4.5 River Basins

4.5.1 Introduction

In an assessment of southeastern states, North Carolina ranked third highest in overall diversity of stream types (Warren et al. 1997). The richness of North Carolina’s aquatic fauna is directly related to the geomorphology of the state, which defines the major drainage divisions and the diversity of habitats within them. Watersheds of large rivers are commonly referred to as basins (Griffith et al. 1999) and North Carolina uses the basin concept as a spatial framework for assessment and management of drainage systems across the state.

Figure 4.5.1 provides a map depicting the boundaries of the 17 major river basins in North Carolina as designated by the NC Department of Environment and Natural Resources (NCDENR). While 11 of the river basins have headwaters that begin in North Carolina, only four basins are contained entirely within the state (Cape Fear, Neuse, Tar-Pamlico, White Oak). The other river basins have waters that drain across adjacent states (Georgia, South Carolina, Tennessee, and Virginia). Information about the river basins is available online at the NCDENR Division of Water Resources Basin Planning Branch web page http://portal.ncdenr.org/web/wq/ps/bpu.

Figure 4.5.1 North Carolina’s river basin boundaries
Five western basins in the state are part of the Interior Basin and drain to the Mississippi River and the Gulf of Mexico (Hiwassee, Little Tennessee, French Broad, Watauga, and New). North Carolina boundaries for these five river basins, along with the Savannah River Basin, have boundaries entirely within the Mountain ecoregion, which dominates the western third of the state. Generally, streams in the Mountain ecoregion are relatively high gradient with cool waters, have boulder and cobble-gravel bottoms, and are of low to moderate fertility. Larger streams and rivers have historically supported exceptionally diverse warmwater communities.

The other 12 basins of the state are part of the Atlantic Slope and flow to the Atlantic Ocean. The headwaters of the Broad, Catawba, and Yadkin-Pee Dee River Basins drain the eastern slopes of the Mountains. These river systems drain toward the ocean through the rolling topography of the Piedmont, where all but three of the remaining river basins originate. The Piedmont is a mosaic of broad valleys interspersed with highlands of varying topography and geology. Streams in the Piedmont are generally warmwater systems, have cobble-gravel and sand bottoms, and are of intermediate gradient and fertility.

The Fall Line marks a change in topography from the Piedmont to the flat terrain of the Coastal Plain. The North Carolina basins of the White Oak, Chowan, and Pasquotank rivers are entirely within the Coastal Plain ecoregion and are characterized by low gradient warmwater streams with sand and mud bottoms and high fertility. Natural lakes and extensive wetlands are important aquatic habitats found only in North Carolina’s Coastal Plain ecoregion.

A method developed by the US Geological Survey (USGS) spatially organizes drainage areas (DAs) by dividing watersheds into successively smaller hydrologic units based on four levels: regions, subregions, accounting units, and cataloging units (Seaber et al. 1987). The hydrologic units are arranged or nested within each other, from the largest geographic area (regions) to the smallest geographic area (cataloging units). Regional hydrologic units are identified by a unique two-digit hydrologic unit code (HUC) but smaller units may represent the most useful planning unit. The HUCs and associated maps have undergone extensive review by principle federal, regional, and state water-resource agencies and are widely accepted for use in planning and data sharing (Seaber et al. 1987). In North Carolina, 12-digit HUCs are commonly used for sharing aquatic resource data; however 14-digit HUCs may also be used.

Surface water classifications are another tool used in North Carolina to manage and protect state waters. The NC Division of Water Resources (NCDWR) assigns primary classifications to freshwaters to designate the highest and best uses (e.g., drinking water supplies, recreation) for protection within the surface waters. Each classification has an associated set of water quality standards to protect those uses. All waters must at least meet the standards for Class C (fishable/swimmable) waters. The other primary classifications provide additional levels of protection for water contact recreation (Class B) and drinking water (Water Supply Classes I through V). Streams, rivers, and lakes may have several classifications applied to the same area because they protect different uses or special characteristics of the waterbody (NCDWR 2014c).

Water classification data are available from the National Hydrography Dataset (NHD), a database that interconnects and uniquely identifies the millions of stream segments or reaches.
that comprise the surface water drainage systems in the United States. The NHD provides a national framework that allows information to be linked by reach address to an organization thereby allowing water quality data to be shared with other organizations, analyzed using a Geographic Information System (GIS), and easily integrated into many different types of applications to the benefit of all (USEPA 2014b). Datasets containing water classification information is available online from http://www.horizon-systems.com/nhdplus/NHDPlusV2_data.php.

4.5.2 Aquatic Biodiversity and Imperilment

The southeast region has the highest aquatic species diversity in the entire United States (Burr and Mayden 1992; Taylor et al. 1996; Warren et al. 2000; Williams et al. 1993). Southeastern fishes make up two-thirds of US fauna, and nearly half of the North American fish fauna (Burr and Mayden 1992). Molluscan diversity in the region is globally unparalleled, with 91% of all US mussel species found in the southeast (Neves et al. 1997). Crayfish diversity and global importance in the region rivals that of mollusks (Taylor et al. 1996), and crayfish in the southeast comprise 95% of the total species found in all of North America (Butler 2002a). North Carolina freshwaters support a significant proportion of that diversity with at least 210 freshwater fish, 125 mollusk, and 45 crayfish species native to the state.

Unfortunately, patterns of imperilment for aquatic species are similar amongst taxonomic groups. Collen et al. (2014) reports almost one in three freshwater species is threatened with extinction worldwide which, in comparison, is proportionally greater than the risk of extinction for terrestrial species (Burkhead 2012). More than two-thirds of the nation’s freshwater mussel and crayfish species are extinct, imperiled, or vulnerable (Williams et al. 1993, Neves et al. 1997, Master et al. 1998). The majority of these at-risk species are native to the southeast.

- North Carolina ranks third among southeastern states in number and percentage of imperiled fishes (Warren et al. 1997).
- Freshwater mollusks are suffering even greater declines, with numerous mussel and aquatic snail species that formerly occurred in the southeast now presumed extinct (Neves et al. 1997).
- Among crustaceans listed as endangered or threatened in the United States, more than half are from the southeast (Schuster 1997).
- Twelve species of North Carolina crayfish are listed as species of concern or rare in the state, with their small native range the primary factor in their vulnerability to habitat loss and competition (Clamp 1999; Taylor et al. 1996). Threats specific to crayfish include pollution and impoundment, but competition with nonindigenous species is also a primary threat to many species (Taylor et al. 1996).

National and regional causes of declines among all aquatic taxa are widely attributed to habitat destruction and degradation and the introduction of nonnative species (Williams et al. 1993; Taylor et al. 1996; Etnier 1997; Warren et al. 1997; Collen et al. 2014). The medium-sized rivers and creeks that provide important habitat for many aquatic species are frequently impounded and substrates have...
been altered by erosion and sedimentation. Habitat alteration from nonpoint source pollution and flow alteration (i.e., impoundments) is the primary cause of population declines for a large percentage of southeastern fishes considered imperiled (Etnier 1997; Collen et al. 2014). Not surprisingly, nonpoint source pollution and the effects of dams and impoundments are also the leading historic and current threats to freshwater mollusks (Bogan 1993; Neves et al. 1997; Richter et al. 1997). The complex life cycles and habitat requirements of mussels make them especially vulnerable to these perturbations (Adams 1990; Bogan 1993; Neves et al. 1997).

In North Carolina, threats to biodiversity are similar to those listed above and include point and nonpoint source pollution, hydrologic alteration, physical habitat manipulation, and pollution. In recent decades, water quality has improved in many watersheds that were historically polluted primarily by point source discharges; however, overall habitat degradation continues to threaten the health of aquatic communities. Increased development and urbanization, poorly managed crop and animal agriculture, and mining have impacted aquatic systems with point and nonpoint source inputs. Impoundments on major rivers and tributaries drastically alter the hydrologic regime of many North Carolina waterways and result in habitat fragmentation, blockage of fish migration routes, and physical habitat alterations.

The US Environmental Protection Agency (USEPA) reports that North Carolina contains approximately 37,662 river miles; 311,236 acres of lakes and impoundments; and 3,121 square miles of coastal bays (USEPA 2013). Information summarized from a USEPA Clean Watershed Needs Survey, NPDES permits, and water quality assessments indicates more than half of the rivers are rated as ‘impaired’ because they are not meeting biological criteria or due to impaired aquatic communities. Similarly, more than half of the lakes and reservoirs are reported to be impaired due to mercury contamination (USEPA 2013). In North Carolina all waters in the state are rated as impaired based on a statewide fish consumption advisory for mercury contamination (NCDPH 2014).

4.5.3 Aquatic Conservation Priorities, Strategies, and Recommendations

There has been increased attention focused on analysis of aquatic biodiversity, patterns of imperilment, and threats to distill priorities for proactive management and/or conservation triage. A few efforts have gone beyond (or bypassed) identifying specific priorities to propose strategies that address long-term aquatic conservation needs and actions to address these priorities. These efforts were outlined in the 2005 WAP (NCWRC 2005). To the greatest extent possible and where applicable, this guidance, as well as more recent efforts, have been incorporated into this Plan.

The following sections outline aquatic conservation priorities, strategies, and recommendations that are applicable throughout North Carolina. The remaining portions of this chapter (Sections 4.5.4 through 4.5.20) describe the 17 river basins, which are organized alphabetically. These descriptions provide a more detailed view of the threats, needs, and conservation priorities within each basin. Priority species are identified for each basin (see Appendix H); however, a complete list of all priority species can be found in Appendix G.
4.5.3.1 Aquatic Conservation Priorities

Conservation priorities have been identified for each river basin at the cataloging unit or stream reach scale and were categorized using two tiers to indicate relative importance when considering the limited resources available for conservation initiatives. The recommendations were developed by Commission biologists through review of their field data as well as data from several agencies and research organizations. The review considered a combination of factors such as the presence of federal- or state-listed species; distribution of priority species; high species diversity; unique habitats, or high-quality habitats in the subbasin; and the importance of the watershed to downstream populations.

Priority areas identified in this chapter are represented by 12-digit hydrologic unit code (HUC) watershed boundaries and 1-km riparian corridors and characterized as Tier 1 (highest priority) and Tier 2 (high priority) recommendations for conservation. Figures depicting the locations of priority areas are provided in each river basin description. In addition to recommendations provided for each river basin, the following general recommendations are applicable statewide in all river basins. Appendix J provides a list of all HUC12 priorities statewide; this list is available for download as an Excel file from the NCWRC web page http://www.ncwildlife.org/plan.

4.5.3.2 Conservation Strategies

Historically, aquatic conservation and management strategies have typically focused on a few commercially or recreationally significant game fish species, with stock enhancement as a primary goal. The passage of the 1973 Endangered Species Act and 1972 Clean Water Act (with amendments) stressed ecosystem protection and allowed for focused attention on all species and their habitats. Ecosystem management is likely the most effective strategy for conserving rare aquatic species because it factors in ecological relationships, land-use patterns, and threats to habitat and water quality. It is a complicated and often costly approach and relies heavily on cooperation among federal and state agencies, local governments, private organizations, and individual citizens. However, its holistic approach can benefit all species within the watershed.

The US Fish and Wildlife Service (USFWS) has led in the development of detailed conservation strategies for mussels in the US (Biggins et al. 1997) and fishes in the southeast (Bibb et al. 2002). Both of these important documents identify specific goals and detailed strategies for achieving them. Jenkinson and Todd (1997) provided a historical perspective of mollusk management in the United States and propose general strategic guidance for habitat protection, population enhancement, harvest controls, public appreciation, and invasive species control and prevention. Some region-scale strategies have recently been drafted and are identified in the applicable river basin descriptions. Conservation efforts have only recently been focused on crayfish. Taylor et al. (2007) identify the present state of crayfish management (and crustaceans in general) and the challenges that face developing adequate management plans.

Surface water classifications are one tool that state and federal agencies use to manage and protect all streams, rivers, lakes, and other surface waters in North Carolina. Classifications and
their associated protection rules may be designed to protect water quality, fish and wildlife, or other special characteristics. Each classification has associated standards that are used to determine if the designated uses are being protected. The NC Division of Water Resources (NCDWR) have assigned some waterbodies in the state supplemental classifications as High Quality Waters (HQW) or Outstanding Resource Waters (ORW) because they either have excellent water quality or they are a significant resource to humans or wildlife (NCDWQ 2015d). The requirements to be classified as ORWs are more stringent than those for HQWs and in some circumstances, the unique characteristics of the water and resource require that a specialized management strategy be developed (NCDWQ 2011d, NCDWR 2015a, 2015d). Another supplemental classification is NCDWR’s trout water designation (Tr), which protects freshwaters for natural propagation of trout and survival of stocked trout on a year-round basis. Trout water designations are used only in the Mountain ecoregion. In addition to the best-use classifications, NCDWR also monitors waters of the state to determine if they are supporting their use classification(s) and assigned use-support ratings. These ratings are published in the most recent 303(d) impaired waterbodies list (USEPA 2014a; NCDWR 2015a).

Another conservation strategy is the listing of species for federal protection under the Endangered Species Act (ESA) and for state protection under North Carolina General Statutes. Chapter 3 Species, Section 3.1.1 provides specific information about regulatory protections. Tables provided in each river basin description (Sections 4.5.4 through 4.5.20) provide the listing status of aquatic species identified as Species of Greatest Conservation Need (SGCN). Table 4.5.1 provides a summary of the listing status designations.

<table>
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<tr>
<th>Federal Listing Status</th>
<th>State Listing Status</th>
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<tr>
<td>E – Endangered; a taxon which is in danger of extinction throughout all or a significant portion of its range.</td>
<td>E – Endangered; any native or once-native species of wild animal whose continued existence as a viable component of the state’s fauna is determined to be in jeopardy or listed as a federal endangered species.</td>
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<tr>
<td>T – Threatened; a taxon which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.</td>
<td>T – Threatened; any native or once-native species of wild animal which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range or listed as a federal threatened species.</td>
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<td>C – Candidate; taxa for which the Fish and Wildlife Service has on file enough substantial information on biological vulnerability and threat(s) to support proposals to list them as endangered or threatened.</td>
<td>SC – Special Concern; any species of wild animal native or once-native to North Carolina which is determined to require monitoring but which may be taken under regulations adopted under state laws.</td>
</tr>
<tr>
<td>FSC – Federal Species of Concern; an informal term not defined in the federal Endangered Species Act. Those species that appear to be in decline or otherwise in need of conservation and are under consideration for listing or for which there is insufficient information to support listing at this time.</td>
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4.5.3.3 Recommendations

While much progress has been made toward understanding basic distribution of many priority species, especially fishes, information is still lacking on the distribution of some species, and population strength and trend data are rare. These gaps are especially pronounced among mollusks and crustaceans. While considerable knowledge gaps exist for freshwater mussels, they are even greater for snails and pea clams. Likewise, information vital for effective management of crayfish is insufficient and such information for microcrustaceans (e.g., water fleas, seed shrimp, scuds) is practically nonexistent. Performing extensive field surveys and collecting voucher specimens are important steps in developing conservation measures for aquatic species.

Much of the aquatic insect data tracked by the NC Natural Heritage Program (NCNHP) is provided by the Biological Monitoring group of the NC Division of Water Resources (formerly Division of Water Quality). However, there is no clear jurisdiction over most of these taxa, and there is a scarcity of biologists focused on these groups. Knowledge levels and data availability for insects, terrestrial gastropods, and arachnids are the lowest of any animal groups in the state. These taxa are an integral part of the ecosystems they share with other invertebrate and vertebrate species. Opportunities to expand our knowledge and understanding of these groups should be taken when possible, and the establishment of habitat-based projects that are mutually beneficial to these groups and to higher taxa should be a focus.

The following recommendations should be considered appropriate to implement statewide and where appropriate in all river basins.

**Surveys.** General surveys are needed to complete primary distributional status for SGCN and other priority species.

- Complete distribution and status surveys for aquatic snails, crayfish, mussels, fish, and nonnative species.
- Coordinate sampling with other resource management groups.

**Monitoring.** Long-term monitoring is critical to assessing species and ecosystem health over time and gauging the resilience of organisms to continued impacts to state waters. Studies should include identification of population trends, as well as assessment of impacts from conservation or development activities. These efforts will inform species and habitat management decisions. Long-term monitoring sites need to be identified and monitoring protocols developed for all priority species. Monitoring plans should be coordinated with other existing monitoring programs where feasible.

- Conduct long-term monitoring to assess performance of specific conservation actions: stream restoration projects; species restoration projects; improvements in flow regions below dams; improvements in best management practices (BMPs).
- Assess nonnative species impacts and monitor populations of potentially injurious nonnative species and their impacts on priority species.
• Establish protocols, schedules, and sites for long-term population monitoring.

**Research.** Research topics that facilitate appropriate conservation actions include habitat use and preferences, reproductive behavior, fecundity, population dynamics and genetics, feeding, competition, and food web dynamics. Increased understanding of life histories and status helps determine the vulnerability of priority species to further imperilment, in addition to identifying possibilities for improved management and conservation. All studies should provide recommendations for mitigation and restoration. Formal descriptions for known or putative undescribed species and investigations aimed at resolving taxonomic status are needed.

• Investigate potential for augmentation or restoration of priority species populations in restored or improved habitats.
• Resolve taxonomic problems and develop species descriptions (if required).
• Review available information and support life history investigations where lacking.
• Support investigations into impacts from habitat fragmentation, especially those due to impoundments or other anthropogenic factors.
• Focus analysis and synthesis of inventory and monitoring data and reporting to inform decision making pertaining to initial species listing and status revision.
• Investigate species vulnerability to impacts from invasive and nonnative species and exposure to chemicals (e.g., endocrine disrupting compounds) and other pollutants.

**Management Practices.** Management practices that reduce impacts and work synergistically with other conservation actions are needed to enhance the resilience of natural resources. Particular needs include preserving biodiversity, protecting native populations and their habitats, and improving degraded habitats. In addition, education about, and regulation and prevention of the introduction and spread of exotic or invasive species are vital.

• Expand aquatic species restoration efforts through increased capacity for captive culture of priority species.
• Eradicate or control invasive and injurious nonnative species within lentic and lotic systems.
• Support county soil and water conservation measures such as BMP recommendations to address sediment and erosion related to agricultural activities.
• Work through the Federal Energy Regulatory Commission (FERC) relicensing process and other opportunities to mitigate negative impacts from hydropower development and support mitigation and restoration efforts.
• Increase stormwater management, erosion control, and education along with associated inspections of all sites with potential for erosion.
• Evaluate regulatory issues and develop rules that address water quality issues and other threats to priority species and habitats.
• Work through site-specific management plans to protect and conserve waters containing federally listed species.
• Support implementation of low-impact development and better stormwater management through program coordination, cooperative projects, and technical guidance.
• Support clean-up efforts and stricter regulation of Concentrated Animal Feeding Operations (CAFOs), in addition to promoting best management practices (BMPs) and improvements for animal waste treatment.
• Identify specific priority areas for habitat conservation and restoration. Criteria include areas with high species diversity, rare species, and endemic species; specific areas that are critical to the survival of priority species (e.g., particular streams or spawning sites); and areas recognized by previous national and/or regional prioritization efforts.
• Support incentive and information programs that help reduce sedimentation and erosion (e.g., fencing livestock from streams, improve tilling practices), minimize pesticide and herbicide use, modernize wastewater treatment facilities, and so forth.
• Prioritize education and other measures to prevent the introduction or spread of invasive nonnative species, particularly crayfishes, Zebra Mussels, and land-locked river herring species (e.g., Blueback Herring, Alewife), as well as nonnative and invasive aquatic and riparian plants.

Conservation Programs and Partnerships. Conservation programs, incentives, and partnerships should be utilized to the fullest extent in order to preserve high-quality resources and protect important natural communities. Protective measures that utilize existing regulatory frameworks to protect habitats and species should be incorporated where applicable. Land conservation or preservation can serve numerous purposes in the face of anticipated climate change, but above all, it promotes ecosystem resilience.

• Support the strategic planning efforts of partner agencies, local governments, and other conservation organizations.
• Support and implement comprehensive land-use planning that reduces secondary or cumulative impacts upon water quality and natural resources.
• Develop and support programs that provide technical guidance and assistance to property owners and businesses on how they can reduce impacts and achieve conservation goals.
• Develop and support education and outreach programs, and distribute materials, deliver presentations, and participate in activities.
• Incorporate aquatic priorities into the NC Division of Mitigation Services (formerly NC Ecosystem Enhancement Program [NCEED]) Watershed Enhancement Program prioritization process, into game lands management, and into game lands acquisitions.
• Support conservation and restoration of streams and riparian zones in priority areas (acquisition, easements, and buffers).
• Support the development and application of an aquatic nuisance species management plan with other agencies/groups.
• Guide academic research projects to help achieve specific conservation goals and objectives.
• Support water quality rules and watershed designations that conserve habitats for priority aquatic species. Outstanding Resource Water and High-Quality Water designations should be supported wherever the criteria are met, especially in watersheds that support priority species.

• Support local and regional land-use planning efforts to affect water quality and habitat conservation, establish riparian buffers along streams, implement low-impact development, and improve stormwater management (e.g., secondary and cumulative impacts). Support and utilize species-listing processes and associated programs to conserve imperiled species and their habitats. When warranted, make recommendations for state listing to the Commission’s Nongame Wildlife Advisory Committee.

• Develop and disseminate print media, including stand-alone documents, press releases, newspaper and magazine articles, and displays.

• Improve and maintain existing web resources (mussel, crayfish, and fish atlases, etc.)

• Continue to seek opportunities for direct outreach throughout the basin.