

# Virginia Freshwater Mussel Restoration Strategy:

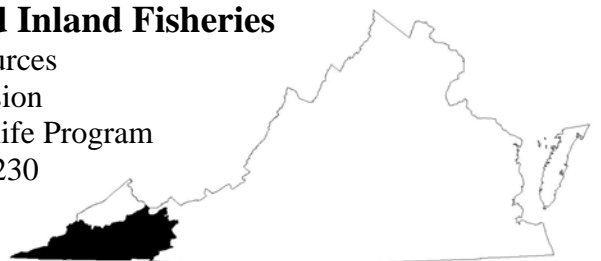
## *Upper Tennessee River Basin*

May 2010



### Virginia Department of Game and Inland Fisheries

Bureau of Wildlife Resources  
Wildlife Diversity Division  
Nongame and Endangered Wildlife Program  
Richmond, Virginia 23230



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## **Virginia Freshwater Mussel Restoration Strategy: *Upper Tennessee River Basin***

### **Background**

Freshwater mussels are an important component of river, lake, and stream environments. They are a food source for many animals including muskrats, minks, otters, fishes, and some birds. Mussels continuously pump water through their siphons to feed on detritus, plankton, bacteria, and other suspended particles. In the process of feeding, mussels clean the water and release unused food particles to the stream bottom that are eaten by other invertebrates such as aquatic insects. Mussel shells are used as habitat by insects and aquatic plants, and the empty shells as egg-laying sites by fish.

The life cycle of a freshwater mussel is one of the most interesting and complex in the animal kingdom. Female mussels filter the males' sperm from the water column to fertilize eggs that develop into a larval stage called the glochidium. Mussels release thousands of glochidia into the water column that must attach to the gills, fins, or scales of a suitable host fish. Most glochidia will only transform on a few fish species, and many of these host-fish/mussel relationships are still unknown. Although many game species, such as black basses and sunfishes, are hosts for certain species, the majority of mussels use darters and minnows. Once the larvae transform into juvenile mussels over a period of a few days to several weeks, they must then fall into suitable habitat to be able to survive, grow, and later reproduce. Adult mussels of some species may live over 100 years in the wild.

Freshwater mussels are present throughout the world but are especially diverse in North America. Of the original 297 species known from the United States, 102 (34%) are found in the Tennessee River system of Tennessee, Alabama, Georgia, North Carolina, and Virginia. Virginia supports 81 species with over 45 species in the upper Tennessee River tributaries of the Clinch, Powell, and Holston rivers. Nationwide, the mussel fauna in the U.S. has experienced drastic declines because of water pollution, dam construction, and exotic species introductions. The U.S. currently has 70 species (24%) listed as federally endangered or threatened. In Virginia, 31 federally or state listed mussel species occur in the upper Tennessee drainage. Based on similar-sized watersheds throughout the country, the Clinch and Powell rivers are ranked first and third, respectively, for the greatest number of at-risk fish and mussel species.

Because of water pollution concerns and the loss of native aquatic species, the federal government passed the Clean Water Act in 1972. Subsequently, federal and state agencies, as well as private industry and landowners, have modified traditional methods of forestry, construction, agriculture, and other activities to manage for good water quality. Unfortunately, even with improvements in water quality, mussel populations have continued to decline. In many areas, mussel densities are so low that the eggs of females go unfertilized. For females that become fertilized and produce viable glochidia, the chances that their larvae will attach to the correct host fish are extremely low under the best conditions, and almost negligible when host densities are reduced. If the mussel survives to the juvenile stage, sufficient habitat also must be present for growth and maturation into an adult. Good water quality and habitat are essential to all stages of development, but are especially critical for the larval and juvenile stages.

Through over 20 years of coordinated research by state and federal agencies, propagation techniques have been developed to recover freshwater mussel populations. These techniques allow researchers to infest the known host fish species with glochidia and produce juvenile mussels that can be released in the wild, thereby adding significant cohorts to the population. Before releasing juvenile mussels, young of certain species can be held under semi-natural conditions and grown to larger sizes. The older mussels are less vulnerable to predation and are better able to withstand water quality and habitat perturbations, compared to younger age classes. In Virginia, two facilities presently can accomplish these tasks in the Upper Tennessee River Basin (UTRB). These are the Freshwater Mollusk Conservation Center at Virginia Polytechnic Institute and State University, and the Aquatic Wildlife Conservation Center operated by the Virginia Department of Game and Inland Fisheries.

### **Freshwater Mussel Restoration Guidelines**

These guidelines are intended to provide a programmatic structure for captive propagation and release of freshwater mussels into the wild, with the goal of developing self-sustaining populations. In support of this objective, we note that each current endangered mussel recovery plan recommends propagation as a task for delisting. Furthermore, while not currently listed as threatened and endangered, many non-listed species also are imperiled and uncommon, and would benefit from population augmentation.

In this document, we consider the following four levels of introduction: augmentation, expansion, reintroduction, and establishment. These levels have been defined by the National Strategy for the Conservation of Native Freshwater Mussels (NSCNFM) (NNMCC 1998) and the Upper Tennessee Mollusk Recovery Group (UTMRG). The UTMRG is comprised of representatives from the Virginia Department of Game and Inland Fisheries (VDGIF), Virginia Polytechnic Institute and State University, U.S. Geological Survey, U.S. Fish and Wildlife Service, and The Nature Conservancy. The NSCNFM was developed by the Freshwater Mollusk Conservation Society, which is comprised of state and federal governmental agencies, non-governmental organizations, and private individuals, as a framework to recover freshwater mussels nationwide.

**Level 1: Augmentation** – release of a species in a river reach where it currently exists.

**Sublevel 1A: Replacement** – release of a species in a river reach where it recently existed, but is now in low numbers or possibly extirpated because of a specific event (e.g., chemical spill).

*Authority:* The decision to augment species will be made by Department biologists in coordination with the UTMRG. Because the species are extant or recently occurred in the reach, no additional regulations or special designations would be needed.

**Level 2: Expansion** – release of a species into suitable historical habitat in a river reach from which it has been extirpated, but where specimens currently survive upstream or downstream, and natural recolonization could occur. Release of species into such reaches that could be

naturally colonized, but for which no records exist of the species' historical occurrence, would also be considered to be population expansions.

*Authority:* Stocking of mussels will be based on the decision of Department biologists and the recommendations of the UTMRG, and may require consultation with appropriate federal, state, and local authorities.

**Level 3: Reintroduction** – release of a species into suitable historical habitat from which it has been extirpated, and where natural recolonization cannot reasonably be anticipated.

*Authority:* Stocking of mussels will be based on the decision of Department biologists and the recommendations of the UTMRG, in consultation with appropriate federal, state, and local authorities. Reintroduced populations may warrant special designation as “experimental” or “non-essential.”

**Level 4: Establishment** – release of a species into suitable habitats in reaches for which no records exist of the species' historical occurrence, and where natural colonization cannot reasonably be anticipated.

*Authority:* Stocking of mussels will be based on the decision of Department biologists and the recommendations of the UTMRG, in consultation with appropriate federal, state, and local authorities. Established populations may warrant special designation as “experimental” or “non-essential.”

Recovery efforts initially will focus on augmenting mussel species at six reaches on the Clinch, Powell, and North Fork Holston rivers, as presented in Figure 1. Additional reaches and species may be added as appropriate, as recommended by the UTMRG, and as approved by VDGIF. All selected reaches have shown evidence of recent mussel recruitment, indicating conditions are likely suitable for augmenting species. Augmentation can occur by: (1) translocation of adult mussels from a source population; (2) release of propagated juveniles; and (3) on-site release of infected host fishes collected from the augmentation site. Before augmentation can begin at a specific river reach, a monitoring site, determined by the UTMRG, will be selected and surveyed within each section to obtain baseline data regarding presence, density, and recruitment of all mussel species. Each site will be revisited periodically to determine augmentation results. Sites that have experienced a catastrophic mussel kill because of events such as toxic spills may be exempted from preaugmentation surveys and instead species information will be based on the best available data.

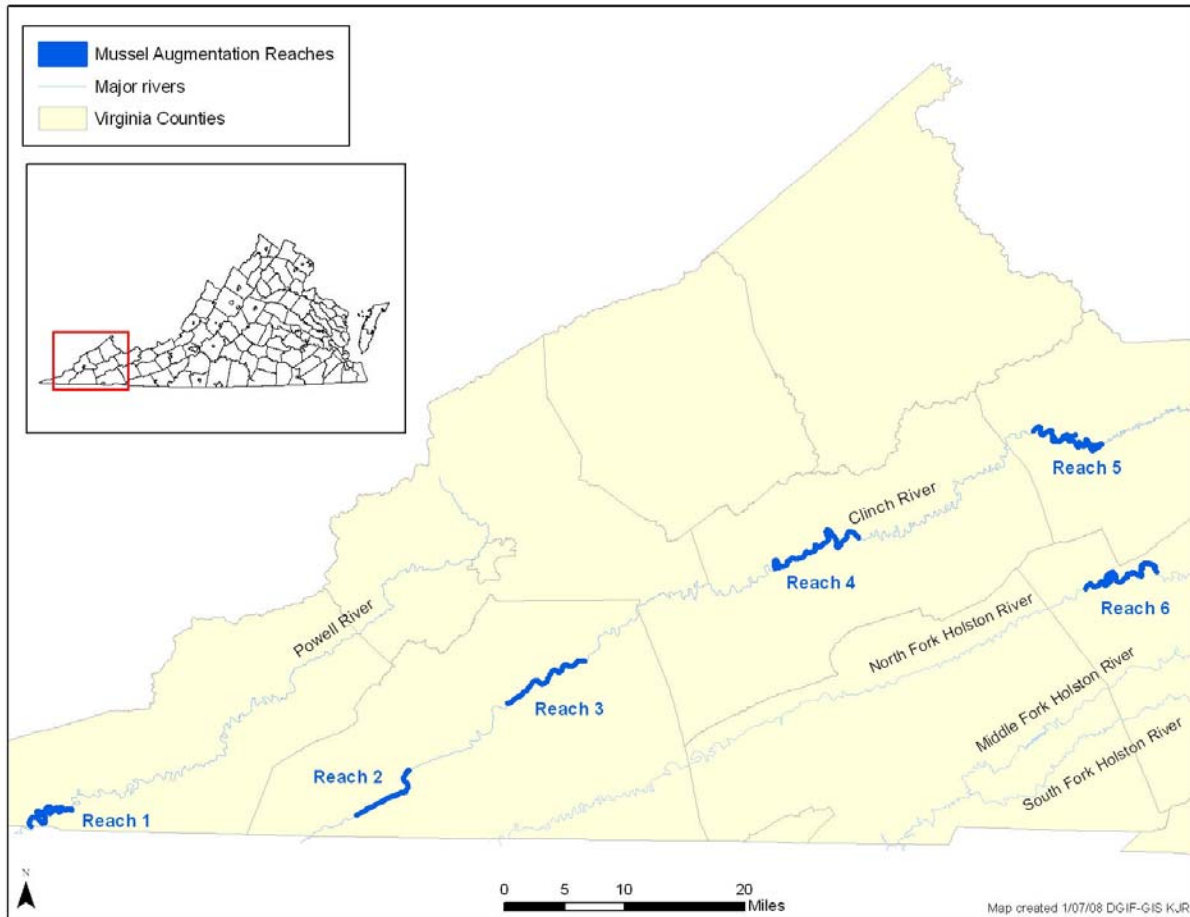
The primary determination of which species are augmented at a specific reach will be based on verifiable species accounts since 1980 (Table 1). Other factors include the ability to successfully propagate the species under captive conditions, the number of specimens available, and the current information on a species' life history. Furthermore, additional species may be added to the list of augmented species based on new distributional records. In certain cases, individuals may need to go beyond the borders of Virginia to collect gravid mussels to conduct propagation. The VDGIF will require all institutions and organizations involved in propagation

to follow protocols outlined in Appendices *A* through *E* before, during, and after augmentation activities. These protocols will ensure that program integrity is maintained.

### **Literature Cited**

National Native Mussel Conservation Committee. 1998. National strategy for the conservation of native freshwater mussels. *Journal of Shellfish Research* 17(5): 1419-1428.

**Figure 1. Augmentation reaches within the Upper Tennessee River drainage of Virginia.**



**Reach 1:** Powell River (RM 124-115.5) from the Snodgrass Ford downstream to the Virginia-Tennessee state line, Lee County (approximately 8 river miles). The Powell River from the confluence with the North Fork Powell River to the state line was impacted by a coal slurry spill in 1996.

**Reach 2:** Clinch River (RM 213.2-206.9) from Clinchport downstream to the mouth of Dry Valley Branch, Scott County (approximately 6 river miles).

**Reach 3:** Clinch River (RM 235.1, 234, 226.3) – Simones, Grays, and Pendleton islands, Scott County. All three islands are located between Reaches 2 and 4.

**Reach 4:** Clinch River (RM 279-267) from Nash Ford to Carbo, Russell County (approximately 12 river miles).

**Reach 5:** Clinch River (RM 329.8-317.7) from Pounding Mill to Richlands, Tazewell County (approximately 12 river miles), including the lower 2 miles of Indian Creek at Cedar Bluff, Virginia. The Clinch River from Cedar Bluff to Richlands (approximately 5 miles) was, until a toxic spill occurred in 1998, one of the best examples of a healthy, reproducing mussel assemblage in the Clinch River in Virginia.

**Reach 6:** North Fork Holston River (RM 97.8-86.2) from Riverside to McCready, Smyth County (approximately 12 river miles).

**Table 1. Selected freshwater mussel species and river reaches for augmentation in the Upper Tennessee River Basin of Virginia.**

| <b>Common name</b>                               | <b>Scientific name</b>                 | <b>Augmentation reach</b> |
|--|--|---------------------------|
| <i><u>Federally Threatened or Endangered</u></i> |  |                           |
| Appalachian monkeyface                           | <i>Quadrula sparsa</i>                 | 1,2,3,4                   |
| Birdwing pearlymussel                            | <i>Lemiox rimosus</i>                  | 1,2,3,4                   |
| Cracking pearlymussel                            | <i>Hemistena lata</i>                  | 1,2,3,4                   |
| Cumberlandian combshell                          | <i>Epioblasma brevidens</i>            | 1,2,3,4                   |
| Cumberland monkeyface                            | <i>Quadrula intermedia</i>             | 1,2,3,4                   |
| Dromedary pearlymussel                           | <i>Dromus dromas</i>                   | 1,2,3,4                   |
| Fanshell   | <i>Cyprogenia stegaria</i>             | 1,2,3                     |
| Finerayed pigtoe                                 | <i>Fusconaia cuneolus</i>              | 1,2,3,4                   |
| Littlewing pearlymussel                          | <i>Pegias fibula</i>                   | 5, 6                      |
| Oyster mussel                                    | <i>Epioblasma capsaeformis</i>         | 1,2,3,4                   |
| Pink mucket                                      | <i>Lampsilis abrupta</i>               | 2,3                       |
| Purple bean                                      | <i>Villosa perpurpurea</i>             | 3,4,5                     |
| Rough rabbitsfoot                                | <i>Quadrula cylindrica strigillata</i> | 1,2,3,4,5,6               |
| Shiny pigtoe                                     | <i>Fusconaia cor</i>                   | 1,2,3,4,6                 |
| Tan riffleshell                                  | <i>Epioblasma florentina walkeri</i>   | 5                         |
| <i><u>State Threatened or Endangered</u></i>     |  |                           |
| Black sandshell                                  | <i>Ligumia recta</i>                   | 1,2,3,4                   |
| Deertoe  | <i>Truncilla truncate</i>              | 1,2,3                     |
| Elephantear                                      | <i>Elliptio crassidens</i>             | 1,2,3                     |
| Pimpleback                                       | <i>Quadrula pustulosa pustulosa</i>    | 2,3                       |
| Sheepnose  | <i>Plethobasus cyphus</i>              | 1,2,3                     |
| Slabside pearlymussel                            | <i>Lexingtonia dolabelloides</i>       | 1,2,3,4,6                 |
| Snuffbox   | <i>Epioblasma triquetra</i>            | 1,2,3                     |
| Spiny riversnail*                                | <i>Io fluvalis</i>                     | 1,2,3,4                   |
| Tennessee heelsplitter                           | <i>Lasmigona holstonia</i>             | 5                         |
| <i><u>Non-listed</u></i>                         |  |                           |
| Cumberland moccasinshell                         | <i>Medionidus conradicus</i>           | 1,2,3,4,5,6               |
| Elktoe   | <i>Alasmidonta marginata</i>           | 3,4                       |
| Fluted kidneyshell                               | <i>Ptychobranthus subtentum</i>        | 1,2,3,4,5,6               |
| Flutedshell                                      | <i>Lasmigona costata</i>               | 1,2,3,4,5                 |
| Kidneyshell                                      | <i>Ptychobranthus fasciolaris</i>      | 1,2,3,4,5,6               |
| Long solid                                       | <i>Fusconaia subrotunda</i>            | 1,2,3,4                   |
| Mucket   | <i>Actinonaias ligamentina</i>         | 1,2,3,4                   |
| Mountain creekshell                              | <i>Villosa vanuxemensis</i>            | 1,2,3,4,5,6               |
| Pheasantshell                                    | <i>Actinonaias pectorosa</i>           | 1,2,3,4,5,6               |
| Pink heelsplitter                                | <i>Potamilus alatus</i>                | 1,2,3,4                   |
| Pocketbook                                       | <i>Lampsilis ovata</i>                 | 1,2,3,4,5,6               |
| Purple wartyback                                 | <i>Cyclonaias tuberculata</i>          | 1,2,3,4                   |
| Rainbow mussel                                   | <i>Villosa iris</i>                    | 1,2,3,4,5,6               |
| Spike  | <i>Elliptio dilatata</i>               | 1,2,3,4,5,6               |
| Tennessee clubshell                              | <i>Pleurobema oviforme</i>             | 2,3,4,5,6                 |
| Tennessee pigtoe                                 | <i>Fusconaia barnesiana</i>            | 1,2,3,4,5,6               |
| Threeridge                                       | <i>Amblema plicata</i>                 | 1,2,3,4                   |
| Wavy-rayed lampmussel                            | <i>Lampsilis fasciola</i>              | 1,2,3,4,5,6               |

\*The spiny riversnail (*Io fluvalis*), is included in this table for information purposes only.



## **Appendix A. Protocol for freshwater mussel restoration in the Upper Tennessee River Basin of Virginia.**

- 1) All organizations and institutions conducting mussel restoration must develop an operational plan indicating their ability and expertise to hold, propagate, and augment freshwater mussels in the upper Tennessee River drainage of Virginia. A list of all species held and propagated to date must be included. Updated plans must be submitted prior to propagation activities and no later than January 31 of each year.
- 2) Prior to propagation activities, each organization and institution shall submit a proposal indicating mussel species that will be augmented and released during each calendar year. The proposal should include, but not be limited to, adult mussel source, release sites (i.e., river name, river mile), release schedule, and age classes of propagated species. The Department must approve the proposal prior to collection of adult mussels. Prior approval is required before releasing adult or juvenile mussels collected in Virginia or produced using Virginia stock into waters of another state.
- 3) The source for adult mussels used to propagate or translocate should come from within the targeted augmentation reach. If a species occurs in insufficient numbers or is absent from the augmentation reach, and subject to prior approval by VDGIF, the adult mussels should come from (in declining order of preference):
  - a. another metapopulation in the same stream/tributary system in the same physiographic province;
  - b. another population in an adjacent stream/tributary system in the same physiographic province;
  - c. another population in an adjacent stream/tributary system in an adjacent physiographic province;
  - d. the only known population.
- 4) Prior VDGIF approval is required for interdrainage transfer of propagated and adult mussels. The Department reserves authority to require genetic analysis of mussel populations to determine suitability for interdrainage transfer.
- 5) To avoid the repeated propagation of the same mussels, all female mussels used for propagation purposes must be marked with Hallprint™ tags before being returned to the source site. A list containing mussel species, source site, and corresponding tag numbers shall be submitted to VDGIF before the end of each calendar year.
- 6) Any adult or juvenile mussels demonstrating signs of disease or stress shall not be returned to the river. The Department reserves authority to require additional testing to ensure all mussels are disease free prior to release.
- 7) Releases of post-infested fish host used in mussel propagation must follow protocols outlined in Appendix B. All fish used in laboratory infestations not suitable for release must be euthanized. This does not include fish that will be infested and immediately released at the collection site.

- 8) Only mussels intended for propagation purposes that will be later returned can be collected from selected monitoring areas. Mussels that will be permanently removed (e.g., for toxicity studies) must come from areas other than the monitoring sites.
- 9) VDGIF shall be notified at least 2 weeks prior to release of all translocated or propagated mussels and a propagated mussel form (Appendix C) shall be submitted to VDGIF within 2 weeks after a release of juvenile mussels or infected host fish. Notifications and forms (electronically or in hard copy) must be forwarded to:

Brian Watson  
VA Department of Game & Inland Fisheries  
1132 Thomas Jefferson Road  
Forest, VA 24551  
[Brian.Watson@dgif.virginia.gov](mailto:Brian.Watson@dgif.virginia.gov)

- 10) All mussels must be collected from waters free of zebra mussels (*Dreissena polymorpha*) and quagga mussels (*Dreissena bugensis*). If mussels cannot be obtained from waters free of these invasive species, quarantine procedures must be followed (Appendix D and E).
- 11) Individuals are required to comply with all federal and state scientific collection permit requirements. For information regarding VDGIF scientific collection permit requirements, please go to <http://www.dgif.virginia.gov/permits/permit-applications.asp>.
- 12) Individuals are required to acquire landowner permission before crossing property to access augmentation sites.

Deviation from the above protocols requires the written approval by VDGIF. Failure to follow the protocols as outlined may result in suspension of all propagation activities until the issue(s) is resolved.

## **Appendix B. Protocol for release of post-infested fish hosts used for mussel propagation.**

Infestation of host fish is an essential component of mussel propagation. To produce sufficient numbers of juvenile mussels, a researcher may use dozens to hundreds of fish at a single time. After the fish are used for mussel propagation, their final deposition is often questioned because of concerns related to genetics, disease, and release of attached glochidia. Certain locations are sampled because of the high quality and quantity of fish species present. Many of these sites are sampled repeatedly, which has the potential of causing localized declines. To address these issues, the UTMRG has set forth the following protocols that must be followed in order to return post-infested fish to the wild.

### **Fish Collection**

All fish host collection and release requires a scientific collection permit issued by the VDGIF. Permission from the property owner must be acquired for all access onto private lands. When collecting host fish, samplers should avoid areas where anglers are present.

Any deviations from this protocol must be approved in advance by the VDGIF Region III Wildlife Diversity Biologist:

Mike Pinder  
VA Dept. of Game & Inland Fisheries  
2206 South Main St., Suite C  
Blacksburg, Virginia 24060  
Mike.Pinder@dgif.virginia.gov

### **Fish Holding**

Fish from separate sites must be held in separate containers before, during, and after infestation.

Other than treatable surface disease such as ich, fish demonstrating diseases, parasites, or abnormal behavior must be destroyed, including all fish held with the suspect fish whether or not they show outward signs of problems.

After completion of the glochidial infestation period, the fish must be held in a separate container for at least 7 days to ensure no additional drop off of juvenile mussels. If the fish continue to be completely free of any signs of disease or parasites, they can be released at the following locations based on their collection sites:

### **South Fork Holston River**

Lower section (Thomas Bridge RM 102.5 – Buller Hatchery RM 105.5) – Collected fish must be released at the Thomas Bridge at the intersection of SR 650 and SR 657.

Upper section (Quebec RM 106.5 – Robert's Mill RM 112.1) – Collected fish must be released at the Appalachian Trail crossing along SR 650 RM 107.3.

### **Middle Fork Holston River**

Upper section (Upstream of the Town of Marion RM 43) – Collected fish must be released at the SR.622 Bridge (RM 48.2) on the Middle Fork near Bear Creek.

### **North Fork Holston River**

Upper section (Above Saltville) – Collected fish must be released within 500 m upstream or downstream of the Hwy 91 Bridge.

### **Clinch and Powell Rivers**

In areas such as the Clinch and Powell rivers, host fish must be returned within 500 m from the point of capture. This includes both game and nongame fish species.

### **Fish Collected Outside the Upper Tennessee River Drainage**

All fish species, including but not limited to centrarchids, sculpins, cyprinids, and darters, must be placed in a dead-end situation. Centrarchids can be placed in a pond or other such habitat providing there is no possibility of escape.

### **Fish Release**

The VDGIF Region III Wildlife Diversity biologist must be notified no later than 3 days after fish have been released.

**Appendix C. UTRB Freshwater mussel propagation and release form.**

**Freshwater Mussel Propagation & Release Form  
Upper Tennessee River Basin**

**Organization:** \_\_\_\_\_ **Primary contact:** \_\_\_\_\_  
**Address:** \_\_\_\_\_ **City:** \_\_\_\_\_ **State:** \_\_\_\_\_ **Zip:** \_\_\_\_\_  
**Phone:** \_\_\_\_\_ **Email:** \_\_\_\_\_

**Adult Mussel Collection**

Species: \_\_\_\_\_ Status: \_\_\_\_\_  
Collection date: \_\_\_\_\_ Number propagated: \_\_\_\_\_  
Hallprint tag ID and color: \_\_\_\_\_  
Condition: \_\_\_\_\_  
Collection method: \_\_\_\_\_ Drainage: \_\_\_\_\_  
State: \_\_\_\_\_ County: \_\_\_\_\_ UTM X/Lat: \_\_\_\_\_ UTM Y/Long: \_\_\_\_\_  
Site location: \_\_\_\_\_  
Habitat: \_\_\_\_\_  
Collection crew: \_\_\_\_\_  
Holding structure: \_\_\_\_\_ Holding duration: \_\_\_\_\_  
Holding location: \_\_\_\_\_  
Additional comments: \_\_\_\_\_

**Fish Host Collection**

Fish Host(s) Collected: \_\_\_\_\_  
Collection date(s): \_\_\_\_\_ Drainage: \_\_\_\_\_ County: \_\_\_\_\_  
State: \_\_\_\_\_ UTM X/Lat: \_\_\_\_\_ UTM Y/Long: \_\_\_\_\_  
Site location: \_\_\_\_\_  
Habitat: \_\_\_\_\_  
Collection method: \_\_\_\_\_  
Fish disposal: \_\_\_\_\_  
Collection crew: \_\_\_\_\_  
Additional comments: \_\_\_\_\_

**Mussel Release**

Release date: \_\_\_\_\_ Augmentation reach: \_\_\_\_\_ Drainage: \_\_\_\_\_  
State: \_\_\_\_\_ County: \_\_\_\_\_ UTM X/Lat: \_\_\_\_\_ UTM Y/Long: \_\_\_\_\_  
Site location: \_\_\_\_\_  
Habitat: \_\_\_\_\_  
Number released: \_\_\_\_\_ Age at release: \_\_\_\_\_ Size range: \_\_\_\_\_  
Mussel condition: \_\_\_\_\_  
Release method: \_\_\_\_\_  
Release crew: \_\_\_\_\_  
Additional comments: \_\_\_\_\_

**Appendix D. VDGIF protocol for collecting and holding freshwater mussels from waters infested with zebra or quagga (zebra) mussels.**

**Use of freshwater mussels from waters infested with zebra or quagga mussels, whether collected in Virginia or from another state, must be approved by VDGIF and conform to the protocols below.** A formal request to utilize such freshwater mussels must be made through your collection permit for review by the VDGIF Aquatic Permit Review Team. If approved, your permit will be amended and may include additional conditions. Any additional conditions will be determined on a permit-by-permit basis and will depend on the nature and scope of the work to be conducted.

*Collection of Freshwater Mussels:*

- 1) All freshwater mussels must be visually inspected on site and all attached zebra mussels must be removed by hand or by scraping and then discarded.
- 2) After visual inspection, all mussels must be hand-scrubbed on site (plastic bristled brushes, scrubbing pads, etc.) to remove any undetected zebra mussels.
- 3) Shell-damaged mussels (broken hinges, unnatural crevices, etc.) may not be collected.
- 4) All mussels must be uniquely tagged, either by clearly marking the periostricum or by attaching a Hallprint tag. This can be done on site or at the quarantine facility. However, all unionids from which zebra mussels were removed must be tagged on site and the tag must clearly distinguish these mussels from visually zebra mussel-free specimens.
- 5) All data including species, location, and tag numbers must be recorded on the attached data sheet. A separate data sheet must be completed for each species and must be received by Brian Watson (1132 Thomas Jefferson Rd., Forest, VA 24551; [brian.watson@dgif.virginia.gov](mailto:brian.watson@dgif.virginia.gov)) no later than 2 weeks after the quarantine procedure is initiated. A copy of a quad map (or equivalent) with the collection location and known zebra mussel population(s) also must accompany the data sheet(s). The permittee also must report the status of these mussels quarterly (Jan. 1, April 1, July 1, Oct. 1) for as long as the mussels are held at the indicated facility. Any change in disposition must be approved by VDGIF.
- 6) Collection should occur when the water temperature is below 50°F, if possible, to avoid the presence of veliger larvae.

*Transportation:*

- 1) If possible, scrubbed unionids should be held and transported in fish trucks with aerated, clean (zebra mussel-free) water.
- 2) If a fish truck is unavailable, scrubbed unionids should be transported in enclosed, water-free containers (coolers) and covered with moist burlap, towels, or a similar material. Chlorine-free ice should be placed on top of the moist material but not directly on the mussels.

- 3) If transported in enclosed containers with water, the water must come from a zebra mussel-free water body.

*Quarantine:*

- 1) All holding tanks or structures must be cleaned with a biodegradable detergent and must be completely dry for 24 hrs prior to use.
- 2) If after cleaning, the mussels are held in water of the water body from which they were collected, they must be rinsed with zebra mussel-free water under high-pressure prior to being quarantined. This must be done in an area that does not drain into an adjacent water body or into a water treatment facility, unless the rinse water is decontaminated with a 25 mg/L chlorine solution or a concentrated salt-water solution (½ cup salt per gallon) prior to discharge.
- 3) If zebra mussels were visible on any of the unionids or are known to occur within a 1-mile diameter of the collection site, all unionids must be quarantined for 45 days. If no zebra mussels were present on the unionids and zebra mussels are not known to occur within a 1-mile diameter of the collection site, all unionids must be quarantined for 30 days.
- 4) All unionids must be held in “closed” systems (i.e., recirculating). All quarantine systems must be described in the permit request and approved by VDGIF.
- 5) At the end of the quarantine period, all unionids must be hand inspected with a 4X-magnifying lens and direct light. A VDGIF biologist must be present during this inspection. If any zebra mussels are found, they must be removed and discarded, and all the unionids must be quarantined in cleaned tanks (see step 1) for a period double the original quarantine time (60 or 90 days). The contaminated tanks must be disinfected according to the procedures outlined in the section “Disinfection of Equipment”.
- 6) At the end of the 2<sup>nd</sup> quarantine period, all the unionids must again be inspected with a 4X-magnifying lens and direct light. A VDGIF biologist must be present during this inspection. If zebra mussels are found, these unionids may not be used for their intended purpose and must be sacrificed, unless otherwise specified by the state from which they were collected.
- 7) Unionids certified by VDGIF as zebra mussel free can be moved to “open” holding systems (i.e., flow-through systems, ponds). However, at no time may these unionids be placed in Virginia waters unless authorized by VDGIF.

*Disinfection of Equipment:*

- 1) All watercraft and related equipment (motors, trailer, etc.) used in the collection of unionids from zebra mussel infested waters, must be decontaminated by high-pressure wash with water heated to at least 140 degrees Fahrenheit and must remain completely dry for 48 hrs before use in non-infested waters. The cooling system of outboard motors must be thoroughly flushed with chlorinated tap water before the motor is used in non-

infested waters. Any vegetation attached to the boat, motor, trailer, etc. must be removed and left at the launch site.

- 2) All SCUBA or snorkel equipment must be sterilized with a 25 mg/L chlorine solution or a concentrated salt-water solution (1/2 cup per gallon). All equipment must be completely submerged for at least 1-2 minutes, rinsed, and then must remain completely dry for 48 hours before use.
- 3) All equipment used to clean unionids must be sterilized with a 25 mg/L chlorine solution or a concentrated salt-water solution (1/2 cup per gallon). This includes all brushes or any other devices. The cleaning equipment must be soaked in this solution for at least 1-2 minutes, rinsed, and then must remain completely dry for 48 hours before use.
- 4) All transport equipment must be sterilized with a 25 mg/L chlorine solution or a concentrated salt-water solution (1/2 cup per gallon). This includes transport containers, ice packs, mesh bags, burlap, aeration devices, etc. The items must remain completely submerged for at least 1-2 minutes, rinsed, and then must remain completely dry for 48 hours before use. Coolers, other large transport containers, and fish trucks can be sterilized during treatment of the transport water, if applicable. However, each should be thoroughly rinsed with one of the above solutions after the water is treated and discharged. These items also can be rinsed with a high-pressure wash with water heated to at least 140 degrees Fahrenheit, and must remain completely dry for 48 hrs prior to use.
- 5) Water used to transport and quarantine unionids must be decontaminated with a 25 mg/L chlorine solution or a concentrated salt-water solution (1/2 cup salt per gallon) prior to discharge. Discharge must be done in an area that does not drain into an adjacent water body or in an area that filters to a drain connected to a water treatment facility. The water does not have to be treated if it will be discharged into the water body from which the unionids were collected.
- 6) All quarantine equipment must be decontaminated with a 25 mg/L chlorine solution or a concentrated salt-water solution (1/2 cup salt per gallon). The equipment should be soaked in this solution for at least 1-2 minutes or thoroughly rinsed if too large to soak. Larger pieces of equipment also can be rinsed by high-pressure wash with water heated to at least 140 degrees Fahrenheit. All decontaminated quarantine equipment must remain completely dry for 48 hrs before use.
- 7) Any equipment used in the collection of unionids from out-of-state zebra mussel infested waters should follow that state's decontamination protocols. However, if any of the equipment will or may enter Virginia, it must be decontaminated according to VDGIF protocols. If representatives from any state will not adhere to VDGIF decontamination protocols, then no unionids may be collected from zebra mussel infested waters in said state.



**Appendix E. Data sheet for collection of mussels from waters infested with zebra or quagga mussels.**

**Collection of Freshwater Mussels from Waters  
Infested with Zebra or Quagga Mussels**

Species \_\_\_\_\_ Number Collected \_\_\_\_\_

Date \_\_\_\_\_ Water body \_\_\_\_\_

State \_\_\_\_\_ County \_\_\_\_\_

Descriptive Location \_\_\_\_\_

UTM\* \_\_\_\_\_

Lat/Long\* \_\_\_\_\_

Zebra Mussels Present \_\_\_\_\_ Number Removed \_\_\_\_\_

Quarantine Location \_\_\_\_\_

Holding Location \_\_\_\_\_

Collectors \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_