

Determine Certainty Program Framework of a Market Based Conservation Initiative for Longleaf Pine Habitat Improvements in Eastern North Carolina

Longleaf Pine Ecosystem Conservation Credit Creation and Development Component Report 2 of 6

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Introduction

Wildlife associated with the once expansive longleaf pine ecosystem has experienced great loss of habitat quality, quantity, and landscape connectivity – elements that influence availability and suitability of habitat. While some wildlife species have adapted to utilize other forest types, many species that primarily depend on longleaf pine have declined to the point of requiring state or federal protection.

Recovery credit systems (RCS) provide wildlife managers with a valuable, innovative conservation tool to contribute to recovery of federally threatened or endangered species. Implementation of RCS, singly, or alongside other conservation programs (e.g., safe harbor agreements, habitat conservation plans, recovery permits, and conservation banks) grants flexibility in formulating a plan to create a “net benefit” for a species of concern (USFWS 2008). This approach is designed to increase the species’ population or habitat through the exchange of credits, defined as “quantifiable [units] of measure recognized [to represent] a contribution to the recovery of a species listed under the ESA” (USFWS 2008).

The RCS model has expanded to include exchange of habitat credits for species not yet federally listed. Credit systems now exist to not only recover listed species, but also to prevent listing of species. A similar model can be used to bolster populations of wildlife associated with the once common longleaf pine ecosystem. Although only a small portion of today’s landscape contains the open, mature longleaf forests that provide habitat for various species of concern, existing longleaf stands can be improved to provide suitable wildlife habitat, especially when land managers are incentivized to implement the necessary management practices over sufficient time periods to achieve suitable conditions.

Our goal in this project was to identify and develop quantifiable metrics for a longleaf credit system in eastern North Carolina which would ultimately contribute to a “net benefit” for longleaf-dependent wildlife species through development and enhancement of habitat. This specifically involved: 1) identification of past projects and ecosystem species to target, 2) development of multi-species habitat metrics, and 3) assessment of the metric system on other open pine ecosystems.

Identification of past projects and ecosystem species to target

Existing Credit Systems

Assessment of habitat metrics is used as a means to quantify the quality and quantity (i.e., conservation value) of properties enrolled in credit systems. We reviewed existing credit systems for the dunes sagebrush lizard, greater sage-grouse, golden-cheeked warbler, and Utah prairie dog, specifically examining the types of habitat metrics used and methods for calculating credits for exchange (see Appendix A for a summary). Common key components among reviewed credit systems included:

1. Credits are traded based on habitat needs for a single species.
2. Metrics used to calculate credits incorporate the best available scientific knowledge of the species and its habitat.
3. Typically, land enrolled contained existing habitat; contracts were primarily used to maintain or improve habitat.
4. Credits were calculated based on a combination of points and weights or multipliers.
5. Site-specific management plans were developed by a natural resources professional associated with the credit system; landowners were expected to follow the management plan as a condition of entering the contract.

Although all reviewed credit systems were designed to reward more credits for greater amounts of habitat quality and quantity, and therefore, greater potential to benefit the species of interest, each credit system used a unique approach for credit calculation. Additionally, metrics used to calculate credits were unique among credit systems, reflecting specific habitat needs of the species of interest. Habitat metrics deemed most important in determining habitat suitability primarily accounted for credits generated through the use of weights and multipliers. These systems were designed to maintain a net gain of habitat for the respective species by adjusting calculations for generation of credits versus credits needed for mitigation, and only releasing credits for mitigation actions after enough habitat credits were generated.

Longleaf Pine Ecosystem Target Species

Wildlife species predominantly associated with longleaf pine ecosystems have declined in number and distribution due to the reduced quantity, quality, and spatial distribution of longleaf habitat. Range-wide, longleaf ecosystems provide habitat for almost 30 federally threatened or endangered species. In North Carolina's Mid-Atlantic Coastal Plain Ecoregion alone, dry longleaf pine provides habitat to over 30 priority species identified in the State Wildlife Action Plan (NCWRC 2005). These include game animals, as well as state- and federally-identified species of concern. Improvement of longleaf habitat benefits all of these species.

We reviewed habitat preferences for seven species (Table 1) to guide formulation of and validate proposed habitat metrics for a longleaf credit system. These were chosen for the following reasons:

1. Identified as priority species in Mid-Atlantic Coastal Plain dry longleaf pine habitats, according to the NC Wildlife Action Plan (NCWRC 2005), representing various levels of conservation status.
2. Previously recognized as species with habitat preferences representative of high quality longleaf habitat known to benefit many other species (e.g., the red-cockaded woodpecker [RCW] is a well-known keystone/umbrella species).
3. Represent various taxa.
4. Utilize various canopy levels within a stand.
5. Habitat preferences are well documented in the scientific literature.

Target species utilize longleaf-dominated habitat, especially upland sites, when available; some almost exclusively require presence of longleaf pine, while others are able to utilize other forest types. Common habitat characteristics for target species include open, mature longleaf stands with high quality, native herbaceous ground cover. Creating and maintaining this habitat requires implementation of similar management practices, particularly prescribed burning at regular intervals of approximately 3 to 5 years. Although specific habitat requirements differ slightly for each species, previous research suggests that habitat preferences of a few species can represent ideal conditions for multiple longleaf-dependent species (McIntyre 2012).

Table 1. Target species used to validate proposed metrics for the longleaf credit system. Much of this assessment incorporates previous research conducted by the National Fish and Wildlife Foundation and Jones Center (McIntyre 2012). Species from various taxa, with varying degrees of conservation concern, and varying degrees of dependence on longleaf habitat are included. All species are identified as priority species in coastal plain dry longleaf pine habitat in North Carolina (NCWRC 2005). Well-understood vegetative characteristics thought to influence habitat quality are included. References for the target species habitat review are listed in Appendix B.

| Species & conservation status | Forest habitat type | Canopy cover | Midstory & understory cover | Pine tree age/DBH ¹ | Fire interval |
|---|---|--------------|---|--|---------------|
| Eastern fox squirrel (<i>Sciurus niger</i>); significantly rare (state) – regionally, game species – regionally | pine-oak forests; historically, longleaf pine forests | open | open | mature | |
| Northern pine snake (<i>Pituophis melanoleucus melanoleucus</i>); special concern (state) | upland pine or pine-oak forests; prefer longleaf pine-scrub, oak-wiregrass habitats | | | | frequent |
| Southern hognose snake (<i>Heterodon simus</i>); special concern (state) | upland pine-dominated or pine-oak woodland; prefer pine-wiregrass flatwoods or longleaf pine-turkey oak sandhill habitats | open | open; low shrub/woody cover; established herbaceous understory | mature | frequent |
| Carolina gopher frog (<i>Rana capito</i>); threatened (state) | Sandhill and mesic pine flatwoods; prefer longleaf pine-turkey oak sandhill | open | | Stumps with dbh ¹ of 16+ inches (used as summer refugia) | frequent |
| Bachman's sparrow (<i>Aimophila aestivalis</i>); special concern (state) | pine savannas, or regenerating pine stands | open | open midstory; dense coverage of grasses and forbs in understory | Age: 50 – 80 years OR early successional, cutover stands 1 – 5 years old, or regenerating stands 6 – 10 years after planting | frequent |
| Northern bobwhite (<i>Colinus virginianus</i>); game species (state) | Southern pine forests; hardwood forests; mixed forests | open | open; few hardwoods and shrubs in midstory; grass and forb ground cover | | frequent |
| Red-cockaded woodpecker (<i>Picooides borealis</i>); endangered (federal and state) | pine forest or savannas; strong preference for longleaf pine | open | open; minimal hardwoods; herbaceous ground cover | Age: 30 years (foraging habitat); 60 years (nesting habitat) | frequent |

¹ Diameter at breast height

Development of multi-species habitat metrics

Design of longleaf pine ecosystem metrics

Although existing credit systems tend to focus on improving and maintaining habitat for a single species, a longleaf ecosystem credit system creates the opportunity to benefit multiple species. Suitable wildlife habitat is currently limited in availability throughout the historical longleaf pine range, especially for species that require mature forests. However, opportunities exist to improve established longleaf stands, as well as reestablish longleaf.

The metrics we propose for a longleaf ecosystem credit system are designed to create habitat for a suite of species that utilize or depend on longleaf pine. Although an ecosystem-level set of habitat metrics is not all inclusive of every habitat aspect for every target species, we verified common applicable metrics with potential to provide ideal habitat for the majority of these species. Collectively, metrics can be used to calculate the amount of credit generated on a per site basis. Evaluation of lands based on these metrics serves to prioritize lands with the greatest potential conservation value by contributing to longleaf wildlife habitat.

Metrics were formulated and validated based on shared habitat preferences of target species, the Longleaf Pine Maintenance Condition Class Definitions provided by America's Longleaf (2014), and longleaf wildlife metrics collaboratively defined by the National Fish and Wildlife Foundation and Joseph W. Jones Ecological Research Center (McIntyre 2012). Additional metrics were incorporated to address suggestions from longleaf and wildlife experts in previous research regarding prioritization of long-term longleaf pine management for wildlife conservation, improvement of existing longleaf stands, and consideration of spatial context of management efforts (McIntyre 2012).

Metrics and valuation

In the proposed longleaf pine ecosystem credit system, credits are awarded based on points and multipliers assigned to metrics, which are divided into two main categories: spatial and temporal context of habitat (Table 2), and stand structure of the canopy (Table 3a), midstory, and understory (Table 3b). Four additional metrics are used as multipliers (Table 4). Points and multipliers are designed to place high value on lands with the greatest potential to contribute high quality wildlife habitat in large, spatially aggregated quantities over a long period of time.

Table 2. Spatial and temporal context of habitat metrics for the longleaf pine ecosystem credit system. Point valuations are designed to prioritize large, contiguous areas of habitat that contribute to connectivity at multiple spatial scales (i.e., property to landscape levels).

| METRIC | CRITERIA | PRIORITY | POINTS |
|---|--------------------------------|----------|--------|
| Spatial and Temporal Context of Habitat (14 possible points) | | | |
| 1. Proximity to longleaf pine significant geographic area (SGA); includes Significant Landscapes and Significant Sites | Within SGA | High | 4 |
| | Adjacent to SGA | | 2 |
| | Within 3 miles of SGA | | 1 |
| | > 3 miles of SGA | Low | 0 |
| 2. Adjacent to legally protected lands (e.g., Federal, State, conservation easement), OR lands enrolled in a longleaf management program for wildlife habitat | Yes | High | 2 |
| | No | Low | 0 |
| 3. Presence of species of concern (e.g., threatened or endangered [T/E] species, state priority species) | Yes – federal/state T/E | High | 4 |
| | Yes – state priority species | | 2 |
| | No | Low | 0 |
| 4. Potential for urban development (based on SLEUTH Projected Urban Growth model for 2100) | Not likely (<70% probability) | High | 2 |
| | Very likely (>70% probability) | Low | 0 |
| 5. Willingness to implement management treatments (e.g., prescribed burning, thinning stands, etc.) | High | High | 2 |
| | Low | Low | 0 |

The following summarizes prioritizations for each metric included in Table 2; numbered metrics correspond with numbered explanations. Higher points awarded for:

1. Spatially aggregated conservation efforts, relative to locations of significant geographic areas (SGA; optimal areas of focus for longleaf pine conservation efforts, as identified in the America’s Longleaf Range-wide Conservation Plan [2009]). Locations within 3 miles of an SGA are awarded points based on the possibility of dispersal events by certain species (e.g., red-cockaded woodpecker).

2. Proximity to legally protected lands, or lands enrolled in longleaf wildlife habitat programs, promoting concentrated conservation efforts.
3. Presence of threatened or endangered, or state priority species (e.g., priority species listed in the North Carolina Wildlife Action Plan); this suggests presence of existing habitat, and rewards continued management of that habitat.
4. Low probability of urban development/encroachment. This is based on urban growth projections according to the SLEUTH model developed for the Southeastern United States (Belyea and Terando, n.d.). Proximity to urban areas can lead to loss or degradation of habitat, and interfere with implementation of necessary management practices (i.e., prescribed burning).
5. Willingness to implement necessary management strategies to achieve desired forest conditions. Implementation of certain management practices (i.e., prescribed burning) will be necessary on all properties, while others will require more intensive management (e.g., thinning stands, planting longleaf, removing hardwood species, etc.).

Table 3a. Stand structure canopy metrics for the longleaf pine ecosystem credit system. Point valuations are designed to prioritize existing stands with open, longleaf-dominated canopies.

| METRIC | CRITERIA | PRIORITY | POINTS | |
|---|--------------------------------|--|--------|---|
| Stand Structure (9 possible points) | | | | |
| 6. Canopy | Longleaf age structure | Multi-aged | High | 4 |
| | | Even-aged | | 2 |
| | | No existing longleaf | Low | 0 |
| | Presence of mature longleaf | Basal area of longleaf trees age 60+ years or 14" dbh \geq 20ft ² /acre, OR presence of flat-top longleaf | High | 2 |
| | | Basal area of longleaf trees age 60+ years or 14" dbh \leq 20ft ² /acre | Low | 0 |
| | Basal area of longleaf pine | 40 – 70 ft ² /acre | High | 1 |
| | | > 70 ft ² /acre OR < 40ft ² /acre | Low | 0 |
| | Canopy cover/closure | 40 – 60% | High | 1 |
| | | < 40% OR > 60% | Low | 0 |
| Basal area of hardwoods/off-site pine \geq 5" dbh | \leq 10ft ² /acre | High | 1 | |
| | >10ft ² /acre | Low | 0 | |

Table 3b. Stand structure midstory and understory metrics for the longleaf pine ecosystem credit system. Point valuations are designed to prioritize open midstory and understory conditions, with minimal hardwood presence and adequate native herbaceous groundcover.

| METRIC | | CRITERIA | PRIORITY | POINTS |
|--|--|--|----------|--------|
| Stand Structure (7 possible points) | | | | |
| 7. Midstory | Shrub cover | ≤ 30% cover, average ≤ 3 feet tall | High | 1 |
| | | > 30% cover | Low | 0 |
| | Midstory cover of hardwoods or off-site pines | ≤ 20% | High | 1 |
| | | > 20% | Low | 0 |
| | Fire-intolerant hardwood/off-site pine species cover | < 5% over 16 ft tall | High | 1 |
| | | ≥ 5% over 16 ft tall | Low | 0 |
| 8. Understory | Presence of native pyrogenic species in herbaceous cover | > 35% | High | 1 |
| | | ≤ 35% | Low | 0 |
| | Contiguous herbaceous cover | ≥ 65% with ≥ 20% graminoid composition | High | 1 |
| | | < 65% or < 20% graminoid composition | Low | 0 |
| | Longleaf regeneration | Advance regeneration cover (grass stage or dbh < 2”) is 5-15% of stand | High | 1 |
| | | Advance regeneration cover < 5% OR > 15% | Low | 0 |
| Non-native invasive species | Exotic invasive plant cover ≤ 1% | High | 1 | |
| | Exotic invasive plant cover > 1% | Low | 0 | |

The following summarizes prioritizations for each metric included in Tables 3a and 3b; numbered metrics correspond with numbered explanations. Higher points awarded for:

6. Multi-aged stand structure, and adequate basal area of mature longleaf trees. This provides habitat for various species, and promotes continued recruitment of pines into older age classes, as well as eventual natural regeneration of the stand.
7. Minimal shrub, hardwood, or off-site pine. This provides optimal wildlife habitat, and facilitates effectiveness of regular management activities (e.g., prescribed burning) to maintain suitable habitat.

- 8. Native herbaceous cover and presence of grass-stage longleaf, indicating continued recruitment of younger longleaf into the stand.

Table 4. Multipliers for longleaf pine ecosystem credit calculation. Multiplier values are designed to prioritize enrollment of lands with larger quantities of habitat, with potential to contribute suitable habitat for long periods of time.

| MULTIPLIER | CRITERIA | MULTIPLIER VALUE |
|---|----------------------|------------------|
| 9. Maximum age of existing longleaf (representing majority of enrolled land) | 60 years | 1.50 |
| | 40 years | 0.75 |
| | 20 years | 0.50 |
| | < 20 years | 0.25 |
| | No existing longleaf | 0.10 |
| 10. Length of contract | Perpetual | 1.50 |
| | 50+ years | 0.75 |
| | 25 - 50 years | 0.50 |
| | 10 - 25 years | 0.25 |
| 11. Years under contract longleaf is managed at minimum target age (60 years) | 50+ years | 1.50 |
| | 25 - 50 years | 0.75 |
| | 10 - 25 years | 0.50 |
| | <10 years | 0.25 |
| 12. Total area managed as longleaf habitat | 150+ acres | 1.00 |
| | 100 - 150 acres | 0.75 |
| | 50 - 100 acres | 0.50 |
| | 10 - 50 acres | 0.25 |

The following summarizes prioritizations for each multiplier value included in Table 4; numbered multiplier categories correspond with numbered explanations. Higher points awarded for:

9. Presence of older ages of longleaf pine. This suggests increased suitability of habitat, especially for species of conservation concern (e.g., RCW, Bachman's sparrow, Carolina gopher frog). An age of 60 years was chosen based on RCW nesting tree requirements (USFWS 2003). This is a minimum age when longleaf stands begin to reach a mature stage.
10. Continued management of habitat under longer contracts. Potential to develop more habitat of higher quality increases over time with proper management.
11. Lands enrolled over longer time periods, with presence of longleaf pine at or above the target age of 60 years (RCW minimum nesting tree age [USFWS 2003]). These lands provide opportunities to develop suitable habitat as quickly as possible, and maintain habitat over an extended period of time.
12. Larger areas of contiguously managed habitat, which hold greater conservation value. Potential to support more species and/or larger populations increases with area of managed habitat. Area thresholds correspond with findings in previous research for acreage requirements for the Bachman's sparrow, Northern bobwhite, and red-cockaded woodpecker (McIntyre 2012).

Point and multiplier values emphasize rewarding credits for large areas of older longleaf pines, able to provide suitable habitat the soonest, and continue providing habitat well into the future. Existing stands rarely exhibit the open, mature canopy characteristics required to support suitable habitat, especially for imperiled species. However, management of existing longleaf gives the best short-term opportunity to create suitable habitat with proper application of proven management techniques (e.g., prescribed burning, thinning, and hardwood removal), which can improve habitat suitability in relatively short time periods. Metrics in the longleaf credit system should be refined as more research (e.g., “Open Pines Project” conducted by NatureServe, U.S. Fish and Wildlife Service, and the East Gulf Coastal Plain Joint Venture) concerning longleaf metrics for different community types and geographic locations becomes available.

Some of these metrics can be evaluated via geographic information systems (GIS), when the appropriate data is available (e.g., location relative to SGAs or protected lands, potential for urban development, and area managed as habitat). On-site evaluations, conducted by a natural resources expert knowledgeable of the credit system, will be necessary for assessment of other metrics (e.g., structural metrics for canopy, midstory, and understory). Further revision of metrics may be needed to address evaluation of properties with multiple stands of differing conditions (e.g., stands of different ages or structural qualities). Considering historical land use could also aid in evaluating a property’s potential value as longleaf wildlife habitat.

Credit calculation

None of the existing credit systems reviewed use the exact same method of calculating credit. This creates flexibility in assigning credits based on the unique biology and habitat preferences of the respective species. Each credit system did include common elements in credit calculation: area of land enrolled, points assigned for habitat characteristics, and weights or multipliers to ensure the most important habitat factors had the greatest influence on credits generated.

The formula proposed to calculate longleaf credit incorporates the same major elements:

$$\text{acres enrolled} \times (\text{total points} \div \text{maximum points}) \times \text{multipliers} = \text{TOTAL CREDIT}$$

Examples of credit calculation are given in the following scenarios:

Scenario 1: 75 acres of habitat, which scores 19 out of 30 total points, with 60 year-old longleaf stands, enrolled for 30 years.

Scenario 2: 200 acres of habitat, which scores 9 out of 30 total points, with 40 year-old longleaf stands, enrolled for 25 years.

Scenario 3: 350 acres of habitat, which scores 8 out of 30 total points, with 20 year-old longleaf stands, enrolled for 10 years.

| Scenario | Acres | Metrics score | Age multiplier value | Contract multiplier value | Target multiplier value | Area multiplier value | TOTAL CREDIT |
|----------|-------|---------------|----------------------|---------------------------|-------------------------|-----------------------|---------------------|
| 1 | 75 | 0.63 | 1.50 | 0.50 | 0.75 | 0.50 | 13.29 |
| 2 | 200 | 0.30 | 0.75 | 0.50 | 0.25 | 1.00 | 5.63 |
| 3 | 350 | 0.27 | 0.50 | 0.25 | 0.25 | 1.00 | 2.95 |

These scenarios illustrate the prioritization of enrolling land with the greatest potential to contribute high quality habitat as soon as possible, and maintain that habitat for as long as possible, by awarding more credits. For example, Scenario 1 receives substantially more credits compared to Scenario 2 or Scenario 3 despite enrolling far less land. The higher conservation value of management of older, existing longleaf for a longer period of time beyond the target age of 60 is reflected in the amount of credit generated. Detailed example “score sheets” and credit calculations associated with these scenarios are given in Appendix C.

Assessment of total credits can similarly be used as a means to rank properties based on their perceived conservation value as measured through habitat metrics. Although this is useful in evaluating the relative potential of a property to contribute to wildlife habitat, contracts may not always be awarded for properties with the highest ranking (i.e., highest number of credits). For example, properties enrolled in the Golden-cheeked Warbler Recovery Credit System were sometimes selected due to their location relative to Fort Hood, despite ranking lower than other properties. In addition to the amount of generated credits, dynamic management priorities should guide decisions to enroll properties.

Assessment of Metric System on Other Open Pine Systems

The longleaf credit system model proposed herein is applicable to other open pine systems. Many of the same structural metrics can be used to define the desired forest condition in other pine systems. However, metric criteria and valuation should be adjusted to appropriately reflect that condition. Findings of the “Open Pines Project”, an ongoing joint effort between NatureServe, U.S. Fish and Wildlife Service, and the East Gulf Coastal Plain Joint Venture, will be particularly useful in this regard as it contains structural metrics and criteria for eight pine ecological system types, including five longleaf forest types, and three shortleaf-loblolly forest types. Additionally, metrics would need to be updated based on target species’ habitat preferences.

With the appropriate updates, credit systems developed for other open pine systems can contribute to habitat conservation. Similar to the proposed longleaf ecosystem credit system, implementation of an ecosystem-level credit system framework for open pines can be used to quantify the conservation value of lands, and promote efficient prioritization of lands with potential to provide habitat for target species over adequate spatial and temporal scales.

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Appendix A – Existing Credit Systems Overview

| Program, Species, and Conservation Status | Requirement for Enrollment/Award of Credits | Calculation of Credits | Length of Contract |
|---|--|--|---|
| <p><i>Utah Prairie Dog Habitat Credits Exchange Program</i></p> <p>Developed for the Utah prairie dog (UPD), downlisted to federally threatened in 1984.</p> | <p>Requires a minimum of 40 acres and 20 UPDs for enrollment. Maintain UPDs on property; follow customized management plan developed by the program administrator and landowner to protect habitat values for UPD, while allowing continued agricultural activities.</p> | <p>Calculated based on acres enrolled, metrics for habitat quality, landscape context, and existing UPD population on property.</p> | <p>Permanent</p> |
| <p><i>Texas Conservation Plan for the Dunes Sagebrush Lizard</i></p> <p>Developed for the dunes sagebrush lizard (DSL), proposed federally endangered in 2010.</p> | <p>Conduct approved recovery activities which encourage maintenance or improvement of habitat.</p> | <p>Calculated based on acres targeted for conservation, likelihood of DSL occurrence, value of recovery activities, and proximity to DSL habitat.</p> | <p>Varies with management activities</p> |
| <p><i>Golden-cheeked Warbler Recovery Credit System</i></p> <p>Developed for the golden-cheeked warbler (GCWA), federally endangered since 1990.</p> | <p>Manage, at minimum, 20 acres “verified as meeting the TPWD criteria for areas that are likely to be inhabited by GCWAs.” Must be within an identified priority landscape for GCWA recovery, and an integral part of a larger block of continuous habitat.</p> | <p>Calculated based on number of conservation units (20-acre units), priority of location according to recovery regions, proximity to existing GCWA populations, and extent of surrounding GCWA habitat.</p> | <p>Determined by landowner</p> |
| <p><i>Nevada Conservation Credit System</i></p> <p>Developed for the Greater sage-grouse, federal listing warranted in 2010, precluded for higher priority species; due for review in 2015.</p> | <p>Site must meet minimum habitat function requirements, and must be located within the “service area”. Credits are awarded for meeting or maintaining habitat performance standards, defined in the management plan for the site.</p> | <p>Calculated based on acres of functional habitat for breeding/brooding/wintering (measured at multiple spatial scales), incorporation of biological factors, and proximity between credit and debit sites.</p> | <p>Minimum of 10 years, up to perpetuity (in 5 year increments)</p> |

Appendix B –References for Target Species Habitat Review

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Appendix C – Credit Score Calculations

NOTE: No on-site property evaluations were conducted for the purposes of this report. Pictures associated with scenarios are intended to offer a visual representation of sites and potential credit scores.

Scenario 1: 75 acres of habitat, which scores 19 out of 30 total points, with 60 year-old longleaf stands, enrolled for 30 years.

$$\begin{array}{cccccccccc} 75 & \times & (19 & \div & 30) & \times & 1.50 & \times & 0.50 & \times & 0.75 & \times & 0.50 & = & \mathbf{13.29} \\ \text{Acres} & & \text{Assigned} & & \text{Possible} & & \text{Age} & & \text{Contract} & & \text{Target} & & \text{Area} & & \text{CREDITS} \\ & & \text{points} & & \text{points} & & \text{multiplier} & & \text{multiplier} & & \text{multiplier} & & \text{multiplier} & & \end{array}$$



Scenario 1 Score Sheet:

| METRIC | | | |
|---|--|--------------------------|-------------------------|
| <i>Spatial and Temporal Context of Habitat – 14 possible points</i> | | Current Condition | Points Assigned |
| Proximity to longleaf pine SGA | | 2.5 miles from SGA | 1 |
| Adjacent to legally protected lands OR lands enrolled in longleaf wildlife habitat program? | | No | 0 |
| Presence of species of concern? | | No | 0 |
| Potential for urban development? | | No | 2 |
| Willingness to implement management treatments? | | Yes | 2 |
| | | SUBTOTAL | 5 |
| <i>Stand Structure – 16 possible points</i> | | | |
| Canopy | Longleaf age structure | Multi-aged | 4 |
| | Presence of mature longleaf? | Yes | 2 |
| | Basal area of longleaf pine | 60 ft ² /acre | 1 |
| | Canopy cover/closure | 60% | 1 |
| | Basal area of hardwoods/off-site pine ≥5" DBH | 7 ft ² /acre | 1 |
| Midstory | Shrub cover | 20% cover, ≤ 3 feet tall | 1 |
| | Midstory cover of hardwoods/off-site pines | 5% | 1 |
| | Fire-intolerant hardwood/off-site pine species cover | 1% over 16 ft tall | 1 |
| Understory | Presence of native pyrogenic species in herbaceous cover | 45% | 1 |
| | Contiguous herbaceous cover | 70%, ≥ 20% graminoid | 1 |
| | Longleaf regeneration | cover 20% | 0 |
| | Non-native invasive species | cover 10% | 0 |
| | | SUBTOTAL | 14 |
| MULTIPLIERS | | Current Condition | Multiplier Value |
| Maximum age of existing longleaf | | 60 years old | 1.50 |
| Length of contract | | 30 years | 0.50 |
| Years under contract longleaf is managed at minimum target age (60 years) | | 30 years | 0.75 |
| Total area managed as longleaf habitat | | 75 acres | 0.50 |

Scenario 2: 200 acres of habitat, which scores 9 out of 30 total points, with 40 year-old longleaf stands, enrolled for 25 years.

$$\begin{array}{cccccccccc} 200 & \times & (9 & \div & 30) & \times & 0.75 & \times & 0.50 & \times & 0.25 & \times & 1.00 & = & \mathbf{5.63} \\ \text{Acres} & & \text{Assigned} & & \text{Possible} & & \text{Age} & & \text{Contract} & & \text{Target} & & \text{Area} & & \text{CREDITS} \\ & & \text{points} & & \text{points} & & \text{multiplier} & & \text{multiplier} & & \text{multiplier} & & \text{multiplier} & & \end{array}$$



Scenario 2 Score Sheet:

| METRIC | | Current Condition | Points Assigned |
|---|---|--------------------------|-------------------------|
| <i>Spatial and Temporal Context of Habitat – 14 possible points</i> | | | |
| | Proximity to longleaf pine SGA | 3 miles from SGA | 1 |
| | Adjacent to legally protected lands OR lands enrolled in longleaf wildlife habitat program? | Yes | 2 |
| | Presence of species of concern? | No | 0 |
| | Potential for urban development? | No | 2 |
| | Willingness to implement management treatments? | Yes | 2 |
| | | SUBTOTAL | 7 |
| <i>Stand Structure – 16 possible points</i> | | | |
| Canopy | Longleaf age structure | Even-aged | 2 |
| | Presence of mature longleaf? | No | 0 |
| | Basal area of longleaf pine | 30 ft ² /acre | 0 |
| | Canopy cover/closure | 80% | 0 |
| | Basal area of hardwoods/off-site pine ≥5" DBH | 60 ft ² /acre | 0 |
| Midstory | Shrub cover | 25% cover, ≤ 3 feet tall | 0 |
| | Midstory cover of hardwoods/off-site pines | 30% | 0 |
| | Fire-intolerant hardwood/off-site pine species cover | 10% over 16 ft tall | 0 |
| Understory | Presence of native pyrogenic species in herbaceous cover | 30% | 0 |
| | Contiguous herbaceous cover | 65%, < 20% graminoid | 0 |
| | Longleaf regeneration | cover 1% | 0 |
| | Non-native invasive species | cover 10% | 0 |
| | | SUBTOTAL | 2 |
| MULTIPLIERS | | Current Condition | Multiplier Value |
| | Maximum age of existing longleaf | 40 years old | 0.75 |
| | Length of contract | 25 years | 0.50 |
| | Years under contract longleaf is managed at minimum target age (60 years) | 5 years | 0.25 |
| | Total area managed as longleaf habitat | 200 acres | 1.00 |

Scenario 3: 350 acres of habitat, which scores 8 out of 30 total points, with 20 year-old longleaf stands, enrolled for 10 years.

$$\begin{array}{cccccccccc} 350 & \times & (8 & \div & 30) & \times & 0.50 & \times & 0.25 & \times & 0.25 & \times & 1.00 & = & \mathbf{2.95} \\ \text{Acres} & & \text{Assigned} & & \text{Possible} & & \text{Age} & & \text{Contract} & & \text{Target} & & \text{Area} & & \text{CREDITS} \\ & & \text{points} & & \text{points} & & \text{multiplier} & & \text{multiplier} & & \text{multiplier} & & \text{multiplier} & & \end{array}$$



<http://www.sciway.net/sc-photos/wp-content/uploads/pine-stand-carolina.com/016.jpg>

Scenario 3 Score Sheet:

| METRIC | | | |
|---|--|----------------------------|-------------------------|
| <i>Spatial and Temporal Context of Habitat – 14 possible points</i> | | Current Condition | Points Assigned |
| Proximity to longleaf pine SGA | | > 3 miles from SGA | 0 |
| Adjacent to legally protected lands OR lands enrolled in longleaf wildlife habitat program? | | No | 0 |
| Presence of species of concern? | | No | 0 |
| Potential for urban development? | | Yes | 0 |
| Willingness to implement management treatments? | | Yes | 2 |
| | | SUBTOTAL | 2 |
| <i>Stand Structure – 16 possible points</i> | | | |
| Canopy | Longleaf age structure | Even-aged | 2 |
| | Presence of mature longleaf? | No | 0 |
| | Basal area of longleaf pine | > 70ft ² /acre | 0 |
| | Canopy cover/closure | > 60% | 0 |
| | Basal area of hardwoods/off-site pine ≥5" DBH | ≤10ft ² /acre | 1 |
| Midstory | Shrub cover | ≤ 30% cover, ≤ 3 feet tall | 1 |
| | Midstory cover of hardwoods/off-site pines | < 20% | 1 |
| | Fire-intolerant hardwood/off-site pine species cover | < 5% over 16 ft tall | 1 |
| Understory | Presence of native pyrogenic species in herbaceous cover | < 35% | 0 |
| | Contiguous herbaceous cover | 40%, < 20% graminoid | 0 |
| | Longleaf regeneration | cover < 5% | 0 |
| | Non-native invasive species | cover > 1% | 0 |
| | | SUBTOTAL | 6 |
| MULTIPLIERS | | Current Condition | Multiplier Value |
| Maximum age of existing longleaf | | 20 years old | 0.50 |
| Length of contract | | 10 years | 0.25 |
| Years under contract longleaf is managed at minimum target age (60 years) | | 0 years | 0.25 |
| Total area managed as longleaf habitat | | 350 acres | 1.00 |