

Georgia's Stream Crossing Handbook

Regulations and ecological considerations



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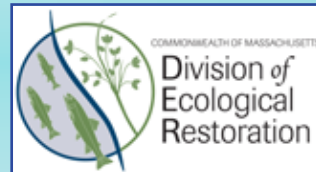
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Cover photographs represent stream-road crossings that are fish passable. All photographs in this handbook are from Georgia and are those of the authors unless otherwise specified. Additional photograph credits provided on final page. Cover photos from top to bottom are Chattahoochee River in White County, Conasauga Creek in Gilmer County (photo courtesy of Brad Ehrman), a creek in Cherokee County (photo courtesy of Heidi Millington), and a Cornish Creek tributary in Newton County.

Additional copies of this publication can be obtained by either downloading from our website or by contacting :

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http://www.fws.gov/athens/stream_crossing/

Forward

The southeastern United States is home to an incredibly large number of stream miles and extraordinary diversity of fish and wildlife. Fishing opportunities usually lie within only a few miles of home. Yet, despite the abundance of streams and fish, the southeast has one of the highest fish imperilment rates in the world owing in part to habitat fragmentation of aquatic species. Stream-road crossings are one of the leading contributors to habitat fragmentation.

Natural resource agencies have worked closely with the Army Corps of Engineers to develop and implement regulations that are intended to improve the safe passage of wildlife. Unfortunately, new stream-road crossings that were surveyed following the inception of the regulations show that crossings continue to fragment habitat and rarely meet the regulations. This handbook was produced, in part, in response to these surveys.

This handbook is intended for general audiences, including consultants, county engineers, back-hoe operators, students, and regulators. Intended as a non-technical handbook, we generally outline the importance of stream continuity for aquatic and terrestrial wildlife and highlight examples of wildlife passable and impassable crossings in Georgia. Regulations are also reviewed in general terms, and examples are provided to illustrate the intent of the regulations as of this publication date. This publication does not supersede any publication or regulations produced by the Army Corps of Engineers.

It is our hope that sharing this handbook will help prevent future species declines and ensure fishing opportunities in streams for generations to come.





A culvert on Rock Creek, Murray County. Culvert is impassable to fish due to shallow water inside culvert and because it is perched on the downstream side.

Introduction

There are approximately 70,150 miles of creeks and rivers in Georgia that flow from the foothills of the Appalachian Mountains to the Atlantic and Gulf Coasts. These streams flow through many different physiographic regions in Georgia creating extremely unique and diverse habitats that can support many different types of species. From aquatic insects to fish to salamanders, the diversity of life supported by Georgia's streams and rivers is outstanding and both nationally and globally significant. Georgia's river and streams are also exceptional for their beauty and recreational value and protecting them is a matter of pride for many Georgia citizens. This is evident through the many stream cleanups, restoration projects, and watershed protection groups found across the State.

Although public awareness of environmental issues is high in Georgia, few people consider the effects of road crossings on the quality of stream habitat. Stream conditions may be different upstream and downstream of a stream-road crossing, and may look different during low or high water.

The design and condition of a stream crossing determines whether a stream behaves naturally and whether animals can migrate along the stream corridor.

Stream continuity rarely has been considered in the design and construction of stream crossings. Many crossings are barriers to fish and wildlife. Even crossings that were not barriers when originally constructed may now be barriers because of stream erosion, deterioration of the structure, or changes in the upstream or downstream channel shape.

Fortunately, we have learned how to design stream crossings that allow wildlife unrestricted access to a watershed. Design guidelines for fish and wildlife passage are now part of the federal permitting process in Georgia. This manual is meant to communicate the basis for well-designed stream crossings for fish and wildlife and allow people to evaluate existing crossings to decide whether they should be replaced. We hope that the information in this handbook will be used by local governments and conservation groups to help protect and restore stream continuity throughout Georgia.

Why is Stream Continuity Important?

Some animals that frequently move through streams include invertebrates such as crayfish and insects, fish such as brook trout and bass, amphibians such as spring salamanders, reptiles such as wood turtles, and mammals such as muskrats, otters, and even bears.

Streams—and the interconnectedness of different parts of a stream or watershed—are essential to these animals. Many riparian animals, such as amphibians and reptiles, are more tolerant of stream discontinuity yet may be affected by road crossings, especially if forced to cross roads where they are vulnerable to traffic and other dangers.

For reasons as simple as escaping extreme environmental conditions or as complex as maintaining genetic diversity, animals living in or along streams need to be able to move through the watershed. Consider the roads you regularly drive to complete your day-to-day tasks. What if the roads you drive on were permanently blocked so that you could not get to



Cochran Creek tributary, Dawson County. Impassable to fish because water is shallow, fast, and downstream end is perched.

important places? This may sound absurd to us, but this is analogous to what we have done to species that inhabit both streams and lands throughout Georgia. Through the combined effects of dams and culverts not designed for wildlife passage, we are preventing animal populations from accessing all of the resources needed for survival and reproduction.

Next time you drive down the road, notice how often you go down a hill and back up. At the bottom of all those hills, there is likely to be a culvert with moving water under the road. Some only flow when it rains, others flow all the time, but each could be a potential barrier to wildlife passage.



Flat Creek in Dawson County. Culvert is impassable to fish because it is perched and because water depths are too shallow.



Raccoon Creek in Paulding County, Probably impassable because water flows under the concrete foundation, not through the culvert.



Salmonid attempting to access upstream habitats. Non-Georgia photo courtesy of U.S Forest Service.

Coldwater habitat access

Small streams with groundwater seeps and springs provide coldwater refuge during the summer. Species such as brook trout and striped bass will travel to these areas and congregate there. Fish that can't make it there—perhaps because of barriers that we created—may be more susceptible to heat stress and mortality. If barriers restrict the availability of a refuge, then animals may be overcrowded and vulnerable to disease and predators

Access to Forage

Different habitats provide different feeding opportunities throughout a day or season, and species regularly travel to exploit these resources. Striped bass swim up tidal creeks to feed during high tide. Insect communities in small ponds, riparian wetlands, and floodplains can be abundant at times, and stream fish will move into these habitats to feed. Fragmentation of streams due to road crossing can impede fish access to these areas.

Genetic Diversity

Movement of species within streams is vital for maintaining healthy populations that are genetically diverse. Where aquatic habitats are divided into small population segments, whole populations may be eliminated, reduced or genetically damaged through the effects of isolation and inbreeding. When aquatic species are able to move, genes don't become isolated in one

population segment and inbreeding is significantly reduced. Movement of species within and between populations is necessary to provide genetic diversity and maintain healthy populations of Georgia's aquatic species.

Access for Reproduction

Many species need to travel long distances to find suitable breeding habitats. For example, the trispot darter of northwest Georgia moves from large creeks and rivers into small tributary streams each spring for breeding. Many minnow species, which often constitute the most diverse and abundant component of forage for larger game species, migrate into smaller creeks for reproduction. Similarly, large sucker runs involve the movement by these species to spawn over gravel bars in the spring. Walleye, trout, and other sport fishes are also known to move long distances for reproduction. Barriers which prevent access to the spawning habitats utilized by these species not only decrease the abundance of these species in our rivers and creeks, they may also constitute a significant threat to population survival.

Natural Dispersal & Population Recovery

Some salamanders, turtles and frogs spend most of their lives near streams and travel in and along a stream's length. Crossings not designed for wildlife passage may force them to climb over an embankment and cross

a road, where they are vulnerable to road mortality. Freshwater mussels disperse by having larvae that attach to the fins or gills of a fish, so if a stream crossing blocks fish then it also blocks upstream dispersal of mussels.

If a stream is damaged by a catastrophic event (such as pollution, flooding, or severe drought) then natural dispersal will allow the recovery of aquatic populations to pre-disturbance levels.

Habitat Alteration

In addition to effects on wildlife movement, many stream crossings degrade nearby habitat, making conditions inhospitable for some native plants and animals. Undersized culverts (e.g. those that significantly change the flow conditions when compared to the natural flow conditions) often create both upstream and downstream bank erosion problems, resulting in wider stream channels and increased fine sediment deposition that affects stream habitats. The effects are also noticeable in tidal creeks. By limiting tidal flow, culverts alter water levels and chemistry, diminish sources of ocean nutrients, and can degrade entire upstream or tidal environments.

Culverts can also alter habitat by preventing natural changes. Stream are not static, they are dynamic. They naturally move side to side and up and down over periods of time. Often a stream changes upstream or downstream of a culvert, but the part of the stream in the culvert is not able to adapt. These changes can result in culverts becoming barriers to wildlife passage.



Shinyrayed pocketbook in Spring Creek, Miller County.

Signs of Poor Designs

Four stream crossing problems—multiple entry crossings, undersized crossings, shallow crossings, and crossings that are perched—can be barriers to fish and wildlife and lead to several common consequences. Recognizing poor stream crossings and their consequences is an important step in evaluating hazards to people and wildlife.

Multiple Entries

Multiple entry crossings are prone to clogging and may inhibit the movement of animals through the crossing. Clogging can cause flooding into roadside ditches, resulting in problems for roadways and hazardous conditions for motorists. Clogged entries sometimes cause water to scour the channel banks, thereby compromising stream crossings. This can lead to increased maintenance costs.

Undersized Crossings

Undersized crossings restrict natural stream flow, particularly during floods, causing several problems, including scouring and erosion, high flow velocity, clogging and ponding. Crossings should be large enough to pass fish, wildlife, woody debris, and floods.

Shallow Crossings

Shallow crossings have water depths too low for many organisms to move through them and may lack appropriate streambed material. Crossings should have an open bottom or should be sunk into the streambed to allow for substrate and water depths that are similar to the surrounding stream.

Perched Crossings

Perched crossings are above the level of the stream bottom at the downstream end. Perching can result from either improper installation or from years of downstream bed erosion. Crossings should be open-bottomed or sunk into the bed to prevent perching.

Dill Creek, Murray County



Multiple barrels

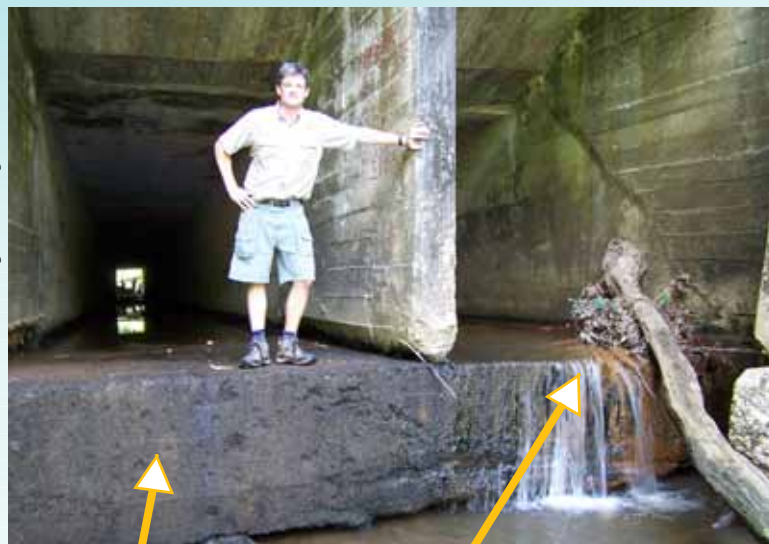
Upstream ends clogged

Tributary to Little Sugar Creek, Morgan County



Undersized pipe culvert

Raccoon Creek, Paulding County



Perched high above streambed

Depth too shallow for fish passage

Consequences of Poor Designs

Shallow Water

Shallow water is a problem for wildlife movement within the stream. Fish and other aquatic organisms need to have sufficient water depths to move through a stream crossing.

Even though shallow water may only be a seasonal issue, many species only disperse during low flow times. It is important that adequate water levels be provided at all times during the year so that all species can migrate.

Unnatural Bed Sediments

Metal and concrete are not appropriate materials for species that travel along the streambed. The substrate (rocks and other material on the bed of the crossing) should match the natural substrate of the surrounding stream. Benthic substrates are important for providing cover from predators and resting habitat during dispersal.

Natural rocks and sand can also assist in slowing water velocities inside the culvert. Rocks and sand create variation in water depth, turbulence, and friction, thereby slowing the water and making culverts more passable to aquatic wildlife.

Scouring and Erosion

In undersized crossings, high water velocities may scour natural substrates in and downstream of the crossing, degrading habitat for fish and other wildlife. High water velocities and related flow alterations may also erode stream banks. Scour pools often develop downstream of perched culverts and may undercut the culvert.



Shoal Creek tributary, Dawson County



Headwaters of Raccoon Creek, Paulding County



Tributary to Little Sugar Creek, Morgan County



High Water Velocity

Water velocity is higher in a constricted crossing than it is upstream or downstream. High water velocities can exist throughout culverts during low flows, but fish need occasional rest in slower moving water. During high flows and floods, high water velocities may degrade wildlife habitat, hinder fish movement, and weaken the structural integrity of crossings. During floods, undersized crossings may be filled with fast-moving water. Many of the problems with poorly designed crossings are heightened during floods.



Unnamed stream, Walton County

Clogging

Some crossings, especially those that are undersized, can become clogged by woody debris, leaves, and other material. This may exacerbate the impact of floods and make a crossing impassable to wildlife. Costly, routine maintenance may be required to prevent this problem.



South River tributary, Clayton County

Ugliness

Ugliness is common in old and new culverts. Excessive rip-rap placed in the stream bed, exposed and eroding dirt, and exposed metal pipe culverts are signs of an ugly crossing. Aesthetically pleasing and publically accessible crossings can be created just as easily. There are no culvert ugliness regulations in Georgia.



Big Cotton Indian Creek tributary, Henry County

Regulations in Georgia

Safe and stable stream crossings can accommodate wildlife and protect stream health while reducing expensive erosion and structural damage. One goal of this handbook is to provide real, easily attainable solutions.

Crossings should be essentially “invisible” to fish and wildlife; they should maintain appropriate flow and substrate through the crossing and not constrict a stream. At the same time, designs should be efficient and cost-effective.

Fish-passable road-stream crossings have been engineered for years in many states, and Georgia is now among a growing number of states with policies aimed at producing fish passable crossings. All road stream crossings in Georgia that are permitted under the Nationwide Permit Program should be designed in accordance with the U.S. Army Corp of Engineers (Savannah District), Nationwide Permit Regional Conditions (ACOE 2007). These conditions, or regulations, for new culverts require road crossing designs to include strategies that promote fish passage by maintaining the existing dimension, pattern and profile of the stream above and below a road stream crossing. These conditions only apply to projects that seek approval under the Nationwide Permit Program, but the strategies and techniques should be used on all road stream crossings to protect Georgia’s fish and wildlife. Although regulations may change over time, guidelines presented in this handbook remain effective for providing aquatic organism passage.



A recent scientific study out of the University of Georgia’s River Basin Center found that nearly half of the pipe culverts surveyed were barriers to fish movement. Another study by USFWS found that most new crossings in Georgia didn’t conform to regulations.

Army Corps of Engineers Savannah District Regional Conditions for all Nationwide Permit Culverts.

1. The width of base flow culvert(s) shall be approximately equal to the average channel width. Culvert(s) shall not permanently widen/constrict the channel or reduce/increase stream depth. Multiple pipe culverts may not be used to receive base flows.
2. Bank-full flows shall be accommodated through maintenance of the existing bank-full cross-sectional area.
3. The upstream and downstream invert of culverts (except bottomless culverts) installed in perennial streams will be buried/embedded to a depth of 20% of the culvert height to allow natural substrate to colonize the structure’s bottom and encourage fish movement.
4. Culvert slope shall be consistent with average stream segment slope, but not exceed 4 percent.
5. Culverts shall be of adequate size to accommodate flooding and sheet flow in a manner that does not cause flooding of associated uplands or disruption of hydrologic characteristics that support aquatic sites on either side of the culvert.
6. Where adjacent floodplain is available, flows exceeding bankfull shall be accommodated by installing equalizer culvert at the floodplain elevation.
7. Nationwide Permit Applications should contain the following information: 1) Culvert type and size, 2) Depth the culvert inlet and outlet will be embedded, 3) Culvert slope, 4) Baseline longitudinal profile of the stream bottom, 5) Three baseline channel cross-sections, and 6) Proposed as-built cross sectional diagram demonstrating culvert position in channel.

These regulations are current as of March 2012. Always check that you have the most recent version of the Regional Conditions before you design a crossing.

For more information on the regulations, fish passage, and the types of information required by the Corps to obtain a permit, visit http://www.fws.gov/athens/stream_crossing/.



Wildlife Passable Crossings

Tributary to Chattahoochee River in Cobb County, Georgia. The dimension, pattern and profile of the stream was largely maintained within and outside the culvert. Sinuosity (stream curviness) within the culvert was maintained. Fish safely moved upstream and downstream through this culvert. Multiple wildlife tracks in the sand indicate that mammals safely traversed under the road.



Unnamed stream in north Georgia. Natural rocks and sediments were placed inside the culvert. These rocks provided refuge from faster moving water for many aquatic species, including salamanders, fish, and dragonflies. However, the culvert was not embedded 20% of the culvert diameter.



photo: Brad Ehrman, GDOT

Birch Creek in Henry County, Georgia. Bankfull flows were accommodated through maintenance of the existing bankfull channel cross sectional area. Floodplain culverts and concrete baffles were installed to accommodate flows that exceed bankfull discharge. Although this crossing was wildlife passable, the culvert was installed askew of the stream. This ultimately caused excessive erosion under the culvert headwalls.

and are aesthetically pleasing. This arch-span culvert was probably fish and wildlife passable. The concrete footers are spaced wide enough to allow a natural range of water velocities needed for fish movement.



Conasauga Creek in Gilmer County, Georgia. The culvert slope matched the stream slope and was less than 4%. Natural substrate lies throughout the structure's bottom. Multiple microhabitats were present, enabling wildlife to live within the culvert. The absence of light can sometime be a barrier to the movement of wildlife through culverts. This culvert was very open, allowing plenty of sunlight for wildlife movement.

Tributary to Long Swamp Creek in Pickens County, Georgia. To minimize costs, the engineer avoided using multiple boxes. Sills were created within the box in order to maintain the natural channel width, avoid over-widening of the channel, and to accommodate flows that exceed bankfull discharge.



Tributary to McNutt Creek, Clarke Co., Georgia. Arch-span culverts are increasingly common because they provide a natural stream bottom



Largemouth bass. Small and large fish have difficulty traversing poorly designed culverts. Image courtesy of the Duane Raver Art, Fish Collection.

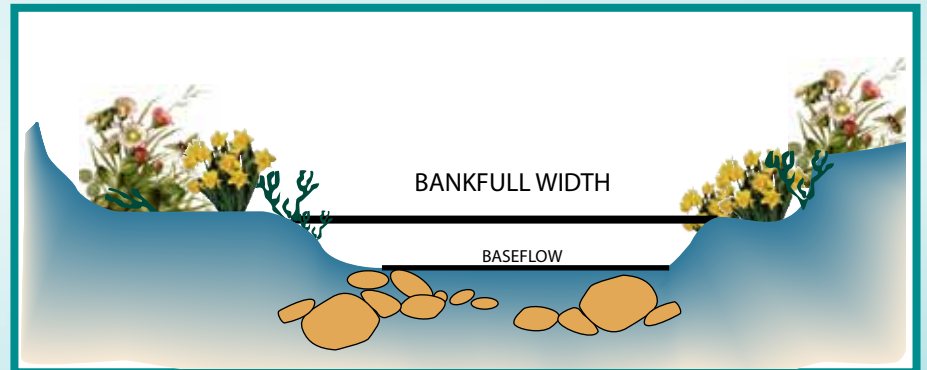
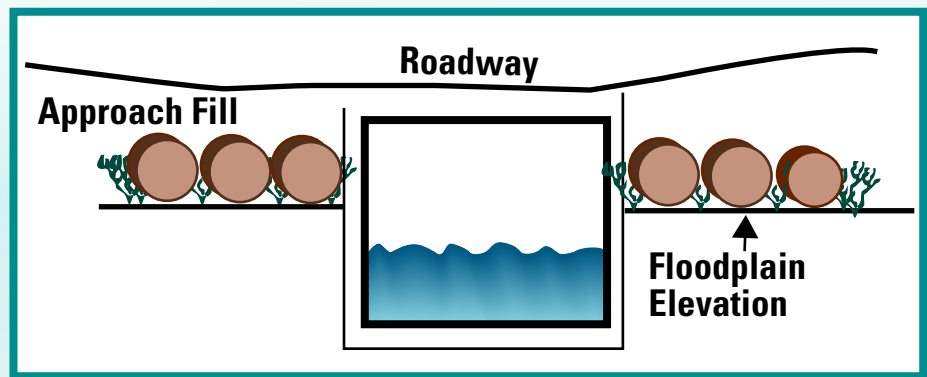
bottom photo: Brad Ehrman, GDOT

Equalizer culverts (a.k.a. floodplain culverts) can be placed at floodplain elevation to accommodate flows from one side of the floodplain to the other side. These culverts also allow mammals to cross under the road freely, without risking their lives or the safety of motorists.



Bankfull Width Measurement

One of the most frequently used measurements in stream crossing design is bankfull width. Unfortunately, determining the location of bankfull on a stream can be a tricky task. Georgia streams do not generally have a well defined bankfull bench and many of our streams are incised due to past land use practices. Throw in the fact that our State covers four different physiographic provinces and consistent bankfull determination becomes even more difficult. Given this difficulty, an agreed upon definition for Georgia is necessary so that surveyors and consultants can provide consistent results.



Bankfull: For a given stream segment, the lowest point at which water can leave the channel and dissipate the stream's energy into the floodplain. For Georgia streams, this will often be top of the bank.



photo: Dick Biggins, Rainbow Darter

Designing Wildlife Passable Crossings

Designing a safe, practical, and fish-friendly crossing doesn't have to be difficult, time consuming, or expensive. But it does require a basic knowledge of the project needs, the stream geomorphology and hydrology, and aquatic fauna. Effective approaches generally fall into three categories. More information on the below techniques can be found in FHWA (2007):

Geomorphic Simulation (Stream Simulation)– this approach recreates or maintains natural stream reach geomorphic elements including slope, channel width, bed material and bedform by using a reference reach. This strategy assumes that crossings that replicate natural conditions will not impact fish passage or stream habitat characteristics.

Hydraulic Simulation– this practice utilizes techniques (embedded culverts, baffles, oversized rock) to provide hydrologic conditions conducive to fish passage. This approach operates on the assumption that providing hydraulic diversity approximately similar to that found in natural channels will create a fish passable structure.

Hydraulic Design– this approach creates water depths and velocities that meet the swimming abilities of target fishes. Hydraulic design is most often used in retrofit projects. General considerations include the effect of culvert slope, size of bed material and culvert length. Flow control structures such as weirs, or oversized substrate are commonly

used to create acceptable hydraulic conditions. This strategy assumes that swimming abilities of aquatic species are known and can be incorporated into the design to provide passage.

Given that the regional conditions generally apply to geomorphic characteristics of a stream,

geomorphic simulation is typically the preferred approach. This does not exclude the use of the other approaches, but if hydraulic simulation or hydraulic design techniques are used, the 2007 Nationwide Permit Regional Conditions still apply.



Top and bottom photos are fish passable culverts over Conasauga Creek, Gilmer County, GA. Photo courtesy of Brad Ehrman GDOT.



Geomorphic Simulation

The United States Forest Service (USFS) has produced a manual of their “Stream Simulation” design technique: (http://stream.fs.fed.us/fishxing/aop_pdfs.html). This methodology utilizes a reference reach approach to understand bed material, channel morphology and structures found within the natural channel. A crossing structure is then designed to match reference reach characteristics. This ideally creates a crossing that is self sustaining and free to adjust similarly to the natural channel.

This approach is simplest for new installations, where open bottom structures can be placed to span the stream channel, leaving natural bed material and bedforms in place. In replacement installations, past channel degradation may require a culvert to be steeper than the natural channel. Replacement culverts and retrofits have a host of different criteria to consider and is discussed in depth on the following page.

The USFS manual is quite comprehensive, but appropriate designs will require a skilled group of design professionals with knowledge covering engineering, hydrology, biology, and geomorphology. Note—many criteria, such as slope, width and applicability are largely left to the discretion of design professionals who work as a team to find the appropriate combination of variables to meet project objectives.

Free Design Software

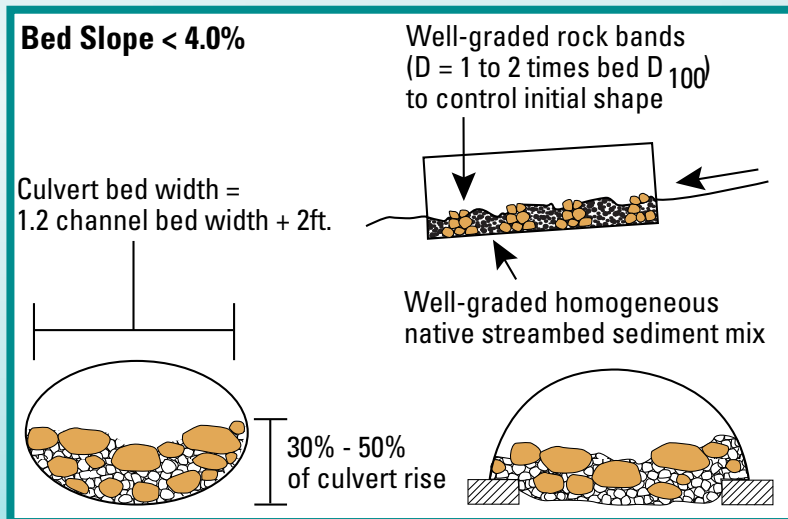
FishXing is a free computer program that allows users to evaluate multiple culvert designs and effects on fish passage.

HY-8, V-7.0 is a free modeling program produced by Federal Highways. It is intended for hydraulic capacity design.

Hec-RAS is a free river modeling program produced by the Army Corps of Engineers. It facilitates hydraulic calculations across a network of natural and constructed channels.



Low flow channel in an open bottom structure. Photo courtesy of USDA 2008a.



Washington Department of Fish and Wildlife Stream Simulation approach for low slope situations, where bed slope $< 4.0\%$ (Bates et al. 2003). D is diameter of sediments and D_{100} represents the largest stream bed sediment.

Consult with ecologists, hydrologists, and geomorphologists to ensure that the design is fish passable and animal friendly.



Greenbreast darter. Photo courtesy of Forrest Aguar, Georgia Fishes Field Course.

Retrofits and Replacements

Most stream crossings in Georgia were designed and installed at a time when the environmental impacts of such crossings were not understood. Even effective but aged crossings may need to be upgraded or replaced because they have weathered decades of floods and erosion. Periodic upgrading of bridges, culverts, and roads is often required to keep crossings safe and effective.

Repairing or replacing deteriorated culverts is not always as straightforward as installing a larger pipe. Streams may naturally adapt to problems caused by poorly designed or degraded crossings. The benefits of retrofitting or replacing a crossing should be weighed against the costs of the project and the environmental consequences. One consequence often overlooked when removing stream crossings is providing upstream accessibility to invasive species whose range was previously limited.

If feasible, culvert replacement is preferable over retrofitting.

Careful analysis and consultation that utilizes the expertise of engineers, construction professionals, and



The invasive red shiner. Photo courtesy of Noel Burkhead, USGS.

conservation professionals should be considered. The following are potential problems that should be evaluated before a culvert is retrofitted or replaced:

- Potential for flooding
- Effect on riparian habitat
- Potential for erosion, including head-cutting (channel erosion upstream of culvert)
- Overall effect on stream stability

When replacement is desirable, the standards for new crossings should be adhered to as much as possible. Crossings should be designed to weather a large flood safely. Otherwise, erosion will occur and the crossing will need to be fixed or replaced again. In some cases a retrofit may be more appropriate, leaving the current culvert in place

and adjusting the streambed to eliminate perching, or adding bed material inside the culvert to create a more natural streambed.

For replacement culverts, a longitudinal profile of the streambed, both upstream and downstream of the culvert, should be completed to see how well the upstream and downstream bed elevations match. If there is a significant difference, additional engineering measures will need to be considered during design.



Raccoon Creek in Paulding County. Impassable because of shallow water depth and perched above creek.



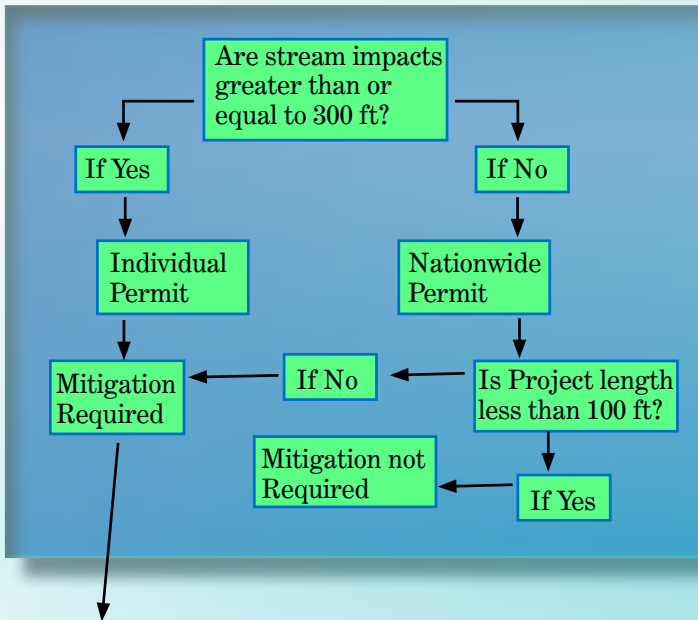
Tributary to Little Sugar Creek, Morgan County. Impassable because outfall is perched above creek. A longitudinal stream profile would show a significant difference in upstream and downstream bed elevations.

Permitting and Mitigation

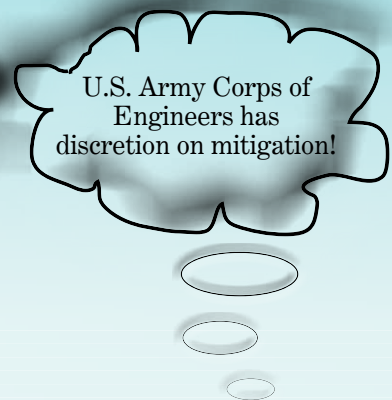
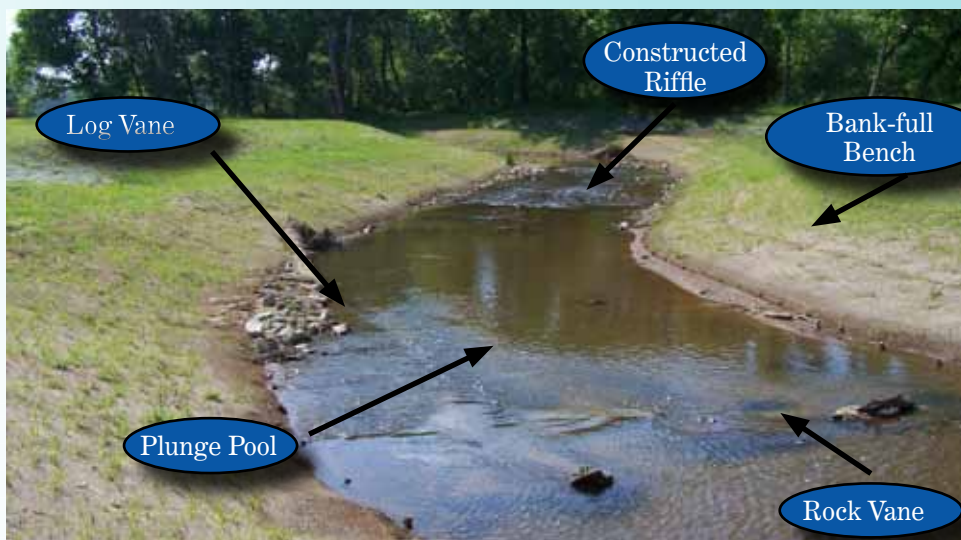
Placement of fill materials in waters of the United States requires a permit from the U.S. Army Corps of Engineers (USACE). Depending on the degree and type of fill material (e.g., concrete, rip-rap, and dirt), permitting for impacts is different.

For general road stream crossing permits resulting in impacts of <300 feet, applicants can pursue approval under the nationwide permit program. Impacts over 300 ft. generally require an Individual Permit. When waters of the U.S. are impacted, the Clean Water Act requires that mitigation for those impacts be provided. Impacts less than 100 feet are considered negligible and mitigation is not

required, but impacts over 100 feet require mitigation either through the purchase of credits or through individual mitigation projects. The USACE has a Standard Operating Procedure (SOP) that provides guidelines for the amount of mitigation necessary for specific impacts. These guidelines, as well as other permitting information, can be found on the USACE webpage.



If a project has multiple crossings there are additional limits on the overall length of impact. The overall limitations are specific to the type of nationwide permit being pursued. If the limitation is exceeded an individual permit may still be necessary. See nationwide permits for specific requirements.



Bannister Creek Mitigation Bank: This stream mitigation bank is located in Forsyth County and provides credits for stream impacts that occur in the Etowah River Watershed. The picture above shows the newly constructed stream channel and floodplain which will provide stream stability and improved aquatic habitat.

Incentives For Smart Designs

Type of crossing– Because bridges and arch-spans typically do not result in stream fill, they do not necessarily need Corps permits. Mitigation is not required. Because the time and expense associated with permitting and mitigation can be significant, the savings also can be significant.

Length of Impact– Pipe culverts generally result in more linear feet of impact to a stream because of the amount of fill associated with these designs. The use of box culverts can significantly reduce the length of impact associated with the crossing which reduces mitigation costs.

Maintenance– Crossings that are shorter in length and bigger in width have a reduced chance of becoming clogged with logs and other debris. Pipe culverts, which are generally long– relative to height and width– become clogged during large storm events. This can result in the culvert blowing out. Consequently, crossings that are sized to pass bank-full flows with out altering the pattern and profile of the stream tend to need less maintenance for debris removal and perform better in large storm events, increasing the lifespan of the crossing.

Endangered Species Act Consultation– When threatened and endangered species are present, federal agencies and developers consult with the U.S. Fish and Wildlife Service. This consultation can be time intensive, both for the applicant and for the Service. However, designs that initially provide for fish passage typically require less review and approval time than those that have not met design requirements.



Fish passable arch-span culvert over a Shoal Creek tributary in Cherokee County. Photo courtesy of Brad Ehrman GDOT.



Fish passable box culvert over Fightingtown Creek in Fannin County. Photo courtesy of Brad Ehrman GDOT.

Georgia's Imperiled Species

Many of Georgia's streams provide habitat for imperiled species of fish and other wildlife. Careful consideration should be taken in these areas so that impacts to these species can be minimized or avoided. Many of these

imperiled species are listed on the Federal Endangered Species List. Listed species have special protection under the law and consultation with the U.S. Fish and Wildlife Service (FWS) is necessary when disturbance activities are occurring within these species ranges. The map below shows watersheds in Georgia where imperiled species live. When pursuing a project in the blue highlighted areas below, applicants should contact the FWS prior to applying for a Corps permit

to determine whether the proposed project could potentially impact listed species. In addition to the map below, the FWS keeps a county list of where species occur on their website. GA DNR also provides information on the distribution of imperiled species. (www.georgiawildlife.com/conservation)



Goldline darter- This fish is endemic to the Mobile River Basin. One of its two populations is found in GA in the Coosawatee River System.



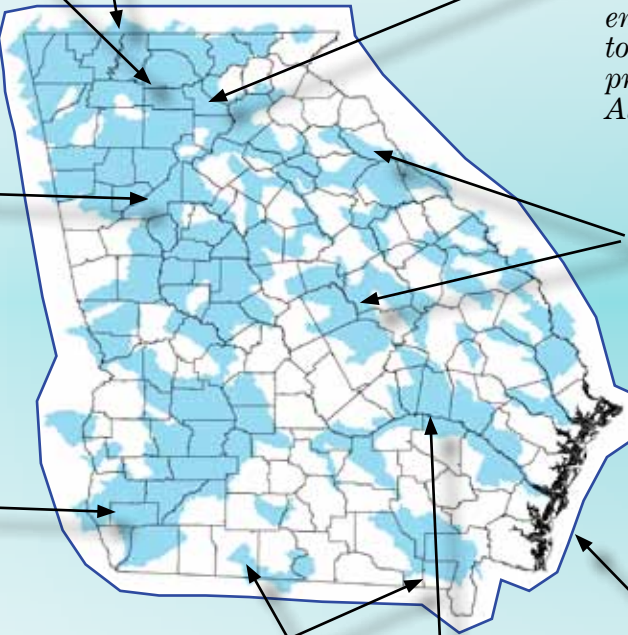
Conasauga logperch- Endemic to the Conasauga Watershed and federally endangered.



Etowah darter- Federally endangered fish endemic to the Upper Etowah River, primarily upstream of Allatoona Reservoir.



Chattahoochee crayfish- This uncommon crayfish has a restricted range near Atlanta.



Robust redhorse- Unique fish found throughout large streams in Georgia and South Carolina. This species has no federal status, but has experienced significant declines throughout the 20th century.



Spring Creek and many other southwest Georgia streams are recognized for having a high diversity of mussels, including federally listed species.



Suwannee bass- This protected game fish has a very limited range.



Altamaha spinymussel- Endemic to the Altamaha River; this unique mussel is federally endangered.



Shortnose sturgeon- Federally endangered fish found in large Atlantic Coast rivers- primarily the Altamaha, Ogeechee and Savannah rivers.

Conclusion

Road stream crossings, when not installed properly, can fragment stream habitat and prevent necessary migration along the stream corridor. Fortunately, certain design standards are required in the State of Georgia that will maintain habitat continuity and minimize movement barriers in aquatic systems.

These standards are required through the Army Corps of Engineers 404 permitting process for Nationwide Permits. The standards address culvert type, orientation, size, slope, and the substrate.

These standards are not new strategies. Many of these practices have been used for decades, and some for centuries, because they do not alter the pattern and profile of streams. Properly sizing crossings and maintaining the pattern and profile of the stream is extremely important for structure stability.

Streams are very powerful forces. When we alter a stream with a road crossing, the stream will often respond negatively. The closer the crossing follows the existing pattern and profile of the stream, the smaller the response. It is no coincidence that the oldest crossings around the State are sized to handle large flows, follow the natural stream pattern, and mimic the natural channel dimensions.

There are incentives for meeting the nationwide conditions, most of which are inherent due to the fact that the crossing should be more structurally stable and have reduced maintenance costs. But there are monetary incentives as well due to decreased mitigation costs and faster permitting, especially where federally protected species are present.

The Natural Resource Agencies, both State and Federal, are very excited about the aquatic passage guidelines that have been adopted in Georgia. We ask that the Georgia citizens, local governments, and the private sector join us in our efforts to provide barrier free waters, so that future generations may have the same opportunities to experience the precious fish and wildlife of Georgia's streams.



The crossing (above) over Dill Creek in Murray County, GA was replaced (below) in the summer of 2010 by Murray County and The Nature Conservancy using a cost-share grant provided by the U.S. Fish and Wildlife Service's Partners for Fish and Wildlife Program. This project re-established habitat connectivity between Dill Creek and the Conasauga River. In the months following culvert replacement, new fish species were found upstream from the crossing.



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Useful Websites

FishXing Software
<http://www.stream.fs.fed.us/fishxing/>

HECRAS Software
<http://www.hec.usace.army.mil/software/hec-ras/>

U.S. Army Corps of Engineers Regulations
<http://www.sas.usace.army.mil/sasinfo.htm>

U.S. Fish and Wildlife Service, Georgia Ecological Services
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Conasauga logperch– Conservation
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Etowah darter– Candace Stoughton
(TNC)

Robust redhorse– Jimmy Evans
(GDNr)

Shortnose sturgeon– Fort Stewart

Altamaha spinymussel– Will Duncan
(USFWS)

Suwannee bass– Adam Kaeser
(GDNr)

Spring Creek mussels– Sandy Abbott
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Chattahoochee crayfish– Chris
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Georgia map produced with the aid of
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