# Aquatic Survey Protocols

**for Transportation Projects within the State of Georgia**


## GEORGIA DEPARTMENT OF TRANSPORTATION

## Office of Environmental Services

**November 2018**

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# Section I.

# INTRODUCTION

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# I. DETERMINING THE NEED FOR AN AQUATIC SPECIES SURVEY

## A. Project Types/Activities Requiring an Aquatic Species Survey

In general, aquatic surveys should be considered when construction or maintenance activities require work within or will result in impacts to water resources where state or federally protected species may occur. These activities could include, but are not limited to, bridge replacement/demolition, culvert replacement or extension, installation of boat ramps, and installation of temporary construction structures (e.g. coffer dams, rock jetties, work bridges). Aquatic surveys should also be considered for activities that involve ground disturbance within stream buffers, but do not necessarily include work within the water. Maintenance activities that do not require access within the water, such as co-polymer overlay and superstructure painting, do not typically warrant an aquatic survey. Consult the Georgia Department of Transportation (GDOT) ecologist if questions arise as to whether a particular project or activity might necessitate an aquatic survey.

## B. Steps for Determining When an Aquatic Species Survey is Appropriate

The steps for determining the need for an initial aquatic survey are enumerated below. Guidance for determining the need for re-surveys follows.

### *1. Identify state and federally protected aquatic species potentially occurring within the project area from early coordination responses*

Prior to any aquatic surveys, early coordination shall be completed with the U.S. Fish and Wildlife Service (USFWS) and the Georgia Department of Natural Resources (GADNR) Wildlife Conservation Section (WCS) per the current process. A list of potential aquatic species for survey will be generated from the elemental occurrences of protected species identified in the early coordination responses. In addition, any aquatic species listed by the USFWS as potentially occurring within the Hydrologic Unit Code (HUC) 10 shall be included as a potential aquatic species for survey. Sub-consultants should coordinate with the Prime consultant to prevent duplication of early coordination requests for each project.

### *2. Assess the habitat suitability for species identified in Step 1*

The GDOT Office of Environmental Services (OES) or the Prime ecology consultant shall conduct a general resource survey and make determinations of habitat suitability for each protected species potentially occurring on the project; these determinations are documented in the Ecology Resource Survey Report (ERSR). Surveyors should be sure to assess habitat suitability well upstream and downstream of the project area. If suitable habitat is identified for any of the species compiled in Step 1, continue to Step 3 to determine if a survey is appropriate for those species. If suitable habitat is not identified within the environmental resource boundary, no aquatic survey is required.

3. ***For species with suitable habitat present within the project site, use the appropriate method to determine the need for an aquatic survey***

   Once a list of potential aquatic species for survey has been identified in the ERSR, the GDOT Aquatic Survey Determination Decision Tree (see below) shall be utilized for each state-listed species to determine if a survey is warranted. Use early coordination and/or communication with USFWS to determine if surveys are warranted for federally listed species. These resources shall be used to determine the target species for an aquatic survey. Keep in mind that aquatic surveys may be contingent on the protected species under consideration. For instance, in the context of a bridge replacement project, a survey may be necessary for mussels in order to determine presence and the subsequent need for relocation, while it may be appropriate to simply assume presence for fishes and implement special provisions. However, always consult with the assigned GDOT ecologist prior to assuming presence for a protected species as this may have design, schedule, and construction implications.

4. ***If appropriate, expand the survey to include other protected species***

   If it is determined a survey should be conducted for a species through the process outlined above, the target species for the survey shall then be expanded to include similar taxa (defined as either belonging to fish, crayfish, mussels, or snails) found within the project HUC 10. For example, if the above process indicates a survey is needed for a fish species identified in early coordination, only other protected fish species with suitable habitat and known occurrences from the project's HUC 10 may be surveyed for; although protected mussels may be present within the HUC 10, a mussel survey would not be appropriate in this instance since protected mussels were not identified in early coordination.

5. ***If needed, contact GADNR WCS and/or USFWS for technical assistance***

   At this stage, the surveyor may find it necessary to contact GADNR WCS and/or USFWS for technical assistance regarding, but not limited to, details such as project location, project impacts, methodologies, and/or length of the search area for a protected species survey. This is the appropriate time to discuss any potential deviations from this Protocol. The GDOT ecologist shall be copied on all correspondence with GADNR WCS and USFWS.

If an aquatic survey was previously conducted for a particular project and reach of an aquatic resource, a re-survey may be necessary depending on the findings from the initial survey and if changes to protected species lists have occurred. If the target protected species was observed during the initial survey, no re-survey is needed for ten years. If the target protected species was not observed during the initial aquatic survey, and the project Let date is four or more years away, one additional survey is required within two years of the project Let date. In the event there are multiple target species, please consult with the assigned GDOT ecologist to determine the need for re-survey as an additional survey may be contingent on a variety of factors (e.g. taxa involved, federal vs. state

protection, etc.). For example, it may be necessary to conduct a re-survey for mussels but not fish. Likewise, it may necessary to re-survey to determine the presence of a federally protected species. An additional survey may also be required if an aquatic species has been listed within the HUC 10 since the initial aquatic survey and suitable habitat is present. Re-survey efforts shall be coordinated with GDOT ecologist and the appropriate agencies. All re-surveys must follow the methods described in the most recently approved Protocol at the time of survey.

GDOT Aquatic Survey Determination Decision Tree
**For State Listed Species Only**
April 2018 Version

**Step 1:** Open http://georgiabiodiversity.org to identify species of concern known from the HUC 10 watershed of interest. Once you have navigated to a HUC 10 report, you may use the "Customize" feature to filter target taxa. When customizing, ensure that "with Georgia protection status", "show federal and Georgia protection status", "show link to range map", and "show link to species profile" options are all included in your customization.

a. *If state listed species are not documented from the HUC 10 watershed, then the project may proceed without a survey or special provisions for state listed species.*
b. *If state listed species are documented from the HUC 10 watershed, GDOT is encouraged to assume presence and develop special provisions to protect the species and associated habitat(s).*
c. *If state listed species are documented from the HUC 10 watershed and GDOT does not assume presence, proceed to Step 2.*

**Step 2:** Review the range map of each target species. Links to species range maps are provided in the search results generated during Step 1. Range maps should be assessed at the HUC 10 level.

a. *If state listed species are documented from the HUC 10 watershed within the last 10 years and GDOT does not assume presence, proceed to Step 3.*
b. *If state listed species are documented from the HUC 10 watershed, but not within the last 10 years, complete a survey following GDOT Aquatic Survey Protocol. Develop special provisions for species and suitable habitat that are detected during the survey.*

**Step 3:** Review the species profile of each target species. Assess life history needs and suitability of local habitat within the project area. It is possible to eliminate some species from consideration. For example, Alabama Shad are only known Gulf Slope mainstem rivers and can be excluded from consideration in tributary streams. Isolation by impoundment or **extreme** habitat degradation are other factors that may justify removing a species from consideration. Additionally, surveys are not required for the following species, and GDOT should contact GADNR for consultation before proceeding with the project: Upland Combshell, Southern Acornshell, Atlantic Sturgeon, Shortnose Sturgeon, Robust Redhorse, Sicklefin Redhorse in Brasstown Creek, and fishes in South Chickamauga Creek downstream of Graysville Dam.

a. *If suitable habitat is not present for state listed species documented from the HUC 10 watershed, the project may proceed without a survey or special provisions for state listed species. Please contact GADNR before removing species from consideration. Justification must be clearly documented within the ecology report.*
b. *If suitable habitat is present for any state listed species documented from the HUC 10 watershed, complete a survey. Develop special provisions for species and suitable habitat that are detected during the survey.*

**GADNR Contact:** Please email Nongame.Review@dnr.ga.gov with subject of "Aquatic Survey"

## C. Pre-Survey Coordination

Coordination must take place with OES and USFWS (when federally listed species are targeted; see Section II.B. *Permit Requirements* below) prior to the survey. This is an important step in determining whether appropriate survey techniques are being adhered to and/or ensuring that deviations from this Protocol will be accepted. Once target species have been identified for a potential survey using the steps outlined above, the surveyor shall provide the GDOT ecologist the following information electronically at least 10 business days prior to conducting any aquatic surveys (surveyors are encouraged to use the Pre-Survey Coordination Worksheet found in Appendix A to ensure a thorough submittal):

- Survey Justification: State the purpose of the survey, and provide a list of target species to be surveyed. Provide early coordination responses from GADNR WCS and USFWS, as well as the USFWS HUC 10 list(s) and the WCS Rare Natural Elements HUC 10 list(s).

- Survey Area Description: Provide a brief description of the aquatic resource(s) to be surveyed. The stream reach(es) and/or open waters proposed for survey should be graphically represented on a 7.5 minute USGS topographical map. Provide a description of the area where the stream(s) to be surveyed is located, including physiographic area, general topography, land use, and drainage basin. Also describe the resource features (substrate, flow velocity, presence of aquatic macrophytes/large woody debris, etc.) that provide potential suitable habitat for the target species.

- Methods: Provide a full text description of the equipment and procedures to be used; describe the method used to determine survey lengths; list the person(s) who will be conducting the field survey and provide a brief summary stating their affiliations, qualifications, and all valid permits; indicate the projected date(s) when the survey will be conducted; list the person(s) who will confirm all identifications and provide a brief summary of their affiliations and qualifications. Include descriptions and justifications for any deviations from the Protocol (include any correspondences as an attachment).

OES will provide a response within 10 business days approving, denying, or requesting augmentation of the survey; if no response is received from OES within 10 business days of submitting the survey request, approval of the survey can be assumed. Surveys and reports will not be accepted by OES if it is obvious that a survey was not warranted (e.g., conducted outside of the basin for a target species) and OES was not contacted. Conversely, if a survey report is insufficient because OES was not contacted, a second survey may be requested at the expense of the consultant. Surveys and reports may be accepted, however, if it is determined after conducting the survey that the waterbodies were within the expected range of a target species but the habitat was not deemed suitable for those species upon closer inspection.

If an environmental consultant has been contracted for an aquatic survey, but it is determined through the process outlined above that no survey is needed, the consultant shall contact the GDOT ecologist, who in turn will contact GADNR WCS, to determine if surveys could be conducted to help fill any data gaps of elemental occurrences in the area. This process, however, does not have to be complete in order to progress the project schedule (i.e., not an environmental commitment for a project).

### D. Preliminary Research

Prior to each aquatic survey, the surveyor must conduct a thorough review of available resources pertaining to the target species for each survey. Such resources include distributional maps, published journal articles, and subject matter experts who have experience with the relevant species or drainage area. Other resources include databases maintained by GADNR, The Nature Conservancy, and USFWS, as well as accredited museums. Relevant information to review should include: regional identification guides or characteristics determining identification, historical distribution and previous collection locations, recovery plans, habitat descriptions, life history (especially spawning seasons), and applicable Federal Register documents.

Adequate desktop review should be conducted when scoping an aquatic survey and every effort taken to estimate the resources required to conduct the survey. This includes, but is not limited to, determining drainage area and reviewing aerial and street view imagery. Reconnaissance or preliminary surveys (e.g. ecology resource surveys typically conducted by the Prime consultant) are necessary to assess the resources to be searched, determine areas of suitable habitat, determine if ambient conditions are suitable for surveying, and appropriately allocate gear/personnel for an aquatic survey.

## II. SURVEY PRE-REQUISITES

### A. Surveyor Qualifications

Personnel who will be conducting surveys must possess all state and federal permits for the species and basins in which surveys will be conducted. In addition, surveyors must be prequalified under GDOT Area Class 1.06(g) – Freshwater Aquatic Surveys. The lead surveyor will have sufficient knowledge within the basin in which the survey will be completed. This includes species-specific biological and ecological requirements, the ability to identify freshwater fish, mussel, crayfish, and/or snail species from the basin, and the ability to identify suitable habitat for fish, mussel, crayfish, and/or snail species. The lead surveyor will have sufficient experience, which includes documented field-time, and the ability to demonstrate skills in correctly executing survey methods and in locating and correctly identifying state and federally protected freshwater fish, mussel, crayfish, and/or snail species. Furthermore, the lead surveyor will be able to document experience in the safe care and handling of state and federally protected freshwater fish, mussel, crayfish, and/or snail species. Documentation of field-time and/or a letter of recommendation from an appropriate regional taxonomist regarding the surveyor's in-

basin experience and their knowledge in surveying, handling, and identifying freshwater fish, mussel, crayfish and snail species, including state and federally protected species, may be requested.

**B. Permit Requirements**

Prior to conducting any aquatic survey, the necessary scientific collecting permit from the Special Permit Unit of the GADNR Law Enforcement Division will be obtained and a copy of the valid permit be appended to the Aquatic Survey Report.

Additionally, prior to any survey where federally listed species could be captured or are targeted, a Section 10(a)(1)(A) recovery permit from the USFWS will be obtained and a copy of the valid permit be appended to the Aquatic Survey Report. Please note that any surveys targeting federally listed species require notification to USFWS at least 15 days prior to the survey, and a letter of approval from the USFWS Georgia Ecological Services (GAES) office must be obtained and carried with the surveyor during those surveys along with their federal permit in accordance with the Section 10 permit.

At least one authorized person listed on each permit must be present during all sampling activities. All conditions of state and federal sampling permits must be followed. Please note and comply with any specific requirements or methods set as permit conditions. If the guidelines identified in this document or the following protocols conflict with permitting conditions, the permit takes precedent over this guidance.

## III. SURVEY SEASON

See Section **II** for fish and crayfish survey protocols, Section **III** for mussel survey protocols, and Section **IV** for snail survey protocols.

Survey seasons for aquatic taxa are as follows:

Fish and crayfish: April 30 – November 30
Mussels and Snails: Year-round

Consultation with USFWS and/or GADNR is required to conduct fish and crayfish surveys outside the accepted survey season; the GDOT ecologist shall be copied on any such request. A request to survey outside of the accepted survey season must also include an adequate justification for why the request is being made and is appropriate.

Generally, surveys should only occur when it is safe for surveyors to enter the water. Surveyors should use best professional judgement to determine when to begin and conclude surveys. For surveyor safety and efficacy, all aquatic surveys must occur when ambient air/water temperatures and water levels/velocity permit safe entry into the stream (see taxa survey protocols for specific temperature thresholds).

Prior to conducting a survey, precipitation data and the closest relevant USGS gage station data will be reviewed to determine hindering factors (weather conditions, increased flow) that could affect collecting conditions (i.e., turbidity, temperature, etc.). If gage stations are

not available, every attempt will be made to determine the condition of the stream before the survey is executed to ensure conditions are appropriate for surveying. This may include contacting the local GADNR, USFWS, or other related natural resource offices.

## IV. DETERMINING SURVEY LENGTH/PRESCRIBED SEARCH AREA (PSA)

Minimum survey lengths in this Protocol, defined as the prescribed search area (PSA), were adopted from mussel field-testing survey sites in Georgia, Florida, and Alabama with the use of species-area curves, and correlating to National Water Quality Assessment (NAWQA) protocol standards, and the range of survey length suggestions from field malacologists. To provide consistency, the PSA for all aquatic taxa shall be the same.

In wadeable streams, a survey length of 100 m (~325 ft) upstream and 300 m (~985 ft) downstream of the proposed area of impact will be used as a minimum length. In non-wadeable streams, minimum survey lengths will be site-specific and survey methodology should be developed in conjunction with OES, GADNR, and USFWS (if applicable). Wadeable streams are defined as those reaches where the mid-channel depth of 75% of the entire PSA is ≤1.5 meters at the time of sampling. Non-wadeable streams are defined as those reaches where >25% of the mid-channel depth of the entire PSA is ≥ 1.5 meters.

To fully encompass all microhabitats within the stream, the minimum survey lengths must incorporate suitable habitat(s) for the target species, such as gravel and cobble substrate, islands, sand bars, muddy sand substrates around tree roots, sand/limestone, and pools/riffle/run complexes, etc. If suitable habitat(s) for a target species is not included in the minimum length, the surveyor should extend the PSA, within reason (~50 m), to locate and search suitable habitat(s). Surveyors must also survey any unique aquatic habitats that may be just outside of the PSA. If a suitable habitat type (specific to the target species of interest) occurs just outside (~50 m) of the required survey length, the PSA should be extended to include that habitat type. Additionally, if the surveyor determines the PSA does not encompass all direct/indirect impacts associated with the project, they should extend lengths as necessary. Conversely, if large reaches of clearly unsuitable habitat fall within the PSA (e.g. impoundments, riprap lined channels) or suitable habitat(s) cannot be located for the target species within or beyond a reasonable distance outside of the PSA, surveyors are not required to survey that reach/waterbody, as long as the rationale for omission from the survey is clearly documented and thorough explanation is provided as to why the habitat(s) were not suitable for the target species. If omitting large sections of the PSA due to lack of suitable habitat(s), it is encouraged to survey additional stream channel to meet the minimum survey length. Desktop reconnaissance and/or prior consultation with the GDOT ecologist is highly recommended, however, to confirm no survey is needed within a particular reach.

If the survey is conducted to determine if protected aquatic fauna would be impacted by projects that do not involve linear stream crossings, the PSA must encompass the stream reach that may sustain cumulative impacts from a project, in addition to the minimum distance upstream and downstream of the project site, or as modified in conjunction with OES, GADNR, and USFWS (if applicable).

## V. SURVEY CONSIDERATIONS

Landowner permission will be obtained, as necessary, to access each bridge or culvert crossing area prior to sampling. Prior to surveying, the local GADNR wildlife office will be contacted and informed of proposed activities as stipulated in the state permit. If appropriate, local law enforcement officers will also be notified.

Additional consideration should be given to prevent the spread or introduction of non-indigenous species while conducting surveys. Before moving between basins, all gear, including, but not limited to, waders, boots, wetsuits, collecting bags, boats and trailers, must be washed, sanitized, and dried and deemed free of mud and aquatic plants. Boats and trailers must also be scrubbed and washed down with chlorine bleach, and live wells must be emptied over dry land or in the basin where the water was collected, especially when they have been in basins where zebra mussels (*Dreissena polymorpha*) or quagga mussels (*Dreissena bugensis*) have been detected.

Special care should be exercised when working in streams in the southern part of the state so that non-native apple snails (*Pomacea insularum*) are not introduced to other basins. This should be of particular concern when working in the Satilla, St. Mary's, Suwannee, and the Ochlockonee River basins.

Visit the USFWS's Aquatic Nuisance Species Task Force website for additional information. Sightings of invasive aquatics can be submitted to USGS via their Nonindigenous Aquatic Species website or mobile app.

## VI. POST-SURVEY DELIVERABLES

***Written Results***

Within two weeks after completing the aquatic survey, a table or spreadsheet quantifying the number and variety of species collected shall be provided to the GDOT ecologist. Verbal communication of the survey results is also encouraged, but not required.

***Aquatic Survey Report***

Electronically submit one full color draft copy of the Aquatic Survey Report for comments and corrections via the OES FTP site. Submit revised drafts as necessary. Requirements of the Aquatic Survey Report can be found on the OES Sharepoint site.

***Additional Copies of Reports***

Once reviews are complete, submit electronic copies of the final Aquatic Survey Report for distribution (via OES FTP and/or email) to the appropriate agencies and any other entities as required by the State and/or Federal permits.

If not included within the GDOT ERSR or Assessment of Effects Report, Aquatic Survey Reports must be sent to the following email addresses with the subject line "GDOT Aquatic Survey Report, PI No. XXXXXXX":

- U.S. Fish and Wildlife Service, Georgia Ecological Services (gaes_assistance@fws.gov)
- Georgia Department of Natural Resources (Nongame.Review@dnr.ga.gov)

Reports of mussel surveys conducted in Georgia within the Apalachicola-Chattahoochee-Flint, Ochlockonee, and Suwannee River basins, and in Florida must also be sent to:

- U.S. Fish and Wildlife Service, Panama City Field Office (panamacity@fws.gov)

# Section II.

# FISH AND CRAYFISH SURVEY PROTOCOLS

November 2018

# FRESHWATER FISH AND CRAYFISH SURVEY PROTOCOLS FOR TRANSPORTATION PROJECTS WITHIN THE STATE OF GEORGIA


Georgia Department of Transportation,
Office of Environmental Services

November 2018

Jeffrey Garnett, Chris Goodson, and Matt Carroll

The following protocols are solely intended to instruct surveys related to transportation improvement projects within the State of Georgia. These protocols have been reviewed by USFWS, Georgia Ecological Services Field Offices and GADNR, Wildlife Conservation Section and deemed appropriate for assessing the likelihood of species presence in the area surveyed by GDOT or their designated agent.

The survey season for fish and crayfish is April 30 – November 30 when water temperatures are above 50°F. See Section **I**.III regarding survey season details.

## I. FISH SURVEY METHODOLOGY

### A. <u>Wadeable Streams</u>

OES recognizes three primary methods for surveying wadeable streams in Georgia: seine hauling, kick-seining, and backpack electrofishing. These methods are described in detail below.

***Seine Hauling***

Seine hauling is generally executed by two individuals pulling a seine through the water. This technique is most effective in slower-moving waters, such as pools, deeper runs, and gently-sloping stream edges that are free of large obstructions. Surveys will be conducted with a 6-20 foot long by 4-6 foot deep seine having 1/8-1/4 inch mesh. The length and mesh size of the seine used will be appropriate for the size of the stream and target species to be surveyed.

***Kick-seining***

Kick-seining is an effective technique for surveying areas of swift flow, such as riffles and fast runs. In this method, the seine is held stationary, perpendicular to stream flow, by two individuals. A third individual, working in a downstream direction, drives fish into the seine by disturbing the substrate upstream of the seine. An electrofisher may also be used (where permitted) to drive fish into the seine (see below). As with seine hauling, kick-seining will be conducted with a 6-20 foot long by 4-6 foot deep seine having 1/8-1/4 inch mesh.

***Backpack Electrofishing****

Backpack electrofishing is an effective collection method in areas of slow to moderate stream flow, around obstructions (large woody debris, boulders), and in areas that are inaccessible with a seine (under root mats and undercut stream banks). In this method, an individual operating the electrofisher intermittently applies power to the electrofishing probe while slowly moving upstream, covering all microhabitats. Electrofishing equipment shall be used to elicit fright or narcosis only, not tetany, and when used, shall be configured at minimal wattage levels to minimize harm. Additionally, an effort should be made to minimize total shocking time in order to

minimize harm to all aquatic animals in the survey reach. In waters with no or minimal flows, at least one individual, preferably two, should follow alongside and behind the electrofisher operator to collect stunned fish with a dip net. In areas with increased flows (riffles or higher flows around woody debris), surveys should occur in a similar manner to kick-seining by using an electrofisher to drive fish downstream into a set seine. These areas should be sampled in seine sets that cover approximately 2x2 m to 5x5 m, depending on seine size and personnel.

A combination of the survey methods may be utilized in order to adequately survey the entire length of the stream reach and the variety of microhabitats found within. Regardless of method(s) used, the survey should occur in an upstream direction to minimize turbidity in reaches yet to be surveyed.

Seining and backpack electrofishing will be the principal collection methods for wadeable streams; species and site specific methods may be utilized as allowed by the surveyor's state and federal permits including, but not limited to, daytime/nighttime snorkeling and dip netting without an electrofisher in densely vegetated habitats. It is highly recommended to consult with OES, USFWS, and GADNR prior to using an alternate survey method.

*Electrofishing is not permitted unless it is clearly allowed by state and federal collection permit conditions. Furthermore, some areas within the state contain sensitive species where electrofishing is discouraged or prohibited. Therefore, pre-survey coordination with OES, USFWS, and GADNR, as outlined in Section **I**.I.C., is necessary to establish appropriate survey methods, minimize duplication of survey efforts with ongoing research projects, and minimize harm to highly sensitive species.

In areas where there is a high probability of collecting a state or federally protected mussel species or protected benthic fish species, use of any electroshocking equipment should be kept to a minimum. Consult the survey recommendations found within the GADNR rare fish species profiles should questions arise concerning gear selection.

**B. Non-wadeable Streams**

Please consult the GDOT ecologist, who in turn will contact USFWS and/or GADNR, to discuss suitable survey methods in non-wadeable streams. Survey methods for fish and/or crayfish in non-wadeable streams will be determined on an as-needed basis.

**C. Fish Handling**

If collected fishes must be held temporarily during survey efforts, they must be kept in containers with flowing water (i.e., aerated holding bucket, submerged seine, live well). If an aerated bucket is used, the bucket shall be kept cool (out of direct sun) and clean (e.g., did not previously contain formalin or other preservatives or toxins) and shall

contain species of similar sizes and not contain individuals or species that could harm or consume others (e.g., crayfish or other predatory fish species). Holding shall be limited to 30 minutes. Water changes should occur to minimize stress to individuals if temperatures become elevated. Captured fish shall be released as close as possible to the point of capture. They shall be released by hand or container at the substrate level to avoid higher risk of predation and allowed to swim under their own power from the container to the substrate.

## II. CRAYFISH SURVEY PROTOCOLS

### A. Stream Crayfishes

Stream-dwelling crayfishes may be surveyed for in the same manner as fish in wadeable streams using either kick-seining, backpack electrofishing, or a combination of both. If a stream reach is to be surveyed for both fish and crayfish, the surveys may occur concurrently. Since most stream-dwelling crayfishes are nocturnal and reside in shallow burrows under stream substrates (e.g. cobble, boulders, woody debris), an effort should be made to overturn or disturb these features to flush crayfishes out for capture. Snorkel surveys or setting overnight traps may be acceptable with prior consent from OES.

### B. Burrowing Crayfishes

Surveying for burrowing crayfishes can be time-intensive and highly-invasive. If within the predicted range of burrowing crayfishes and suitable habitat exists, the presence of crayfish burrows along stream banks and/or within the floodplain will act as a surrogate for species presence. The abundance of burrows should be qualified as either absent, present (scattered burrows observed), or extensive (many burrows easily observed within a small area). Excavating burrows is not permitted without the consent of the GDOT ecologist, GADNR, and USFWS (if applicable).

### C. Crayfish Handling

If collected crayfishes must be held temporarily during survey efforts, they must be kept in containers with flowing water (i.e., aerated holding bucket, submerged seine, live well). If an aerated bucket is used, the bucket shall be kept cool (out of direct sun) and clean (e.g., did not previously contain formalin or other preservatives or toxins) and shall contain no more than 5 individuals and should not be held in the same container as any fish. Captured crayfishes shall be released as close as possible to the point of capture.

## III. SURVEY EFFORT

The amount of survey effort and gear should be appropriate for the size of the stream to be surveyed. A survey team is comprised of a minimum of two individuals when using a backpack electrofisher (one operating the electrofisher, and one individual with a net and collection bucket), or a minimum of three individuals while operating a seine (two

individuals holding the seine, and one individual driving fish into the seine). In larger streams (average width ≥ 5 m), the survey team shall include at least three people. A barge electrofisher may also be used to sample larger streams; when using a barge, two netters must accompany each electrofishing probe and an individual to guide the barge is needed. In streams with an average width ≤ 30 m, only one survey team is required. Streams with an average width > 30 m shall utilize at least two survey teams or the use of a barge electrofisher. An additional survey team may be utilized to expedite the survey.

When two survey teams are utilized, each team will survey an area ranging from one side of the stream bank to the center of the stream, so that each team surveys approximately one-half of the total stream area. When three survey teams are employed, each team will survey approximately one-third of the stream width. If a barge electrofisher is used, an appropriate number of electrofishing probes to adequately survey the entire width of the stream is needed.

The entire length of survey reach, including all microhabitats, will be surveyed, beginning at the most downstream end of the reach and progressing upstream in a zig-zag pattern to cover the entirety of the stream. If suitable habitat for a target species is clearly not present within sections of the survey reach, a survey will not be required in those sections; non-survey of particular habitats and stream reaches will be clearly noted within the survey report. Please be cognizant, however, that standard survey techniques may drive fish from habitats that might be considered suitable into adjacent, less suitable habitats (e.g. riffle-dwelling darters being driven into pools); climatic conditions, such as drought, and lower than normal flow regimes may also cause shifts in habitat utilization as riffle-dwelling species may seek thermal refuge in runs and pools.

## IV. SPECIES IDENTIFICATION AND DATA COLLECTION

### A. Data Collection

Information relevant to the survey site will be collected and recorded on the field data form in Appendix B. Of particular importance are water quality parameters (water temperature, stream flow, turbidity, pH, conductivity, etc.) and instream features. Locations of suitable habitats should be shown in the sketch map and the level of suitability for the species being surveyed for should be indicated (marginal, suitable, or preferred). See Appendix D for an example sketch map. If surveys for fishes, crayfishes, mussels, and/or snails are also conducted, indicate how much time was spent during the survey for each in the Notes section on the field data form.

All fish and crayfish collected, both with and without protection status, shall be enumerated and recorded on field data sheets. Field data sheets for fish and crayfish surveys are located in Appendix B. Data sheets will be completed for all streams surveyed for target species. Data sheets will also be completed for perennial streams within the project corridor that were assessed for habitat and not surveyed because it was determined to not contain suitable habitat for target species. If surveys are not performed

because the determination is made onsite that suitable habitat does not exist in the stream for the target species, the surveyor will document the justification for not conducting the survey by completing a data sheet which will be included along with a detailed discussion in the subsequent aquatic survey report.

**B. Photo Vouchers**

A representative color photograph will be taken of each fish species observed during the survey. Photographs will be of good quality; sufficient to show the important diagnostic characteristics necessary to differentiate between species of similar appearance. It is recommended that these photographs be taken of the live fish while it is held in a viewing tank designed for fish photography. The viewing tank should be filled with site water, and photographs should be taken streamside.

At least three representative color photographs will be taken of each crayfish species observed during the survey. For each species, a photograph will be taken of the chela from a dorsal perspective and one photograph of the entire carapace, also from the dorsal perspective. An additional photo of the carapace will be taken from the side. All photographs should be taken as close as possible while still maintaining sharp focus and encompassing the entire chela or carapace.

Voucher specimens may be taken for any questionable identifications in accordance with the surveyor's state and federal permit(s). Any voucher specimens or mortalities of rare species should be incorporated into the research collection of fishes at an accredited state school or the Georgia Museum of Natural History. Voucher specimens are not required.

# Section III.

# MUSSEL SURVEY PROTOCOL

November 2018

# FRESHWATER MUSSEL SURVEY PROTOCOLS FOR TRANSPORTATION PROJECTS WITHIN THE STATE OF GEORGIA

Georgia Department of Natural Resources,
Wildlife Resources Division

Georgia Department of Transportation,
Office of Environmental Services

November 2018

Jason Wisniewski, Jeffrey Garnett, Chris Goodson, and Matt Carroll

## ABSTRACT

Within the Southeastern Atlantic Slope and Northeastern Gulf Drainages of Florida and Georgia, the U.S. Fish and Wildlife Service (USFWS) identified a need for a standardized mussel survey protocol that could be used across physiographic provinces. In 2008, USFWS and the Georgia Department of Transportation (GDOT) worked cooperatively to develop the *Freshwater Mussel Survey Protocol for the Southeastern Atlantic Slope and Northeastern Gulf Drainages in Florida and Georgia* (2008 Protocol) to fulfill the dual objectives of USFWS and GDOT. The 2008 Protocol was designed to serve as a tool to qualitatively determine if federally protected species (endangered, threatened, or proposed) or candidate species are present within an area. The 2008 Protocol has ensured a level of consistency and comparability among surveys. It established minimum qualifications of surveyors, discussed permit requirements, suggested preliminary research needs, detailed a standard operating procedure for qualitative surveys, and provided guidance for deliverables.

The following protocol, *Freshwater Mussel Survey Protocols for Transportation Projects within the State of Georgia*, is largely adapted from the 2008 Protocol, however it includes modifications that provide more precise application of the sampling methods for wadeable and non-wadeable streams and provides a measure of uncertainty in the presence/absence of state and federally protected freshwater mussel species at a project site. Additionally, the following protocol is solely intended to instruct surveys related to transportation improvement projects within the State of Georgia. These protocols have been reviewed by USFWS, Georgia Ecological Services Field Offices and deemed appropriate for assessing the likelihood of species presence in the area surveyed by GDOT or their designated agent.

## I. INTRODUCTION

The Endangered Species Act (ESA) requires consultation with USFWS for activities that are authorized, funded, or carried out by a Federal agency that may affect federally protected species or critical habitat. USFWS consults with many local, State, and Federal agencies, as well as private entities, regarding the conservation and protection of federally protected species. The role of USFWS in coordinating with various entities in order to protect listed and proposed freshwater mussels has significantly increased as instream construction, maintenance, and relicensing of new and existing structures has become more commonplace. Therefore, a Protocol entitled *Freshwater Mussel Survey Protocol for the Southeastern Atlantic Slope and Northeastern Gulf Drainages in Florida and Georgia* (2008 Protocol) was developed beginning in 2004, and published in 2008, to provide standard operating procedures for establishing the presence/absence of federally listed, proposed, or candidate species within a project area and documenting potential impact(s) of projects on these species,

as well as ensuring that the most conservative measures are being taken to protect these species.

The need for the 2008 Protocol stemmed from increasing impacts to streams in the Southeast due to urban expansion, development, and highway construction, as well as the need for a reporting framework to ensure quality data are collected. It was intended to be used for surveys that determine the presence/absence of federally protected and candidate mussels, their communities, and/or the impacts to these mussels that would occur as the result of highway construction, impoundments, pipeline crossings, dredging, channelization, and riparian land-use practices. These activities can alter stream characteristics, causing sediment accumulation, loss of suitable habitat, stagnation, accumulation of pollutants, and eutrophication in the immediate area, and for an unknown distance downstream of the proposed project. The 2008 Protocol was also intended for use in conducting freshwater mussel status surveys on private, public, or other conservation lands that are funded, permitted, or requested by the USFWS.

In preparation of the 2008 Protocol, an exhaustive literature search was completed, and freshwater malacologists throughout the Southeast region were interviewed. Three proposed methods of determining Prescribed Search Area (PSA; status quo, minimum lengths, and multiplier) were originally presented at the Coosa Summit meeting in Rome, Georgia on February 4-6, 2003, and in poster format at the 2003 Freshwater Mollusk Conservation Symposium in Durham, North Carolina on March 16-19, 2003 (Carlson et al. 2003). As comments were received, the status quo option was omitted from further consideration based on review of the compiled survey reports from the GDOT (Carlson et al. 2003). The GDOT survey reports indicated that relying exclusively on best professional judgment (as reported in the status quo option) did not produce consistent survey methods in the past. The multiplier method was omitted during the field-testing phase, as it became clear that this method would not be feasible due to the large PSA that would need to be surveyed in large streams and rivers. The minimum length method was consistently chosen as the preferred method by environmental consultants versus the multiplier factor when given the option between the two methods. The actual distances to be surveyed for the minimum length method were finalized after the completion of field-testing in September 2007.

There is an inherent difficulty in creating a standardized freshwater mussel protocol, as surveying efforts for presence/absence of state and federally protected and candidate species is site-specific, and stream types and sizes vary across ecoregions. Establishing survey methods to determine PSAs is also difficult because PSAs are directly linked to project and site-specific impacts. The length of the PSA must be established in relation to the cumulative impacts, both upstream and downstream of the project site. These project-specific impacts

were difficult to ascertain without the use of complex models that may not factor variables (e.g., habitat types) also needed to determine PSAs specifically for freshwater mussels. In order to devise a mussel survey protocol without including the use of a model to determine impact distances, the 2008 Protocol focused on establishing PSAs based on a method that would provide conservative search distances. This method established a PSA that focused on including a range of mussel habitats indicative of a targeted stream and assumed that the representative mussel species should also be found in these habitats. Specifically, the PSA lengths must include a range of appropriate mussel habitats to search for a targeted stream type and a high proportion of the potential impacts (i.e., increased sedimentation and altered flow rates) from the specific project.

Qualitative mussel sampling methods typically provide detection/non-detection data and may provide relative abundance and species diversity. Qualitative surveys are demonstrated to produce more robust species lists, especially when the presence of a rare species is in question (Vaughn et al. 1997, Strayer and Smith 2003). However, qualitative survey methods fail to estimate and account for incomplete detection (i.e. probability of not collecting a species when present) and thus may provide biased estimates of species occurrence. Various biotic and abiotic factors may influence mussel detection including but not limited to, species, brooding period, animal length, population density, searcher experience, stream, stream size, physical habitat conditions, stream stage, water and air temperature, and survey effort (Meador et al. 2011, Wisniewski et al. 2013, Wisniewski et al. 2014). Average estimated detection probabilities among 13 species in the Flint River Basin of Georgia ranged from 0.26-0.96 with detection of federally listed species ranging from 0.54-0.71 (Peterson et al. 2010). On average, species detection during complete coverage surveys was 22% greater than qualitative surveys consisting of 30, 1-meter wide lateral transects across wadeable stream channels (Peterson et al. 2011). Species detection in non-wadeable streams in the Flint River Basin ranged from 0.01-0.69 with detection of federally listed species ranging from 0.01-0.40 when 1, 10-meter long X 1-meter wide transect was searched (Wisniewski et al. 2014). Cumulative detection probability among all species collected in the Flint River when sampling 10 transects was 0.96 and 0.99 for the federally threatened *Elliptoideus sloatianus* and federally endangered *Amblema neislerii*, respectively (Wisniewski et al. 2014). Cumulative detection of *Hamiota subangulata, Pleurobema pyriforme*, and *Medionidus penicillatus* was 0.07 but these species have rarely been reported from non-wadeable reaches of the Flint River over the past century (Wisniewski et al. 2014; Wisniewski 2015). Similar multi-observer approaches have been used in other watersheds in Georgia including the Altamaha Basin (Meador 2008), Tennessee Basin (Wisniewski 2014) and Upper Coosa Basin (in progress). Meador (2008) utilized 10, 1-meter wide lateral transects per site in the Altamaha River whereas the Tennessee Basin and Coosa Basin surveys utilized multiple independent observers searching for 1 person-hour at each site. Although producing detection probabilities comparable to fixed area random transects, the multiple independent observer methodology allows greater

flexibility in sampling but may be less consistent than random transects. Hence, the 2008 Protocol has been adapted here to employ a multiple independent observer methodology to facilitate the documentation of species occurrence while accounting for incomplete detection, which will better inform inferences regarding the potential presence/absence of species of concern and provide a level of confidence in this estimate. For this protocol, the purpose of conducting qualitative surveys is to provide resource agencies with presence/absence data, assemblage richness, and an indication of relative abundances and recruitments. Therefore, the following protocol employs the multiple independent observer method.

A standardized survey is important in creating comparable and consistent survey efforts. The methods outlined in this protocol were created to be specific. This protocol is a dynamic document subject to change and will be updated as relevant data become available. Specific survey methods for the 2008 Protocol were originally field-tested from 2004 through 2007 for feasibility and applicability in determining the presence/absence of federally protected and candidate mussel species within a potential project area. However, after 10 years since the implementation, several improvements to the 2008 Protocol have been suggested. For instance, the 2008 Protocol provided a PSA in which searching should occur but the survey reports indicated that the PSA was not completely searched due to the impracticality of searching such a large sampling area. For this reason, sampling efforts varied greatly among projects, stream sizes, and contractors conducting sampling. Additional research completed from 2008 through 2016 provided insight into modifications of the 2008 Protocol that will improve the feasibility and applicability of the following protocol. These modifications will allow for more precise application of the sampling methods for wadeable and non-wadeable streams as well as providing a measure of uncertainty in the presence/absence of freshwater mussel species at a project site. In addition, these improvements should greatly simplify and standardize cost estimates associated with the bidding process for these projects. Lastly, these modifications will allow us to further investigate the ability to detect rare species during sampling which will aid in the future refinement of this protocol.

Although the 2008 Protocol outlined specific methods for conducting mussel surveys at GDOT project sites, it was intended to serve as a guideline for other mussel surveys that are requested or funded by USFWS (e.g., land development proposals and dam relicensing). The following protocols, however, are solely intended to instruct surveys for state and federally protected mussels related to transportation improvement projects within the State of Georgia. These protocols have been reviewed by USFWS, Georgia Ecological Services Field Offices and deemed appropriate for assessing the likelihood of species presence in the area surveyed by GDOT or their designated agent.

Goals

1) Provide standardized procedures and recommendations for survey methods used to determine presence/absence of state and federally listed mussel species.
2) Provide standardized procedures and recommendations for mussel surveys when additional quantitative information is necessary to determine project impacts on endangered, threatened, or proposed mussel species within the project area and provide an understanding of the level of effort needed for relocating mussels, if necessary for the project.
3) Provide comparable and consistent mussel survey methods, which will also allow for expanding the mussel survey Geographic Information Systems (GIS) database and updating protocol procedures.
4) Assist with statewide population monitoring and assessment efforts.

## II. STANDARD OPERATING PROCEDURES

### A. Survey Methods

All surveys can be completed at any time during the year, but must be conducted when the summed air and water temperatures at the site exceed 100ºF (38°C). The GDOT ecologist, GADNR, and USFWS (if applicable) must be contacted if surveys are proposed to be conducted at temperatures lower than this. Additionally, disturbing these non-thermoregulators during cold air and water temperatures could cause wet tissue to freeze when exposed to air and/or increase vulnerability to predation or to being swept downstream due to slower re-anchoring capabilities.

***Wadeable Streams***

At wadeable streams (≥75% of the survey reach at a depth ≤ 1.5 m), the PSA (see Section A) shall be divided into 8 50-meter long segments with 2 segments located upstream of the proposed project and 6 segments located downstream of the proposed project. For streams with an average width ≤ 15 m, each of the 8 segments shall be surveyed by a minimum of 3 searchers for a minimum of 1 person(p)-hour (i.e. 3 searchers X 20 minutes = 1 p-hour; 5 searchers X 12 minutes = 1 p-hour) to reduce surveyor bias. Streams with an average width > 15 m shall be surveyed for a minimum of 2 p-hours per segment (i.e. 3 searchers X 40 minutes = 2 p-hours; 5 searchers X 24 minutes = 2 p-hours) in order to adequately sample all suitable habitat. Each searcher must carefully search all habitats using tactile and visual search within each segment of the PSA. Searchers should not overlap search areas in order to ensure independence of searches. The PSA should begin outside of any disturbance areas (i.e. scour pools, culvert bottoms, etc.). However the disturbance areas should be searched using the same approach as used in each segment. All surveying must be conducted from the downstream reach to the upstream reach to minimize potential increases in searcher

induced turbidity. All animals collected should be retained by the individual searcher that collected them.

***Non-wadeable Streams***

At non-wadeable streams (≥25% of the survey reach at a depth ≥ 1.5 m), the PSA shall be divided into 50-meter long segments with 25% of the search area located upstream of the proposed project and 75% of the search located downstream of the proposed project. The PSA will be determined on a case-by-case basis that will be site-specific and take the project activity into account. Each of the 50-meter segments shall be surveyed by a minimum of 3 searchers for a minimum of 2 person-hours (i.e. 3 searchers X 40 minutes = 2 p-hours; 5 searchers X 24 minutes = 2 p-hours) to reduce surveyor bias. Each searcher must carefully search all habitats, from bank to bank, using tactile and visual searches within each segment of the PSA. Searchers should not overlap search areas in order to ensure independence of searches. The PSA should begin outside of any disturbance areas (i.e. scour pools, culvert bottoms, etc.). However the disturbance areas should be searched using the same approach as used in each segment. All surveying must be conducted from the downstream reach to the upstream reach to minimize potential increases in searcher induced turbidity. All animals collected should be retained by the individual searcher that collected them.

The survey should begin by conducting a visual search to examine dead shells along stream shorelines and all exposed areas. The visual search on the bank(s) should be conducted in addition to a tactile (hand-grubbing 1-2 inches into substrate to increase detection of more deeply buried mussels) search and, if possible, visual search for individuals within the water. For tactile and visual searches within the stream channel, searchers should be spaced equidistant across the stream channel and slowly move upstream in longitudinal transects; if a substantial amount of space exists between them, searchers should progress upstream in in a zig-zag pattern to cover a larger area (Figure 1). These should be used in conjunction with the following techniques: 1) for areas less than 1.5 meters in depth, mask and snorkel combined with tactile search should be used. In some streams, mask and snorkel is not appropriate and/or feasible due to turbid conditions and extreme low flows, in which case, only tactile searches would be sufficient. The use of view buckets may be appropriate when visibility permits; 2) for areas greater than 1.5 meters in depth, SCUBA diving or surface supplied air equipment should be used (divers must follow all applicable safety regulations).

Habitat conditions may change within a given area of stream over time and therefore mussel species may be found in unsuitable habitats during surveys. Given the ephemeral and dynamic nature of freshwater mussel habitat, the entire PSA must be surveyed, not just the presumed suitable habitat areas within it.

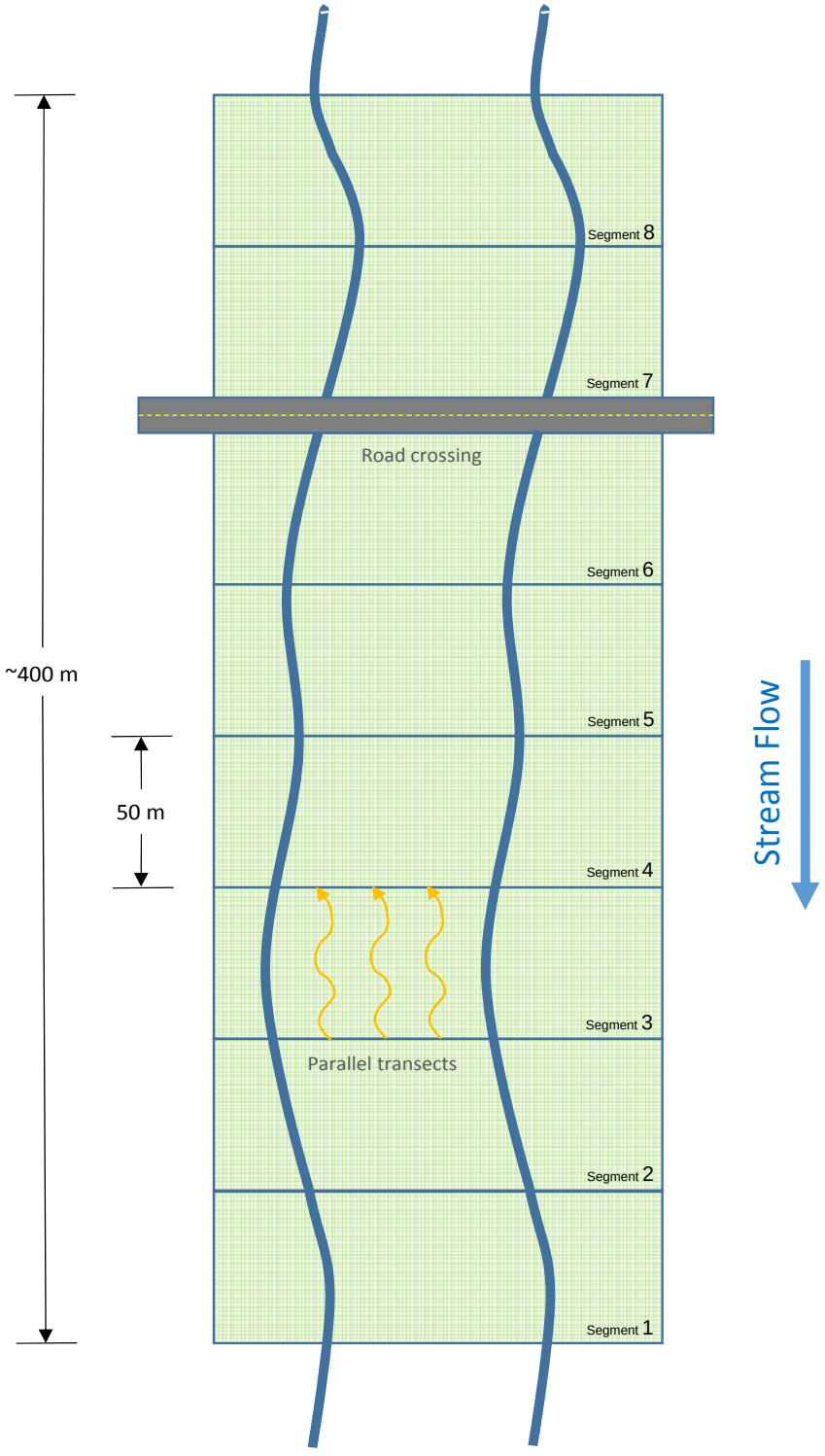


**Figure 1.** Illustration of mussel sampling methodology depicting eight 50 m survey segments, totaling approximately 400 m of survey area (300 m downstream and 100 m upstream of the project area). Note the parallel transects moving in an upstream fashion within the survey segment.

## B. Mussel Handling

Collected mussels awaiting identification and data collection shall be temporarily held in mesh bags suspended in the stream; mussels may be held dry in a container if wrapped in a wetted towel and indirectly on ice. Specimens may be held for up to 3 hours provided that they are held in the stream in bags that allow free movement of water the mussels were taken from or, if dry, out of the direct sun.

All mussels shall be returned to the point of capture and hand placed with their anterior ends in the substrate and posterior end exposed to the water with siphon facing upstream. The substrate must be loosened and each mussel carefully embedded to avoid damaging internal tissues. No live specimens may be removed from the site unless authorized.

## C. Species Identification and Data Collection

### *Data Collection*

Information relevant to the survey site will be collected and recorded on the field data form in Appendix B. Of particular importance are water quality parameters (water temperature, stream flow, turbidity, pH, conductivity, etc.) and instream features. Locations of suitable habitats should be shown in the sketch map and indicate the level of suitability for the species being surveyed for (marginal, suitable, or preferred). See Appendix D for an example sketch map. If surveys for fishes, crayfishes, and/or snails are also conducted, indicate how much time was spent during the survey for each in the Notes section on the field data form.

At the conclusion of searching each 50-meter segment, the collections of each searcher should be separately processed and recorded. Segments shall be numbered sequentially beginning with "Segment 1" as the downstream most segment within the PSA. Each searcher should sort and identify each mussel and count the number of individuals of each species collected. All federally listed mussels shall be measured, as well as the smallest and largest individuals of each non-listed species. Mussels shall be measured with calipers to the nearest 1 mm in length across the longest axis parallel to the hingeline of each mussel (Figure 2). This data is recorded separately for each searcher in the survey crew for each 50-meter segment within the PSA. The identity of each searcher and segment must be clearly identified. See Appendix B for the Mollusk Measurement Data Sheet; one data sheet should be used for each 50-meter segment. Species checklists for each drainage basin are included in Appendix C (Williams et al. 2017, Blalock-Herod et al. 2005, Williams 2004, Brim Box and Williams 2000).

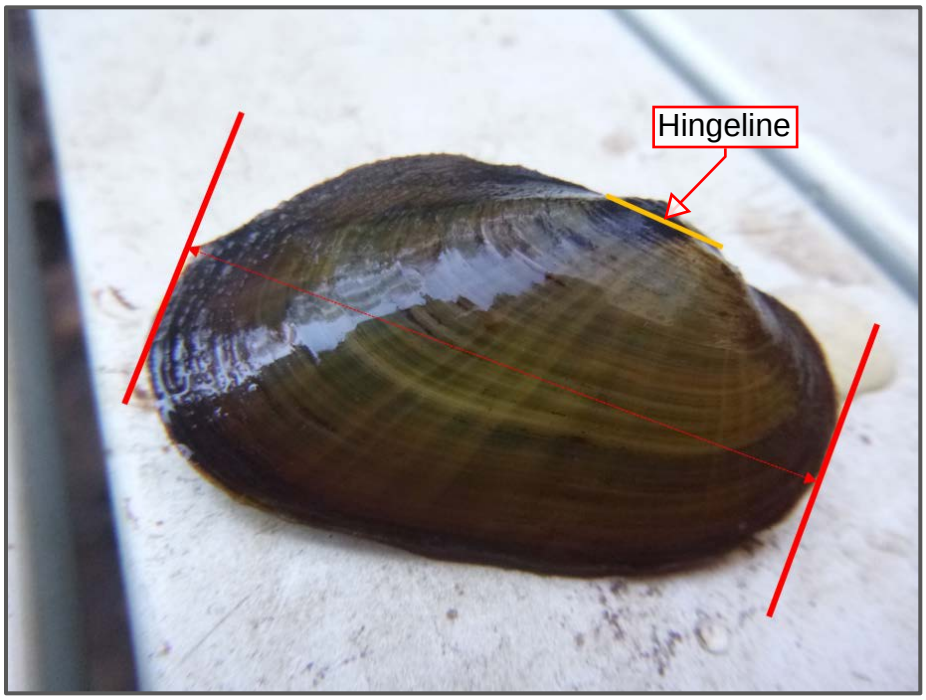


**Figure 2.** To determine total length of a freshwater mussel, measure the maximum distance, parallel to the hingeline, between the posterior and anterior shell margins (distance between the two red lines). Photo Credit: Jeffrey Garnett

***Photo Vouchers***

One color photograph of each species collected at the project site should be taken. Photographs should show the right valves of each animal photographed and should be taken so that the image of the animal is not distorted. Photographed specimens should be gently scrubbed to ensure that the periostracum of the right valve is visible. Photographs shall be of a resolution and distance from the camera to sufficiently show all external characteristics necessary to identify each specimen. The shells of dead individuals should be identified with the estimated time of death (i.e. weathered dead vs. fresh dead), counted, and recorded on the data sheet. Shells may be retained by the survey crew providing that crew members have all necessary permits to legally retain such items.

Justifications as to why the above protocols were not followed must be included in the final report, as well as any correspondence or communication with OES, GADNR, and USFWS (if applicable) regarding these deviations.

## III. MUSSEL RELOCATION PROTOCOL

Mussel relocations have become an increasingly popular method for avoiding, minimizing, or mitigating impacts to freshwater mussels. In order to protect state and federally listed mussel species from harm associated with construction projects (e.g. bridge demolition and construction), a relocation effort (described below) shall be undertaken.

### A. Relocation Site Assessment

The success of mussel relocations is mostly dependent on the selection of the relocation site, especially substrate stability and handling methods during relocation.

Prior to the initial relocation effort, a suitable relocation site must be identified. The chosen relocation site must have stable substrate that meets the habitat requirements of the mussel(s) to be relocated. In addition, the chosen site should also include other individuals of the relocation species or a related species. The presence of other individuals provides an indication of a stable substrate with minimal disturbance. When practical, the selected site should also be in close proximity to the mussel population that will be relocated to minimize stress to the animals. A relocation site upstream of the project area is highly recommended.

The population boundary coordinates of the relocation site should be recorded using a Global Positioning System (GPS). When practical, the relocation site should be marked by the use of poles (e.g., rebar, PVC, etc.) or flagging on the banks.

### B. Mussel Relocation Methodology

Prior to the relocation effort, personnel from the following agencies shall be notified to be given the opportunity to be present:

- The Lead Federal Agency
- U.S. Fish and Wildlife Service
- Georgia Department of Natural Resources
- GDOT Office of Environmental Services

The work envelope (area to be surveyed) will be largely determined by the nature of the proposed construction activity. For example, a bridge replacement may require a work envelope that extends 35 feet upstream and 55 feet downstream of the centerline of the existing and/or proposed bridge; dam removal/construction projects may require a larger work envelope. Surveyors shall consult with the appropriate natural resource agencies to determine the length of the work envelope.

A minimum of three sampling efforts shall be undertaken for the capture and relocation of protected mussels from the work envelope prior to any construction activity. Only one sampling effort will be completed per day (i.e. a complete relocation will require a

minimum of three days). Sampling events shall occur when flows are low to enhance surveyor safety and increase the likelihood of mussel collection. All sampling efforts shall occur after lockdown plans have been received, while the last sampling effort shall occur within 14 days of commencement of in-water work at the project site.

***Relocation Survey***

Biologists experienced in handling mussels shall be used for mussel relocation efforts. The entire work envelope will be surveyed by one-meter wide transects, spaced one meter apart from each other. Surveys shall begin downstream and should move in an upstream direction. The surveys shall be completed using mask and snorkel and/or scuba gear, as appropriate. Given the ephemeral and dynamic nature of freshwater mussel habitat, the entire work envelope must be surveyed, not just the presumed suitable habitat areas within it, using tactile searches (hand grubbing). Excavation or suction-dredging is not permitted.

All mussels found within the work envelope, regardless of species and protection status, shall be collected for relocation. State and federally protected mussels shall be tagged with a unique number on each valve and/or a PIT tag on the left valve, measured in millimeters, and photographed. Notes shall be taken on the collection method used, when the mussel was found, and the microhabitat in which it was located.

All mussels being relocated must be kept moist by use of a cooler or the use of a live well (e.g. mesh bags suspended in the stream). If using a cooler to transport mussels, the mussels must be layered in damp burlap or other suitable medium to retain moisture. The mussels shall not be stacked directly on top of one another without a damp medium in between layers, and no more than four layers will be placed in a cooler. Ice packs may be used to maintain the temperature inside the cooler, however ice packs are not allowed to come in direct contact with a mussel. To further reduce stress during handling and relocation activity, the time the mussels are out of water should be minimized. Biologists should also make an effort to avoid exposing mussels to extreme temperatures (e.g. using a cooler, performing the relocation at times of the day/year when air temperatures are above 50°F and below 90°F).

***Distribution within the Relocation Site***

Quadrats of 1 $m^2$ shall be installed over the relocation site. The number and orientation of quadrats at the relocation site shall depend on the quantity of mussels to be relocated and the size of the suitable habitat at the site. An initial survey of each quadrat will be necessary to identify all resident mussels. Surveys will be tactile (hand grubbing) and will not involve excavation of the quadrat. All mussels in each quadrat shall be identified and the total number of mussels per quadrat recorded. Any protected mussels shall be tagged and measured. Resident mussels shall be placed back into their quadrat. The total number of mussels being relocated into a quadrat shall be recorded. The density of each species within each quadrate must not be increased by more than three times the existing

density. Some quadrats that contain resident mussels must not receive relocated mussels; these will act as controls to assess natural mortality.

***Monitoring***

Thirty days after construction activity has ceased, a tactile survey shall be conducted to determine mortality of the relocated protected mussels. After this initial post-construction survey, the relocated mussels shall be monitored for recovery, survival, movement, and growth each year for five years. Annual monitoring surveys should be conducted at least eight months apart from each other but preferably 12 months apart. During the annual monitoring surveys, the number of mussels and species composition shall be recorded per quadrat. Data on stream stability, turbidity, bank vegetation, bank stability, water temperature, and sedimentation shall also be recorded. In addition, all protected mussels shall be measured and placed back into the same quadrat. Protected mussels not previously tagged shall be tagged to assess recruitment within the relocation site. The search area for the annual monitoring surveys shall include the relocation site, as well as the area 10 meters downstream of the relocation site.

***Post Survey Deliverables***

Following the completion of a survey (relocation or monitoring), a report shall be written detailing the site conditions (i.e. stream stability, turbidity, bank vegetation, bank stability, water temperature, sedimentation), survey methodology, and survey results. The report shall be prepared on behalf of the GDOT Office of Environmental Services and submitted to the Lead Federal Agency, U.S. Fish and Wildlife Service, and Georgia Department of Natural Resources.

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# Section IV.

# SNAIL SURVEY PROTOCOL

November 2018

# FRESHWATER SNAIL SURVEY PROTOCOLS FOR TRANSPORTATION PROJECTS WITHIN THE STATE OF GEORGIA

Georgia Department of Natural Resources,
Wildlife Resources Division

Georgia Department of Transportation,
Office of Environmental Services

November 2018

Jeffrey Garnett, Jason Wisniewski, Chris Goodson, and Matt Carroll

The following protocol is solely intended to instruct surveys related to transportation improvement projects within the State of Georgia. These protocols have been reviewed by USFWS, Georgia Ecological Services Field Offices and deemed appropriate for assessing the likelihood of species presence in the area surveyed by GDOT or their designated agent.

The survey season for snails is year-round when combined air and water temperatures are above 100°F (38°C). See Section **I**.III regarding survey season details. Because snail surveys are highly visual in nature, surveys should only occur when streams are clear and turbidity is relatively low.

## I. SURVEY METHODOLOGY

The survey should begin by conducting a visual search to examine dead shells along stream shorelines and all exposed areas. Within the stream, surveys of snails should include a visual assessment of suitable habitat. Surveys should be conducted in an upstream fashion to minimize potential increases in searcher induced turbidity. The PSA should be surveyed by transects equally spaced across the width of the stream to identify suitable habitat for protected snails. While slowly moving upstream along transects, surveyors should work parallel to one another, dividing the stream width equally among them; for larger streams, surveyors may need to travel upstream in a zig-zag pattern to provide better coverage. Transects/surveyors should be spaced no more than 5 m apart.

Areas of potential habitat should be visually surveyed using a mask and snorkel or SCUBA (if necessary); the use of view buckets may be appropriate in shallower habitats when visibility permits. When found, snails shall be carefully removed by hand from the substrate for processing.

If collected snails must be held temporarily during survey efforts, they must be kept in containers with flowing water (i.e., aerated holding bucket, live well). If an aerated bucket is used, the bucket shall be kept cool (out of direct sun) and clean (e.g., did not previously contain formalin or other preservatives or toxins) and shall not contain individuals or species that could harm or consume snails (e.g., predatory fish species). Holding shall be limited to 30 minutes. Water changes should occur to minimize stress to individuals if temperatures become elevated. Once processed, snails shall be released as close as possible to the point of collection.

## II. SPECIES IDENTIFICATION AND DATA COLLECTION

### A. Data Collection

All snails collected, both with and without protection status, shall be enumerated and recorded on field data sheets. Field data sheets for snail surveys are the same as those for mussel surveys (Mollusk Measurement Data Sheet), which can be found in Appendix B. Data sheets will be completed for all streams surveyed for target species. Data sheets will also be completed for perennial streams within the project corridor that were assessed for habitat and not surveyed because it was determined to not contain suitable habitat for target species. If surveys are not performed because the determination is made onsite that suitable habitat does not exist in the stream for the target species, the surveyor will document the justification for not conducting the survey by completing a data sheet which will be included along with a detailed discussion in the subsequent aquatic survey report.

Information relevant to the survey site will be collected and recorded on the field data form found in Appendix B. Of particular importance are water quality parameters (water temperature, stream flow, turbidity, pH, conductivity, etc.) and instream features. Locations of suitable habitats should be shown in the sketch map and the level of suitability for the species being surveyed for should be indicated (marginal, suitable, or preferred). See Appendix D for an example sketch map. If surveys for fishes, crayfishes, and/or mussels are also conducted, indicate how much time was spent during the survey for each in the Notes section on the field data form.

### B. Photo Vouchers

A representative color photograph will be taken of each snail species observed during the survey. Photographs will be of good quality; sufficient to show the important diagnostic characteristics necessary to differentiate between species of similar appearance.

Voucher specimens may be taken for any questionable identifications in accordance with the surveyor's state and federal permit(s). Any voucher specimens or mortalities of rare species should be incorporated into the research collection of fishes at an accredited state school or the Georgia Museum of Natural History. Voucher specimens are not required.

# APPENDICES

# Appendix A

# Pre-Survey Coordination Worksheet

## Pre-Survey Coordination Worksheet (Please complete a separate worksheet for each aquatic resource to be surveyed)

### Project Information

PI No.: _____ County: _____

Project Description: _____

Project Location (Lat/Long): _____ HUC 10: _____

### Resource Information

Water to be Surveyed (Please attach project map identifying the aquatic resource): _____

Target Species to be Surveyed For (Please attach early coordination responses and the USFWS and GADNR HUC 10 lists):

_____

_____

Bankfull Width: _____ Bankfull Depth: _____ Wetted Width: _____ Wetted Depth: _____

Flow Velocity (slow, moderate, swift): _____ Dominant Substrate Type(s): _____

Other Relevant Habitat Information (in-stream features, surrounding land use/topography, etc.): _____

_____

_____

### Survey Methods

Prescribed Search Area (PSA) Length Upstream of Project: _____ PSA Length Downstream of Project: _____

Fish/crayfish (check all that apply): seine ☐ kick seine ☐ shock ☐ other ☐

Mussels/snails (check all that apply): snorkel ☐ SCUBA ☐ other ☐

Deviation(s) from Aquatic Survey Protocol? YES ☐ NO ☐

Describe "other" survey methods and/or any deviations from the Protocol (please attach any correspondence with the agencies):

_____

_____

_____

### Surveyor Information

Expected Date of Survey: _____ Number of Surveyors: _____

Names of Surveyors (please indicate who will confirm identifications and attach valid permits): _____

_____

_____

# Appendix B

# Field Data Sheets

Site Number: Field Number: **Time Beg**: Date:
Watershed/Drainage: **End:** County/State:
Waterbody: Latitude: Long:
Location: Drainage Area*: Stream Type:
Gage Station: Surveyor(s):

| | | | |
|---|---|---|---|
| **Determining PSA** | Distance upstream:<br>Distance downstream: | **Mussel/Snail Survey** | Tactile Only O Tactile With Snorkel O<br>Tactile With SCUBA O |
| **Fish/Crayfish Survey** | Boat Electrofishing O BP Electrofishing O Kick-seine O Seine haul O | | |

## Instream Features Quantitative

Please specify all units of measurement
**% Canopy Cover:** _____ **Wetted Width:**_____
**Surface Velocity (at thalweg):**_____
**Water Depth (at thalweg):**_____
**Bank Height (rt/lt*):**_____ **Bank Angle(rt/lt*):**_____

## Instream Features Qualitative

**Channel Alteration:** O No O Yes
Describe:

**Shoring Structures:** O None O Limerock O Gabion
O Concrete O Rip-rap O Other:_____ **Extent:**

**Substrate composition (% est.):** Gravel___ Silt _____ Clay_____
Clay Marl_____ Fine sand_____ Coarse s. _____ Medium s. _____
Boulder _____ Bedrock _____ Cobble _____

## Water Quality

**Water Temp:** ____ ℃
**Dissolved Oxygen:** ____mg/L
**Conductivity** _____
**pH** ____ **Other:**
**303d Listed:** O yes O no
**Designated Use:**
**Violated Criteria:**

**Water Clarity**
O Clear
O Slightly turbid
O Turbid
O Opaque

**Heavy Rain in past 7 days:** Yes O No O
**Air Temperature:** _____ Est. O Act. O

**Survey Weather Conditions:**
Heavy rain O Clear/sunny O
Steady rain O Scattered showers O
% Cloud cover____

**Channel Stability** (Check one box for each column):

| | Deposition/Aggradation | Incision/Degradation |
|---|---|---|
| **Excellent** | Large, fresh deposits absent<br>High number of deep pools O | No mass-wasting or significant erosion of banks<br>Channel slightly entrenched<br>High number of deep pools O |
| **Good** | Large, fresh deposits uncommon<br>Moderate number of deep pools O | Some bank erosion apparent, no mass wasting<br>Channel slightly-moderately entrenched<br>Moderate number of deep pools O |
| **Fair** | Large, fresh deposits common<br>Low-moderate number of deep pools O | Active bank erosion, potential mass-wasting<br>Channel moderately-highly entrenched<br>Low-moderate number of deep pools O |
| **Poor** | Large, fresh deposits very common<br>Few, if any, deep pools O | Active bank erosion, frequent mass-wasting<br>Channel moderately-highly entrenched<br>Few, if any, deep pools O |

**Impoundments:**
O None O yes (Describe):

**Fish Passage: Blocked?**
O yes
O no
Describe:

**Fish Presence:**
O Absent
O Rare
O Common
O Abundant

**Woody Material:**
O None/infrequent
O Moderate
O Extensive

## Riparian Features Quantitative

**Rt* Buffer width(ft):**
O 10-25
O 25-75
O 75-150
O 150+

**Lt* Buffer width(ft):**
O 10-25
O 25-75
O 75-150
O 150+

**Landuse Characterization:**
(100 feet to either side of the stream)

| | Rt Bk | Lt Bk | |
|---|---|---|---|
| Natural Forest | | | % |
| Silviculture | | | % |
| Pasture | | | % |
| Agricultural | | | % |
| Residential | | | % |
| Commercial | | | % |
| Industrial | | | % |

## Site Road Crossing

**Road Type:** O Paved O Unpaved
Name (if known): _____

**Crossing Type:** O Pipe culvert O Box culvert
O Bridge O Paved box culvert

## Riparian Features Qual.

**Local Non-Point Source Pollution Potential:**
O No evidence O Slight
O Moderate potential O Obvious sources
O Livestock access
Describe:

**Floodplain Access:**

| | Rt* | Lt* |
|---|---|---|
| None | O | O |
| Partial | O | O |
| Full | O | O |

**Bank Erosion:**
O Non-eroding
O Active Erosion
O Mass-wasting

## Notes

* - http://streamstats.usgs.gov/ss

| Other notable aquatic species observed, including invasive species, and their relative abundance: |
| --- |
| |
| Explain/describe any deviations from protocol: |
| |
| Include sketch map, using back of page if necessary. Include north arrow, flow directions, label any locations where listed species were collected, indicate and label any unique characteristics or instream structures. |
| |

Fish/Crayfish Data Sheet page____of____

Field Number: Date:

State: County: Locality:

Surveyors:

| Species Name | Count Tally | Total Number | Sex* (m/f/form**) | Comments* |
|---|---|---|---|---|
| | | | | |
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*Optional
**For crayfishes: sex, adult/juvenile, male Form, female with eggs or young

# Mollusk Measurement Data Sheet



Field/PI Number: County: Date:

Aquatic Resource: PSA Segment Number:

Surveyor (Record mussels collected per surveyor below if multiple surveyors listed per sheet):

| Species Name | Length (mm) | Width* (mm) | Height* (mm) | Sex* (m/f/u)** | Comments* |
|---|---|---|---|---|---|
| | | | | | |

*= Optional

**= Male, female, undetermined

# Appendix C

# Mussel Species Checklist Data Sheets

# ACF River Basin Freshwater Mussels



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | | Live | Fresh Dead | Relict Shell | |
|---|---|---|---|---|---|---|---|
| | | | Alasmidonta triangulata | | | | **Pleurobema pyriforme** |
| | | | **Amblema neislerii** | | | | Pyganodon cataracta |
| | | | Anodontoides radiatus | | | | Pyganodon grandis |
| | | | Cyclonaias infucata | | | | Strophitus radiatus |
| | | | Elliptio arctata | | | | Toxolasma paulum |
| | | | **Elliptio chipolaensis** | | | | Uniomerus columbensis |
| | | | Elliptio complanata | | | | Utterbackia imbecillis |
| | | | Elliptio crassidens | | | | Utterbackia peggyae |
| | | | Elliptio fraterna | | | | Utterbackiana heardi |
| | | | Elliptio icterina | | | | Villosa lienosa |
| | | | Elliptio nigella | | | | Villosa vibex |
| | | | Elliptio purpurella | | | | Villosa villosa |
| | | | **Elliptoideus sloatianus** | | | | Other unionid |
| | | | Fusconaia sp | | | | Other unionid |
| | | | Glebula rotundata | | | | |
| | | | **Hamiota subangulata** | | | | |
| | | | Lampsilis binominata | | | | |
| | | | Lampsilis straminea | | | | |
| | | | Lampsilis teres | | | | |
| | | | Lasmigona subviridis | | | | |
| | | | **Medionidus penicillatus** | | | | |
| | | | Megalonaias nervosa | | | | |

## Corbiculidae

| | | | |
|---|---|---|---|
| | | | Corbicula fluminea |

# Altamaha River Basin Freshwater Mussels



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| | | | Alasmidonta triangulata |
| | | | Elliptio complanata |
| | | | Elliptio dariensis |
| | | | Elliptio hopetonensis |
| | | | Elliptio icterina |
| | | | Elliptio shepardiana |
| | | | **Elliptio spinosa** |
| | | | Lampsilis dolabraeformis |
| | | | Lampsilis splendida |
| | | | Pyganodon gibbosa |
| | | | Toxolasma paulum |
| | | | Uniomerus carolinianus |
| | | | Utterbackia imbecillis |
| | | | Utterbackiana couperiana |
| | | | Villosa delumbis |
| | | | Villosa vibex |
| | | | Other unionid |
| | | | Other unionid |

## Corbiculidae

| | | |
|---|---|---|
| | | Corbicula fluminea |

# Tennessee River Basin Freshwater Mussels GA Only



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | | Live | Fresh Dead | Relict Shell | |
|---|---|---|---|---|---|---|---|
| | | | Actinonaias ligamentina | | | | Plueronaia barnesiana |
| | | | Alasmidonta marginata | | | | Potamilus alatus |
| | | | Alasmidonta viridis | | | | Ptychobranchus fasciolaris |
| | | | Amblema plicata | | | | Pyganodon grandis |
| | | | **Epioblasma capsaeformis** | | | | Theliderma cylindrica |
| | | | **Epioblasma walkeri** | | | | **Toxolasma cylindrellus** |
| | | | Epioblasma lenoir | | | | Toxolasma lividum |
| | | | Epioblasma gubernaculum | | | | Toxolasma parvum |
| | | | Eurynia dilatata | | | | Tritogonia verrucosa |
| | | | Fusconaia subrotunda | | | | **Venustaconcha trabalis** |
| | | | Lampsilis cardium | | | | Villosa iris |
| | | | Lampsilis fasciola | | | | Villosa taeniata |
| | | | Lampsilis ovata | | | | Villosa vanuxemensis |
| | | | Lasmigona complanata | | | | Other unionid |
| | | | Lasmigona costata | | | | Other unionid |
| | | | Lasmigona holstonia | | | | |
| | | | Leptodea fragilis | | | | |
| | | | Medionidus conradicus | | | | |
| | | | Obovaria subrotunda | | | | |
| | | | **Pleurobema pyriforme** | | | | |

## Corbiculidae

| | | | |
|---|---|---|---|
| | | | Corbicula fluminea |

# Coosa River Basin Freshwater Mussels GA

page____ of ____

Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | | Live | Fresh Dead | Relict Shell | |
|---|---|---|---|---|---|---|---|
| | | | Alasmidonta mccordi | | | | **Pleurobema georgianum** |
| | | | Amblema elliottii | | | | **Pleurobema hanleyianum** |
| | | | Cyclonaias asperata | | | | **Pleurobema perovatum** |
| | | | Ellipsaria lineolata | | | | Potamilus purpuratus |
| | | | Elliptio arca | | | | **Ptychobranchus greeni** |
| | | | Elliptio arctata | | | | Pyganodon grandis |
| | | | Elliptio crassidens | | | | Quadrula rumphiana |
| | | | **Epioblasma metastriata** | | | | Strophitus connasaugaensis |
| | | | **Epioblasma othcaloogensis** | | | | Strophitus subvexus |
| | | | **Hamiota altilis** | | | | Toxolasma corvunculus |
| | | | Lampsilis ornata | | | | Tritogonia verrucosa |
| | | | Lampsilis straminea | | | | Truncilla donaciformis |
| | | | Lampsilis teres | | | | Utterbackia imbecillis |
| | | | Lasmigona alabamensis | | | | Utterbackiana suborbiculata |
| | | | Lasmigona etowahensis | | | | Villosa lienosa |
| | | | Leptodea fragilis | | | | Villosa nebulosa |
| | | | Ligumia recta | | | | Villosa umbrans |
| | | | **Medionidus acutissimus** | | | | Villosa vibex |
| | | | **Medionidus parvulus** | | | | Other unionid |
| | | | Megalonaias nervosa | | | | Other unionid |
| | | | Obliquaria reflexa | | | | |
| | | | **Pleurobema decisum** | | | | |

## Corbiculidae

| | | | |
|---|---|---|---|
| | | | Corbicula fluminea |

# Ochlockonee River Basin Freshwater Mussels FL/GA



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| _____ | _____ | _____ | Alasmidonta wrightiana |
| _____ | _____ | _____ | Cyclonaias infucata |
| _____ | _____ | _____ | Elliptio complanata |
| _____ | _____ | _____ | Elliptio crassidens |
| _____ | _____ | _____ | Elliptio icterina |
| _____ | _____ | _____ | **Elliptoideus sloatianus** |
| _____ | _____ | _____ | Glebula rotundata (Florida only) |
| _____ | _____ | _____ | **Hamiota subangulata** |
| _____ | _____ | _____ | Lampsilis straminea |
| _____ | _____ | _____ | Lampsilis teres |
| _____ | _____ | _____ | **Medionidus simpsonianus** |
| _____ | _____ | _____ | Megalonaias nervosa |
| _____ | _____ | _____ | **Pleurobema pyriforme** |
| _____ | _____ | _____ | Pyganodon grandis |
| _____ | _____ | _____ | Toxolasma paulum |
| _____ | _____ | _____ | Uniomerus columbensis |
| _____ | _____ | _____ | Utterbackia imbecillis |
| _____ | _____ | _____ | Utterbackia peggyae |
| _____ | _____ | _____ | Utterbackiana couperiana |
| _____ | _____ | _____ | Villosa lienosa |
| _____ | _____ | _____ | Villosa vibex |
| _____ | _____ | _____ | Villosa villosa |
| _____ | _____ | _____ | Other unionid |
| _____ | _____ | _____ | Other unionid |

## Corbiculidae

| | | | |
|---|---|---|---|
| _____ | _____ | _____ | Corbicula fluminea |

# Suwannee River Basin Freshwater Mussels



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| _____ | _____ | _____ | Elliptio complanata |
| _____ | _____ | _____ | Elliptio icterina |
| _____ | _____ | _____ | Elliptio jayensis |
| _____ | _____ | _____ | Elliptio sp. |
| _____ | _____ | _____ | Lampsilis straminea |
| _____ | _____ | _____ | Lampsilis teres |
| _____ | _____ | _____ | **Medionidus walkeri** |
| _____ | _____ | _____ | **Pleurobema pyriforme** |
| _____ | _____ | _____ | Pyganodon cataracta |
| _____ | _____ | _____ | Quadrula kleiniana |
| _____ | _____ | _____ | Toxolasma paulum |
| _____ | _____ | _____ | Uniomerus carolinianus |
| _____ | _____ | _____ | Utterbackia imbecillis |
| _____ | _____ | _____ | Utterbackia peninsularis |
| _____ | _____ | _____ | Villosa lienosa |
| _____ | _____ | _____ | Villosa vibex |
| _____ | _____ | _____ | Villosa villosa |
| _____ | _____ | _____ | Other unionid |
| _____ | _____ | _____ | Other unionid |

## Corbiculidae

| | | | |
|---|---|---|---|
| _____ | _____ | _____ | Corbicula fluminea |

# Tallapoosa River Basin Freshwater Mussels (above Fall Line)



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| _____ | _____ | _____ | Cyclonaias asperata |
| _____ | _____ | _____ | Elliptio arca |
| _____ | _____ | _____ | Elliptio arctata |
| _____ | _____ | _____ | Fusconaia cerina |
| _____ | _____ | _____ | **Hamiota altilis** |
| _____ | _____ | _____ | Pyganodon sp. |
| _____ | _____ | _____ | Toxolasma parvum |
| _____ | _____ | _____ | Utterbackia imbecillis |
| _____ | _____ | _____ | Villosa lienosa |
| _____ | _____ | _____ | Villosa vibex |
| _____ | _____ | _____ | Other unionid |
| _____ | _____ | _____ | Other unionid |

## Corbiculidae

_____ _____ _____ Corbicula fluminea

# Satilla River Basin Freshwater Mussels



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| _____ | _____ | _____ | Elliptio downiei |
| _____ | _____ | _____ | Utterbackia imbecillis |
| _____ | _____ | _____ | Other unionid |
| _____ | _____ | _____ | Other unionid |

## Corbiculidae

| | | | |
|---|---|---|---|
| _____ | _____ | _____ | Corbicula fluminea |

# St. Marys River Basin Freshwater Mussels



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| | | | Elliptio icterina |
| | | | Utterbackiana couperiana |
| | | | Villosa vibex |
| | | | Villosa villosa |
| | | | Other unionid |
| | | | Other unionid |

## Corbiculidae

| | | | |
|---|---|---|---|
| | | | Corbicula fluminea |

# Ogeechee River Basin Freshwater Mussels



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| _____ | _____ | _____ | Alasmidonta arcula |
| _____ | _____ | _____ | Elliptio angustata |
| _____ | _____ | _____ | Elliptio complanata |
| _____ | _____ | _____ | Elliptio congarea |
| _____ | _____ | _____ | Elliptio fisheriana |
| _____ | _____ | _____ | Elliptio hopetonensis |
| _____ | _____ | _____ | Elliptio icterina |
| _____ | _____ | _____ | Elliptio producta |
| _____ | _____ | _____ | Fusconaia masoni |
| _____ | _____ | _____ | Lampsilis cariosa |
| _____ | _____ | _____ | Lampsilis splendida |
| _____ | _____ | _____ | Leptodea ochracea |
| _____ | _____ | _____ | Pyganodon cataracta |
| _____ | _____ | _____ | Toxolasma pullus |
| _____ | _____ | _____ | Uniomerus carolinianus |
| _____ | _____ | _____ | Utterbackia imbecillis |
| _____ | _____ | _____ | Villosa delumbis |
| _____ | _____ | _____ | Villosa vibex |
| _____ | _____ | _____ | Other unionid |
| _____ | _____ | _____ | Other unionid |

## Corbiculidae

| | | | |
|---|---|---|---|
| _____ | _____ | _____ | Corbicula fluminea |

# Savannah River Basin Freshwater Mussels GA



Field Number: Date:

County/State: Locality:

Surveyors: Search Time: man-hours

## Unionidae

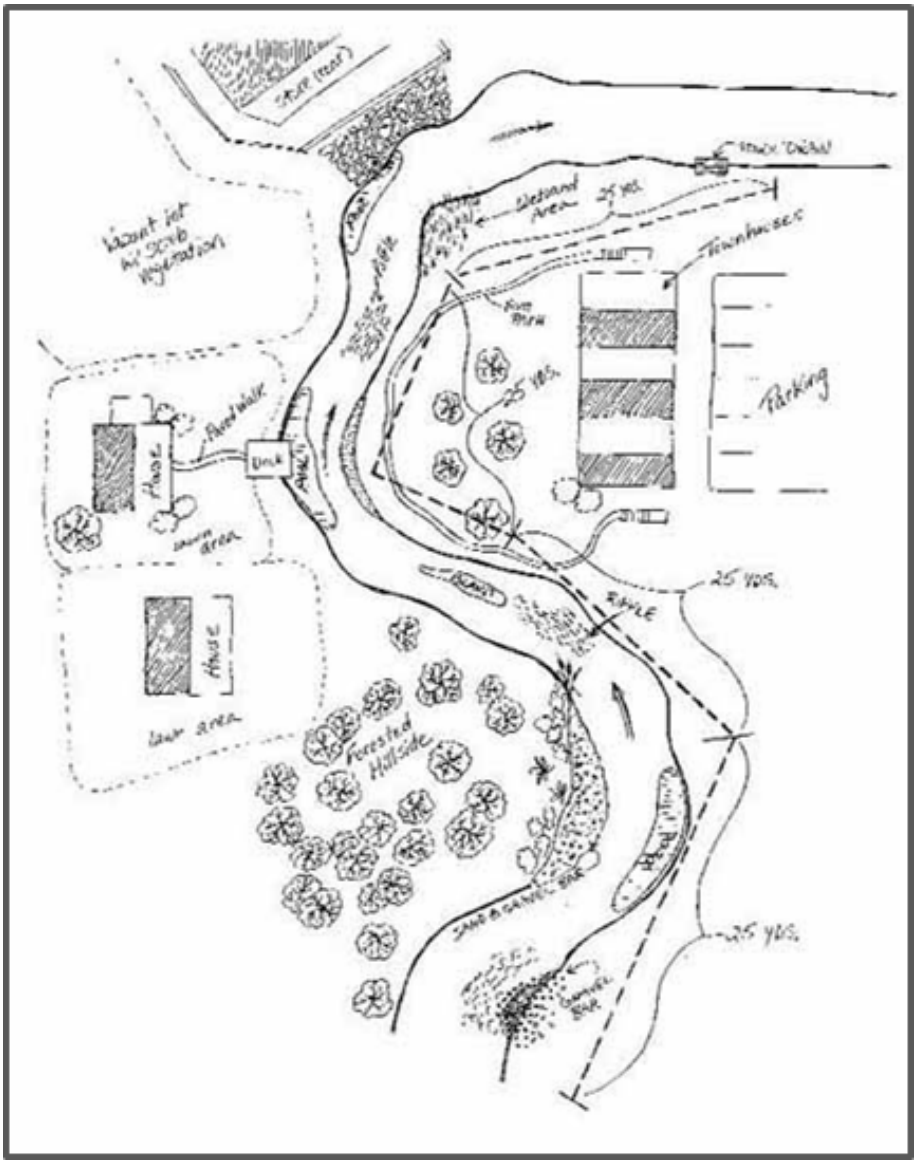
| Live | Fresh Dead | Relict Shell | |
|---|---|---|---|
| | | | Alasmidonta triangulata |
| | | | Alasmidonta varicosa |
| | | | Alasmidonta undulata |
| | | | Elliptio angustata |
| | | | Elliptio complanata |
| | | | Elliptio congaraea |
| | | | Elliptio folliculata |
| | | | Elliptio fraterna |
| | | | Elliptio icterina |
| | | | Elliptio producta |
| | | | Elliptio roanokensis |
| | | | Fusconaia masoni |
| | | | Lampsilis cariosa |
| | | | Lampsilis splendida |
| | | | Leptodea ochracea |
| | | | Pyganodon cataracta |
| | | | Toxolasma pullus |
| | | | Uniomerus carolinianus |
| | | | Utterbackia imbecillis |
| | | | Villosa delumbis |
| | | | Other unionid |
| | | | Other unionid |

## Corbiculidae

| | | | |
|---|---|---|---|
| | | | Corbicula fluminea |

# Appendix D

# Example Sketch Map




Example field data form sketch identifying potential habitats, lengths, stream flow, riparian buffers, etc. From: Dohner, E., Markowitz, A., Barbour, M., Simpson, J., Byrne, J. and Dates, G. 1997. Volunteer Stream Monitoring: A Methods Manual. Environmental Protection Agency: Office of Water (EPA 841-B-97-003).