

State of the Sandhills: Results of Biological Monitoring in the Sandhills

Ana Castillo, Conservation Planner/ORISE Fellow

Jeff Marcus, NC Longleaf Applied Scientist

Introduction

The North Carolina Sandhills Conservation Partnership developed a Biological Monitoring Plan as part of the Strategic Conservation Plan finalized in June 2013. The overall goal of the monitoring plan was to devise a plan to identify conservation targets within the general longleaf ecosystem in the Sandhills, and identify specific desired future conditions of these habitats. At the time, the most intensive and extensive monitoring occurring in the Sandhills was carried out for red-cockaded woodpeckers as part of data collection efforts necessitated by its Endangered status. Recognizing a need for monitoring of other habitats and species of conservation concern, the goal was to also increase information and data sharing and overall coordination amongst Partners in the Sandhills. The results of these monitoring efforts would then be shared with the Partnership to inform how to best conserve, restore, and manage habitats in the Sandhills.

Monitoring Framework

The Biological Monitoring Program is structured such that the current ORISE Fellow leads the project and data collection focusing on one Conservation Target per year. The Conservation Targets that were decided to focus on were Longleaf Pine Mosaic, Upland Depressional Wetlands, Blackwater Streams, and Streamhead Pocosins and Seeps. This effort began in FY 2013 with the Longleaf Pine Mosaic and end with a final State of the Sandhills Report in the final year of the monitoring cycle.

Year 1 (FY 2013)	Finalize indicators and responsible parties for monitoring Longleaf Pine Mosaic Target; Report on longleaf at end of year
Year 2	Upland Depressional Wetlands
Year 3	Blackwater Streams
Year 4	Streamhead Pocosins/ Seeps
Year 5	Full State of Sandhills report

Summary of Monitoring Projects

Longleaf Pine Mosaic

Summary of Work

Much of the monitoring efforts of the upland longleaf mosaic system has been guided by the need to understand the extent and condition of Longleaf Pine forests on the landscape. America's Longleaf Restoration Initiative (ALRI) published the Longleaf Pine Maintenance Condition Class Definitions in October 2014 outlining the ideal vegetation characteristics of longleaf forests that would

count towards the 8 million acre conservation goal. Ryan Bollinger and then Matthew Moskwik, the ORISE Fellows at the time, led an effort to conduct field surveys of longleaf mostly on protected lands using the ALRI metrics and criteria to classify condition. They surveyed 6,936 acres primarily on Calloway Forest, Sandhills Gameland, and NC Parks land. The full results of this survey are [here](#). This method provided a rapid assessment of accessible land but there was concern that subjective assessments of conditions would make detecting changes over time difficult to discern.

To address the need for information of longleaf on private land, Matthew Moskwik conducted an analysis using the National Agricultural Imagery Program (NAIP) imagery and data from the US Forest Service Forestry Inventory Analysis (FIA). By combining field data points and data from FIA plots for metrics such as trees per acre, basal area, etc. Matthew build a predictive model to project onto the Longleaf Pine Range of North Carolina. The next ORISE Fellow, Ana Castillo then used these data to create a Habitat Quality Index based on the maintenance class criteria outlined by ALRI. The resulting product provided a landscape level snapshot of where potentially open pine forest might exist within the longleaf pine range of North Carolina.

Despite various surveying efforts, gathering detailed enough information on the extent and location of longleaf, especially on private lands remains a challenge. A recent model for conducting rapid field assessments of longleaf was developed by the Florida Natural Area's Inventory (FNAI) program to document longleaf and produce a geodatabase as part of the Longleaf Element Occurrence Project. Led by Amy Knight and Carolyn Kindell of FNAI, and Karen Zilliox Brown of the Longleaf Alliance, they have been able document millions of acres of longleaf across the range. This survey is currently being implemented in the Sandhills beginning with polygon delineation of potential longleaf stands using aerial imagery, a species distribution model, Natural Heritage Program data, and various other sources. Ana Castillo will complete much of the polygon delineation and the incoming ORISE Fellow, Dan Hannon, will lead rapid assessment field surveys in collaboration with help from the members of the Partnership. This inventory and monitoring effort will fill in many of the information gaps on the extent and condition of the Longleaf Mosaic especially on private lands and in the corridor area towards the Uwharrie National Forest.

Monitoring of Indicator Species

The benefits and importance of monitoring are exemplified by the great success of the red-cockaded woodpecker's recovery in the Sandhills. The population reached the target recovery goal of 450 potential breeding groups (PBG) ahead of the target goal date. In 2019 the partnership documented 759 Potential Breeding Groups in the NC Sandhills, with 687 PBGs counting towards recovery (i.e. on protected lands, 491 PBGs in the Sandhills East population and 196 in Sandhills West). Monitoring has also documented that the Sandhills East and West subpopulations achieved demographic connectivity in about 2017.

Another upland longleaf indicator species is the Bachman's Sparrow, a ground nesting bird of conservation concern. From 2012-2014, the NC Wildlife Resources Commission (led by Jeff Marcus, Scott Anderson, John Carpenter, and Paul Taillie) conducted a state-wide status assessment of Bachman's sparrows. This survey involved gathering existing Bachman's sparrow records, revisiting observations that were >5 years old, identifying potential habitat in areas that had not been previously surveyed through interpretation of aerial photos, and visiting survey points in the field on both private and public lands to evaluate habitat suitability and conduct point count surveys in suitable habitat.

Results from this work were published by [Taillie et al 2016](#) and [Pickens et al 2017](#) and provide a baseline of distribution and relative abundance of Bachman's sparrows in NC. In the Spring 2020, a subset of the survey points on properties that received management funded by NFWF (TNC preserves, Sandhills GL, Uwharrie NF, Carver's Creek and Weymouth Woods SP, Moss Foundation) were revisited by staff of The Nature Conservancy. These data will provide valuable information on how Bachman's Sparrow respond to restoration activities such as Timber Stand Improvement and prescribed burning.

Recommendations

Partners should continue monitoring of red-cockaded woodpecker populations, however it will likely be necessary to revisit the intensity and extent of monitoring that can reasonably be sustained. As of the summer of 2020, the RCW is being considered by the US Fish and Wildlife Service for downlisting or delisting, and the outcome may impact the imperative for monitoring. Key partners, such as NC Wildlife Resources Commission have already indicated that personnel resources for monitoring are limited and they may further scale back their monitoring efforts. The RCW Recovery Committee of the Partnership should meet after a listing decision has been made to identify the key attributes and sample size that should and can be monitored into the foreseeable future.

The Partnership has committed to conducting field surveys for the Longleaf Ecosystem Occurrences database project. This survey will provide information on the distribution and a rough measure of condition class for longleaf in the NC Sandhills. Once the survey is completed, we should evaluate the results and compare them to the results produced by the initial field condition class surveys and the NAIP analysis and determine which methodology provides the best opportunity to track progress over time in the extent and habitat quality of upland longleaf.

If resources permit, the Partnership should consider expanding upon the Bachman's sparrow monitoring conducted on conservation lands in 2020 to repeat the baseline surveys on private lands and unmanaged lands as well. This will provide a more complete snapshot of the change in sparrow distribution and abundance across the entire Sandhills, and not just on conservation lands which support the best habitat and the largest populations.

Other upland longleaf-associated species that could benefit from additional surveys and monitoring include northern pine snake and southern hognose snake. Better data could help to inform conservation status and needs and they could serve as additional indicator species to track progress on conservation of upland longleaf habitats. For some monitoring purposes, a more generalist and easy to survey species like wiregrass and little bluestem could provide a quick and dirty indicator of managed longleaf.

When considering future monitoring needs, it is worth considering potential impacts of emerging issues that could negatively impact the Longleaf Mosaic Target such as non-compatible solar energy development, biomass sourcing, etc. North Carolina is 2nd in solar energy development and solar farms are being built in critical habitat areas, sometimes even longleaf being clear cut to make way. The Nature Conservancy and the NC Wildlife Resources Commission have been working to form partnerships with solar companies to help mitigate negative effects to longleaf forests but there is further potential for collaboration. Furthermore, biomass sourcing for wood pellets is a growing industry and has become relevant with new Enviva pellet mill in Hamlet. There are conflicting opinions on the sustainability of biomass sourcing but there is also potential to provide income for private and public land owning

entities. By removing the mid-story hardwood in restoration forests, landholders could earn a modest amount per acre instead of paying to have it mulched. This is an ongoing area of development.

Finally, thinking about longleaf pine forest at a larger context there is potential to think about the Sandhill's role in part of a resilient and connected landscape. The Sandhills is home to significant high quality habitat core areas that are considered resilient due to their condition and size. It is important to think about connecting resilient core landscapes through climate corridors such as to the Uwharrie National Forest and the Cape Fear coastal longleaf through the Bladen Lakes Corridor. This approach requires landscape level thinking and collaboration with key partners such as the US Forest Service and the NC Forest Service. Connecting these core landscapes will be key to maintaining resiliency and corridors for species that share these habitats as the climate changes.

Monitoring for the Longleaf Mosaic is the area where there has been the most intensive work has been completed. Much of this work has been promoted by the range wide efforts to document and assess the condition of longleaf towards ALRI's 8 million acre goal. This has led to a greater understanding of what makes a "good" site and highlighted the importance of restoring and maintain groundcover for habitat. The LEO project continues this body of work and this monitoring will continue to be an iterative process with collaboration from many Partners.

Upland Depressional Wetlands

Summary of Work

Upland depressional wetlands (UDW) include vernal pools, small depressional ponds and Carolina Bays and support many rare plants and are critical breeding habitat for many rare herpetofauna. The NC Wildlife Resources Commission (Jeff Humphries, Mike Sisson, Nate Shepard, Mike Martin) and NC Museum of Natural Sciences (Jeff Beane, Alvin Braswell) have been the entities that have contributed the most to our understanding of the quality of UDW and the distribution and relative abundance of species that use these wetlands. NCWRC has restored 6+ wetlands, created one, and has conducted species surveys at over a dozen sites on Sandhills Game Land. Surveys have included egg mass counts, dip net surveys, and auditory surveys including remote acoustic recording devices. The most intensively studies has been 17 Frog Pond, where NCWRC conducts annual egg mass surveys for Carolina Gopher Frog and Tiger Salamander, collects incidental observations from many herpers, and where they conducted an intensive drift fence and gopher frog telemetry project, with some of the results published by [Humphries and Sisson 2012](#).

In order to understand the spatial relationship and overall condition of all Upland Depressional Wetlands, Matthew Moskwik analyzed a 15 year dataset of breeding records for at-risk species. The dataset included data for 6 amphibian species, including Carolina Gopher Frog and Mabee's Salamander, at 26 wetlands on Sandhills Gameland and Fort Bragg. For the study, they conducted field work to document the condition of the wetland in winter/spring 2016, measuring habitat characteristics such as canopy, mid-story, shrub cover, number of logs, etc. They also quantified isolation of the individual wetlands defined by the number of and distance of neighboring wetlands to understand how isolation and fragmentation would affect breeding events and species richness. The 2011 National Land Cover dataset was used to calculate the percent forested habitat up to 500m from the edge of wetlands and classify barriers to migration. Overall, they observed lower species richness and nonbreeding periods in part due to reduced immigration between the wetlands. There was a negative relationship between the

number of amphibians found and the average distance to the nearest wetland. Also, the extirpation rate increased with average distance from wetlands within 10km. Many of these species are maintained as a meta-population, so migration and multiple suitable wetlands for breeding are crucial to maintaining these populations. The full results of this study can be found [here](#).

Recommendations

Species associated with upland depressional wetlands such as the at-risk Carolina gopher frog, stand to experience the greatest population declines given the current lack of suitable habitat and habitat fragmentation. These wetlands are becoming increasingly isolated with habitat destruction and increased development posing irreversible barriers to migration for these species. This situation presents a huge area of opportunity to prevent rare, sensitive species from being extirpated from the landscape. There continues to be gaps in crucial knowledge necessary to successfully manage for these species such as their life history, appropriate prescribed burn regime, and how to restore and create artificial wetlands. Although there is an ongoing effort to head start gopher frogs in collaboration with the NC Zoo, survival in the field remains limited. Habitat creation and protection is crucial in the meanwhile to protect existing herpetofauna. There have been efforts by the NCWRC and TNC to create artificial wetlands with varying degrees of success. There is potential to continue to expand on these efforts to improve the process from site selection, vegetation management, and burn regime. Efforts such as the Workshop on Restoration and Fire in Ephemeral Wetlands hosted by NCWRC will continue to be crucial to promote collaboration and share challenges and lessons learned amongst the Partnership. Continued support for land protection will also be an important factor in moving towards achieving adequate connectivity between the wetlands.

NCWRC should be encouraged and supported in continuing their monitoring of UDW. NCWRC has introduced ornate chorus frogs and gopher frogs into Block T (Racktrack) Pond and continued monitoring at this site will be a priority to document success of habitat restoration and introduction efforts. The ORISE Fellow can update species records at ponds and help to fill information gaps where needed. Another area ripe for study is assessing the Jordan tract in Scotland County for amphibian use and potential for creation of wetlands and artificial stumpholes. This 2020 acre property links Blocks T, C and B of Sandhills Game Land, each of which has UDW that support at-risk species. Restoration and enhancement of habitat on Jordan will be a priority to improve demographic linkages between herp populations.

Blackwater Streams

Summary of Work

The conservation target of Blackwater Streams is inclusive of all the waterways in the Sandhills. This includes the Drowning Creek, Little Creek, and Hitchcock watersheds, which are notable for their importance in biodiversity and drinking water supply. However, land use changes pose many threats to these systems from direct habitat destruction to nutrient pollution. An analysis of these watersheds was conducted using available water quality data from the US Geological Survey, Environmental Protection Agency, and National Land Cover Database to study changes over time. Overall, measures of water quality and aquatic biodiversity were average to good across most of the Sandhills. Drowning Creek

stands out as a particularly important and high quality waterway. Subwatersheds downstream of Fayetteville show the greatest signs of impairment, while watersheds immediately downstream of Southern Pines are showing signs of deteriorating quality.

The common issues identified included declining flows, decreased oxygen, increased nutrients particularly of Nitrogen and phosphorus, and increased turbidity and water conductance. These issues particularly affect native fish, such as the Sandhills Chub which is endemic to Sandhills of North and South Carolina and need clear, cool streams with little vegetation. Agriculture for example, can degrade habitat for Sandhills Chub through siltation and increased nutrient load leading to increased algae production.

The study also found that macro-invertebrate and fish communities are strongly correlated with natural, forested, pervious surfaces within the watersheds analyzed. This analysis found the macro and fish classes in protected areas generally ranked in the Excellent to Good-Fair categories, but notably several of the sites on Fort Bragg scored Fair to Poor the fish community class. While urbanization and land-use change is not occurring as quickly as other areas in the Southeast, areas of the Sandhills such as Southern Pines and particularly Fayetteville are experiencing a loss in natural cover, and the effects are reflected in degrading water quality and declining health in aquatic communities.

Recommendations

Water quality issues are some of the hardest to address, as they require extensive collaboration between many types of stakeholders. Land development is the biggest single source of aquatic habitat degradation and is largely irreversible. This makes land protection forest management the most effective tools in protecting aquatic biodiversity and water quality. By continuing to protect and restore longleaf pine forests, the Partnership is contributing towards the overall health of the watershed. This is a great benefit to the greater aquatic ecosystem and helps maintain this ecosystem service for the larger Sandhills community. This is a benefit that can be more actively highlighted when conducting outreach to the community, especially in light of increasing development in the area. It is important to continue to work with local stakeholders and promote use of the Green Growth Toolbox to promote compatible development in the region.

In terms of future monitoring, this landscape level analysis should be able to be repeated as long as the USGS, EPA, and NLCD data are available. Results can be used to highlight trends and areas of concern, for more intensive monitoring and restoration opportunities. The Strategic Environmental Research and Development Program (SERPD) conducted an [extensive study](#) to develop ecological reference models that specifically quantify fish and macroinvertebrate communities and hydrogeomorphic conditions. This body of work can be used to help restore degraded sites identified through this biological monitoring.

One area that was highlighted in the previous analysis was a long term trend of declining flows in Drowning Creek. We don't currently have an adequate explanation for why this is, how much of a threat it creates, or what can be done about it. At the time some effort was made to reach out to the Town of Southern Pines (which gets drinking water from Drowning Creek), NCWRC and other partners to look into this matter, but this inquiry was not able to gain any traction at the time.

Summary of Work

Streamhead pocosins and sandhill seeps are biodiverse, and increasingly rare, plant communities associated with areas where groundwater is forced to the surface by a clay layer. They are an important habitat within the longleaf ecosystem, and are home to a variety of rare species. However, we have a limited understanding of how to characterize these habitats and how to best manage them. The North Carolina Natural Heritage Program hosts the best available spatial database of these community types across the Sandhills, thanks to intensive surveying in the past. Much of this work was completed a larger effort inventory natural areas in the Sandhills, especially the Sandhills Gameland and Fort Bragg. However, much of these survey points, or Element Occurrences (EOs), haven't been revisited in over a decade and many do not accurately map the extent of these communities, especially Seeps. In an effort to update the EOs and improve mapping of Seeps, field work was conducted in Summer of 2019 by Ana Castillo. This effort included revisiting known EO's on the Sandhills Gameland, Calloway Forest, Bonnie Doone, and the Walthour Moss Foundation and other Partner lands. The seeps were delineated based on field explorations and photo points were also established. Additionally, a rapid assessment method modeled after NatureServe's Ecological Integrity Assessment framework was developed for this community type based on vegetation metrics such as canopy, mid-story, and ground cover as well as relative patch size. This updated and improved spatial database will be added to the NHP database. Overall, [this project](#) provided a baseline assessment of known Sandhill Seeps and identified restoration opportunities such as at the Walthour-Moss Foundation and so called "powerline seeps" found in right of ways where rare species are sometimes found.

There have been a limited number of partner efforts that inform our understanding of seeps and drains. Data on the extent and diversity of canebreaks was evaluated by [Gray et al 2016](#). Natural Heritage, Plant Conservation Program, Fort Bragg Endangered Species branch, and other surveys for Sandhills Lily, Venus flytrap, rough-leaf loosestrife, and other rare species associated with seeps and drains help to inform locations of high quality sites. NCWRC has been conducting inventory surveys, and some repeat monitoring and limited telemetry studies of pine barrens tree frog.

Recommendations

Good examples of Sandhills seeps and streamhead pocosins are becoming increasingly rare as the overall condition deteriorates with continued fire suppression. However, the community appears to respond well to fire reintroduction or even mechanical clearing of excessive vegetation. For example, Bonnie Doone has a few small, fire suppressed seeps that the land manager, Wendy Dunaway, has been keeping open to the best of her ability by hand clearing and they sustain an impressive amount of plant diversity. However, the best and most extensive examples are found on public land where there is regular prescribed burning. Since seeps and streamhead pocosins are embedded in the larger longleaf ecosystem, management through fire can be achieved as part of a whole system approach. Operationally, it will be important to continue to burn in this often challenging terrain and push fire into the drains when possible. To do so successfully, it is important to ensure fire burns through drainages and firelines are not constructed in a way that would impede this from doing so. The ecotone between the uplands and the drainages is where many of the species of concern are found and where vegetation is prone to become too dense and shrubby.

Finally, there is an opportunity to conduct further studies to understand how fire affects plant community by conducting intensive surveys. Although some species are intrinsically rare, many others respond to fire frequency and it would be beneficial to understand how the assemblages may change. In particular, it will be instructive to know more about how management impacts populations of Sandhills Lily and rough-leaf loosestrife. NCWRC has had issues with their loosestrife population and Plant Conservation Program has lingering questions about lily management on Eastwood preserve.

Another potentially important component to study is the relationship between connectivity of seeps to each other and to drainages. Understanding these relationships will further our ability to identify sites for restoration focused on these community types when possible. In particular there is a need to understand more about the distribution and status of pitcher plant moths, and the dispersal potential for this species between seeps. This species have a metapopulation dynamic where they depend on dispersal from connected populations to re-colonize after a burn.

Conclusions

These collective efforts towards biological monitoring have provided a foundational knowledge and helped further our understanding of the longleaf pine ecosystem in the North Carolina Sandhills. The Partnership has had many accomplishments, notably meeting the RCW recovery goal, increasing prescribed fire on private land, and restoring and protecting many more acres of longleaf in the Sandhills region. As the new iteration of the biological monitoring program begins, it is important to acknowledge and think critically about how to build upon these great accomplishments and further develop the monitoring program. The Biological Monitoring Program plan was structured within an annual framework, where the ORISE Fellow would focus on one Conservation Target per year. However, the 5 year timeline has been delayed by approximately 3 years based on the original plan. This in part due to turnover of the ORISE Fellow each with their own unique skill set and limited tenure. Before the next iteration of the biological monitoring cycle, it is recommended to form a sub-committee to review the findings reviewed in this report and discuss how to update the plan and timeline. This will also serve as an opportunity to discuss strategies for coordination and funding strategies for conservation.

While each of the conservation targets is important within the longleaf ecosystem, the Sandhills Conservation Partnership is poised to contribute greatly to the conservation and restoration of Upland Depressional wetlands. There is a history of work in these habitats and institutional knowledge held within members of the Partnership. Notably, there are species at high risk of extirpation such as the Carolina gopher frog present in the protected lands. Of all the conservation targets, this appears to be the area of highest need and urgency as evidenced by continued declines in habitat and breeding events. It would be recommended to establish a working group dedicated to wetlands that would work on restoration and issues associated with both Upland Depressional Wetlands and Sandhill Seeps when applicable.