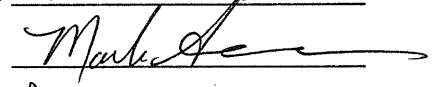
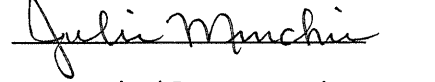


Effective Date 15 AUG 2016

Approved By

 Attached Documentation:
 Mussel Shell Length Data Sheet (Attachment AZ1)
SOP A1.01: Measuring Adult MusselsI. Summary

Mussels should be measured in the same manner each time. Try not to overlook small mussels; they can be <1 mm long and difficult to see. When mussels are collected, they may open from stress or tissue decay and small mussels can fall into the shells of larger mussels. Finding small mussels can be made easier by using a 10x loupe or magnifying glass. Wiping or rinsing with water algae and dirt from larger mussels may reveal smaller mussels attached to the larger ones or in the algae.

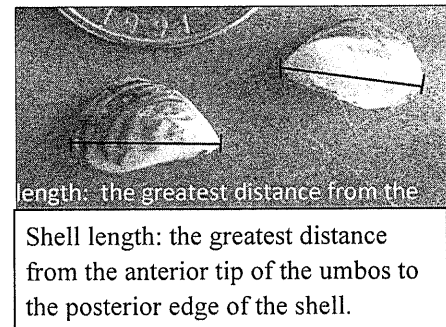
II. Equipment

Digital calipers
 Forceps
 Weigh boat

Towel
 Tray
 Wash bottle of RO water

III. Measuring Mussels

1. Mussels should be measured and preserved at the Biological Storage and Work Area (Bug Lab) in the Warehouse. Wipe down the counter before and after measuring.
2. Measure an adult mussel's shell length along the long axis to the nearest 1/10th of a millimeter with digital calipers.
3. Number mussels as they are measured; each year start at 1 for the first mussel collected that year.
4. Record the shell length, source, date measured, and technician initials on Attachment AZ1.




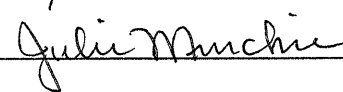
a. Source should include the date and location of field collection. The location will either be the site number or the growth monitor location and depth (Ex: 17MAR15 Site2; 14MAY15 APMBW10).

5. Start a new Excel file each year for mussels collected in that year. Save files in the appropriate folder in U:\Aquatic\WaterLab\ZM – Adult\ZM Adult Data\yyyy\yyyy Shell Length Data AZ1, where yyyy is the current year.

6. Once a data sheet is entered, review to ensure it is error-free, then write at the bottom of the data sheet "Entered to database," the date, and your initials.
7. Shell length data should be recorded electronically on a regular basis. Every 1-2 months, depending on frequency of updates, select "Save As" to create a new file with the current date to create an historic record of the data.

Effective Date 15 AUG 2016

Approved By

Attached Documentation:

Routine Shoreline Survey Sites (Attachment AZ2)

Shoreline Survey Field Data (Attachment AZ4)

SOP A1.02: Quantified Shoreline Surveys for Adult MusselsI. Summary

Mussels attached to canyon walls can be found by doing surveys of newly exposed shorelines when the reservoir drops. These surveys let us easily examine natural substrates.

II. Equipment

Sample bottles
 Forceps
 GPS unit

0.5 m scale bar
 Tape

III. Performing Shoreline Surveys

1. Do not do shoreline surveys on windy days; see JHA-Shoreline Surveys.
2. Do surveys in the late winter/early spring before the reservoir starts to fill. Ideally, do surveys as soon as possible after the reservoir has fallen 15-20' from its summer peak. Do surveys within 3 months after the reservoir has fallen 15-20'.
 - a. Exposed mussels decay and fall off the canyon walls. Limited anecdotal data indicates that takes 3-4 months; after that time frame survey data will be unreliable.
3. In years when the reservoir level does not rise, surveys could be timed to a known or estimated mussel spawning event instead.
 - a. Do surveys on (near-) vertical canyon walls that can be surveyed from the boat and do not require beaching. Survey north-facing substrates where possible.
4. See Attachment AZ2 for a list of routine survey sites, to be visited yearly.
5. Log survey sites on a GPS unit. The file should be a ZM_SAMPLE with Post-Processing named AZyymmdd.
6. In infested areas where mussels are growing in high densities, surveys will record the fraction of area covered by adult mussels, a proxy for density.

- a. Day of sampling, check the current lake elevation. Compare to the previous summer's peak (Attachment AZ4). Calculate and record how far above the water line the survey needs to be done to capture areas 15-20' below the peak.
 - i. Summer peak and winter/spring low lake elevations are available at the BOR's Lake Powell website <http://www.usbr.gov/uc/water/crsp/cs/gcd.html>.
 - b. Boat to a routine survey site. To keep the sample site consistent, refer to the UTM coordinates (Attachment AZ2). Record pre-survey data on Attachment AZ4.
 - c. Log a survey point and record its UTM's on Attachment AZ4.
 - d. Surveys are numbered starting at 1 for each day. Survey points for infested areas should be named with the number of the survey (Ex: Survey 1 = "1").
 - e. Tape or hold flat against the wall a 0.5 m scale bar at a point in the 15-20'-below-peak survey range. The scale bar should be horizontal on the wall.
 - i. Record how many feet above the water the scale bar is on Attachment AZ4.
 - ii. Take a picture of the data sheet; be sure to capture the name of the site.
 - iii. Take a picture of the infested area at the highest digital resolution and magnification possible that still includes the entire scale bar.
7. In non-infested and lightly infested areas where mussels are not present or are present in low densities where a picture would not accurately describe mussel density, a survey along the canyon wall will be done. No pictures need to be taken.
- a. Day of sampling, check the current lake elevation. Compare to the previous summer's peak (Attachment AZ4). Calculate and record how far above the water line the survey needs to be done to capture areas 15-20' below the peak.
 - b. Boat to a routine survey site. Refer to the UTM coordinates (Attachment AZ2) for the start point of your survey. Record pre-survey data on Attachment AZ4.
 - c. Log a Survey Start point and record its UTM's on Attachment AZ4. Move slowly along the wall, surveying for mussels in the 15-20'-below-peak range.
 - i. Surveys are numbered starting at 1 for each day. Survey Start points should be named "#A" with the number of the survey.
 - d. Spend no more than 30 minutes surveying for mussels. Count and/or collect no more than 100 mussels. At the end of the survey, log a survey end point and record its UTM's on Attachment AZ4.
 - i. Survey end points should be named "#B," where # is the number of the survey.

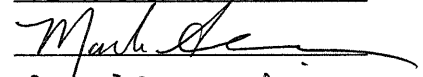
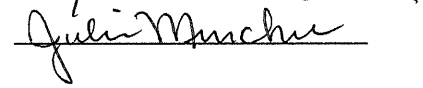
IV. Recording and Processing Electronic Data

1. Field data will be recorded in an Excel workbook at U:\Aquatics\WaterLab\ZM – Adult\ZM Adult Data\yyyy\yyyy Shoreline Dive and Wheel Gate Surveys AZ4 AZ9.
2. JPEGs of infested survey areas are saved in U:\Aquatics\WaterLab\ZM – Adult\ZM Adult Data\yyyy\yyyy Shoreline Surveys AZ4\yyyy Images. JPEG names include the date, survey number, and location where the image was taken (Ex: 20150321.2.LoneRock).
3. GIS data is saved in U:\Aquatics\WaterLab\Spatial_Data\Adult_Mussels_yyyy.
 - a. For point surveys (infested areas) and linear surveys (non-infested and lightly infested areas), process point data recorded in the field as in SOP Z2.07: Downloading and Differential Correction of GPS Points.
 - i. Use the appropriate folders in \Adult_Mussels_yyyy when processing the point data. Shapefiles should be saved in \Adult_Mussels_2015\GIS\Search_Areas\yyyyymmdd. After projecting and editing the data, the edited shapefile should be saved in the edited subfolder as AZ_yyyyymmdd.
 - b. Create a point shapefile to record results for each survey done that day, point and/or linear.
 - i. Copy and paste AZ_yyyyymmdd into the same edited subfolder; rename the copied file *SurveyResultsyyyyymmdd*.
 - ii. Add *SurveyResultsyyyyymmdd* to ArcMap; open the attribute table and add the following fields:
 - a. SURVEY – type: short integer, precision = 0
 - b. DATE – type: date
 - c. PRESENCE – type: text, length = 5
 - iii. Start editing *SurveyResultsyyyyymmdd*.
 - a. Delete extra points that were recorded by mistake (if needed).
 - b. Delete survey end points for linear surveys. Keep one point for each survey: the single point generated for a point survey and the Survey Start point (#A) for linear surveys.
 - c. Fill in the SURVEY column with the survey number (no text); this will be the number currently recorded in SITEID.

- d. Fill in DATE with the collection date in mm/dd/yyyy format.
- e. Rename the SITEID fields; record the number of the site associated with the survey, if adult mussels were found. If no mussels were found in that survey leave the SITEID field blank.
- f. Fill in PRESENCE with *yes* if mussels were found, *no* if none were found.
- g. Save edits, stop editing.
- h. Create a polyline shapefile for linear survey data. Follow SOP AZ1.03: Digitizing Linear Shoreline Search Areas to create a polyline shapefile with survey area data.

Effective Date 15 AUG 2016

Approved By

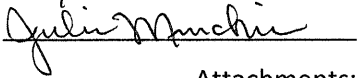
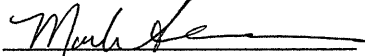

SOP A1.03: How to Digitize Shoreline Search AreasI. Summary

When shoreline surveys are done the start and end points of the survey are recorded in the field, linear features representing the survey area are made in ArcMap using that point data. If mussels are found, one mussel site is recorded per survey.

II. Digitize Survey Area

1. Open ArcCatalog. Go to the folder for the appropriate date in the U:\Aquatic\WaterLab\Spatial_Data\Adult_Mussels_yyyy\GIS\Search_Areas\yyyymmdd folder. The point data should be projected and edited, in the edited subfolder, and renamed *AZ_yyyyymmdd*.
2. Copy and paste the *SearchArea_template* polyline shapefile (in Search_Areas folder) into the edited subfolder. Rename the shapefile to *SearchAreayyyyymmdd*.
3. Open ArcMap. Bring the newly-made polyline shapefile into a blank document.
4. Bring the most appropriate bathymetry layer over to ArcMap. In ArcCatalog go to U:\Aquatic\WaterLab\Spatial_Data\Bathymetry, and drag and drop the most appropriate bathymetry layer given the lake level on the survey date over to ArcMap.
5. Bring the processed point shapefile with survey start and end points (*AZ_yyyyymmdd*) into ArcMap. There should now be three layers on your map: *SearchAreayyyyymmdd*, *AZ_yyyyymmdd*, and a *bathy83new_ele.lyr* file where ele is the elevation for the layer.
6. Right-click the polyline shapefile and select Edit Features>Start Editing. Pin the Create Features window to the right of the map screen. Click the Line and create a line segment representing the survey area by tracing the shore on the bathymetry layer; double-click to end the line segment.
 - a. Use the Survey Start and Survey End GPS points, named “#A” and “#B” (1A and 1B for SURVEY1, for example) to find the start and end of the survey. You may also rely on written records or memory to designate survey areas. If something other than GPS points were used to find survey extent, record on Attachment AZ4.
 - b. Keep a copy of any Point shapefiles used to generate the polyline shapefile in the folder for that survey date. Delete points not used to create the line segments (for example, if a shapefile has points from mussel sites and from the start/end of surveys, delete the mussel sites but keep the survey start/ends).

7. Once lines representing all survey areas have been made, open the Attribute Table.
 - a. Name the surveys (SURVEY1, etc.) and record the survey date (ddMMMyy).
 - b. Right-click the LENGTHM column header and select Calculate Geometry; defaults should be Property=Length, Coordinate system of the data source PCS=NAD 1983 UTM Zone 12N, and Units=Meters. Click OK, Save Edits and Stop Editing.
 - c. Record survey lengths in the “yyyy AZ4 Shoreline Survey Data” Excel workbook and use to calculate mussel density.

Effective Date 15 AUG 2016Approved By 

Attachments:

Substrate Deployment (Attachment AZ3)

SOP A1.04: Making, Assembling, and Deploying Artificial Substrates for Mussel MonitoringI. Summary

Artificial substrates are used to monitor presence/absence, growth, and settlement of mussels in Lake Powell and on the Colorado River between Glen Canyon Dam and Lee's Ferry.

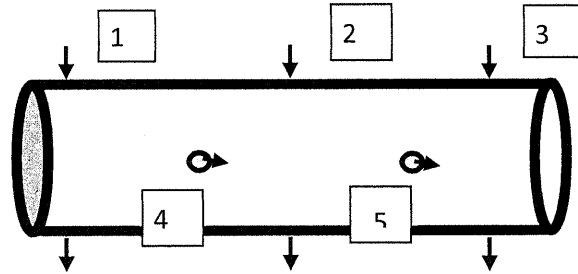
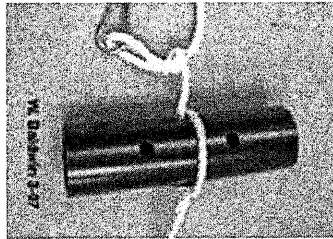
II. Equipment

2" foam-core ABS pipe
 ABS plate
 Anchors
 Table saw
 Drill press

Carabiners
 Fishing line
 Meter tape
 Permanent markers
 Flagging tape

III. Make Samplers

1. ABS pipe segments must be cut. Talk to Facilities staff for assistance. They can provide assistance and/or information on safe use of the tools, equipment, and PPE like gloves and eye protection.
2. Clean the area around the equipment when you are done and throw away the plastic dust and trash. There are brooms and dustpans on the walls you can use.
3. Portland-style samplers are used for presence/absence and growth monitoring in Lake Powell and on the Colorado River.
 - a. Buy 2" diameter foam-core ABS pipe. Ten foot-lengths are easiest to transport in the Water Lab truck and are usually available at Page Lumber.
 - b. Use a table saw to cut pipe into 7 5/8" long pieces. You should get about 15 pieces from each pipe, allowing for a 1/8" saw kerf.
 - c. Use a drill press with a 1/2" bit to drill through each piece 5 times (10 holes) for rope attachment and to allow water flow and veliger access.
 - d. See Appendix H, NPS Quagga/Zebra Mussel Infestation Prevention and Response Planning Guide, published May 2007 for more information.



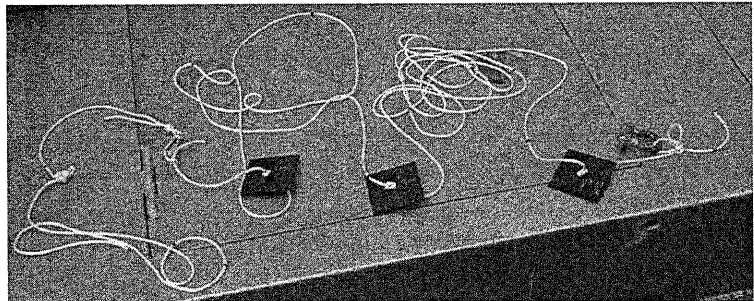
4. Plate samplers are used for settlement monitoring in Lake Powell.
 - a. Buy black ABS plate. Plates 24"x24" are easy to ship from online retailers.
 - b. Use a table saw to cut plate into 4"x4" squares. You should get about 20 pieces from each plate, allowing for a 1/8" saw kerf.
 - c. Use a drill press with a 1/4" bit (or appropriate size for the line to be used) to drill through the center of each plate for rope attachment.

IV. Assemble Substrates

1. Substrates are made of line with samplers attached with an anchor at the bottom, and hang from marinas, breakwaters, floating pump-outs, and camming devices in the canyon wall.
2. Use line that will not decay in the water (avoid cotton). Paracord or nylon work well.
3. Anchors may be cement blocks or shackles. Foam-core ABS is buoyant; the more samplers on a line the more weight you need at the bottom.
 - a. In Lake Powell, use cement blocks for presence/absence and growth substrates. Blocks or shackles can be used for settlement substrates.
 - b. In the Colorado River use shackles or other weights that produce less drag in the current.
4. Presence/absence substrates are made by hanging Portland-style samplers at 1, 5, and 10 meters below the water's surface, and every 10 meters after through the water column.
 - a. Prep the line.
 1. Tie a figure-8 knot or otherwise mark the water's surface, leaving about 3' of line above for attachment. Measure 1 meter down from the knot and tie a knot with a non-slipping loop for sampler attachment. Measure down 4 meters and tie another knot for the 5 meter samplers. Tie a knot 5 meters

below that for 10 meters, then every 10 meters. Leave at least 3' of line below the last sampler knot for anchor attachment.

- b. Use fishing line to hang two samplers at each sampling depth.
 - c. Samplers and anchors can be attached in the field to avoid tangling in the line.
5. Make growth substrates the same way as presence/absence substrates, but hang three samplers at each sampling depth instead of two.
 6. Make settlement substrates by hanging 4"x4" ABS plates at 1, 5, and 10 meters below the water's surface. Make two substrates for each location. Deploy one each month, then switch out with the other to monitor monthly changes in settlement. A carabiner is attached to the line tied to the attachment point so substrates can be switched out easily.
 - a. Thread three plates onto the line, rough side facing down. Tie a bowline above the plates for field attachment.
 - b. Measure 37 cm down from the top of the bowline and mark with a pen. Move one plate above the mark, two below. Tie a (figure-8) knot just below the mark for the 1 meter plate to rest on. Tie another knot above the plate to keep it in place.
 - c. Measure 4 meters down from the first mark, mark the line again. Move one plate above the mark, one below. Tie knots above and below the mark for the 5 meter plate.
 - d. Repeat for the 10 meter plate, measuring 5 meters below the 5 meter mark. Leave at least 3' of line below the knot for anchor attachment.
 - e. Mark each plate with the deployment location, line (A or B), and depth in meters.



V. Deploy Substrates

1. Deploy substrates from sturdy structures where they will not interfere with the structure's purpose. Do not tie to a buoy unless it has been approved spoken with the Aids to Navigation lead.
2. Pick an attachment point that will not be immediately noticed by visitors to reduce the chance of interference, such as:
 - a. Floating pump outs: tie to the back-right corner. The front of the pump out has the name plate for the location and the bathrooms.

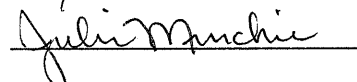
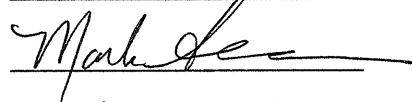
b. Breakwaters: tie to lights if available. Cable clamps can also be used.

c. Courtesy docks: dock structures or connectors may be used.

3. Attach the substrate with a bowline knot and adjust the knot so that the water surface-mark on the line is at water's surface. If the substrate is on a breakwater, tie some flagging tape marked NPS MUSSEL MONITOR to the line so Facilities can identify it.
4. Record the information at the top of the first page of Attachment AZ3. Record field data in the first table.

Effective Date 15 AUG 2016

Approved By



Attached Documentation:

Substrate Deployment (Attachment AZ3)

SOP A1.05: Presence/Absence SubstratesI. Summary

Presence/absence substrates are used to monitor for adult mussels in areas where mussel reproduction has not been found, in Transitional or Mussel-Free areas.

II. Equipment

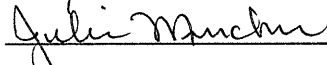
Substrate field binder
Ziploc or garbage bag

Secchi disk
WQ monitors

III. Deploy and Monitor Substrates

1. Make, assemble, and deploy substrates as described in SOP A1.04: Making, Assembling, and Deploying Artificial Substrates for Mussel Monitoring.
 - a. When the substrate is deployed, record information at the top of the first page of Attachment AZ3 and record field data in the first table.
 - b. Record the information at the top of the first page of Attachment AZ3 again if the substrate is moved or at the start of a new calendar year, even if the substrate has not been removed since it was first deployed.
 - c. Only record field data in the tables for the rest of the year.
2. Check monthly (at marinas and courtesy docks) or as time allows (pump outs).
 - a. Pull the substrate out of the water.
 - b. Visually inspect the inside and outside of the samplers. Do not feel for mussels.
 - c. Record field data and observations on Attachment AZ3.
3. If there are suspected mussels on a sampler at a given depth:
 - a. If two samplers: cut off one, bag it, and bring back to examine with the microscope.
 - b. If one sampler: put it back in the water and check again the next month.

4. If mussels are found, discuss with the Aquatic Ecologist. Decide if the substrate should be pulled, left in the water and continue monitoring for mussels at the other depths, or if it should be left in the water and used as a mussel growth monitor.
5. At the end of each year, evaluate if a substrate should be retained, moved, or removed. If a substrate is removed, move its data sheets to the "Archived" binder.
6. Start a new Excel file (*yyyy AZ3 Portland style substrate monitoring*) each year for Portland-sampler substrate field data (Attachment AZ3). Each file will contain a worksheet with deployment and location information (at the top of the first page of Attachment AZ3) and worksheets for each substrate where field data will be recorded. Presence/Absence and Growth Monitor substrates' field data are recorded in the same file. Files are saved in the appropriate folder in U:\Aquatic\WaterLab\Water Lab – ZM Adult\ZM Adult Data\yyyy\yyyy Artificial Substrates and Temperature Loggers AZ3 AZ5 AZ8.

Effective Date 15 AUG 2016Approved By 

Attachments:

Mussel Shell Length Datasheet (Attachment AZ1)

Substrate Deployment (Attachment AZ3)

Growth Monitor Processing (Attachment AZ5)

SOP AZ1.06: Growth Monitor SubstratesI. Summary

Growth monitor substrates are used to measure settlement and growth of adult mussels in Quagga-Infested areas.

II. Equipment

Substrate field binder
Ziplock or garbage bags
Secchi disk

WQ monitors
Straight-edge razor blades
Cooler with ice

III. Deploy and Monitor Substrates

1. Make, assemble, and deploy substrates as described in SOP A1.04: Making, Assembling, and Deploying Artificial Substrates for Mussel Monitoring.
 - a. When the substrate is deployed record information at the top of the first page of Attachment AZ3 and record field data in the first table. Only record field data in the tables for the rest of the year.
2. Collect one sampler from each depth every two months; bag it and bring back to the lab.
 - a. Record field data on Attachment AZ3. Note in comments that samplers were removed and how many samplers remain at each depth.
 - b. Start recording data on the Growth Monitor Processing datasheet, Attachment AZ5.
 - i. Record the date the samplers are removed and deployed.
 - ii. Record the holding method(s). Keep samplers on ice in coolers in the field, then move to the Bug Lab refrigerator or freezer. Put in the refrigerator if they'll be processed within a week, in the freezer otherwise. Note the date and holding method any time samplers are moved before processing.
 1. Ex: "On ice in field. 27MAY15 moved to refrigerator." OR "Ice in field. 26MAY15 moved to freezer. 04JUN15 moved to fridge."

- c. When all samplers have been collected, remove the substrate and dry and clean the line and anchors; save for future use. See SOP A1.07: Handling, Preservation, Removal, and Disposal of Adult Mussels, Section III.3 for guidance.
3. Record the processing information and number of mussels collected on Attachment AZ5.
 - a. Samplers may be processed (mussels collected) in the field. Three samplers were deployed at each depth so that mussels could be scraped off in the lab.
 - b. Collect at least 20 mussels if possible; increase the area if needed.
4. Measure shell lengths of mussels collected and record on Attachment AZ1. Preserve measured mussels as described in SOP A1.07.
5. Clean and re-use samplers. See SOP A1.07, Section III, for guidance.
6. After substrates are removed at 6 months post-deployment, evaluate if a substrate should be deployed in the same location in the future. Move the substrate's field sheets to the "Archived" binder.
7. Start a new Excel file (*yyyy AZ3 Portland style substrate monitoring*) each year for Portland-sampler substrate field data (Attachment AZ3). Each file will contain a worksheet with deployment and location information (at the top of the first page of Attachment AZ3) and worksheets for each substrate where field data will be recorded. Presence/Absence and Growth Monitor substrates' field data are recorded in the same file. Files are saved in the appropriate folder in U:\Aquatic\WaterLab\Water Lab – ZM Adult\ZM Adult Data\yyyy\yyyy Artificial Substrates and Temperature Loggers AZ3 AZ5 AZ8.
8. Start a new Excel file (*yyyy AZ5 Growth monitor processing*) each year for growth monitor processing data (Attachment AZ5). The file will contain a worksheet for each substrate. Files are saved in the appropriate folder in U:\Aquatic\WaterLab\Water Lab – ZM Adult\ZM Adult Data\yyyy\yyyy Artificial Substrates and Temperature Loggers AZ3 AZ5 AZ8.

Effective Date 15 AUG 2016Approved By Mark LeJulie ManchieSOP A1.07: Handling, Preservation, Removal, and Disposal of Adult MusselsI. Summary

Describes procedures for handling mussels collected by Water Lab staff and partners, as well as protocols for preservation or disposal.

II. Equipment

Sample bottles	95% denatured ethanol
Labels and tape	Substrates
Cut-proof gloves	Straight-edged razors
Eye protection	Brushes
Plastic aprons	

III. Handling Adult Mussels

1. Avoid handling mussels unless necessary. Mussels collected from growth rate monitors should be measured and preserved. Mussels collected in Visitor Use Zones where no signs of reproduction (veliger evidence and/or multiple adult size classes in one collection) have been found should be measured and preserved. After signs of reproduction are found in an area, mussels from that area should be measured then discarded or not collected at all. If mussels are brought to the lab from infested areas or with no location information, they should be discarded.
2. Care should be taken when handling mussels to avoid cutting your hands on shells. When handling objects covered by mussels, there is a risk of mussels detaching and accidentally becoming airborne. Objects covered in high densities of mussels pose the greatest risk because they lack mussel-free handholds. Wear appropriate PPE (cut-proof gloves, eye protection, and apron) as necessary. See JHA-Mussel Handling for more information.
3. Mussels should be stored in sealable containers at low temperatures until they are processed.
 - a. In the field: Store on ice in coolers. Add water if the mussels are still alive.
 - b. In the Bug Lab: Store in the refrigerator (~3°C) if processing mussels within one week. Store in the freezer (~-10°C) if processing will be delayed longer. Let frozen mussels thaw in the refrigerator before processing.
4. See SOPs A1.01 (Mussel Measurement), A1.02 (Shoreline Surveys), A1.05 (Presence/Absence), and A1.06 (Growth) for more on collecting and measuring mussels.

IV. Preservation of Adult Mussels

1. Only preserve adult mussels collected from growth rate monitors and Zones with no signs of reproduction.
2. Preserve mussels in 95% (denatured) ethanol in glass containers capped with polypropylene lids with polyethylene liners.
 - a. Do not fill a container to the top with specimens. Ethanol should more than completely cover the specimens, some ethanol may be absorbed or evaporate, so fill to the top with ethanol to allow for some loss over time.
3. Labels should be attached to the outside of the glass vial and covered with clear tape to prevent damage in case of ethanol or water spills. Labels should include the collection date and location, species name, number of specimens, mussel identifier, name of collector, and type and concentration of preservative. Record if the ethanol is denatured.
 - a. Label example: 25FEB15 Antelope Point Marina downstream breakwater
Dreissena rostriformis bugensis
 123 individuals Q3-Q125
 Collected by (tech initials) 95% denatured etch
4. Specimens preserved in ethanol are stored in a flammables cabinet. Boxes of specimens from the same project should be labeled on the outside with the project, date range of the specimens, and preservative(s) used. A sheet in a plastic sleeve or envelope with the project name, date range of the specimens, preservative used, and an inventory list of the specimens should be enclosed. If more than one preservative/preservation method was used for specimens, then the inventory list should include preservation method for each bottle.

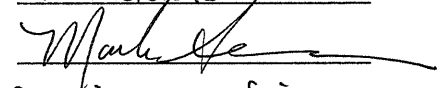
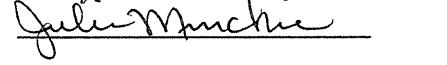
V. Removal and Disposal of Adult Mussels

1. Discard in waste container when:
 - a. Mussels are found on equipment *not* including growth monitors.
 - b. Mussels from infested areas after they have been measured.
 - c. Mussels on growth monitors that are not measured and preserved.
2. Mussels or mussel-encrusted objects should be double-bagged, if possible.
3. If a mussel-encrusted object is disposable, discard the entire piece.
4. If a mussel-encrusted object needs to be saved or re-used:
 - a. Small objects and/or low mussel-density objects, remove mussels with brushes. Rinse equipment.

- i. If the object is small and freezing won't harm it, it can be put in the -20°C chest freezer in the Warehouse; check with Cultural first to avoid freezer conflicts. Double-bag the object in heavy-duty garbage bags and freeze for at least one day. Remove the object and let it thaw, wipe away the mussels, throw them away, then rinse and clean the equipment.
- ii. For objects that cannot be frozen or are too big for the freezer, they can be left outside exposed to the air to dry completely. Prop up the object on blocks if needed to let air circulate. After the mussels have dried out, remove them with brushes, razors, etc. and discard them. Rinse and clean the equipment.

Effective Date 15 AUG 2016

Approved By


SOP A2.01: Monitoring Environmental Impacts of Quagga MusselsI. Summary

Quagga mussels can have significant impacts on their environment, changing water clarity and chemistry and altering the occurrence of algae, bacteria, and zoonotic diseases. This SOP describes informal monitoring for impacts of quagga mussels on the environment. All observations should be discussed with the Aquatic Ecologist.

II. Equipment

Secchi disk
WQ monitors

Colilert system

III. Monitoring

1. Water clarity and chemistry could be impacted by quagga mussels. Collect Secchi depth, measure pH, dissolved oxygen (DO), and conductivity in surface water when possible.
2. Algae may be impacted by quagga mussels. Algae could increase or even form blooms or mats; the algal community might also change. Take note of any unusual blooms or mats and ask other field staff if they have seen anything unusual. Consult with the Aquatic Ecologist for investigation of algal blooms.
3. Aquatic plants are rare at Glen Canyon NRA, but the quagga mussel infestation may aid in their introduction and/or establishment and growth. Take note of any unusual occurrences and ask other field staff, particularly the Aids to Navigation crew, if they have seen anything unusual.
4. Birds and fish could be positively or negatively impacted by quagga mussels, partly depending on species. Mussels and their impacts could create anoxic conditions, causing fish kills. They could increase the prevalence of botulism, leading to fish and/or bird die-offs. Mussels provide an ample food source for molluscivorous fish and birds, like carp and scaups, but can also contribute to bioaccumulation of contaminants in these species. Be alert to, and ask other field staff if they have seen any changes in the aquatic wildlife community.
5. Dense mussel infestations can reduce visitor enjoyment due to unpleasant smells and sharp shells. Other Divisions will more likely be the first to notice or be told if that happens, but

be alert to indications of negative impacts and discuss any with the Aquatic Ecologist and other appropriate parties.

6. Mussels have been known to impact *Escherichia coli* levels. It is believed they indirectly can increase amounts of *E. coli* in the environment. Popular swimming areas will be monitored when possible for unsafe or changing *E. coli* conditions using standard GLCA beach monitoring procedures.