# British Columbia Invasive Mussel Lake Monitoring Field Protocol

BRITISH COLUMBIA

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## ACKNOWLEDGEMENTS

*Front cover photo credit: Ministry of Water, Land and Resource Stewardship*

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## Glossary

**Epilimnion**: The upper, wind-mixed layer of a thermally stratified lake (Water on the Web 2011).

**Eutrophic lakes:** A very *biologically productive* type of lake due to relatively high rates of nutrient input (usually phosphorus and nitrogen) which leads to excessive plant growth - algae in the open water, periphyton (*attached* algae) along the shoreline, and macrophytes (the higher plants we often call *weeds*) in the nearshore zone (Water on the Web 2011).

**Hypolimnion:** The bottom, and most dense layer of a stratified lake. It is typically the coldest layer in the summer and warmest in the winter (Water on the Web 2011).

**Lentic:** Body of standing water, ranging from ditches, seeps, ponds, seasonal pools, basin marshes and lakes.

**Lotic:** Refers to bodies of water with flowing water (e.g. rivers, streams)

**Metalimnion**: The middle or transitional zone between the well mixed epilimnion and the hypolimnion layers in a stratified lake. This layer contains the thermocline (Water on the Web 2011).

**Secchi Disk**: A disk with a 4-6 inch radius, divided into 4 equal quadrates of alternating black and white colors. It is lowered into a section of shaded water until it can no longer be seen and then lifted back up until it can be seen once again (Water on the Web 2011).

**Spring turnover**: Period of complete or nearly complete vertical mixing in the spring after ice-out and prior to thermal stratification (Water on the Web 2011).

**Thermal Stratification**: when a lake is broken into distinct horizontal layers due to changes in water temperature which leads to differences in density (Water on the Web 2011).

**Thermocline**: The depth at which the temperature gradient is steepest during the summer; usually this gradient must be at least $1^0$C per meter of depth (Water on the Web 2011).

**Veliger**: the microscopic free-swimming larvae (veligers) stage of the dreissenid mussel life cycle.

# 1. INTRODUCTION

Monitoring is critical for early detection of new invasive species incursions in British Columbia (B.C.) and is an important first step in the Provincial Early Detection Rapid Response (EDRR) plan[1]. Zebra (*Dreissena polymorpha*) and quagga (*Dreissena rostriformis bugensis*) mussels, are two freshwater invasive species that are not currently found in B.C. but pose significant environmental and economic risks if they were to be introduced. In October 2024 the invasive golden mussel was detected for the first time in North America in California. This protocol encompasses both zebra and quagga mussels (dreissenid mussels) and the Golden mussel. These three species will be collectively referred to as "invasive mussels" herein. For more information about invasive mussels please visit www.gov.bc.ca/invasivemussels and see Section 2 below.

B.C. is a signatory on the *100th Meridian Initiative's Columbia River Basin (CRB) Interagency Invasive Species Response Plan: Zebra Mussels and other Dreissena spp*. (Heimowitz and Phillips 2008). Under this Plan the Province is committed to prevention efforts to mitigate the risk of invasive mussels in B.C. and across the Pacific Northwest. As part of this commitment the Province has been conducting early detection monitoring for invasive mussels since 2011. B.C. is one of the many jurisdictions across North America conducting early detection monitoring and active prevention efforts for invasive mussels. Furthermore, as a signatory on the CRB Interagency Invasive Species Response Plan the Province is committed to following the minimum standard protocols for invasive mussel prevention efforts including watercraft inspection and decontamination protocols, and early detection lake monitoring protocols.

The invasive mussel life cycle consists of three primary life stages; veligers, juveniles and adults and the appropriate sampling method varies depending on the target life stage for early detection monitoring efforts. The sections below outline the appropriate field sampling methods for the different target life stages of invasive mussels. The applicable protocols pertaining to field sample preservation and equipment decontamination for invasive mussel monitoring are also outlined below.

In 2018 the Habitat Conservation Trust Foundation (HCTF) launched a granting program to fund lake monitoring in BC for the presence of invasive mussels. This granting program is in partnership with the BC Ministry of Water, Land and Resource Stewardship (WLRS). The grants provide funding for sampling for the presence of invasive mussels and must follow the protocols outlined in this document. This includes protocols for conducting plankton tows, deploying substrate samplers, and preserving and shipping of samples to the WLRS designated lab.

This protocol serves as an update to the *2025 BC Invasive Mussel Lake Monitoring Protocol* to reflect the minimum recommended protocols being used by other jurisdictions in the Columbia River Basin. To complete the 2026 HCTF grant application this protocol must be read in detail. Please refer to the HCTF Invasive Mussels Monitoring Grant guidelines for complete instructions on filling out the grant application.

[1] The Zebra and Quagga Mussel Rapid Response Plan for British Columbia can be downloaded from https://www2.gov.bc.ca/assets/gov/environment/plants-animals-and-ecosystems/invasive-species/invasive-mussels/prov_zqm_edrr_plan.pdf

## 2. IDENTIFICATION

Zebra and quagga mussels

Zebra and quagga mussels are small, triangular bivalves. Adults are typically 1- to 3-cm (0.4- to 1-inch) in shell length and juveniles range between 350-µm to ~5-mm in size. Shell color varies but they usually have black and white stripes, although some are all dark and others are cream colored to light orange (Figure 1 and Figure 2). When sampling for adult zebra and quagga mussels, pay attention that any native mussels present should not be disturbed (Figure 3). For more information on zebra and quagga mussels please visit the provincial website.


**Figure 1. Invasive Dreissenid mussels with scale reference**


**Figure 2. Size comparison between invasive zebra and quagga mussels (top) versus native mussels (bottom)**

Native freshwater mussels:

The B.C. Species and Ecosystems Explorer contains information on native mussel species present in B.C., including their federal and/or provincial threat status. The Rocky Mountain Ridged Mussel (*Gonidea angulata*) (Figure 3) is native to B.C. and was listed as Special Concern under SARA in 2003 and assessed as Endangered by COSEWIC in 2010. Its presence is limited to the Columbia River system and its tributaries, including the Okanagan and Kootenay rivers. It is trapezoidal in shape, ~12.5 cm long and ~0.4 cm wide. Any live specimens of a species at risk should not be disturbed. Collect photographs, the location (GPS coordinates preferred) and other information about the specimen and submit it to the B.C. Conservation Data Centre (CDC) as soon as possible (see Appendix A for reporting information). Additional information on identifying native freshwater mussels in B.C. is available on the CDC website and more information on other native freshwater molluscs in B.C. can be found here.

**Figure 3. Rocky Mountain Ridged Mussel (*Gonidea angulata*) native to B.C. Photo credit: The Xerces Society**

**Figure 4. Native floater mussel. Photo credit: WLRS.**

Golden mussels (*Limnoperna fortunei*):

Golden Mussels are native to rivers and creeks in China and southeastern Asia. They have been introduced to other parts of Asia (Hong Kong, Japan, Taiwan) and Southern America. In October 2024 the Golden Mussel was detected in the Sacramento - San Joaquin Delta in California. This represents the first detection in North America. There have been no reports of Golden Mussels in B.C. Golden Mussels can be found in fresh and brackish water. They attach to natural and manmade substrates. Waterbodies with extreme pollution, water temperature, pH, and nutrient levels are habitable for Golden Mussels.

The golden mussel could be confused with zebra and quagga mussels as they are very similar in size and also attach to hard surfaces.

- Shells are dark brown, yellow or golden in colour on the exterior.
- Are purple to white on the shell's interior.
- Average 2-3 cm in length but can reach up to 4.5 cm. Note that individuals this size are adults, larvae of this species are microscopic.
- Do not have a byssal notch, which is seen in other mussel species, or hinge teeth.

**If you observe any suspected invasive mussels, contact the Provincial Invasive Mussel Defence Program immediately by calling the Conservation Officer Service Report All Poachers and Polluters Hotline 1-877-952-7277 (RAPP).** This allows the trained Provincial inspectors to respond quickly and take the appropriate steps.

**Figure 5. Invasive golden mussels (*Limnoperna fortunei*). Photo credit: Henrique Andrades (iNaturalist).**

Marine (Blue) Mussels

The blue mussel (*Mytilus edulis*) is a marine mussel that only survives in salt water. Just like the zebra and quagga mussels and the golden mussel, the blue mussel has byssal threads which allow them to attach onto solids surfaces including boats. Watercraft traveling from saltwater to freshwater could transport blue mussels into freshwater. Dead marine mussels have been mistaken for invasive mussels due to the small size of juvenile blue mussels (< 5cm). Blue mussels do not survive in freshwater but it is still important to practice Clean, Drain (pull the plug), Dry when moving your boat from salt water to freshwater to prevent a false report of the marine blue mussel as an invasive mussel.

The blue mussel can be identified by the following characteristics (see Figure 6):

- Outside shell is glossy bluish or bluish black, sometimes pale brown.
- Inside shell is generally violet in color.
- Pear-shaped and ventrally flattened shell.
- Typically, full size is 5-10 cm but can range from 2 to 20 cm.
- Presence of byssal threads.


**Figure 6. Marine blue mussel (*Mytilus edulis*) on the left and right.**

Other invasive bivalve species:

There are two invasive bivalve species already present in B.C.; the invasive freshwater clam (*Corbicula fluminea*) and the New Zealand mudsnail (*Potamopyrgus antipodarum*) that could be mistaken for invasive mussels during adult substrate sampling.

**Invasive freshwater clam (*Corbicula fluminea*):**

- Native to Southeast Asia and parts of central and eastern Australia, Africa, Indonesia and Turkey.
- Shell is triangular shaped and usually less than 2.5 cm but up to 6.5 cm in length, and yellow-green to light-brown in color with elevated growth rings.
- They are found in brackish to freshwater rivers, lakes, streams, canals and reservoirs, in the sediment surface or slightly buried in silt, sand or gravel substrates.

- They are filter-feeders, with a preference for flowing water and they have a low tolerance for polluted or near freezing water temperatures.
- Confirmed locations in B.C. include the Lower Fraser, Pitt, Pend d'Oreille, and Coquitlam Rivers, southern-Vancouver Island, and Sproat, Moyie, Cultus, Kawkawa, and Shuswap Lakes.
- A factsheet is available for download on the BC Inter-Ministry Invasive Species Working Group website.
- Juvenile *C. fluminea* can resemble the native fingernail/pea clam species (Sphaeriidae family) but the shells of the native clam are thinner and oval shaped, and brown to gray in color.

**New Zealand mudsnail (*Potamopyrgus antipodarum*):**

- Freshwater snail native to New Zealand.
- Small with cone shaped shells and 5-8 whorls on shell with a pointed end
- Grow up to 8 mm in length and 4mm wide and range from light brown to black in colour
- Prefer vegetated habitat close to the shore of lakes and low flowing streams with silt and organic substrate. This species has high tolerance to various water quality, temperature (above freezing), and salinity levels.
- Confirmed location in BC is the Somass River near Port Alberni on Vancouver Island.


**Figure 7. Invasive freshwater clam (*Corbicula fluminea*) (left) and invasive New Zealand mudsnails (*Potamopyrgus antipodarum*) (right). Photo credit: Portland State University.**

**Figure 8. Comparison between invasive freshwater clam (*Corbicula fluminea*) top and invasive dreissenid mussels (bottom).**

## 2.1 Whirling Disease

Whirling disease is a disease affecting juvenile salmonid fish including trout and whitefish. It is caused by a microscopic parasite, *Myxobolus cerebralis*, which infects fish through their skin. Physical signs of the disease may include a deformed body or skull, and dark colouration of the tail area. Deformations sometimes cause a whirling swimming pattern. Although there is no risk to human health, the parasite can be lethal in susceptible fish populations (trout, salmon, whitefish).

The first documented case of whirling disease in B.C. was in winter 2023 in Yoho National Park and in 2024 trout samples taken from the southern arm of Kootenay Lake tested positive for the parasite that causes whirling disease.

The movement of fish, mud, and water can spread whirling disease. There is no treatment currently available for whirling disease therefore containment and prevention are the best response.

**Best Practices for preventing the spread of whirling disease, include:**

- Never move fish or fish parts from one waterbody to another.
- Use fish cleaning stations where available or put fish parts in the local solid waste system. Do not dispose of fish or any fish parts in a kitchen garburator.
- Clean, Drain and Dry boats or any equipment (waders, life jackets, kayaks, etc.) before moving between waterbodies.
- Pull the plug! It's the law! It is now illegal to transport your watercraft in B.C. with the drain plug still in place.
- Before transporting a boat or other watercraft, owners/operators must remove the drain plug and drain all water on dry land including all internal compartments such as ballasts, bilges, and live wells.

For more information visit B.C. Whirling Disease. Please forward any reports or inquiries regarding whirling disease in B.C. to WhirlingDisease@gov.bc.ca.

# 3. INVASIVE MUSSEL VELIGER SAMPLING

## 3.1 Plankton tows

Veliger samples are collected using a plankton net and conducting vertical and/or horizontal tows. Due to their small size, invasive mussels will pass through mesh > 65µm. Therefore, to effectively sample for invasive mussel veligers the plankton net must have a mesh of 64µm, and the net mouth opening must be 30cm to 50cm in diameter (Figure 9).

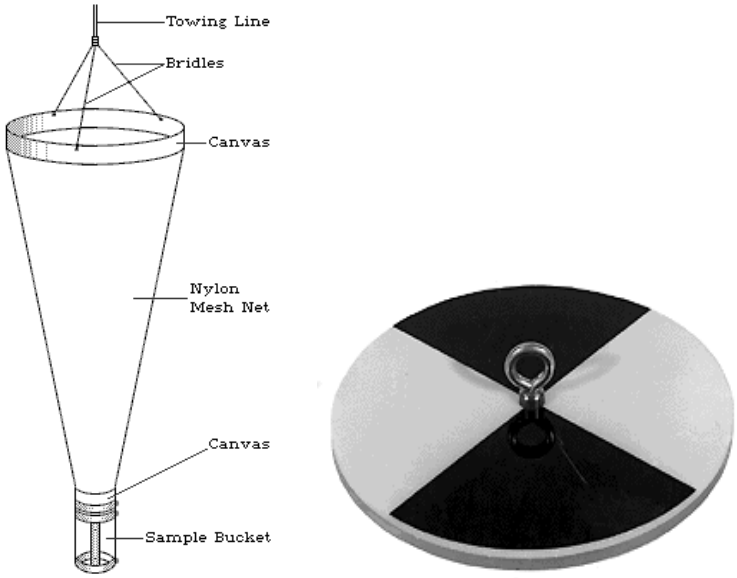


**Figure 9. Plankton net used for collecting veliger samples and secchi disk used for measuring secchi depth.**

## 3.2 Where to Sample

The number of sample sites per waterbody should be scaled to the size and complexity of the waterbody. A minimum of three replicates/plankton tows are recommended at each sample site. When choosing locations for the sample sites, try to select the number and location in such a way to represent a diversity of areas in the entire water body (Figure 7). Sample site locations should include high use and near shore areas such as marinas, boat launches, docks, at inlets and outlets of the waterbody (e.g. mouth of tributaries; dams) and in downwind areas and eddies which can be identified by the accumulation of leaves, pollen and debris on the surface of the water. Samples should be collected from a boat. If a boat is not available, sampling can take place from a dock and preferably from public docks/marinas with high boat traffic. When sampling from a dock please use a vertical plankton tow if depth permits, or a horizontal plankton tow in shallower waters.

To reduce the risk of spreading aquatic invasive species via sampling gear within the same waterbody, sampling should start at upstream sites and move in a downstream direction. This will minimize the need for decontamination of equipment between sites.

If resources do not permit three replicates/plankton tows per sample site, it is critical that a minimum of 1000 L of water is filtered through the net for each sample site.

Replicates/plankton tows for each sample site should be combined into one sample container. The number of tows at each sample site should be based on the net diameter and the depth of each tow, with the goal of a minimum total volume of 1000 L per sample site filtered through the net. The number of tows per sample site to filter 1000 L can be calculated using the equation below.

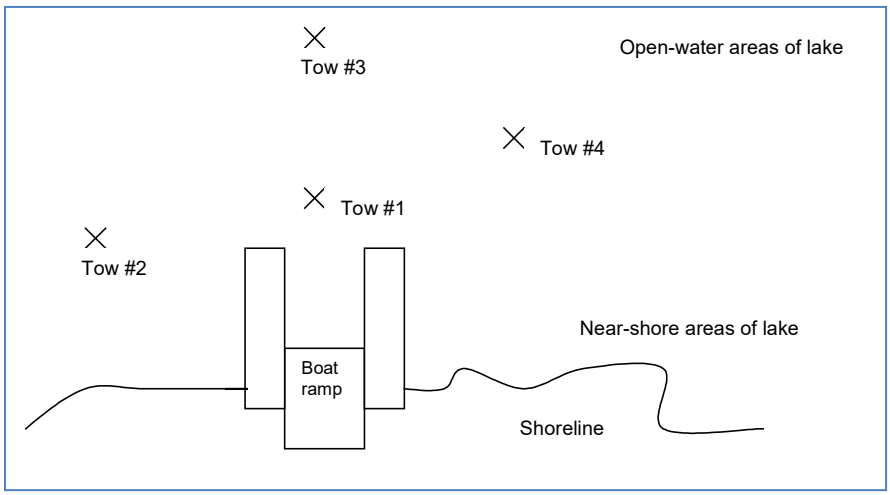


**Figure 10. An example of plankton tow collection within one site.**

Vertical Tow Volume

$$\text{Tow volume (L)} = \text{Area of the net mouth (m}^2\text{)} \times \text{tow depth (m)} \times 1000\ \text{L/m}^3$$

*Example:* A 30 cm net is used to collect 3 x 20 m tows. All 3 of the tows are dispensed into the sample collection bottle.

$$A = \pi \times r^2 = \pi \times 0.15^2 = 0.07\ \text{m}^2$$

$$\text{Tow volume} = 0.07\ \text{m}^2 \times 60\ \text{m} \times 1000\ \text{L/m}^3 = 4200\ \text{L of source water represented in the bottle}$$

**Table 1. Plankton net diameter and the corresponding area ($m^2$) of the net mouth, used to determine the minimum tow depth required to achieve a 1000 L tow volume.**

| Net Diameter | Area of Plankton Net Mouth | Minimum Tow Depth to get 1000 L Total Volume |
|---|---|---|
| 13 cm (5 in) | 0.01 $m^2$ | 100 m (328 ft) |
| 20 cm (8 in) | 0.03 $m^2$ | 33.4 m (109.5 ft) |
| 30 cm (12in) | 0.07 $m^2$ | 14.3 m (46.9 ft) |
| 50 cm (20in) | 0.2 $m^2$ | 5.3 m (17.3 ft) |

The actual depths and number of tows should be adjusted depending on the sample site (site depth, location, stratification etc.) to reach the required minimum of 1,000 L filtered per sample site. For example, the depth of the tow can be adjusted to the secchi depth reading (see section 6 for instructions on taking secchi depth).

Net clogging can occur in highly eutrophic (productive) lakes when a thin layer of plankton, accumulates at the inner surface of the net. This blocks water from going through the net and leads to under sampling. If clogging occurs, first try reducing the depth of the tow and if needed increase the number of tows to reach the minimum of 1,000 L filtered per site.

Horizontal tow volume

An estimate of horizontal tow volume can be made in the same way vertical tow volume is calculated: use the length of the tow in meters multiplied by the hoop area in square meters then multiplied by 1000 L/$m^3$. Record the amount of time the net was held in the water, the percentage of the net opening that was under water, and the rate of flow of the water.

## 3.3 WHEN TO SAMPLE

Invasive mussel spawning is temperature dependent and can begin as early as when water temperatures reach ≥ 9°C for a minimum of two weeks. However, optimal conditions for spawning occur when water temperature reach ≥ 12°C for zebra and quagga mussels and >15°C for the golden mussel. The golden mussel can spawn continuously under suitable temperatures compared to the batch spawning of zebra and quagga mussels. Generally, sampling should occur from June to October, with increased sampling effort from July to September when water temperatures are optimal for spawning for all invasive mussel species (>12°C). The timing of the sampling period will vary by waterbody, based on suitable water temperature levels (>12°C) and adjustments to the timing and frequency of sampling may be required throughout the season to ensure sampling is occurring during optimal temperatures for spawning. For example, sampling may need to be delayed in the spring if water temperatures are cooler and/or water flows are unseasonably high. Conversely, sampling may need to run later into the fall if water temperatures are warmer. It is important to contact HCTF and WLRS right away to request approval for changes to the timing and frequency of sampling. If sampling events need to be cancelled in the spring or fall due to unfavourable conditions, it may be recommended by WLRS to instead collect additional samples during the summer months (e.g. July and August) when water temperatures are the warmest.

Veliger sampling can be performed anytime during the day but preferably not immediately following a storm or flooding event. Storm and flooding events can increase water turbidity and hence the time required to process the sample.

## 3.4 Sampling Methods

Plankton tows can be made in one of two ways, based on the waterbody type and sample site conditions: vertical and horizontal tows. Wherever possible, it is preferred to do vertical tows from a boat.

**Vertical Tows -** For waterbodies with little flow and depth greater than 4 m, tows are made by lowering the net to the desired depth and pulling it back vertically. In waterbodies that stratify (upper and lower water column separated by thermocline -see glossary for definitions) veligers are found above (epilimnion) and below (metalimnion) the thermocline. Therefore, in waterbodies that stratify both the epilimnion and metalimnion should be sampled. The literature supports that veligers are most concentrated from 0-15m. **If stratification levels are unknown, the minimum recommended depth for the vertical plankton tow is 15 m.** If the depth of stratification is known, then sampling should occur above and below the thermocline. For shallower waters, subtract the length of the plankton net, plus .5

meters to keep it from hitting the bottom. See Appendix B for a complete list of equipment for plankton tows and Appendix C for detailed sampling methods.

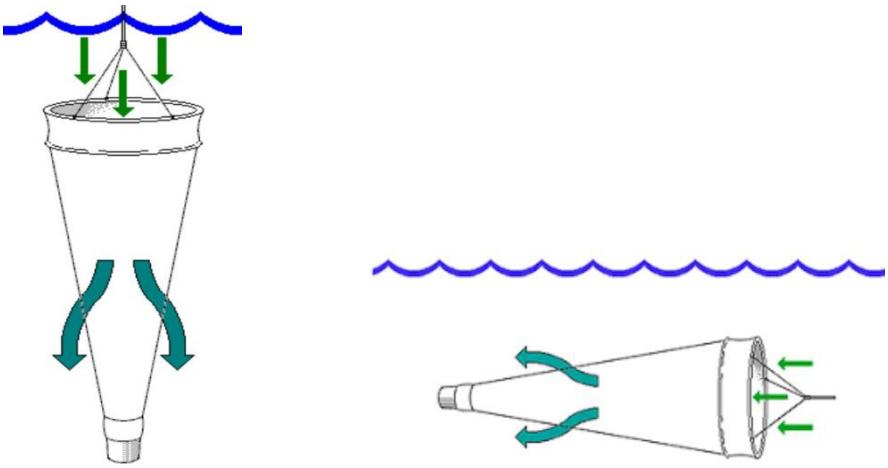

Figure 11. Vertical (left) and horizontal (right) plankton tows.

**Horizontal Tows** - For waterbodies less than 4m, or that are flowing (drainage ditches, pipes, rivers, streams, etc.), horizontal tows are recommended. Horizontal tows are made by releasing the net in the flow and either holding it stationary, or by pulling it back at an oblique angle or horizontal to the surface of the water. Horizontal tows can be done from a boat (trawling) or from a dock by walking the length of the dock or using a shoreline toss. See Appendix B for a complete list of equipment and Appendix D for detailed sampling methods.

Figure 12. Shoreline toss (Photo: S. Wells)

Table 2. Summary of plankton tow sampling recommendations.

| Parameter | Recommendation |
|---|---|
| Water temperature | ≥12°C for a minimum of two weeks |
| Locations | Around floating structures, marinas, inlets, and outlets, coves, down-wind areas and eddies |
| Depth | 15 m (50 ft) but will depend on depth of waterbody and depth of the thermocline |
| Number of sampling sites per waterbody | Variable; based on size and complexity of waterbody (some sites provided) |
| Number of site replicates/plankton tows per sampling site | Variable; when possible a minimum of 3, based on depth and net size, minimum 1000 liters per sample site. |

# 4. ADULT INVASIVE MUSSEL SAMPLING METHODS

The objective of sampling for juvenile and adult invasive mussels is to detect bivalves attached to hard submerged surfaces in freshwater environments. Invasive mussels are one of the few freshwater mussels capable of adhering to hard surfaces using byssal threads. The adults can only attach to hard substrate, so in muddy areas they will be found attached to embedded rocks, native clams, or crayfish. In lakes with little hard substrate, invasive mussels may initially settle on sticks, logs, shells or plants, or sometimes attach directly to sand grains, and later settle onto each other, eventually forming large mats. Adult invasive mussels can be sampled using a number of different methods such as tactile and visual inspections of existing submersed surfaces and shoreline areas, a surface scraper (Figure 13a), artificial settlement substrates (Figure 13b), and a thatch rake on a rope (Figure 13c). **A brief description of these methods is provided below but for the purposes of monitoring for juvenile and adult invasive mussels in BC artificial substrate samplers is the recommended method. Shoreline surveys are encouraged when checking substrate samplers.**

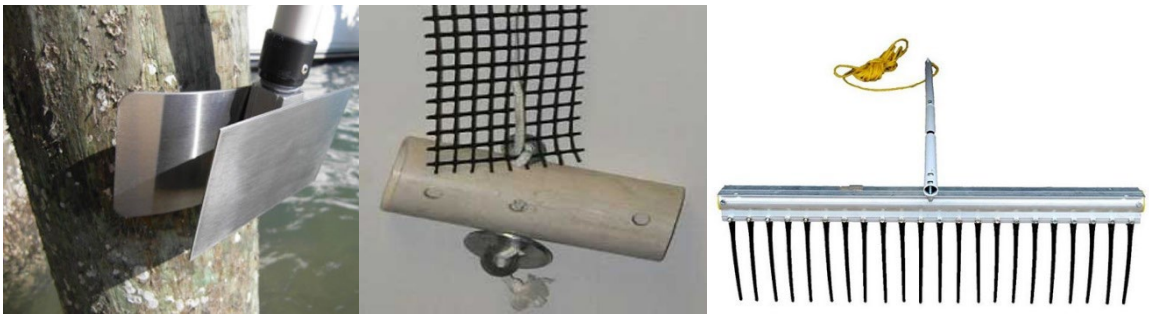

Figure 13. Adult mussels sampling tools: a) surface scraper, b) substrate sampler, c) thatch rake on a rope.

**Shoreline surveys** and inspections of structures in the water are conducted to identify the presence or absence of adult and juvenile invasive mussels. Visual and tactile inspections of natural and other man-made submersed surfaces (including the undersides of buoys and dam booms, buoy mooring chains, the undersides of dock floats, rocks, logs, shoreline areas and other items) increase the surface area sampled for invertebrate colonization and thereby increase the likelihood of early detection.

**A surface scraper** can be used to sample submerged portions of hard, smooth surfaces including concrete walls, bridge abutments, pilings, channel markers, underwater booms, floating bathrooms, and

dock floats. The surface scraper that is attached to a long pole should be lowered into the water, and then raised while dragging the metal rim along the surface (Figure 13a). The dislodged organisms will be collected in the attached mesh bucket for inspection at the surface. Repeat at multiple locations per structure in order to sample a representative portion. It is important that a surface scraper is used with caution to ensure that no damage is done to underwater infrastructure.

**Submersed macrophytes** can be collected to sample for attached juveniles and adult invasive mussels. Aquatic plants can be collected from a boat by throwing a thatch rake attached to a rope (Figure 13c), allowing the rake to sink and then dragging for approximately 1- to 2m along the sediment. Macrophyte sampling should occur at locations with plant beds visible from water surface, in areas near marinas and boat launches, and in littoral areas likely to support macrophytes. The collected macrophytes should be visually inspected for bivalves and then shaken in 5-gal buckets of water to detach smaller animals. Bucket water should be poured through a sieve and the sieve and bucket should be inspected for bivalves.

## 4.1 ARTIFICIAL SUBSTRATE SAMPLER

Artificial substrate sampling allows for widespread/low cost and low effort monitoring of invasive mussels (Figure 13 b). Substrate refers to any substance in the water that invasive mussels may attach to. Substrate samplers are for monitoring newly-settled juvenile and adult invasive mussels that colonize substrate surfaces. See Appendix E for more information on how to build a substrate sampler.

### 4.1.1 WHERE TO SAMPLE

Two substrate samplers should be deployed at each of the sampling locations in a manner that will not interfere with boater or swimmer activities. Ideally the substrate sampler should be deployed in a covered area with some water flow and as deep as possible (≥6m is preferred but not required; this will vary depending on the depth at the sample site). During the warmest months, surface water temperatures in some areas may exceed the physiological tolerances of invasive mussels therefore substrate samplers should be placed at depths of 6 meters or greater when possible. Samplers must be placed at the priority locations listed below, even if the depth is less than 6m. Samplers should not be deployed offshore just to achieve the 6m depth. It should also be noted that multiple artificial substrates can be deployed at multiple depths on a single line**.**

<u>Waterbody distribution</u>

- Areas where the water currents and/or wind patterns are likely to concentrate the planktonic larvae, as well as dead adult shells, e.g., near dam or outflow, bays, eddies, etc.
- High boat use areas and points of entry, public boat ramps, marinas, fishing hot spots, resorts, campgrounds, etc.). Main stem, open water areas (on the existing floating objects) and near-shore areas.

The substrate sampler is a small surface area, so it is recommended that other substrates nearby are also checked, such as:

- Submerged hard surfaces including docks, pilings, seawalls, rocks, and logs.
- Shoreline areas including gravel, sand, mud, cobble and woody debris, especially in downwind, downstream, or other positions where shells and other debris are collected.

- Focus on the bottom and sides of submerged objects; in protected and shaded areas such as nooks, crannies and junction of two different surfaces.
- Periphyton may obscure attached bivalves and other specimens.

Remember that any solid surface is a suitable substrate to observe. Rub your hands along some of the submerged surfaces. Invasive mussels on the surface will feel like sandpaper.

### 4.1.2 WHEN TO SAMPLE

Veligers begin to settle out of the water column and develop a shell 3-5 weeks after spawning which can occur when temperatures are greater than 12°C. Therefore, it is recommended that substrate checks begin as early as 3-5 weeks after water bodies have reached spawning temperatures (i.e., warmed to ≥12°C) and veligers begin to settle out of the water column. The timing of sampling will vary by geographic region but typically occurs between June and October. One of the two substrate samplers should be removed and checked monthly from June through October using the methods outlined in Appendix E. The other substrate sampler should be left in the entire monitoring season and then checked at the end of the monitoring season. A physical description and GPS coordinates of each monitoring station must be obtained at initial deployment. See Appendix E for details on how to retrieve the substrate sampler.

**Table 3. Summary of Artificial substrate sampler recommendations.**

| ***Parameter*** | ***Recommendation*** |
|---|---|
| **Timing** | beginning 3-5 weeks after water bodies have warmed to ≥12°C |
| **Waterbody Locations** | Around floating structures, marinas, inlets and outlets, boat ramps, docks, coves, downwind areas and eddies |
| **Artificial Substrate Depth** | Epilimnion or mesolimnion; ≥6 meters |

# 5. SAFETY

When conducting any field work in and around the water it is important to ensure that all staff/volunteers have the necessary safety equipment and training to do so safely. Always check weather conditions before going out on the water and do not conduct field work if conditions are unsafe or if someone does not feel comfortable. It is recommended to conduct any work on or near the water with a minimum of two people. When working on or near water ensure that Transport Canada, WorkSafe BC and any other applicable regional, provincial or federal laws/regulations are being followed.

When conducting plankton tows be sure to do so safely. If you are conducting the tow from a boat, first anchor/secure the boat at the sampling site and make sure the boat is not drifting. If conducting the tow from a stationary position (e.g. dock, shore), make certain that you have stable footing. Before deploying the net examine both the net and line to be sure the cod end is securely attached, and the tow line is free of tangles. When conducting sampling from the shore ensure that the water current/flow is safe before wading into deeper waters.

# 6. COLLECTION OF ANCILLARY DATA

It is also important to collect key data (e.g. temp and depth) at each sample site. If a sonde/probe is not available to collect data at depth, measure the site information at the surface using available equipment. If there is no boat launch or dock, and you are conducting a shoreline toss or a horizontal plankton tow from the shore, then wade out into the water (if safe to do so) to collect the water quality profile. In water that is less than 1 meter deep, collect one profile reading just under the surface.

1. Anchor boat or tie-off to structure close to sample site. Record GPS location on datasheet.
2. Attach the slotted probe cover to multi-probe unit sensor. Immerse probes in lake and turn unit on. Allow unit to equilibrate and record values on data sheet.
3. Deploy Secchi disk on shady side of boat. For accurate estimate of depth, the line must be vertical when the measurement is taken; additional weight may be necessary to hold the disk down in a current. Lower the Secchi disk in the water until the white quarters are no longer visible and note this depth, then raise the disk until the white quarters reappear record this depth. The mean of these two values is your Secchi disk depth reading to be recorded on the datasheet. Do not use sunglasses or a view finder.
4. Record multi-probe readings at 1-m depth intervals. Start at surface and lower by 1-m intervals until at least 1-m off the lake bottom.
5. Allow unit to stabilize at each depth (temperature ±0.01°C, depth ±0.1 m, DO ±0.01 mg/L, and pH ±0.01).
6. Record values on datasheet. Report water temperatures in degrees Centigrade.
7. Continue to obtain profile. Raise unit to 2-m depth and record values a second time. Compare first and second measurements to assess instrument drift. Repeat profile if outside acceptable range

# 7. FIELD EQUIPMENT DECONTAMINATION

The purpose of decontaminating field equipment when sampling for invasive mussels is twofold, the first is to prevent the accidental transport of these 'aquatic hitchhikers' on waders, boats, trailers, nets and other equipment into new waterbodies. The second reason for decontamination is to prevent cross-contamination of field sampling equipment when traveling between waterbodies which can lead to false-positive results for a waterbody. Multiple sets of gear and thorough decontamination procedures are used to minimize the risk of cross contamination and spread.

## 7.1 GENERAL RECOMMENDATIONS

When leaving a waterbody, remove any visible plants and animals from your gear and boat –follow the **CLEAN, DRAIN, DRY** procedures. It should be done away from the lake where run-off will not go into any water body, stream or drain. DO NOT clean the gear with water from the site as you might just re-contaminate it, unless you use additional decontamination procedures afterwards.

**CLEAN**-Thoroughly inspect boat (hull, drive units, trim plates, transducers), trailer and components (rollers, bunk boards, axles, etc.), equipment (i.e., water pumps, hatchery equipment, siphons, nets, ropes, traps, etc.) for adult invasive mussels. Remove any mud and dirt since they may contain very

small AIS such as New Zealand mud snails and diseases such as whirling disease. Pay attention to hidden, hard to reach areas, gaps, crevices, holes and other inconspicuous places (i.e., around the motor housing, trim tabs, and water intake screens, or pump fittings). All trash, mud, vegetation, should be removed and properly disposed of in the trash. **Any suspected invasive mussels or other AIS must be reported and submitted to the BC Ministry of Water, Land and Resource Stewardship (see Appendix A for reporting information).**

**DRAIN**- Whenever possible, areas that hold water should be drained so there is no standing water. Eliminate water from any conceivable item before you leave the visiting area. This includes live wells, bilges, cargo areas, pipes, water pumps, etc.

> **Pull the plug! It's the law! It is illegal to transport your watercraft in BC with the drain plug still in place.**
>
> - Before transporting a boat or other watercraft, owners/operators must remove the drain plug and drain all water on dry land including all internal compartments such as ballasts, bilges, and live wells.

**DRY**– Dry all areas of the watercraft that may have gotten wet. Drying boats, gear and equipment will help to minimize risk of contamination.

If possible, avoid launching a watercraft into more than one waterbody per day (depending on weather conditions) to allow time for the boat and gear to dry. The use of felt-soled waders is strongly discouraged, as they are a known vector for the spread of AIS, and difficult to disinfect. Rubber-soled alternatives are available on the market, and provide the same non-slip qualities, but are much easier to clean.

## 7.2 WATERCRAFT

If you are conducting sampling within the Columbia River watershed then you must decontaminate all watercraft, equipment and gear to help prevent the spread of whirling disease. The Columbia River Watershed has been identified as the high-risk area for whirling disease. The decontamination steps outlined below for field equipment is effective for both whirling disease and invasive mussels. For more information about whirling disease visit: www.gov.bc.ca/whirlingdisease

If you are bringing your boat from outside of B.C. then you must contact the BC Invasive Mussel Defence Program by emailing the program inbox (COS.Aquatic.Invasive.Species@gov.bc.ca) to arrange for inspection and possible decontamination if necessary.

Complete decontamination of watercraft for invasive mussels requires hot water (60° C) and high pressure (3,000 PSI) using specialized equipment and provincial inspectors are trained in decontamination. High pressure may cause damage to some parts of watercraft therefore pressure washers should only be used by someone trained in its operations. The hot temperature (60° C) with appropriate contact time is what kills the invasive mussels and high pressure is used to assist with removing the mussels. Low pressure can be used for decontamination to minimize risk of damage to the watercraft.

## 7.3 FIELD EQUIPMENT

Field crews can be vectors for the unintentional movement of AIS associated with field sampling equipment. For waters that are suspect, positive or infested with invasive mussels (or whirling disease) having separate equipment for each waterbody is strongly recommended. Decontamination involves both physical and chemical means to prevent transfer of a variety of taxa within and between systems and samples. Decontamination must be conducted such that runoff does not reach any waterbody and should be done in locations that are high and dry and must be conducted at least 60 meters (200 feet) away from any waterbody, ditch or storm drain.

**Equipment does not need to be decontaminated between sampling sites on the same waterbody unless sampling in an upstream direction. If sampling in an upstream direction equipment must be decontaminated between sites or separate equipment can be used.** Field equipment that is used in multiple water bodies must undergo full decontamination between each use. If equipment is only used within one waterbody for the entire sampling season and all sampling occurs in a downstream direction, the equipment does not need to decontaminated between each use. The dedicated equipment should be fully decontaminated at the end of every season.

Sensitive Equipment:

Water quality probes and sensors may be damaged by chemicals and should only be rinsed with clean water and dried thoroughly. Please follow the manufacturers instructions for proper cleaning of probes and multi-meters.

General Sampling Equipment:

For decontaminating equipment (net, cod-end, rope, net anchor, sieve, surface scraper, wash bottles, buckets, waders, boots, ropes etc.) a vinegar and bleach soak must be used. The vinegar degrades the calcium carbonate shell resulting in a negative microscopy result while the bleach denatures the DNA. The volume of decontamination solution used (both vinegar and bleach) should be the minimum necessary to fully submerge the equipment. This will minimize the amount of solution required for disposal and reduce costs of decontaminating equipment.

Step 1 – Vinegar soak (5% acetic acid):

- Standard household vinegar should have a 5% acetic acid concentration and can be used for the vinegar soak.
- All sampling gear that comes into contact with the water must be fully immersed in household vinegar (5% acetic acid concentration) for two hours.
- Following the acetic acid soak, thoroughly rinse all equipment with a large volume of clean water this will help to prevent corrosion of equipment
- The vinegar can be reused multiple times and should be poured back into the original container for storage. The vinegar should be periodically checked with pH test strips to make sure the pH level remains at approximately 2-3.
- The use of vinegar can present safety hazards if not used properly. Appropriate Material Safety Data Sheets (SDS) should be included and followed in the standard operating procedures
- For disposal, the vinegar must be diluted with a large amount of water to a very low concentration and disposed in a large gravel area far away (>100m) from any drains or natural waterways with no possibility for drainage/seepage into natural waterways.

Step 2 – Bleach soak:

- Use the following formula to prepare a 10% bleach solution:
  Total volume of solution desired x 0.1 = volume of bleach to add
- *Example:* Add 50 milliliters of bleach to 450 milliliters to prepare a 10% bleach solution. A measuring cup can be used to measure the bleach and water at a 1:10 proportion. It is recommended that the bleach solution be prepared in an opaque approximately 32 oz spray bottle. The opaque bottle will help protect the bleach from degradation (Western Regional Panel 2018).
- Smaller items can be fully sprayed with a 10% bleach solution and allow the items to sit for 15 minutes. Larger items must be fully immersed in a 10% bleach solution in a large rubber tote or similar container for 15min
- Bleach is corrosive, and equipment must be thoroughly washed with tap water following decontamination. Allow the items to air dry completely.
- The bleach solution should be discarded after 24 hours.
- 10% bleach should be retained in a plastic carboy and disposed of following protocols for waste disposal. Check with the local municipality regarding proper disposal of chemicals.

***Important safety note:*** *Always follow the manufacturers instructions for any equipment that has specific cleaning requirements and take the necessary safety precautions when handling bleach and vinegar solutions (i.e. personal protective equipment).*

**Freezing (optional):**

- Place equipment in a freezer for 48 hours (when possible) or a minimum overnight between each use. Freezing can be done in addition to the vinegar and bleach soaking but cannot replace it as a decontamination method.

**Table 4. Invasive mussel decontamination methods for field equipment. Note the bleach soak is also affective against whirling disease.**

| Type of Equipment | Decontaminant | Concentration | Contact Time | Guidelines |
|---|---|---|---|---|
| Sensitive equipment (probes,sondes, meters) | Tap/distilled water | - | - | Please refer to the user manual for cleaning instructions. |
| Field equipment | Vinegar & Bleach | 5% acetic acid & 10% bleach solution | 2 hours for vinegar and 15min for bleach | Immerse equipment into vinegar (5% acetic acid) for 2 hours, wash off thoroughly, followed by 15min soak in 10% bleach solution |
| Field equipment | Freezing | <0° C | 48hrs (minimum overnight) | Equipment must be fully inside a freezer for 48hrs, or minimum overnight |

# 8. PRIORITY WATERBODY LIST

This section provides an overview of the priority waterbodies selected for carrying out plankton tow sampling efforts across the province (Table 5). The risk of invasive mussel invasion is based on a combination of risk of introduction and risk of establishment and both are used to identify the priority waterbodies for sampling listed in Table 5. The risk of invasive mussel introduction is based on human behaviour, such as the potential for introduction through overland transport of watercraft traveling from mussel infested waterbodies. The risk of establishment is based on chemical and physical attributes of the waterbody that make it suitable for invasive mussel survival and establishment. Minimum dissolved calcium levels are required in a waterbody to support invasive mussel shell growth and mean minimum summer temperatures are required to support invasive mussel reproduction (Stanczykowska 1977; Baker et al. 1993; Sprung 1993; Nichols 1996; McMahon 1996). Calcium concentration is considered the most critical environmental variable for invasive mussel survival and establishment and to delineate risk categories for invasive mussel infestation (Neary and Leach 1991; Cohen and Weinstein 1998; Whittier et al. 2008; Wells et al. 2010; Claudi and Prescott 2011; Therriault et al. 2013).

The risk of invasive mussel establishment was assessed using total and dissolved calcium data from the B.C. Environmental Monitoring System (EMS) as the primary variable. Risk categories were assigned based on calcium tolerance ranges for zebra and quagga mussels taken from the literature (DFO 2024) (<8mg/L = No risk, 8 to <15mg/L = Low risk, 15 to < 30mg/L = moderate risk and >30mg/L = high risk). The risk level was then adjusted if temperature or pH levels were outside the suitable ranges for zebra and quagga mussels.

This method was also conducted separately for the golden mussel based on adjusted suitable calcium tolerances (<1mg/L = no risk, 1-6mg/L low risk, 6-12mg/L = moderate risk and >12mg/L =high risk). A temperature correction factor was also applied to any sub-watershed that do not reach a mean minimum temperature of 15°C required for golden mussel spawning (Boltovskoy et al. 2025). For these sub-watersheds the risk level based on calcium was reduced by one (e.g. medium risk based on calcium is reduced to low risk when corrected for temperature). A correction was also applied for pH and risk was reduced by one level if pH was not suitable for the golden mussel.

The risk of invasive mussel introduction for waterbodies was estimated using the following variables; the Provincial watercraft inspection data for the 2015-2025 seasons; angler use (British Columbia 2022-23 Freshwater Recreational Fishing Survey); the number of marinas on a waterbody, and Transport Canada boating restrictions. The waterbody priority list is reviewed on an annual basis to assess if new variables and new data are available for inclusion in the model.

The risk of survival for the golden mussel was combined with the data variables used for zebra and quagga mussels risk of introduction to generate a separate priority waterbody list for the golden mussel. The golden mussel and ZQM waterbody lists were compared and any new major waterbodies that were on the golden mussel list were added to the waterbodies selected for zebra and quagga mussels to create the final priority waterbody list for all three invasive mussel species (see Table 5 below).

The waterbodies listed in Table 5 have been prioritized for either bi-weekly or monthly plankton tow sampling or substrate samplers only. This is to prioritize sampling efforts to the waterbodies ranked at highest risk for invasive mussel invasion. Substrate samplers and shoreline surveys are still encouraged to be deployed in any of the waterbodies listed in Table 5 to either complement plankton tow sampling

or when plankton tow sampling cannot be completed. Substrate samplers and shoreline surveys are also encouraged to be deployed in waterbodies that are not listed in Table 5 through opportunistic sampling. The Ministry must also prioritize resources towards the frequency of sampling, with the highest priority waterbodies selected for bi-weekly sampling as indicated in Table 5. Resources must balance the number of priority waterbodies sampled with the frequency and number of sampling locations within a waterbody. Therefore not all waterbodies listed in Table 5 may get sampled annually.

**Table 5. Priority waterbodies, including the frequency of plankton tow sampling (bi-weekly or monthly) based on the waterbody priority ranking.**

| Region | Waterbody | Sampling method and frequency | Lat | Long |
|---|---|---|---|---|
| Okanagan | Mabel Lake | Plankton Bi-weekly | 50.5657 | -118.7153 |
| Lower Mainland | Cultus Lake | Plankton Bi-weekly | 49.0533 | -121.9871 |
| Thompson-Nicola | Kamloops Lake | Plankton Bi-weekly | 50.7517 | -120.6932 |
| Kootenay, Omineca | Kinbasket Lake | Plankton Bi-weekly | 52.0822 | -118.2026 |
| Cariboo, Omineca | Bowron Lake | Plankton Bi-weekly | 53.2333 | -121.3666 |
| Thompson-Nicola | Clearwater Lake | Plankton Bi-weekly | 52.2644 | -120.2298 |
| Kootenay | Moyie Lake | Plankton Bi-weekly | 49.3258 | -115.8349 |
| Kootenay | Slocan Lake | Plankton Bi-weekly | 49.9358 | -117.4226 |
| Kootenay | Upper Arrow Lake | Plankton Bi-weekly | 50.53 | -117.9177 |
| Kootenay | Kicking Horse River | Plankton Bi-weekly | NA | NA |
| Kootenay | Pend-d'Oreille River | Plankton Bi-weekly | NA | NA |
| Kootenay | Revelstoke Lake | Plankton Bi-weekly | 51.5075 | -118.449 |
| Omineca | Whitefish Lake | Plankton Bi-weekly | 54.5766 | -124.9539 |
| Okanagan | Christina Lake | Plankton Bi-weekly | 49.1214 | -118.2538 |
| Okanagan | Osoyoos Lake | Plankton Bi-weekly | 49.0412 | -119.47 |
| Okanagan | Skaha Lake | Plankton Bi-weekly | 49.4101 | -119.5854 |
| Okanagan | Kalamalka Lake | Plankton Bi-weekly | 50.1728 | -119.3274 |
| Kootenay | Lake Koocanusa | Plankton Bi-weekly | 49.1906 | -115.2581 |
| Thompson-Nicola, Okanagan | Mara Lake | Plankton Bi-weekly | 50.7726 | -119.0162 |
| Peace | Charlie Lake | Plankton Bi-weekly | 56.3316 | -120.9929 |
| Kootenay | Columbia Lake | Plankton Bi-weekly | 50.2303 | -115.8529 |
| Kootenay | Premier Lake | Plankton Bi-weekly | 49.9365 | -115.6537 |
| Kootenay | St. Mary Lake | Plankton Bi-weekly | 49.61 | -116.193 |
| Kootenay | Surveyors Lake | Plankton Bi-weekly | 49.2458 | -115.2357 |
| Kootenay | Tie Lake | Plankton Bi-weekly | 49.4149 | -115.3185 |
| Kootenay | Wasa Lake | Plankton Bi-weekly | 49.7797 | -115.7354 |
| Kootenay | Whiteswan Lake | Plankton Bi-weekly | 50.1415 | -115.4823 |

| Region | Waterbody | Sampling method and frequency | Lat | Long |
|---|---|---|---|---|
| Kootenay | Kootenay Lake | Plankton Bi-weekly | 49.6332 | -116.8626 |
| Okanagan | Okanagan Lake | Plankton Bi-weekly | 49.9007 | -119.5471 |
| Thompson-Nicola | Shuswap Lake | Plankton Bi-weekly | 50.942 | -119.1497 |
| Kootenay | Windermere Lake | Plankton Bi-weekly | 50.4591 | -115.989 |
| Kootenay | Columbia River | Plankton Bi-weekly | NA | NA |
| Kootenay | Elk River | Plankton Bi-weekly | NA | NA |
| Kootenay | Flathead River | Plankton Bi-weekly | NA | NA |
| Lower Mainland, Thompson-Nicola, Cariboo, Omineca | Fraser River | Plankton Bi-weekly | NA | NA |
| Lower Mainland | Alta Lake | Plankton Monthly | 50.114 | -122.9814 |
| Thompson-Nicola | Big Bar Lake | Plankton Monthly | 51.3099 | -121.7968 |
| Skeena | Bulkley River | Plankton Monthly | NA | NA |
| Kootenay | Cartwright Lake | Plankton Monthly | 50.8132 | -116.4268 |
| Lower Mainland | Chilliwack River | Plankton Monthly | NA | NA |
| Vancouver Island | Cowichan Lake | Plankton Monthly | 48.8729 | -124.2627 |
| Peace | Dinosaur Lake | Plankton Monthly | 55.968 | -122.1064 |
| Kootenay | Dogsleg Lake | Plankton Monthly | 50.6334 | -116.2303 |
| Kootenay | Duncan Lake | Plankton Monthly | 50.4236 | -116.9596 |
| Thompson-Nicola | Edith Lake | Plankton Monthly | 50.5717 | -120.3493 |
| Kootenay | Erie Lake | Plankton Monthly | 49.1891 | -117.3453 |
| Thompson-Nicola | Face Lake | Plankton Monthly | 50.5431 | -120.6347 |
| Skeena | François Lake | Plankton Monthly | 54.012 | -125.7053 |
| Cariboo | Ghost Lake | Plankton Monthly | 51.365 | -124.9664 |
| Kootenay | Hahas Lake | Plankton Monthly | 49.7452 | -115.8256 |
| Cariboo | Horsefly Lake | Plankton Monthly | 52.4169 | -121.0236 |
| Kootenay | Horseshoe Lake | Plankton Monthly | 49.5728 | -115.5193 |
| Okanagan | Jewel Lake | Plankton Monthly | 49.1743 | -118.6099 |
| Kootenay | Larchwood Lake | Plankton Monthly | 49.9507 | -115.7972 |
| NA | Leighton Lake | Plankton Monthly | 50.6192 | -120.8453 |
| Thompson-Nicola | Mahood Lake | Plankton Monthly | 51.9125 | -120.3833 |
| Peace | Moberly Lake | Plankton Monthly | 55.8207 | -121.7654 |
| Peace | Muncho Lake | Plankton Monthly | 58.9884 | -125.7832 |
| Peace | Muskwa River | Plankton Monthly | NA | NA |
| Kootenay | Nine Bay Lake | Plankton Monthly | 50.9502 | -116.5406 |

| Region | Waterbody | Sampling method and frequency | Lat | Long |
|---|---|---|---|---|
| Kootenay | North Star Lake | Plankton Monthly | 49.3436 | -115.2627 |
| Peace | One Island Lake | Plankton Monthly | 55.3073 | -120.2939 |
| Okanagan | Otter Lake | Plankton Monthly | 49.5729 | -120.7648 |
| Thompson-Nicola | Pigeon Lake | Plankton Monthly | 51.3719 | -121.8118 |
| Lower Mainland | Pitt Lake | Plankton Monthly | 49.434 | -122.5601 |
| Thompson-Nicola | Red Lake | Plankton Monthly | 50.8883 | -120.7856 |
| Kootenay | Salmo River | Plankton Monthly | NA | NA |
| Lower Mainland, Okanagan | Similkameen River | Plankton Monthly | NA | NA |
| NA | Stave Lake | Plankton Monthly | 49.3554 | -122.2904 |
| NA | Stump Lake | Plankton Monthly | 50.3621 | -120.3726 |
| Kootenay | Summer Lake | Plankton Monthly | 49.7617 | -115.3991 |
| Kootenay | Summit Lake | Plankton Monthly | 49.6415 | -114.6974 |
| Kootenay | Sylvan Lake | Plankton Monthly | 49.5182 | -115.7237 |
| Omineca | Sylvan Lake | Plankton Monthly | 54.0241 | -123.1856 |
| Okanagan | Two John Lake | Plankton Monthly | 49.776 | -118.892 |
| NA | Whatshan Lake | Plankton Monthly | 50.0185 | -118.1023 |
| Kootenay | White River | Plankton Monthly | NA | NA |
| Cariboo | Williams Lake | Plankton Monthly | 52.1154 | -122.0696 |
| Omineca, Peace | Williston Lake | Plankton Monthly | 56.0694 | -122.8776 |
| Okanagan | Wood Lake | Plankton Monthly | 50.0817 | -119.3898 |
| Cariboo | Bridge Lake | Plankton Monthly | 51.5043 | -120.7306 |
| Kootenay | Cedar Lake | Plankton Monthly | 51.2614 | -116.9814 |
| Cariboo | Deka Lake | Plankton Monthly | 51.6504 | -120.7915 |
| Kootenay | Duck Lake | Plankton Monthly | 49.2342 | -116.6366 |
| Cariboo | Green Lake | Plankton Monthly | 51.407 | -121.2139 |
| Cariboo | Horse Lake | Plankton Monthly | 51.594 | -121.1101 |
| Kootenay | Loon Lake | Plankton Monthly | 49.1145 | -115.1067 |
| Lower Mainland | Silver Lake | Plankton Monthly | 49.3142 | -121.4118 |
| Lower Mainland | Harrison Lake | Plankton Monthly | 49.5194 | -121.8663 |
| Kootenay | Lower Arrow Lake | Plankton Monthly | 49.6792 | -118.0606 |
| Cariboo | Quesnel Lake | Plankton Monthly | 52.5599 | -120.9839 |
| Thompson-Nicola | Adams Lake | Plankton Monthly | 51.1889 | -119.5812 |
| NA | Alouette Lake | Plankton Monthly | 49.3343 | -122.4149 |
| Kootenay | Baynes Lake | Plankton Monthly | 49.2337 | -115.2245 |

| Region | Waterbody | Sampling method and frequency | Lat | Long |
|---|---|---|---|---|
| Cariboo | Canim Lake | Plankton Monthly | 51.8493 | -120.765 |
| Kootenay | Champion Lakes | Plankton Monthly | 49.1875 | -117.62 |
| Thompson-Nicola | Dutch Lake | Plankton Monthly | 51.6519 | -120.0559 |
| Kootenay | Grave Lake | Plankton Monthly | 49.8635 | -114.8345 |
| NA | Heffley Lake | Plankton Monthly | 50.835 | -120.0654 |
| Kootenay | Jim Smith Lake | Plankton Monthly | 49.4811 | -115.8474 |
| NA | Kawkawa Lake | Plankton Monthly | 49.3873 | -121.4012 |
| Thompson-Nicola | Lac Le Jeune | Plankton Monthly | 50.4805 | -120.4782 |
| Kootenay | Lake Enid | Plankton Monthly | 50.5482 | -116.1237 |
| Kootenay | Lazy Lake | Plankton Monthly | 49.8249 | -115.6228 |
| Kootenay | Lillian Lake | Plankton Monthly | 50.5077 | -116.0982 |
| Thompson-Nicola | Little Shuswap Lake | Plankton Monthly | 50.8503 | -119.6463 |
| Thompson-Nicola | Logan Lake | Plankton Monthly | 50.4961 | -120.8066 |
| Thompson-Nicola | Loon Lake | Plankton Monthly | 51.1046 | -121.2494 |
| Kootenay | Mitten Lake | Plankton Monthly | 50.9639 | -116.572 |
| Thompson-Nicola | Nicola Lake | Plankton Monthly | 50.1802 | -120.5294 |
| Kootenay | Norbury Lakes | Plankton Monthly | 49.5371 | -115.4832 |
| Thompson-Nicola | Paul Lake | Plankton Monthly | 50.7399 | -120.1155 |
| Thompson-Nicola | Peter Hope Lake | Plankton Monthly | 50.2935 | -120.3172 |
| Thompson-Nicola | Roche Lake | Plankton Monthly | 50.4746 | -120.1522 |
| Kootenay | Rosen Lake | Plankton Monthly | 49.3997 | -115.2569 |
| Thompson-Nicola | Salmon Lake | Plankton Monthly | 50.2689 | -120.0033 |
| Cariboo | Sheridan Lake | Plankton Monthly | 51.5161 | -120.8944 |
| Kootenay | Susan Lake | Plankton Monthly | 51.5696 | -117.397 |
| Kootenay | Suzanne Lake | Plankton Monthly | 49.3207 | -115.2393 |
| Peace | Swan Lake | Plankton Monthly | 55.5182 | -120.0151 |
| Kootenay | Trout Lake | Plankton Monthly | 50.585 | -117.4366 |
| NA | Tunkwa Lake | Plankton Monthly | 50.6088 | -120.8576 |
| Thompson-Nicola | White Lake | Plankton Monthly | 50.8826 | -119.2644 |
| Kootenay | Whitetail Lake | Plankton Monthly | 50.214 | -116.0259 |
| Thompson-Nicola | Woods Lake | Plankton Monthly | 50.3828 | -119.7907 |
| Kootenay | Bull River | Plankton Monthly | NA | NA |
| Okanagan | Kettle River | Plankton Monthly | NA | NA |
| Thompson-Nicola | Lac des Roches | Plankton Monthly | 51.4771 | -120.5701 |
| Cariboo | Lac la Hache | Plankton Monthly | 51.8239 | -121.5438 |
| Peace | Murray River | Plankton Monthly | NA | NA |

| Region | Waterbody | Sampling method and frequency | Lat | Long |
|---|---|---|---|---|
| Thompson-Nicola | North Thompson River | Plankton Monthly | NA | NA |
| Peace | Peace River | Plankton Monthly | NA | NA |
| Kootenay | Slocan River | Plankton Monthly | NA | NA |
| Thompson-Nicola | Thompson River | Plankton Monthly | NA | NA |
| Vancouver Island | Elk Lake | Substrate Only | 48.5296 | -123.3981 |
| Kootenay | Kootenay River | Substrate Only | NA | NA |
| Kootenay | Beaver Lake | Substrate Only | 50.1808 | -117.4611 |
| Kootenay | Blackwater Lake | Substrate Only | 51.6236 | -117.4062 |
| Cariboo | Dragon Lake | Substrate Only | 52.9494 | -122.4208 |
| Kootenay | Emerald Lake | Substrate Only | 51.4432 | -116.5315 |
| Okanagan | Gardom Lake | Substrate Only | 50.6035 | -119.201 |
| Kootenay | Island Lake | Substrate Only | 49.5074 | -115.178 |
| Kootenay | Kokanee Lake | Substrate Only | 49.7479 | -117.1753 |
| Kootenay | Monroe Lake | Substrate Only | 49.3642 | -115.8665 |
| Kootenay | Nancy Greene Lake | Substrate Only | 49.2539 | -117.9448 |
| Kootenay | Rosebud Lake | Substrate Only | 49.0475 | -117.2673 |
| Okanagan | Swan Lake | Substrate Only | 50.3184 | -119.2561 |
| Omineca | Stuart Lake | Substrate Only | 54.5533 | -124.6319 |

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Western Regional Panel 2018. Minimum Monitoring Guidance For Utilizing Plankton Tows For The Detection Of Dreissenid Veligers. Standard Operating Procedure.

## APPENDIX A: REPORTING INFORMATION

**Conservation Data Center:**

https://www2.gov.bc.ca/gov/content/environment/plants-animals-ecosystems/conservation-data-centre/submit-data

Email: cdcdata@gov.bc.ca

**Invasive species information and alert sheets:**

www.gov.bc.ca/invasive-species

**Reporting Information:**

Immediately report any suspected invasive mussels to the **Report All Poachers and Polluters Hotline: 1-877-952-7200 (RAPP)**

**BC Ministry of Water, Land and Resource Stewardship (WLRS) contact:**

Amalis Riera Vuibert, Aquatic Invasive Fauna Specialist

Email: Amalis.RieraVuibert@gov.bc.ca

**Habitat Conservation Trust Foundation (HCTF) grant application information:**

https://hctf.ca/apply-for-funding/invasive-mussel-monitoring/

**Analytical Lab:**

The chain of custody (COC) form and shipping information for the lab will be provided by HCTF at the start of the respective sampling season. The COC form must be sent to the lab when shipping samples.

## Appendix B: Equipment for plankton tows

- Plankton net (simple, conical plankton-tow net, 63-64 µm mesh size, recommended 0.3 m (1 ft) diameter net opening (0.5m diameter can also be used), removable, weighted cod-end piece.
- Line for deploying the net (about 20m) with 1 meter interval markings;
- Sample container (preferably polyethylene material, 250 to 500 mL volume, screw lid; but any leak-proof container suitable for shipping can be used);
- Preservative (95% regular ethanol or 99% isopropyl alcohol);
- Baking soda solution
- Squirt Bottle
- Field sheets and pen/ pencils;
- Waterproof labels (write in the rain paper);
- Thermometer;
- Permanent marker;
- GPS unit (*recommended*);
- Tweezers or small spatula (*recommended*);
- Boat (*recommended*);
- pH strips or pen meter
- Secchi disk
- Measuring tape or ruler (*optional*)

# Appendix C: Vertical Plankton Tow

1. Secure the cod-end piece and check that the line is securely attached to the plankton net. Secure the other end of the line to the boat.
2. Lower the net to planned sampling depth (see Table 2). For waterbodies <15m, calculate the appropriate sampling depth using a depth finder or marked rope.
3. Ensure the bottom of the net does not disturb the lake bottom, touching the bottom will clog the net. If you disturb the lake bottom, discard the sample, rinse out the sampling equipment and try shorter tows, or go to a different area of the lake that will provide enough depth for a good tow. Record the approximate depth that the net is lowered to.
4. Keep the net at the desired depth for 60 seconds and then manually retrieve up vertically using a hand-over-hand technique at a rate of 0.5 m/s. Slow and steady retrieval is the key to collecting a good plankton tow. Care should be taken to pull the net up slowly enough so that no pressure wave is created on the surface of the water. If you are creating a pressure wave, you are under-sampling the water column.
5. Rinse the net by raising the net so that the cod end of the net is just above the water surface. Rinse organisms into the cod end of the net by lowering the net back into the water, keeping the net opening well above the water surface. Then quickly pull the net straight up; this action will move collected plankton into the cod-end piece. Repeat this procedure several times to ensure that all the organisms inside the net are in the cod end.
6. A squirt bottle, filled with either tap water or water from the lake or river, can be used to wash down the sides of the net. Spray the outside of the net starting at the cod end interface and moving down to rinse organisms into the cod end.
7. Condense the sample by swirling the sample in the cod-end piece. Carefully remove the cod-end piece without spilling collected water and plankton. Decant your plankton sample into your sampling container after each tow to obtain an accurate enumeration of the larval density.
8. The sample container should be no more than about 1/4 full to allow room for the preservative. If samples are too large to combine into one sample container use a separate sample container for each tow.
9. Add preservative to the sampling container following the procedures outlined in Appendix F and the procedure in Appendix G for labeling the sample.
10. Record the number and depth of tows as well as diameter of net mouth opening, so that the volume of water sampled can be determined. GPS locations and depths of tows should be recorded on the chain of custody form.
11. Record the water temperature at the maximum depth that the plankton net was set. If the maximum depth cannot be reached record the water temperature as deep as possible from the surface. When multiple tows are taken from one sample site use the average temperature from each of the tows.

# Appendix D: Horizontal Plankton Tow

Horizontal tow from a boat:

1. A weight (1-2 kg or 2-4 lbs) is attached to the rope immediately in front of the net opening to keep the net below the water surface.
2. To determine the depth, subtract the length of your plankton net, plus minimum .5 meters off the bottom to avoid fouling the net/sample.
3. The net is thrown into the water and allowed to sink to no more than 1 m above the bottom and keep at consistent depth.
4. Record the start time and the starting location coordinates on field datasheet. Record the distance that the net is towed through the water.
5. Use the boat engines and/or the river current to move the net horizontally through the water for three to 5 minutes (depends on boat speed, net mouth opening, eutrophic status of the waterbody), or slowly pull the net back to you at a slow and steady rate as described above (the total length of the tow can be determined using the graduation marks on the tow rope). The tow should be done at low speeds, e.g., 0.5 to 3-Km/h. The boat may be driven directly upstream, essentially keeping the boat in the same approximate longitudinal position and allowing river to flow through net. Trawling can also be done transversely to the current. Reduce the trawling time in productive and turbid waters as the net may clog. Keep the net off the bottom to avoid both snagging and collecting debris.
6. Idle or stop the boat engine and manually retrieve the net using a hand-over-hand technique at a rate of 0.5-m/s. Your goal is to pull the net on a diagonal path from bottom to top, sampling as much of the water column as possible without letting the net or cod end hit the bottom.
7. Record the stop time, boat speed and the coordinates of the stop location on the COC form (Appendix B). The trawling time and boat speed are used to estimate the volume of water filtered (i.e., distance = rate x time). The table below provides some minimum tow durations to achieve an adequate volume of water filtered based on plankton net diameter and flow rate.
8. Repeat techniques used for vertical plankton tows to concentrate organisms into the cod end of the net.
9. Follow the procedure outlined in Appendix F for preserving the sample and Appendix G for labeling the sample.

| | Tow duration (s) based on plankton net diameter and flow rate | |
|---|---|---|
| Flow Rate (m/s) | Plankton Net Diameter (50 cm) | Plankton Net Diameter (30 cm) |
| 0.5 | 33 | 93 |
| 1.0 | 17 | 46 |
| 1.5 | 11 | 31 |
| 2.0 | 8 | 23 |
| 2.5 | 7 | 19 |
| 3.0 | 6 | 16 |

Horizontal Tow from a Dock

1. If conducting horizontal plankton tow from a dock, lower the net and allow the net to sink into the water to within 0.5-1m of the bottom. Your goal is to pull the net on a diagonal path from bottom to top, sampling as much of the water column as possible without letting the net or cod end hit the bottom. If an air bubble gets trapped in the net, retrieve the net and start again.
2. If possible avoid sampling in aquatic vegetation, but if it is a high use/high boat traffic site sampling should still be conducted.
3. Follow steps 5-8 in Appendix C to concentrate organisms into the cod end of the net. Record length of each tow, and number of tows.
4. Follow the procedure outlined in Appendix F for preserving the sample and Appendix G for labeling the sample.

Shoreline Toss

When a boat is not available or when you are sampling from a dock or other land structures then a shoreline toss can be used.

1. Remove the net anchor, which is secured to a loop in net rope.
2. Screw on the weighted cod end, check that the hose clamp is secure, and that the net rope is secured to steel ring.
3. Hold the net ring using thumb and forefinger of your throwing hand. Make large loops of the net rope and hold loosely with the same hand holding the net. Grasp the loops of the rope in front of the net opening.
4. Firmly hold the other end of the rope with free hand.
5. Throw the net using a sidearm-style, opening your hand upon release to allow rope to feed out with the net.
6. Allow the net to sink into water body. A weighted cod end will aid in pulling the net into the water. If an air bubble gets trapped in the net, retrieve the net and start again.
7. Manually retrieve the net using a hand over hand technique at a rate of 0.5-m/s (1.5-ft/s). Keep the net off the sediment to avoid both snagging and collecting debris.
8. Repeat techniques used for vertical plankton tows to concentrate organisms into the cod end of the net.
9. Follow the procedure outlined in Appendix F for preserving the sample and Appendix G for labeling and shipping of the samples.

Stationary shoreline sampling (variation of the Shoreline Toss)

When conditions don't allow for tossing the net and sufficient depth is available, the current can be used to move water through the net when holding the net stationary. Use a flow meter to determine the current speed, and then calculate how long the net needs to be held in the water for.

$$Time\ (s)\ = \frac{distance\ (m)}{flow\ rate\ (m/s)}$$

Use Table 6 to determine the distance needed to have the minimum adequate volume of water go through the net based on your net diameter. Then input that distance and the measured flow rate in the equation above to determine the duration that the net must be held under water.

**Table 6. Plankton net diameter and the corresponding area ($m^2$) of the net mouth, used to determine the minimum distance required to achieve an adequate tow volume with this method.**

| Net Diameter | Area of Plankton Net Mouth | Minimum Distance to get Adequate Volume |
|---|---|---|
| 13 cm (5 in) | 0.01 $m^2$ | 350 m |
| 20 cm (8 in) | 0.03 $m^2$ | 117 m |
| 30 cm (12in) | 0.07 $m^2$ | 50 m |
| 50 cm (20in) | 0.2 $m^2$ | 18 m |

For example, if you have a net diameter of 30 cm, and a flow of 0.83 m/s, you will input a distance of 50 m into the formula. The net will need to be held under water for at least 60 s to get an adequate volume of water sampled:

$$Time\ (s) = \frac{50\ (m)}{0.83\ \left(\frac{m}{s}\right)} = 60\ s$$

## APPENDIX E: ARTIFICIAL SUBSTRATE SAMPLERS

Either a Portland sampler or a plate sampler can be used for substrate monitoring. This section provides the instructions and materials needed to build both types of samplers.

**Portland Sampler:**

Materials needed

- 13mm diameter plastic construction mesh or plastic gutter guard (x3 17cm wide strips)
- 17cm white PVC pipe (5cm diameter) x 2
- 17 cm black PVC pipe (5 cm diameter) x2
- 500g concrete anchor
- 4 large flat washers
- Rope (nylon or paracord, do not use polypropylene plastic rope as it will degrade over time)

Portland Sampler Construction:

1. Cut the rope to the appropriate length for the depth of the sample site. At the end of the rope tie a small (500g) concrete anchor at the bottom.
2. Cut the white and black PVC pipe (5-cm diameter) into 17cm pieces. The PVC pipe sections will be placed 2ft apart along the length of the rope, so the exact number of PVC pieces will depend on the length of the rope but should be around 3-4 per substrate sampler (2 white and 2 black).
3. In the middle of the 17cm PVC pieces drill two holes 7mm wide (at the opposite sides of the pipe) this will be for feeding the rope through. Repeat the same with the black PVC pipe with the same dimensions. Sand down the edges of the holes to make a smooth surface.
4. On the other side of the PVC pipe drill three 7mm wide holes at equal distance across the length of the 17cm PVC section. Sand down the edges of the holes to make a smooth surface. These holes provide additional surface area for dreissenid mussel to settle on. Nothing will be thread through these holes (see Figure below).
5. Cut the plastic mesh into 17 cm wide strips (the number of strips will depend on the length of the rope).
6. First thread a large flat washer followed by the first 17cm piece of white PVC pipe to the bottom of the rope just above the secured anchor. Thread another large flat washer just above the first pipe section. Weave the plastic mesh strip lengthwise through the rope just above the flat washer and the first pipe section see Figure below).
7. About 2 ft above the top of the first PVC pipe section tie a knot in the rope and thread a flat washer through the rope so it sits just above the knot.
8. Repeat steps 5 and 6 until all the PVC pipe sections and plastic mesh sections have been thread through the full length of the rope section with 2ft spacing between each PVC pipe-mesh section. Alternate between black and white PVC pipe along the rope section.

9. Use a secure surface structure to tie the surface end of the rope off. Docks and piers can be used but these are high traffic areas for recreational activity and increases the risk of theft or damage to the sampler.
10. If theft or vandalism is a concern a small laminated label can be attached to the surface end of the rope with the following:

MONITORING EQUIPMENT – DO NOT REMOVE (you can provide a contact number if available)

**Plastic gutter guard (left) and white PVC pipe (right). Photo credit: Home Depot. One PVC pipe and mesh section of the portland sampler (below) that is repeated 3-4 times along the length of the rope.**

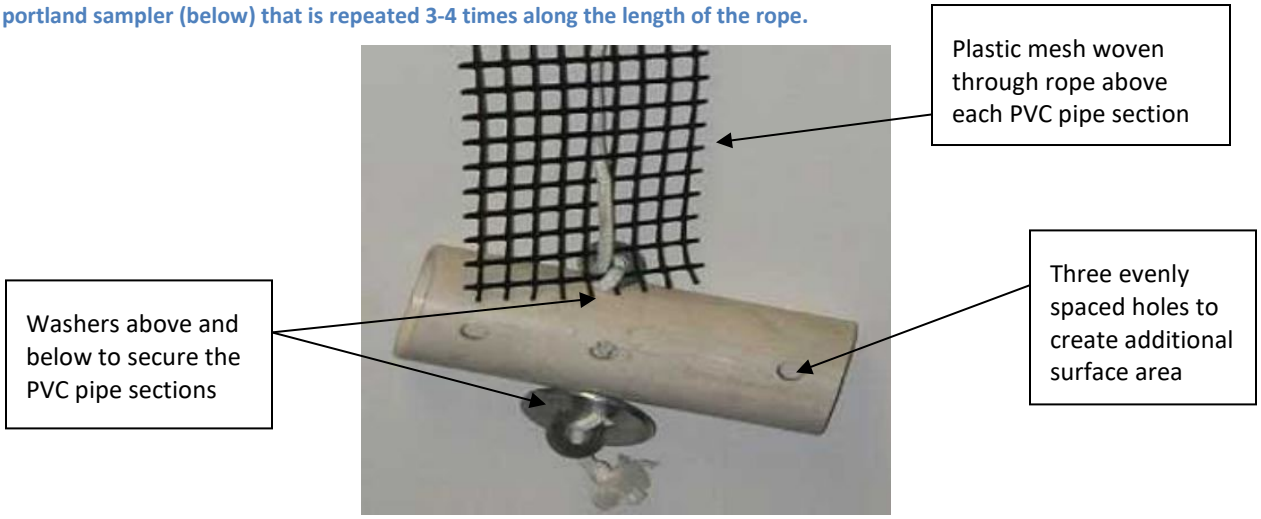

**Plate Sampler**

Materials needed:

- (4) 6” x 6” x 0.25” black/grey PVC with 1” hole through center
- (5) 1.5” x 1.375” (35mm) exterior diameter PVC or ABS tube
- (1) 8.5” x 0.8125” (21 mm) exterior diameter PVC or ABS tube
- ~6m rope (length will depend on the depth at each sample site)
- Weight to keep plates from floating up
- Laminated label with your contact information

Plate Sampler Construction:

- Tie a weight at one of the rope
- Run the 8.5” tube (21mm exterior diameter) through the rope and secure it just above the weight. This will be the shaft support.
- From the loose end of the rope string on the pieces of PVC plate and PVC spacers through the rope and 8.5” tube, alternating between the short segments of tube (spacers) and the PVC plates, beginning and ending with the spacers (see figure below).
- Tie a knot above the final spacer to prevent the pieces from moving up.
- Attach a label to the rope where the rope is secured to the structure.

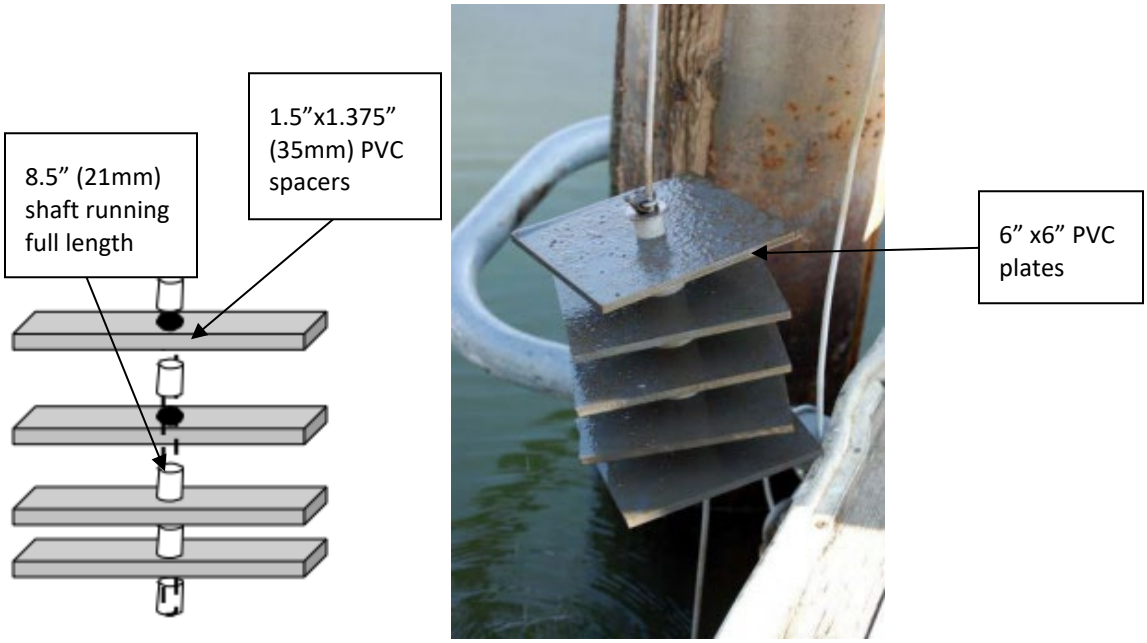


Plate Sampler (photo credit: California Department of Fish and Wildlife)

**Retrieving the substrate sampler:**

1. Retrieve substrate sampler from water carefully – place in a bucket for close inspection.
2. Inspect the sample closely for invasive mussels. Juvenile mussels are very small, but have a rough sand-paper feel relative to the substrate sampler. Adult invasive mussels are most likely to be found in dark areas, in corners or crevices.
3. **If you suspect that the sampler is contaminated with invasive mussels DO NOT return it to the water.** The suspected invasive mussel specimens should be photographed with an object/ruler in the photo for scale. The suspected specimens should be collected into a vial, with water, and then kept cool in a refrigerator OR be preserved in regular ethanol or isopropyl alcohol for expert verification. **Report it immediately to WLRS** (see Appendix A for contact information).
4. Examine the bucket for other suspect AIS such as New Zealand mudsnails. For more information on how to identify other AIS see Section 2 above or visit gov.bc.ca/invasive-species. **If any unknown organisms are found on the substate sampler report it immediately to WLRS** (see Appendix A for contact information). The unknown specimens should be photographed with an object/ruler in the photo for scale. The unknown specimens should be collected into a vial, with water, and then kept cool in a refrigerator OR be preserved in regular ethanol or isopropyl alcohol for expert verification.
5. If no AIS are found, return the substrate sampler back into the water where it was found.
6. The substrate sampler tracking form provided by HCTF must be filled out at the start and end of the season when the samplers are deployed and each time the substrate sampler is checked. At the end of the season submit the completed form to HCTF.
7. Follow the procedure outlined in Appendix F for preserving the sample and Appendix G for labeling and shipping of the samples.

## APPENDIX F: SAMPLE PRESERVATION

Sample preservation plays a significant role in the accurate identification of veligers in the laboratory analyses. Plankton tow samples must be preserved in a 70% alcohol concentrated solution immediately after collection to ensure sample integrity. Do not wait more than three hours to preserve samples. Regular ethanol (95%) is strongly recommended, but 99% isopropyl alcohol is acceptable - DO NOT use denatured ethanol. Avoid placing samples in direct sunlight or freezing conditions. Samples that cannot be preserved immediately after collection should be placed on ice until preservative can be added. Keep preserved samples in a plastic container such as a bin or cooler in the back of the car while in transit.

To buy regular ethanol in B.C. a Purchase Permit is required, more info can be found at the following link:

https://www2.gov.bc.ca/gov/content/employment-business/business/liquor-regulation-licensing/liquor-licences-permits/applying-for-a-liquor-licence-or-permit/ethyl-alcohol-purchase-permit

Regular ethanol (with purchase permit) can be ordered from Fisher Scientific or other chemical scientific lab suppliers.

4% Baking Soda (sodium bicarbonate) Solution:

If the pH in the sample is below 7 then a baking soda solution must be added to raise the pH above 7. A pH below 7.0 can result in shell dissolution and the loss of birefringence. The pH must be checked and baking soda solution added, if necessary, before adding the preservative. To make a 4% solution the following concentrations should be used; add 40 grams of baking soda to 1000 milliliters (1L) of water. A standard 28 mm soda bottle cap holds about 5 grams of baking soda and ½ teaspoon of baking soda is about 3 grams. For example, adding a level soda bottle capful of baking soda to a 250 ml Nalgene container that is approximately ½ full with water will provide a solution of baking soda close enough to 4% that it can be used to adjust the pH of plankton tow samples.

Plankton tow sample preservation (70% alcohol concentration):

- **Step 1:** After tows have been poured into the collection bottle, mark the level with a permanent marker and measure the height (H) of the liquid using a ruler with millimeter (mm) graduations.
- **Step 2:** Check the pH of the water sample, if it is below 7 then the 4% baking soda solution must be added (see above for concentrations). First divide the height measurement from step 1 by 0.95. This measurement (mm) is the level to which the baking soda solution is added to the sample. This will be a relatively small quantity. A small cup should be used to pour the baking soda solution into the sample to avoid adding too much.
- **Step 3**: Next note the new volume of sample water in the container (in centimeters or inches) and multiply by 3.0. The result of this calculation is the amount of alcohol, in centimeters or inches, that should be added to the sample. Add alcohol to the sample until the height of liquid increases by the calculated number. For example, if your sample bottle contained 2.5 cm of sample, you would add 7.5 cm of preservative so that the sample bottle contained 10 cm of combined sample and preservative. This is why it is important to not fill the sample bottle more than ¼ full of sample. It is very important to use pure alcohol as lower alcohol percentages (below 90%) may not allow you to reach the end goal of 70% alcohol in the sample. A measuring tape or ruler may be placed alongside the sample container to estimate the volumes.

- If the prescribed alcohol to sample ratio (4:1) cannot be achieved after repeated condensing and decanting, then the sample should be split between two (or more) sample bottles. Label each with the same information, and label one as "Split 1 of 2" and the other as "Split 2 of 2".

- **Step 4:** Check the pH of the sample again after adding the preservative it should now be greater than 7. If the pH is below 7 add more baking soda solution. If the sample is not shipped within 1-2 weeks after preserving, check the pH again before shipping the samples. If the pH is below 7 add more baking soda solution. The lab will also check the pH of the sample upon arrival and add more baking soda solution as needed.
- **Step 5:** Pack all sample bottles and keep cool until they can be shipped to the lab. Do not freeze plankton samples. Freezing damages shells and reduces detection sensitivity.

Adult invasive mussel sample preservation

- Preserve suspect specimen(s) immediately after collection to ensure sample integrity. Place in a sample jar or vial and if possible avoid using a plastic bag for samples with shells (to avoid damage).
- Either 95% regular ethanol or 99% isopropyl alcohol should be used and DO NOT use denatured ethanol. Add enough preservative so that specimen(s) and/or associated substrate are completely submerged in the sample container. Do not add a buffer to samples that are not plankton tows.
- If preservative is not available freezing is an acceptable method of preserving specimens. See Appendix G instruction on labeling and shipping of samples.

Other invasive/unknown bivalves

- Collect samples and send detailed, high-resolution images by email with corresponding collection date and location (lat/long) to WLRS (see Appendix A for contact information) to check if samples are needed to confirm ID.
    - Dry samples (only shells) don't need to be preserved before mailing.
    - Wet samples (with tissue) need to be preserved in ethanol (at least 70% ethanol, <30 ml fluid volume). Grain alcohol (e.g. Everclear) is best.
    - If samples are not required for ID purposes, they can be discarded.
    - If samples are requested for ID, please isolate the vial with fluid in three layers of bag + absorbent (e.g. paper towel). i.e. put the vial in a bag with absorbent, then put that into a second bag with absorbent, and that into a third bag with absorbent.
      Please include collection information (geographical coordinates, date, and name of person who collected the specimens) with the samples.

# APPENDIX G: LABELING AND SHIPPING OF SAMPLES

Labeling Samples

- Sample containers must be labeled. Be sure to write legibly and using a wax pencil or alcohol resistant marker as many permanent markers are ink soluble in alcohol (e.g. Sharpie).
- To prevent the loss of information on the container a label should also be placed in the sample using waterproof paper and pencil. The label should contain the following information:
    - Date of collection
    - Name of waterbody;
    - Site location
    - Name/agency collecting sample.

This information MUST also be recorded on the form. Below is an example of a label on a sample container:

| |
|---|
| **Date:** 06/24/2018 |
| **Waterbody:** Columbia River |
| **Location:** Chinook Boat Landing Boat Ramp |
| **Sampler:** John Doe/name of the organization |

Packaging and Shipping Samples

Plankton tow samples must be sent to the lab throughout the sampling season, please follow the instructions provided by HCTF regarding frequency of shipping samples. Ethanol/isopropyl alcohol preserved samples must be shipped or mailed to the designated analytical lab via ground mail and following the appropriate Transport Canada shipping regulations. Ethanol/isopropyl alcohol is a Class 3 flammable liquid and there are restrictions regarding its transport. Keep preserved samples in a plastic container such as a bin or cooler in the back of the car while in transit. Ethanol can be mailed but there are training, certification, labeling and shipping requirements that must be followed. **Do not ship any samples via air and do not fly in an airplane with ethanol, ethanol can only be transported on the ground/surface.**

1. Samples must be in plastic containers with a screw lid. Secure screw lids with tape.
2. Place sample containers into a box lined with a plastic bag and add cushioning material such as plastic grocery bags or scrap paper. Once all samples are inside, close plastic bag tightly, and tie a knot to close the bag to prevent spills during shipping. Seal the box with packing tape. The box does NOT need to be a specific type of box so long as it is sturdy. DO NOT send samples in coolers.
3. Include a complete return address.
4. Include a paper copy of the chain of custody (COC) form with the samples and email an electronic copy of the COC form to the lab and the WLRS contact in Appendix A.
5. Ensure that all fields in the COC form are filled out as instructed and using the correct unit