Guidelines for Aquatic Resource Relocation Plans for Fish and Shellfish, Including Freshwater Mussels

Dewatering, maintenance, and construction related activities in rivers, creeks, streams, lakes, sloughs, reservoirs, bays, estuaries, stilling basins, and other flood control structures may negatively impact fish, shellfish, and other aquatic resources. The Texas Parks and Wildlife Department is the state agency with primary responsibility for protecting the state's fish and wildlife resources. The Texas Parks and Wildlife Code authorizes the department to investigate fish kills and any type of pollution that may cause loss of fish or wildlife resources, estimate the monetary value of lost resources, and seek restitution or restoration from the party responsible for the fish kill or pollution through suit in county or district court. The Texas Administrative Code requires the department to actively seek full restitution for and/or restoration of fish, wildlife, and habitat loss occurring as a result of human activities. The restitution value of lost resources can be significant, in particular for species classified as threatened or endangered. Restitution for each individual of a threatened species is at least $500 and for each individual of an endangered species is at least $1,000. In addition, the Texas Parks and Wildlife Code makes it a criminal offense to kill any fish or wildlife resources classified as threatened or endangered.

Besides potential impacts to other aquatic resources, the department is particularly concerned about declining freshwater mussel populations, reflected in the 2009 Texas Parks and Wildlife Commission's decision to list 15 species of freshwater mussels as threatened. In order to avoid adverse impacts to aquatic resources and potential civil and criminal liability, the department recommends entities coordinate with the department to develop a plan to avoid impacts to aquatic resources and, in some instances, relocate aquatic resources outside of the project area.

There are two steps to this planning process. First, an applicant develops a written Aquatic Resource Relocation Plan (ARRP) to control and limit the impacts of dewatering, maintenance, or construction related projects on aquatic resources and submits it to the appropriate TPWD representative. The plan should be submitted no less than four weeks prior to beginning the project. The applicant must receive formal approval of the ARRP by the department prior to initiating dewatering, maintenance, or construction related activities. See Attachment 1 below for the specific information necessary for the ARRP. The TPWD point of contact for the project location can be found in Attachment 5.

If state or federal threatened or endangered freshwater mussel species are present or likely to be present in the project area, a mussel survey may be necessary prior to department approval of the ARRP. Surveyors must obtain one of two authorizations from the department to handle threatened and endangered species: 1) a Relocation Letter of Authorization, or 2) a TPWD Scientific Research Permit (i.e., "collection permit"). Both the Relocation Letter of Authorization and the Scientific Research Permit are issued in the name(s) of the person(s) conducting the surveys, and may not be issued to organizations or other entities. Additional information on freshwater mussel surveys may be found in Attachment 4.

Second, an applicant must complete an "Application for Permit to Introduce Fish, Shellfish, or Aquatic Plants into Public Waters." Because the application is to be received 30 days prior to the

activity, it is suggested that both the ARRP and this permit application be submitted at the same time. The application can be obtained at the following web link:

http://tpwd.texas.gov/publications/pwdforms/media/pwd_1019_t3200_app_permit_stock_public_waters.pdf

There is no application fee for the ARRP or introduction permit. Once the department has issued the introduction permit, please have a copy available at the project site in case the local game warden or other department staff requests to see it. A department representative may be present during some or all of the proposed activity.

Please do not hesitate to contact your TPWD point of contact if you have any questions or require additional assistance.

Attachment 1

Aquatic Resource Relocation Plan (ARRP). The ARRP should include the following information to be considered complete.

1) A description of the project and associated aquatic/instream activities with sufficient detail for department staff to evaluate the risk to aquatic resources.

2) A computer generated map showing the project location and the relocation site, including the county, GPS coordinates, and the Texas Commission on Environmental Quality (TCEQ) water body segment number.

3) Expected start dates of the project and the aquatic resource relocation. An applicant must submit any changes to the start date of aquatic resource relocation activities at least 72 hours prior to the revised start date.

4) Identify any state or federally threatened or endangered species that may occur. Explain what methods will be used to protect these species. If the project area contains any state or federally listed freshwater mussels, a mussel survey may be necessary prior to approval of the ARRP (see Attachment 4 for Freshwater Mussel Survey Protocols). The following web link may help in identifying the location of these species by county: http://www.tpwd.texas.gov/gis/rtest/

5) List all shellfish that may become stranded due to the operation. Explain what methods will be used to protect these shellfish including freshwater mussels (See Attachment 2 for Freshwater Fish and Shellfish Handling Protocols).

6) Identify List all known exotic and invasive species in the project area. Describe decontamination procedures for preventing the spread of exotic and invasive species. See link below for more information: http://tpwd.texas.gov/huntwild/wild/species/exotic/

7) Methods of collecting and relocating aquatic resources, including the types and sizes of containers used, the mode of transportation, and best management practices (BMPs) to protect aquatic resources. Provide an estimate of the time expected to complete the collection and relocation (See Attachment 2 for Freshwater Fish and Shellfish Handling Protocols).

8) Describe how the receiving waters will be protective of aquatic life (i.e., sufficient dissolved oxygen levels, water body size and flow, and similar habitat as the source water).

9) Describe how dead fish and shellfish, as well as exotic and invasive species, will be disposed of and documented. Documentation should include no less than the species and number of individuals found dead, or disposed of, including the lengths (inches) of all fish for both native and non-native species.

10) Identify best management practices (BMPs) to be used to prevent or minimize the risk of transporting any species, including aquatic invasive species (AIS) to new locations on equipment, boats, trailers, and vehicles. These BMPs should also ensure compliance with regulations that prohibit the possession and transport of certain AIS species. For more information see Attachment 3.

Attachment 2

Fish and Shellfish Handling Protocols

Introduction

A key element in the survival of aquatic life such as fish and shellfish (oysters and freshwater mussels) which are caught and released is how they are handled during the process. Physiologically, these organisms experience many stressors during a catch and release and transport. By minimizing the amount of stress, the chance of survival after release improves greatly. During a catch and release event, fish, as well as shellfish, can experience a combination of many stress factors. Below is a list of some types of stressors that aquatic life can experience during catch and release.

- behavior stress – crowding
- handling stress – capture, struggle, confinement
- exercise stress – prolonged swimming, being chased
- temperature stress – change in temperature
- salinity stress – change in salinity
- hypoxial stress – removal from the water/low oxygen
- toxicity stress – exposure to ammonia

The primary response of stress is the releasing of hormones into the blood causing a disturbance to the physical state of the fish. The secondary stress responses are disturbances to osmoregulation, blood chemistry, metabolism, and immune system. These effects can reduce the fish's resistance to fungal and bacterial infections that lead to mortality in some cases.

In order to reduce these effects, proper care and procedures should be taken when catching and releasing aquatic life. In order to minimize these stressors, follow the recommendations listed below.

Handling, Maintaining, and Transporting Aquatic Life

Fish

- Catch the fish fast and efficiently. As the fish resists capture, its oxygen demand increases. The fish will need oxygen to recuperate after the capture. Therefore, keep the water in the transport basin well aerated.

- If a landing net is used, rubber netting works best for minimizing mucous loss. Cloth and nylon type dip nets disrupt the protective mucous coating, disturb scales, and increase the possibility of injury or secondary infection that usually results in fish mortality.
- Help keep the protective mucous coat and scales of the fish from rubbing off by using wet hands when handling fish.
- Keep handling of the fish to a minimum. If at all possible, do not grab fish with hands. Instead, go directly to the transport basin. Avoid excess handling and/or dropping of the fish on the ground and the floor of the boat.
- Help keep the protective mucous coat and scales of the fish from rubbing off by using wet hands when handling fish. NovAqua ® or StressCoat ® can be added to the water in holding tanks to help mitigate the abrasive damage of capture and handling to the external mucous coating.
- Keep the fish in the water as much as possible to reduce stress. As a rule, keep the fish out of water no longer than you can hold your breath. Fish can suffer from brain damage from prolonged loss of oxygen.
- Water temperatures above 84° Fahrenheit tend to be stressful for warm water fish. Therefore, adding ice to the transport basin can minimize stress.
- Avoid overcrowding fish in the transport basin. A good rule of thumb to use would be to place no more than 5 fish in the 15″-20″ range for a 120 quart cooler equipped with some type of an aeration system. Plan on 25% water exchange every 20-30 minutes. About 7.5 gallons (1.5 buckets if using a five gallon bucket). Use common sense, the more fish (>5) and the longer they sit in the transport basin, the more frequent water exchanges need to occur.
- Livewells or other holding tanks should be fitted with a water recirculation system. Oxygen cylinders are expensive, but provide the best aeration while maintaining water temperature.
- Run the aeration system continuously! Transport basins should be filled with ambient water to aid in acclimating the fish to the transport conditions.

When transporting saltwater fish, it is important to keep the transport water as close to the same salinity and temperature as the water from which the fish were collected. If possible, it is preferable to lower the water temperature a couple of degrees to reduce stress during the transport procedure. The oxygen concentration in the water should be between 5.0 - 7.0 mg/L. Water with oxygen levels lower than 4.0 mg/L can cause stress and eventually lead to a fish kill. The pH of the water should range between 8.0-8.3 for saltwater fish and 6.5-8.0 for freshwater fish.

Shellfish (freshwater mussels)

- While collecting freshwater mussels, place them in 3-5 gallon mesh bags or 5 gallon buckets keeping them inundated in the water until they are ready to be brought ashore.
- Once brought to shore, place the mussels in appropriate sized ice chests containing ambient water (with small amounts of ice if necessary) for use in transportation to the relocation site.
- Keep live mussels in transportation containers no longer than 8 hours.
- When placing mussels back in the sediment at the relocation site, carefully hand place them with the anterior end down.

Aquatic Surveys, Introductions, and Relocations: Best Management Practices to Prevent or Minimize Aquatic Invasive Species (AIS) Transfer

Introduction

All permitted aquatic surveys, aquatic species introductions, and aquatic resource relocations are required to comply with regulations regarding possession, transport, and introduction of controlled exotic species into public waters. These regulations apply even to small fragments or seeds of these species, regardless of whether transfer is intentional or accidental. Implementation of Best Management Practices (BMPs) is necessary to prevent or minimize the risk of accidentally possessing or transferring controlled exotic species or pathogens.

Aquatic invasive species (AIS) cause or are likely to cause harm to our native ecosystems, both directly by competition or predation on native species and indirectly by altering the environment (e.g., reducing dissolved oxygen, shading). Many AIS cause significant economic harm in a number of ways—by damaging water transfer and hydroelectric infrastructure and increasing maintenance costs, clogging waterways and costing millions of dollars each year to manage, increasing evaporative water loss from reservoirs, and even lowering property values. These AIS can also impact human health and quality of life by helping to cause harmful algal blooms, impeding boater access, fouling beaches, and creating hazards for swimmers.

Because of these potential impacts, the legislature delegated to the Texas Parks and Wildlife Commission [TPW 66.007 & 66.0072] the authority to develop a list of Exotic Harmful or Potentially Harmful Fish, Shellfish, and Aquatic Plants that may not be possessed, transported, or introduced into public waters except as authorized by rule or permit issued by the department [31 TAC§57.112]. A complete list of these species, hereafter referred to as controlled AIS, can be found on the department website at http://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml. Possession or transfer of controlled AIS—live or dead—or the eggs, seeds, or fragments thereof, is punishable as a Class C Misdemeanor (with a fine up to $500); repeat violations can be elevated.

Examples of controlled AIS include zebra mussels (*Dreissena polymorpha*) and their microscopic larvae, tilapias (*Oreochromis* spp.), hydrilla (*Hydrilla verticillata*), giant and common salvinia (*Salvinia molesta, S. minima*), and Eurasian watermilfoil (*Myriophyllum spicatum*). Some controlled AIS are fairly widespread in Texas, but their prevalence increases, rather than negates, the risk of accidental transfers that could cause infestations in new areas. More information about most of the controlled AIS that have been found in Texas, including maps of where they have been

Abbreviations:
AIS: Aquatic Invasive Species
TAC –Texas Administrative Code; numbers before refer to title and numbers after to specific regulations
TPW –Texas Parks and Wildlife Code; numbers after TPW refer to specific statutes

found, is available on www.TexasInvasives.org and a few especially problematic species are described below.

It is your responsibility to ensure that you and your team are not possessing, transporting, or introducing controlled AIS. However, it is not always necessary for you to know how to identify each species. By implementing a few general BMPs, you can achieve a high degree of confidence that you aren't accidentally doing so. In addition, implementing these BMPs will help to prevent transfer of non-prohibited, yet potentially harmful, AIS as well as harmful algae or pathogens that could negatively impact native species.

General BMPs

- DURING surveys, introductions, and relocations, do not transfer water from one site to another unless specifically approved by the department; minimize water transfer whenever possible, using nets to transfer fish. For questions about treating hauling water, see the section on fish hauling units below.

- AFTER work in the water is complete:

    - **CLEAN:** Remove mud, plant fragments, and other debris from all equipment before leaving the site—this includes nets, mesh bags, buckets, boot tread, waders, snorkel/SCUBA gear, boats, trailers, vehicles, and ANY other equipment used in or adjacent to the water. Before leaving the site, you should also rinse equipment that may harbor plant fragments (e.g., boot tread)—a gallon jug of water and a scrub brush or scraper can help to get things clean. If a carwash is available, the high pressure spray can help to clean boats, trailers, vehicles, and equipment. Otherwise, you should use a spray nozzle and water hose to finish cleaning equipment before use in another water body.

    - **DRAIN:** Drain all water from boats, fish hauling units, buckets, or other receptacles at a location where the water will not drain into any water body.

    - Soaking equipment with 10% bleach solution (i.e., 1 part household bleach to 9 parts water) for 10 minutes followed by a thorough rinse before drying can help to prevent transfer of zebra mussel larvae, golden algae, and fish pathogens such as viruses and should neutralize any hidden snails or plant fragments. Milder disinfectants (e.g., 1% Virkon Aquatic® for 10 minutes) or a 20-30 minute soak in very hot tap water (at least 110˚F) can help decontaminate nets or equipment that bleach could damage.

    - **DRY:** Allow all equipment to dry completely before use in another water body.

Special Rules and Recommendations

Boats

Regulations require that all water be drained from vessels traveling to and from any public water body, except for travel between access points on the same water body within the same day [31 TAC §57.1001]. Texas law also specifically requires that all controlled aquatic plants be immediately removed from boats, trailers, and vehicles used to transport or launch them, and disposed lawfully [TPW 66.0071].

Vehicles

Vehicles used to launch boats or driven in the water or in mud adjacent to the water can easily harbor and transport AIS. It is especially important to check them thoroughly, remove all vegetation, rinse well with a spray nozzle, and allow them to dry completely before you visit another water body. Check the wheels, axle, bumper, and undercarriage carefully and be sure to rinse well everything well. Texas law specifically requires that all controlled aquatic plants be immediately removed from vehicles used to transport or launch boats and disposed lawfully.

Fish Hauling Units

For specific recommendations for decontaminating fish hauling units and treating hauling water to prevent transferring controlled AIS, golden alga, or fish pathogens, please see "A Biosecurity Manual for Inland Fisheries Division Hatcheries," online at:
http://tpwd.texas.gov/publications/pwdpubs/media/pwd_rp_t3200_1776.pdf

Zebra Mussel Infested Water Bodies

A current map and list of infested lakes can be found on the department website at: http://tpwd.texas.gov/huntwild/wild/species/exotic/zebramusselmap.phtml. Zebra mussels are spread via both transfer of adults and microscopic larvae in water. When working at a site on a water body where zebra mussels or their larvae have been found, it is critical to ensure that no water is transferred and all equipment is allowed to dry thoroughly. You will also need to be very thorough in checking equipment for mud or debris that could harbor dislodged adults. For these projects, your methods should specify where decontamination will take place and identify and address any special equipment that could transfer zebra mussel larvae (e.g., bladder dam) and how it will be cleaned. **If zebra mussels are found at the site, you must report the finding to TPWD immediately by calling Monica McGarrity (512-552-3465), Brian Van Zee (254-495-8341), or your department contact. Native mussels with zebra mussels attached should never be relocated to another water body; if zebra mussels are attached, consult the department before proceeding.**

Non-native Species and Aquatic Resource Relocations

The aquatic resource relocation plan (ARRP) should stipulate that non-native species will not be relocated or specifically describe which species will (or will not be) relocated. In most cases, the department will not issue a permit for relocation of non-native species (i.e., not native at the watershed or sub-watershed level), regardless of whether or not they are designated as controlled AIS by TPWD regulations, because permitting their introduction would be inconsistent with department management goals. For example, suckermouth catfishes (genera *Hypostomus* and *Pterygoplichthys*) are highly invasive and their relocation will not be permitted, even though they are not controlled AIS. Asian Clams (*Corbicula fluminea*) are not native to Texas and should not be relocated. Rio Grande Cichlids (*Herichthys cyanoguttatum*) are native only to the lower Rio Grande drainage in Texas but may be found in other water bodies and can impact some native species; although they should not typically be relocated outside their native range, in some cases it may be permitted (e.g., park ponds or reservoirs). In some cases, relocation of Common Carp (*Cyprinus carpio*) may be permitted at the discretion of the Inland Fisheries district supervisor.

Controlled fish AIS, such as tilapia, that are removed from a water body cannot be relocated and also must be promptly beheaded or gutted prior to disposal or transport for disposal. A complete list of controlled AIS can be found on the department website at: http://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml

Grass Carp (*Ctenopharyngodon idella*) is a controlled AIS for which relocation could be approved, but only if the relocation site is in the same water body. If triploid (sterile) Grass Carp were stocked for nuisance aquatic vegetation control, they must be relocated within the same water body unless otherwise approved by the department. The department website provides a current list of all public water bodies where triploid grass carp have been stocked:

http://www.tpwd.state.tx.us/landwater/water/environconcerns/nuisance_plants/public_tgc_permits.phtml

If grass carp are encountered in other water bodies not on this list, they must be beheaded or gutted and disposed unless otherwise directed by the Inland Fisheries district superv7isor.

Disposal of Fish (Non-native or Native)

Dead animals, including fish, are classified as municipal solid waste [30 TAC §330.3]. Although they are considered special waste [30 TAC §330.171], no special authorization is required for disposal at any Type I or Type IAE landfill. For government roadway maintenance projects by TxDOT or county or municipal agencies, fish may be disposed by burial on the highway right away as long as the disposal does not cause a nuisance or endanger public health or the environment and the carcasses are covered with at least two feet of soil [30 TAC §330.13; TCEQ communication]. Other individuals or entities should dispose of fish in a landfill.

Some Controlled AIS to Know – Easily Transported by Accident

Giant Salvinia (Salvinia molesta)

http://www.texasinvasives.org/plant_database/detail.php?symbol=SAMO5

Common Salvinia (S. minima)

http://www.texasinvasives.org/plant_database/detail.php?symbol=SAMI7

Hydrilla (Hydrilla verticillata)

http://www.texasinvasives.org/plant_database/detail.php?symbol=HYVE3

http://aquaplant.tamu.edu/plant-identification/alphabetical-index/hydrilla/

http://plants.ifas.ufl.edu/node/183

Eurasian Watermilfoil (Myriophyllum spicatum)

http://www.texasinvasives.org/plant_database/detail.php?symbol=MYSP2

http://aquaplant.tamu.edu/plant-identification/alphabetical-index/eurasian-watermilfoil/http://plants.ifas.ufl.edu/node/278

Alligatorweed (Alternanthera philoxeroides)

http://www.texasinvasives.org/plant_database/detail.php?symbol=ALPH

http://aquaplant.tamu.edu/plant-identification/alphabetical-index/alligator-weed/

Torpedograss (Panicum repens)

http://aquaplant.tamu.edu/plant-identification/alphabetical-index/torpedograss/

http://plants.ifas.ufl.edu/node/308

Zebra mussels (Dreissena polymorpha)

http://texasinvasives.org/animal_database/detail.php?symbol=10

Island applesnail (Pomacea insularum)

http://texasinvasives.org/animal_database/detail.php?symbol=15

A complete list of controlled AIS can be found on the department website at: http://tpwd.texas.gov/huntwild/wild/species/exotic/prohibited_aquatic.phtml

To learn more about other AIS, how to identify them, and where they've been found in Texas, visit: http://www.texasinvasives.org/invasives_database/

Attachment 4

Kills and Spills Team
Freshwater Mussel Survey and Relocation Protocols

This protocol is a living document and may change over time and will be updated as relevant data become available. These methods represent the minimum amount of effort needed to conduct a mussel survey. These protocols are typically used for, but not limited to, construction and maintenance type projects that may impact aquatic life.

A. Desired Surveyor Qualifications

Personnel who will be conducting surveys for freshwater mussels should have sufficient knowledge within the river basin they propose to survey. This includes familiarity with species-specific biology and ecological requirements, and the ability to identify mussel species from the basin, particularly state and federally listed species. A potential mussel surveyor should have field experience and possess demonstrable skills in the independent execution of standard freshwater mussel survey methods. Surveyors should be able to demonstrate their experience in the safe-care and handling of freshwater mussels. Individuals familiar with freshwater mussels, but lacking experience with rare species, should work with a malacologist who is familiar with those species.

B. Review of Existing Information

Prior to any fieldwork, surveyors should conduct a thorough review of available resources to determine if historical freshwater mussel data exists for a particular site or river basin. This data should include historical distribution information, life history information such as spawning and brooding behavior, and general ecology information such as burrowing behavior and habitat preferences. Potential information resources include peer-reviewed journal articles, published and unpublished reports, TPWD's Natural Diversity Database, museum collections, and malacologists who have experience with the relevant species or water body. This information can be used to develop a preliminary list of mussel species historically known from an area and help determine appropriate sampling. Absence of available data or other information does not imply that a mussel species is absent from a particular area. Historical data can only be used to indicate that mussels have been found in past surveys but **cannot be used as a definitive statement to presence/absence** of a mussel species within a particular area. If a survey has been conducted in the area of interest within the last two years, and no mussels were found at that time, TPWD will review the previous survey methodology and results to determine if an additional survey is necessary.

C. Survey Time Frame and Proper Handling of Specimens

Mussel sampling is to be conducted during the months of April through November (Carlson et al. 2008) or when water temperatures are greater than or equal to 60°F (Mackie et. al. 2008) and avoiding spawning and glochidia release timeframes for state-listed mussel species (when known).

Sampling outside of this time frame will need prior authorization from TPWD. Sampling during warm water periods when mussels are more active will allow individuals disturbed during sampling to re-establish themselves in the substrate. Disturbing mussels during cold temperatures could potentially cause adverse impacts to mussels by increasing their vulnerability to predation, or causing individuals to be swept downstream due to slower re-anchoring capabilities. Sampling could also be impacted by cold temperatures from decreased detection rates as the result of seasonal vertical mussel migrations (Amyot and Downing 1997, Schwalb and Pusch 2007, Block et.al. 2013), and/or decreased surveyor efficiency.

To minimize stress on mussels, live or suspected-live native mussels should be handled gently at all times and be placed back to the original location where they were found. An exception to returning native mussels to their original location is if mussels are being handled under an approved Aquatic Resource Relocation Plan (ARRP) which states that mussels will have to be removed from harm's way due to potential impacts from any construction and maintenance type project (Section F). Mussels should not be exposed to air any longer than necessary (less than 10 minutes) for identification, measurement, and photographic documentation. Mussels should be kept in mesh bags submerged in the water at all times when not being processed. Once identified, native mussels should be returned to their original point of collection except under an ARRP as described above. All native mussels should be carefully placed partially into the sediment ensuring that the posterior side is facing upwards above the sediment. If there is uncertainty as to the posterior side, then the mussel should be placed on the substrate surface and left to burrow into the sediment. Typically, the surveyor should only retain shells or dead mussels, but live mussels may be kept if species verification is necessary.

D. Survey Area Delineation

The survey area for mussels in lotic (flowing water) habitats shall include areas of the wetted stream bed that would be directly impacted by the project footprint (e.g., bridge support structure, in-channel coffer dam, dewatered area, etc.) as well as areas that could potentially be impacted from project activities (e.g. sedimentation). As such, the survey area should include the entire project footprint, as well as buffers for areas of potential impact that include a minimum of 50 m upstream of the project footprint, and a minimum of 100 m downstream of the project footprint. As these are minimum buffer lengths, projects with larger instream project footprints and/or potential for larger downstream sediment plumes (e.g. dredging), longer downstream buffer lengths may be required.

The survey area for mussels in lentic (still water) habitats (e.g. bridges over reservoirs) shall include the wetted area that would be directly impacted by the project footprint (e.g., bridge support structure, in-channel coffer dam, dewatered area, etc.) as well as areas that could potentially be impacted from project activities (e.g. sedimentation). As such, the survey area should include the entire project footprint area, as well as buffers for areas of potential impact that

include a minimum of 50 m upstream of the project footprint, and a minimum of 50m downstream of the project footprint.

The survey area for mussels along reservoir shorelines (not to include a bridge) shall include the wetted area that would be directly impacted by the project footprint as well the areas that could be potentially impacted from project activities (e.g. sedimentation). As such, the survey area should include the entire project footprint area, as well as a buffer for areas of potential impact of 20 m out from the project footprint.

E. Survey Procedures

Survey protocols for wadeable and non-wadeable waterbodies, as well as reservoir shorelines, are presented below. The level of effort for the survey procedure is generally based on whether or not the location is wadeable or non-wadeable and whether state listed species are present.

If state listed mussel species have previously been found in the vicinity of the project area during previous mussel surveys, then bypass the initial survey method and proceed with the comprehensive survey methods (referred to in this document as a quantitative survey) described below, for either wadeable or non-wadeable locations.

Wadeable

Initial Survey

A stream or river is considered wadeable if ≥50% of the channel is accessible by wading during normal flow conditions. Generally these streams are third order or less. Pool areas or high-flow conditions may make the stream inaccessible to wading in certain places or at certain times (but does not preclude these areas from being searched); however, the stream will still be considered wadeable when determining which survey procedures to employ.

The initial survey for wadeable locations is a qualitative survey (Strayer and Smith 2003) during which sampling is used to establish the presence/absence of state-listed mussel species. This method allows the surveyor to also develop a species list of mussels present within the survey area using timed searches. Because the amount of survey effort (person-hours) varies by water body type to obtain an adequate representation of the mussel species present (Huang et al. 2011), a minimum search time of five person-hours (divided into five one person-hour searches) is required within the delineated search area as described in Section D above. At the end of each search period (e.g. a one person-hour search), mussels should be identified and retained in mesh bags submerged in the stream. If no new species of mussels are collected during the fifth search period, the survey is complete. If at least one new mussel species is collected in the fifth search period, additional one person-hour search periods are required until no new species are collected. If at any time during the timed search periods a live state-listed mussel species is encountered, terminate the initial survey process and begin the quantitative survey.

Visual, combined with tactile searching (hand-grubbing into the top 1-4 inches of substrate to increase detection of more-deeply buried mussels) should be used. Searchers should select a shoreline and begin searching from downstream to upstream moving back and forth across the stream, ensuring that all of the delineated search area is sufficiently covered. For areas in the delineated search area that are non-wadeable (depths greater than 3 ft), SCUBA or surface supplied air (i.e. hookah) equipment should be utilized to efficiently sample those areas.

Searchers should stop occasionally in areas of loose or fine substrate and hand grub to detect mussels not visible at the substrate surface. Areas of mixed loose gravel should be fanned occasionally to detect mussels hidden between the substrate. Searchers need to explore all habitat types within the search area including riffles, banks, pools, and backwater areas to locate species that prefer these habitats. Additional habitat types that should be searched if present within the site include crevices in bedrock, root-wads, undercut banks, and woody-debris.

All live mussels collected during the timed searches shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected (for quality assurance purposes).

Quantitative Survey

When state-listed mussel species are present within the delineated search area, quantitative sampling methods are necessary to remove mussels from the delineated survey area to minimize take of these species due to construction and maintenance type projects.

A multiple-pass depletion survey method is required within the survey area to ensure that the majority of state-listed mussel species present (and all other subsequently collected mussel species) at the site are removed for relocation. The delineated survey area would be divided into 1 m wide lanes parallel to flow for the entire wetted width of the survey area and for the entire length of the delineated survey area which includes the project footprint and the upstream and downstream buffer. Each 1 m wide lane is divided into 1 m x 5 m cells (or any cell arrangement providing full coverage of the delineated search area with cells no greater than $5m^2$) (Figure 1) and each cell will be searched for a minimum of two 10 minute search periods with all live mussels collected in each search period identified and enumerated separately. At the end of the second 10 minute search period if the catch rate (number of individual mussels) is less than 20% of the first 10 minute search period, then that cell is complete and the surveyors may move on to the next cell.

If the catch rate during the second 10 minute search period is greater than 20% of the first 10 minute search period then additional 10 minute search periods are required until the catch rate is less than 20% of the first search period for that cell.

All live mussels collected during the multiple-pass depletion surveys shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected (for quality assurance purposes).

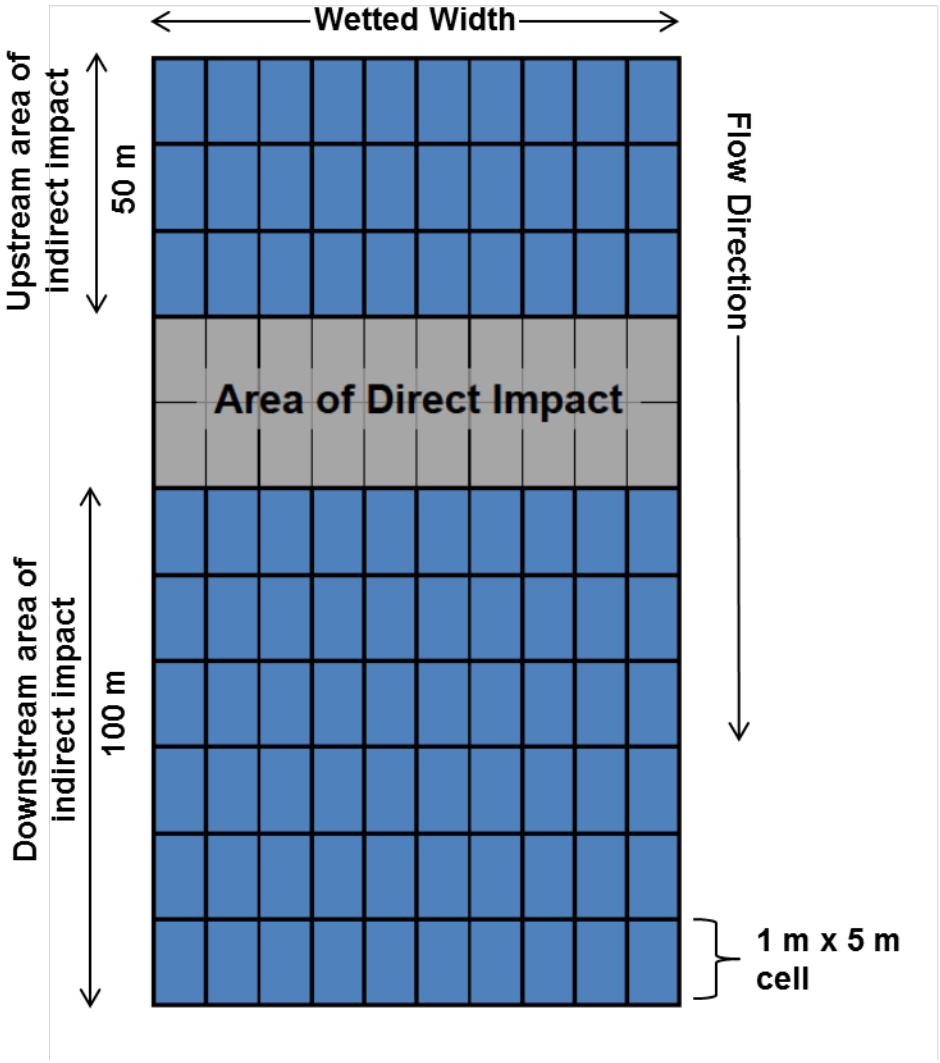


Figure 1. Example cell layout for multiple-pass depletion type comprehensive surveys for wadeable locations (not drawn to scale, for illustrative purposes only).

Non-Wadeable

Initial Survey

In non-wadeable locations, difficulty exists in efficiently using timed searches to determine if mussels are present and their species composition. Therefore, semi-quantitative survey methods are required to adequately determine the mussel species present in the delineated survey area. Due to water depths that are prohibitive of snorkel surveys (generally greater than 3 ft) in non-wadeable sites, SCUBA or surface supplied air (i.e. hookah) equipment may be required to perform the survey.

In order to ensure adequate coverage of the site, transects oriented parallel with flow (or the bank in lentic habitats) should be placed on both left bank and right bank of the delineated survey area and additional transects equally spaced between these at intervals no greater than 5 m. Each transect is then divided into 10 m segments, where a minimum of 10 minutes of search time is conducted for each segment using tactile searches along the transect and a meter on both sides of the transect centerline until all segments of each transect have been surveyed. At the end of each search period within each 10 m segment, all mussels are identified, enumerated, and placed in mesh bags submerged in flowing water.

When all transects have been surveyed, the area around segments with the highest mussel abundances will be resurveyed for an additional one person-hour and will include the area between the adjacent transects on both sides of the segment. If no additional species are collected, the survey is complete for that area. Additional one person-hour searches will be conducted in the area until no new species are collected.

All live mussels collected during the timed searches shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected (for quality assurance purposes).

Quantitative Survey

When state-listed mussel species are present within the delineated search area, quantitative sampling methods are necessary to remove mussels from the delineated survey area to minimize take of these species due to construction and maintenance type projects.

A multiple-pass depletion survey method is required within the survey area to ensure that the majority of state-listed mussel species present (and all other subsequently collected mussel species) at the site are removed for relocation. Utilizing the mussel density information obtained from the previously established transects during the initial survey, the segments that contain 75% of the total mussel abundance can be identified. Additional transects (along the entire length of the survey area for convenience) will be placed at 2.5 m (parallel to the existing transect) on each side of the previously established transect identified with a segment with high mussel abundance. The search area for the multiple-pass depletion survey will then be each identified segment with high mussel abundance, and each adjacent segment (up, down, left and right) surrounding it. Each segment will be searched for a minimum of two 20 minute search periods with all live mussels collected in each search period identified and enumerated separately.

At the end of the second 20 minute search period, if the catch rate (number of individual mussels) is less than 20% of the first 20 minute search period, then that cell is complete and the survey may move on to the next cell. If the catch rate during the second 20 minute search period is greater than 20% of the first 20 minute search period then additional 20 minute search periods are required until the catch rate is less than 20% of the first search period for that cell.

All live mussels should be handled gently and remain in mesh bags submerged in flowing water while not being processed. All live mussels collected during the multiple-pass depletion surveys shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected (for quality assurance purposes).

Reservoir Shorelines

Initial Survey

Mussel surveys for reservoir shoreline projects that do not include a bridge component (reservoir bridge surveys should follow the wadeable/non-wadeable guidelines described above) may include wadeable and non-wadeable areas within the delineated search area (see Section D) and may require the use of SCUBA or surface supplied air (e.g. hookah) equipment. The initial survey will comprise of a qualitative survey utilizing timed searches. A minimum search time of five person-hours (divided into five one person-hour searches) is required within the delineated search area as described in Section D above. At the end of each search period (e.g. a one person-hour search), mussels should be identified and retained in mesh bags submerged in water. If no new species of mussels are collected during the fifth search period, the survey is complete. If at least one new mussel species is collected in the fifth search period, additional one person-hour search periods are required until no new species are collected. If at any time during the timed search periods a live state-listed mussel species is encountered, terminate the initial survey process and begin the comprehensive survey.

Visual, combined with tactile searching (hand-grubbing into the top 1-4 inches of substrate to increase detection of more-deeply buried mussels) should be used. Searchers should spread throughout the delineated search area, and search moving back and forth across the area ensuring that all of the delineated search area is sufficiently covered. For areas in the delineated search area that are non-wadeable (depths greater than 3ft), SCUBA or surface supplied air (i.e. hookah) equipment should be utilized to efficiently sample those areas.

All live mussels collected during the timed searches shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected (for quality assurance purposes).

Quantitative Survey

When state-listed mussel species are present within the delineated search area, quantitative sampling methods are necessary to remove mussels from the delineated survey area. A multiple-pass depletion survey method is required within the survey area to ensure that the majority of state-listed mussel species present (and all other subsequently collected mussel species) at the site are removed for relocation.

A minimum of 6 transects parallel to the shoreline will be established within the delineated survey area. One transect will be placed along the shoreline edge (this should be at average pool elevation

if sampling is occurring at above average pool elevation) with the 5 remaining transects to be placed at equally spaced intervals of 20% of the width of the delineated survey area. Each transect shall be divided into a maximum of 10 m segments. Each segment will be searched for a minimum of two 20 minute search periods, to include a meter on each side of the transect, with all live mussels collected in each search period identified and enumerated separately. At the end of the second 20 minute search period, if the catch rate (number of individual mussels) is less than 20% of the first 20 minute search period, then that segment is complete and the survey may move on to the next cell.

If the catch rate during the second 20 minute search period is greater than 20% of the first 20 minute search period then additional 20 minute search periods are required until the catch rate is less than 20% of the first search period for that cell.

All live mussels collected during the multiple-pass depletion surveys shall be identified, enumerated, and one color photograph should be taken of each live mussel species and of the total mussels collected (for quality assurance purposes).

F. Mussel Relocation Protocols

Prior to any mussel relocation activity, it will be necessary to have an approved ARRP, along with a stocking/relocation permit. All mussels collected during survey efforts need to be relocated as a best management practice in order to minimize impacts to mussels from construction and maintenance projects. At a minimum, all state-listed mussels should be tagged, preferably with a passive integrated transponder (PIT) tag, to aid in the recovery of relocated individuals during post-relocation monitoring. Mussel relocation protocols should follow those outlined in Tsakiris and Randklev (2014).

Mussel relocation sites should be located well outside of the project's area of direct and indirect impact (preferably upstream), and ideally nearby the survey site (relocation sites identified that are greater than 5 river miles from the survey sites will need prior TPWD approval). Mussel relocation sites should be of similar or better quality to that of the survey area and should be of the same habitat type (e.g. run, pool, backwater, etc.), comparable area of habitat, and comparable depths and velocities from which the mussels were initially collected. Efforts should be made to relocate mussels to a site that already has established mussels of the same species, which should ensure that hydraulic habitat conditions are suitable for relocated mussels, as well as evaluate the site for any potential future threats (e.g. unstable banks, land-use changes, etc…) which would preclude the site from being acceptable.

Mussels should be transported in an ice chest with a layer of ice to keep them cool and moist. Mussels should be wrapped in a wet towel and a piece of cardboard or similar material should be placed over the ice to protect the mussels from coming in direct contact with the ice and meltwater.

At the relocation site, the mussels should be carefully placed partially into the sediment ensuring that the posterior side is facing upwards above the sediment. If there is uncertainty as to the posterior side, then the mussel should be placed on the substrate surface and left to burrow into the sediment.

Post-relocation monitoring is an integral component to mussel relocation and for assessing the efficacy of relocation efforts for the conservation of these species. Post-relocation surveys should be conducted around one month post-relocation to assess short-term survival of relocated individuals. Observed mortality rates should be less than 10% one month post-relocation. If observed mortality rates are greater than 10% one month post-relocation, TPWD shall be notified and alternative relocation sites shall be discussed. A one year post-relocation survey should also be conducted to assess long-term survival of relocated individuals. Observed mortality rates should be less than 20% one year post-relocation. If observed mortality rates are greater than 20% on year post-relocation, TPWD shall be notified and alternative relocation sites shall be discussed.

References

Amyot, J., and J. Downing. 1997. Seasonal variation in vertical and horizontal movement of the freshwater bivalve Elliptio complanata (Mollusca: Unionidae). Freshwater Biology 37:345-354.

Block, J., G. Gerald, and T. Levine. 2013. Temperature effects on burrowing behaviors and performance in a freshwater mussel. Journal of Freshwater Ecology 28(3): 375-384.

Carlson, S., A. Lawrence, H. Blalock-Herod, K. McCafferty, and S. Abbott. 2008. Freshwater mussel survey protocol for the southeastern Atlantic slope and northeastern Gulf drainages in Florida and Georgia. United States Fish and Wildlife Service, Ecological Services and Fisheries Resources Offices. Georgia Department of Transportation, Office of Environment and Location.

Huang, J., Y. Cao, and K. S. Cummings. 2011. Assessing sampling adequacy of mussel diversity surveys in wadeable Illinois streams. Journal of North American Benthological Society 30(4):923-934.

Mackie, G., T. Morris, and D. Ming. 2008. Protocol for the detection and relocation of freshwater mussel species at risk in Ontario-Great Lakes area (OGLA). Canadian Manuscript Report of Fisheries and Aquatic Sciences 2790, Fisheries and Oceans Canada.

Schwalb, A., and M. Pusch. 2007. Horizontal and vertical movements of unionid mussels in a lowland river. Journal of the North American Benthological Society 26(2):261-272.

Strayer, D. L., and D. R. Smith. 2003. A guide to sampling freshwater mussel populations. American Fisheries Society Monograph No. 8. American Fisheries Society, Bethesda, Maryland.

Tsakiris, E.T., and C.R. Randklev. 2014. Evaluation of freshwater mussel (Family: Unionidae) relocation in Texas: a case study in the San Saba River at County Road 340. Report on file with TXDOT, Austin, Texas.

Attachment 5

Texas Parks and Wildlife Department
Aquatic Resource Relocation Plan

Contacts

Below are the names of the Biologists to be contacted for coordinating Aquatic Resource Relocation Plan development for the counties listed in the respective regions on the map below.

Region 1

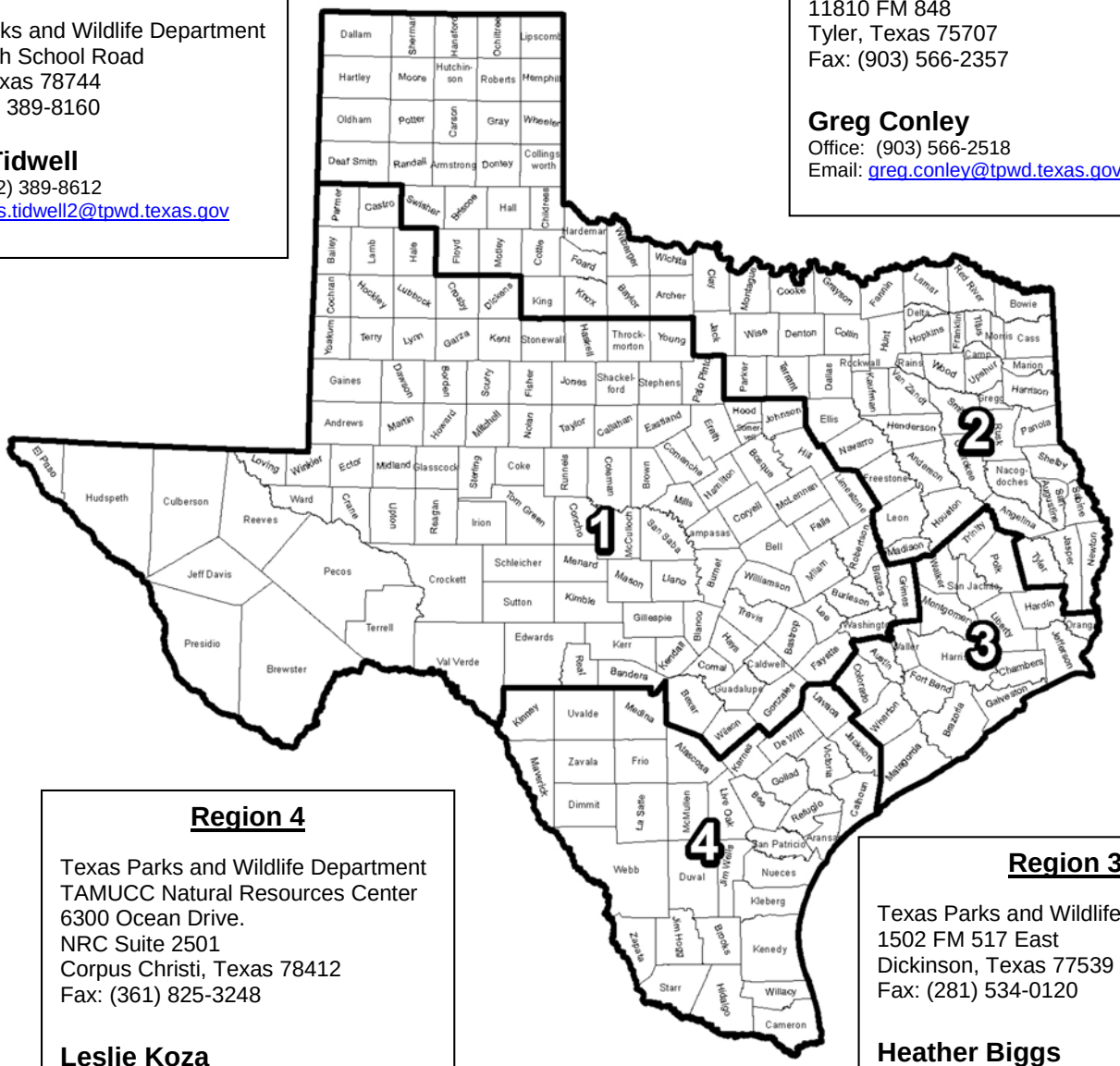
Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744
Fax: (512) 389-8160

Travis Tidwell
Office: (512) 389-8612
Email: travis.tidwell2@tpwd.texas.gov

Region 2

Texas Parks and Wildlife Department
11810 FM 848
Tyler, Texas 75707
Fax: (903) 566-2357

Greg Conley
Office: (903) 566-2518
Email: greg.conley@tpwd.texas.gov



Region 4

Texas Parks and Wildlife Department
TAMUCC Natural Resources Center
6300 Ocean Drive.
NRC Suite 2501
Corpus Christi, Texas 78412
Fax: (361) 825-3248

Leslie Koza
Office: (361) 825-2329
Email: leslie.koza@tpwd.texas.gov

Region 3

Texas Parks and Wildlife Department
1502 FM 517 East
Dickinson, Texas 77539
Fax: (281) 534-0120

Heather Biggs
Office: (281) 534-0133
Email: heather.biggs@tpwd.texas.gov

PWD LF T3200-1954 (1/18)

Life's better outside.®

In accordance with Texas State Depository Law, this publication is available at the Texas State Publications Clearinghouse and/or Texas Depository Libraries.