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## Conservation of Aquatic Critical Habitats in North Carolina

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*Abstract:* North Carolina's State Endangered Species Act for Animals was established in 1987. Since that time, approximately 200 species have been listed as endangered, threatened, or species of special concern. The act, however, provides few ways to prevent take of these species or to conserve the listed species' habitats. Therefore, state regulatory agencies have been establishing procedures for conserving wetland and aquatic endangered and threatened species. Approximately half of the listed species are aquatic; therefore, significant aquatic habitat conservation is expected during the next decade.

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From 1980 through the year 2000, North Carolina's human population is projected to grow from 5.9 million to 7.6 million. During this period, the population density will grow from 43 to 56 citizens per square kilometer (U.S. Bur. Census 1983, 1990).

The increasing use of the state's natural resources via development projects, reservoir construction, highway construction, waste processing, and other activities will continue to cause loss of wildlife habitat. To some extent, the number of state endangered, threatened, and special concern species is one measure of past human impact on wildlife habitat. North Carolina's state list of protected animals will soon exceed 200 species. Roughly half of these are aquatic species. Half of North Carolina's approximately 70 freshwater mussel species and a quarter of the approximately 225 freshwater fish species are state-listed. Better management of protected species' habitats would conserve not only these species but also other components of properly functioning ecosystems.

The North Carolina Wildlife Resources Commission (NCWRC) is responsible for identifying critical habitats for state-listed endangered and threatened species.

Once an aquatic critical habitat is identified, the NCWRC can request that the North Carolina Environmental Management Commission (NCEMC) designate it as high quality waters, and the habitat then will receive special protection from the state. This process takes place in 3 stages. Each stage requires citizen input through the public hearing process.

### Methods for Designating Critical Habitats

In the first stage, the NCEMC adopts definitions and rules for the protection of high quality waters. These definitions and rules include provisions for the conservation of NCWRC designated critical habitats as high quality waters.

The second stage requires that the NCWRC develop definitions and rules to allow designation of critical habitats. A critical habitats subcommittee is formed. Members include NCWRC nongame staff and heads of all scientific councils charged with developing basic definitions for critical habitats and with identifying the state's endangered, threatened, and special concern animals. The critical habitats subcommittee's charge is to identify all aquatic critical habitats for state listed endangered and threatened species. These critical habitats are considered essential for the conservation of these species. The NCWRC's Nongame Wildlife Advisory Committee would receive a report from the Critical Habitats Subcommittee which recommends definitions for critical habitats and areas to be designated as critical habitat by the NCWRC. The Nongame Wildlife Advisory Committee will review the documents, make recommendations for modifications, and recommend that the modified documents be forwarded to the NCWRC for consideration and adoption. The NCWRC will then consider adoption of the definitions for critical habitats and designation of critical habitats. The NCWRC can then recommend to the NCEMC that these critical habitat areas be designated high quality waters of the state.

The third stage requires the NCEMC to designate NCWRC critical habitats as high quality waters.

### Results

The first stage in critical habitat conservation has been completed by the NCEMC. High quality waters regulations apply to new or expanded wastewater discharges (NCEMC 1992). Effluent limitations for oxygen consuming wastes are 5-day biological oxygen demand (BOD) = 5 mg/l, ammonia and total nitrogen (NH<sub>3</sub>-N) = 2 mg/l, and dissolved oxygen (DO) = 6 mg/l. More stringent limitations will be set, if necessary, to ensure that the cumulative pollutant discharge of oxygen-consuming wastes will not cause the DO of the receiving water to drop more than 0.5 mg/l below background levels, and in no case below the standard. Total suspended solids will be limited to 20 mg/l. Failsafe treatment designs will be employed, including stand-by power capability for entire treatment works, dual train design for all treatment components, or equivalent failsafe treatment designs. The total volume of treated wastewater for all discharges combined will not exceed 50% of the total instream flow under 7Q10 (the 10-year minimum average flow for

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As human population is pro-  
gressing, the population  
growth rate (U.S. Bur. Census

via development projects,  
mining, and other activities  
increasing, the number of state  
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7 consecutive days) conditions. If required, appropriate effluent limitations will be set for phosphorus or nitrogen or both. In general, only the discharge of domestic (multi-family) or non-process industrial wastewater will be permitted. A sedimentation / erosion control plan will be required for high density development projects on lands which drain to and are within 1.6 km of high quality waters. Such plans will also be required for other projects where necessary to protect the existing uses present in the high quality waters.

The first 2 steps of the second stage have been completed by the NCWRC. In order for an area to be designated as critical habitat, the NCWRC determined that the following 4 definitions or conditions must be met:

(1.) "Critical habitat" shall mean any habitat which is considered essential for the continued survival of an endangered or threatened wildlife species.

(2.) Critical habitats shall be recommended for Commission adoption by the Nongame Wildlife Advisory Committee based on sound biological evidence.

(3.) Critical habitats shall include those areas within the geographical area occupied by an endangered or threatened species on which are found physical or biological features which are essential to the conservation of the species and which may require special management considerations or protection. A given critical habitat may also include specific areas outside the geographical area occupied by an endangered or threatened species that are determined to be essential for the conservation of the species and which may require special management considerations or protection.

(4.) Critical habitats shall not necessarily include the entire geographical area which can be occupied by a threatened or endangered species unless the management and protection of the area has been determined to be essential for the conservation of the species.

Using this formula and given the known ranges and health of various endangered and threatened species' populations, 34 aquatic critical habitat areas have been recommended for NCWRC designation. These proposed critical habitats include only the listed freshwater mussels ( $n = 21$ ) and fish species ( $n = 3$ ) in North Carolina. State listed fish and crustacean species were not available when the first critical habitats package was being developed. The 34 proposed critical habitats are found throughout the state's major physiographic provinces: Mountains, Piedmont, and coastal plain. Among the 34 proposed critical habitats are significant subbasins in 9 river basins: the New (Mountains), Watauga, Little Tennessee, Catawba, Pee Dee, Waccamaw, Cape Fear, Neuse, and Tar. Most of the proposed critical habitats are cluster areas for several endangered, threatened, or special concern species. In general, these areas also have high species diversity and significant sport fish and game animal populations.

### Discussion

High quality waters designations of critical habitats is only 1 layer of protection being developed in North Carolina to conserve state and federally listed endangered and threatened species. It is required since activities associated with some land uses, such as agriculture and forestry, are not addressed by high quality waters regulations.

In the future, river basins will be managed by the North Carolina Division of Environmental Management on a basinwide scale to better manage point and non-point sources of pollution. Part of this effort is to expand protection of highly valued resource water (including high quality waters) by limiting input of wastewaters and by implementing best management practices to reduce sediment and nutrient runoff. The first comprehensive management plan is being developed for the Neuse River Basin (N.C. Div. Environ. Manage. 1992a) which covers 12% of the state and contains 6 of the proposed critical habitat subbasins. Other management plans will be developed in the near future for other river basins.

Still another layer of protection is being developed for the Albemarle-Pamlico Estuarine Area which covers parts or all of 35 counties in eastern North Carolina (Albemarle-Pamlico Estuarine Study 1992). Major river basins involved include the Neuse, Pamlico, Roanoke, and Chowan. Eleven of the 34 proposed critical habitats are in the Albemarle-Pamlico Estuarine Area. Control of point and nonpoint sources of pollution are emphasized on a region-wide basis. One of the major goals is to protect rare natural communities and habitat essential to the survival of rare species.

Wetlands associated with high quality waters may also receive special protection in the near future. The North Carolina Division of Environmental Management (1992b) is considering rules required to conserve wetlands adjacent to high quality waters. For such wetlands, a project must be water dependent before it can be permitted. If a permit is issued, mitigation for the loss of these wetlands requires replacement at an acreage ratio of 4:1 within the same river sub-basin.

Private conservation organizations are becoming involved in the conservation of aquatic critical habitats. A conceptual protection plan for the upper Tar River has been developed for the North Carolina Nature Conservancy (Roe 1992). Numerous strategies are included in 6 major goals. These goals include making the protection of the Tar River Basin's critical habitats a priority project of The Nature Conservancy, expanding public education of the significance of the river basin, completing a systematic inventory of rare aquatic species populations, developing a river management plan, helping to implement management recommendations of the Albemarle-Pamlico Estuarine Study, and securing long-term ecological protection of significant areas in the river basin. Such goals should complement the U.S. Fish and Wildlife Service's (USFWS) plans to make the conservation of the Tar River Basin a priority USFWS project.

Conservation of aquatic critical habitats in North Carolina is consistent with recommendations developed at the North American Fisheries Leadership Workshop (Harville 1991). The top priority for management and allocation of resources required for a vision for North American fisheries into the 21st century was the following:

Aquatic resources are managed for long-term sustainability on a holistic, ecosystem basis. Intrinsic and ecological values are of primary importance, and healthy fisheries to meet human needs are being maintained within those guidelines. Biodiversity remains undiminished.

Another high priority under short-term and long-term issues and strategies was conservation of habitat. Specifically, under long-term issues and strategies, 3

major goals for the next several decades are to protect existing habitat, to develop an ecosystem approach to habitat protection, and to identify and prioritize habitats for restoration and acquisition throughout all ecological regions of North America. The identification and conservation of critical habitat areas in each state, which usually are the best representatives of properly functioning ecosystems, give conservation agencies their best hope for fulfilling the goals of the North American Fisheries Leadership Workshop. Such areas will provide the diverse genetic resources required for future restoration projects in improved aquatic habitats.

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## Natural Resources and Conservation of the Swift Creek Subbasin

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*Abstract:* The results of biological inventories and information about land uses in a North Carolina subbasin are linked to conservation directives. The product identifies the biological and ecological importance of a region which may be severely impacted by human developments if measures are not undertaken to conserve the rich fauna of the region.

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The Swift Creek Subbasin originates in the Piedmont of North Carolina and runs southeastward toward the Tar River near Tarboro, North Carolina. The subbasin is approximately 138 km long and encompasses approximately 690 km<sup>2</sup>, including parts of 5 counties that are primarily forest land and farmland. There is some development in the headwaters of the subbasin around the city of Henderson and near Gold Rock in Nash County, the only areas in the subbasin which are currently developed beyond rural agricultural and residential levels.

For several years the North Carolina Wildlife Resources Commission has known of many rare and endangered species of freshwater mussels in the Swift Creek Subbasin. Several attempts to initiate conservation actions for those species went virtually unnoticed by other state or federal agencies. In an effort to increase awareness and cooperation among conservation interests, the North Carolina Recreation and Natural Heritage Trust Fund provided a project grant, distributed among several state agencies, for subbasin inventories of certain taxa. The North Carolina Parks and Recreation Natural Heritage Program conducted inventories of plants, plant communities, and birds. The North Carolina State Museum conducted inventories of reptiles and amphibians. The North Carolina Wildlife Resources Commission's Nongame and Endangered Wildlife Program conducted inventories

of mollusks, crayfish, fish, and some mammals. Aquatic macroinvertebrate data was compiled by the North Carolina Division of Environmental Management. Alderman et al. (1993) reports the data collected by these agencies. Separately, the impacts of human activities on the Tar spiny mussel were examined (McGrath 1992), and threats to the species from development, point sources of pollution, nonpoint pollution, and several other activities were identified.

The information from Alderman et al. (1993) and McGrath (1992) is summarized here to provide direction for conservation actions that protect the resources of the Swift Creek Subbasin, especially those resources in the most danger of being lost in the near future.

### Methods

The subbasin inventory project detailed natural community types represented within the subbasin as well as rare plant species, reptiles, amphibians, small mammals, birds, terrestrial snails, aquatic snails, crayfish, mussels, aquatic insects, and fish. The goal of the project was to provide presence-absence data of species with particular attention to rare species. The specific methodology of each taxa inventory, and specific location data can be found in Alderman et al. (1993). The information presented about land use trends and other potential impacts upon the natural system were derived from numerous publications, agency reports, interviews, and aerial photography of the region (McGrath 1992).

### Results and Discussion

#### Flora

Ten natural community types were documented within the subbasin (Table 1). The subbasin originates in the Piedmont physiographic province and terminates in the coastal plain and this accounts for the diversity of plant communities found. Many of the communities are biologically important because of their size and quality or the presence of rare species. Seven rare plants were reported from the subbasin (Alderman et al. 1993). Granitic flatrock communities contained 3 rare plants, and a large coastal plain swamp and forest near the Nash-Edgecombe county line contained 2 rare plants. The remaining rare plant species were found in dry oak-hickory forest and dry-mesic oak-hickory forest communities.

The ecological significance of the communities extends beyond the rare plants. Representative communities like Piedmont/low mountain alluvial forests, and mesic mixed hardwood forests are present in the subbasin and are large enough to warrant conservation attention. A floodplain pool community was documented and supported a population of the 4-toed salamander (*Hemidactylum scutatum*), a species of special concern (Alderman et al. 1993). The integrity of natural community composition in the subbasin depends upon retaining representatives of each of the communities found there. Alterations to the structure of these community representatives could change the fauna and flora and eliminate the community from the area.

**Table 1.** Natural communities represented in the Swift Creek Subbasin, North Carolina.

Community	Description*
Dry oak-hickory forest	Dry uplands and steep slopes with only few canopy species of oak and hickory. Rare plant (nestronia).
Dry mesic oak-hickory forest	Dry to mesic uplands with several oaks, hickory, sweetgum and poplar canopy. Rare plant (Lewis's heartleaf).
Mesic mixed hardwood forest	Moist slopes with very diverse canopy including several oaks, hickories, beech, elm, and maple. Rare plant (Lewis's heartleaf).
Granitic flatrock	Smooth bedrock outcrops with vegetation dispersed in islands. Rare plants (granite flatsedge, Piedmont quillwort, Small's portulaca).
Piedmont/low mountain alluvial forest	Associated with small floodplains with diverse canopy including oaks, hickories, willow, birch, ash, walnut, poplar, pine, beech, maple, and sweetgum.
Cypress-gum swamp	Broad and flat floodplain, canopy of baldcypress, sweetgum, red maple, water tupelo, swamp cottonwood, and overcup oak. Rare plants (yellow water-crowfoot, crowfoot sedge).
Coastal plain levee forest	Similar to cypress-gum swamp; however, canopy also includes birch, ash, sycamore, willow, and elm. Understory vegetation is also different.
Coastal plain bottom land hardwoods	Occurs away from levee with canopy including maple, ash, pine, sweetgum, and at least 7 species of oaks.
Coastal plain small stream swamp	Similar to Piedmont/low mountain alluvial forest; however, the canopy includes baldcypress, swamp cottonwood, and black gum.
Floodplain pool	Depression in an abandoned creek channel that is infrequently flooded. Plants include red maple, river birch, greenbrier, and swamp rose. Supports a rare animal population (Salamander).

\* For a complete description see Alderman et al. 1993.

**Fauna**

The inventory of the subbasin documented 459 species of animals. Because of the nature and scope of the project and the limitations discussed, this is not a definitive list of occurrences. Surveys for bats, terrestrial insects, and other taxa would increase the total number of species found. However, the inventory provided an overview of the much of the fauna of the area.

Several taxa were diverse relative to the size of the subbasin. For example, 7 of 29 species of crayfish in North Carolina were found in the Swift Creek Subbasin (Alderman et al. 1993). Nearly 30% of the freshwater fish species expected from the Atlantic drainages in North Carolina were found in Swift Creek (Alderman et al. 1993). In addition, the 14 species of freshwater mussel species found in Swift Creek may make it one of the most significant streams along the entire Atlantic seaboard (Alderman et al. 1993).

Several of the animal groups surveyed included species from both physiographic provinces. The faunal list includes some species found only on the coastal plain and others found only in the Piedmont. This was the case for some crayfish, aquatic snails, reptiles, amphibians, and mammals. The subbasin's transition from Piedmont to coastal plain is significant because it may contain clues which define the habitat requirements of many of the animal species (Alderman et al. 1993).

Aquatic macroinvertebrate data Environmental Management. All of these agencies. Separately, the mussel were examined (McGrath et al. 1992) and McGrath (1992) is summarized the resources in the most danger of

community types represented reptiles, amphibians, small mammals, mussels, aquatic insects, and absence data of species with methodology of each taxa inventory (Alderman et al. 1993). The potential impacts upon the agency reports, inter-agency (1992).

within the subbasin (Table 1). The province and terminates in plant communities found. Because of their size and number of plants were reported from the 3 rare communities contained 3 rare species were found in the Nash-Edgecombe plant species were found in the rest communities. The rare extends beyond the low mountain alluvial forests, the subbasin and are large pool community was documented salamander (*Hemidactylum* (Alderman et al. 1993). The integrity of the subbasin upon retaining representations to the structure of these communities and flora and eliminate the



Thirty-two species of rare animals were documented within the subbasin. Of those, 30 are aquatic species which depend upon the surface waters of the subbasin for their continued survival. They include the Tar spiny mussel (*Elliptio steinstan-sana*), a federally-listed endangered species, 7 other state listed freshwater mussel species, and 2 state listed species each of amphibians, fish, and birds. Fifteen species of rare aquatic insects were recorded from the creek (Alderman et al. 1993).

The creek is critical for the continued survival of many rare animals found in the subbasin. Many factors produce the conditions favorable to these animals and to conserve these resources care must be taken not to shift the delicate balance to the detriment of these species.

#### Land and Water Uses

The 5 counties that the Swift Creek Subbasin traverses are essentially rural counties where agriculture and forestry are the predominant land uses (Table 2). The estimates of land uses in Table 2 represent entire counties and, if it were possible to extract the subbasin from those figures, the percentage of farmland and forestland would be higher.

In the subbasin counties, there appears to be a trend during the last 10–15 years in which the amount of land in farms and the number of farms are declining (McGrath 1992). The amount of woodland on farms is also declining in these counties. However, the amount of cropland does not show the same decline (McGrath 1992) and this suggests that conversion of woodland to cropland or other uses is occurring. There are portions of the subbasin which are more disposed to conversion of woodland to developed land. Parts of the subbasin in Vance County are being developed for homesites due to their proximity to Henderson. There is also some residential development in Nash County (McGrath 1992).

The impacts of development upon natural systems are numerous and varied. In general, urbanization negatively impacts many species of animals, particularly those which inhabit waters that drain from developed areas (N.C. Div. Environ. Manage. 1979a, McGrath 1992). Some of the impacts are runoff and toxics loading, and elevated erosion rates. Developed areas or areas undergoing development are susceptible to erosion and together with highway construction are major causes of increased sedimentation in North Carolina (N.C. Div. Environ. Manage. 1979a, 1979b).

Another potential impact upon the aquatic system from development is the increased pressure to use the water supply as a source of raw water or as a sink for wastes. Presently, no plans exist to use Swift Creek as a water source. There are, however, indications that the creek may be relied upon as a receiving stream for waste water from Henderson at some future time (McGrath 1992).

#### Conservation of Resources

Given what is known about the biological resources of the subbasin and the land use trends there, questions of how to conserve the resources will undoubtedly increase. The biological inventories have shown significant areas for rare plants and natural communities and the presence of many rare animal species. The creek itself is important to the continued survival of many rare animals.

**Table 2.** Land use estimates<sup>a</sup> in counties of the Swift Creek Subbasin 1990.

County	Harvested cropland (%)	Forestland (%)	Other (%)
Warren	8	72	20
Vance	11	64	25
Franklin	11	60	29
Nash	23	53	24
Edgecombe	31	46	23
Total	18	58	24

<sup>a</sup>Compiled from North Carolina Agricultural Statistics Division 1987, 1991; Thompson 1990; and Brown 1991.

There are essentially 3 directions to take for conservation of the subbasin's biological resources while the area grows and expands into the formerly rural subbasin. Portions of the natural communities and their associated rare plant species should be protected. The use of Best Management Practices (BMPs) on agricultural and forestland should be expanded and vigorously encouraged by the state and federal agencies in contact with the landowners. Finally, the integrity of the aquatic ecosystem and its inhabitants should be maintained.

Since residential and urban development is increasing in parts of the subbasin, we need to ensure that significant areas are not severely impacted by this growth. Portions of the granitic flatrock communities, the swamp and forest communities along the Nash-Edgecombe County line, the Piedmont/low mountain alluvial forest, and the mesic mixed hardwood forest on Red Bud Creek in Franklin County should only be minimally disturbed. This could be accomplished by an easement or purchase. Those areas need to be managed in such a way as to retain community integrity. The North Carolina Wildlife Resources Commission supports and encourages acquisition or easement by local land trusts or The Nature Conservancy.

Since the majority of the land in the subbasin is farmland or forestland and will likely remain that way into the future, implementation of BMPs on all such lands is important. Implementation of BMPs will not only increase water quality, but will also improve habitat for wildlife and increase streamside natural community refuges.

The North Carolina Wildlife Resources Commission continues to provide technical assistance to agencies or persons regarding BMPs on both agricultural and forestland. In addition several projects have been initiated or proposed for the Swift Creek Subbasin that will increase the amount and coverage of BMPs. These projects are collaborative projects with the U.S. Fish and Wildlife Service, the North Carolina Division of Soil and Water Conservation, and the North Carolina Division of Forest Resources. Consultation and technical guidance will be the primary focus of the Wildlife Commission's efforts; however, the projects will also involve some cost-sharing incentives for certain activities.

To ensure that the biological integrity of the creek is maintained the creek and its tributaries could be designated high quality waters. The high quality waters designation could provide a mechanism for habitat conservation. This water quality

designation imposes some land use constraints such as minimum lot sizes and imperviousness ceilings on development within the subbasin. It also sets constraints on additional point source discharges into Swift Creek or its tributaries. Point sources of pollution are detrimental to many aquatic animals including freshwater mussels and amphibians (Goudreau et al. 1988, Alderman et al. 1993).

The North Carolina Wildlife Resources Commission continues to pursue the designation of high quality waters for Swift Creek by first designating it as critical habitat for the endangered Tar spiny mussel. If and when the critical habitat designation occurs, then high quality waters status can be requested of the North Carolina Environmental Management Commission.

Carefully planned development with some restrictions is not a mandate for preservation, it is merely an attempt to ensure that the qualities of an area that make it attractive to both people and wildlife are maintained and the complex natural system continues to function.

The planned approach was and continues to be an educational and cooperative strategy towards conserving the resources of Swift Creek. Rather than adopt a hands-off preservation strategy, the approach was an attempt to educate individuals and agencies about the resources of the area and impress upon them that these resources can be conserved despite the many threats to the natural balance of the system. The fruits of this labor are not fully realized at present; however, continued efforts such as described above could produce positive results for the many valuable resources and the people of this unique area.

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