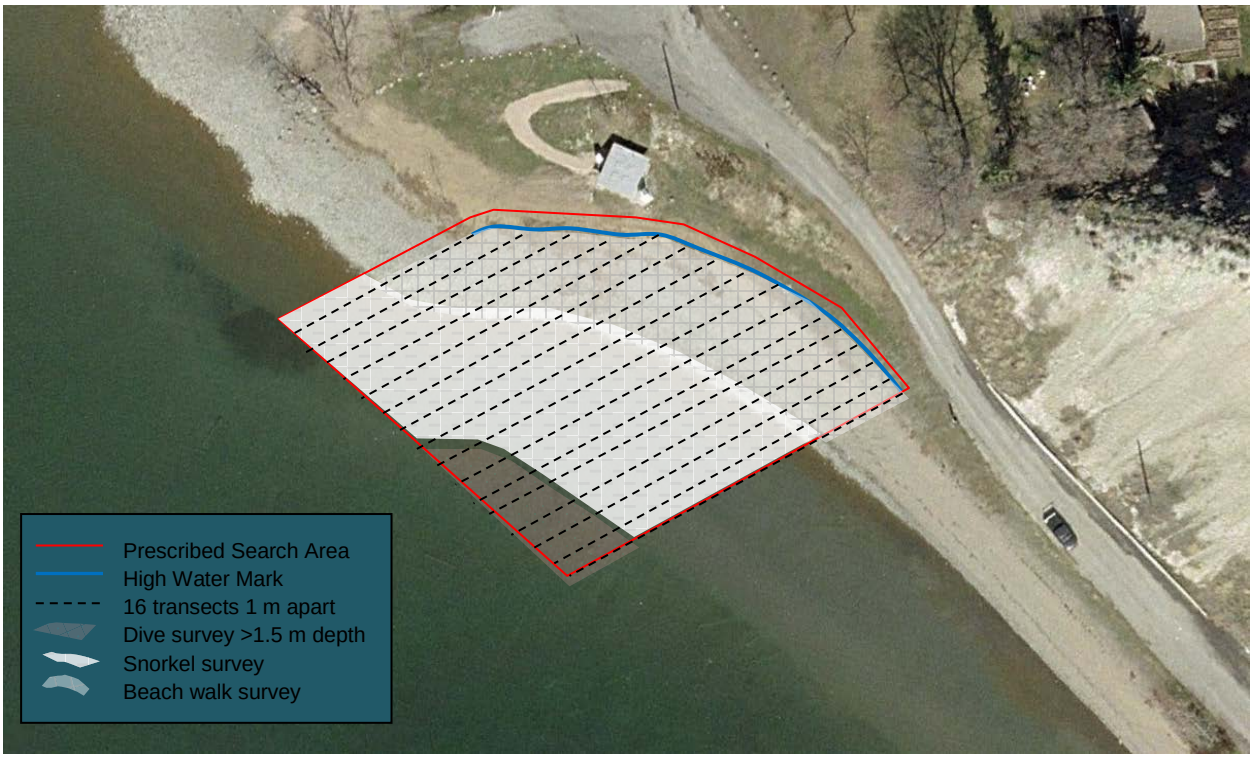


Figure 2 Example of Prescribed Search Area (PSA) showing the different visual search methods to detect mussels

4.4 Survey Types

4.4.1 Beach Walk

Surveys from the HWM to approximately 30 cm (or 1 ft) of water can be conducted through a beach walk along the transect line. The search effort is focused on siting empty shells versus live mussels.

Piles of discarded shells (middens) can occasionally be found where a predator has been active or historic harvesting has occurred.

4.4.2 Snorkel (Dive)

Surveys from approximately 30 cm water depth to 1.5 m water depth (depending on height of surveyor, eyesight and ability to free dive) can be conducted through snorkelling. Surveys beyond 1.5 m depth, or in areas were detection is limited via snorkelling; the surveys should be conducted through SCUBA diving. Appropriately trained and certified SCUBA divers must complete these surveys and they must have the professional qualifications as per Section 2.0.

Note: Survey data collected must include the count of live specimens and empty shells of each mussel species, as well as null data (see Section 7.0 for Data Collection requirements)

Note: Tactile surveys can be conducted to confirm species, and minimize disturbance of mussels, if surveyor is confident in ability to identify species through tactile practices.

4.5 Visual Survey Field Equipment List

The equipment required for visual surveys for mussels includes:

- Snorkel/mask
- Wet or dry suit recommended
- Fins not recommended
- 40 m rope marked off at 1 m intervals
- 30 m+ measuring tape
- GPS
- Field book
- Camera
- Mussel Identification Fact Sheets
- Mussel Detection Fact Sheet
- Mussel data sheet (Appendix A)

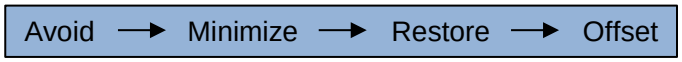
Note: View finders not recommended in a lake environment due to the limited scope of view.

5.0 MITIGATION FOR FRESHWATER MUSSELS

General measures for mitigating effects to environmentally sensitive features are provided in the existing provincial guidance documents (e.g., *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (MoE 2014), *Standards and Best Practices for Instream Works* (MoE 2018b)). The mitigation measures provided in this document relate specifically to Rocky Mountain Ridged Mussels and foreshore developments on Okanagan large lakes. Mitigation will be required where live Rocky Mountain Ridged Mussels are identified within the project area. The scale of mitigation will be dependent on the risk of the activity.

The Environmental Mitigation Policy for British Columbia (MoE 2018a) was enacted in 2014 as provincial policy on mitigating impacts to environmental components and developing mitigation plans. The associated Environmental Mitigation Procedures support implementation of the Policy and provide guidance for considering environmental values, effects to these values as a result of project interactions, and mitigation measures to avoid, minimize, and restore or offset adverse effects. These Procedures should be considered when developing mitigation for mussels.

In general mitigation measures can be ordered as a hierarchy based on preferred mitigation action as follows:



5.1 Selecting Targets for Mitigation

Mussels, if confirmed at the site, are considered an environmental value as described in the Policy. To develop appropriate mitigation the associated environmental components must be identified (i.e., attributes of the environmental values that can be measured, managed, and maintained) that will be adversely affected by a proposed project. Table 1 provides an example of the value, its potential components and possible indicators of those components relative to the management target set for Rocky Mountain Ridged Mussel. This example may be used as a guide for proponents and qualified professionals in identifying the mussel value, specific components and target for mitigation relative to current conditions, as well as the management targets for this species. Refer to the Environmental Mitigation Procedures for additional information on defining values, components, indicators and management targets, as well as a detailed description of the mitigation hierarchy.

Table 1 Example of a Mussel Environmental Value, Components and Indicators

Value[1]	Component	Possible Indicators	Management Target[2]
Live Rocky Mountain Ridged Mussels	Functional habitat area	% area occupied	To maintain viable, self-sustaining, ecologically functioning and broadly distributed populations within suitable habitats at the species' current distribution and range in B.C.
	Functional habitat condition (of area occupied)	% native substrate % invasive cover % disturbance	
	Population size	# individuals	
	Reproductive success	Variation in age class	

[1] See Environmental Mitigation Procedures for guidance on selecting values, components and indicators
[2] Management target from Fisheries and Oceans Canada (2010).

5.2 Avoid and Minimize

Avoidance, as defined in the Environmental Mitigation Procedures, means to fully avert any potential impact on one or more environmental components resulting from a project or activity. Complete avoidance of adverse effects is the most preferred mitigation option for mussels. Avoidance measures to consider include:

- **Relocate** project outside of areas known to be occupied by live mussels
  - Move developments to less sensitive foreshore area
- **Redesign** project to avoid areas known to be occupied by live mussels
  - Use methods such as directional drilling or boring instead of trenching
- **Avoid** projects that are in areas known to be occupied by live mussels
  - Avoid project if relocation and/or redesign options do not exist

Minimize, as defined in the Environmental Mitigation Procedures, means to partially avoid or reduce the level of impacts on one or more environmental components resulting from a project or activity. This should only be considered where complete avoidance is not possible. For mussels, some mitigation measures have been provided below:

- Minimize size of project footprint
- Maximize spacing on piles to reduce impact to substrate with known live mussels
- Use rail launch system rather than cement pads
- Orient developments perpendicular to the shoreline
- Limit disturbance to mussels or their habitat from October – May when the water temperature is low and mussels are more susceptible to impacts
- Limit sediment, deleterious substances and debris from entering the lake

Note: In certain cases, complete or partial avoidance may be the only acceptable mitigation option for mussels, and projects may not be permitted to proceed if adverse effects cannot be avoided.

5.3 Restore, Offset and Relocate

If avoiding and minimizing impacts to mussel components have not been successfully addressed after following the above guidance (Section 5.2) then restoration, offsetting and relocating must be considered as per the Environmental Mitigation Procedures. Again, this should only be considered an option where complete or partial avoidance is not possible.

Restoration, as defined in the Environmental Mitigation Procedures, includes onsite activities to restore, replace or remediate environmental components that are adversely affected by the project. For mussels there are currently no options for habitat restoration.

Offsetting, as defined in the Environmental Mitigation Procedures, means to counteract, or make up for, an impact on an environmental component that cannot be adequately addressed through other mitigation measures in the hierarchy. Offsetting (also known as compensation) is the last and least preferred option in the mitigation hierarchy, and may include offsite restoration, land securement, conservation covenants and/or a contribution to gaining more science.

Relocation involves deliberately moving mussels from one location to another, either onsite or offsite, to mitigate threats. Relocation success for Rocky Mountain Ridged Mussels is under evaluation in the Okanagan; as such, multi-year monitoring is a requirement if this option is selected. If relocation is being undertaken the methods for relocation outlined in Section 6.0 must be followed.

Note: Restoration, offsetting, and relocation projects are often much more expensive than avoiding or minimizing adverse effects and may not be possible for some projects.

6.0 RELOCATION METHODS

To determine if relocation is required see Section 3.0, above. In general, relocation of mussels is required where the presence of Rocky Mountain Ridged Mussels has been confirmed and a High or Moderate Risk activity that will disrupt the lakebed substrate is proposed. It is important to note that mussels are only to be relocated where the lakebed is being disturbed or if there is significant impacts in the other areas of the PSA (e.g., significant siltation). The goal of the relocation is to remove all adult and juvenile Rocky Mountain Ridged Mussels that could be affected by the project,

in a cost-effective manner that will result in high survival of both transplanted individuals and resident fauna at the recipient site (Mackie et al. 2008, Havlik 1997).

Relocation of mussels requires that both a relocation site and control site be located and established prior to relocation activities. The purpose of each of these sites is as follows (Mackie et al. 2008):

- Relocation Site – the relocation site will provide habitat for mussels that have been moved from the PSA.
- Control Site – The control site has matching habitat to the PSA and relocation sites, but no mussels are moved to the control site. The control site is necessary to determine the impacts (if any) to mussels already established in the habitat resulting from the introduction of mussels from the PSA.

The habitat at the relocation and control sites must match the habitat of the PSA (or site to be disturbed). This is to ensure survival of relocated mussels, continued attraction of host fish, and survival/recruitment of juvenile mussels.

6.1 General Measures

- Mussels should not be exposed to air any longer than required to collect data (USFWS Georgia 2008)
- Must have approval from FLNRORD Ecosystems before proceeding with relocation
- Must have a *Water Sustainability Act* permit
- Must have a *Wildlife Act* permit
- Other permits may be required, consult with DFO
- Must occur in water >16^{o}C
- No handling of mussels when they are spawning (May-June) (Stanton et al. 2012)
- Relocation must occur within 30-45 days of instream construction

6.2 Specific Relocation Measures

- Relocation site must be as close to the site of disturbance as possible
- Relocated mussels should not be placed fronting another private landowner property
- Relocated population must be monitored 1 month, 1 year, and 2 years post relocation
- Original site that mussels were taken from must also be monitored in follow up monitoring
- A control site must be established and monitored
- The relocation and control sites must be: the same size as the PSA, similar in water depth (and other characteristics) and with similar substrates from where the mussels were removed
- Mussels must be kept in buckets with holes in shallow water (buckets must have holes so water can flow through) during collection
- Collection buckets must be kept in a shaded area to avoid water temperature increases
- Relocation should occur 1 month prior to water temperatures dropping below 16^{o}C to allow for 1 month monitoring while temperatures are within optimal range
- Collecting mussels for relocation must occur in the entire PSA
- Transects must be placed 1m apart perpendicular to the shoreline throughout the entire PSA

6.3 Steps for Mussel Relocation

It is recommend that a team of two work in the water, while one or two additional team members work on the shoreline to record data and tag mussels

To Establish Control and Relocation Sites

1. Locate and establish the mussel relocation and control sites (see Section 5.1 in Mackie et al. 2008)
2. Collect site data and baseline mussel data using a random plot design (see Section 5.2.3 in Mackie et al., 2008, and Section 7.0 herein) from both the relocation and control sites prior to moving mussels from the PSA:
    a. Mussels are located and removed through visual surveys (see Section 4.0) within the quadrat first
    b. Once visual survey is completed large rocks must be removed from within the quadrat
    c. Using a hand in a rapid back and forth manner (near bottom) the soft substrate is to be fanned away.
    d. Allow material to settle and the water column to clear so visibility allows for a resurveying for adult or juveniles that may have been subsurface within the quadrat
    e. Mussels are then tagged (Figure 3 and Section 6.4) and data is to be collected (see Section 7.0 for specifics on data collection)
    f. Mussels should then be placed back into each quadrat at the control and relocation sites in position it was found in (Figure 5)

Note: If mussels at control and relocation site are not the same species as the PSA the surveyor will need to collect, tag, and enter data for additional mussel species so that comparisons can be made.

Note: It is thought that juveniles can be observed within the water column if dislodged through the fanning process. These mussels (often very small) float and move different than sediment in the water columns allowing for detection.

Note: Mussels that are removed must be placed immediately in the 20 L bucket (with holes) that is in the shallow water (out of direct sunlight). To allow you to collect all mussels from quadrat before placing them in 20 L bucket and to reduce stress on mussels it is recommended you have a closable mesh bag that can be kept in the water (looped on collectors arm) to store mussels in (mesh bags can be found in any produce section of a grocery store).

Figure 3 Tagged Rocky Mountain Ridged Mussel (a) during tagging process, and (b) relocated in Okanagan Lake

Assessment and Removal of Mussels from the PSA (project area)

1. Within the PSA place a measuring tape along the foreshore along the entire PSA (Figure 4a)
2. Place a rope (marked at 1 m intervals) at the start of the measuring tape perpendicular to the shoreline out to the end of the PSA (see Figure 4b)

Figure 4 (a) Tape measure running length of PSA, and (b) Rope marked at 1 m intervals running perpendicular to shore within PSA

3. Using the 1 m^2 quadrat start the survey at the 0 m mark on the rope (Figure 5)
4. Conduct a visual survey and subsurface fanning for mussels in the quadrant (as above)
5. Tag and collect data (as above)
6. Mussels from the PSA should be placed at the relocation site before proceeding to next quadrant so similar depth and habitat can be provided for relocated mussel. If water depth does not change significantly within the PSA all mussels can be collected and held in bucket, data recorded, and mussels relocated. Ensure that mussels are not overcrowded in buckets
7. Move the 1 m^2 quadrant along the rope to the next meter mark and repeat steps 1-6 until all mussels in the entire PSA have been relocated.

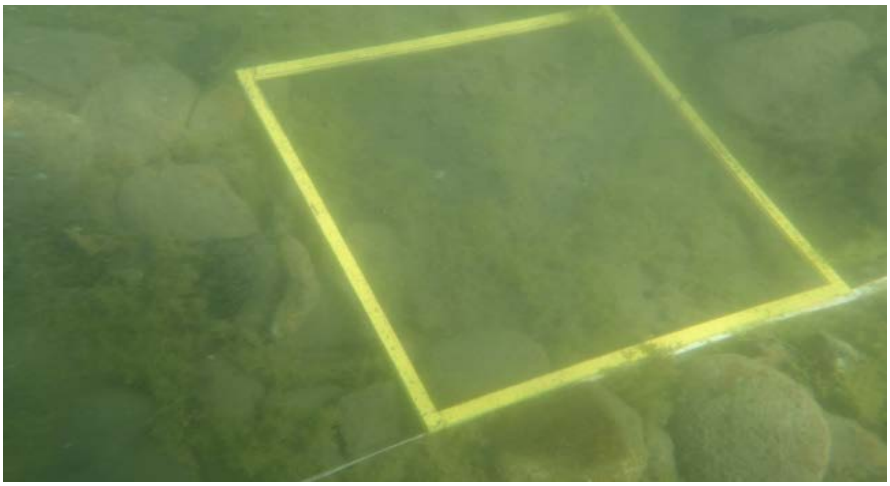


Figure 5 Quadrat placed on transect

6.4 Tagging a Mussel

Correctly tagging a mussel is essential to monitor relocation success. Choice of tag, location and timing must be correct to limit impact to mussel growth and survival. The tag must last for the duration of the monitoring period, and be relatively easy to recover in follow-up monitoring. Tagging of Rocky Mountain Ridged Mussels in the Okanagan watershed has occurred as part of several studies currently underway. The following advice is based on this experience and is provided to ensure proper tagging technique is used:

- Both valves should be tagged; tags can be ordered in pairs e.g., A### and B###,
- Etching is not permitted as it can weaken or puncture shells,
- Tags should be placed on the posterior end, opposite the foot, of both valves to assist in detection for post-relocation monitoring (Figure 6),

Figure 6 External anatomy of Rocky Mountain Ridged Mussel, showing recommended location for tagging

- Mussels <4 cm in length (along longest anterior to posterior axis) should not be tagged
- Tag location should be consistent,
- Shells must be scraped (thumb nail is recommended) to remove debris and growth at tag location
- Shells should be damp but not wet, to ensure adhesion
- Using tweezers to hold tag, apply glue to the tag, and press down firmly on shell – holding for a few seconds (Figure 7), a gloved hand is recommended to avoid bonded skin,
- Double check that edges are adhered,
- Record all data and include photographs (see Section 7.0),
- Place mussels back in holding bucket(s), triple checking tags when replacing mussels into the lake.

Figure 7 Tagging a mussel

The equipment required for relocation and tagging of mussels includes:

- At least one 1 m^2 quadrat
- 30-50 m of rope (chain or measuring tape) marked off at 1 m intervals
- Measuring tape for shoreline to run transects off of
- Krazy glue (cyanoacrylate)
- Tweezers
- Shellfish tags
- Snorkeling gear (possible diving gear dependent on site depths)
- 20 L bucket with holes (put in shallow water using a rock to keep in place)
- Shovel or scope
- Calipers
- Fish pond basket (you can buy in pet store they are used to keep juvenile fish separated in tank environment – this will be used to hold juvenile mussels) with 7mm Sieve
- Mesh collection bags
- Camera
- GPS
- Field book
- Data collection sheets (see Appendix A)
- Field guides/Factsheets
- Thermometer
- Meter stick (water depth)

7.0 DATA COLLECTION

Adequate data collection is essential for measuring success of a project. Detailed notes and observations provided in data collection sheets and monitoring reports will also help refine guidance, monitor populations in the watershed, and help to better understand the basic biology of mussels in the Okanagan watershed. To aid in this important work, the following list and sample data collection sheets (Appendix A) are provided.

7.1 Visual Survey Data

Collected data should include:

- Size, description, and location of PSA and each component within it
- UTM of start and end of guideline that is placed along shoreline
- Location of transect off guideline
- Transect number
- Water depth at furthest extent of PSA
- Substrate type
- Weather conditions
- Visibility
- Fish observed during surveys
- Date
- Surveyor
- Time of survey
- Water temperature
- Number of mussels observed in each transect (live and shells)
- Species of mussels observed in each transect
- Method of detection (beach, snorkel or dive)
- Estimated size range by species
- Photos of each species/habitat

7.2 Relocation Data

The control and relocation sites must be assessed before mussels are moved from the PSA. These sites must have similar habitat conditions to the PSA, and estimates of mussel density and diversity in each are required.

Collected data at the relocations and control sites should include:

- Size, description, and location of PSA and each component within it
- Size, description, and location of control site
- Size, description, and location of relocation site
- UTM of start and end of guideline (measuring tape) that is placed along shoreline
- Location of transect off guideline
- Transect number
- Location of quadrat off transect line
- Quadrat number
- UTM of Quadrat (taken in north west corner)
- Water depth in meters
- Shell or live observations
- The measurements should be taken with calipers and reported with two decimal degrees
- Measurements of length, width and height must be taken (Figure 8) where length is taken from the anterior edge to the posterior edge, height is from the dorsal to the ventral, and width is the thickness of the shell
- Substrate type
- Weather conditions and Visibility
- Fish observed during surveys

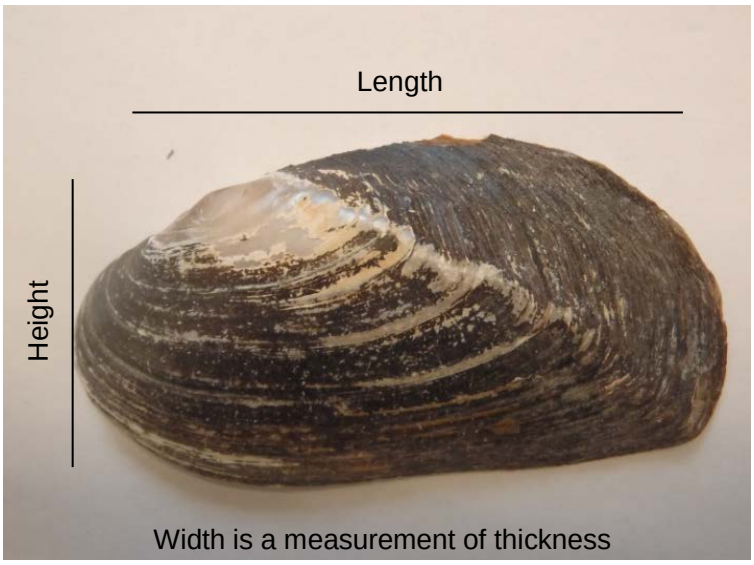


Figure 8 Depiction of where measurements are taken from

8.0 RELOCATION MONITORING

- Monitoring must be conducted 1 month, 1 year, and 2 years post relocation
- Water temperatures must be >16^{o}C at monitoring time and for one month post monitoring to allow for reburying
- Monitoring data must be sent to FLNRORD Ecosystems Section after each monitoring (102 Industrial Place Penticton BC V2A 7C8). Please reference FLNRORD *Water Sustainability Act* file number on the report
- Mussels that are relocated and mussels that were tagged within the relocation and control sites must be monitored
- During all post relocation monitoring the surveyor should visit the original site (PSA) and see if any mussels have re-established. This should be done through random quadrat placement throughout the PSA and visual surveys as per Section 4.0
- All data recorded during initial relocation should be recaptured during monitoring (Section 6.0)
- *Wildlife Act* permit should include monitoring to allow for the handling during
- Monitoring should not be conducted during mussel spawning
- Accurate GPS points should be used (colour pegs should be avoided if possible)
- Survival data must be reported

9.0 REPORTING

All data (including null data) and reporting should be submitted to the Senior Ecosystem Biologist for FLNRORD in Penticton. In addition you must submit you data to the Conservation Data Centre.

10.0 REFERENCES

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APPENDIX A MUSSEL DATA COLLECTION SHEET

Mussel Data Collection Sheet	
Date	
Start_Time	
End_Time	
Waterbody_Name	
Location	
UTM_Zone_Start	
Easting_Start	
Northing_Start	
UTM_ Zone_ End	
Easting_End	
Northing_End	
UTM_Method	
Surveyors	
Survey_Technique_Effort	
Search_Time (mins)	
Mean_Depth_Searched (m)	
Distance_Covered_ in_Search (m)	
Total_Area_Searched (m2)	
Adjacent_ Land_ Use	
Disturbance_Features	
Substrate	
Aquatic_Vegetation	
Water _larity (m)	
Water_Color	
Water_Temperature (C)	
Water Conductivity	
pH	
Fish_Present	
Live_Gonidea	
Gonidea_Shells	
Live_Anodonta	
Anodonta_Shells	
Live_Western_Pearlshell	
Western_Pearlshell_Shells	
Live_California_Floater Mussel species	
California_Floater Mussel species_Shells	
Live_Western_Floater	
Western_Floater_Shell	
Live_Winged_Floater	
Winged_Floater_Shell	

Mussel Data Collection Sheet	
Live_Fingernail_Clams (Sphaeriidae)	
Fingernail_Clams (Sphaeriidae) Shells	
Live_S.rhomboideum	
Shells_S.rhomboideum	
Number_Unknown_Species_Live	
Number_Unknown_Species_Shells	
Known_Species	
Number of mussels and shells found	
Comments	