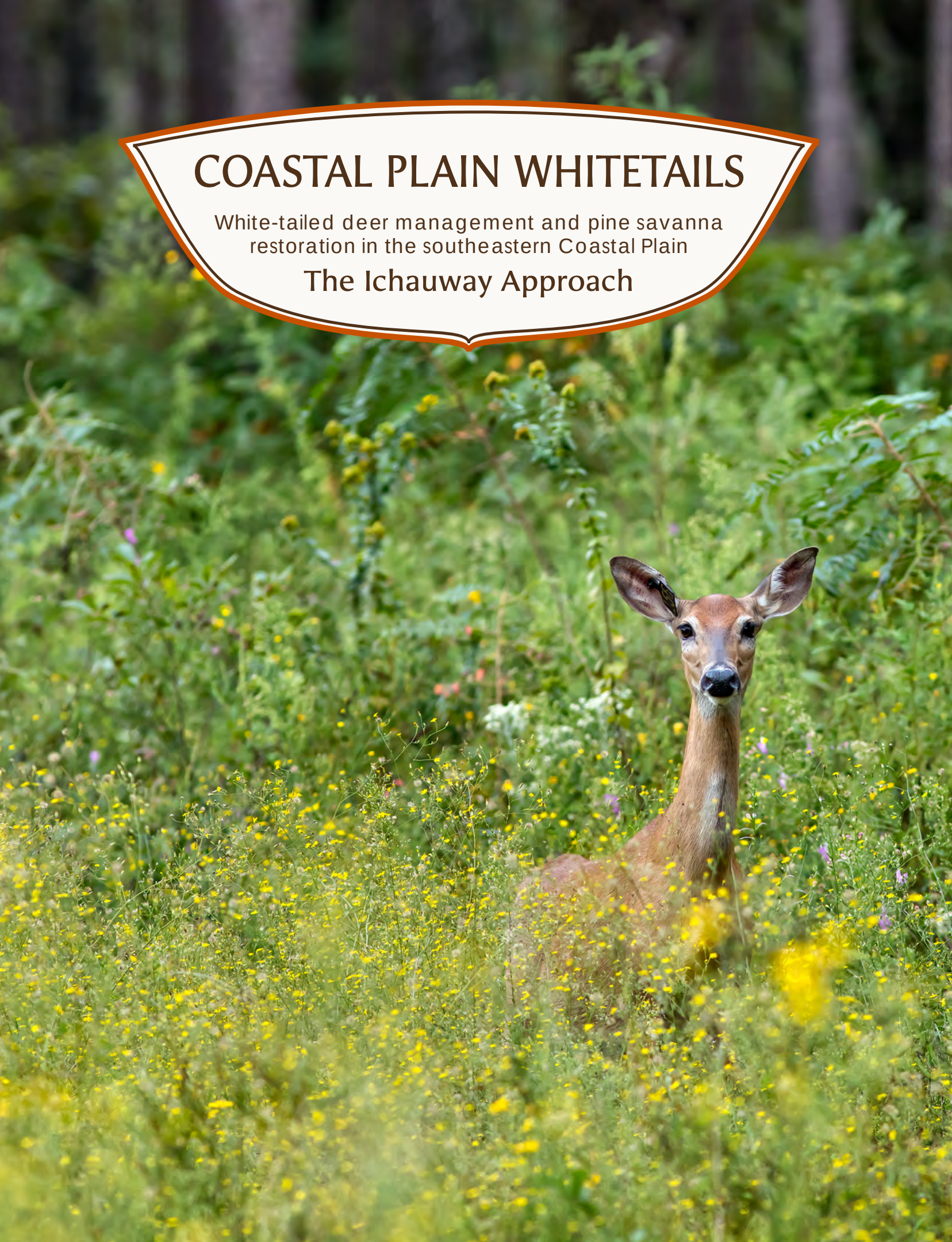
# COASTAL PLAIN WHITETAILS

White-tailed deer management and pine savanna restoration in the southeastern Coastal Plain

## The Ichauway Approach



The intent of this publication is to provide information from our white-tailed deer management and monitoring programs, in the context of longleaf management and restoration at Ichauway. We have attempted to demonstrate how desirable deer herds can be maintained on properties managed with "non-traditional" white-tailed deer management objectives. It is our experience that managing for quality habitats can have a net-positive impact on white-tailed deer herds in the southeastern Coastal Plain. In making natural resource decisions, we encourage land owners and managers to consider multiple resource objectives and the promotion of quality habitats. It is also important to note that there is a wealth of information and technical assistance regarding habitat management available through state forest and wildlife management agencies, universities, and non-governmental organizations. In addition, we have taken the opportunity to present some information on the history and habitats of white-tailed deer in the Coastal Plain along with several emerging issues relative to deer management in the Southeast.

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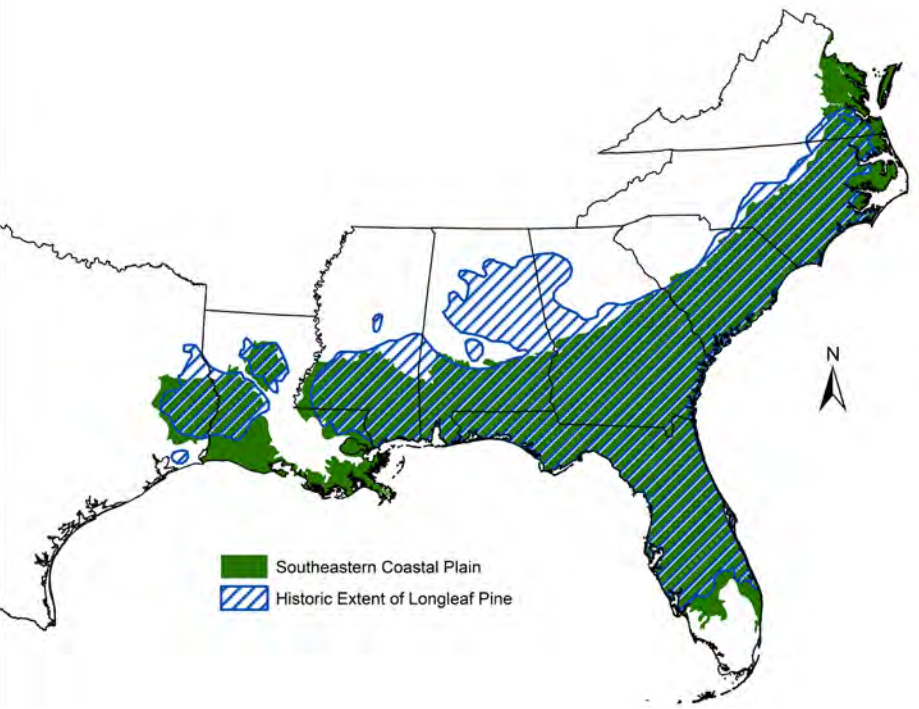
## White-tailed Deer in the Coastal Plain

Historically, white-tailed deer were abundant and occupied most of the habitats present across the Coastal Plain of the southeastern United States, utilizing upland, bottomland, and coastal areas. Estimates of deer populations during this pre-settlement time period range from 10–100 deer per square mile. Deer were a vital resource for Native Americans providing an important source of food and materials for clothing and tools (McCabe and McCabe 1984).

White-tailed deer also became an important source of food and clothing for early settlers. As the human population increased, the exploitation of deer as a resource began in earnest. In the period between 1850 and 1900, deer were being harvested in increasing number for hides and subsistence. After the Civil War, market hunting began to exact a heavy toll on deer populations due to advancements in firearms that facilitated deer harvest. This over-harvest led to extreme population decline and the end of white-tailed deer exploitation. At the turn of the 20th century, there were estimates of only 350,000–500,000 white-tailed deer in all of North America (McCabe and McCabe 1984).




In the early 1900s, due primarily to the interests of sportsmen, restoration of white-tailed deer began with the implementation of game laws and protection of remaining populations. After World War II, techniques were developed to restock deer throughout their range, largely through the movement of adult deer from larger populations. This restocking, in addition to improving habitat conditions favorable for white-tailed deer, led to one of the most successful restoration projects in the history of wildlife management. Deer populations continued to increase through the end of the 20th century. In 1969, there were an estimated 1.7 million deer in the Coastal Plain of the Southeast. In 1975, a harvest of 556,000 Coastal Plain whitetails exceeded the total deer population of the United States in 1900 (Newsom 1984). In the late 1990s, these significant increases in white-tailed deer populations led wildlife managers to anticipate the need to address white-tailed deer overabundance (Warren 1997). A recent estimate from the Quality Deer Management Association (Adams and Ross 2015) suggests 11.9 million deer occur in the states of the southeastern Coastal Plain (19.5 deer per square mile). This estimate includes Alabama, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas, and Virginia.

As deer populations expanded and increased in abundance, regulations controlling the sex of harvest, season of harvest, and methods of harvest evolved. Early hunting regulations focused on the harvest of small numbers of antlered deer within relatively narrow time periods of the fall and winter. More recent regulations have tended to expand the length of season and

focus a higher percentage of harvest on antlerless deer with more liberal bag limits. In general, white-tailed deer management has shifted from that of restoration of white-tail populations along with subsistence and recreational hunting to the regulation of populations and harvest of mature or trophy bucks.

## Habitat of the Coastal Plain

Prior to European settlement, the majority of the Coastal Plain of the southeastern United States was forested. Although agriculture was employed by Native Americans, most Coastal Plain habitats were relatively undisturbed. Fires occurred rather frequently across the landscape as a result of lightning strikes and Native American burning. This disturbance led to the dominance of fire tolerant habitats in the uplands and restriction of hardwood dominated forests to wetter areas that burned less frequently. Extensive and numerous riparian forests and forested wetlands existed along waterways and within this matrix of frequently burned woodlands.

The longleaf pine ecosystem, covering 90 million acres, made up most of this pre-settlement forest. The presence of fire across the landscape helped longleaf pine secure its dominance. Early travelers indicated areas where longleaf pine occurred on greater than 90% of the landscape (Oswalt et al. 2012). The plants and animals of the longleaf pine ecosystem, including the white-tailed deer, are well adapted and thrive in the presence of fire. Many of these species are dependent on routine fire for some aspect of their natural history. The longleaf pine ecosystem also boasts one of the highest plant diversities on the planet. This diversity is located in the understory where plants supply abundant wildlife food resources in the form of legumes, other herbaceous species, and high-quality browse, in addition to providing the fuels necessary for frequent fire.

In particular, legumes are an important source of protein to herbivores in this system (Hainds et al. 1999). Greater than 10% of the vascular plants found in the longleaf pine ecosystem are legumes. While fire is not required for legumes to flower, legumes are highly abundant in frequently burned systems and fire results in significant flowering. In addition to providing protein and nutrients for white-tailed deer, the seeds of many legumes are a valuable food resource for other longleaf associated wildlife species (Norden and Kirkman 2006).

This extensive longleaf pine forest has been largely replaced over time, with only about 4–5 percent of the ecosystem remaining. Widespread and exploitative logging, conversion of forested land to agriculture, and fire suppression were some of the leading factors in this replacement. Conversion of longleaf forested lands to agriculture began in the mid-1700s. From the middle of the 18th to mid-19th century, many of the best longleaf sites were converted from forest to agriculture (Oswalt et al. 2012). Significant logging began around 1850 and by the 1930s most of the mature pine had been harvested (Van Lear et al. 2005). Seedlings and saplings, not merchantable at the time, made up most of what remained of the once extensive forest. By the middle of the 20th century, young trees that had been left during previous harvests reached merchantable size and were harvested through the 1980s (Oswalt et al. 2012). Along with this harvest of second-growth timber, the development of a pulpwood market in the 1950s led to the replacement of longleaf with other pine species that were more suitable for shorter rotations. All of these factors contributed to the vastly different landscape of today (Oswalt et al. 2012; Van Lear et al. 2005).

Riparian forests and wetlands of the Coastal Plain have also been heavily altered since settlement. Many wetlands were drained, ditched, and filled for agricultural production. Initially, this occurred in close proximity to rivers which were used for the transportation of commodities. As agricultural technology improved, additional wetlands were impacted. Intensive logging also occurred within these forests. Historically, these riparian forests and wetlands provided beneficial habitat for white-tailed deer and many other wildlife species.

The type of forested land in the Coastal Plain has changed drastically in the last 75 years. In the 1950s, there were very few pine plantations (typically slash pine or loblolly pine) across the landscape. In 1987, the Coastal Plain started to gain more forested land than was lost due to the addition of industrial forests. By 2000, pine plantations (29.7 million acres) occupied an area almost as large as that of natural pine (34.6 million acres). In studies conducted by the United States Geological Survey, from 1973–2000 the Southern Coastal Plain, Southeastern Plains, and Middle Atlantic Coastal Plain ecoregions had the three highest levels of land cover change, respectively, of all ecoregions in the eastern United States. These ecoregions encompass the vast majority of the southeastern Coastal Plain excluding portions of western Louisiana and eastern Texas. When combined, percentages of forested land (39% to 36.1%), agricultural land (19.3% to 17.4%) and wetlands (19.8% to 17.9%) all decreased slightly. The amount of developed land increased from 10.1% to 13.3% of the landscape in these ecoregions (Auch 2016; Drummond 2016; Sohl 2016).

White-tailed deer have occurred in the Coastal Plain throughout many changes in their populations and habitats. Management of white-tailed deer populations has transitioned over time as these landscape-level changes have occurred. More recently, interest in the restoration of the longleaf pine ecosystem has increased. Management of white-tailed deer must continue to adapt in order to face further changes across the Coastal Plain. Land management focused on the restoration, improvement, or maintenance of quality habitats, including longleaf pine, allows managers to sustain healthy, quality deer herds in light of these changing conditions.

# HERD MONITORING

Obtaining estimates of white-tailed deer population parameters (such as recruitment, abundance, herd composition, and fitness) are critical components of responsible deer monitoring and management programs. These parameter estimates aid in reaching management goals. Using these estimates for yearly comparisons to guide proper management decisions is an integral process for balancing deer and their interaction with the environment, as well as increasing hunter success and satisfaction. A wide variety of techniques have been developed and implemented in attempts to obtain deer population parameters (Amos et al. 2014; Fryxell et al. 2014; Halls 1984; Jacobsen et al. 1997). The most popular methods implemented by land managers and conservation agencies include spotlight surveys, track counts, baited camera surveys, and the collection of hunter observation and harvest data. Spotlight surveys are a relatively convenient and inexpensive method when attempting to


inventory deer populations. This type of survey is normally conducted at night by driving transects, using a light to detect eye shine from deer, or deer cohorts, and counting individual occurrences (Mitchell 1986). Using digital rangefinders to determine distances and compasses for angular measurements (azimuths), deer locations can be determined along each transect, allowing managers to create indices of deer abundance, densities (typically deer/square mile), and cohort sizes within an area of interest.

The track count method is designed to relate the number of observed deer tracks crossing transect lines to the total deer abundance of a particular area. This method requires each transect (roads or firebreaks) to be smoothed and cleared of all tracks prior to being surveyed,

and each track that intercepts the transect after a specified amount of time is recorded. Research on deer herds of known densities have resulted in a conversion ratio of 1.6 tracks (of individual deer) per km to 1 deer per $km^2$ (Tyson 1959; Daniels and Frels 1971). Using this ratio, an index in abundance can be derived for the deer herd.


The baited camera survey gains its popularity in part due to its relatively low cost, ease of use, and effectiveness in a wide variety of habitats and landscapes. This method requires users to place remote, infrared-triggered cameras over a number of evenly-spaced bait piles (typically corn) for 10–14 days, usually before or after the hunting season (Jacobsen et al. 1997). Photographs of individual males are identified based on unique antler configurations and ratios of all animals photographed are used to estimate abundance, sex ratios, and fawn recruitment (i.e., doe:fawn ratios).

Recording observational data collected while hunting is one of the easiest and most cost-effective methods for censusing deer herd composition. Observations can consist of the number and sex of deer seen during an individual hunt or per hour on the stand, and can be used to determine relative abundance, fawn recruitment, age structure of bucks, and sex ratios. In addition to collecting observational data, the collection of biological data from harvested deer is used to estimate nutritional condition (tail fat and/or kidney fat index, weight, and bone marrow index), age (jawbone inspection, antler measurements), reproduction (lactation rates), and conception dates (fetal growth measurements) depending on the time of year the animal was harvested.

## Habitat Management in the Coastal Plain

Habitats of the Coastal Plain are managed for numerous objectives. Oftentimes, decisions are based on economic returns and actions are focused on the production of revenue. In addition, ownership frequently influences objectives. Recent changes in land ownership have the potential to increase multiple resource objectives (i.e., wildlife, aesthetics, and longleaf pine restoration). Pine stands are often managed using an even-aged management approach. Typically, short rotations (<30 years) with 2 to 4 harvests occurring during the life of the stand are employed to maximize yield of timber products. As a rotation comes to an end, trees are clear-cut and re-planted. Management for white-tailed deer, and other wildlife species, is most often secondary to timber production. Prescribed fire use can be fairly common for managing competition within these stands.

The production of pine straw has become a more significant management objective in Coastal Plain pine stands. Pine stands are often maintained at higher densities, with very little to no understory vegetation, to maximize production and facilitate harvest of straw. A stand that is raked for pine straw typically provides very little value for wildlife.

There is increasing interest in the promotion of pine savanna habitat, including longleaf as well as other southern yellow pine. Pine savannas produce multiple resource benefits not associated with industrial management of pine stands, while maintaining a source of timber revenue. To restore and maintain pine savannas, stands are thinned to ensure that a minimum of 40% of the ground is maintained in direct sunlight (40–60 square feet of basal area per acre). The increase of light reaching the forest floor allows for additional forage that provides enhanced structure, species composition, and nutritional benefits for numerous wildlife species. When merchantable, first harvests typically occur through a combination of row and within row selection methods. Subsequent harvests occur when the stand reaches approximately 70–80 $ft^2$/ac to maintain the benefits of lower volumes. Frequent prescribed fire is integral for maintenance of pine savanna as it maintains an herbaceous understory and minimizes competition from woody species.

Today, mixed pine-hardwood forests in the Coastal Plain are often the result of fire exclusion or a lack of active management. They can occur on cut-over sites that are allowed to naturally regenerate. Mixed pine-hardwood can also be found at the transition between upland pine and bottomland hardwood stands. Although these forest types often occur due to a lack of habitat management, they can provide beneficial habitat for wildlife.

Hardwood-dominant stands can be generally categorized as upland, mid-slope or bottomland hardwood forests. Bottomland forests are the primary hardwood forest of concern in the Coastal Plain. These are managed through natural succession and occasional timber stand improvements that leave the most desirable mast-producing species, such as oak, hickory, and persimmon. These forests are also occasionally managed through the use of openings or forest gaps created to allow for the regeneration of these desirable species. This natural regeneration is much more common than plantation style silviculture for hardwood species.

Habitat management on public lands in the Coastal Plain is often focused on creating and maintaining early successional vegetation for wildlife. An emphasis is placed on species of priority concern, as well as managing timber in a manner compatible with other conservation and recreation-oriented objectives, such as hunting and wildlife viewing. A number of habitat management techniques are used to improve the health of a forest, but thinning (harvesting), reforestation (artificial or natural), and prescribed burning are the primary tools. Most of these lands have also had some history of industrial timber practices associated with them (e.g., bedding). Many of the upland stands on public lands in the Coastal Plain have an extensive history of site disturbance and contain little to no intact native ground cover. Some pine stands on public lands that have previously been planted in loblolly or slash pine for forest industry are being converted back to longleaf pine over time.

Upland forests are often managed through the use of prescribed fire on a relatively frequent fire-return interval. Fire is usually excluded from bottomland hardwood forests, or preferably allowed to feather into these areas before going out. Prescribed fire not only reduces the chances of wildfires by reducing fuel loads, it also promotes the growth of new vegetation that is beneficial to a variety of wildlife. Habitat managers often recommend using a 3–5 year fire-return interval for white-tailed deer in the Coastal Plain. However, a more frequent return interval provides benefits for a greater number of additional species, such as eastern wild turkey, red-cockaded woodpecker, gopher tortoise, Bachman's sparrow, and northern bobwhite. Additionally, more frequent fire aids in the management and control of off-site hardwoods, such as water oak and sweetgum. A frequent fire-return interval, coupled with a thinned forest, allows for a reduction in the shrub layer and increased production of available forage for white-tailed deer and other species.

*Federally endangered red-cockaded woodpecker*

## Habitat Restoration in the Coastal Plain

Within the last 25 years, efforts to restore longleaf pine forests and the longleaf pine ecosystem have intensified across the Coastal Plain. Government agencies have encouraged restoration of longleaf pine through management actions on their own properties, as well as programs designed to support restoration activities on private lands. There has also been a notable increase in sentiment with regards to the desire of private landowners to restore longleaf pine within its historical range.

The development of federal programs providing incentives for establishing longleaf pine has led to millions of acres of longleaf pine seedlings being planted across the Coastal Plain. Most of this acreage has been converted from less productive agricultural land to longleaf pine plantations. Additional incentives have provided for the burning of longleaf pine stands and mature pine stands of other species, along with thinning of mature pine stands to provide forest and wildlife benefits similar to those of the historical longleaf pine forest.

Historically, due to the frequent occurrence of fire, many hardwood tree species were limited in range and composition in Coastal Plain forests. As a result of fire suppression, the removal of mature longleaf timber, and conversion of land to other uses, hardwood forests occupy a much larger portion of the Coastal Plain today. Fire suppression, coupled with loss of native pyrogenic ground cover, such as grasses, has also resulted in an increased presence of hardwood trees and stems within existing pine forests. Once hardwoods become established, the ability of pine forests to provide benefits similar to those of historical forests is diminished, largely through difficulties with the ability to burn. Hardwood removal has become an important consideration in restoration of pine savannas and longleaf forests. Hardwood control is often implemented through mechanical removal/reduction, herbicide application, and the use of frequent prescribed fire. Although the production of hard mast from desirable hardwoods can provide benefits for white-tailed deer, a historical misconception regarding the importance of hardwoods for nutrition and cover in the Coastal Plain remains. Adequate cover and nutritional resources are readily available to appropriately sized white-tailed deer herds in regularly burned pine savannas. However, total elimination of hardwood trees and stems is not necessary nor desirable. Presence of hardwood trees and stems, in the correct landscape context and at the correct density, can provide additional nutritional resources for deer and may be an important component for other wildlife species such as Sherman's fox squirrel, eastern wild turkey, black bears, small mammals, and some cavity-nesting birds. Indeed, it has been argued that a modest presence of scattered large, desirable oaks may be essential for longleaf ecosystem function. Some of these desirable oaks include: turkey oak, bluejack oak, post oak, southern red oak, and sand live oak (Hiers et al. 2014). As

*Mechanical hardwood control within upland pine stand*


WARNING

such, managers should give consideration to leaving some of these oaks within longleaf restoration sites.

*Longleaf pine plantation with restored, native understory*

More recently, consideration has been given to restoration of native ground cover associated with the longleaf pine ecosystem. Many species native to this system provide valuable resources for white-tailed deer. Availability of seed, competition from non-native plants, establishment, and costs are all current impediments to native understory restoration. However, many native plant species are retained in the seed bank and can be released over a period of years with the implementation of frequent prescribed fire along with periodic thinning of pine stands, hardwood control/removal, or the application of herbicides. Forested stands with an "old-field" understory dominated by native warm-season grasses can function very similarly to the native longleaf pine understory. An important aspect of this savanna type understory is the advantage it provides as fuel for prescribed fire. Prescribed fire is the dominant management tool for these systems, producing the most benefit for white-tailed deer, and numerous other wildlife species, most efficiently.

## Ichauway

Ichauway is the 30,000 acre land base of the Joseph W. Jones Ecological Research Center (Jones Center). It is located in the Coastal Plain of southwestern Georgia and is centrally located within the historical range of the longleaf pine ecosystem. Ichauway was assembled in the early 1900s as a quail hunting plantation for Mr. Robert W. Woodruff, the longtime leader of The Coca-Cola Company. A large portion of the property still retains longleaf dominated forest (approximately 18,000 acres). Much of this forest contains highly diverse and native ground cover, boasting more than 1,100 documented vascular plants (Drew et al. 1998; Kirkman et al. 2001) and one of the highest number of legume species reported in the southeastern Coastal Plain (Hainds et al. 1999). Approximately 80% of Ichauway is forested (38% pine forest, 16% mixed pine-hardwood, 10% pine plantation, 9% hardwood/pine, and 8% hardwood), with 15% of the property in agriculture (11%) or shrub/scrub (4%) habitat. The eastern boundary of Ichauway is formed by 13 miles of the Flint River, and approximately 15 miles of the Ichawaynochaway Creek flows through the central portion of the property. About 50 endangered, threatened, or special concern species are found on-site with a large representation of species endemic to the longleaf pine ecosystem.

The primary management goal for Ichauway is found within the mission of the Jones Center: "To understand, to demonstrate, and to promote excellence in natural resource management and conservation on the landscape of the southeastern Coastal Plain of the United States." Management of Ichauway's natural resources is used to both facilitate research and provide an example of positive land stewardship. Actions include both the promotion and restoration of

# PREDATION

In the Coastal Plain, white-tailed deer populations have been subjected to dynamic predator populations that have changed dramatically over the years. Historically, deer in the Coastal Plain were preyed upon by red wolves, pumas, black bears, bobcats, and alligators. Red wolves were ubiquitous in the region but are now considered by the United States Fish and Wildlife Service to be one of the world's most endangered canids. The abundance and distribution of red wolves was greatly reduced through intensive predator removal programs and changes in land use. Currently, there are fewer than 100 wolves in the wild. The remaining population is the result of an extensive predator restoration program in eastern North Carolina. Pumas were also historically common across the Southeast. The subspecies of puma (also known as cougar, mountain lion, panther, catamount, and many other local colloquialisms) present in the Southeast was *Puma concolor coryi*, commonly referred to as the Florida panther. The Florida panther is listed as an endangered subspecies and the only breeding population remaining is in southwestern Florida. In these isolated locations where red wolves and Florida panthers still occur, they are major predators of deer.

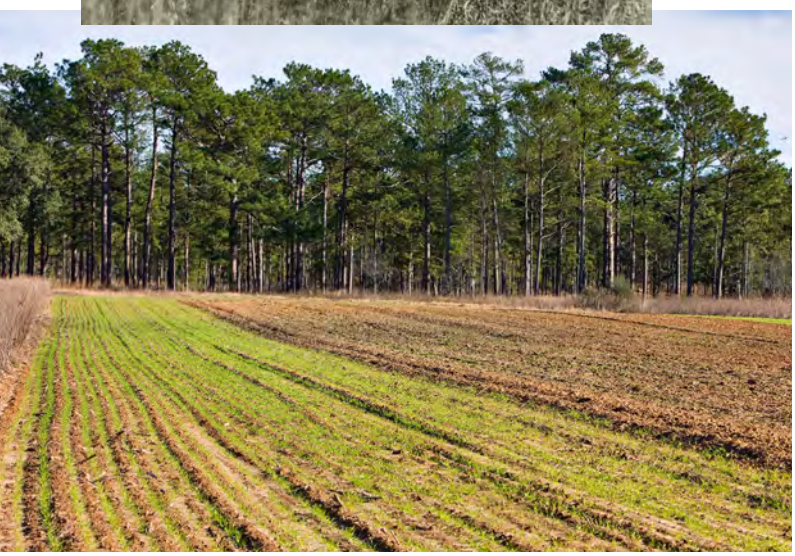
Black bears were historically common across the Southeast but their distribution and abundances have been greatly reduced. While their populations are not as reduced as those of the puma or red wolf, there are vast expanses of their historic range that have lacked bears for decades. Black bears occasionally prey upon adult deer, but their impacts on deer populations are likely to be through fawn predation. Bears have a tremendous sense of smell and can be very effective hunters of bedded fawns. Bobcats prey on both adult deer and fawns, but deer typically do not make up a large portion of their diets. Unlike the previously mentioned predators, bobcats remain common in the landscapes of the Coastal Plain. Alligators occasionally take deer but are rarely a consequential mortality source for deer populations. In addition to these predators, deer have been hunted by humans in the Coastal Plain for at least the last 17,000 years. While there is little information on how deer populations interacted with these populations of predators, it is clear that those forces have changed substantially over the last 200 years.

Large changes in predator communities have altered the nature of predation on deer populations. Wolves and pumas have been largely eliminated from the landscape, likely reducing adult mortality from predation. Human populations have erupted and the density of human hunters is likely several orders of magnitudes larger than it was just a couple hundred years ago. It is also important to note that human hunters, while likely less skilled and motivated, are probably much more effective because of advancements in technology of weaponry. Another significant change is the colonization of coyotes within the region.

Coyotes are a highly adaptable predator of the Great Plains and deserts of Central North America that have been both revered and despised because of their cunning. The removal of larger predators and the conversion of forests to fields has facilitated a rapid range expansion

only slowed by the Atlantic Ocean. Coyotes can survive off of numerous food sources and are capable of living in close proximity with humans. They occur on high-elevation mountain ranges, lowland swamps, metropolitan cities, and agricultural landscapes. They readily consume ungulates when available, but are not dependent on deer and can exist entirely on a diet of rodents, rabbits, and vegetation. In the southeastern United States, coyotes are largely fawn predators and their impacts on deer populations through fawn predation can be profound. Recent coyote studies investigated the effects of coyote fawn predation on deer populations. Frustratingly, these effects appear to be either highly significant or nonexistent. Fawn mortality from coyotes is most likely to reduce population growth in low density herds occurring on low productivity sites. In these circumstances, the mortality is additive (i.e., there are few other natural mortality sources and most of the fawns were likely to make it through the first winter). Low productivity limits the ability of does to respond by increasing litter sizes. On high or moderate productivity sites, fawn mortality due to coyote predation is simply compensatory to other mortality sources and unlikely to have a major effect. This complexity presents a situation where coyotes are unlikely to help reduce over abundant deer herds operating at carrying capacity, but may decrease herds that are maintained at low densities to achieve management strategies such as quality deer management.

Managing predation in the Southeast can be a complex process. While it is an undeniable truth that a dead coyote does not kill deer, in practice, predator removal is far from guaranteed to result in increased fawn survival, let alone deer population growth. There are a few studies that have experimentally demonstrated that intensive predator removal immediately before and during fawning can result in increased fawn recruitment. However, there are also several studies that showed no response or inconsistent responses to predator removal (Gulsby et al. 2015, Howze et al. 2009, Kilgo et al. 2014, Stout 1982, VanGilder et al. 2009). There is also evidence that predator removal can destabilize social structure of coyotes and result in a younger age structure of the coyote population, which is predicted to cause increases in deer predation. Given the inconsistent nature and extremely high cost, predator removal is not a scientifically-based recommended management action to increase fawn recruitment across the Southeast. However, there are direct ways to increase fawn recruitment. Doe productivity can be increased through sound habitat management actions that improve the nutritional condition of does. These habitat management actions can also increase concealment cover for fawns and produce diversionary food items (i.e., rodents, soft mast, etc.) that are available during fawning for coyotes, potentially reducing predation pressure on fawns. In most cases, reduction of hunter harvest of does can also increase productivity. Managers should incorporate this new source of mortality into white-tailed deer management plans. A feasible solution is to improve doe productivity through habitat management and modification of doe harvest to maintain more fawn producers in the herd.



natural communities. The Jones Center's philosophy towards wildlife management is holistic rather than centered around single species, and management actions are intended to provide benefits to the system as a whole. Objectives are to manage the property in a manner that provides quality habitat for the range of longleaf pine associated species.

The early history of Ichauway parallels that of the majority of the Coastal Plain. Prior to settlement, the area was dominated by the longleaf pine ecosystem and occupied by Native Americans. When the Lower Creek Indians inhabited southwestern Georgia, the area along the Flint River and Ichawaynochaway Creek was known as *Isawaya* in the Creek Indian language, meaning "land of the sleeping deer." Upon settlement, the area was heavily logged, used for production of naval stores, and portions of the property were converted to agriculture. When Mr. Woodruff assembled the property now known as Ichauway, he inherited a largely cut-over forest interspersed with small tenant-farmed agricultural fields. However, he recognized the unique natural characteristics of the land and from the mid 1920s maintained an extensive tract of longleaf pine and wiregrass for quail hunting. The mature longleaf pine forest on Ichauway today is a second-growth forest that developed from seedlings and saplings left during early logging. Parts of the property were still used for agriculture, turpentining, logging, and grazing during Mr. Woodruff's ownership. Most of these land uses, aside from agriculture and moderate logging, were discontinued in the latter half of the 20th century.

Due to the hunting of deer during European settlement, habitat conditions at the time of Woodruff's acquisition, and subsistence hunting by tenant farm families, deer populations were most likely relatively low in the early 1900s. However, due to the change in ownership and use of the land making up Ichauway, white-tailed deer were not completely extirpated from the area. Early population estimates and anecdotal information from individuals living on-site indicate a historical deer population of 7–12 deer per square mile. As the longleaf forest matured and the property was managed as a shooting plantation through the 1900s, the deer population was regulated and maintained at a similar density through subsistence hunting. Deer were viewed as a supplement to the annual food resources of individuals living on site. Following Woodruff's death, the Robert W. Woodruff Foundation established the Jones Center in 1991. Shortly after the founding of the Jones Center, a formal deer management program was developed for Ichauway.

Prescribed fire is the primary management tool employed on-site. Fires are conducted every two years in both the dormant and growing season, with a more intense focus on frequency. Approximately 30% of prescribed fires have been implemented during the growing season. Prescribed fire is utilized in all habitat types found on Ichauway, including stands containing a significant hardwood component. Forest resources are managed using a modification of the Stoddard-Neel Approach (uneven-aged, see McIntyre et al. 2008) to maintain a multi-aged forest in perpetuity and restore the longleaf pine ecosystem. Very conservative timber harvest is conducted using individual tree selection. While specific prescriptions regarding stocking or diameter distribution are not written for each stand, all upland pine stands are maintained at relatively low basal areas with an herbaceous understory. The average basal area for Ichauway is 50 square feet per acre. Longleaf pine is replanted into areas converted from either agriculture or hardwood-dominated upland. A food plot program is used to facilitate harvest of white-tailed deer. Plots are planted in corn, wheat, oats, or clover annually.

Although much of Ichauway has remained a functional longleaf pine ecosystem, restoration has occurred across altered portions of the property that were formerly longleaf pine. Approximately 2,500 acres of agricultural land or hardwood-dominated upland have been converted to longleaf pine forests. Restoration of native understory plants, primarily wiregrass, has occurred in conjunction with a portion of these pine plantings. Existing ground cover has been enhanced by the implementation of prescribed fire on a routine basis and the use of herbicides in some instances. Hardwood removal has been conducted across approximately 10,000 acres of the property. This removal has focused on less desirable mesic hardwoods (e.g., water oak, laurel oak) that occur in areas not typical for the species in the longleaf pine ecosystem. This leads to removal occurring primarily in the uplands within existing pine stands and stands with a significant hardwood component.

## Managing Whitetails in the Coastal Plain: The Ichauway Approach

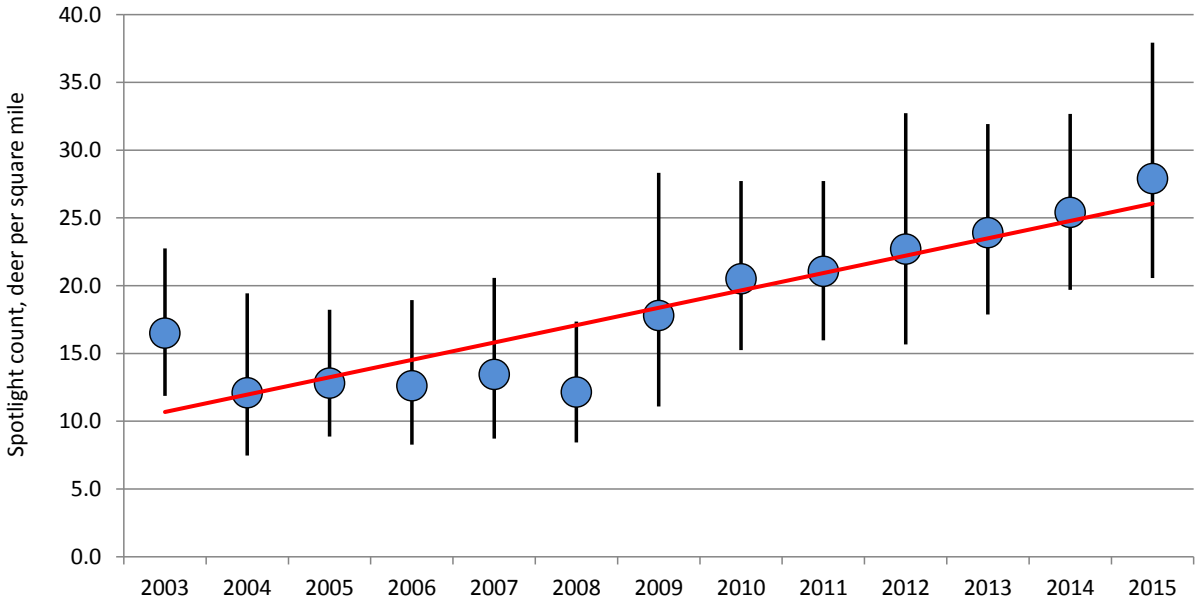
The management of white-tailed deer has never been a primary objective for the stewardship of Ichauway. An historical focus on northern bobwhite management transitioned to the current management philosophy with the establishment of the Jones Center. The primary objective of the white-tailed deer management program at the Center is to regulate population density to limit potential damage to sensitive ecological communities. Based on historical estimates of deer density and measured densities upon establishment of the Jones Center, a population goal of 15 deer per square mile was established. Included in management objectives is a focus of harvest on the antlerless portion of the herd and mature bucks to maintain this population

level and promote a healthy herd. Due to the history of subsistence hunting on site, an intense restriction on the harvest of immature bucks is not implemented. Hunting has been used to regulate population levels and is conducted by employees of the Jones Center and their families. Harvest goals are set each year for the herd by the Natural Resource Manager.

As a research institution, the Jones Center employs a rigorous monitoring program to record changes across the property and to inform management. Monitoring is an important component of the white-tailed deer management program. Population densities and indices are derived from thermal camera counts, track counts, and occasionally baited camera surveys. Biological data are collected from every harvested deer and hunter observations are recorded when hunters check a harvested deer. Additionally, a subset of employees maintain observational data for each hunt. All of this data is used to make management decisions regarding the deer herd.

Population trends are determined from population indices to evaluate whether the population is increasing or decreasing in a given year. This information is often corroborated with biological data. Age structure of the antlerless deer harvest is an example of such a consideration. A large percentage of the doe harvest ≥3.5 years old can indicate an increasing deer population. On Ichauway, when deer harvest is regulating population growth, about 70% of the doe harvest will be younger than 3.5 years. Lactation rates of yearling does are also used to evaluate population trend. A lactating 1.5 year old deer in the harvest would have been a fawn at the time it was bred. Typically, fawns are not bred until most mature does have been bred. A small portion of 1.5 year old does displaying lactation can indicate a sufficient number of mature does for breeding and a population that is increasing. Additionally, mature does tend to exhibit higher reproductive success than young does. Doe:fawn ratios are also used to evaluate herd trends. A departure from the long-term average can indicate an increase or decrease in the population the following year. All of this information is taken into consideration when establishing harvest goals for a hunting season. An attempt is made to keep sex ratios as close to even as possible. However, buck harvest is an underemphasized component of the deer management plan.

There are many different management strategies throughout the range of the white-tailed deer. Oftentimes, these management strategies focus on specific aspects of the herd. Some of these might include: production of trophy bucks, traditional deer management, increasing deer recruitment, and hunter satisfaction. As a result, land management is often geared specifically towards white-tailed deer. This is understandable as white-tailed deer are one of the most economically valuable game species in North America and produce significant revenue for local economies and wildlife agencies. Many managers realize the importance of managing quality habitats to meet deer management objectives. The white-tailed deer management philosophy at Ichauway is less common in that the management of white-tailed deer is often secondary to, or a beneficiary of, the positive management of the natural system as a whole. Routine management decisions and actions are not implemented to specifically enhance one component of the deer population. This model has demonstrated that responsible management and restoration of a natural system can produce desirable results with regard to management of white-tailed deer.




*Deer density derived from thermal image spotlight counts on Ichauway*

## Response of Ichauway White-tailed Deer to Management and Restoration

Utilizing this management strategy, the Jones Center had been able to maintain a stable and healthy deer herd for over 20 years. Recently, the deer population on Ichauway has been increasing. This is most likely due to an adjustment in antlerless harvest over two previous seasons in response to declining deer numbers and skewed sex ratios. As a result of changes in habitat due to restoration, and advancements in monitoring technology, consideration is being given to adjusting the property-wide population goal. However, the 20 year population average of 18 deer per square mile is within the margin of error for current stated population goals.

The maintenance of the white-tailed deer population at relatively low densities has prevented deer-related damage to sensitive plant communities. Additionally, evidence of disease within the Ichauway deer herd remains low and may be a benefit of low density. Occasionally, deer display evidence of hemorrhagic disease and cranial abscess but the expression of these diseases is not common. Deer have also been found rarely with the presence of fibromas.

Average live weights of does (adult doe: 120 pounds) and bucks (mature buck: 195 pounds) have remained stable over time and reflect a herd that is not nutritionally limited.

*Several mature bucks harvested on Ichauway*

| Age | Number harvested | Average score | Maximum score | Minimum score |
|---|---|---|---|---|
| **1.5** | 146 | 43 1/8 | 87 2/8 | 9 0/8 |
| **2.5** | 194 | 95 0/8 | 138 6/8 | 27 6/8 |
| **3.5** | 189 | 117 7/8 | 178 1/8 | 53 4/8 |
| **4.5** | 76 | 123 2/8 | 162 7/8 | 49 2/8 |
| **5.5** | 39 | 129 2/8 | 163 0/8 | 65 6/8 |
| **6.5** | 16 | 122 0/8 | 180 3/8 | 77 0/8 |
| | | | | |
| **Total** | 660 | 104 6/8 | 180 3/8 | 9 0/8 |

*Gross Boone and Crockett scores of harvested bucks at Ichauway 1993-2016*

Lactation rates are typical of other populations within the Coastal Plain (72% of does >2.5 years old). Recruitment (doe:fawn ratio) remains relatively low, but is clearly capable of sustaining a healthy population. The 20 year doe:fawn average for Ichauway is one fawn for every two does.

All bucks harvested are scored according to Boone and Crockett Club guidelines (Nesbitt et al. 2009). Long-term averages of gross Boone and Crockett (B&C) scores are typical, or exceed those, of a well-managed deer herd in the Coastal Plain [3.5 year old (n=189): 118, 4.5 year old (n=76): 123, 5.5+ year old (n=55): 127]. Inside spread of antlers for mature (3.5+ years old) bucks has averaged 16.5 inches with an average base circumference of 4.4 inches. Since 1993, forty-seven bucks have been harvested with a gross B&C score greater than 140. Three 160 and 170 class bucks have been harvested with one buck, found dead, gross scoring 180 3/8 inches. A 3.5 year old buck was harvested gross scoring 178 1/8 inches. Sex ratios have fluctuated around one buck for every two does in the population.

Annual harvest has ranged from a minimum of 2.3 deer per square mile (0.25 does/mile$^2$) to 4.7 deer per square mile (3.5 does/mile$^2$). The 23 year harvest average is 2.4 deer per square mile (1.6 does/mile$^2$) per season. Hunter success is high in most years, with an average of 1.6 deer per hunter (high of 4.7; low of 0.5) and 6.5 hunt days per deer (high of 8.9; low of 2.4). Extremes with regards to harvest have occurred as a result in modification of harvest objectives due to an increasing or decreasing deer herd. Hunter success and days of hunting per deer are also related to changes in annual harvest objectives. The number of hunters per season has

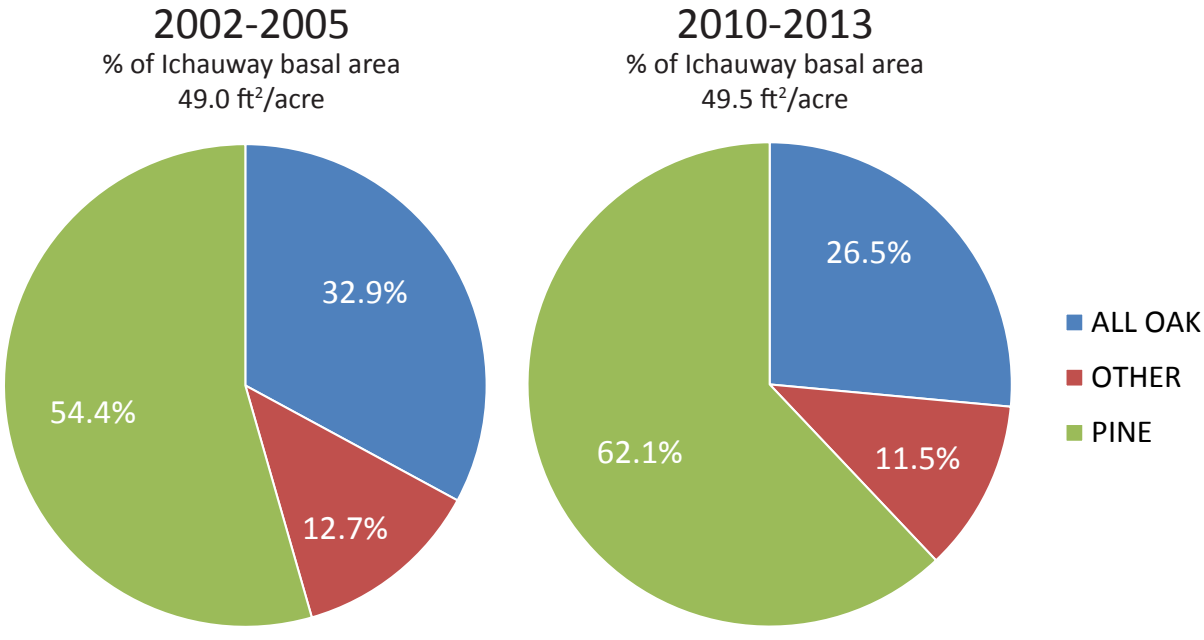
varied from 0.6 to 2.3 hunters per square mile. Hunter days have ranged from 13.7 to 35.1 hunting days per square mile.

Forest monitoring conducted on-site indicates an increase in pine volume and density over the last 15 years. Due to restoration activities, hardwood volume and density has significantly decreased. A stable to increasing deer herd might seem counterintuitive under these conditions. However, our experience demonstrates the lesser importance of hardwoods and hardwood mast for whitetails in the Coastal Plain. This nutritional resource is replaced with a significant density of highly nutritious plants in the understory and quality browse produced as a result of frequent fire in open stands.

A two-year fire-return interval has benefitted the deer population. Frequent fire triggers a vigorous regrowth and fertilization of herbaceous plants and woody browse. Browse is maintained at an optimum height for white-tailed deer accessibility. This burn regime maintains a high volume of quality forage across the landscape.

Conversion of agricultural fields to longleaf pine plantations has not negatively affected the deer population. These stands provide areas of forage for the first several years after establishment. As the stands develop, they are utilized as cover. Upon thinning, understory vegetation recovers and provides nutritional resources. Native understory restoration conducted in conjunction with conversion supplements the diversity of available forage. However, approximately 11% of the property remains in agriculture.

The importance of monitoring to the white-tailed deer management program at Ichauway cannot be overstated. Data collected from these activities is integral to the decision making process regarding the herd. Monitoring data is used to ensure regulation of the population and to evaluate and validate the effects of land management on the herd.




*Changes in basal area (square feet per acre) on Ichauway*

# DISEASE

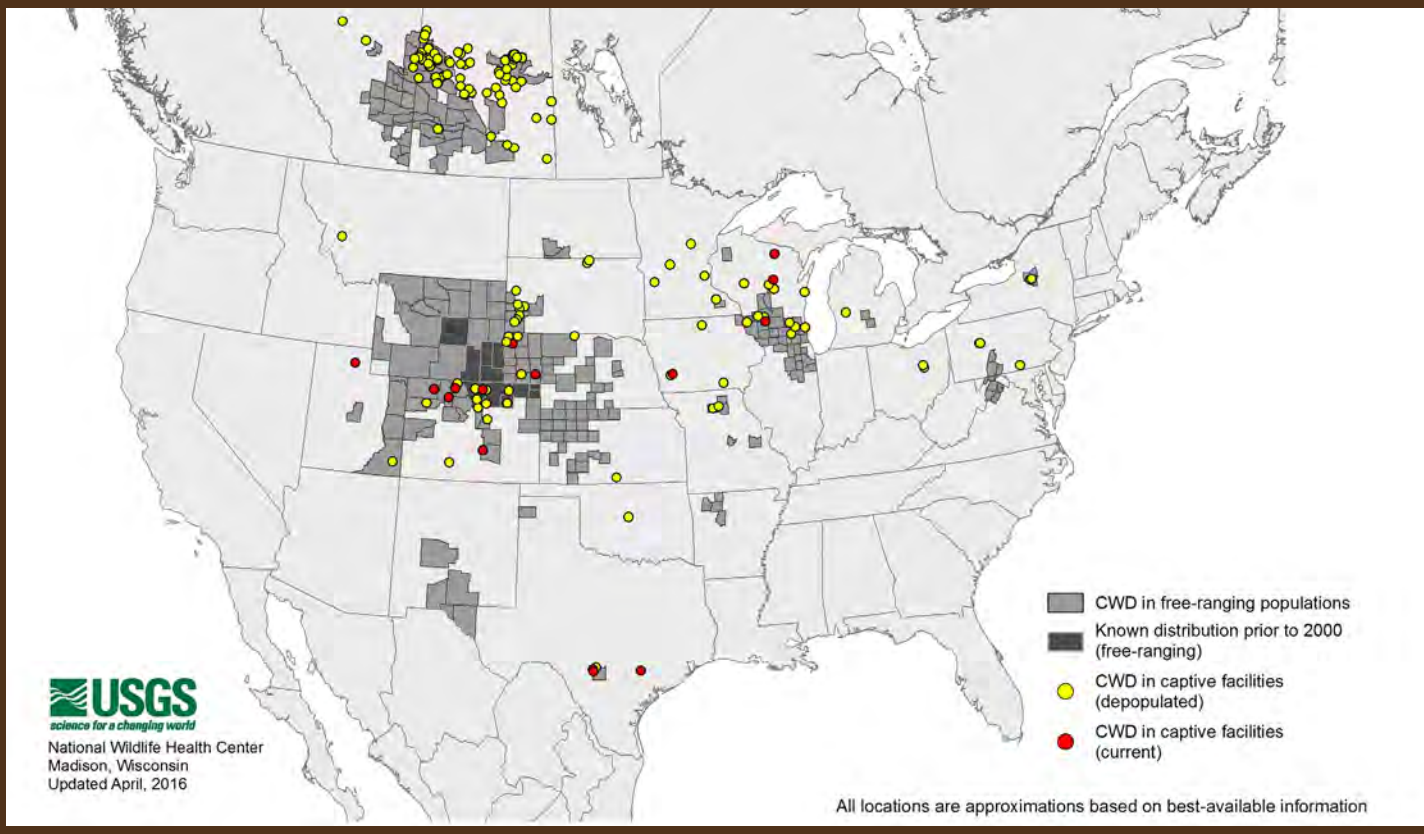
Diseases have always been a source of mortality and morbidity for white-tailed deer in the Coastal Plain. Although not fully understood, historically disease likely caused a small amount of annual mortality. At the forefront of these diseases was hemorrhagic disease, which is responsible for killing deer throughout the Southeast in the present. Because of low disease-induced mortality, deer managers in the Coastal Plain did not previously consider disease as a major factor in management. However, the dynamics of deer diseases are changing; the transportation of deer across state lines historically for population restoration and currently for intensive deer management has placed disease at the forefront of deer management. One disease, cranial abscess disease, is already present and responsible for mortality events of mature male white-tailed deer across the Coastal Plain. Another disease, chronic wasting disease, is spreading to different states at an alarming rate. Although not reported in the Coastal Plain (currently found in Texas and Virginia outside of the Coastal Plain), if it were to occur, deer management could change significantly.

Hemorrhagic disease (HD) is the most well-known and common disease throughout the white-tail's range. HD is spread when small insects called *Culicoides* midges bite deer and transfer the virus. Although it is responsible for large mortality events further north and west, these mortality events are rarely seen in the Southeast. In the Coastal Plain, deer are exposed to the HD virus annually, which allows their immune system to respond more effectively. Maternal antibodies for fawns, annual exposure, and genetic predispositions allow deer in the Southeast to oftentimes survive HD infections, although peracute/acute mortalities (within several days after infection) and chronic infections can occur. Deer that die rapidly from HD show hemorrhaging along organ linings when necropsied. Deer that die after a chronic infection will have ulcerations on their tongue and rumen; hoofs will look irregular or cracked. HD causes extreme thirst for infected animals and deer that have died of the disease are oftentimes found in or near water.

*Deer skull with evidence of cranial abscess*

A cranial abscess occurs when naturally occurring bacteria living on a deer's skin enter small wounds in the head, causing an infection. Eventually, the infection grows large and penetrates the skull, killing the animal. This disease is a possible cause of mortality for male deer older than 3.5 years across the Coastal Plain. Behaviors like rubbing and fighting put bucks, particularly mature bucks, at the highest risk for cranial abscesses. This is especially true in areas with a more balanced buck:doe ratio resulting in intense competition for does and increased fighting, leading to small head wounds and a higher risk of infection. However, cranial and brain

abscesses are absent in many locations with advanced buck age structure and a balanced sex ratio. For example, close inspection of a large sample of bucks from a Texas population found zero cases, while nearly 35% of the bucks in a population in Maryland died from brain abscesses in one year. Researchers have identified that the historical restocking of deer into the Southeast from Wisconsin appears related to areas where the disease occurs. As a result, this disease is found in pockets of the Coastal Plain where deer from Wisconsin were used in restocking efforts. Deer surviving this disease will have a malformed antler on the side of infection the following year. Deer killed from cranial abscess display pus leaking from the head if found quickly. If a skull is found, small pin-sized holes and erosion along the suture lines of the skull will be present.




*Current distribution of chronic wasting disease in North America*

Chronic wasting disease (CWD) may have the largest impact on the future of deer management. CWD is a prion disease, similar to mad cow disease, which once contracted is always fatal. CWD is transmitted via saliva, urine, fecal matter, and a number of other ways. It can remain in the soil, infecting deer years later. Once established in a herd, there is no way to eliminate CWD. It lowers recruitment and is responsible for a significant amount of mortality in areas where it is present. Although the pattern of CWD occurrence appears random, there is a strong link between transportation of live or dead deer from infected areas to areas where new locations of CWD occur. Prohibiting the movement of white-tailed deer could be the most important tool to inhibit the spread of CWD. Deer that have died of CWD show no gross malformations, making diagnosis difficult. Deer will be emaciated, salivating heavily, or acting abnormal if infected. However, those symptoms can be similar to other diseases.

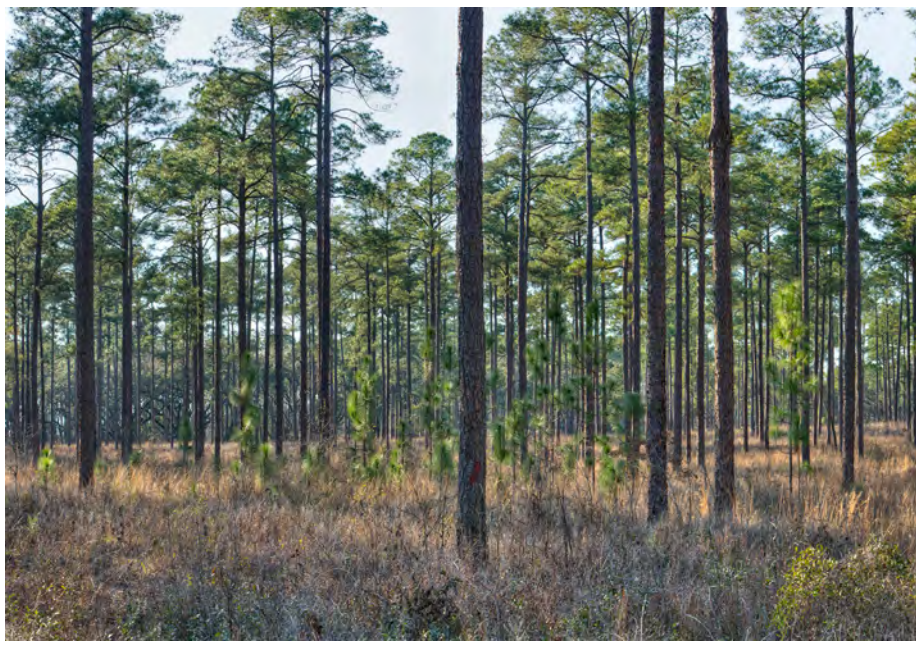
Research has been conducted on several aspects of white-tailed deer ecology at the Jones Center. Research has mainly focused on the interaction between white-tailed deer and predators, primarily coyotes. These studies have shown that coyotes can negatively influence fawn survival, reproductive potential, and behavior of white-tailed deer on-site. Additional monitoring activities related to predator populations have been used to support these investigations. From a management perspective, periods with low coyote abundance have tended to coincide with growth of the white-tailed deer population. Currently, research is being conducted to evaluate and refine camera census techniques for white-tailed deer.

## Suggestions for Management of White-tailed Deer in the Coastal Plain

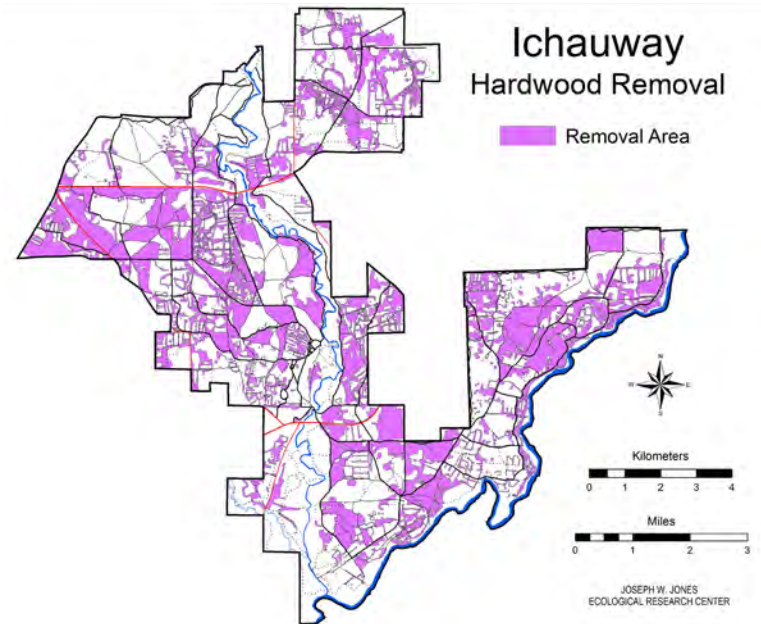
Monitoring is critical to the implementation of sound white-tailed deer management. Monitoring provides important data used to set objectives for, and plan and evaluate, land management activities. However, intensive monitoring is not always necessary for white-tailed deer management. At a minimum, land managers should employ monitoring to evaluate population trends and the results of management actions. Availability of resources should be included in decisions regarding implementation of monitoring. Population indices, observational data, and biological data can be collected rather inexpensively and efficiently.

In the Coastal Plain, prescribed fire is one of the most beneficial wildlife management tools. When applied correctly, prescribed fire can produce positive effects for white-tailed deer and many other species. These positive effects can occur on a scale much larger than other available management actions. The use of prescribed fire is vital to the restoration and maintenance of pine savanna habitats. Fire should be implemented on a scale, frequency, and season appropriate for individual properties and their overall management objectives. Historically, burn rotations of every 3–5 years have been suggested for white-tailed deer, but a higher frequency of burn rotation (<3 years) can still produce desired habitat conditions for deer while broadening habitat benefits for other Coastal Plain species.

Thinning of pine stands allows sunlight to reach the forest floor producing vegetation beneficial to white-tailed deer. Historically, white-tailed deer management recommendations for the stocking density of pine stands suggest that higher basal areas (80+ square feet per acre) are valuable for deer. Lower volumes can sustain both healthy and quality deer herds through, in part, the production of additional forage. Lower basal areas often provide resource benefits for other wildlife species typical of the Coastal Plain.



Hardwood removal is often a component of longleaf pine or pine savanna restoration. Although




*Hardwood removal treatment across Ichauway (approx. 10,000 acres)*

providing additional resources for deer, hard mast is not as important to deer herds with available high-quality forage and browse. Quality deer herds can be maintained on properties where hardwood removal has been implemented. Hardwood removal in the uplands should focus on less desirable species (e.g., water oak, laurel oak, sweetgum) in inappropriate areas, yet leave some desirable and fire tolerant hardwoods (e.g., southern red oak, turkey oak, post oak). It should also occur primarily in upland habitats that can be burned regularly. Hardwood removal in areas that will not typically burn may result in undesirable conditions. It is important to note that in the short term, hardwood removal can have negative localized effects on white-tailed deer populations. However, recovery typically occurs in subsequent years and may not initially impact large properties. In short, uplands should be managed with frequent fire to promote native ground cover for browse and bedding sites; more mesic hardwood sites should be managed to sustain and/or improve hard mast production.

Predation plays a role in white-tailed deer management. Some evaluation of predator populations and potential impacts should be conducted prior to implementing predator management programs. Predator regulation can be a cost-prohibitive management action and must be conducted routinely to provide herd benefits. If warranted, habitat manipulation may be a more cost effective tool for reducing the impacts of predators.

Historical and emerging diseases can have significant impacts on white-tailed deer in the Coastal Plain. Maintaining deer herds at lower densities may alleviate some disease concerns by supporting healthy individuals within the population. Movement of white-tailed deer between states or properties is not recommended due to both real and potential disease concerns. The confinement, purchase, sale, and movement of white-tailed deer is currently illegal in many states.

Native understory restoration has become a component of restoration of the longleaf pine ecosystem. As techniques develop, this restoration activity may become more economically and operationally feasible. Restoration of native understory can potentially provide additional diversity in white-tailed deer forage and fuels necessary for supporting frequent prescribed fire.

Thought should be given to managing Coastal Plain habitats as an entire system rather than focusing on particular species. As such, managers should focus land management and restoration activities on the production of quality, site appropriate, habitats. Desirable deer herds can be maintained on properties managed in this manner, while providing benefits for other species. Evaluation of the trade-offs of primary land management goals focused specifically on white-tailed deer, or some characteristic of white-tailed deer populations, versus managing for quality habitat should be considered.

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