Protocol for monitoring Alberta's irrigation infrastructure for invasive mussels

Outlet at north end of Stafford Reservoir

Updated

January 2017

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Zebra and quagga mussels are two species of invasive mussels that pose major threats to Alberta's irrigation industry. These small mollusks can heavily colonize hard surfaces, and quagga mussels are known to colonize soft surfaces such as sand. This has major implications for irrigation canals, pipelines, and associated infrastructure (Figure 1).

Figure 1. Examples of pipes fouled by invasive mussels.

Monitoring for Invasive Mussels

Irrigation infrastructure needs to be monitored so that if mussels are found, the appropriate treatment measures can be implemented to reduce the impacts of the infestation and prevent further spread of mussels throughout the system. If mussels are found, it will be important to refer to monitoring records to determine the duration and the extent of the infestation. Records that show when and where mussels were absent will also be very important.

Three types of monitoring that could occur in the irrigation districts are: (1) infrastructure, (2) PVC substrates, and (3) veliger. Figure 2 shows the consideration of resources and expertise that are required for monitoring. If resources are limited, it is recommended that at minimum, irrigation infrastructure be monitored at the end of the irrigation season once water is drawn down. Monitoring PVC substrates is relatively easy and cost-effective as well. Veliger monitoring requires more equipment (e.g., boat, veliger net, ethanol for sample storage), expertise (e.g., trained field staff), and expense (e.g., lab analyses) than the other monitoring methods. Invasive mussels are most likely to be introduced into Alberta during the boating season, so it is important to monitor during the summer. Monitoring should occur at least once a year, but monthly during the irrigation season would be best.

	Good	Better	Best
	More resources and expertise		
Methods	Monitor infrastructure	Monitor infrastructure Check PVC substrates	Monitor infrastructure Check PVC substrates Monitor for veligers
Frequency	End of season	Twice per season	Monthly during season

Figure 2. Continuum of monitoring options for mussels in irrigation infrastructure.

The purpose of this protocol is to provide direction on monitoring infrastructure. This protocol outlines how to identify zebra and quagga mussels, prioritizes what to look for when monitoring irrigation infrastructure, and what to do if mussels are found.

1. Identifying Zebra and Quagga Mussels

Use the following details on the physical features and preferred habitat conditions of zebra and quagga mussels to identify them.

Physical features

- Byssal threads, fine thread-like filaments, which allow them to attach to hard surfaces in the water (Figure 3a).
- As a general rule, zebra mussels have stripes or a zigzag pattern on their shells, while quagga mussels often have dark, concentric rings on their shells, though colours can vary greatly (Figure 4).
- Adult mussels range in size from 2 to 4 cm.
- Newly established colonies could include up to 75 mussels in a 10-cm by 10-cm area.
- Newly attached juvenile mussels are small, about 1 to 3 mm (Figure 3b).
- The time frame from fertilization to attachment ranges from 18 to 90 days, depending on water conditions (temperature).

Preferred habitat conditions

- Zebra mussels can reproduce when water temperatures reach 12 ºC and quagga mussels can reproduce at 9 ºC.
- Velocities less than 1.5 m/s are ideal for mussel attachment.
- Intakes at depths of less than 30 m from the water surface are ideal for mussel attachment.
- Preferred mussel substrates include concrete, stone, iron/stainless steel, aluminum, PVC, plastics, and wood. Copper and copper alloys are toxic to mussels.
- Establishment on older infrastructure tends to occur before newer structures, likely due to leaching out of surface toxins with time, and development of biofilms and other deposits that present a barrier.

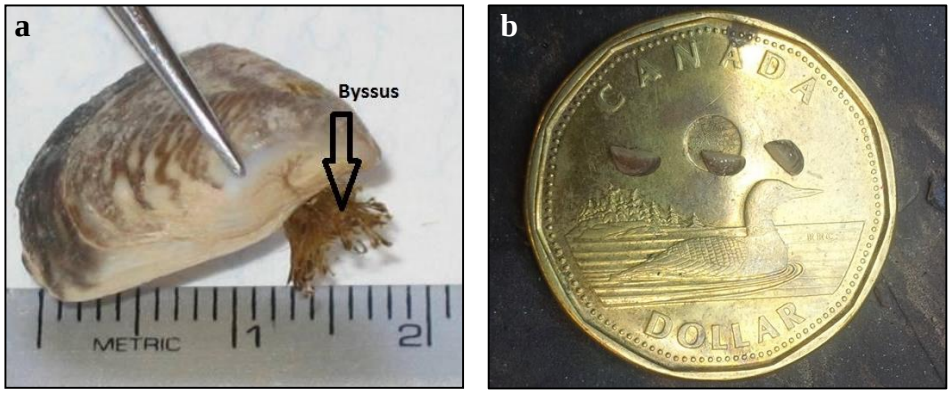

Figure 3. Physical features of invasive mussels showing (a) byssal threads and (b) the small size of three juvenile zebra mussels taken from a mussel-fouled boat.

The irrigation districts have been provided with identification stickers to help field staff identify invasive mussels (Figure 4). Staff are encouraged to keep these stickers on hand for quick reference (i.e., trucks, field notebooks, laptops).

Figure 4. Identification stickers to help irrigation district staff identify invasive mussels.

The phrase: "*an attached mussel is an invasive mussel*" is the key to determining if a mussel is invasive or not. In Alberta, there are several species of *native* mussels (Figure 5), which are not a concern. Native mussels are commonly found along river banks and the bottom of earthen canals. The main difference between a native mussel and an invasive mussel is that native mussels do not have a byssus, and thus do not attach to anything. Native mussels produce far fewer offspring and are much larger than invasive mussels, reaching up to 13 cm on average.

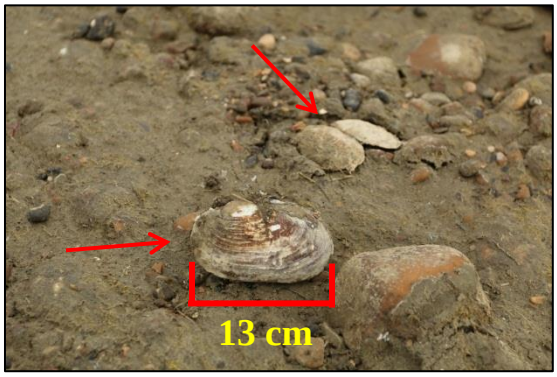

Figure 5. Arrows point to native mussels on the banks of the Bow River near Hays, Alberta.

2. Checking Infrastructure: Reservoirs

Because Alberta's irrigation reservoirs are used frequently for recreational boating and angling, this puts them at high-risk of invasive mussels being introduced. Twenty-one, high-risk reservoirs have been identified within Alberta's irrigation districts (Table 1). There are several structures in irrigation reservoirs that irrigation district staff should check on a regular basis (Table 2).

Table 1. High-risk irrigation reservoirs in Alberta.

Reservoir	Operated by	District(s) served
Oldman River Basin (12 reservoirs)		
Payne Lake	EP	MVID/LID/AID
Jensen	EP	MID/RID/TID
Milk River Ridge	EP	RID/TID
Waterton Reservoir	EP	SMRID/MID/RID/UID/TID
St. Mary	EP	SMRID/MID/RID/TID
Oldman River Reservoir	EP	LNID
Keho	EP	LNID
Park Lake	LNID	LNID
Sauder/Rattlesnake	SMRID	SMRID
Forty Mile	SMRID	SMRID
Chin Lake	SMRID	SMRID/TID
Stafford	SMRID	SMRID/TID
Bow River Basin (9 reservoirs)		
Chestermere	WID	WID
McGregor	EP	BRID
Travers	EP	BRID
Little Bow	EP	BRID
Badger	BRID	BRID
H Reservoir	BRID	BRID
Lake Newell	EID	EID
Rolling Hills	EID	EID
Crawling Valley	EID	EID

Table 2. Structures to check in irrigation reservoirs, in order of risk (i.e., the structures at the top of the list are the most likely to have mussels if present).

Location	Structures
1. Boat launches / marinas (Figure 6)	• Docks, dock floats, and supports • Nearby shoreline rocks • Cement launching pads • PVC substrates
2. Swimming areas (if present)	• Floating docks and swimming platforms • Buoys, ropes, and floating markers • Shoreline rocks
3. Irrigation outlets	• Concrete structures (high water mark) • Areas shallower than 30 m • Intake gates, trash bars

At minimum, structures should be checked once a year in the fall at drawdown (October), especially structures that come out of the water, such as docks and buoys. Structures can be checked once a month during irrigation season (May, June, July, August, September, and October). In Alberta's irrigation districts, it is not uncommon for water to reach temperatures greater than 15 ºC in early June (Charest et al. 2014), at which point mussels could begin reproducing.

Boat launches and marina areas should be prioritized before swimming areas and irrigation outlets due to the inherent risk posed by watercraft traffic. If PVC substrates have been installed, these should continue to be checked. The PVC substrates provide the observer a good understanding of what may be present below the water surface, especially when visibility conditions are poor, such as when water levels fall far below dock platforms, or if there is poor water clarity, making it difficult to see into the water.

Next, swimming areas should be inspected, due to their usual proximity to boat launches, marinas, and shorelines. Shoreline surveys should also be performed to examine rocks in shallow water, especially near water access points (boat launches, beaches). This allows the observer to monitor a large surface area in a short period of time.

Irrigation outlets in reservoirs should be prioritized last because of the time it will take for currents to move veligers beyond the boat launches. However, this depends on the proximity of irrigation outlets to boat and beach areas. The advantage of checking outlets is that all flowing water to irrigation will pass these points, maximizing the volume of water in which veligers may be transported. Outlets also have structures and associated riprap or armour that present good substrate for attachment.

Figure 6. Inspection locations at a boat launch, including shoreline rocks, and dock railings and support stakes, as indicated by red arrows.

3. Checking Infrastructure: Canals

After reservoirs, irrigation intakes are the next likely places that mussels could establish. Grates and trash bars at the intakes of conveyance systems are often the first structures to be fouled or colonized when mussels establish in a water body because they are the initial point of contact before entering a conveyance system (Table 3; Figure 7). Canal infrastructure and canals should be checked once a year in the fall at drawdown (October). If possible, check once a month during irrigation season as well.

Table 3. Structures to check in irrigation canals.

Location	Structures or preferred habitat
1. Canal infrastructure	• Intake gates • Trash bars (Figure 7a) • Screens • Weed removal equipment (rakes, conveyors)
2. Canals	• Canals along water mark (Figure 7b) • Water temperatures higher than 10 ºC • Standing, pooled water • Areas of flow less than 1.5 m/s

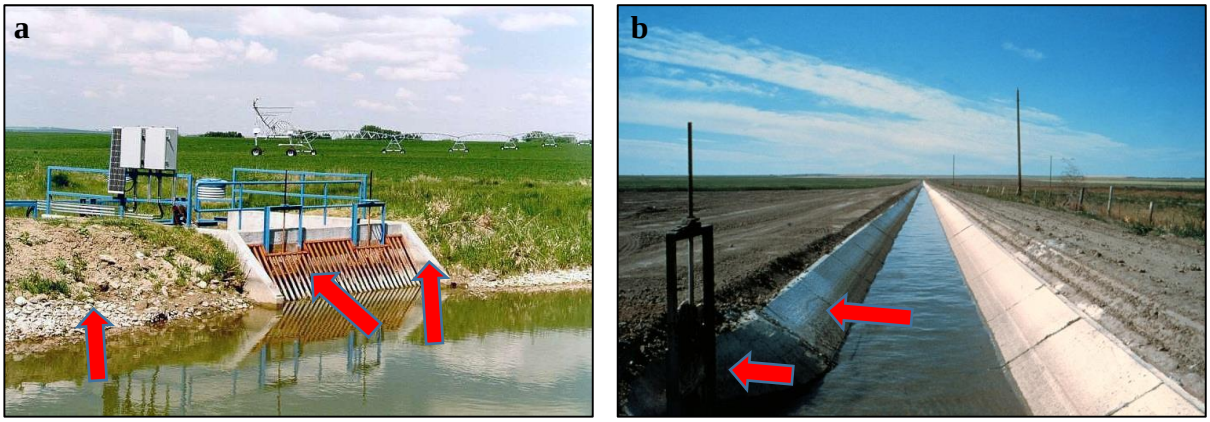

Figure 7. Indicated by red arrows, irrigation canals and infrastructure should be inspected for mussels, including (a) turnouts, intakes, and weed removal equipment, as well as (b) the canal itself along the high water mark.

4. Checking Infrastructure: Dams and Hydro Facilities

Inspections should occur monthly at dams and hydro facilities (Figure 8). Infrastructure where water enters these facilities should be inspected, and internal infrastructure should be inspected as well (Table 4).

For hydro facilities, be aware of increased friction and turbulence of flow, which may be due to increased surface roughness in pipes as a result of attached mussels.

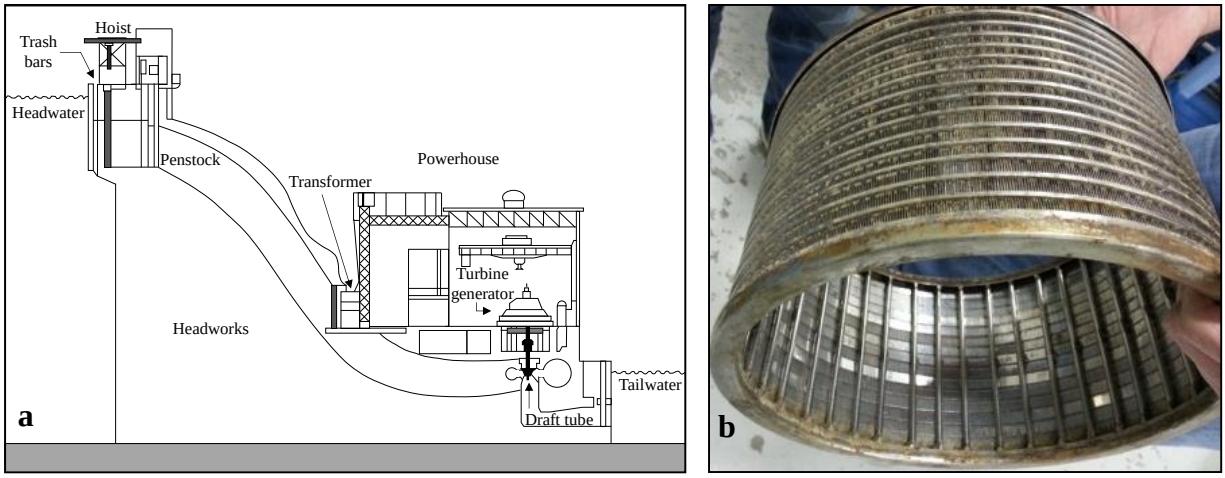

Figure 8. Irrigation water serves several hydroelectric generating facilities, which have (a) integrated internal and external components (adapted from Mackie and Claudi 2010) including (b) filters, all of which should be monitored regularly for mussels.

Table 4. Structures to check at dams and hydro facilities.

Location	Structures
1. External	• Intake grates • Trash bars • Screens • Weed removal equipment
2. Internal	• Pumps • Turbines • Strainers • Filters (Figure 8b) • Drainage sumps

5. Data Recording

Be sure to fill out a reporting sheet (Examples, see Appendix A) each time you perform an infrastructure inspection. Even if nothing is found, it should be documented on a reporting sheet. Data should be kept on file in the irrigation district office.

Note that Appendix A shows only examples of inspection records. Each district will need to determine what structures need to be inspected in terms of what makes sense and what is practical.

6. What to do if Mussels are Found

Make note of any mussels *attached or stuck* to irrigation infrastructure, the size, shape, and number, the location (i.e., boat launch, canal), and how recently the location was last checked. If possible, take a few pictures. You should then call the Aquatic Invasive Species HOTLINE (**1-855-336- BOAT [2628])**, and relay these details to the dispatcher. In the event that an attached mussel is found on any component of irrigation infrastructure, the appropriate actions, outlined in Appendix B, should be followed.

7. References

Charest, J., Olson, B., Kalischuk, A., and Gross, D. (eds.). 2015. Water Quality in Alberta's Irrigation Districts 2011 to 2015: 2014 Progress Report. Alberta Agriculture and Rural Development, Lethbridge, Alberta, Canada.

Mackie, G.L. and Claudi, R. (eds.). 2010. Monitoring and control of macrofouling mollusks in fresh water systems. 2nd Edition. Boca Raton, FL, CRC Press. Taylor & Francis Group.

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Aquatic Invasive Species HOTLINE: 1-855-336-BOAT (2628)

Appendix A. Reporting sheets.

Irrigation infrastructure reporting form - Reservoir

Irrigation district:	SMRID	**Reservoir:**	Stafford
Staff member:	John Doe		
Date:	October 5, 2014		

Irrigation Component	Inspected site description	Inspected ☑	Comments
Reservoir			
	Dam Armour – North End	✓	No mussels found
	North End Outlet Structure	✓	No mussels found
	Private Boat Launch and Docks – Subdivision	✓	No mussels found
	Public Boat Launch NE	✓	No mussels found
	Public Boat Launch NW	✓	No mussels found
	Public Docks	✓	No mussels found
	Water Treatment Pump Intake	N/A	
	Private Docks?	X	Permission not received

General notes, comments, concerns:

Was not given permission to inspect John Henry's private dock.

**Note, an attached mussel is an invasive mussel. *If an attached mussel is found, call 1-855-336-BOAT (2628). Refer to the attached flow chart.*

Irrigation infrastructure reporting form - Canal

Irrigation district:	SMRID	Canal:	As listed
Staff member:	John Doe		
Date:	October 5, 2014		

Irrigation Component	Inspected site description	Inspected ☑	Comments
Reservoir	Armour		
	Structures		
	Chin #9 Pipeline Entrance	✓	No mussels found
	Chin #10A Pipeline Entrance	✓	No mussels found
	Cameron Extension A	✓	No mussels found
	Pipeline Entrance – North Lateral Sublat 2	✓	Mussels suspected – process in Appendix B followed. Aquatic Invasive Species Hotline called at 10:04 am. Reported about 10 attached mussels: match the description of zebra mussels: last inspection was October 9, 2013 and no mussels were found. Irrigation district manager notified at 11:00 am.
	Canal Extension Canal		
	Armour		
	Structures		
	Farm TO331035		
	Main Canal (km 79 – km 81)	✓	No mussels found
	Armour		
	Structures		

General notes, comments, concerns:

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**Note, an attached mussel is an invasive mussel. *If an attached mussel is found, call 1-855-336-BOAT (2628). Refer to the attached flow chart.*

Irrigation infrastructure reporting form - Facility

Irrigation district:	SMRID	**Hydro facility:**	Chin
Staff member:	John Doe		
Date:	October 5, 2014		

Irrigation Component	Inspected site description	Inspected ☑	Comments
Hydro facility	Entrance – Trash Racks	✓	No mussels found
	Entrance – Concrete Wing Walls	✓	No mussels found
	Entrance Armour / Rip Rap	✓	No mussels found
	Entrance – Gates	✓	No mussels found
	Plant – Penstock	✓	No mussels found
	Plant - Filters	✓	No mussels found
	Tailwater – Gates	✓	No mussels found
	Tailwater – Wing Walls	✓	No mussels found

General notes, comments, concerns:

**Note, an attached mussel is an invasive mussel. *If an attached mussel is found, call 1-855-336-BOAT (2628). Refer to the attached flow chart.*

Appendix B. Flow chart for the visual inspection action process.