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Ecosystem Description

Stream swamp communities represents all smaller water features of the coastal plain not included in the Coastal Plain Large River community. It includes streams, swamps and ditches. Although ditches are artificial habitats, over time the aquatic communities resemble natural systems and are therefore included in this theme.

Substrate in these systems is typically sand or organic matter and many waters have high quantities of tannins. They are found in each river basin within the lower Coastal Plain ecoregion. Examples include: Town Creek, Great Coharie Creek, and Juniper Creek. Priority habitats identified in the Wildlife Action Plan that are a component of this community includes the Mid-Atlantic Coastal Plain Riverine Aquatic Communities and Tidal Swamp Forest and Wetlands (see Chapter 5A) (NCWRC 2005).

Table 1 at the end of this report provides of summary of expected climate change impacts to these natural communities.

Predicted Effects to Wildlife Species

Tables 2 through 6 at the end of this report identify the species of greatest conservation need (priority species) that use habitats in this ecosystem.

Several bird species of greatest conservation need are threatened by sea level rise through habitat conversion from saltwater intrusion; loss of nesting, foraging, or cover habitats from inundation; and impacts that reduce prey species found in this habitat. For instance, little blue heron and wood stork prefer fresh water pools, inland swamp, or mudflats and usually nest more inland (LeGrand *et al*. 2012); inundation and saltwater intrusion will reduce habitat quality and availability and potentially displace birds when currently occupied habitats are converted to brackish systems.

Most of the listed priority amphibian and reptile species associated with riverine habitat have limited distributions, unknown distributions or widely dispersed but small populations. Isolation or fragmentation of particular habitat stretches occupied by those species could have significant long-term effects upon the sustainability of those populations in the Coastal Plain of North Carolina (NCWRC 2005).

Temperature may have significant effects on developmental pathways or behaviors influencing reproduction and survival. For example, sex determination in hard-shell turtles is largely temperature dependent (Bull 1980). Rising temperatures can also affect metabolic and growth rates in insects and other ectotherms (*e.g.,* Dukes *et al.* 2009, Bickford *et al*. 2010), resulting in faster development and shorter lifecycles in some cases. Increased winter temperatures and frostfree days may also affect overwinter survival of some insects and pathogens (Dukes *et al*. 2009), resulting in increased population sizes that contribute to outbreaks."

According to DeWan *et al*. (2010), "hydrologic regimes in the coastal plain are likely to be much more sensitive to changes in precipitation than to changes in temperature." Rapid changes in water temperature will have direct impacts on the physiology and metabolic rates of freshwater biota (Allan *et al.* 2005), which are dominated by cold-blooded organisms with no physiological ability to regulate their body temperature.

The ability of freshwater organisms to move to new locations is constrained by the connectivity of streams and rivers within drainage basins. Eaton *et al.* (1995) reported maximum temperature tolerance estimates for 30 species of freshwater fishes occurring in the U.S. Temperature tolerance ranges are species specific, and the availability of cooler waters may become limiting to some species in their current range in a warmer climate."

Aquatic species could experience shifts in their range or distribution and sensitive species may experience decline or extirpation due to changes in water quality and habitat. Aquatic species are particularly sensitive to temperature cues and recent research has shown that many species of freshwater mussels may already be living at the upper thermal tolerances of their early life stages (glochidia and juveniles) (Pandolfo *et al.* 2010).

Because of the link between freshwater mussels and fish, phenological disruptions are a possibility, but exact mechanisms or effects are unknown at this time. Freshwater mussel larvae, called glochidia, are dependent on a host fish for transformation into juveniles. Host fish species are known for some mussels species, yet unknown for others. Temperature cues play a large role in the release of glochidia from female mussels and also in the movement and migrations of fish. Therefore, with changing temperatures predicted with climate change, there could be phenological disruptions affecting the reproductive capacity of freshwater mussels.

Climate Change Compared to Other Threats

Aquatic systems have been under threat from a variety of perturbations in the past and many of those continue today. Conversion of land, both from forest to agriculture or silviculture, as well as from development projects, continues to threaten stream integrity resulting in increased sediment, bank erosion, and stormwater runoff containing sediment and other potentially toxic materials.

Table 7 compares climate change with other existing threats.

Table 7. Comparison Of Climate Change With Other Threats		
Threat	**Rank Order**	**Comments**
Development	1	Direct, secondary, and cumulative effects from development.
Groundwater Depletion	2	Increased pumping due to lower flows can cause depletion.
Logging/Exploitation	2	While bank vegetation is usually undisturbed, logging is a major threat to streams in the coastal plain.
Water Withdrawals	2	Irrigation, water supply, and energy development withdrawals pose a threat to flow regime.
Climate Change	2	Sea level rise, as a result of climate change, is a major threat to large coastal plain rivers.
Pollution	3	Point and nonpoint sources - runoff, endocrine disrupting chemicals – are threats.
Lack of riparian vegetation	3	Loss of riparian vegetation causes numerous problems.
Cattle in Streams	4	Nutrient and sediment inputs; bank destabilization.
Invasive Species	4	Invasive plants and animals are potential problems, although specific interactions are unknown.

Summary and Recommendations

Monitoring of aquatic taxa is critical to assessing species and ecosystem health and in gauging resiliency of organisms to a changing climate. These monitoring efforts will inform future decisions on how to manage aquatic species. In addition to monitoring, there are several research questions that need to be answered about certain species or taxa of aquatic organisms.

Recommended Actions

Surveys

- Surveys are needed to document the distribution, relative abundance, and status of priority species in these communities.
- Determine the components of foraging bat communities along rivers.
- Establish species-specific surveys to improve our knowledge of the status and distribution of least bittern, American bittern, yellow rail, and black rail at all times of the year (Conway *et al*. 2004).

Monitoring

- Monitoring systems need to be expanded and/or targeted to be able to assess current population status and trend information for the priority species associated with this habitat.
- Monitor water quality below large agricultural farms (including livestock and

poultry operations).
- Establish mist net stations for passerine birds in this habitat type at all times of the year.

Research

- Verify the genetic makeup of the Sandhills salamander, which has yet to be formally described.
- Examine the extent and impact of exotic species introductions; conduct research on effective control measures for the most problematic exotics.
- Conduct research on fire management in marsh habitats to determine optimal frequency, timing, and firing techniques (*e.g.,* flanking fire, back fire) to benefit priority birds.
- Conduct a systematics study to differentiate between the two subspecies of least shrew.
- Examine habitat use and conduct nesting habitat research on the black rail using telemetry, and then on other marshbirds (Bogner and Baldassarre 2002).
- Examine foraging and habitat use patterns of priority species in this habitat.
- Investigate the past, current and potential future impact of nutria.
- Investigate the effect of beaver ponds on downstream movement of pollutants (toxins and sediment).

Management Practices

- Determine the effect of buffer widths on amphibian and reptile species diversity and productivity.
- Determine the impacts of "snagging" (removing woody debris after storms) on wildlife populations.
- Explore techniques for restoration of tidal swamp forest and wetlands.
- Mandatory and incentive-based practices to improve water quality need to be actively pursued with cooperation from agencies and organizations at local, state and federal levels.
- Bridge and culvert design standards may need alteration to accommodate environmental changes due to climate change (Transportation Research Board 2008).
- The biggest need in coastal plain riverine aquatic communities is topreserve and increase buffer widths to mitigate impacts from pollution into river systems, and to maintain habitat at the edge of these aquatic communities that will provide cover and foraging areas for many wildlife species using riverine habitat (NCWRC 2005).
- The implementation of various types of agriculture and forestry best management practices (BMPs) can aid in erosion control
- Fencing of livestock away from stream access can reduce nutrient inputs to the aquatic system.

- Aquatic nuisance plant species can be a problem particularly in impounded waters and in slower moving waters. Biological controls for some aquatic plant species are recommended and these should be explored as alternatives to using herbicides.

Land Protection	• Connectivity that allows for species and ecosystem migration is crucial and can be accomplished through protection of potential migration corridors. Where possible forest patches should be connected along river systems to provide connectivity. • River and stream ecosystem enhancement and restoration efforts and programs need to be enhanced and supported. • Riverine habitats need to be permanently protected from the negative impacts of development through conservation ownership (fee title or easement) of as much habitat as possible. Fee title (linear length protection) and easements acquisition through partnerships with land trusts is essential. • Floodplain and wetland protection and preservation provides a natural and economical means for flood water attenuation, which can save human lives and property, in addition to sustaining aquatic ecosystems.

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Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Increased Temperature	Chronically warmer temperatures and lower dissolved oxygen levels may increase stress on organisms. Increased air temperatures may lead to increased water temperatures and potentially lower dissolved oxygen levels. Shifts in the geographic distribution of species in places where temperature increases exceed physiological tolerances are likely.
Sea Level Rise -- Inundation	Coastal inundation is predicted to varying degrees. The combined increase of inland flooding during higher precipitation events with elevated sea levels will exacerbate coastal inundation. Several small streams will become completely inundated by salt water with sea level rise.
Sea Level Rise -- Salt Intrusion	Salt water intrusion into currently freshwater streams is a possibility as sea level rises. The chemical composition of currently freshwater systems could change and freshwater wetlands and swamps could be converted to salt marshes (Band and Salvensen, 2009; USEPA, 2010; Bakke 2009; Burkette *et al*. 2000). Salt wedge will move upstream.
Hot Spells	Algal blooms are possible in these systems and can exacerbate dissolved oxygen problems, particularly when flows are low. Low dissolved oxygen associated with hot spells may increase fish kills.
Flooding	Flooding events often encourage local governments to snag and/or dredge ditches and streams that hold back water. This disturbs habitat for fish, and other aquatic species. Increased frequency and severity in storms will impact small coastal plain streams. Forest Canopy gaps may be beneficial to some species.
Drought	Severe and prolonged droughts may decrease streamflow, decrease groundwater recharge, and increase evaporation, resulting in impacts to streams of this theme. Decreases in overall summer precipitation will likely cause reduced water flows, which will further contribute to warmer water temperatures and further stress water quality. Headwater and other small streams of this theme could dry up, posing potential impacts to aquatic species and downstream flow regimes (DeWan *et al*., 2010; Karl *et al*., 2009; USEPA, 2010).
Water Pollution	Seasonal droughts coupled with low-flow periods allow nutrients to become concentrated and flush out of systems more slowly. Resuspension of bottom sediment during storms and increased nutrient content of freshwater and coastal waters can increase pathogen replication, persistence, survival, and transmission (DeWan *et al*. 2010; Karl *et al.* 2009; Band and Salvensen, 2009; USEPA, 2010). Recent studies have shown that endocrine disrupting chemicals (EDC) in treated wastewater can inhibit reproduction and cause feminization of mussels and fish (Conn *et al.* 2006; Kim *et al.* 2007; Kasprzyk-Hordern *et al*. 2008; Joss *et al*. 2006; Kolpin *et al.* 2002; Nowotny *et al.* 2007).

Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Increased Storm Activity	Some research suggests that there will be an increased frequency of severe storms (potentially hurricanes) thus theses waterways will enter a higher disturbance regime. They will likely experience more frequent organic suspension, which results in excessive dissolved oxygen depletion. Thus, resulting in widespread aquatic taxa kills. Increased storm activity contributes to flooding and tropical events can cause flash flooding. Increased stormwater runoff and increased erosion are likely to occur. With a change in intensity and variability of rainfall, there are potential changes to streamflow patterns, channel hydrodynamics, lake levels, and the volume of groundwater from aquifers (Band and Salvensen, 2009; USEPA, 2010; Bakke,2009).
Acreage Change	Small streams will be completely inundated and their "freshwater" components will be lost. Development of floodplains or riparian areas removes critical habitat adjacent to aquatic habitat that may be of equal importance to species that only spend a portion of their lives in the water, like some amphibians (NCWRC 2005).
Phenological Disruption	Aquatic species are particularly sensitive to temperature cues and recent research has shown that many species of freshwater mussels may already be living at the upper thermal tolerances of their early life stages (glochidia and juveniles) (Pandolfo *et al*. 2010). Uncertain if disruptions in organismal interactions (mussel-fish host relationship) will be affected. Warmer winters and higher temperatures will create shifts in growing season that may have a direct physiological impact on species and habitats or an indirect impact on community relationships through competition.
Exotic species invasion	Invasive plants (alligatorweed, Asian dayflower, hydrilla, water hyacinth, and giant *Salvinia*) in the riparian area can have negative impacts on stream systems by often times creating a monoculture with poor nutrient inputs, reducing bank stability, and allowing too much sunlight and therefore warmer stream temperatures. Invasive aquatic animal species, such as Asian clam and red swamp crayfish, may have negative effects on native species, such as competition for space and resources
Flow Regime	Flashiness of the system may increase with more storm events, thus changing overall habitat composition.
Sediment Transport	Changes in streamflow could change overall sediment transport dynamics, leading to altered habitat composition. Increased stormwater runoff will amplify the loading of nutrients, sediment and contaminants into streams, rivers, and reservoirs. The increased loads could affect water quality and habitat for aquatic species, as well as drinking water for municipalities.

Table 1. Predicted Impacts of Climate Change	
Climate Change Factor	**Comments**
Channel Hydrodynamics	Changes in channel morphology and streamflow could change overall habitat composition as well as changes in flow regime, sediment transport, and overall channel design.
Compositional Change	These systems may experience a change in species composition due to various changes in habitat and water quality. Changes in species composition from freshwater to more salt-tolerant species are expected.
Groundwater Drawdown	During droughts, recharge of groundwater will decline as the temperature and spacing between rainfall events increase. Responding by increasing groundwater pumping will further stress or deplete aquifers and place increasing strain on surface water resources. Increasing evaporation and plant water loss rates alter the balance of runoff and groundwater recharge which is likely to lead to saltwater intrusion into shallow aquifers. Water withdrawals can be problematic, particularly in streams with already low 7Q10 flows, because they may reduce available habitat for aquatic species. Drainage for mosquito control also will change the characteristics of this habitat (NCWRC 2005).
Impoundments	Rivers and stream impoundments for hydroelectric power generation, flood control, water supply, and recreation/aesthetics will have been both direct and indirect effects. Lotic habitat will be lost and the food web is likely to shift, at least in portions of former riverine habitat, to species that do not depend upon flowing water.

Table 2. Bird Species Utilizing Stream Swamp Communities							
Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/ Extirpation Prone	US/ NC/ WAP*	Comments
BIRDS							
Aix sponsa	Wood Duck						
Anhinga anhinga	Anhinga					-/SR/ P	
Ammodramus caudacutus	Saltmarsh Sharp-tailed Sparrow					-/-/P	
Ammodramus nelsoni	Nelson's Sharp-tailed Sparrow					-/-/P	
Botaurus lentiginosus	American Bittern					-/SR/ P	
Circus cyaneus	Northern Harrier					-/SR/ P	
Cistothorus platensis	Sedge Wren					-/-/P	
Coturnicops noveboracensis	Yellow Rail					-/SR/ P	
Egretta caerulea	Little Blue Heron					-/SC/P	
Egretta thula	Snowy Egret					-/SC/P	
Elanoides forficatus	Swallow-tailed Kite					-/-/P	
Gallinula chloropus	Common Moorhen					-/-/P	
Haliaeetus leucocephalus	Bald Eagle					BGPA/ T/P	
Himantopus mexicanus	Black-necked Stilt					-/SR/ P	
Ixobrychus exilis	Least Bittern					-/-/P	
Laterallus jamaicensis	Black Rail					-/SR/ P	
Mycteria americana	Wood Stork					E/E/P	
Nyctanassa violacea	Yellow-crowned Night-heron					-/-/P	
Plegadis falcinellus	Glossy Ibis					-/SC/P	

Table 3. Mammal Species Utilizing Stream Swamp Communities							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
MAMMALS							
Condylura cristata	Star-nosed Mole					-/SC/P	
Cryptotis parva	Least Shrew					-/-/P	
Sylvilagus palustris	Marsh Rabbit					-/-/P	

Table 4. Reptile Species Utilizing Stream Swamp Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
REPTILES							
Alligator mississippiensis	American Alligator					T/T/P	
Apalone spinifera aspera	Gulf Coast Spiny Softshell					-/- /P	
Deirochelys reticularia	Eastern Chicken Turtle					-/SR/ P	
Farancia abacura abacura	Eastern Mudsnake					-/- /P	
Farancia erytrogramma erytrogramma	Common Rainbow Snake					-/- /P	
Kinosternon baurii	Striped Mud Turtle					-/- /P	
Regina rigida	Glossy Crayfish Snake					-/SR/ P	
Seminatrix pygaea	Black Swamp Snake					-/SR/ P	
Thamnophis sauritus sauritus	Common Ribbonsnake					-/- /P	

Table 5. Amphibian Species Utilizing Stream Swamp Communities							
Species	**Common Name**	**Element Rank:**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
AMPHIBIANS							
Necturus lewisi	Neuse River waterdog	G3/S3	YES			-/SC/P	
Eurycea guttolineata	Three-lined salamander					-/-/P	
Eurycea sp 1	Sandhills salamander					-/-/P	
Rana heckscheri	River frog					-/SC/P	
Siren lacertina	Greater siren					-/-/P	
Stereochilus marginatus	Many-lined salamander					-/-/P	

Table 6. Invertebrate Species Utilizing Stream Swamp Communities							
Species	Common Name	Element Rank	Endemic	Major Disjunct	Extinction/ Extirpation Prone	US/ NC/ WAP*	Comments
INVERTEBRATES							
Alasmidonta heterodon	Dwarf wedgemussel	G1G2/ S1				E/E/P	
Alasmidonta undulata	Triangle floater	G4/S2				-/T/P	
Attaneuria ruralis	Giant stone	G4/S2S3				-/SR/-	A stonefly
Baetisca becki	A mayfly	G2G3/ S1				-/SR/-	
Baetisca obesa	A mayfly	G5/S1				-/SR/-	
Ceraclea cancellata	A caddisfly	G5/S2				-/SR/-	
Choroterpes basalis	A mayfly	G5/S2				-/SR/-	
Elliptio fisheriana	Northern lance	G4/S3				-/SR/-	
Elliptio lanceolata	Yellow lance	G2G3/ S1			YES	FSC/ E/P	
Elliptio roanokensis	Roanoke slabshell	G3/S1				-/T/P	
Elliptio steinstansana	Tar River spinymussel	G1/S1	YES		YES	E/E/P	
Fusconaia masoni	Atlantic pigtoe	G2/S1			YES	FSC/ E/P	
Helisoma eucosmium	Greenfield rams-horn	G1Q/S1	YES		YES	FSC/ E/P	Greenfield Lake
Lampsilis cariosa	Yellow lampmussel	G3G4/ S1				FSC/ E/P	
Lampsilis radiata	Eastern lampmussel	G5/S1S2				-/T/-	
Lasmigona subviridis	Green floater	G3/S1				FSC/ E/P	
Macdunnoa brunnea	A mayfly	G3G4/ S2				-/SR/-	
Matrioptila jeanae	A caddisfly	G4/S3				-/SR/-	
Orconectes carolinensis	NC spiny crayfish	G3/S3	YES			-/SC/P	
Orconectes virginiensis	Chowanoke crayfish	G3/S3				FSC/ SC/P	

Table 6. Invertebrate Species Utilizing Stream Swamp Communities							
Species	**Common Name**	**Element Rank**	**Endemic**	**Major Disjunct**	**Extinction/ Extirpation Prone**	**US/ NC/ WAP***	**Comments**
INVERTEBRATES							
Planorbella magnifica	Magnificent rams-horn	G1/S1	YES		YES	E/E/P	Orton Pond
Procambarus braswelli	Waccamaw crayfish	G3/S2S3				-/SC/P	
Procambarus plumimanus	Croatan crayfish	G4/S3				-/SR/P	
Strophitus undulatus	Creeper	G5/S2				-/T/P	
Villosa constricta	Notched rainbow	G3/S3				-/SC/P	
Villosa delumbis	Eastern creekshell	G4/S3				-/SR/P	
Viviparus intertextus	Rotund mysterysnail	G4/S2?				-/SR/P	

*** US/ NC/ WAP Abbreviations (species are subject to reclassification by USFWS, NHP, or WRC).**

E	Endangered	SC	Special Concern	P	WAP Priority Species
T	Threatened	SR	Significantly Rare		
FSC	Federal Species of Concern	W	Watch Category		
T(S/A)	Threatened due to Similarity of Appearance				

NatureServe Element Rank: http://www.natureserve.org/explorer/ranking.htm

USFWS Endangered Species Listing Status: http://www.fws.gov/raleigh/es_tes.html

NC Natural Heritage Program Status:
http://www.ncnhp.org/Images/2010%20Rare%20Animal%20List.pdf

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