



SECTION 3. HABITAT CONSERVATION RECOMMENDATIONS

The purpose of this section is to provide conservation recommendations that are based on the scientific literature regarding how much habitat priority wildlife need in order to remain in developing landscapes. These recommendations come from two N.C. Wildlife Resources Commission (NCWRC) guidance documents referenced at the end of this section: the NCWRC (2012) conservation recommendations, available from www.ncwildlife.org/greengrowth and the NCWRC (2002) guidance to address cumulative impacts.¹ Many wildlife species need a large amount of habitat. We encourage readers to use this information to do what is possible to minimize negative impacts to wildlife through planning, policies, and development design. Because developed landscapes are becoming the face of our state, implementing these guidelines as much as possible in land use planning is essential to preventing the loss of much of our state's wildlife and biodiversity.

This section details the wildlife habitat conservation component of green infrastructure. Large habitat areas can be conserved by connecting contiguous habitat among different parcels. Habitat open space can be owned by the homeowner association, which can also fund habitat management.

NATURAL RESOURCE-BASED LAND USE AND DEVELOPMENT PRACTICES

Comprehensive natural resource stewardship includes conservation of priority wildlife species and habitats. Scientific research has revealed certain conservation thresholds, or minimum habitat area requirements, are needed to sustain priority species and habitats near built areas.

- Incorporating these recommendations in plans, incentives, ordinances, and development designs will help reduce the likelihood that species are placed on the federal endangered and threatened species list and reduce permit delays.
- We encourage local governments and developers to conserve as much habitat as possible as a first step, even if it is less than what is recommended.

How can this information be used?

In local government planning documents to inform:

- The goals, objectives, strategies, and natural resources component in all community planning documents (in addition to the N.C. Wildlife Action Plan).
- Policy recommendations.

In incentives and ordinances to inform:

- The proportion or width of open space conservation to consider in certain districts or development standards.

In development review and site design to inform:

- Review of development proposals to evaluate habitat conservation opportunities.
- Development designs that will enhance wildlife habitat conservation.

Referencing the Conservation Data for Green Growth

Habitats described in this section can be identified using the Conservation Data map layers described in Section 2. The **blue boxes** throughout this section highlight specific conservation map layers associated with habitat recommendations. The GIS map layers contain a data table with information on habitat type and can be searched or filtered.

Principles for Maintaining Healthy Ecosystems

Keep ecosystems and our communities healthy by maintaining a connected network of healthy habitats.

The land use principles below are basic guidelines for designing communities that maintain healthy ecosystems. These principles can be goals to help your community achieve Green Growth.²

- 1) Maintain large, wide blocks of contiguous habitat to avoid habitat fragmentation.
- 2) Maintain functional connections between core habitat areas that wildlife can travel through to avoid isolating habitats. Major roads and large developments, make wildlife travel difficult or impossible while working farms and forests are more conducive to species movement.
- 3) Protect rare landscape elements, sensitive areas and associated species. Not all open spaces are created equal. Natural open spaces—such as wetlands, riparian and native upland forests—will protect water, air, and wildlife much better than manicured open spaces.
- 4) Allow patterns of natural disturbance to continue, such as periodic fire and river flow patterns. Encourage habitat management, which can be funded by homeowner associations and parks departments.
- 5) Minimize the introduction and spread of nonnative, invasive species.
- 6) Minimize the human introduction of nutrients, chemicals, and pollutants, particularly near wetlands and streams.
- 7) Avoid and compensate for adverse effects of development on natural processes, such as the cumulative effects of stormwater runoff on aquatic ecosystems. Maintain or mimic the natural hydrology on development sites.
- 8) Avoid land uses that deplete or degrade natural resources in environmentally sensitive areas, including habitat for species of conservation concern.



Wildlife Travel Corridor

Associated Conservation Data

Any areas that rank 1 – 10 in the Biodiversity and Wildlife Habitat Assessment are very important to ecosystem function.

Area Sensitive Species Need Large Core Habitat Areas



black-throated green warbler

JOURNALS
FURTHER GROSSETT



tiger salamander

JEFF HALL

Many of the over 370 wildlife species of conservation concern in North Carolina require large areas of habitat that have sufficient interior habitat. Interior habitat is an area of contiguous habitat far from an edge, or a transition to an incompatible land type. Interior habitat is maximized when habitats are more circular in shape and have minimal edge. Interior habitat is different for forest dwelling and grass or shrubland dwelling wildlife. Interior habitat for forest dwelling species begins approximately 350 feet from the edge of a large unforested or developed area. Sufficient habitat interior for grass and shrubland species is only present in agricultural landscapes with many grasslands greater than 20 acres. Grass and shrubland species need 125 to 250 acres of habitat in patches greater than 15 acres, in close proximity, in an urban setting. See pages 48 to 49 for more information.

Reduce Habitat Fragmentation and Maintain Wildlife Travel Corridors

In sensitive areas consider encouraging or requiring that wide contiguous natural open space be set-aside on developed parcels and that it be connected to natural open space on adjacent parcels. In priority areas maintain wildlife travel corridors that are at least 150 to 330 feet wide through development standards. Coupled with appropriate land use districts this will maintain interior habitat and connectivity in developed areas.

Maintain Agricultural or Conservation Districts Around and Between Managed Areas

- Development projects located adjacent to NC Wildlife Commission Game Lands and other Managed Areas degrade habitat quality within conserved lands and make prescribed fire difficult. See page 4 for information on prescribed fire. Ideally, agricultural districts should be maintained in these areas. Developments should try to create as wide a buffer as possible between built structures and public land boundaries.
- If buffers cannot be placed around entire Game Lands or in all Smoke Awareness Areas:
 - ▶ maintain buffers around narrow portions of Game Lands,
 - ▶ prioritize buffers along parts of Managed Areas where prescribed fire is used
 - ▶ and buffer areas mapped in the Biodiversity and Wildlife Habitat Assessment.

How much area is ideal?

- Within Smoke Awareness Areas, design a land use category, district or a development project so that a ½ mile smoke management buffer—or the widest buffer possible—without inhabited structures exists. This will minimize resident’s exposure to smoke from prescribed fire every two to five years.
- If the development will occur adjacent to NC Wildlife Commission Game Lands, design a land use category, district or a development project so that permanently inhabited structures are located at least 150 yards from the edge of the Game Land.

Associated Conservation Data

- Managed Areas
- Game Lands Hunting Safety Buffer
- Smoke Awareness Areas

Core Habitat, Habitat Edge, and Connectivity



Maximum habitat interior (core habitat) and minimum edge



Maximum habitat edge and no interior habitat



Connect core habitat 'nodes' to prevent habitat fragmentation

Images courtesy of Benjamin Penington, 1000 Friends of Florida

Maintain large circular nodes (core areas) of habitat to maximize interior habitat and minimize edge. Habitat edges occur at the border of incompatible land and are generally detrimental to priority wildlife species because edges are more accessible to predators and parasites that reduce the survival of their young. For this reason, wider wildlife travel corridors are better. Wildlife also need to be able to travel through uninterrupted, contiguous habitat.

Conservation Recommendations for Upland Habitats

“Upland” habitats are terrestrial habitats that are located outside of the floodplain, wetlands and riparian zones. Priority upland habitats in North Carolina include longleaf pine forests, grasslands - shrublands (early successional habitat), high elevation habitats (above 3500 ft.), caves and mines, rock outcrops, and large, unfragmented forests.

Upland Forest Habitats

- Try to conserve a connected network of forests and create plans to properly manage habitats post-construction.
- We recommend as little development as possible take place in: Natural Heritage Areas, areas with natural vegetation within Natural Heritage Element Occurrence polygons or within Landscape Habitat Indicator Guilds that rank a 7 to 10 on the Biodiversity and Wildlife Habitat Assessment.
- Try to conserve more than 50 percent of the total tree cover within your jurisdiction or at least 50 percent of forest cover within 1.5 miles of existing Managed Areas.
- Try to conserve larger, wide blocks of forest with less edge on open areas. This can be done by encouraging connection of natural open space among parcels. Forest dwelling priority species need the following areas of forest in North Carolina:
 - ▶ Contiguous upland, floodplain and wetland forest blocks of at least 500 acres in the Mountains, southern Piedmont and Coastal Plain.
 - ▶ Seventy-five contiguous acres of non-floodplain (upland) forests in the Piedmont and Coastal Plain can support most priority bird species.
 - ▶ Cerulean warblers in the southwest Mountains and many fire dependent species in the Sandhills and the Coastal Plain only occur in forests of over 1,750 acres.
 - ▶ Smaller blocks of forest have conservation value as bird migration stop over areas but do not support as many priority species.
- Longleaf pine forest needs to be managed with prescribed fire if fire-dependent wildlife are intended to be conserved.

Associated Conservation Data

- Natural Heritage Natural Areas
- Natural Heritage Element Occurrences
- Biodiversity and Wildlife Habitat Assessment
- Forest Lands Assessment

Benefits of Conserving Forests

Forest protection provides many benefits. The NC Greenhouse Gas (GHG) Inventory estimates that NC's forests sequester 193.9 metric tons of CO₂e/per acre, offsetting 25 percent of North Carolina's gross GHG emissions.³ Carbon storage benefits from conserved forests are estimated to be valued at \$2,300 to \$6,000 per acre. The health benefits related to improved air quality due to forest conservation is estimated to be valued at an average of \$212 per acre (\$18 to \$2,500 per acre). Other co-benefits include: water quality improvements into our reservoirs, which translate into increased value of recreation (\$1 to \$7,000 per acre) and lake-shore property values (\$1 to \$1,500 per acre), and reduced water treatment costs (\$3 to \$270 per acre).⁴

Grassland Habitats

Many grasslands are not mapped, but can be defined as pastures and fallow fields of at least 20 acres in agricultural landscapes and 15 acre fields in close proximity, totaling 125 to 250 acres, overall, in urbanizing areas.



- Develop farmland protection plans and integrate grassland and early successional habitat conservation and management recommendations.
- Focus on policies that maintain viable, contiguous working farms.
- Re-vegetate utility rights-of-way into grassland or shrubland habitat using native plant species and establish rotational vegetation control schedules. Native plants use less water and require less maintenance.
- Mow half to one-third of grasslands per year to maintain habitat structure. Try to mow only from mid-March and mid-April to reduce impacts to ground nesting birds.
- Prescribed fire can produce better habitat at less cost than mowing or herbicides.
- Utilize and promote the many state and federal programs that provide monetary and technical assistance for landowners to create and maintain early successional habitats (www.ncwildlife.org/CURE.aspx). Many of these programs can also be used for prescribed burning of longleaf pine forest as well.
- If your community has the resources to conduct active resource management, prioritize the protection and management of some early successional habitat when purchasing land for open space. Consult with a qualified biologist to develop a management plan for long-term management of this habitat.
- When early successional habitat is to be protected as open space in a development project, require applicants to submit 1) a long-term habitat management plan, and 2) plans to fund long-term management. Habitat management can be funded and administered by the homeowners association.

Associated Conservation Data

- Agricultural Lands Assessment
- Natural Heritage Element Occurrences for grassland wildlife species
- Aerial photos (available on NC OneMap)

Riparian Habitat Conservation Recommendations

Protect wide forest areas along streams.

Benefits of Conserving Forested Riparian Buffers

- Some of the greatest environmental health benefits come from improving downstream water quality and reducing the intensity of floods and droughts.
- Forest soils and root systems filter up to 15 inches of water per hour storing and cleaning water while preventing floods and drought.⁵
- The riparian forest along rivers and streams is the sole source of the food base (leaves) and shade necessary for fish and other aquatic life to live in streams.
- Once pollution is released in water, the only things that keep air and water clean are the animals and plants that remove pollutants through filter feeding.
- Forests adjacent to streams support a high diversity and abundance of wildlife. Protecting wide buffers around rivers and streams in as many places as possible is necessary to preserve habitat for species using riparian zones.
- Protection and restoration of riparian corridors has a large potential for carbon sequestration and storage.



All recommended stream buffers presented here are mapped in the Biodiversity and Wildlife Habitat Assessment

What conservation measures are needed?

- Forested buffers comprised of native trees and plants are recommended around all streams (perennial, intermittent and ephemeral channels).
- Because wider buffers produce the most environmental benefits and also safeguard communities, we recommend protecting and maintaining the maximum width buffer possible in as many places as possible along streams.
- If wide buffers are not possible everywhere, focus on buffers in priority watersheds ([see page 26](#)). Conserving large 'nodes' of wide buffers can be encouraged through development standards.
- We recommend that impervious surfaces be kept below 10 percent within all watersheds in order to safeguard aquatic life and fishing.

Stream Buffers to Protect Water Quality for Aquatic Life⁶

Recognizing that wider is always better and that some buffer is better than no buffer, the NC Wildlife Commission typically recommends the following buffer widths to minimize impacts to aquatic species (such as fish and mussels):

- In subwatersheds **without federally listed aquatic species**:
 - ▶ Preserve 100 foot native, forested buffers on *each side* of perennial streams.
 - ▶ Preserve 50 foot native, forested buffers on *each side* of intermittent streams.
- In subwatersheds **that contain federally listed aquatic species**:
 - ▶ Preserve 200 foot native, forested buffers on *each side* of perennial streams.
 - ▶ Preserve 100 foot native, forested buffers on *each side* of intermittent streams.
- In all watersheds, buffer ephemeral streams and drainages. Narrower buffers than those recommended for perennial streams will suffice, but again, wider is better.
- Note that subwatersheds containing federally listed species are identified in the Conservation Data for Green Growth.



M.C. BARHART

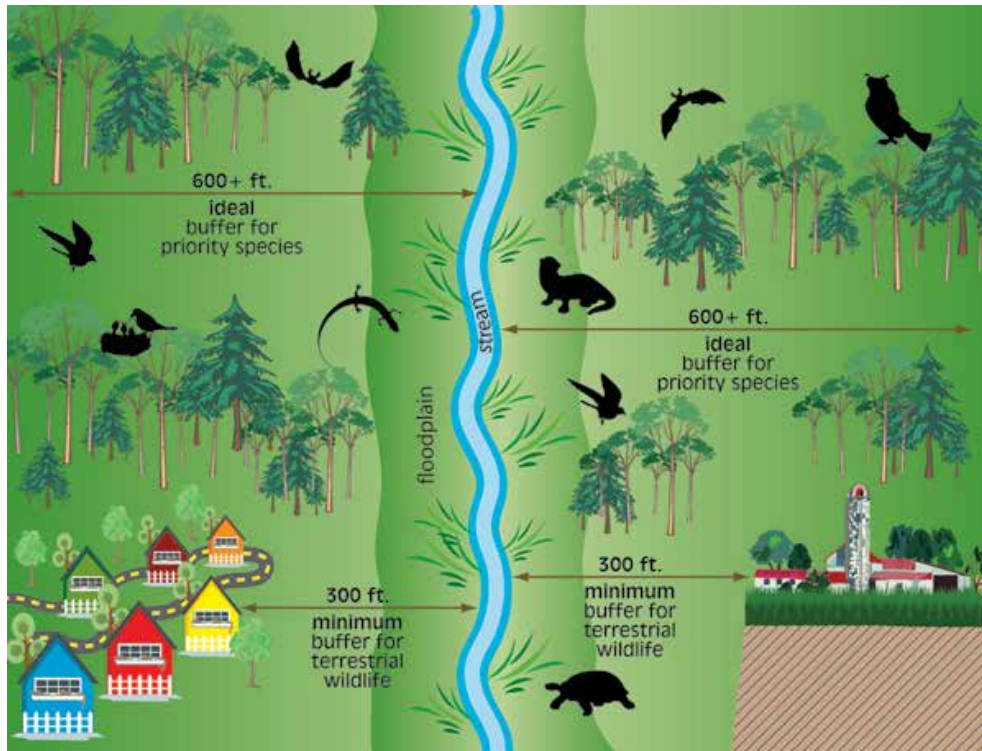
Freshwater mussel filtering water and removing pollutants.

Why are stream species important?

Freshwater mussels are an important signal of our own health. They clean our water by filtering bacteria and chemicals. Without enough forest along streams to soak up rain water, sediment and other pollutants can reach levels that kill the aquatic life that help to keep our water clean and safe.

Associated Conservation Data

- Biodiversity and Wildlife Habitat Assessment
- 'hydro_24k' streams layer includes DWR stream class
- Subwatersheds with Federally Listed Fish and Mussels
- Outstanding Resource Waters and High Quality Waters
- Natural Heritage Natural Areas
- Natural Heritage Element Occurrences



GRAPHIC BY KIMBERLY KC SCHOTT, RED GATE DESIGN

Riparian Forest Habitat and Wildlife Travel Corridors

A majority of wildlife rely on riparian forest zones to raise their young and to feed. As such, wide riparian forest buffers are needed to conserve a majority of wildlife.

- Protect wide forested buffers of 300–600 feet or more on each side of the stream. Research has shown this will provide sufficient travel corridors and some habitat for forest interior birds (such as the wood thrush), while 250 foot buffers are needed for most stream salamanders.⁷
- Other species of conservation concern, however, require forested travel corridors at least 1000 feet wide.⁸ This is why it is important to conserve some nodes this wide along streams and rivers where possible.
- Use the relevant Conservation Data to identify priority places for wide stream buffer areas and habitat nodes if wide buffers are not possible along entire waterways.
- Wide riparian forest buffers can be achieved through properly designed and managed greenways.

Recommendations for Minimizing On-Site Stream Impacts

In addition to protecting wide riparian buffers, incorporating the following practices into the design and construction of development projects will help minimize negative impacts to aquatic species and habitats.

- Identify and delineate all streams using the N.C. Division of Water Resources criteria. See <https://edocs.deq.nc.gov/WaterResources/DocView.aspx?d-bid=0&id=2488192&cr=1> for information.
- Refer to the NCWRC (2002) guidance to address cumulative impacts available from www.ncwildlife.org/Conserving/Programs/HabitatConservationProgram.aspx.

Recommendations for Floodplains



Rapid development in some parts of North Carolina is leading to changes in floodplain boundaries and flooding frequency. Floodplains may widen and become more inundated due to urbanization.

Benefits of Floodplains

In addition to helping to protect communities from flood hazards, intact floodplain forests and wetlands store 2.1 billion MT CO₂e and sequester 10 million metric tons CO₂e each year in NC.⁹ Floodplains are a priority wildlife habitat identified in the N.C. Wildlife Action

Plan. Conservation can greatly help to keep species off of endangered species lists.¹⁰ Many floodplain pools provide important habitat for breeding turtles, salamanders and frogs. When floodplain corridors are intact, they provide migration corridors for birds and mammals.

Conserve Floodplains

- Where the floodplain is wider than required stream buffers, protect the full extent of the 100-year floodplain.
- Where feasible, do not place sewer lines, water lines, manholes, and other utility infrastructure in the 100-year floodplain.
- Try to avoid clearing, excavating, filling, altering, draining, or placing structures of any kind within the floodplain boundaries. This will also help to prevent or reduce the burden to taxpayers from disaster clean up.
- Consider extending these practices to the 500-year floodplain to safeguard against increasing extreme flood events.

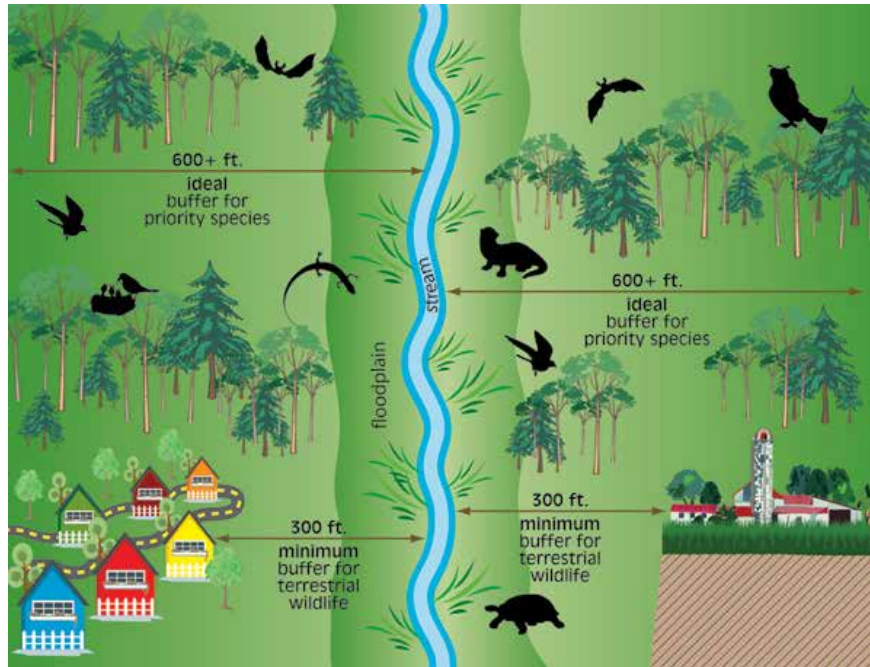
Stewarding Floodplain Property

In addition to keeping built areas outside of the floodplain, plans are needed to minimize floodplain impacts during and after construction.

- Floodplain land can be dedicated and deeded to the local government, homeowners association, or land trust as permanent open space.
- In partnership with a qualified natural resource manager, develop plans to properly manage floodplain wetland resources during and post-construction. [See pages 54 to 57](#) for wetlands recommendations.

Associated Conservation Data

- 100 and 500-year floodplains from the N.C. Floodplain Mapping Program



GRAPHIC BY KIMBERLY KC SCHOTT, RED GATE DESIGN

Recommendations for Greenways

- Greenways are a great community resource for providing recreation opportunities and for connecting core habitat areas.
- Maintain forested areas at least 1,000 feet wide over as much of the greenway as possible. This has been shown to conserve the full suite of forest wildlife habitat.
- Greenways that are at least 330 feet wide still offer breeding habitat to some forest interior species.
- Greenways that are 150 feet wide provide wildlife travel corridors for some priority species but do not provide enough breeding habitat for most species.
- If wide greenway areas are not possible along the entire greenway, nodes of wide habitat areas should be encouraged for conservation along thinner areas.
- Locate trails toward the edge of the greenway rather than the middle and keep trails as far as possible from streams, ideally 100 feet away.

Conserving Wetlands for Declining Wildlife

Protect wide upland buffers around wetlands, especially small wetlands.

Benefits of Wetlands Conservation

Wetlands are important because of their role in helping to mitigate floods and droughts, purifying and storing surface water and for providing important wildlife habitat, particularly for amphibians and reptiles. Dramatic amphibian and reptile declines are occurring around the world due to habitat loss and road construction, among other factors. As with streams, wider buffers will produce the most environmental benefits. Wetland communities are identified as a priority for conservation in the N.C. Wildlife Action Plan.¹¹

Small Wetland Communities



Small wetland communities include isolated upland pools, vernal pools, springs, bogs and seeps, where surface water collects or ground water feeds the beginning of a stream. These wetlands are not connected to water from the main body of a stream or river and are usually temporarily flooded such that they are dry for much of the year. They typically fill with water during the winter and hold water into the spring and early summer. Because they do not support fish, which prey heavily on amphibian eggs, these wetland communities provide the only breeding habitat for many amphibians and some reptiles. Vernal pools and other small wetland communities are often overlooked during land conversion because their protection is often not regulated and because they are small and dry for part of the year. As such, they have undergone extensive decline. Wetlands may become more threatened as weather events become more extreme. Frequent extreme flooding and drought can cause local wetland species extinctions.

Wetland Buffers for Water Quality

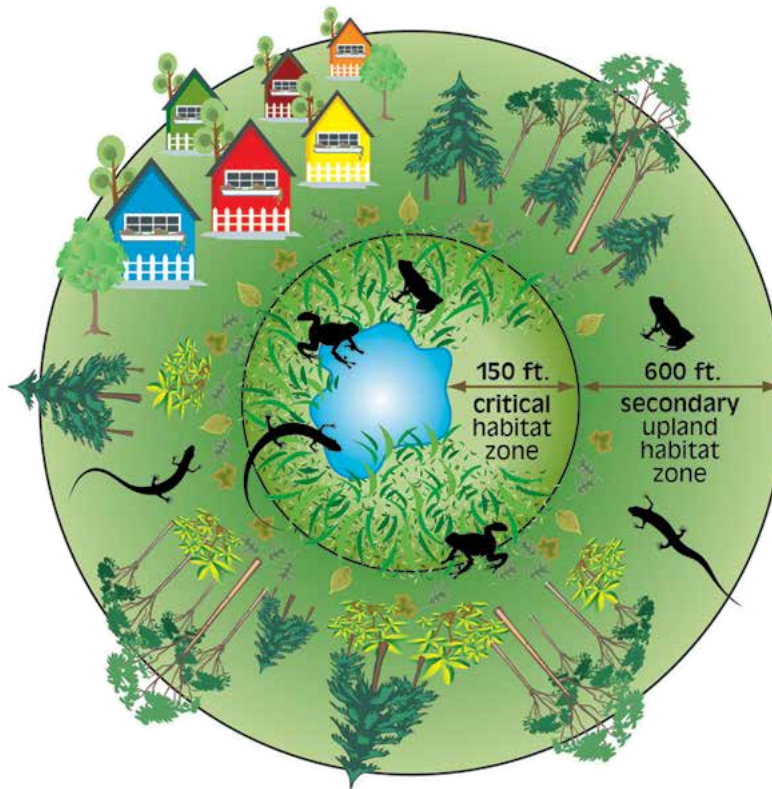
- To minimize negative impacts to water quality associated with wetlands along streams, at minimum 100 foot buffers are needed for wetlands on perennial streams and 50 foot buffers are needed for wetlands on intermittent streams.¹² To conserve wetland wildlife habitat wider buffers are needed.

Buffers Needed to Protect Wildlife Habitat at Small Wetlands

Buffer widths that will protect basic water quality are more narrow than buffers needed to protect wildlife habitat at small wetlands. Amphibians and reptiles live part of the year far from the wetland pool in the surrounding upland forest where they forage and burrow to escape extreme temperatures. As such the intensity of land use surrounding the wetland pool will affect wildlife diversity and abundance in small wetlands. In addition, the amount of disturbance and development in a watershed affects local extinction of amphibians.¹³

The following buffer recommendations based on the scientific literature are particularly important to reducing threats to wildlife and our communities caused by extreme flooding and drought.

- Maintain a 150 foot Critical Habitat Zone around each wetland pool, that is undisturbed to ensure that many wetland species are not lost from development.
- A Secondary Upland Habitat Zone of an additional 600 feet is needed to protect core habitat for many semi-aquatic reptiles and amphibians.¹⁴ This Secondary Upland Habitat Zone does not need to be symmetrical and can be more narrow or wide in places.
- Habitat conservation can still be achieved when 25 percent of the Secondary Upland Habitat Zone is developed in a clustered manner.



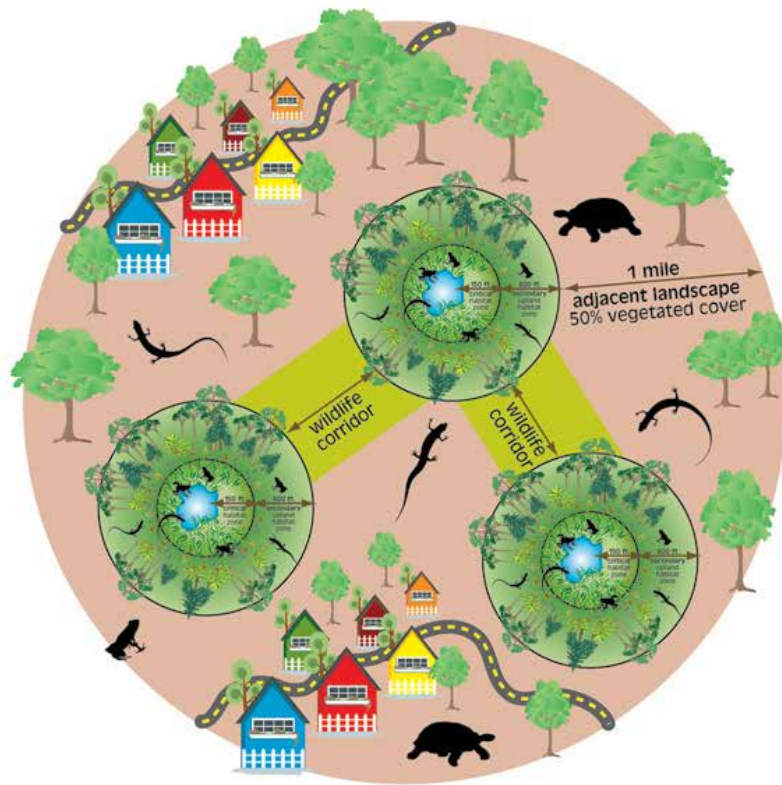
GRAPHICS BY KIMBERLY KC SCHOTT, RED GATE DESIGN

Limit Impacts of Development Near Wetlands

- Maintain the maximum amount of upland habitat possible around and between wetlands.
- Minimize impervious surfaces around wetlands, particularly pools with many different amphibian and reptile species.
- Exclude roads and driveways from upland areas within 750 feet of priority wetland habitats.
- If roads must run between important wetlands, install wildlife underpasses to allow for reptile and amphibian movement under roads between wetlands. See [page 66](#) for information on wildlife road crossing structures.
- Cluster development and place houses as far away from upland pools as possible.
- Do not use small wetlands for stormwater retention ponds and locate retention ponds at least 750 feet from small wetlands to minimize hydrological disturbance to natural water flow into small wetlands.

Associated Conservation Data

- Natural Heritage Natural Areas
- Natural Heritage Element Occurrences
- The National Wetlands Inventory or Coastal Region Evaluation of Wetland Significance



GRAPHICS BY KIMBERLY KC SCHOTT, RED GATE DESIGN

Maintain Small Wetland Complexes and Priority Wetland Regions

- As much as possible, avoid placing development and roads between small wetlands that are within 1 mile of each other.
- Connect wetlands to one another and to streams via forested wildlife travel corridors that are made to be as wide as possible and at least 330 feet wide.
- Limit impervious surfaces to 10 percent and road density in watersheds that contain your jurisdiction's most biologically diverse and important wetlands.
- Maintain at least 50 percent natural vegetation in large, connected nodes throughout the landscape.

WILDLIFE CONSERVATION IN CONSTRUCTION AND POST-CONSTRUCTION¹⁵

Wetlands Management Plan Guidelines

To manage wetlands, streams and floodplains during and after construction:

- Avoid the use of insecticides and herbicides within or adjacent to buffer areas.
- Avoid removal of forested tree cover or leaf litter and any soil disturbance in the surrounding upland forest.
- Eradicate and do not plant invasive, exotic vegetation.
- Covenants or deed restrictions can be used to ensure wetland habitats are managed properly by future homeowners or the homeowner association.

Recommendations for Stormwater



Manage stormwater on-site with structures that maintain natural hydrology and provide habitat.

State and federal law requires the implementation of certain stormwater management standards which affect many communities in North Carolina. The recommendations below are not intended to replace legal requirements.

These recommendations explain how a development project must manage stormwater in order to be beneficial for wildlife and better safeguard the community from heavy rain events and flash flooding.

- Control stormwater on-site and design stormwater management structures to mimic predevelopment hydrographic conditions.
- Incorporate “low impact development” (LID) practices into site design, such as capturing rainwater for irrigation use and incorporating rain gardens into residential landscaping. LID provides significant cost savings. Information about LID can be found at the following websites:
 - ▶ N.C. State University *Low Impact Development Guidebook* https://www.uni-groupusa.org/PDF/NC_LID_Guidebook.pdf
 - ▶ Cost benefit information - www.epa.gov/nps/urban-runoff-low-impact-development
 - ▶ Stormwater Manager’s Resource Center - www.stormwatercenter.net
- Do not discharge stormwater to streams through pipes or ditches. Stormwater should only be released in a dispersed manner through vegetation.
- Avoid using wetlands for stormwater discharge or retention ponds.
- Design stormwater retention ponds to also provide or maintain wildlife habitat of native trees, shrubs and other plants around detention ponds.
- Create rain gardens with native plants and wildlife-friendly materials.

Recommendations for Sediment and Erosion Control

Minimize land clearing and grading.

Construction practices that completely clear and grade the landscape are extremely harmful to water quality, terrestrial and aquatic wildlife resources. Such practices often cause the loss of topsoil, forest cover and the sedimentation of streams and water bodies, which

can be devastating to entire ecosystems in your community.¹⁶ The following wildlife friendly development practices will help minimize these harmful impacts:

- Minimize all clearing and grading associated with construction, particularly adjacent to waterways and steep slopes.
- Only perform clearing and grading based on a stream protection strategy.
- Instead of clearing and grading to landscape a site, retain as much natural vegetation and soil cover as possible.
- Phase construction to reduce the area and time over which soils are disturbed.
- Stabilize soils as quickly as possible (< 2 weeks) by establishing a native grass or mulch cover.
- Establish appropriate perimeter controls at the edge of construction sites to retain or filter concentrated runoff from relatively short distances before it leaves the site.

Recommendations for Impoundments

Minimize the negative effects of impoundments on wildlife.

Ponds and other small impoundments, if not properly constructed and managed, can negatively impact water quality as well as aquatic habitats and species. In-stream impoundments can negatively impact fish migration, reduce aquatic ecosystem diversity and abundance and introduce nonnative species that reduce ecosystem health. With thousands of ponds and small in-stream impoundments in North Carolina, the level of cumulative negative impacts on the state's streams is high.

To minimize the negative effects of impoundments when designing a development project:

- Locate impoundments away from stream channels. Locate ponds on stream channels only when there is no other option.
- Avoid constructing impoundments near existing wetlands to avoid altering the hydrology of that wetland.
- Avoid locating ponds in naturally reproducing trout waters, anadromous fish species waters and waters that contain state or federally listed species.

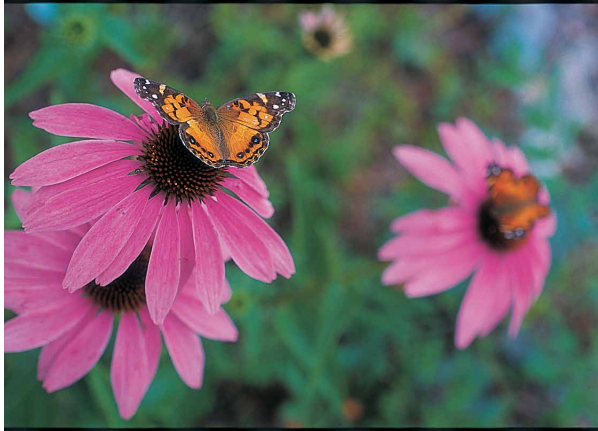
Recommendations for Right-of-Ways

Construction of utility right-of-ways (ROW), when properly maintained, can provide habitat for birds, reptiles and mammals.

To minimize wildlife impacts and maximize wildlife benefits:

- Minimize grading and retain large trees at the edges of construction corridors.
- When disturbing the soil, stabilize it as quickly as possible. Reseed with wildlife-beneficial seed mixtures (e.g., native warm season grasses or creeping red fescue, native seed or fruit producing plants and so forth).
- Avoid planting fescue (except creeping red fescue) or Bermuda grass based mixtures because these are invasive and provide little wildlife benefit.
- Keep brush piles of woody debris at the edges of cleared ROW. These provide good cover and food.
- Allow corridors to re-vegetate into a brush or scrub habitat.
- Minimize ROW corridor maintenance and mow only between mid-March and mid-April to minimize impacts to ground nesting birds.

Going Native!



North Carolina State University's website Going Native! presents a step-by-step guide on how to landscape with native plants. The website also presents photos and descriptions of nonnative, invasive species. Planners, developers, engineers, landscape architects and homeowners will benefit from using this guide at www.ncsu.edu/goingnative/. The Audubon Society has many native plant resources, including a Plant Database where the user can input their zipcode and get a list of plants native to their area. www.audubon.org/native-plants. Also, see the N.C. Native Plant Society for native plant suggestions and suppliers at www.ncwildflower.org/index.php.

Recommendations for Landscaping

Create landscaping plans that will benefit wildlife.

Use Only Native Plants

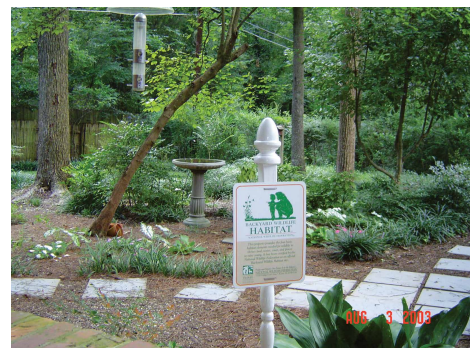
One of the most important components of a wildlife friendly landscaping plan is using native plants and removing invasive, exotic plants where possible. Native plants are more nutritious for important pollinators and wildlife. Invasive, exotic plants often out-compete and gradually displace our native plants. This negatively impacts native wildlife and the overall health and stability of our environment.

- Avoid planting invasive, exotic plant species and, where practical, remove such species from the development site. Lists of invasive plants and methods for removal can be found in the, "Southeast Exotic Pest Plant Council Invasive Plant Manual," at www.se-eppc.org/weeds.cfm or through the North Carolina Botanical Garden's website at <http://ncbg.unc.edu/invasive-plants-resources/>.
- The N.C. Forest Service provides guidance on street tree selection. See their website at https://www.ncforestservice.gov/Urban/urban_recommendedstreettrees.htm for lists of trees and guidance on which trees are best suited for different sites.
- Avoid using insect resistant plants. Birds feed their young entirely on insects and are threatened by a reduction in insects.

Attract Birds and Butterflies for Wildlife Watching

In addition to using only native plants, landscaping plans can incorporate design elements that will attract popular species for wildlife watching. To attract birds, butterflies, and other "watchable wildlife" species include these landscaping practices:

- Limit the amount of lawn. Replace lawn area with islands of native vegetation planted with native ground cover or wildflowers.
- Increase "vertical layering," or planting vegetation of different heights.
- Plant a butterfly garden.
- Create birdbaths or small ponds.
- Provide bird or bat houses and bird feeders.
- Reduce pesticide use.
- Do not use insect resistant plants.



ERNIE MCLANEY

Habitat Management is Important

Many developments, local parks and even utility lines that contain priority habitats need to conduct habitat management activities to truly conserve habitat for highly sensitive priority species. For example:

- Grasslands and shrublands will grow into forests if they are not mowed or burned.
- Longleaf pine forests need to burn every few years in order to maintain the grassland savannah structure that priority wildlife require. Longleaf pine forest species cannot live in dense thick forests dominated by hardwood trees, even if longleaf pine trees are present.

Habitat management in developments can be funded and administered by the home or property owner association dues. In local parks and public utility lines the local government can support habitat management. Habitat management recommendations are provided throughout this section and in the NC Wildlife Commission (2012) conservation recommendations document that can be included in habitat management plans and activities.

REGIONAL DEVELOPMENT PRACTICES

Different development practices may be needed to create wildlife-friendly developments in different regions of the state, for example:

- Development projects in the mountains will need to avoid building on steep slopes.
- Development projects on the coast will need to protect shorebird nesting areas.
- Longleaf pine forest only benefits rare species when blocks of 2000 acres can be conserved as contiguous area among parcels and when prescribed burning is done.
- Small wetlands in the Sandhills and the Coastal Plain need wider upland forest buffers of more than 1000 feet and prescribed fire because the amphibian and reptile species in these regions need more space due to their unique habitat needs.

Regional wildlife friendly development practices are outlined in regional appendices to the Green Growth Toolbox handbook and in the NC Wildlife Commission (2012) conservation recommendations document referenced below. Visit the Green Growth website at www.ncwildlife.org/greengrowth to download these documents.

For More Information

Many resources provide information on ways to review and design development projects that will minimize impacts to wildlife habitats and important biological resources. A few of these are listed below.

Center for Watershed Protection. [Internet]. [2013]. Available from: www.cwp.org

Environmental Law Institute. 2008. Planners Guide to Wetland Buffers for Local Governments. ELI. Washington D.C. Available from: <https://www.eli.org/research-report/planners-guide-wetland-buffers-local-governments>

Hostetler, M. 2012. The Green Leap: A Primer for Conserving Biodiversity in Subdivision Development. University of California Press, Berkeley and Los Angeles, California.

N.C. Wildlife Resources Commission. 2002. Guidance Memorandum to Address and Mitigate Secondary and Cumulative Impacts to Aquatic and Terrestrial Wildlife Resources and Water Quality. Raleigh, N.C. Available from: https://www.ncwildlife.org/portals/0/Conserving/documents/2002_GuidanceMemorandumforSecondaryandCumulativeImpacts.pdf

N.C. Wildlife Resources Commission. 2012. Conservation Recommendations for Priority Terrestrial Wildlife Species and Habitats in North Carolina. Raleigh, N.C. Available from: www.ncwildlife.org/greengrowth

Perlman, D.L. and J.C. Milder. 2005. Practical Ecology for Planners, Developers, and Citizens. Island Press, Washington, D.C.

Washington State Dept. of Ecology. 2005. Wetlands in Washington State: Volume 1. A Synthesis of the Science. Sheldon and Associates. Available from: <https://apps.ecology.wa.gov/publications/documents/0506006.pdf>

WATERSHEDSS: A Decision Support System for Nonpoint Source Pollution Control. [Internet]. [Updated 2003 Dec 10]. Raleigh (NC): N.C. State University Water Quality Group. Available from: <https://www.epa.gov/ceam/watershedss>

Wenger, S. 1999. A Review of the Scientific Literature on Riparian Buffer Width, Extent and Vegetation. Office of Public Service and Outreach, Institute of Ecology, University of Georgia. Available from: <http://lshs.tamu.edu/research/1999/a-review-of-the-scientific-literature-on-riparian-buffer-width-extent-and-vegetation/>

-
- 1 Information produced by an extensive review of the scientific literature for wildlife in the southeastern U.S. by the N.C. Wildlife Commission and other N.C. species experts. The resulting NCWRC documents are: a) NCWRC. 2012. Conservation Recommendations for Priority Terrestrial Wildlife Species and Habitats in North Carolina. North Carolina Wildlife Resources Commission Raleigh, N.C. Available from: www.ncwildlife.org/greengrowth and b) NCWRC. 2002. Guidance Memorandum to Address and Mitigate Secondary and Cumulative Impacts to Aquatic and Terrestrial Wildlife Resources and Water Quality. North Carolina Wildlife Resources Commission Raleigh, N.C. Available from: www.ncwildlife.org/Conserving/Programs/HabitatConservationProgram.aspx.
 - 2 These nine guidelines were drawn from McElfish (2004). Nature Friendly Ordinances. Washington DC: Environmental Law Institute, and Dale et al. (2000). Ecological Society of America report: Ecological principles and guidelines for managing the use of land. Ecological Applications 10: 639-670.
 - 3 N.C. Department of Environmental Quality. (2019, January). North Carolina Greenhouse Gas Emissions Inventory: (1990 – 2030). North Carolina Division of Air Quality. Retrieved from <https://deq.nc.gov/energy-climate/climate-change/greenhouse-gas-inventory>.
 - 4 North Carolina Natural and Working Lands Action Plan. June 2020. Department of Environmental Quality, Raleigh, NC.
 - 5 PA Trees. Trees and forests reduce impacts of stormwater [Internet]. [Cited 2012 Dec 14]. Available from: www.patrees.org/trees-reduce-stormwater.
 - 6 Ibid. 1.
 - 7 Crawford, J.A. and Semlitsch, R.D. 2007. Estimation of Core Terrestrial Habitat for Protection of Biodiversity. Conservation Biology 21(1):152-158.
 - 8 Mason, J., Moorman, C.E., Hess, G., and Sinclair, K. 2006. Designing suburban greenways to provide habitat for forest-breeding birds. Landscape and Urban Planning, 1-13; Sinclair, K.E., Hess, G.R., Moorman, C.E., and Mason, J.H. 2005. Mammalian nest predators respond to greenway width, landscape context, and habitat structure. Landscape and Urban Planning, 71, 277-293.
 - 9 North Carolina Natural and Working Lands Action Plan. June 2020. Department of Environmental Quality, Raleigh, NC.
 - 10 N.C. Wildlife Resources Commission. 2015. North Carolina Wildlife Action Plan. Available from: www.ncwildlife.org/plan.aspx.
 - 11 Ibid. 7. "Small wetland communities," Pp. 185-188, 256-259.
 - 12 These numbers should be doubled in watersheds that support federally listed species
 - 13 Willson, J.D. and Dorcas, M.E. 2003. Effects of Habitat Disturbance on Stream Salamanders: Implications for Buffer zones and Watershed Management. Conservation Biology 17(3), 763-771; Rubbo, M.J. and J.M. Kiesecke. 2005. Amphibian Breeding Distribution in an Urbanized Landscape. Conservation Biology, 19 (2): 504-511; Houlihan, J.E. and C.S. Findlay. 2003. The Effects of Adjacent Land Use on Wetland Amphibian Species Richness and Community Composition. Canadian Journal of Fisheries and Aquatic Sciences. 60: 1078-1094
 - 14 Semlitsch, R.D. and Bodie, J.R. 2003. Biological Criteria for Buffer zones around Wetlands and Riparian Habitats for Amphibians and Reptiles. Conservation Biology 17(5), 1219-1228; Semlitsch, R.D. and Jensen, J.B. 2001. Core Habitat, Not Buffer zones. National Wetlands Newsletter 23(4), 5-6, 11.
 - 15 These recommendations were drawn primarily from the N.C. Wildlife Resources Commission's (2002) Guidance Memorandum to Address and Mitigate Secondary and Cumulative Impacts to Aquatic and Terrestrial Wildlife Resources and Water Quality. Available from: www.ncwildlife.org/Conserving/Programs/HabitatConservationProgram.aspx.
 - 16 Ibid.