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Georgia Species at Risk Project

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Executive Summary

The Georgia Species at Risk project was a cooperative effort of the U.S. Department of Defense Legacy Resource Management Program, the U.S. Fish and Wildlife Service, and the Georgia Department of Natural Resources, Wildlife Resources Division, Nongame Conservation Section (GADNR). The project itself was carried out by GADNR out of their Social Circle office in 2006-8. The primary objective of the project was to map potential habitats for “Species at Risk” at Fort Benning, Fort Gordon, Townsend Bombing Range, Robins Air Force Base, Fort Stewart, and King’s Bay Submarine Base, both on the bases themselves and within buffer zones, and to identify management activities that might benefit these species/habitats. NatureServe defines Species at Risk on Department of Defense (DoD) installations to be: (1) plant and animal species that are not yet federally listed as threatened or endangered under the Endangered Species Act, but that are either designated as candidates for listing or are regarded by NatureServe as critically imperiled or imperiled throughout their range AND (2) with populations that are known to occur on or near DoD installations. In addition, GA-DNR elected to include the gopher tortoise as a species at risk based on recent petitions to the Fish and Wildlife Service to list as a federally threatened species, and the development of a multi-agency/organization Candidate Conservation Agreement for the gopher tortoise to work towards pro-active tortoise management that may prevent the need for listing. GA-DNR identified a total of nine Species at Risk (including the tortoise) at Fort Benning, five at Fort Gordon, one at Townsend, two at Robins, ten at Fort Stewart, and three at King’s Bay.

GA-DNR contracted with the Natural Resources Spatial Analysis Laboratory (NARSAL) to produce Landsat Thematic Mapper (TM)-derived maps of Ecological Systems at all of the above installations and buffer areas, a total of over 1.6 million acres. Ecological Systems are a mid-scale classification unit for natural vegetation types. They are specifically defined as “recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes” (Grossman et al. 2003). It was determined prior to mapping that Ecological Systems, in their melding of physical environment with current vegetative conditions, would probably provide a good surrogate for the habitats of Species at Risk.

NARSAL completed Ecological Systems maps based on 2004-5 TM imagery in 2007. Following the completion of these maps, Tom Govus, a consulting botanist/ecologist, was contracted in 2007-8 to conduct field visits to high priority habitats as mapped, mainly within the buffer areas of the military installations. The purpose of these visits was to verify the accuracy of the maps, and to identify conservation targets of particular importance to Species at Risk and GA-DNR in general. In general, the field visits determined that the Ecological Systems level of mapping can be useful in identifying potential habitats for Species at Risk, although this determination may be more complex for species that inhabit ecotones or depend on specific forest stand structures. In addition, a number of high-quality natural environments were identified during the field visits.

Finally, in 2008, GA-DNR compiled a set of management recommendations for Species at Risk and their associated habitats, especially at the Ecological Systems level.

Study/Project Objective

The objective of this project was to map potential habitats for “Species at Risk” (Table 1) at Fort Benning, Fort Gordon, Townsend Bombing Range, Robins Air Force Base, Fort Stewart, and King’s Bay Submarine Base, both on the bases themselves and within buffer zones, and to identify management activities that might benefit these species/habitats. NatureServe defines Species at Risk on Department of Defense (DoD) installations to be: (1) plant and animal species that are not yet federally listed as threatened or endangered under the Endangered Species Act, but that are either designated as candidates for listing or are regarded by NatureServe as critically imperiled or imperiled throughout their range AND (2) with populations that are known to occur on or near DoD installations. (NatureServe 2004). Known locations for Species at Risk for the project areas are depicted in the following section in Figures 1 through 7.

MILITARY INSTALLATION	SPECIES NAME	
	SCIENTIFIC	COMMON
Ft. Stewart	BALDUINA ATROPURPUREA	PURPLE BALDUINA
	CALOPOGON MULTIFLORUS	MANY-FLOWERED GRASS-PINK
	ELLIOTTIA RACEMOSA	GEORGIA PLUME
	GOPHERUS POLYPHEMUS	GOPHER TORTOISE
	HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE
	ILLICIAM PARVIFLORUM	YELLOW ANISE-TREE
	LOBELIA BOYKINII	BOYKIN'S LOBELIA
	NOTOPHTHALMUS PERSTRIATUS	STRIPED NEWT
	PTEROGLOSSASPIS ECRISTATA	CRESTLESS PLUME ORCHID
	SIDEROXYLON THORNEI	SWAMP BUCKTHORN
Townsend Bombing Range	DICERANDRA RADFORDIANA	RADFORD'S MINT
	GOPHERUS POLYPHEMUS	GOPHER TORTOISE
Robins Air Force Base	LOBELIA BOYKINII	BOYKIN'S LOBELIA
	SCUTELLARIA OCMULGEE	OCMULGEE SKULLCAP
Kings Bay Submarine Support Center	FORESTIERA GODFREYI	GODFREY'S PRIVET
	GOPHERUS POLYPHEMUS	GOPHER TORTOISE
	PTEROGLOSSASPIS ECRISTATA	CRESTED FRINGED ORCHID
Ft. Benning	AESCULUS PARVIFLORA	SMALL-FLOWERED BUCKEYE

	ARABIS GEORGIANA	GEORGIA ROCK-CRESS
	BRICKELLIA CORDIFOLIA	HEARTLEAF BRICKELLIA
	CYPRINELLA CALLITAENIA	BLUESTRIPE SHINER
	GOPHERUS POLYPHEMUS	GOPHER TORTOISE
	GRAPTEMYS BARBOURI	BARBOUR'S MAP TURTLE
	HELIANTHUS SMITHII	SMITH'S SUNFLOWER
	MACBRIDEA CAROLINIANA	CAROLINA BOGMINT
	STYLISMA PICKERINGII VAR PICKERINGII	PICKERING'S MORNING-GLORY
Ft. Gordon	ELASSOMA OKATIE	BLUEBARRED PYGMY SUNFISH
	GOPHERUS POLYPHEMUS	GOPHER TORTOISE
	HETERODON SIMUS	SOUTHERN HOGNOSE SNAKE
	MACBRIDEA CAROLINIANA	CAROLINA BOGMINT
	STYLISMA PICKERINGII VAR PICKERINGII	PICKERING'S MORNING-GLORY

Table 1. Species at Risk identified at military bases for the Georgia Species at Risk project.

Completion of the project involved three basic tasks:

- 1) Mapping of military bases and buffer lands to the Ecological Systems level (Comer et al. 2003), and, where necessary, to the Association level (Grossman et al. 1998). Determination of the necessity to map to Associations will be made upon review of the Species at Risk and their specific habitat requirements.
- 2) Field verification. Areas to be field verified will depend on the habitat requirements of the Species at Risk.
- 3) Development of management guidelines for Ecological Systems/Associations that are important for Species at Risk.

It is believed that habitat associations of Species at Risk at the Ecological Systems level may, in many cases, provide a reasonable approximation of potential occurrence for these species.

The Species at Risk

Following is a brief discussion of the Species at Risk by military installation.

Fort Gordon

Elassoma okatie, Bluebarred pygmy sunfish

This G2G3S1S2 (Georgia Department of Natural Resources 2007), State Endangered fish is known from Boggy Gut Creek and Sandy Run Creek on Fort Gordon. It is associated with slow-moving or stagnant, tannin-stained waters in creeks and impoundments, especially in areas with heavy aquatic vegetation (Hoover et al. 1998). A management plan for this species on Fort Gordon (Hoover et al. 2004) recommends minimizing military traffic near streams and wetlands and managing for natural forest cover in occupied watersheds. Additional survey effort in off-base areas is needed for this species.

Gopherus polyphemus, Gopher tortoise

This G3G2, State Threatened reptile is known from sandhill habitats in several locations on Fort Gordon primarily on the Lakeland soil series. Several new locations for this species were discovered during Phase 2 of this project on private lands in western Richmond County, just to the east of the Army Base. Threats to this species include pine silviculture and resultant shading (Birkhead and Tuberville 2008), habitat fragmentation, roads (Ashton and Ashton 2008), and, potentially, increased military activities (Guyer et al. 2006).

Heterodon simus, Southern hognose snake

This G2S2, State Threatened snake is known from one un-dated museum specimen from Fort Gordon, probably from sandhills just north of Brier Creek, and another historic, imprecise location off-base near the Jefferson/Glascock County line. Like the gopher tortoise, the southern hognose snake is primarily associated with upland habitats on sandy soils. Populations are frequently disjunct (Tuberville and Jensen 2008). It appears to have declined throughout much of its range due to habitat degradation, intensive soil disturbance, road mortality, and introduced fire ants (Tuberville et al. 2000). More distribution information is needed for this species throughout its range, including the Fort Gordon vicinity.

Macbridea caroliniana, Carolina bogmint

This G2G3S1, State Rare plant is known from four locations on Fort Gordon, all in the transition zones between upland sandhills and blackwater swamps of Headstall and Brier Creeks. Clearcutting should be avoided in these habitats, and, ideally, fire should be allowed to creep into them from adjoining uplands at a frequency of approximately every two to three years (Chafin 2007).

Stylisma pickeringii var *pickeringii*, Pickering's morning-glory

This G4T3S2, State Threatened plant is known from seven locations on Fort Gordon, two near South Prong Creek, one near Rachel Branch, and four in the cantonment area on the eastern end of the base. It is associated with xeric sandhills of longleaf pine and turkey oak. It may be threatened by soil disturbance, including site preparation, and excessive vehicle traffic. It is recommended that sandhills sites be burned on a two to three year rotation (Chafin 2007).

Fort Stewart

Balduina atropurpurea, Purple balduina

This G2S2, State Rare plant is known from several locations in the western section of Fort Stewart near the Long/Tattnall county line. It is most commonly associated with wet pine flatwoods, seepage slopes, and pitcherplant bogs. It requires frequent fire and avoidance of soil disturbance, especially ditching, draining, or bedding (Chafin 2007). Vehicle traffic may also be detrimental.

Calopogon multiflorus, Many-flowered grass-pink

This G2G3SH plant is known from a single location in the southwestern corner of Fort Stewart in Long County. It is associated with frequently burned pine flatwoods habitats, blooming after winter or early spring fires. Fire suppression and intensive pine silviculture have led to the extirpation of nearly all Georgia populations (Chafin 2007). The status of the Fort Stewart population is uncertain.

Elliottia racemosa, Georgia-plume

This G2G3S2S3, State Threatened Georgia endemic small tree is known from sandhill/swamp transitions in the Long County portion of Fort Stewart, and in similar transition zones in the northern part of the base near the Canoochee River (Evans and Bryan Counties). This species requires periodic low-intensity fire, and clearcutting should be avoided (Chafin 2007).

Gopherus polyphemus, Gopher tortoise

This G3G2, State Threatened reptile is known from sandy uplands throughout Fort Stewart, particularly on longleaf pine-turkey oak sandhills. It is also known from several locations outside the base on similar habitats, particularly on sandhills associated with the Canoochee and Ogeechee Rivers. Threats to this species include pine silviculture and resultant shading (Birkhead and Tuberville 2008), habitat fragmentation, roads (Ashton and Ashton 2008), and, potentially, increased military activities (Guyer et al. 2006).

Heterodon simus, Southern hognose snake

This G2S2, State Threatened snake is known from recent records on sandhills in the southern portion of Fort Stewart, and historic records off-base to the north, particularly

along the Ogeechee River. Like the gopher tortoise, the southern hognose snake is primarily associated with upland habitats on sandy soils. Populations are frequently disjunct (Tuberville and Jensen 2008). It appears to have declined throughout much of its range due to habitat degradation, intensive soil disturbance, road mortality, and introduced fire ants (Tuberville et al. 2000). More (particularly recent) distribution information is needed for this species throughout its range, including the Fort Stewart vicinity.

Illicium parviflorum, Yellow anise-tree

This G2SH shrub is known from a single location just outside of Fort Stewart in Bryan County, likely of cultivated origin, and another occurrence on Fort Stewart itself on a Taylors Creek tributary near an old home site. Chafin (2007) considers this plant to be native only to central Florida. It is unlikely that it occurs naturally in Georgia (Tom Patrick, *personal communication*).

Lobelia boykinii, Boykin's lobelia

This G2G3S2S3 plant is known on Fort Stewart from four depressional ponds within pine flatwoods. Habitat for this species is typically cypress ponds or other depressional wetlands (Georgia Department of Natural Resources 2007). Environments are generally quite open (Bates 1996). Management recommendations should include avoidance of hydrology alteration, keeping tracked vehicles out, and not permitting wetlands to become overgrown, preferably through frequent prescribed burning.

Notophthalmus perstriatus, Striped newt

This G2G2S2, State Threatened amphibian is known from a number of locations on Fort Stewart and one historic site off-base in northern Bryan County near the Ogeechee River. It is associated with longleaf pine-wiregrass sandhills with wet depressions for breeding. Breeding ponds are typically quite open (Stevenson and Cash 2008). Ditching and draining of wetlands should be avoided, as should tracked vehicles within breeding ponds, and frequent prescribed burning is recommended.

Pteroglossapsis ecristata, Crestless plume orchid

This G2G3S1, State Threatened plant is known from four locations in the western half of Fort Stewart, all in mesic pine flatwoods that have been disturbed to varying degrees. It thrives in sunny, open areas, so frequent prescribed burning is recommended, but does not do well after extreme soil disturbance such as bedding (Chafin 2007). Exotic cogon grass could have negative effects on this species if it becomes established (Chafin 2007).

Sideroxylon thornei, Swamp buckthorn

This G2S2, State Rare shrub is known from one location on Fort Stewart, an extensive hardwood swamp in the southern end of the base known as Cedar Bay. Fort Stewart is at

the northeastern end of the range of this species. It is found in swampy depressions, frequently (though not always) over limestone (Chafin 2007). Management recommendations include avoidance of draining or clearcutting wetlands (Chafin 2007).

Robins Air Force Base

Lobelia boykinii, Boykin's lobelia

This G2G3S2S3 plant is known on Robins Air Force Base from a wet depressional meadow just to the south of Scout Lake. Habitat for this species is typically cypress ponds or other depressional wetlands (Georgia Department of Natural Resources 2007). Environments are generally quite open (Bates 1996). As noted in Appendix A, this habitat type is rather rare in the Robins vicinity, but efforts should be made to survey existing depressional ponds for rare species. Management recommendations should include avoidance of hydrology alteration, keeping tracked vehicles out, and not permitting wetlands to become overgrown, preferably through frequent prescribed burning.

Scutellaria ocmulgee, Ocmulgee skullcap

This G2S2, State Threatened plant is known from Robins Air Force Base on bluffs above the Ocmulgee River floodplain, and from James Dykes Memorial Park on river bluffs in Bleckley County. During Phase 2 of this project, two new populations were discovered on private lands in Twiggs County near Crooked Creek. These are discussed in more detail in Appendix A. Management recommendations for this species include avoidance of clearing and development on river bluffs, and eradication of exotic invasives such as Japanese honeysuckle, Chinese privet, and autumn olive (Chafin 2007).

Townsend Bombing Range

Dicerandra radfordiana, Radford's mint

This G1S1, State Endangered plant is known from two locations near Townsend Bombing Range: one is on the recently state-purchased Barrington/Plumorchard tract and the other is on lands belonging to the Barrington Hunt Club. Both are now in permanent protection. Both are found on very deep, rapidly-drained sand ridge habitats. The state-owned site was planted to sand pine by previous owners and has suffered somewhat in the heavy shade created by that species. Current plans are to remove the sand pine and restore an open longleaf pine-turkey environment and its associated fire regime (2-3 years).

Gopherus polyphemus, Gopher tortoise

This G3G2, State Threatened reptile is known from the Townsend vicinity from deep sand ridges on both sides of the Altamaha River. Some populations are quite dense, particularly on the state-owned Barrington tract. Several of these sites are permanently

protected but badly in need of ecological restoration. It is not known to occur on the Bombing Range itself; the only suitable habitat is a small area in the northeast corner of the Range; the rest of the area is too wet. Threats to this species in this area include pine silviculture and resultant shading (Birkhead and Tuberville 2008), habitat fragmentation, and roads (Ashton and Ashton 2008).

Kings Bay Submarine Base

Forestiera godfreyi, Godfrey's privet

This G2S1, State Endangered shrub is known from a single location on Crooked River State Park, just to the north of the Sub Base. It is found in an extremely high quality old-growth maritime forest hammock/ shell midden. The Sub Base has received substantial botanical survey work (Richard Carter, *personal communication*), and it is not likely that the plant occurs there. Other maritime hammocks in Camden County, especially those with known shell middens, should be surveyed, however. Management recommendations for this species include avoidance of clearing and eradication of invasive exotics if they appear (Chafin 2007).

Gopherus polyphemus, Gopher tortoise

This G3G2, State Threatened reptile is known from areas of sandy soils scattered on and around the Sub Base. Preferred soil types in this vicinity appear to be Cainhoy sands. The largest concentration on the base seems to be in the vicinity of Cherry Point. A small population is protected in Crooked River State Park. Threats to the species in this area include development, pine silviculture and resultant shading (Birkhead and Tuberville 2008), habitat fragmentation, roads, and encroachment from vegetation due to fire suppression (Ashton and Ashton 2008).

Pteroglossapsis ecristata, Crestless plume orchid

This G2G3S1, State Threatened plant is known from a single on the sub base, in an open, mowed field with exotic Bahia grass, adjacent to maritime forest on Cainhoy sand. There are very few plants in this location, and in recent years plants have not been visible at all, although this is not terribly unusual for this species, and it may reappear if prescribed fire is applied regularly (Richard Carter, *personal communication*). It is recommended that additional surveys be conducted for this species around Camden County. Sites should be managed with regular prescribed fire (Chafin 2007).

Fort Benning

Aesculus parviflora, Bottlebrush buckeye

This G3S2S3 shrub is known from one location on Fort Benning – a steep ravine in the far southeast portion of the base – and two new locations discovered during Phase 2 of this project, both in northeastern Stewart County near Slaughter Creek (see Appendix A).

It is typically found in mesic bluff and ravine forests (Georgia Department of Natural Resources 2007), especially in sheltered areas of very steep topography, sometimes with other relict species (Wyatt 1985). Management recommendations include protection from clearcutting and potentially removal of exotic species, including Chinese privet, Japanese honeysuckle, and feral hogs.

Arabis georgiana, Georgia rock-cress

This G1S1, State Threatened, Federal Candidate is known from one site on Fort Benning, on a rocky slope of Oswichee Creek near its confluence with the Chattahoochee River. This is the second largest population of this species in Georgia (the Goat Rock Dam population north of Columbus in Muscogee county is the largest – it is just outside of the mapping area for this project) (Moffett 2007). It typically occupies rocky river bluffs in steep terrain. Logging and clearing on slopes with this plant should be avoided, and exotic pests such as Japanese honeysuckle, Chinese privet, and feral hogs should be eradicated (Moffett 2007).

Brickellia cordifolia, Heartleaf brickellia

This G3G2S2, State Threatened plant is known from a number of locations scattered around Fort Benning. The largest concentrations are in the southeastern portion of the base in the Glen Alta topographic quadrangle in Chattahoochee County. It is typically found in sunny openings within dry to mesic oak-hickory forests, often in the company of white oak and southern red oak (Chafin 2007). Management recommendations include avoiding conversion to pine plantation, and application of prescribed fire on a 3-5 year rotation (Chafin 2007).

Cyprinella callitaenia, Bluestripe shiner

This G2G3S2, State Rare fish is known on Fort Benning from lower Upatoi Creek and a couple of locations on the mainstem Chattahoochee. It is typically found in riffle areas of large streams (Freeman 1999). Management recommendations include not impounding large streams and avoiding siltation, especially during land-disturbing activities (Freeman 1999). Siltation of streams is considered the primary threat to this species (Freeman 1999).

Gopherus polyphemus, Gopher tortoise

This G3G2, State Threatened reptile is known from a number of areas on Fort Benning on sandy Lakeland and sometimes Troup soils. The largest concentration is in the northeast corner of the base in Chattahoochee County. Smaller, though significant, populations are also located off-base, particularly in northern Marion County in Fall Line sandhills habitats. Threats to this species include pine silviculture and resultant shading (Birkhead and Tuberville 2008), habitat fragmentation, roads (Ashton and Ashton 2008), and, potentially, increased military activities, particularly from tracked vehicles (Guyer et al. 2006).

Graptemys barbouri, Barbour's map turtle

This G2S2, State Threatened reptile is known from two areas in the headwaters of Lake Walter F. George reservoir on the southwestern end of Fort Benning, on the Alabama side. It prefers streams that are rich in mollusks, and, although the native mussel fauna in the Chattahoochee and many of its tributaries have been devastated by a variety of activities, non-native Asian clams have proven to be acceptable substitute forage (Moulis 2008). However, Barbour's map turtle is known to be very sensitive to pollution, and activities contributing to stream degradation should be avoided (Moulis 2008).

Helianthus smithii, Smith's sunflower

This G2S1 plant is known from a single location in the northeast corner of Fort Benning near Upatoi Creek. It is typically found in areas of dry, open woods, particularly upland pine-oak-hickory (Georgia Department of Natural Resources 2007). The Benning location is from an open longleaf pine stand. Information on management for this species is scarce, but, given its predilection for open areas, regular prescribed burning should be beneficial.

Macbridea caroliniana, Carolina bogmint

This G2G3S1, State Rare plant is known from a single location in the Fort Benning vicinity, off-base along Juniper Creek in northern Marion County. However, a second population has recently been discovered just to the northeast of the mapping area for this project, and additional surveys of likely habitat may be warranted. It is typically found in the boggy areas in the midst of sandhills. Ideally, fire should be allowed to creep into these habitats from adjoining uplands at a frequency of approximately every two to three years (Chafin 2007).

Stylisma pickeringii var *pickeringii*, Pickering's morning-glory

This G4T3S2, State Threatened plant is known from several locations scattered around Fort Benning. It is associated with xeric sandhills of longleaf pine and turkey oak. There is potential for this species on off-base areas, especially in the deep sands of northern Marion County. It may be threatened by soil disturbance, including site preparation, and excessive vehicle traffic. It is recommended that sandhills sites be burned on a two to three year rotation (Chafin 2007).

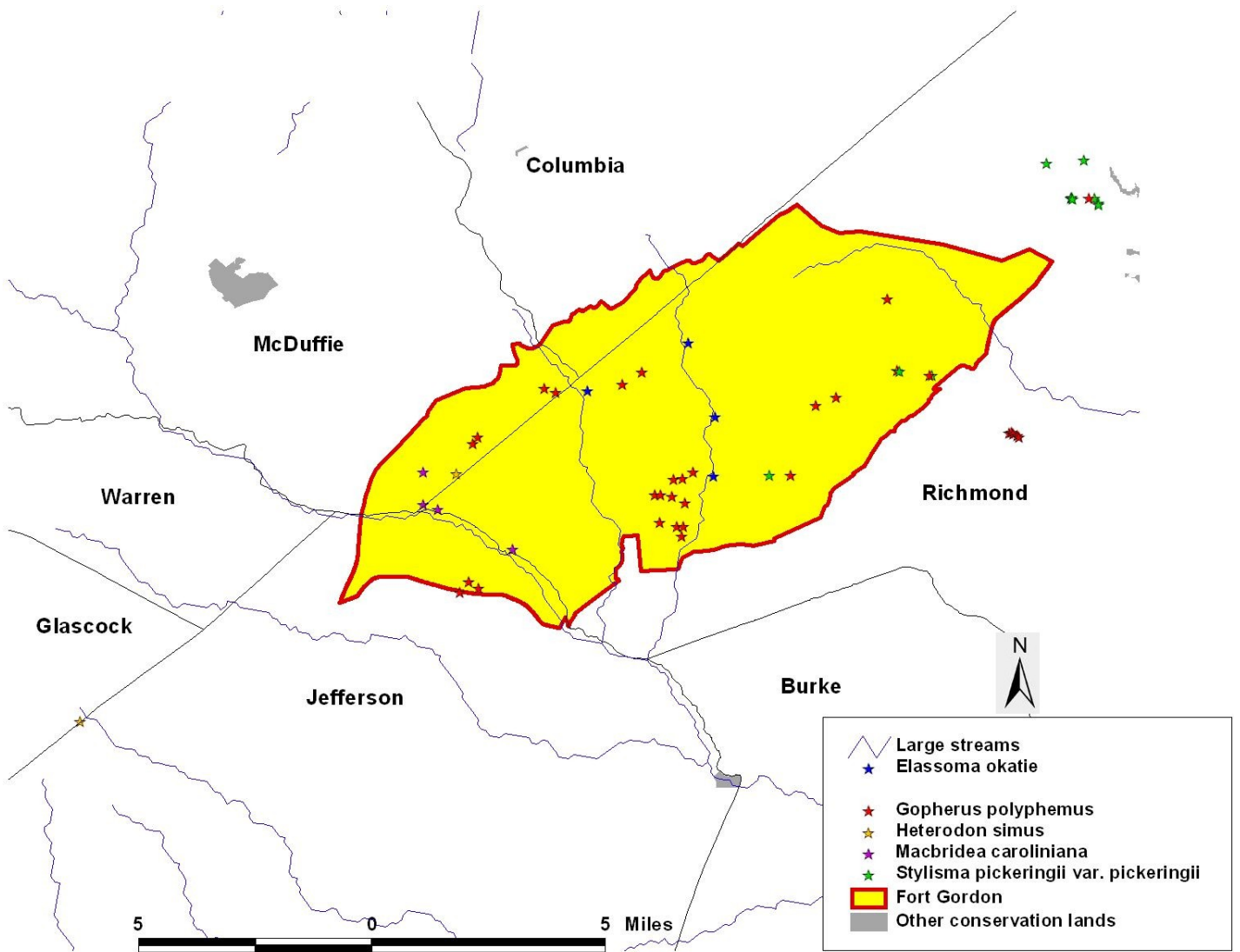


Figure 1. Species at Risk on and around Fort Gordon Army Base.

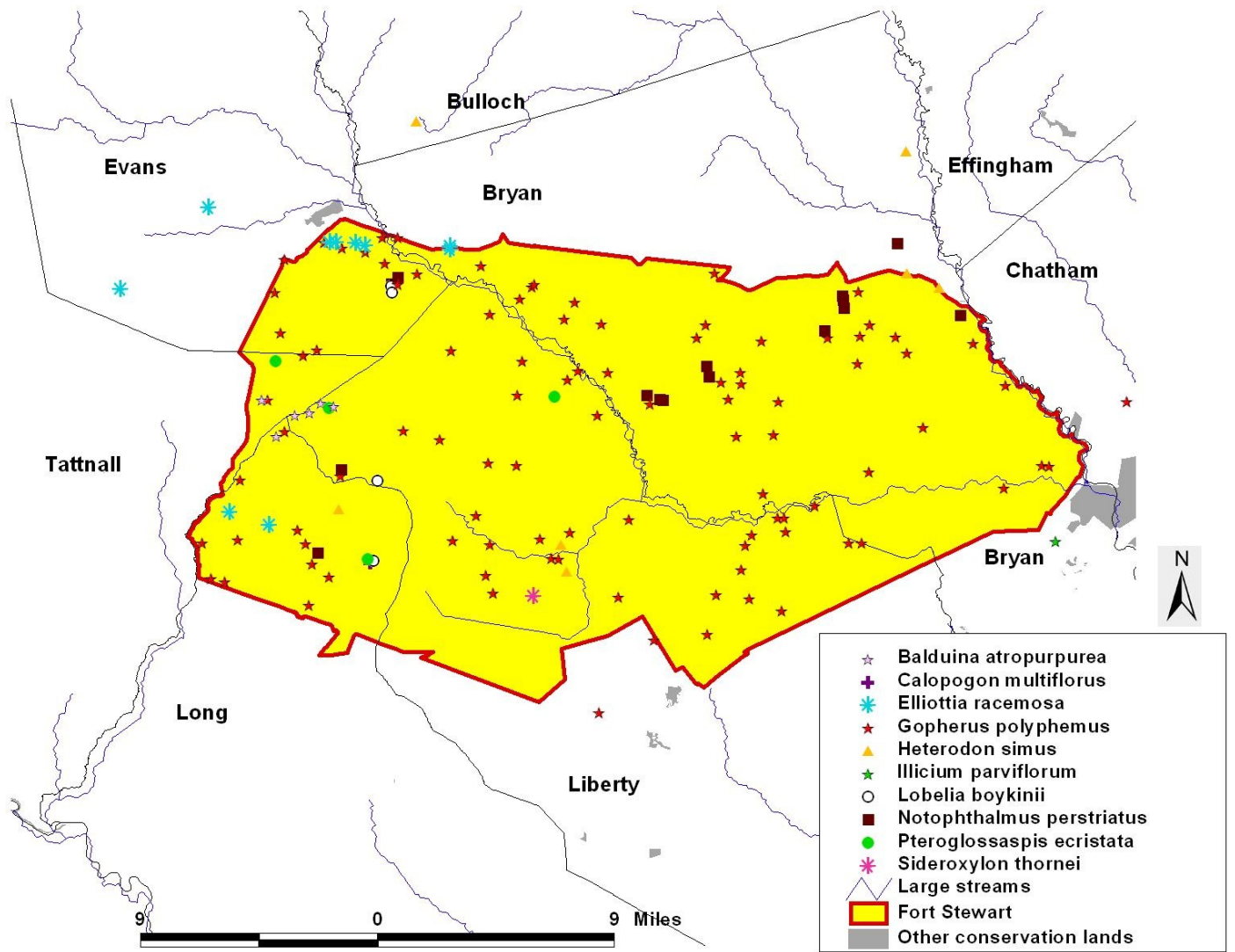


Figure 2. Species at Risk on and around Fort Stewart Army Base.

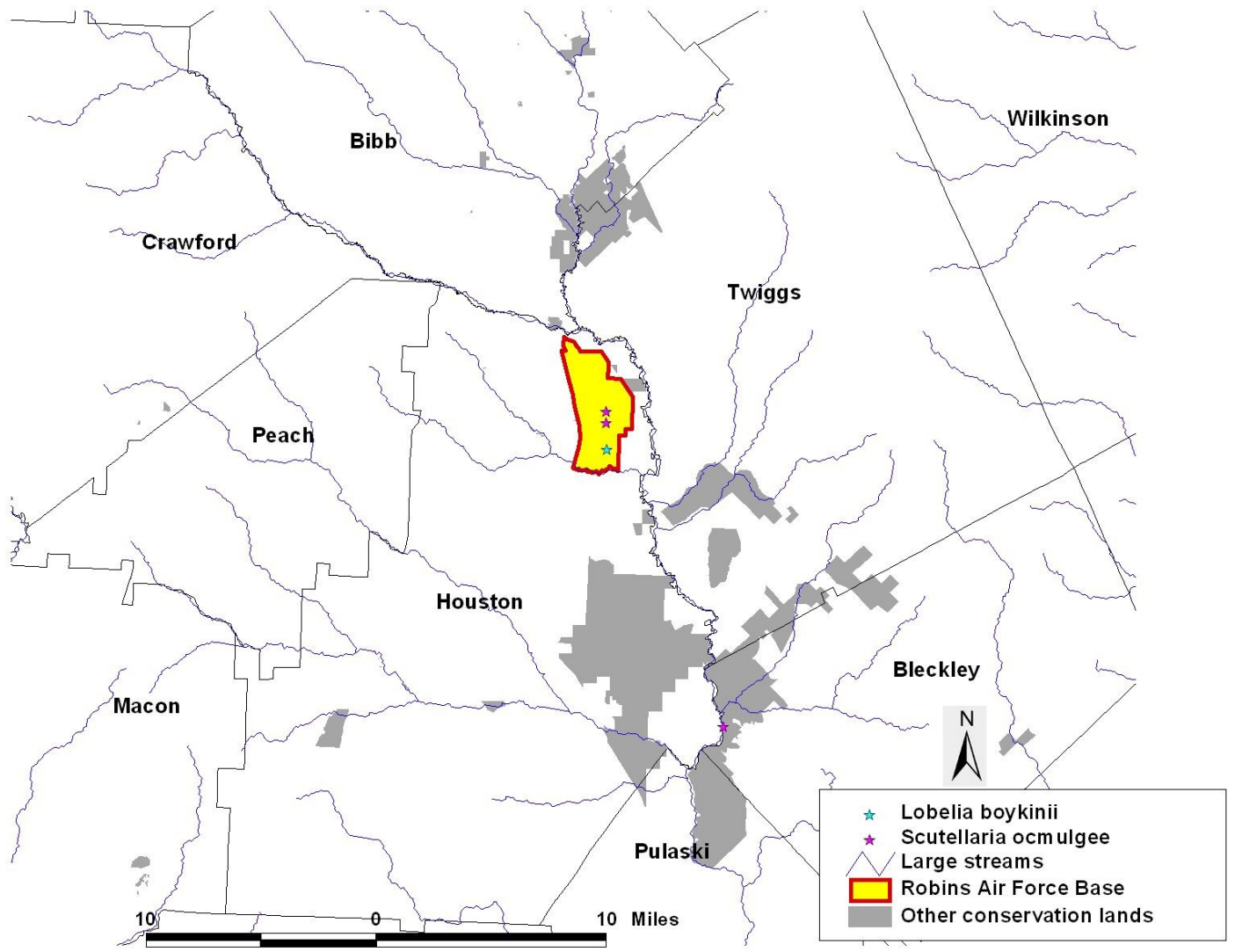


Figure 3. Species at Risk on and around Robins Air Force Base.

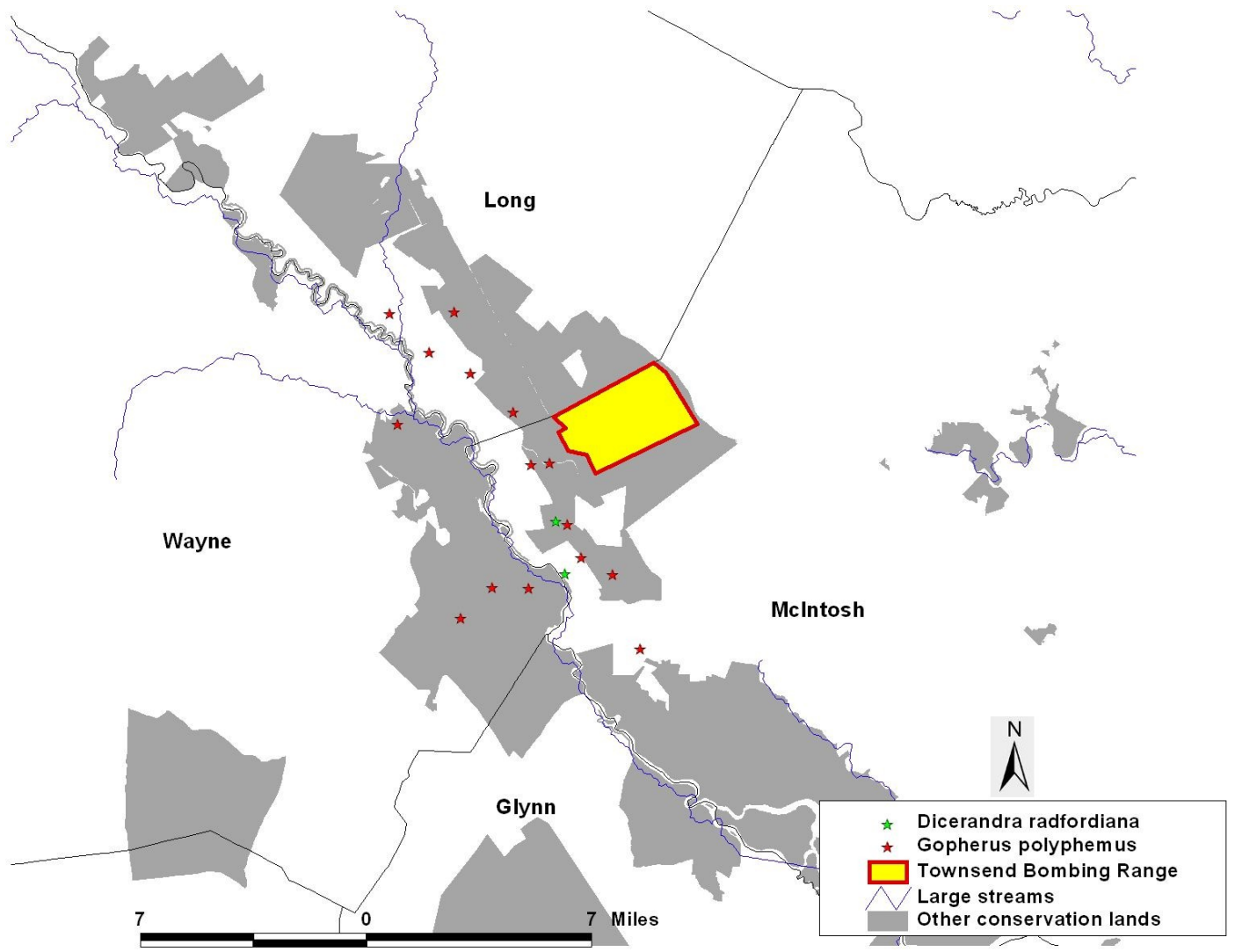


Figure 4. Species at Risk on and around Townsend Bombing Range.

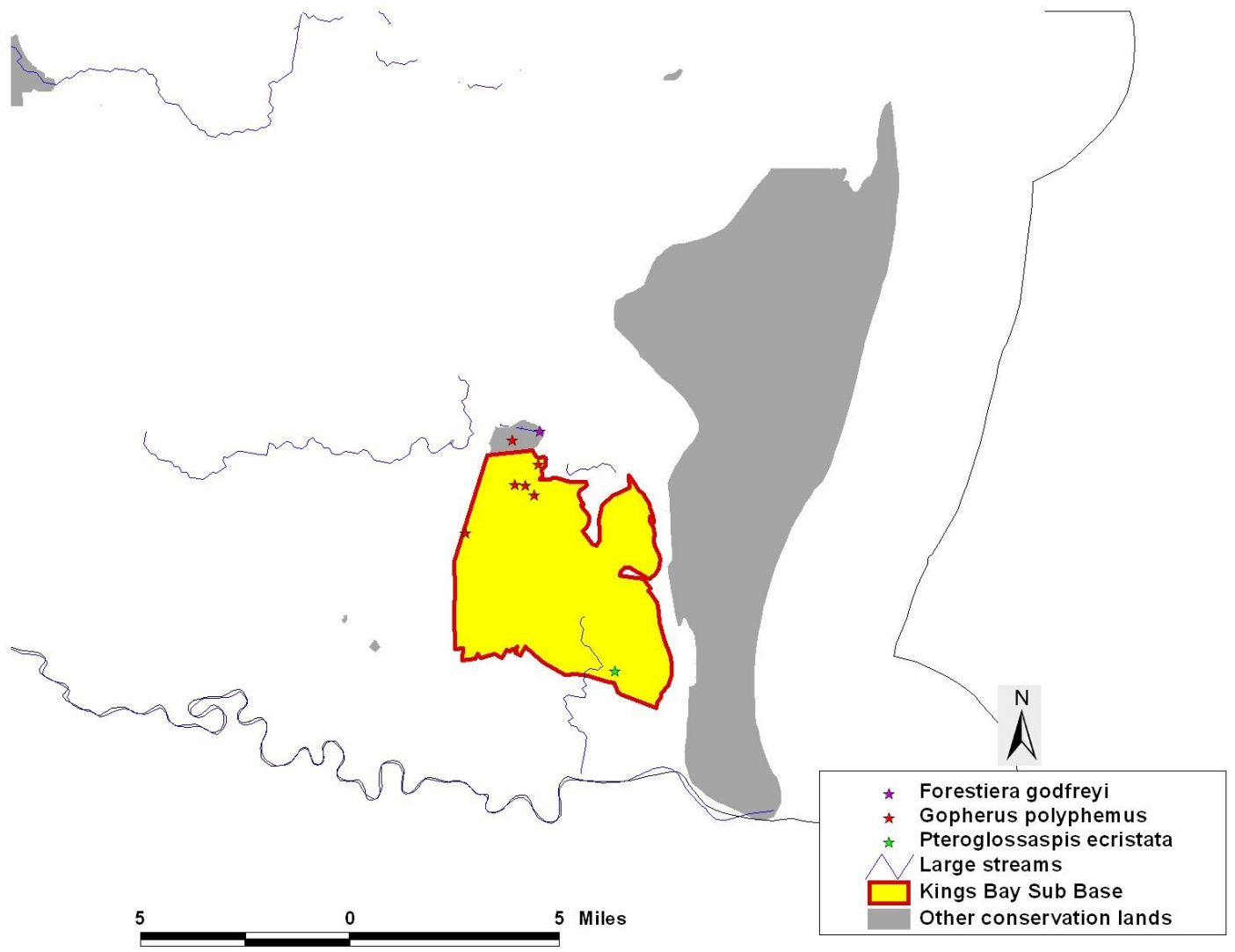


Figure 5. Species at Risk on and around King’s Bay Submarine Base.

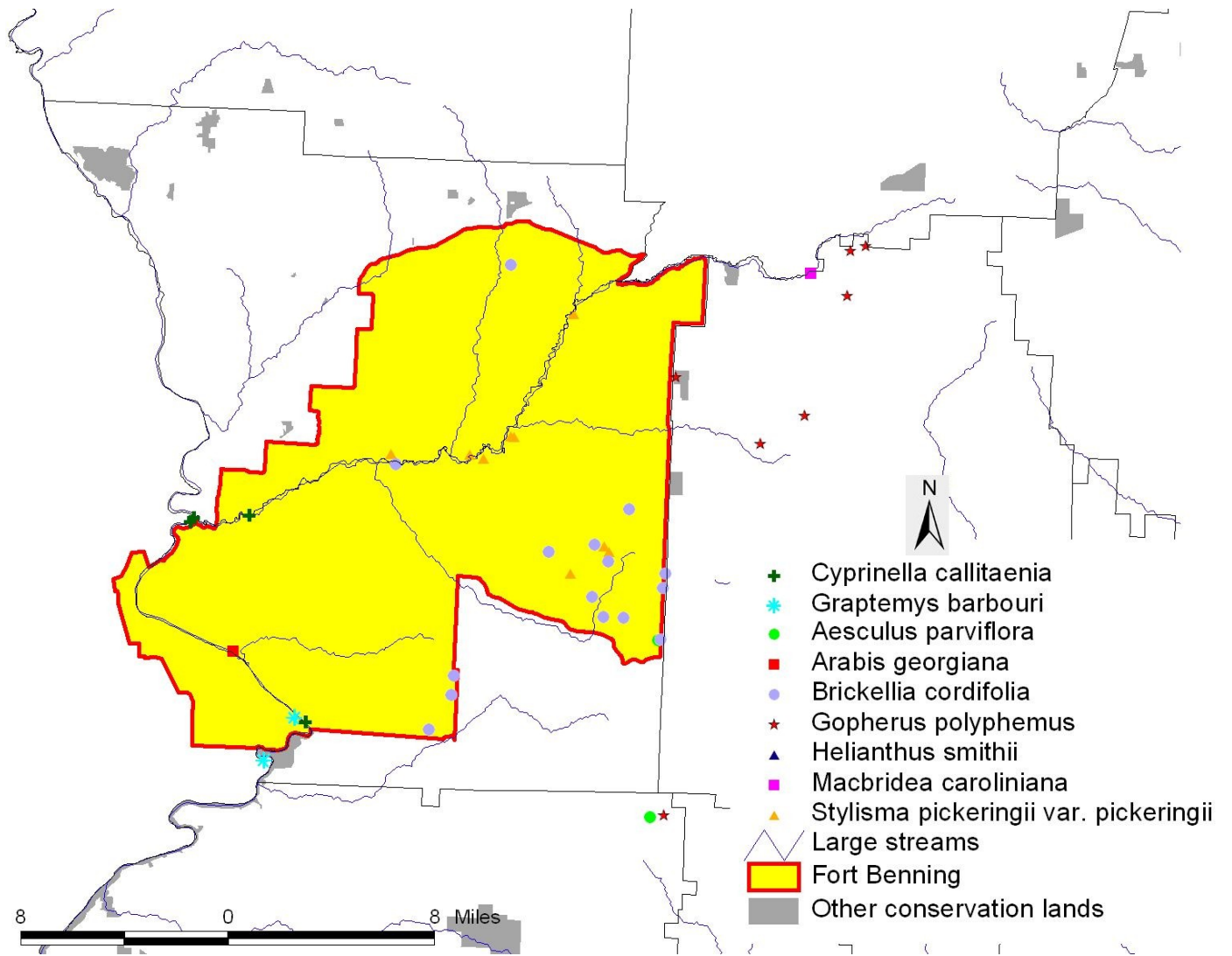


Figure 6. Species at Risk on and around Fort Benning, exclusive of on-base gopher tortoises (*Gopherus polyphemus*).

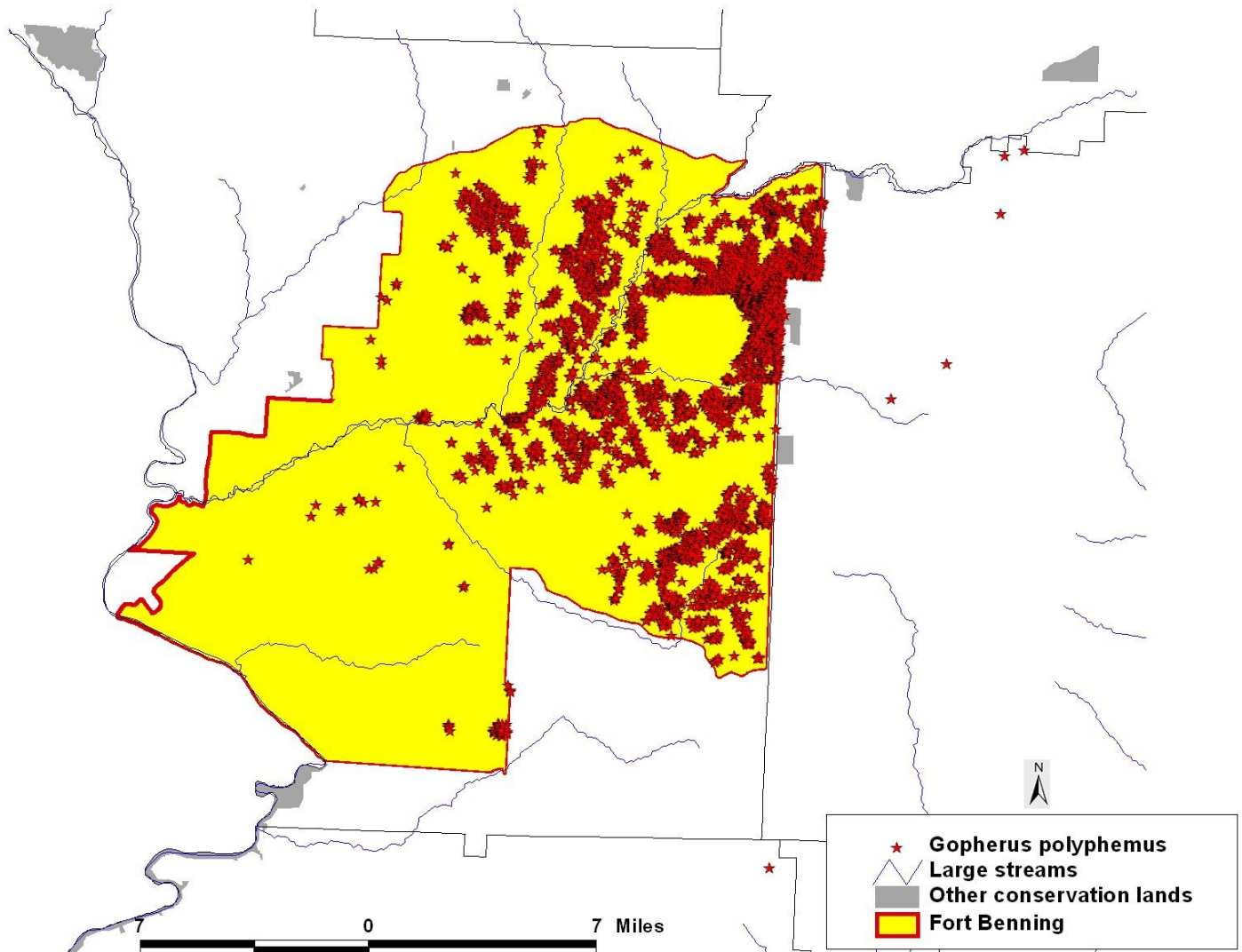


Figure 7. Gopher tortoise (*Gopherus polyphemus*) locations on and around Fort Benning. Note: locations off base may represent multiple burrows, while those on base are individual burrows.

Mapping to the Ecological Systems Level

Ecological Systems are a mid-scale classification unit for natural vegetation types. They are specifically defined as “recurring groups of biological communities that are found in similar physical environments and are influenced by similar dynamic ecological processes, such as fire or flooding. They are intended to provide a classification unit that is readily mappable, often from remote imagery, and readily identifiable by conservation and research managers in the field” (Comer et al. 2003). They are intended to fit into a hierarchical classification system that includes Associations (Grossman et al. 1998) at finer thematic scales.

In discussions at the inception of this project, it was determined that Ecological Systems, in their melding of physical environment with current vegetative conditions, would probably provide a good surrogate for the habitats of Species at Risk. In practice, this is likely to be true in MOST cases, but there will be exceptions. These will be discussed in greater detail later in the report.

For this project, a map of Ecological Systems was produced for areas within 10km of the military bases in question, except Robins Air Force Base, where a slightly larger area was mapped so as to include several very high priority lands and habitats (Figure 8).

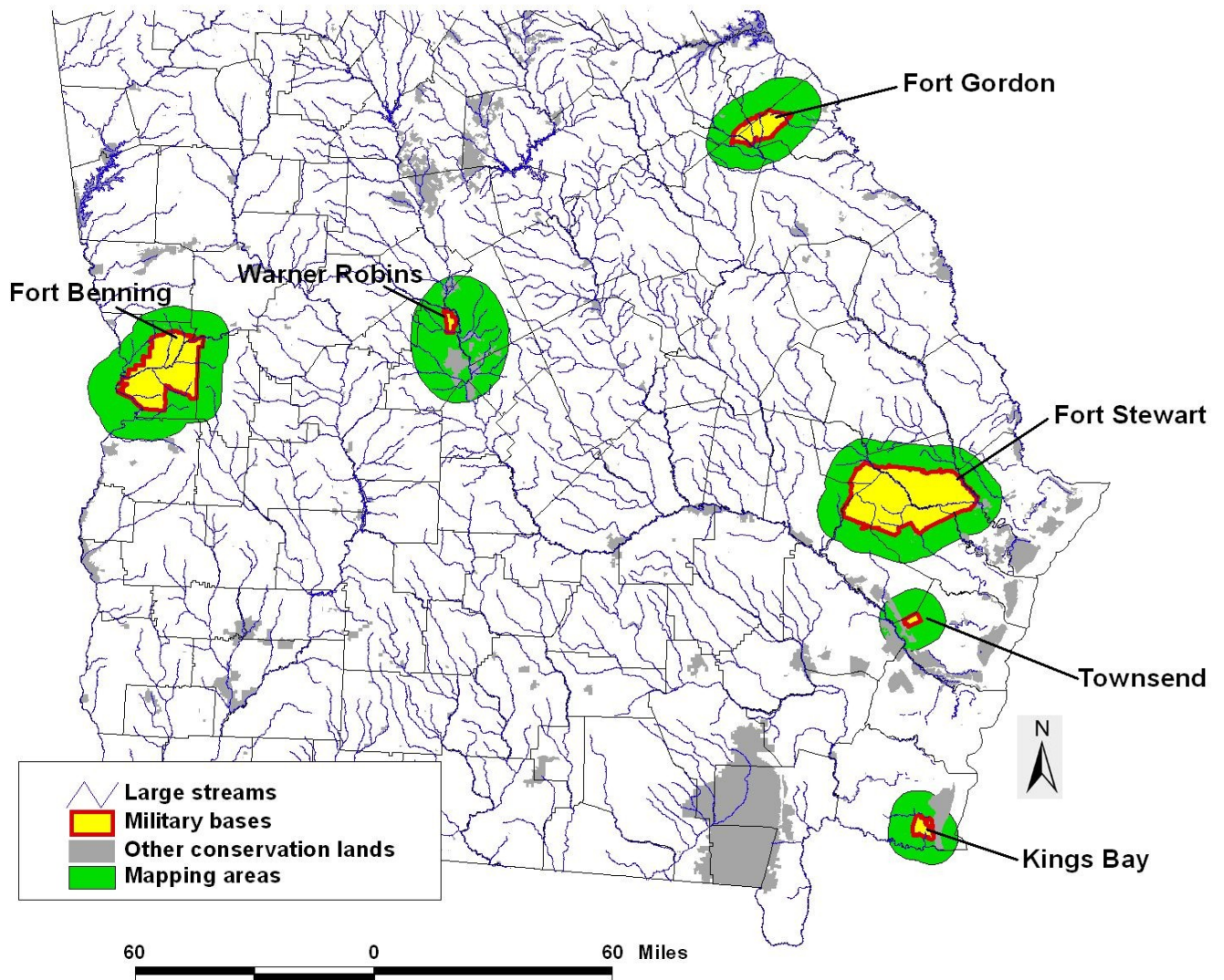


Figure 8. Areas mapped at the Ecological Systems level for the Georgia Species at Risk project.

Mapping of Ecological Systems was contracted to the Natural Resources Spatial Analysis Laboratory (NARSAL) at the University of Georgia, who previously completed mapping at a similar scale for the Georgia Gap Analysis Project (Kramer et al. 2003). Base imagery for Ecological Systems was 2004-5 Landsat Thematic Mapper, leaf on and leaf off (Table 2) (U.S. Geological Survey 2006). Initially, an unsupervised classification was performed on all nine TM bands (which had been subjected to a tasseled cap transformation). Subsequently, urban areas were removed from the image, and an unsupervised ISODATA classification was performed on remaining data (Samples and Lee 2005). Trial and error led to a classification consisting of 100 classes to represent the spectral variability across a zone. Clusters from the unsupervised classification were grouped into general land cover classes (Anderson 1976). Forest stand age models were developed using Georgia GLUT general land cover data for the purposes of determining areas of “natural vegetation” (Elliott and Kramer 2005). Areas of “natural vegetation” became those modeled to the Ecological Systems level for this project. From this point, specific methodologies for mapping to the Ecological Systems level varied by installation/mapping area, and will be discussed in separate sections.

A formal accuracy assessment was not conducted on the Ecological Systems. However, a cross-validation of general land cover classes yielded an accuracy of 87.9% (Samples and Lee 2005). Further, we did conduct informal accuracy assessment/field verification in conjunction with a field-based assessment of high priority habitats of the six military bases (Appendix A and Appendix B). This field verification/assessment will be discussed further later in the report.

Path_Row	Leaf Off Date	Leaf On Date
16_38	12/15/2004	10/15/2005
17_38	1/23/2005	6/16/2005
18_38	12/23/2004	9/11/2005
16_39	11/29/2004	5/24/2005
17_39	1/23/2005	3/12/2005
18_39	12/29/2004	9/11/2005
17_37	1/23/2005	9/4/2005
18_37	12/13/2004	9/11/2005
19_36	1/21/2005	9/18/2005
19_37	1/21/2004	9/2/2005
19_39	12/20/2004	4/27/2005
20_36	12/27/2004	9/22/2004
18_36	12/13/2004	10/29/2005
19_38	12/20/2004	4/27/2005

Table 2. Dates of Thematic Mapper imagery used in mapping Ecological Systems for Georgia Species at Risk project,

Fort Gordon

Background:

For the purposes of this project, the Fort Gordon vicinity includes the entire Army base as well as a 10km buffer, a total area of just over 300,000 acres. The base itself sits in the Augusta, GA metropolitan area primarily in Richmond County on the Fall Line (division between the Piedmont and Southeastern Plains ecoregions) (Griffith et al. 2001), and consists of approximately 44,000 acres. Adjoining counties within the buffer zone include Columbia, Warren, McDuffie, Glascock, Jefferson, and Burke. Augusta itself is a metropolitan area of 195,000 people (U.S. Census Bureau 2001), and dominates much of the mapping area. The Piedmont ecoregion, at least in that portion of it where natural vegetation persists, is characterized by rolling terrain and alternating mesic hardwood and dry oak-pine forests (Kramer et al. 2003). There are also extensive areas of successional forests and pine silviculture, the latter practiced at highly varying intensities. The Coastal Plain in this area is much less densely populated, and contains a wide array of ecosystems, from sandhills along the Fall Line, to extensive riparian swamps, to Carolina bays (Kramer et al. 2003). There is also a great deal of row crop agriculture, particularly in Jefferson and Burke Counties, and pine silviculture throughout the area.

Methods:

NARSAL applied several techniques in mapping Ecological Systems at Fort Gordon. SSURGO soil maps (U.S. Department of Agriculture 2008) were used in identification of sandhills and other soil-dependent communities. These communities were often further divided by spectral signature (i.e. deciduous separated from evergreen). Topographic/landform models, especially a Topographic Relative Moisture Index (Parker 1982) were developed from the National Elevation Database (U.S. Geological Survey 2005), and applied to a variety of natural vegetation types across a moisture gradient (mesic to xeric), and were thus used to identify Ecological Systems such as Southern Piedmont Mesic Forest and the Dry Oak-Pine types. Blackwater vs. brownwater streams were delineated using a simple rule: those with origins on the Piedmont physiographic province were called “brownwater”, as those stream-types invariably carry a high sediment load of suspended clays, while those originating on the Coastal Plain do not, and instead are often stained with tannins from decomposed organic matter (Wharton 1978). Other Ecological Systems, especially non-riverine wetlands, were identified using aerial photographs and manually classified by their position in the landscape or other factors.

Results:

The Fort Gordon Ecological Systems map is shown in Figure 9 and classifications and their acreages and relative coverages are given in Table 3.

Class	Acres	Percent
Open water	3320.27	1.10
Developed open space	37663.18	12.46
Low intensity developed	23829.23	7.88
Medium intensity developed	7406.81	2.45
High intensity developed	3572.58	1.18
Successional shrub/scrub (clearcut)	6927.53	2.29
Unconsolidated shore (lake/river/pond)	7.34	0.00
Quarry/strip mine/gravel pit	2482.42	0.82

Evergreen plantations	32780.36	10.85
Successional shrub/scrub (other)	5320.75	1.76
Grassland/herbaceous (other)	29730.85	9.84
Pasture/hay	14093.60	4.66
Row crop	19650.88	6.50
Utility swath	1507.86	0.50
Southern Piedmont dry oak-(pine) forest - hardwood modifier	10060.85	3.33
Southern Piedmont dry oak-(pine) forest - loblolly pine modifier	3860.24	1.28
Southern Piedmont dry oak-(pine) forest - mixed modifier	2428.41	0.80
Southern Piedmont mesic forest	2003.81	0.66
Atlantic Coastal Plain blackwater stream floodplain forest	33401.91	11.05
Atlantic Coastal Plain brownwater stream floodplain forest	1970.47	0.65
Southern Coastal Plain nonriverine cypress dome	193.18	0.06
Atlantic Coastal Plain streamhead seepage swamp, pocosin, and baygall	505.07	0.17
Atlantic Coastal Plain Fall Line sandhills longleaf pine woodland - barren modifier	379.91	0.13
Atlantic Coastal Plain Fall Line sandhills longleaf pine woodland - herbaceous modifier	8683.70	2.87
Atlantic Coastal Plain Fall Line sandhills longleaf pine woodland - deciduous modifier	10904.48	3.61
Atlantic Coastal Plain Fall Line sandhills longleaf pine woodland - evergreen modifier	10799.78	3.57
Atlantic Coastal Plain Fall Line sandhills longleaf pine woodland - mixed modifier	1734.83	0.57
Atlantic Coastal Plain depression pondshore	688.69	0.23
Atlantic Coastal Plain nonriverine swamp	189.18	0.06
Atlantic Coastal Plain dry and dry-mesic oak forest - deciduous modifier	13096.58	4.33
Atlantic Coastal Plain dry and dry-mesic oak forest - evergreen modifier	7607.33	2.52
Atlantic Coastal Plain dry and dry-mesic oak forest - mixed modifier	5414.78	1.79
Total	302216.85	100

Table 3. Vegetation/land cover classes for Fort Gordon and vicinity, 2005.

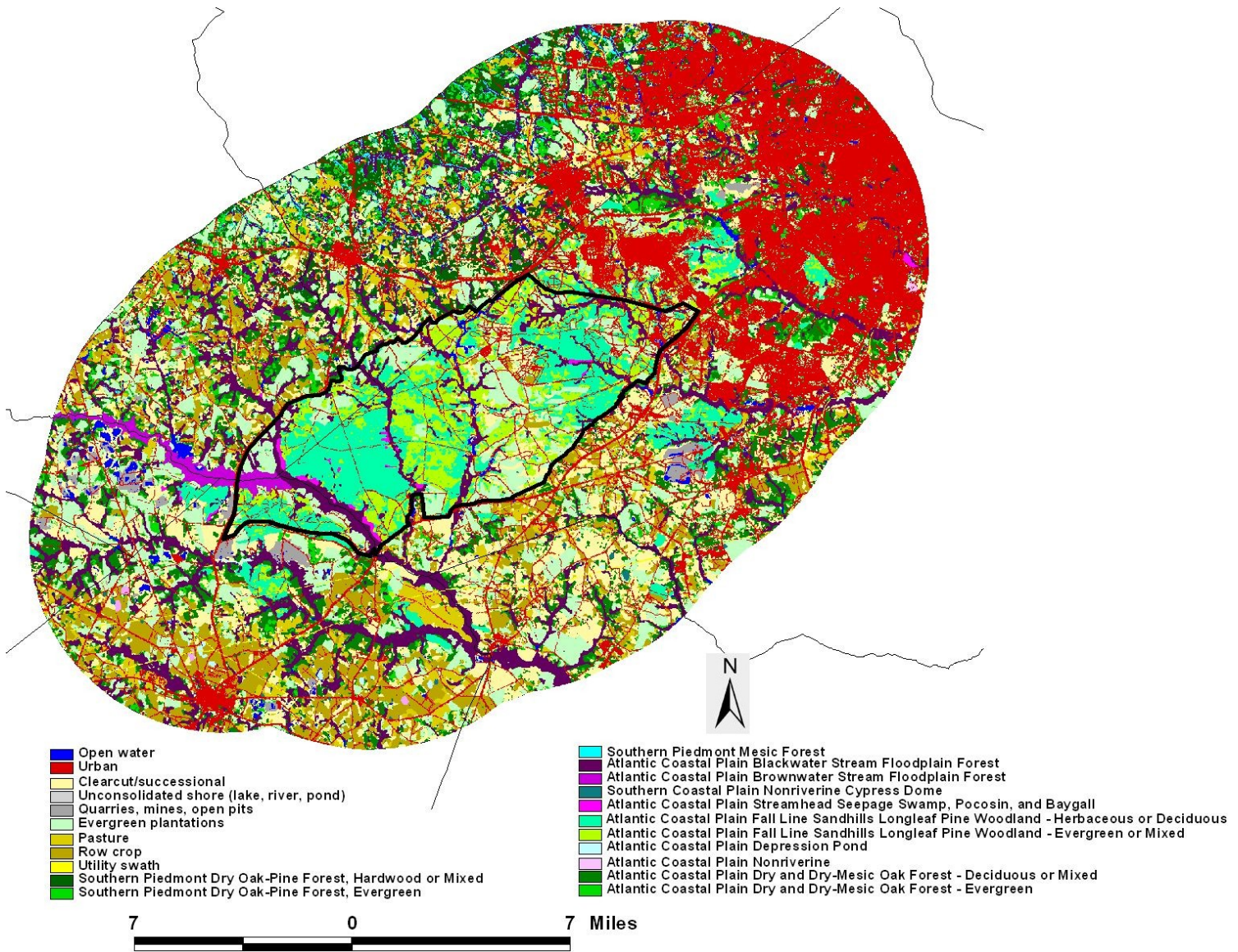


Figure 9. Ecological Systems map for Fort Gordon and vicinity, 2005. Some classes from the original legend have been collapsed for simplicity in display.

Nearly 62% of the Fort Gordon vicinity is classified as possessing an anthropogenic landcover type (urban, agriculture, intensive silviculture, quarries) in this map; 38% is classified as “natural vegetation” (Elliott and Kramer 2005). 24% of the Fort Gordon vicinity is actually classified as some type of urban landcover, reflecting the landscape dominance of the Augusta metropolitan area which lies mainly to the northeast of the Army base.. On the base itself, the percent of anthropogenic landcover classes and developed land is much lower – 30% and 9%, respectively.

Following is a discussion of the “natural vegetation” types of the Fort Gordon vicinity – the Ecological Systems.

Southern Piedmont Dry Oak-(Pine) Forest (CES202.339)

Description from Comer et al. (2003): “This system encompasses the prevailing upland forests of the southern Piedmont. High-quality and historic examples are typically dominated by combinations of upland oaks, sometimes with pines as a significant component, especially in the southern portions of the region. These forests occur in a variety of habitats and, under natural conditions, were the matrix vegetation type covering most of the landscape. Much of this system is currently composed of successional forests that have arisen after repeated cutting, clearing, and cultivation of original oak-hickory forests.”

These forests cover around 16,000 acres, or 5.4% of the Fort Gordon vicinity, mainly north of the base itself. This Ecological System is not represented on the base itself. The loblolly pine modifier indicates an ecosystem in an earlier successional state

Southern Piedmont Mesic Forest (CES202.342)

Description from Comer et al. (2003): “This system encompasses mixed deciduous hardwood or occasionally hardwood-pine forests of mesic sites in the Piedmont (TNC Ecoregion 52) of the southeastern United States. Most examples occur on lower or north-facing slopes where topography creates mesic moisture conditions. A mix of a small number of mesophytic trees is usually dominant, with *Fagus grandifolia* most prominent. Both acidic and basic substrates are currently included in this concept, as are certain heath bluffs, where dense shrub layers of mesophytic ericaceous shrubs may occur beneath an open tree canopy. Fire is naturally infrequent in this system, due to the slopes and moist conditions. If fire does penetrate, it is likely to be low in intensity and may not have significant ecological effects.”

These forests cover just over 2000 acres, or 0.7% of the Fort Gordon vicinity, mainly north of the base. A very small area, less than an acre, was actually mapped on Fort Gordon itself.

Atlanta Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system, which is apparently most abundant in the Carolinas, occurs in floodplains of small streams that carry little mineral sediment (blackwater streams). These streams have their headwaters in sandy portions of the Coastal Plain. The water is usually strongly stained by tannins but has little suspended clay and is not turbid. Depositional landforms may be absent or present only in limited variety and of small size. Soils are usually strongly acidic. Periodicity of flooding ranges from long (semi-permanent) in the wettest portions to short in higher gradient streams. Some small blackwater streams have most of their flow from sandhill seepage and have limited fluctuation in water levels. Vegetation varies from north to south, but generally consists almost entirely of forests of wetland trees, but occasional, small shrubby sloughs may also be present. A variety of tree species may be present; wetter examples (especially toward the northern range limits of this system) are often strongly dominated by *Taxodium distichum* and *Nyssa biflora*. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods tolerant of blackwater conditions. Species richness ranges from low to moderate, but is lower than in comparable brownwater systems. Flooding

is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This Ecological System covers around 33,400 acres, or about 11.1% of the Fort Gordon vicinity, and just under 5000 acres, or 11.3% of the base itself. The most significant stands mapped are along Brier Creek and several smaller streams, especially Reedy Creek, which is to the south of Fort Gordon, and Headstall Creek, Sandy Run Creek, Boggy Gut Creek, and Spirit Creek, all of which flow through the base itself.

Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system ranges from the Inner Coastal Plain of Maryland, to the Outer Coastal Plain of southeastern Virginia to Georgia on floodplains of smaller streams that carry significant mineral sediment (brownwater or redwater streams). These streams have their headwaters in the Piedmont, Blue Ridge, or other interior regions, or in portions of the Coastal Plain where fine-textured sediment predominates. The water generally carries substantial amounts of silt and clay. Depositional landforms, at least a natural levee, are often distinctly present but are fairly small relative to the scale of communities but help create some variation in duration of flooding and nutrient input. Soils are generally fertile and not strongly acidic. Flooding is generally seasonal, but may range to nearly semi-permanent. Vegetation consists almost entirely of forests of wetland trees. Wetter examples are strongly dominated by *Taxodium distichum* and *Nyssa* spp. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods. Except in the very wet examples, understory, shrub, and herb layers are generally well-developed and woody vines are also prominent. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This ecological system covers around 1970 acres, or about 0.7% of the Fort Gordon vicinity, and about 540 acres, 1.2% of the base itself. All of this Ecological System is found along Brier Creek and Little Brier Creek at the Fall Line, where they still carrying significant suspended clays from the Piedmont.

Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)

Description from Comer et al. (2003): : This system consists of small forested wetlands, typically dominated by *Taxodium ascendens*, with a characteristic and unique dome-shaped appearance in which trees in the center are higher than those around the sides (Monk and Brown 1965). Examples are known from the Southern Coastal Plain (Omernik Ecoregion 75) (EPA 2004) of Florida and Georgia. Examples occupy poorly drained depressions which are most often embedded in a matrix of pine flatwoods. The oldest and largest individual trees typically occupy the center of these domed wetlands, with smaller and younger individuals around the margins. Pools of stagnant, highly acidic water may stand in the center of these depressions ranging from 1-4 feet in depth, but becoming increasingly shallow along the

margins. These sites are underlain by an impervious clay pan which impedes drainage and traps precipitation. Some examples may have thick (50-100 cm) organic layers. In addition to *Taxodium ascendens*, other woody species may include *Nyssa biflora*, *Cephalanthus occidentalis*, *Liquidambar styraciflua*, *Clethra alnifolia*, *Lyonia lucida*, and *Styrax americanus*.

This Ecological System is uncommon in the Fort Gordon vicinity, covering only 193 acres, and just 15 acres on the base itself. Ponds that could fall into this category are in the southern sector of the mapping area, in far southern Richmond, Burke, and Jefferson Counties. One of these ponds was visited during the second phase of this project (see Appendix A), and was found to be incorrectly mapped. It is probably unlikely that the System actually occurs this high on the Southeastern Plains ecoregion.

Atlantic Coastal Plain Streamhead Seepage Swamp, Pocosin, and Baygall (CES203.252)

Description from Comer et al. (2003): “This system encompasses seepage-fed wetlands in dissected Coastal Plain landscapes, from southeastern Virginia to northeastern Florida. Examples are usually associated with ravines or along headwater streams. Overbank flooding is a negligible influence. Fire may be an important force in some associations and not in others. Vegetation consists of open to closed forest of acid-tolerant wetland hardwoods or pine. Generally there is a dense shrub layer consisting primarily of species shared with Atlantic Coastal Plain Peatland Pocosin (CES203.267).”

This Ecological System as mapped covers approximately 500 acres in the vicinity of Fort Gordon, 371 of them on the base itself. It most often occurs on the lower slopes of sandhills as they transition into wetlands.

Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)

Description from Comer et al. (2003): “This system occurs in the Fall-line Sandhills region of central North Carolina extending into central Georgia. It is the predominant system in its range, covering most of the natural landscape of the region. It occurs on upland sites ranging from gently rolling, broad ridgetops to steeper side slopes, as well as locally in mesic swales and terraces. Most soils are well- to excessively drained. The vegetation is naturally dominated by longleaf pine (*Pinus palustris*). Most associations have an understory of scrub oaks (*Quercus laevis*, *Quercus marilandica*, *Quercus incana*, and *Quercus margarettiae*). The herb layer is generally well-developed and dominated by grasses. Wiregrass (*Aristida stricta* in the north, *Aristida beyrichiana* in the south) dominates in most of the range, but other grasses dominate where it is absent. Forbs, including many legumes, are also abundant. Frequent, low-intensity fire is the dominant natural ecological force.”

This Ecological System is the dominant upland type in the Fort Gordon vicinity, covering around 32,500 acres as mapped, 10.75% of the area, and 24,500 acres, 55.8%, of the base itself. The various modifiers applied to this Ecological System may reflect the removal of longleaf pine or, on the Army base, use as a range.

Atlantic Coastal Plain Depression Pondshore (CES203.262)

Description from Comer et al. (2003): “This system consists of wetlands in small basins formed in unconsolidated sediments of the Atlantic Coastal Plain, from southeastern Virginia to Florida. Most basins are formed by subsidence of surface sediments caused by solution in underlying limestone. Others may be formed as swales in mainland eolian sands, natural blockage of small drainages by sediment movement, and more obscure causes. Soils are generally sandy, with mucky surfaces in the wettest areas. Vegetation is often zonal in response to variation in duration of flooding in different parts of the depression pond. Vegetation usually ranges from open water or floating-leaved aquatics in the center of the deepest basins, to emergent marsh zones in semi-permanent water, to drawdown zones with diverse small graminoid and forb vegetation, to dense shrub or woodland edges. A smaller number of basins may have emergent trees throughout their extent. Hydroperiod can vary substantially from year to year, and vegetation can similarly vary significantly in aspect and dominants. Besides flooding and its variation, fire is an important natural force in the outer drier portions.”

This small patch Ecological System covers just under 700 acres of the Fort Gordon mapping area, and only 47 acres on the base itself. Significant natural ponds are found in northern Burke and Jefferson Counties, and, on Fort Gordon, near Taylor Cemetery in the south-central portion of the base.

Atlantic Coastal Plain Nonriverine Swamp (CES203.304)

Description from Comer et al. (2003): This system consists of poorly drained, organic or mineral soil flats of the outer Atlantic Coastal Plain. These areas are saturated by rainfall and seasonal high water table without influence of river or tidal flooding. Fire is generally infrequent, but may be important for some associations. Vegetation consists of hardwood or mixed forests of *Taxodium distichum*, *Nyssa* spp., bottomland oaks, or other wetland trees of similar tolerance. The lower strata have affinities with pocosin or baygall systems rather than the river floodplain systems that have affinities with the canopy. The combination of canopy dominants and nonriverine, non-seepage hydrology distinguishes this system from other Coastal Plain systems.

As mapped, this Ecological System covers 189 acres in the Fort Gordon vicinity, four natural ponds all off-post in northern Jefferson County. However, a visit to one of them during the second phase of this project indicated that perhaps they would be more properly categorized as Atlantic Coastal Plain Depression Pondshore.

Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241)

Description from Comer et al. (2003): This system encompasses oak-dominated forests of somewhat fire-sheltered dry to dry-mesic sites in the Mid-Atlantic and South Atlantic Coastal Plain. Sites where this system occurs are somewhat protected from most natural fires by a combination of steep topography and by limited flammability of the vegetation. If fires were

more frequent, the vegetation would likely be replaced by more tolerant southern pines especially *Pinus palustris*.

This Ecological System is mapped as covering over 26,000 acres in the Fort Gordon vicinity, 8.6% of the total area, but only 130 acres on the base itself. This may be a reflection of the last sentence in the Comer et al. (2003) description, as prescribed fire is frequently used on Fort Gordon, but not elsewhere in the vicinity. At any rate, most stands are located off-post in the transition zone between uplands and wetlands.

Fort Stewart

Background:

For the purposes of this project, the Fort Stewart vicinity includes all of the Army base as well as a 10km buffer, a total area of just over 700,000 acres. The base itself is just to the southwest of the Savannah, GA metropolitan and just to the north of Hinesville, GA, is approximately 267,000 acres, and contains portions of five counties: Tattnall, Evans, Bryan, Liberty, and Long. The majority of Fort Stewart lies within the Southern Coastal Plain ecoregion, although some higher areas to the west are within the Southeastern Plains ecoregion (Griffith et al. 2001). Adjoining counties within the mapping buffer zone include Bulloch, Jefferson, and Chatham. Aside from some areas of suburban sprawl to the southwest of Savannah and around Hinesville and Richmond Hill, this is still a largely rural area, though population has been on the increase (U.S. Census Bureau 2001), and sprawl can be expected to be an ever-increasing threat in the area. Much of the Southern Coastal Plain ecoregion is presently dominated by large industrial tree farms, though the largest forest industry companies have divested many holdings in the last ten years. This ecoregion is very low-lying and contains many wetlands, many of them marine-influenced. Two large blackwater rivers, the Ogeechee and Canoochee, drain much of the area, and contain very xeric aeolian sandhills, home to many rare species, adjacent to their floodplains. The Southeastern Plains is rolling terrain, generally containing a rural mix of agriculture, tree farms, and wetlands. The dominant natural upland vegetation type in most of the Southeastern Plains was longleaf pine-wiregrass, and in the Southern Coastal Plain was longleaf/slash pine savanna, both of which are now comparatively rare (Kramer et al. 2003). Fort Stewart contains an abundance of both, and as such is an ecological reserve of national importance.

Methods:

SSURGO soil maps (U.S. Department of Agriculture 2008) were used in identification of sandhills and other soil-dependent communities. These communities were often further divided by spectral signature (i.e. deciduous separated from evergreen). Topographic/landform models, especially a Topographic Relative Moisture Index (Parker 1982) were developed from the National Elevation Database (U.S. Geological Survey 2005), and applied to a variety of natural vegetation types across a moisture gradient (mesic to xeric). However, in the low-lying, extremely flat environment of Fort Stewart, very small changes in elevation may create substantial shifts in vegetation, and moisture indices sometimes did not provide adequate differentiation between, for example, upland longleaf pine and longleaf pine flatwoods. In these areas, community boundaries were often hand-

digitized using a combination of topographic and soil maps. Extensive use was also made of stand maps provided by Natural Resources staff at Fort Stewart – these were often key in determining whether longleaf or slash pine was found in a particular area. Other Ecological Systems, especially non-riverine wetlands, were identified using aerial photographs and manually classified by their position in the landscape or other factors.

Results:

The Fort Stewart Ecological Systems map is shown in Figure 10 and classifications and their acreages and relative coverages are given in Table 4.

Class	Acres	Percent
Exposed soil	1.56	0.00
Open water	5817.81	0.83
Developed open space	35329.25	5.04
Low intensity developed	15118.85	2.16
Medium intensity developed	4991.30	0.71
High intensity developed	1539.21	0.22
Successional shrub/scrub (clearcut)	46891.30	6.68
Unconsolidated shore (lake/river/pond)	79.14	0.01
Quarry/strip mine/gravel pit	85572.38	12.20
Evergreen plantations	10397.42	1.48
Successional shrub/scrub (other)	11912.61	1.70
Grassland/herbaceous (other)	177.40	0.03
Pasture/hay	11467.79	1.63
Row crop	64744.43	9.23
Utility swath	1083.49	0.15
Atlantic Coastal Plain Southern Tidal Wooded Swamp	10610.16	1.51
Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest	89.81	0.01
Atlantic Coastal Plain Clay-Based Carolina Bay Wetland	952.33	0.14
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	174091.58	24.82
Atlantic Coastal Plain Small Blackwater River Floodplain Forest	11763.67	1.68
Southern Coastal Plain Nonriverine Cypress Dome	2942.81	0.42
Atlantic Coastal Plain Southern Depression Pondshore	8989.81	1.28
Atlantic Coastal Plain Upland Longleaf Pine Woodland- deciduous phase	10492.56	1.50
Atlantic Coastal Plain Upland Longleaf Pine Woodland- longleaf phase	18189.25	2.59
Atlantic Coastal Plain Upland Longleaf Pine Woodland- longleaf mixed phase	136.94	0.02
Atlantic Coastal Plain Upland Longleaf Pine Woodland- loblolly/slash phase	8661.25	1.23
Atlantic Coastal Plain Upland Longleaf Pine Woodland- loblolly/slash mixed phase	3491.22	0.50
Atlantic Coastal Plain Upland Longleaf Pine Woodland- sandhill phase	2842.55	0.41
Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh	9283.47	1.32
Southern Coastal Plain Mesic Slope Forest	110.26	0.02
Southern Coastal Plain Oak Dome and Hammock	1983.14	0.28
Atlantic Coastal Plain Xeric River Dune	9518.00	1.36
Southern Coastal Plain Seepage Swamp and Baygall	2749.18	0.39
Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods	128239.31	18.28
Atlantic Coastal Plain Southern Maritime Forest	1249.33	0.18
Total	701510.55	100.00

Table 4. Vegetation/land cover classes for Fort Stewart and vicinity, 2005.

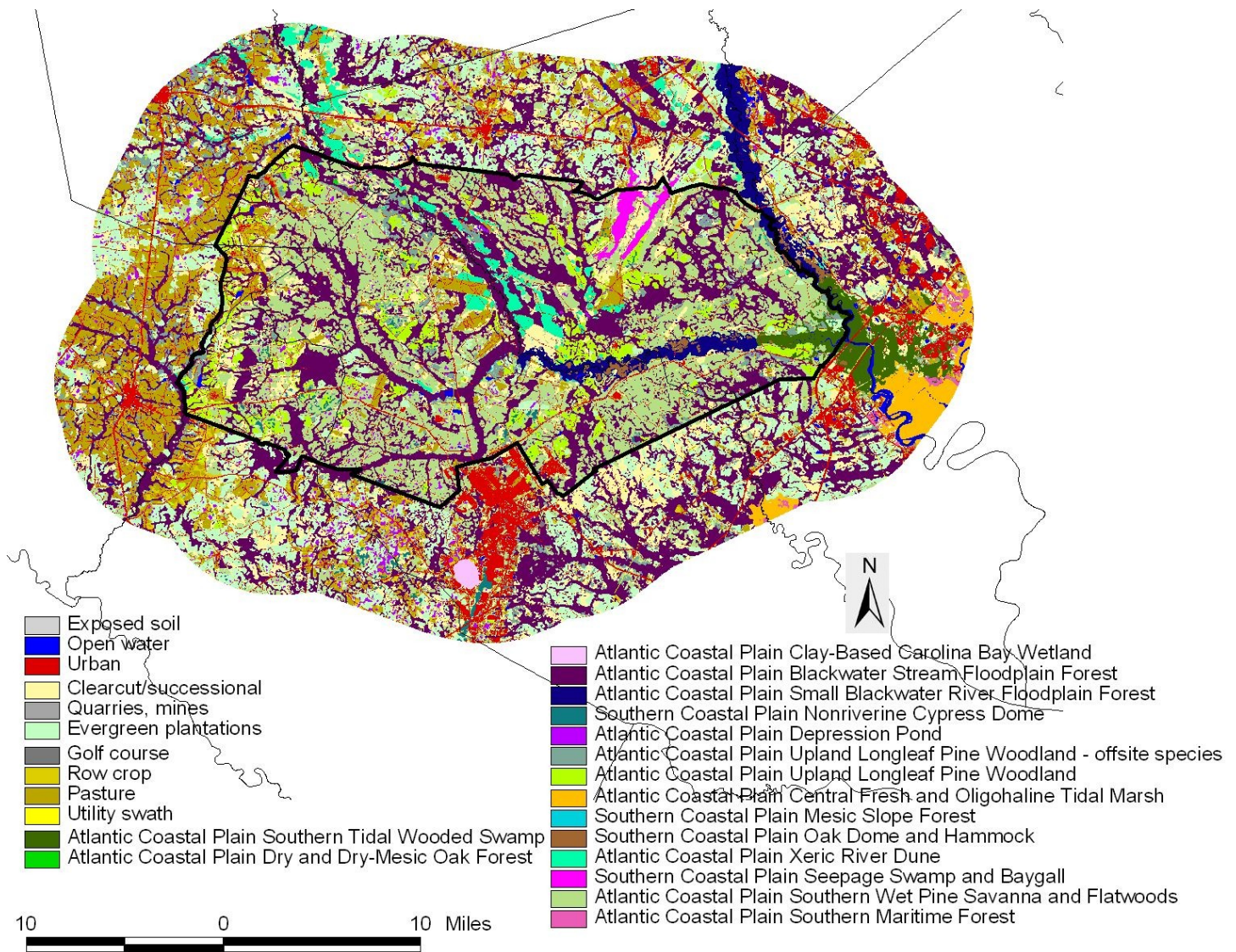


Figure 10. Ecological Systems map for Fort Stewart and vicinity, 2005.

In contrast to Fort Gordon, only 8.2% of the Fort Stewart vicinity is developed (urban cover type), and only 4.5% of the base itself. 58% of the Stewart vicinity is in a “natural vegetation” type (Elliott and Kramer 2005), including 82% of the Army base itself.

Following is a discussion of the “natural vegetation” types of the Fort Stewart vicinity – the Ecological Systems.

Atlantic Coastal Plain Southern Tidal Wooded Swamp (CES203.240)

Description from Comer et al. (2003): This system encompasses the tidally flooded areas in lower river floodplains and edges of estuaries of the Atlantic Coastal Plain from southeastern Virginia southward to northern Florida that have sufficiently fresh water and short enough flooding to be able to support tree canopies. *Taxodium*, *Nyssa*, or *Fraxinus* generally dominate. Swamps may be either regularly flooded by lunar tides or irregularly flooded by wind tides.

This Ecological System covers over 10,600 of the mapped Fort Stewart vicinity, or 1.5% of the total acreage, and just over 2800 acres on the base itself, around 1% of the total. It is found along the Ogeechee and Canoochee Rivers, and Clyde Creek, and adjacent to tidewater areas east of the base in Chatham and Bryan Counties. Substantial off-post acreages are protected by a conservation easement along the Ogeechee just to the east of the base.

Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241)

Description from Comer et al. (2003): “This system encompasses oak-dominated forests of somewhat fire-sheltered dry to dry-mesic sites in the Mid-Atlantic and South Atlantic Coastal Plain. Sites where this system occurs are somewhat protected from most natural fires by a combination of steep topography and by limited flammability of the vegetation. If fires were more frequent, the vegetation would likely be replaced by more tolerant southern pines especially *Pinus palustris*.”

This Ecological System as mapped covers just 90 acres in the Fort Stewart vicinity, all on the base itself in the northeast quadrant on bluffs above the Canoochee River. However, during the second phase of this project three additional high quality examples were observed on other Canoochee- and Ogeechee-area bluffs, leading one to conclude that this System is likely under-represented on the Ecological Systems map.

Atlantic Coastal Plain Clay-Based Carolina Bay Wetland (CES203.245)

Description from Comer et al. (2003): “This system consists of wetlands associated with ovoid, shallow depressions with nearly flat bottoms in parts of the Atlantic Coastal Plain. Often called Carolina bays, these areas are most numerous and extensive in South Carolina but are also present in the Inner Coastal Plain of North Carolina. The depressions have mineral soils with clay hardpans that trap and retain water from a combination of rainfall and exposure of a high regional water table. Some examples are essentially permanently flooded, while others support water levels that vary substantially from year to year and over longer climatic cycles. Vegetation includes a series of primarily herbaceous and woodland associations. The wettest sites have open water and floating-leaved aquatic vegetation, or marsh vegetation of tall graminoids. Drier sites often have an open canopy of *Taxodium ascendens*, with a dense, often fairly species-rich herbaceous layer beneath. A few occurrences are shrubby, but none contain the dense shrub layers of characteristic pocosin species that occur in the bays with organic soils. Vegetation composition often varies substantially from year to year, in response to differences in water levels and drawdown times. Variation in hydroperiod is the most important dynamic, causing rapid major changes in the herbaceous vegetation. Unlike the steeper-sided solution depressions, where many

different hydroperiods are present within a short distance and vegetation zones simply shift, the flat-bottomed Carolina bays experience drastic yearly changes in hydroperiod over most of their extent. Fire periodically spreads into the bays from adjacent uplands when conditions are dry, helps prevent invasion by less water-tolerant trees during dry periods, and interacts with flooding to affect vegetation composition. Where fire is removed, *Pinus taeda* often invades the bays. Fire may also be important in preventing buildup of organic matter on the soil surface.”

This Ecological System covers 952 acres in the Fort Stewart vicinity, all off-post in a large wetland near Hinesville known as Terrell’s Millpond.

Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system, which is apparently most abundant in the Carolinas, occurs in floodplains of small streams that carry little mineral sediment (blackwater streams). These streams have their headwaters in sandy portions of the Coastal Plain. The water is usually strongly stained by tannins but has little suspended clay and is not turbid. Depositional landforms may be absent or present only in limited variety and of small size. Soils are usually strongly acidic. Periodicity of flooding ranges from long (semi-permanent) in the wettest portions to short in higher gradient streams. Some small blackwater streams have most of their flow from sandhill seepage and have limited fluctuation in water levels. Vegetation varies from north to south, but generally consists almost entirely of forests of wetland trees, but occasional, small shrubby sloughs may also be present. A variety of tree species may be present; wetter examples (especially toward the northern range limits of this system) are often strongly dominated by *Taxodium distichum* and *Nyssa biflora*. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods tolerant of blackwater conditions. Species richness ranges from low to moderate, but is lower than in comparable brownwater systems. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This Ecological System is the most widespread landcover-type in the Fort Stewart vicinity, covering over 174,000 acres, nearly 25% of the entire area, and just under 74,000 acres on the base itself, almost 28% of that area. Virtually every stream in the mapping has a floodplain with this forest type.

Atlantic Coastal Plain Small Blackwater River Floodplain Forest (CES203.249)

Description from Comer et al. (2003): “This system encompasses the floodplains of small to medium blackwater rivers, intermediate between the smaller streams and the largest rivers. Blackwater rivers originate in the sandy areas of the Coastal Plain and have less well-developed depositional alluvial landforms. Soils are sandy or mucky, acidic, and infertile. Vegetation is a mosaic of cypress and gum swamps and bottomland hardwoods of a limited set of oaks and other species. In general vegetation is low in species richness.”

This Ecological System covers around 11,700 acres in the Fort Stewart vicinity, or 1.7% of the mapping area, and 5742 acres on the base itself, 2.2% of the area. It is restricted to the two largest rivers above tidewater: the Ogeechee and the Canoochee below its confluence with Canoochee Creek.

Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)

Description from Comer et al. (2003): “This system consists of small forested wetlands, typically dominated by *Taxodium ascendens*, with a characteristic and unique dome-shaped appearance in which trees in the center are higher than those around the sides (Monk and Brown 1965). Examples are known from the Southern Coastal Plain (Omernik Ecoregion 75) (EPA 2004) of Florida and Georgia. Examples occupy poorly drained depressions which are most often embedded in a matrix of pine flatwoods. The oldest and largest individual trees typically occupy the center of these domed wetlands, with smaller and younger individuals around the margins. Pools of stagnant, highly acidic water may stand in the center of these depressions ranging from 1-4 feet in depth, but becoming increasingly shallow along the margins. These sites are underlain by an impervious clay pan which impedes drainage and traps precipitation. Some examples may have thick (50-100 cm) organic layers. In addition to *Taxodium ascendens*, other woody species may include *Nyssa biflora*, *Cephalanthus occidentalis*, *Liquidambar styraciflua*, *Clethra alnifolia*, *Lyonia lucida*, and *Styrax americanus*.”

This small patch Ecological System covers over 2900 acres in the Fort Stewart mapping region, and over 1700 acres on the base itself. It is generally found in the southern portion of the mapping area, with notable concentrations in the southwestern portion of the Army base, and both on and off-post in the vicinity of Hinesville and Walthourville.

Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)

Description from Comer et al. (2003): “This system consists of wetlands in small basins formed in unconsolidated sediments of the Atlantic Coastal Plain, from southeastern Virginia to Florida. Most basins are formed by subsidence of surface sediments caused by solution in underlying limestone. Others may be formed as swales in mainland eolian sands, natural blockage of small drainages by sediment movement, and more obscure causes. Soils are generally sandy, with mucky surfaces in the wettest areas. Vegetation is often zonal in response to variation in duration of flooding in different parts of the depression pond. Vegetation usually ranges from open water or floating-leaved aquatics in the center of the deepest basins, to emergent marsh zones in semi-permanent water, to drawdown zones with diverse small graminoid and forb vegetation, to dense shrub or woodland edges. A smaller number of basins may have emergent trees throughout their extent. Hydroperiod can vary substantially from year to year, and vegetation can similarly vary significantly in aspect and dominants. Besides flooding and its variation, fire is an important natural force in the outer drier portions.”

This small patch Ecological System covers nearly 9000 acres in the Fort Stewart vicinity, 1.3% of the total area, and 2300 acres and 0.9% of the base itself. As noted, this System

occurs in very small patches, so the fact that it covers 9000 acres in the mapping area means that is actually quite prevalent. It is common throughout most of the mapping area, though a particularly notable concentration occurs along the Liberty/Long County line just to the south of the Army base.

Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)

Description from Comer et al. (2003): “This system of upland *Pinus palustris*-dominated vegetation ranges from southern Virginia (beginning approximately at the James River) to northeastern Florida (excluding longleaf pine of the Fall-Line Sandhills, accommodated by another ecological system), where it was once perhaps the most extensive system in the Outer Coastal Plain within its range. Examples and associations share the common feature of upland (non-wetland) moisture regimes and natural exposure to frequent fire. They occur on a variety of well- to excessively drained soils, and on the higher parts of upland-wetland mosaics. The vegetation is naturally dominated by *Pinus palustris*. Most associations have an understory of scrub oaks. The herb layer is generally well-developed and dominated by grasses. *Aristida stricta* primarily dominates in the northern part of its range, and *Aristida beyrichiana* in the southern part. Frequent, low-intensity fire is the dominant natural ecological force.”

This Ecological System covers a total of nearly 44,000 acres in the Fort Stewart vicinity, 6.25% of the land area, and around 28,500 acres, 10.7% of the total, on the base itself. Off-site species (i.e. loblolly pine, slash pine, hardwoods) dominate 9000 acres (32%) of the on-post coverage, and 14,000 (85%) of the off-post total, indicative of both the use of prescribed fire on the Army base and its lack of use off-post. Historically, this vegetation type would have dominated uplands in most of the mapping area; current acreages represent but a fraction of what once would have been found in this area (Georgia Department of Natural Resources 2005).

Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376)

Description from Comer et al. (2003): This system represents tidally influenced fresh marsh and tidal shrublands ranging from approximately Morehead City, NC, southward to St. Johns River, FL [see Montague and Wiegert (1990)]. This system occurs where there is adequate river flow and discharge to maintain fresh to oligohaline conditions, while still within tidal range. These marshes most often occur well inside the mouths of tidal creeks and rivers. Elevation differences within the marsh correspond to the occurrence of different vegetation types.

This Ecological System covers over 9800 acres (1.3%) of the Fort Stewart mapping area, nearly all of which is found to the east of the base in the tidal reaches of the Ogeechee, Little Ogeechee and Jerico Rivers.

Southern Coastal Plain Mesic Slope Forest (CES203.476)

Description from Comer et al. (2003): “This forested system of the southern East Gulf and Atlantic Coastal Plains occurs on steep slopes, bluffs, or sheltered ravines where fire is naturally rare, generally within the natural range of *Pinus glabra* as mapped by Kossuth and Michael (1990) and *Magnolia grandiflora* as mapped by Outcalt (1990). Stands are mesic, and vegetation typically includes species such as *Fagus grandifolia*, *Magnolia grandiflora*, *Illicium floridanum*, and other species rarely encountered outside this system in the region. Related forests which occur on deep loess soils along the western margin of the region are classified as ~East Gulf Coastal Plain Southern Loess Bluff Forest (CES203.556). Some component associations are also found in temporarily flooded floodplains adjacent to these slopes, but this is primarily an upland system. The system also includes essentially upland vegetation of Pleistocene terraces, although these are conceptually transitional to creek floodplain systems.”

This Ecological System as mapped covers 110 acres in the Fort Stewart vicinity, all on the Army base on steep north-facing slopes near the confluence of the Canoochee River and Canoochee Creek. It is possible that it also occurs under similar conditions along the Ogeechee, but this was not observed.

Southern Coastal Plain Oak Dome and Hammock (CES203.494)

Description from Comer et al. (2003): “This small-patch system occurs in the Southern Coastal Plain (Omernik ecoregion 75). Examples are known from inland portions of this region including parts of the East Gulf Coastal Plain (TNC ecoregion 53) and Florida peninsula (TNC ecoregion 55), and nearby portions of the South Atlantic Coastal Plain (TNC ecoregion 56). Thick stands of *Quercus virginiana* and/or *Quercus geminata* are diagnostic of this system. Examples often occupy locally distinct microhabitats that differ from the surrounding landscape, such as shallow depressions or slight topographic highs in a predominantly longleaf pine-dominated landscape. Although embedded in a matrix of vegetation with extremely frequent fire regimes, patches of this system are subject to only infrequent or rare fire events. Under more frequent fire regimes, these sites would likely be occupied by longleaf pine. It has been postulated that winter burning regimes have allowed this type to expand. A range of soil and moisture conditions may be present. More mesic examples have relatively thin soils (to 50 cm) above clay, while xeric examples occupy deep (>130 cm) well-drained sands. Dominant plant taxa of mesic examples are *Quercus virginiana* and *Quercus hemisphaerica*, along with *Diospyros virginiana*. *Campsis radicans* and *Smilax* spp. dominate the sparse ground cover. In xeric examples, dominants include *Quercus geminata*, *Pinus palustris*, *Quercus virginiana*, *Aristida stricta*, and *Stylisma humistrata*. This system is low in plant species diversity compared to most other habitats in the region.”

This Ecological System covers just under 2000 acres in the Fort Stewart vicinity, of which 1360 are mapped as occurring on the base itself. They occupy isolated sandy hills within the fire shadow floodplains of the Ogeechee and Canoochee Rivers.

Atlantic Coastal Plain Xeric River Dune (CES203.497)

Description from Comer et al. (2003): “This system encompasses a range of vegetation present on inland sand dunes of the Coastal Plain of Georgia. These dunes are associated with certain rivers such as the Ochopee (Wharton 1978) and are apparently eolian in origin formed of riverine alluvial sands. The sandy soils are deep, coarse, and xeric in nature. The vegetation consists of an assemblage of xeric communities that also occur in other xeric habitats in the Coastal Plain. These include *Pinus palustris* - *Quercus laevis* communities and a scrub community akin to Inland Florida Scrub. This system is distinguished from more typical xeric sandhills of the Coastal Plain by its occurrence on river dunes. In addition this environment is naturally topographically isolated and consequently has a lower fire-return interval than other upland system of which *Pinus palustris* is a component.”

This Ecological System occurs on over 9500 acres (1.4%) of the Fort Stewart vicinity, and around 5200 acres (2%) of the base itself. As mapped it is restricted to Pleistocene sand dunes of aeolian origin adjacent to the Canoochee River and Canoochee Creek, but field work during the second phase of the project indicates that it also occurs along the Ogeechee River and Black Creek (an Ogeechee tributary).

Southern Coastal Plain Seepage Swamp and Baygall (CES203.505)

Description from Comer et al. (2003): “This wetland system consists of forested wetlands in acidic, seepage-influenced habitats of the East Gulf Coastal Plain, extending into central Florida. These are mostly evergreen forests generally found at the base of slopes or other habitats where seepage flow is concentrated. Resulting moisture conditions are saturated or even inundated. The vegetation is characterized by *Magnolia virginiana* and *Nyssa biflora*. Examples occur in the outer portions of the Coastal Plain within the range of *Persea palustris*, and where *Magnolia virginiana* is an important or even dominant species. To the north this system grades into ~East Gulf Coastal Plain Northern Seepage Swamp (CES203.554), where evergreen species are largely replaced by deciduous species in the canopy. Due to excessive wetness, these habitats are normally protected from fire except those which occur during extreme droughty periods. These environments are prone to long-duration standing water, and tend to occur on highly acidic, nutrient-poor soils.”

This Ecological System occurs on over 2700 acres, 0.4% of the total area, in the Fort Stewart vicinity, and over 2400 acres (0.9% of the total) on the base itself. As mapped, all of this acreage occurs in a seepage area along Malden Branch and a tributary in north-central Bryan County. However, it may occur in other areas also.

Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)

Description from Comer et al. (2003): “This system of pine-dominated savannas and/or flatwoods ranges from southern South Carolina to northeastern Florida where it was the former matrix system, centered in southeastern Georgia, near the coast. This general area has been referred to as the Longleaf Pine Wiregrass Savannas region (Platt 1999) and the Sea Island Flatwoods sub-Ecoregion (75f of Griffith et al. (2001, 2002)). Examples of this system and component community associations share the common features of wet, seasonally saturated, mineral soils and historic exposure to frequent low-intensity fire. They occur on a

wide range of soil textures, which is an important factor in distinguishing different associations. The vegetation is naturally dominated by *Pinus palustris* or, on wetter sites, *Pinus elliottii* or less commonly *Pinus serotina*. Understory conditions may be dramatically altered by fire frequency and seasonality. In natural condition (frequent fires, including a growing-season component) there tends to be a dense ground cover of herbs and low shrubs; grasses can dominate, but there is often a large diversity of other herbs and shrubs.”

This Ecological System occurs on over 128,000 acres in the Fort Stewart vicinity, 18.3% of the total land area; on the base itself, it occurs on over 94,000 acres (35.25%). It has the greatest aerial extent of any on-post landcover type. Historically this Ecological System would have also been dominant off-post in the Southern Coastal Plain ecoregion, but it has been largely replaced by industrial silviculture (Wharton 1978).

Atlantic Coastal Plain Southern Maritime Forest (CES203.537)

Description from Comer et al. (2003): “This system encompasses a range of woody vegetation present on stabilized upland dunes of barrier islands and near-coastal strands, from central South Carolina (approximately Cooper River) southward to approximately Volusia County, Florida. It includes vegetation whose structure and composition are influenced by salt spray, extreme disturbance events, and the distinctive climate of the immediate coast. Examples are known from the barrier islands of Georgia and Florida, such as Big Talbot Island, Florida, and probably Sapelo Island, Georgia. Vegetation may include different woodland communities often dominated by southern pine species. *Pinus palustris*, *Pinus serotina*, and *Pinus elliottii* var. *elliottii* are all important in documented examples. These examples tend to have densely shrubby subcanopies and understories with species such as *Quercus virginiana*, *Quercus geminata*, *Quercus hemisphaerica*, *Quercus chapmanii*, *Quercus myrtifolia*, and *Magnolia grandiflora*. Unlike maritime vegetation to the north, this system may be more heavily influenced by natural fire regimes that may help to explain the predominance of the fire-tolerant pine species. It has been postulated that the natural fire frequency is from 20-30 years.”

This Ecological System does not occur on Fort Stewart itself, but is found on nearly 1250 acres in the broader mapping area. It occurs closer to the immediate coast, to the east of the base in Chatham, Bryan, and Liberty Counties.

Robins Air Force Base

Background:

For the purposes of this project, the Robins Air Force Base mapping area includes all of the Air Force Base as well as a buffer that extends out 10 km to the north and west, and approximately 20km to the east and 30km to the south. This 400,000 acre area was designed so as to include several areas of very high conservation priority to the State of Georgia - Oaky Woods and Ocmulgee Wildlife Management Areas, both managed by the Department of Natural Resources but held in a mix of lease/private ownership and State ownership. The mapping area contains portions of six counties: Houston, Peach, Bibb, Twiggs, Bleckley, and

Pulaski. The Air Force Base itself is located in Houston County and contains about 7000 acres.

The Robins landscape is dominated by two features: the Ocmulgee River and its vast bottomlands, and the suburban sprawl of the community of Warner Robins, and to an extent Macon as well. The base sits essentially in the middle of Warner Robins. Much of the rest of the area is covered by agriculture and industrial silviculture, although steep drainages and low-lying swamps are generally intact. To the south of the Air Force base there is an area of limestone bedrock that contains several unusual vegetation types and a host of rare species (Echols 2007). This is an extension/outlier of the Blackland Prairies that run in swath through central Alabama and Mississippi (Griffith et al. 2001, Echols 2007).

Methods:

SSURGO soil maps (U.S. Department of Agriculture 2008), in conjunction with aerial photographs (U.S. Department of Agriculture 2005) and Georgia Natural Heritage Program element occurrence data were used in identification of Blackland Prairies and other soil-dependent communities. Topographic/landform models, especially a Topographic Relative Moisture Index (Parker 1982) were developed from the National Elevation Database (U.S. Geological Survey 2005), and applied to a variety of natural vegetation types across a moisture gradient (mesic to xeric). Other Ecological Systems, especially non-riverine wetlands, were identified using aerial photographs and manually classified by their position in the landscape or other factors.

Results:

The Robins Air Force Base Ecological Systems map is shown in Figure 11 and classifications and their acreages and relative coverages are given in Table 5.

Class	Acres	Percent
Exposed soil	15.56	0.00
Open water	2996.38	0.75
Developed open space	19376.11	4.86
Low intensity developed	14232.54	3.57
Medium intensity developed	3577.92	0.90
High intensity developed	2273.02	0.57
Successional shrub/scrub (clearcut)	18696.10	4.69
Quarry/strip mine/gravel pit	2698.50	0.68
Evergreen plantations	76666.38	19.22
Successional shrub/scrub (other)	15864.22	3.98
Grassland/herbaceous (other)	8641.91	2.17
Golf course	674.46	0.17
Pasture/hay	7189.18	1.80
Row crop	77510.01	19.43
Utility swath	3468.10	0.87
Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest	1238.43	0.31
Atlantic Coastal Plain Mesic Hardwood Forest	13925.54	3.49
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	29731.74	7.45

Atlantic Coastal Plain Brownwater Stream Floodplain Forest	2103.62	0.53
Atlantic Coastal Plain Small Brownwater River Floodplain Forest	39066.34	9.79
Atlantic Coastal Plain Southern Depression Pondshore	2806.09	0.70
Atlantic Coastal Plain Upland Longleaf Pine Woodland- deciduous phase	23837.90	5.98
Atlantic Coastal Plain Upland Longleaf Pine Woodland- loblolly phase	29806.87	7.47
Atlantic Coastal Plain Upland Longleaf Pine Woodland- loblolly mixed phase	1806.41	0.45
Southern Coastal Plain Mesic Slope Forest	529.96	0.13
East Gulf Coastal Plain Black Belt Calcareous Prairie and Woodland	151.39	0.04
Totals	398884.67	

Table 5. Vegetation/land cover classes for Warner Robins Air Force Base and vicinity, 2005.

As of 2005, 9.9% of the Robins Air Force Base vicinity is developed (urban cover type); over 50% of the base itself has been developed. 36% of the Robins vicinity is in a “natural vegetation” type (Elliott and Kramer 2005); on the Air Force Base itself this figure is similar, 37%. The dominant anthropogenic cover types are evergreen tree plantations and row crop agriculture.

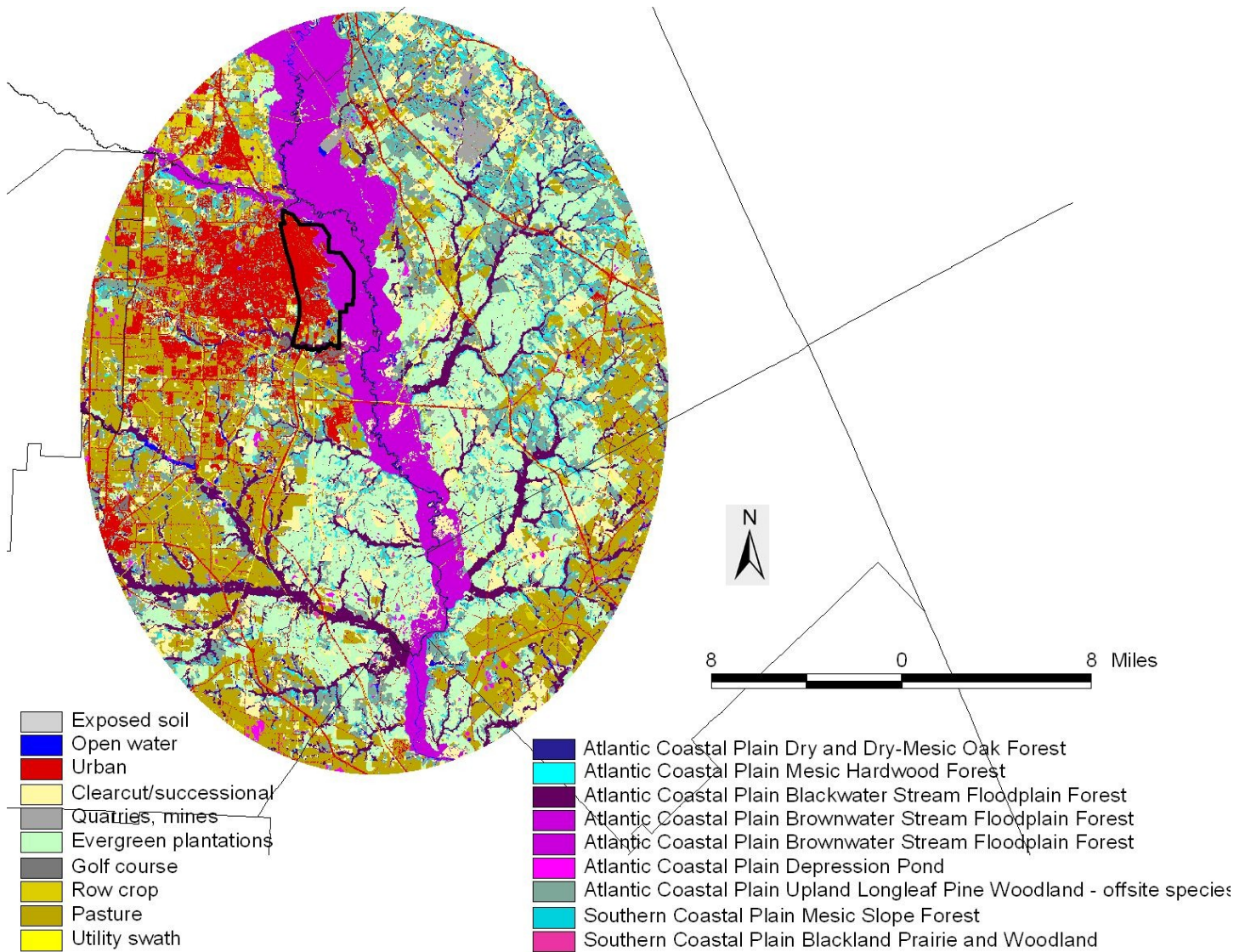


Figure 11. Ecological Systems map for Robins Air Force Base and vicinity, 2005.

Following is a discussion of the “natural vegetation” types of the Robins Air Force Base vicinity – the Ecological Systems.

Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241)

Description from Comer et al. (2003): “This system encompasses oak-dominated forests of somewhat fire-sheltered dry to dry-mesic sites in the Mid-Atlantic and South Atlantic Coastal Plain. Sites where this system occurs are somewhat protected from most natural fires by a combination of steep topography and by limited flammability of the vegetation. If fires were more frequent, the vegetation would likely be replaced by more tolerant southern pines especially *Pinus palustris*.”

This Ecological System covers over 1200 acres in the Robins vicinity, only 2 of which are on the base itself. During the second phase of this project, Tom Govus noted that this ecosystem was “rare in the landscape”. Most examples have likely been converted to other land uses (especially agriculture). There are several stands, however, to be found in Ocmulgee Wildlife Management Area and Bond Swamp National Wildlife Refuge. Prior to conversion to planted pine monocultures, this was apparently the dominant upland ecosystem in Oaky Woods Wildlife Management Area.

Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242)

Description from Comer et al. (2003): “This upland system of the Coastal Plain ranges from southern New Jersey south to Georgia in a variety of moist but non-wetland sites that are naturally sheltered from frequent fire. Such sites include lower slopes and bluffs along streams and rivers in dissected terrain, mesic flats between drier pine-dominated uplands and floodplains, and local topographic high areas within bottomland terraces or nonriverine wet flats. Soil textures are variable in both texture and pH. The vegetation consists of forests dominated by combinations of trees that include a significant component of mesophytic deciduous hardwood species, such as *Fagus grandifolia*, or *Acer barbatum*. Its southern limit is generally exclusive of the natural range of *Pinus glabra* as mapped by Kossuth and Michael (1990) and *Magnolia grandiflora* as mapped by Outcalt (1990). Upland and bottomland oaks at the mid range of moisture tolerance are usually also present, particularly *Quercus alba*, but sometimes also *Quercus falcata*, *Quercus michauxii*, *Quercus shumardii*, or *Quercus nigra*. *Pinus taeda* is sometimes present, but it is unclear if it is a natural component or has entered only as a result of past cutting. Analogous systems on the Gulf Coastal Plain have pine as a natural component, and this may be true for some examples of this system. Understories are usually well-developed. Shrub and herb layers may be sparse or moderately dense. Within its range, *Sabal minor* may be a prominent shrub. Species richness may be fairly high in basic sites but is fairly low otherwise.”

This Ecological System as mapped occurs on just under 14,000 acres in the Robins vicinity (3.5% of the mapping area), about 33 acres of which are on the base itself. It is found in steep-sided ravines and coves throughout much of the mapping area. This System may closely resemble *CES203.476 Southern Coastal Plain Mesic Slope Forest*.

Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system, which is apparently most abundant in the Carolinas, occurs in floodplains of small streams that carry little mineral sediment (blackwater streams). These streams have their headwaters in sandy portions of the Coastal Plain. The water is usually strongly stained by tannins but has little suspended clay and is not turbid. Depositional landforms may be absent or present only in limited variety and of small size. Soils are usually strongly acidic. Periodicity of flooding ranges from long (semi-permanent) in the wettest portions to short in higher gradient streams. Some small blackwater streams have most of their flow from sandhill seepage and have

limited fluctuation in water levels. Vegetation varies from north to south, but generally consists almost entirely of forests of wetland trees, but occasional, small shrubby sloughs may also be present. A variety of tree species may be present; wetter examples (especially toward the northern range limits of this system) are often strongly dominated by *Taxodium distichum* and *Nyssa biflora*. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods tolerant of blackwater conditions. Species richness ranges from low to moderate, but is lower than in comparable brownwater systems. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This Ecological System covers just under 30,000 acres in the Robins vicinity (7.5% of the mapping area); 212 acres (3% of base total) are on the Air Force Base. It occurs along all small-to-medium streams in the area that originate below the Fall Line.

Atlantic Coastal Plain Brownwater Stream Floodplain Forest (CES203.248)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system ranges from the Inner Coastal Plain of Maryland, to the Outer Coastal Plain of southeastern Virginia to Georgia on floodplains of smaller streams that carry significant mineral sediment (brownwater or redwater streams). These streams have their headwaters in the Piedmont, Blue Ridge, or other interior regions, or in portions of the Coastal Plain where fine-textured sediment predominates. The water generally carries substantial amounts of silt and clay. Depositional landforms, at least a natural levee, are often distinctly present but are fairly small relative to the scale of communities but help create some variation in duration of flooding and nutrient input. Soils are generally fertile and not strongly acidic. Flooding is generally seasonal, but may range to nearly semi-permanent. Vegetation consists almost entirely of forests of wetland trees. Wetter examples are strongly dominated by *Taxodium distichum* and *Nyssa* spp. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods. Except in the very wet examples, understory, shrub, and herb layers are generally well-developed and woody vines are also prominent. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This Ecological System covers just over 2100 acres in the Robins vicinity, all along Echeconnee Creek, north of the Air Force Base, which is the only stream other than the Ocmulgee River in the mapping area with origins in the Piedmont. There are examples of it preserved within Echeconnee Creek Natural Area.

Atlantic Coastal Plain Small Brownwater River Floodplain Forest (CES203.250)

Description from Comer et al. (2003): “This system encompasses the floodplains of small to medium brownwater rivers of the Atlantic Coastal Plain which are intermediate between the smaller streams and the largest rivers. Brownwater rivers originate in clayey areas and carry substantial amounts of mineral sediment, creating well-developed deposition alluvial

landforms and fertile soils. Vegetation is a mosaic of cypress and gum swamps, oak-dominated bottomland hardwoods, and mixed levee forests, with only local non-forested communities.”

This Ecological System covers nearly 40,000 acres in the Robins vicinity, 9.8% of the total acreage. On the base itself it covers about 1800 acres, or 26% of the total area. This System occurs on the broad floodplains of the Ocmulgee, which in this area is categorized a “medium” sized brownwater stream, and is the dominant natural vegetation type in the mapping area. Significant acreages are protected in Bond Swamp National Wildlife Refuge and Ocmulgee Wildlife Management Area.

Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)

Description from Comer et al. (2003): “This system consists of wetlands in small basins formed in unconsolidated sediments of the Atlantic Coastal Plain, from southeastern Virginia to Florida. Most basins are formed by subsidence of surface sediments caused by solution in underlying limestone. Others may be formed as swales in mainland eolian sands, natural blockage of small drainages by sediment movement, and more obscure causes. Soils are generally sandy, with mucky surfaces in the wettest areas. Vegetation is often zonal in response to variation in duration of flooding in different parts of the depression pond. Vegetation usually ranges from open water or floating-leaved aquatics in the center of the deepest basins, to emergent marsh zones in semi-permanent water, to drawdown zones with diverse small graminoid and forb vegetation, to dense shrub or woodland edges. A smaller number of basins may have emergent trees throughout their extent. Hydroperiod can vary substantially from year to year, and vegetation can similarly vary significantly in aspect and dominants. Besides flooding and its variation, fire is an important natural force in the outer drier portions.”

This small patch Ecological System covers about 2800 acres in the Robins vicinity, only 15 acres of which are on the Air Force Base itself. The small examples on the base, mainly south and west of Scout Lake, exist within a highly modified context. Other examples of varying size and quality are found throughout the broader mapping area, especially south of the base.

Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)

Description from Comer et al. (2003): “This system of upland *Pinus palustris*-dominated vegetation ranges from southern Virginia (beginning approximately at the James River) to northeastern Florida (excluding longleaf pine of the Fall-Line Sandhills, accommodated by another ecological system), where it was once perhaps the most extensive system in the Outer Coastal Plain within its range. Examples and associations share the common feature of upland (non-wetland) moisture regimes and natural exposure to frequent fire. They occur on a variety of well- to excessively drained soils, and on the higher parts of upland-wetland mosaics. The vegetation is naturally dominated by *Pinus palustris*. Most associations have an understory of scrub oaks. The herb layer is generally well-developed and dominated by grasses. *Aristida stricta* primarily dominates in the northern part of its range, and *Aristida*

beyrichiana in the southern part. Frequent, low-intensity fire is the dominant natural ecological force.”

This Ecological System as mapped covers over 55,000 acres in the Robins mapping area, almost 14% of the total; on the Air Force Base itself, it covers around 500 acres, 7% of the total. Unfortunately, nearly all this acreage is presently dominated by off-site species, most commonly hardwoods or loblolly pine. To an extent the coverage of this Ecological System is speculation, and it is conceivable that some of it belongs in *Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest (CES203.241)*. However, remnant individual trees and the likely fire history of the area indicate that, aside in the previously noted Oaky Woods vicinity, it likely belongs classified in the longleaf System.

Southern Coastal Plain Mesic Slope Forest (CES203.476)

Description from Comer et al. (2003): “This forested system of the southern East Gulf and Atlantic Coastal Plains occurs on steep slopes, bluffs, or sheltered ravines where fire is naturally rare, generally within the natural range of *Pinus glabra* as mapped by Kossuth and Michael (1990) and *Magnolia grandiflora* as mapped by Outcalt (1990). Stands are mesic, and vegetation typically includes species such as *Fagus grandifolia*, *Magnolia grandiflora*, *Illicium floridanum*, and other species rarely encountered outside this system in the region. Related forests which occur on deep loess soils along the western margin of the region are classified as ~East Gulf Coastal Plain Southern Loess Bluff Forest (CES203.556). Some component associations are also found in temporarily flooded floodplains adjacent to these slopes, but this is primarily an upland system. The system also includes essentially upland vegetation of Pleistocene terraces, although these are conceptually transitional to creek floodplain systems.”

As mapped, this Ecological System covers about 530 acres in the Robins vicinity, 57 of which are on the base itself. There is significant overlap in this Ecological System concept with *Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242)*. Examples are scattered throughout the mapping area, but are particularly numerous in the hilly topography of Twiggs County.

East Gulf Coastal Plain Black Belt Calcareous Prairie and Woodland (CES203.478)

Description from Comer et al. (2003): “This system includes natural grassland vegetation and associated wooded vegetation in a relatively small natural region (approximately 480 km (300 miles) long and 40-50 km (25-30 miles) wide) of Mississippi and Alabama north to a small part of southern Tennessee (Black Belt Subsection 231Ba of Keys et al. 1995; Blackland Prairie Ecoregion 65a of Griffith et al. 2001). This region, which generally derives its name from the nearly black, rich topsoil that developed over Selma Chalk, has long been noted as a distinct topographic region in the state of Mississippi (Lowe 1921). In Alabama, the formations on which this system primarily occurs are the Demopolis Chalk and the Mooreville Chalk (members of the Selma Group). In Tennessee, only Demopolis Chalk is mapped (Hardeman 1966). Examples occur over relatively deep soils (as opposed to "glades and barrens"), with circumneutral surface soil pH. Vegetation of this ecological system

includes evergreen *Juniperus virginiana*-dominated forests and deciduous *Quercus*-dominated woodlands of varying densities, interspersed with native prairie-like grasslands. Much of the natural vegetation of the region has been converted to pasture and agricultural uses, but even old-field vegetation reflects the distinctive composition of the flora and ecological dynamics. In most cases individual prairie openings are small and isolated from one another, but were formerly more extensive prior to European settlement, forming a mosaic of grasslands and woodlands under frequent fire regimes. The flora has much in common with other prairies of the East Gulf Coastal Plains as well as the classic Midwestern prairies. Within this natural region, there are pockets of acidic soils which produce more typical pine-oak woodland or forest vegetation.”

Description from Echols et al. (2007): “This herbaceous association includes tallgrass prairies on the Fort Valley Plateau of Houston, Peach, Twiggs, and Bleckley counties in the South Atlantic Coastal Plain of Georgia on "gumbo flats" over Sumter soils. There is substantial variation in composition due to edaphic factors, fire suppression and disturbance. The dominant vegetation consists of a variety of native grasses usually dominated by *Sorghastrum nutans*. Other important grasses include *Andropogon gerardii*, *Aristida purpurascens*, *Eragrostis spectabilis*, *Muhlenbergia capillaris*, *Sporobolus clandestinus*, *Sporobolus junceus*, *Sporobolus vaginiflorus*, *Tridens flavus*, and *Tripsacum dactyloides*. The disjunct prairie grass *Bouteloua curtipendula* is present in at least one occurrence. In addition, a large number of state listed rare or disjunct prairie herbaceous perennials also occur. Prominent among these are *Draba cunefolia*, *Galium virgatum*, *Glandularia bipinnatifida*, *Ophioglossum engelmannii*, *Polygala boykinii*, *Scutellaria drummondii*, *Spermolepis inermis*, *Symphyotrichum georgianum*, *Symphyotrichum laeve* var. *concinnum*, *Symphyotrichum novae-angliae*, and *Thaspium chapmanii*. Other characteristic or dominant herbaceous species include *Agalinis tenuifolia*, *Asclepias viridiflora*, *Asclepias viridis*, *Asclepias verticillata*, *Asclepias tuberosa*, *Erigeron strigosus*, *Houstonia nigricans* var. *nigricans*, *Lythrum alatum* var. *lanceolatum*, *Ratibida pinnata*, *Rudbeckia hirta*, *Salvia azurea*, *Salvia lyrata*, *Silphium asteriscus* var. *dentatum*, *Solidago nemoralis*, and *Symphyotrichum undulatum*. Woody cover in these grasslands varies considerably due to edaphic factors, disturbance and fire suppression. Characteristic species that might be abundant to sparse would include *Celtis tenuifolia*, *Cercis canadensis*, *Cornus asperifolia*, *Crataegus crus-galli*, *Crataegus spathulata*, *Crataegus triflora*, *Diospyros virginiana*, *Frangula caroliniana* (= *Rhamnus caroliniana*), *Fraxinus americana*, *Juniperus virginiana*, *Quercus muehlenbergii*, *Quercus sinuata*, *Sideroxylon lanuginosum* (= *Bumelia lanuginosa*), *Ulmus alata* and *Viburnum rufidulum*. Common vines include *Berchemia scandens* and *Cocculus carolinus*.

This community occurs on calcareous soils of the Dry Branch, Tivola and Ocmulgee Formations of late Eocene origin. The Ocmulgee Formation, previously known as Cooper Marl in Georgia, is a combination of indurated and argillaceous limestone that also falls within the Ocala Group. Calcareous soils are the main abiotic factor driving the occurrence of blackland prairie vegetation within Georgia. The shrink-swell clays and alkaline pH of these soils account for a distinctive suite of vegetation not found elsewhere in the state. The Sumter Series most commonly underlies the prairie sites and consists of shallow, alkaline, moderately well-drained silty clays underlain by marl, chalk, or limestone. The Oktibbeha,

Boswell, and Susquehanna Series are also present to a lesser extent and occur together in intricate patterns (Echols 2007). The nine prairies found on Ocmulgee WMA and Oaky Woods WMA represent the only blackland prairies in Georgia occurring on protected lands. These areas may be subjected to development if the current transfer of leased timberland to private interests occurs.”

This community does not occur on Robins Air Force Base itself. Examples are known, however, from Oaky Woods Wildlife Management Area, Ocmulgee Wildlife Management Area, and several nearby private lands. It is of very high conservation priority in Georgia. As mapped, this Ecological System covers a total of 151 acres in the Robins vicinity.

Townsend Bombing Range

Background:

For the purposes of this project, the Townsend Bombing Range vicinity includes all of the Range as well as a 10km buffer, a total area of just over 127,000 acres. The Range itself is in McIntosh County, within the Southern Coastal Plain ecoregion and the Sea Island Flatwoods sub-ecoregion (Griffith et al. 2001), and covers approximately 5165 acres. Adjoining counties within the buffer zone include Long, Wayne, and a very small portion of Glynn. The Altamaha River runs through the mapping area, and its floodplain and sandhills dominate much of the region. Otherwise, the Townsend vicinity is dominated by a mosaic of low-lying flatwoods and wetlands. Much of the Southern Coastal Plain ecoregion is presently dominated by large industrial tree farms, though the largest forest industry companies have divested many holdings in the last ten years. Suburban sprawl has not overtaken much of this mapping area at this time, and a good deal of the mapping area is either in state ownership or under conservation easement (over 28,000 acres total, plus more under negotiation), but all of the Georgia coastal counties have seen population increases in recent years (U.S. Census Bureau 2001), and development may become more of an issue on unprotected tracts in the future.

Methods:

SSURGO soil maps (U.S. Department of Agriculture 2008)) were used in identification of sandhills and other soil-dependent communities. These communities were often further divided by spectral signature (i.e. deciduous separated from evergreen). Topographic/landform models, especially a Topographic Relative Moisture Index (Parker 1982) were developed from the National Elevation Database (U.S. Geological Survey 2005), and applied to a variety of natural vegetation types across a moisture gradient (mesic to xeric). However, in the low-lying, extremely flat environment surrounding much of the Range, very small changes in elevation may create substantial shifts in vegetation, and moisture indices sometimes did not provide adequate differentiation between, for example, upland longleaf pine and longleaf pine flatwoods. In these areas, community boundaries were often hand-digitized using a combination of topographic and soil maps. The reaches of tidally influence swamps were delineated after extensive conversations with persons familiar with this section of the Altamaha River. Other Ecological Systems, especially non-riverine wetlands, were identified using aerial photographs and manually classified by their position in the landscape or other factors.

Results:

The Townsend Bombing Range Ecological Systems map is shown in Figure 12 and classifications and their acreages and relative coverages are given in Table 6.

Class	Acres	Percent
Exposed soil	19.56	0.02
Open water	2185.43	1.69
Developed open space	3657.28	2.83
Low intensity developed	542.86	0.42
Medium intensity developed	35.12	0.03
High intensity developed	0.89	0.00
Successional shrub/scrub (clearcut)	6276.86	4.85
Evergreen plantations	47892.76	37.00
Successional shrub/scrub (other)	2146.31	1.66
Grassland/herbaceous (other)	13502.06	10.43
Pasture/hay	316.56	0.24
Row crop	819.84	0.63
Utility swath	345.01	0.27
Atlantic Coastal Plain Large River Floodplain Forest	9543.34	7.37
Atlantic Coastal Plain Southern Tidal Wooded Swamp	3777.77	2.92
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	26773.15	20.68
Southern Coastal Plain Nonriverine Cypress Dome	54.69	0.04
Atlantic Coastal Plain Southern Depression Pondshore	1462.96	1.13
Atlantic Coastal Plain Upland Longleaf Pine Woodland	577.98	0.45
Atlantic Coastal Plain Upland Longleaf Pine Woodland- loblolly/slash phase	358.79	0.28
Atlantic Coastal Plain Upland Longleaf Pine Woodland- loblolly/slash mixed phase	116.04	0.09
Southern Coastal Plain Oak Dome and Hammock	2347.27	1.81
Atlantic Coastal Plain Xeric River Dune	4160.12	3.21
Southern Coastal Plain Seepage Swamp and Baygall	152.72	0.12
Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods	2367.94	1.83
Total	129433.3	

Table 6. Vegetation/landcover classes for Townsend Bombing Range and vicinity, 2005.

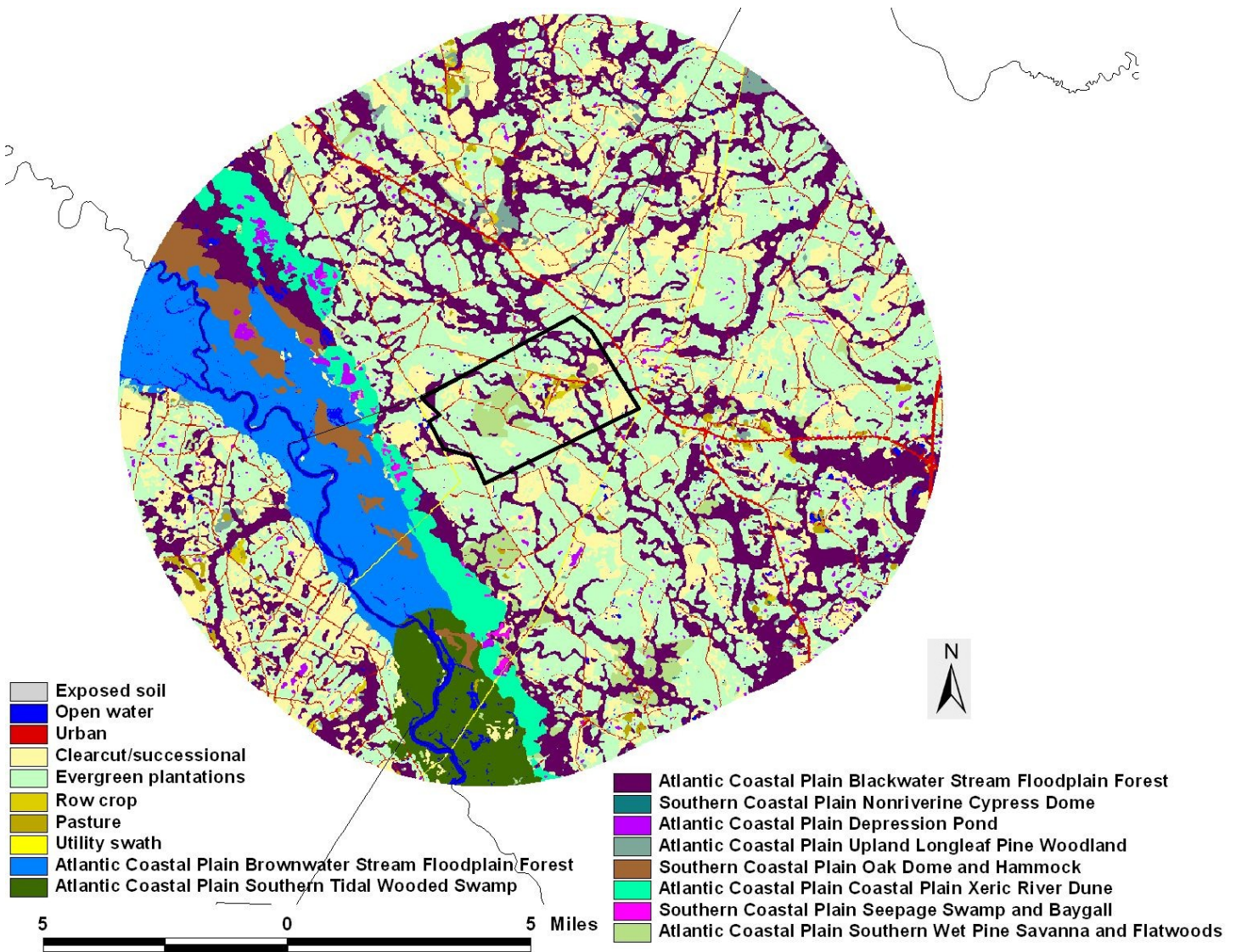


Figure 12. Ecological Systems map for Townsend Bombing Range and vicinity, 2005.

As of 2005, 3.3% of the Townsend Bombing Range vicinity is developed (urban cover type), the smallest amount of any of the bases in this project; on the base itself the figure is 2.6%, nearly all of which is roads. 40% of the Townsend vicinity is in a “natural vegetation” type (Elliott and Kramer 2005), while on the Range itself the total is 29%. The dominant anthropogenic cover types by far are evergreen tree plantation and early successional stages of forests related to timber harvest.

Following is a discussion of the “natural vegetation” types of the Townsend Bombing Range vicinity – the Ecological Systems.

Atlantic Coastal Plain Southern Tidal Wooded Swamp (CES203.240)

Description from Comer et al. (2003): This system encompasses the tidally flooded areas in lower river floodplains and edges of estuaries of the Atlantic Coastal Plain from southeastern Virginia southward to northern Florida that have sufficiently fresh water and short enough flooding to be able to support tree canopies. *Taxodium*, *Nyssa*, or *Fraxinus* generally dominate. Swamps may be either regularly flooded by lunar tides or irregularly flooded by wind tides.

This Ecological System covers nearly 3800 acres in the Townsend vicinity, or 2.9% of the mapped area; none of this is on the base itself. As mapped, this includes the Altamaha River floodplain downstream from Barrington Lake. Other estimates (U.S. Fish and Wildlife Service 2002) have placed the influence of tides higher upstream – nearer Miller Lake and the Long County line – so the acreage figure for this System could potentially be higher than that given here.

Atlantic Coastal Plain Large River Floodplain Forest (CES203.066)

Description from Comer et al. (2003): “This system consists of poorly drained, organic or mineral soil flats of the outer Atlantic Coastal Plain. These areas are saturated by rainfall and seasonal high water table without influence of river or tidal flooding. Fire is generally infrequent, but may be important for some associations. Vegetation consists of hardwood or mixed forests of *Taxodium distichum*, *Nyssa* spp., bottomland oaks, or other wetland trees of similar tolerance. The lower strata have affinities with pocosin or baygall systems rather than the river floodplain systems that have affinities with the canopy. The combination of canopy dominants and nonriverine, non-seepage hydrology distinguishes this system from other Coastal Plain systems.”

This Ecological System covers over 9500 acres, or 7.4% of the Townsend vicinity. It does not occur on the Bombing Range itself. It is found on the floodplains of the non-tidally influenced section of the Altamaha River.

Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system, which is apparently most abundant in the Carolinas, occurs in floodplains of small streams that carry little mineral sediment (blackwater streams). These streams have their headwaters in sandy portions of the Coastal Plain. The water is usually strongly stained by tannins but has little suspended clay and is not turbid. Depositional landforms may be absent or present only in limited variety and of small size. Soils are usually strongly acidic. Periodicity of flooding ranges from long (semi-permanent) in the wettest portions to short in higher gradient streams. Some small blackwater streams have most of their flow from sandhill seepage and have limited fluctuation in water levels. Vegetation varies from north to south, but generally consists almost entirely of forests of wetland trees, but occasional, small shrubby sloughs may also be present. A variety of tree species may be present; wetter examples (especially toward the northern range limits of this system) are often strongly dominated by *Taxodium*

distichum and *Nyssa biflora*. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods tolerant of blackwater conditions. Species richness ranges from low to moderate, but is lower than in comparable brownwater systems. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This Ecological System covers nearly 27,000 acres, or 21% of the total land area, in the Townsend vicinity, and over 900 acres or 18% of the land area on the Bombing Range itself. It occurs along virtually every small stream in the mapping area. There are numerous protected examples on conservation easements and state-owned property.

Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)

Description from Comer et al. (2003): “This system consists of small forested wetlands, typically dominated by *Taxodium ascendens*, with a characteristic and unique dome-shaped appearance in which trees in the center are higher than those around the sides (Monk and Brown 1965). Examples are known from the Southern Coastal Plain (Omernik Ecoregion 75) (EPA 2004) of Florida and Georgia. Examples occupy poorly drained depressions which are most often embedded in a matrix of pine flatwoods. The oldest and largest individual trees typically occupy the center of these domed wetlands, with smaller and younger individuals around the margins. Pools of stagnant, highly acidic water may stand in the center of these depressions ranging from 1-4 feet in depth, but becoming increasingly shallow along the margins. These sites are underlain by an impervious clay pan which impedes drainage and traps precipitation. Some examples may have thick (50-100 cm) organic layers. In addition to *Taxodium ascendens*, other woody species may include *Nyssa biflora*, *Cephalanthus occidentalis*, *Liquidambar styraciflua*, *Clethra alnifolia*, *Lyonia lucida*, and *Styrax americanus*.”

As mapped, this small patch Ecological System occurs on about 55 acres in the Townsend vicinity; 3 acres are on the Range itself. There is likely considerable overlap between this Ecological System and *Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)*, which may also contain pond-cypress.

Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)

Description from Comer et al. (2003): “This system consists of wetlands in small basins formed in unconsolidated sediments of the Atlantic Coastal Plain, from southeastern Virginia to Florida. Most basins are formed by subsidence of surface sediments caused by solution in underlying limestone. Others may be formed as swales in mainland eolian sands, natural blockage of small drainages by sediment movement, and more obscure causes. Soils are generally sandy, with mucky surfaces in the wettest areas. Vegetation is often zonal in response to variation in duration of flooding in different parts of the depression pond. Vegetation usually ranges from open water or floating-leaved aquatics in the center of the deepest basins, to emergent marsh zones in semi-permanent water, to drawdown zones with diverse small graminoid and forb vegetation, to dense shrub or woodland edges. A smaller

number of basins may have emergent trees throughout their extent. Hydroperiod can vary substantially from year to year, and vegetation can similarly vary significantly in aspect and dominants. Besides flooding and its variation, fire is an important natural force in the outer drier portions.”

This small patch Ecological System occurs on nearly 1500 acres of the Townsend vicinity, and about 27 acres of the Range itself. Small ponds are scattered throughout the area; many are protected by conservation easement or on state property.

Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)

Description from Comer et al. (2003): “This system of upland *Pinus palustris*-dominated vegetation ranges from southern Virginia (beginning approximately at the James River) to northeastern Florida (excluding longleaf pine of the Fall-Line Sandhills, accommodated by another ecological system), where it was once perhaps the most extensive system in the Outer Coastal Plain within its range. Examples and associations share the common feature of upland (non-wetland) moisture regimes and natural exposure to frequent fire. They occur on a variety of well- to excessively drained soils, and on the higher parts of upland-wetland mosaics. The vegetation is naturally dominated by *Pinus palustris*. Most associations have an understory of scrub oaks. The herb layer is generally well-developed and dominated by grasses. *Aristida stricta* primarily dominates in the northern part of its range, and *Aristida beyrichiana* in the southern part. Frequent, low-intensity fire is the dominant natural ecological force.”

This Ecological System occurs on just over 1000 acres in the Townsend vicinity, nearly all off the Range. About 45% of the total acreage is presently in off-site species, primarily a mix of loblolly pine, slash pine, and mixed hardwoods. Historically this System would have dominated upland areas that were not extremely xeric sandhills, but most of them have been converted to pine monocultures or lost through fire suppression. The best remaining example occurs on private land near the junction of Highway 57/Tibet Road; it was not mapped correctly during Phase 1 of the project. Other examples (mapped correctly) are located nearby on the same low sand ridge.

Southern Coastal Plain Oak Dome and Hammock (CES203.494)

Description from Comer et al. (2003): “This small-patch system occurs in the Southern Coastal Plain (Omernik ecoregion 75). Examples are known from inland portions of this region including parts of the East Gulf Coastal Plain (TNC ecoregion 53) and Florida peninsula (TNC ecoregion 55), and nearby portions of the South Atlantic Coastal Plain (TNC ecoregion 56). Thick stands of *Quercus virginiana* and/or *Quercus geminata* are diagnostic of this system. Examples often occupy locally distinct microhabitats that differ from the surrounding landscape, such as shallow depressions or slight topographic highs in a predominantly longleaf pine-dominated landscape. Although embedded in a matrix of vegetation with extremely frequent fire regimes, patches of this system are subject to only infrequent or rare fire events. Under more frequent fire regimes, these sites would likely be occupied by longleaf pine. It has been postulated that winter burning regimes have allowed

this type to expand. A range of soil and moisture conditions may be present. More mesic examples have relatively thin soils (to 50 cm) above clay, while xeric examples occupy deep (>130 cm) well-drained sands. Dominant plant taxa of mesic examples are *Quercus virginiana* and *Quercus hemisphaerica*, along with *Diospyros virginiana*. *Campsis radicans* and *Smilax* spp. dominate the sparse ground cover. In xeric examples, dominants include *Quercus geminata*, *Pinus palustris*, *Quercus virginiana*, *Aristida stricta*, and *Stylisma humistrata*. This system is low in plant species diversity compared to most other habitats in the region.”

This Ecological system occurs on about 2350 acres in the Townsend vicinity, 1.8% of the mapping area. It does not occur on the Range itself. There are several very high-quality examples, especially on the Rayonier Murff Tract.

Atlantic Coastal Plain Xeric River Dune (CES203.497)

Description from Comer et al. (2003): “This system encompasses a range of vegetation present on inland sand dunes of the Coastal Plain of Georgia. These dunes are associated with certain rivers such as the Ochopee (Wharton 1978) and are apparently eolian in origin formed of riverine alluvial sands. The sandy soils are deep, coarse, and xeric in nature. The vegetation consists of an assemblage of xeric communities that also occur in other xeric habitats in the Coastal Plain. These include *Pinus palustris* - *Quercus laevis* communities and a scrub community akin to Inland Florida Scrub. This system is distinguished from more typical xeric sandhills of the Coastal Plain by its occurrence on river dunes. In addition this environment is naturally topographically isolated and consequently has a lower fire-return interval than other upland system of which *Pinus palustris* is a component.”

This Ecological System occurs on over 4000 acres in the Townsend vicinity, 3.2% of the total mapping area. All examples are located off the Range itself. It is found on deep Kershaw sands deposited parallel to the Altamaha River. Attempts (largely unsuccessful) have been made to convert this System to pine silviculture, although poor growth of tree plantations has allowed most native species to persist. Intact examples of this ecosystem are protected by conservation easement on property belonging to the Fort Barrington Hunt Club.

Southern Coastal Plain Seepage Swamp and Baygall (CES203.505)

Description from Comer et al. (2003): “This wetland system consists of forested wetlands in acidic, seepage-influenced habitats of the East Gulf Coastal Plain, extending into central Florida. These are mostly evergreen forests generally found at the base of slopes or other habitats where seepage flow is concentrated. Resulting moisture conditions are saturated or even inundated. The vegetation is characterized by *Magnolia virginiana* and *Nyssa biflora*. Examples occur in the outer portions of the Coastal Plain within the range of *Persea palustris*, and where *Magnolia virginiana* is an important or even dominant species. To the north this system grades into ~East Gulf Coastal Plain Northern Seepage Swamp (CES203.554), where evergreen species are largely replaced by deciduous species in the canopy. Due to excessive wetness, these habitats are normally protected from fire except

those which occur during extreme droughty periods. These environments are prone to long-duration standing water, and tend to occur on highly acidic, nutrient-poor soils.”

As mapped, this Ecological System occurs about 150 acres in the Townsend vicinity, none of which are on the Bombing Range. However, during Phase 2 of the project several unmapped examples were located, meaning that it is likely under-mapped.

Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)

Description from Comer et al. (2003): “This system of pine-dominated savannas and/or flatwoods ranges from southern South Carolina to northeastern Florida where it was the former matrix system, centered in southeastern Georgia, near the coast. This general area has been referred to as the Longleaf Pine Wiregrass Savannas region (Platt 1999) and the Sea Island Flatwoods sub-Ecoregion (75f of Griffith et al. (2001, 2002)). Examples of this system and component community associations share the common features of wet, seasonally saturated, mineral soils and historic exposure to frequent low-intensity fire. They occur on a wide range of soil textures, which is an important factor in distinguishing different associations. The vegetation is naturally dominated by *Pinus palustris* or, on wetter sites, *Pinus elliottii* or less commonly *Pinus serotina*. Understory conditions may be dramatically altered by fire frequency and seasonality. In natural condition (frequent fires, including a growing-season component) there tends to be a dense ground cover of herbs and low shrubs; grasses can dominate, but there is often a large diversity of other herbs and shrubs.”

This Ecological System occurs on over 2300 acres in the Townsend vicinity, 1.8% of the total acreage; 546 (10.6%) are on the Range itself. Historically this would have been the dominant ecosystem in the area (Wharton 1978), but most examples have been converted to planted pine monocultures, or lost to hardwoods due to fire suppression. The largest and best remaining example is located on the Range itself. Another may be found nearby (adjacent to the state-owned Barrington Tract) on private land belonging to Edgar Davis.

Kings Bay Submarine Base

Background:

For the purposes of this project, the Kings Bay Submarine Base vicinity includes all of the base as well as a 10km buffer (within Georgia), a total area of just over 126,000 acres. The Sub Base itself is in Camden County, within the Southern Coastal Plain ecoregion and the Sea Island Flatwoods sub-ecoregion (Griffith et al. 2001), and covers approximately 13,750 acres. The buffer area is also entirely within Camden County. Much of the area is covered by open water (22%) or tidal marsh, and the large barrier island of Cumberland sits in the eastern quadrant. Otherwise, the Kings Bay vicinity is dominated by a mosaic of maritime forest, low-lying flatwoods and wetlands. A few higher sandy ridges contain more xeric vegetation, but many of them contain commercial or residential developments, including the cities of St. Mary’s and Kingsland, two of the fastest growing communities in Georgia (U.S. Census Bureau 2001). Two conservation properties of significance are located

in the Kings Bay mapping area, Crooked River State Park and Cumberland Island National Seashore, together accounting for over 20,000 acres of coastal and near-coastal ecosystems.

Methods:

SSURGO soil maps (U.S. Department of Agriculture 2008) were used in identification of sandhills and other soil-dependent communities. These communities were often further divided by spectral signature (i.e. live oak hammocks separated from scrub communities). Topographic/landform models, especially a Topographic Relative Moisture Index (Parker 1982) were developed from the National Elevation Database (U.S. Geological Survey 2005), and applied to a variety of natural vegetation types across a moisture gradient (mesic to xeric). However, in the low-lying, extremely flat environment surrounding much of the base, very small changes in elevation may create substantial shifts in vegetation, and moisture indices sometimes did not provide adequate differentiation between, for example, upland longleaf pine and longleaf pine flatwoods. In these areas, community boundaries were often hand-digitized using a combination of topographic and soil maps. The reaches of tidally influence swamps and salt vs. brackish vs. freshwater wetlands were delineated with the assistance of National Wetlands Inventory data (U.S. Fish and Wildlife Service 2002). Other Ecological Systems, especially non-riverine wetlands, were identified using aerial photographs and manually classified by their position in the landscape or other factors.

Results:

The Kings Bay Submarine Base Ecological Systems map is shown in Figure 13 and classifications and their acreages and relative coverages are given in Table 7.

Class	Acres	Percent
Exposed soil	622.8846	0.49
Open water	27785.7216	22.05
Utility swaths	47.1276	0.04
Developed open space	6131.2563	4.87
Low intensity developed	4316.3991	3.43
Medium intensity developed	1368.0342	1.09
High intensity developed	530.1855	0.42
Successional shrub/scrub (clearcut)	4638.9564	3.68
Evergreen plantations	17050.41	13.53
Successional shrub/scrub (other)	1759.2822	1.40
Grassland/herbaceous (other)	2613.3588	2.07
Golf course	461.9394	0.37
Pasture/hay	211.6296	0.17
Row crop	1776.177	1.41
Atlantic Coastal Plain Southern Tidal Wooded Swamp	7055.802	5.60
Atlantic Coastal Plain Blackwater Stream Floodplain Forest	3076.632	2.44
Southern Coastal Plain Nonriverine Cypress Dome	201.1815	0.16
Atlantic Coastal Plain Xeric River Dune	166.5027	0.13
Atlantic Coastal Plain Southern Depression Pondshore	2360.6037	1.87
Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh	28786.0716	22.84
Atlantic Coastal Plain Southern Dune and Maritime Grassland	486.837	0.39
Atlantic Coastal Plain Upland Longleaf Pine Woodland	78.9165	0.06

Atlantic Coastal Plain Upland Longleaf Pine Woodland - sandhill phase	239.6394	0.19
Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh	1053.0351	0.84
Atlantic Coastal Plain Sea Island Beach	1350.0279	1.07
Southern Coastal Plain Seepage Swamp and Baygall	62.244	0.05
Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods	1878.2127	1.49
Atlantic Coastal Plain Southern Maritime Forest	9897.0183	7.85
Total	126006.0867	

Table 7. Vegetation/landcover classes for Kings Bay Submarine Base and vicinity, 2005.

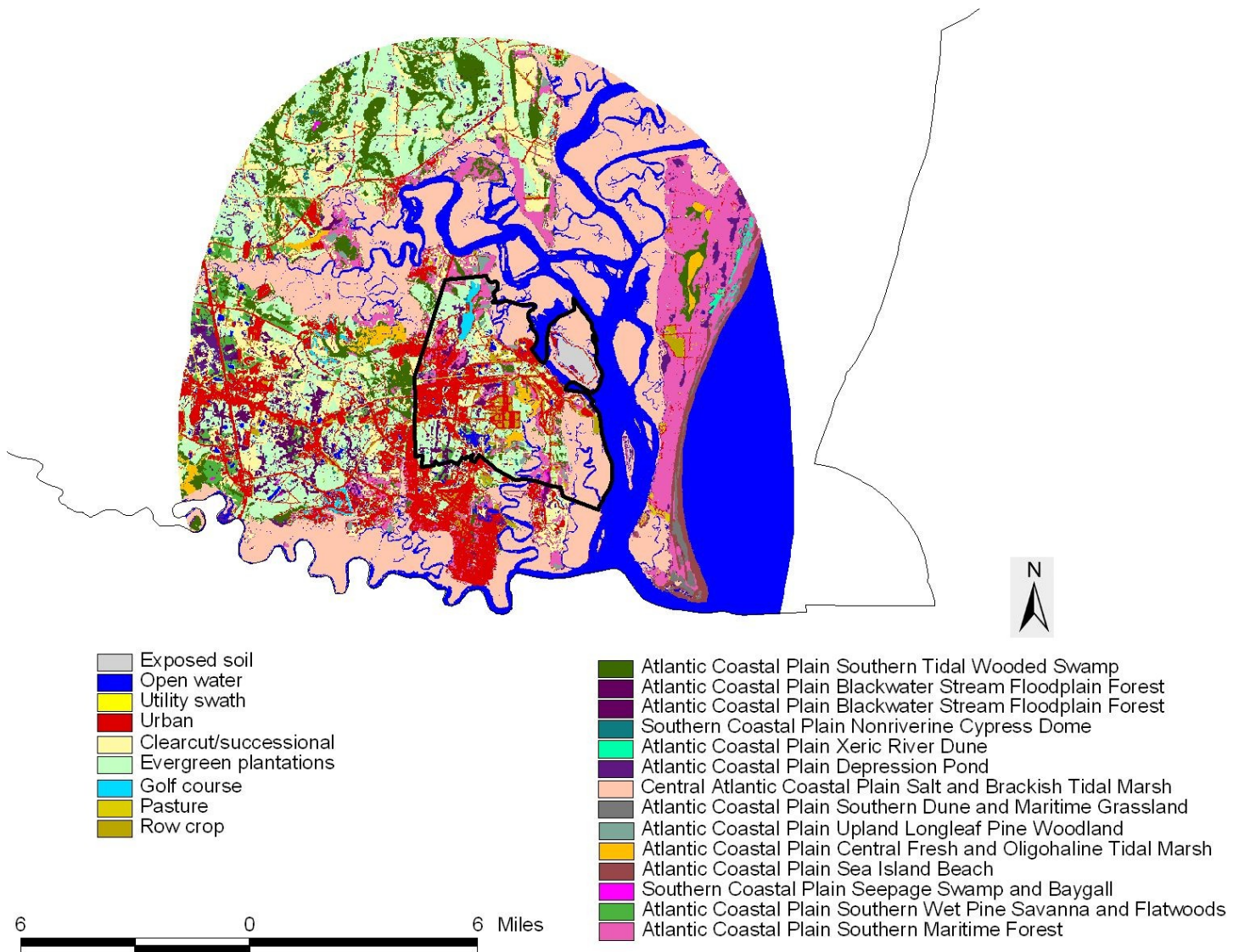


Figure 13. Ecological Systems map for Kings Bay Submarine Base and vicinity, 2005.

As of 2005, 10.2% of the Kings Bay Submarine Base vicinity is developed (urban cover type); on the base itself the figure is 22%. 45% of the Kings Bay vicinity is in a “natural

vegetation” type (Elliott and Kramer 2005), while on the Sub Base itself the figure is 39%. The dominant anthropogenic cover types are evergreen tree plantation, low density urban, and early successional forest stages associated with timber harvest.

Following is a discussion of the “natural vegetation” types of the Kings Bay Submarine Base vicinity – the Ecological Systems.

Atlantic Coastal Plain Southern Tidal Wooded Swamp (CES203.240)

Description from Comer et al. (2003): This system encompasses the tidally flooded areas in lower river floodplains and edges of estuaries of the Atlantic Coastal Plain from southeastern Virginia southward to northern Florida that have sufficiently fresh water and short enough flooding to be able to support tree canopies. *Taxodium*, *Nyssa*, or *Fraxinus* generally dominate. Swamps may be either regularly flooded by lunar tides or irregularly flooded by wind tides.

As mapped, this Ecological System occurs on over 7000 acres in the Kings Bay vicinity, 5.6% of the mapping area; on the sub Base itself this figure is around 340 acres, 2.5% of the area. The most significant stands appear to be along the St. Mary’s river upstream of the salt marsh, near one of its tributaries, Catfish Creek , and along Gum branch, a Crooked River tributary. Observations made during Phase 2 of this project indicate that this Ecological System may have been overestimated, most likely due to imprecision in the National Elevation Dataset.

Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)

Description from Comer et al. (2003): “This Atlantic Coastal Plain system, which is apparently most abundant in the Carolinas, occurs in floodplains of small streams that carry little mineral sediment (blackwater streams). These streams have their headwaters in sandy portions of the Coastal Plain. The water is usually strongly stained by tannins but has little suspended clay and is not turbid. Depositional landforms may be absent or present only in limited variety and of small size. Soils are usually strongly acidic. Periodicity of flooding ranges from long (semi-permanent) in the wettest portions to short in higher gradient streams. Some small blackwater streams have most of their flow from sandhill seepage and have limited fluctuation in water levels. Vegetation varies from north to south, but generally consists almost entirely of forests of wetland trees, but occasional, small shrubby sloughs may also be present. A variety of tree species may be present; wetter examples (especially toward the northern range limits of this system) are often strongly dominated by *Taxodium distichum* and *Nyssa biflora*. Other examples have mixtures of these species with *Quercus* spp. and other bottomland hardwoods tolerant of blackwater conditions. Species richness ranges from low to moderate, but is lower than in comparable brownwater systems. Flooding is an important ecological factor in this system and may be the most important factor separating it from adjacent systems. Flooding brings nutrients and excludes non-flood-tolerant species. Unlike river systems, flooding tends to be variable and of shorter duration.”

This Ecological System as mapped covers over 3000 acres in the Kings Bay vicinity (2.4% of the total area), and nearly 560 acres on the base itself (4% of total). However, indications from Phase 2 of this project are that some of the forest mapped as *Atlantic Coastal Plain Southern Tidal Wooded Swamp (CES203.240)* instead belongs in this category.

Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)

Description from Comer et al. (2003): “This system consists of small forested wetlands, typically dominated by *Taxodium ascendens*, with a characteristic and unique dome-shaped appearance in which trees in the center are higher than those around the sides (Monk and Brown 1965). Examples are known from the Southern Coastal Plain (Omernik Ecoregion 75) (EPA 2004) of Florida and Georgia. Examples occupy poorly drained depressions which are most often embedded in a matrix of pine flatwoods. The oldest and largest individual trees typically occupy the center of these domed wetlands, with smaller and younger individuals around the margins. Pools of stagnant, highly acidic water may stand in the center of these depressions ranging from 1-4 feet in depth, but becoming increasingly shallow along the margins. These sites are underlain by an impervious clay pan which impedes drainage and traps precipitation. Some examples may have thick (50-100 cm) organic layers. In addition to *Taxodium ascendens*, other woody species may include *Nyssa biflora*, *Cephalanthus occidentalis*, *Liquidambar styraciflua*, *Clethra alnifolia*, *Lyonia lucida*, and *Styrax americanus*.”

This Ecological System as mapped covers just over 200 acres in the Kings Bay vicinity, about 43 of which are on the base itself. It is scattered throughout areas of pine flatwoods or former pine flatwoods (now planted pine).

Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)

Description from Comer et al. (2003): “This system consists of wetlands in small basins formed in unconsolidated sediments of the Atlantic Coastal Plain, from southeastern Virginia to Florida. Most basins are formed by subsidence of surface sediments caused by solution in underlying limestone. Others may be formed as swales in mainland eolian sands, natural blockage of small drainages by sediment movement, and more obscure causes. Soils are generally sandy, with mucky surfaces in the wettest areas. Vegetation is often zonal in response to variation in duration of flooding in different parts of the depression pond. Vegetation usually ranges from open water or floating-leaved aquatics in the center of the deepest basins, to emergent marsh zones in semi-permanent water, to drawdown zones with diverse small graminoid and forb vegetation, to dense shrub or woodland edges. A smaller number of basins may have emergent trees throughout their extent. Hydroperiod can vary substantially from year to year, and vegetation can similarly vary significantly in aspect and dominants. Besides flooding and its variation, fire is an important natural force in the outer drier portions.”

This Ecological System as mapped occurs on nearly 2400 acres in the Kings Bay vicinity, of 1.9% of the total area, and 250 acres, 1.8% of the total area on the base itself. Examples are scattered throughout the mapping area.

Central Atlantic Coastal Plain Salt and Brackish Tidal Marsh (CES203.270)

Description from Comer et al. (2003): “This system encompasses the brackish to salt intertidal marshes of the Atlantic Coast, ranging from south of the Embayed Region of North Carolina to northern Florida (south to the vicinity of Daytona Beach). It is dominated by medium to extensive expanses of *Spartina alterniflora*, flooded twice daily by lunar tides. *Juncus roemerianus* and other brackish marshes occur upstream in tidal creeks, and a variety of small-patch associations occur near the inland edges. Examples of this system may also support inclusions of shrublands dominated by either *Baccharis halimifolia* and/or *Borrchia frutescens*, as well as forests or woodlands with *Juniperus virginiana* var. *silicicola* in the overstory.”

This Ecological System covers nearly 30,000 acres in the Kings Bay vicinity, or 23% of the total area. On the base itself, it covers 2860 acres, 21% of the total. It has the greatest aerial extent of any cover type in both the mapping area as a whole and on the Sub Base.

Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)

Description from Comer et al. (2003): “This system of upland *Pinus palustris*-dominated vegetation ranges from southern Virginia (beginning approximately at the James River) to northeastern Florida (excluding longleaf pine of the Fall-Line Sandhills, accommodated by another ecological system), where it was once perhaps the most extensive system in the Outer Coastal Plain within its range. Examples and associations share the common feature of upland (non-wetland) moisture regimes and natural exposure to frequent fire. They occur on a variety of well- to excessively drained soils, and on the higher parts of upland-wetland mosaics. The vegetation is naturally dominated by *Pinus palustris*. Most associations have an understory of scrub oaks. The herb layer is generally well-developed and dominated by grasses. *Aristida stricta* primarily dominates in the northern part of its range, and *Aristida beyrichiana* in the southern part. Frequent, low-intensity fire is the dominant natural ecological force.”

This Ecological System covers just over 300 acres in the Kings Bay vicinity, 113 of which are on the base itself. The best example is on Crooked River State Park, just to the north of the Sub Base.

Atlantic Coastal Plain Central Fresh and Oligohaline Tidal Marsh (CES203.376)

Description from Comer et al. (2003): This system represents tidally influenced fresh marsh and tidal shrublands ranging from approximately Morehead City, NC, southward to St. Johns River, FL [see Montague and Wiegert (1990)]. This system occurs where there is adequate river flow and discharge to maintain fresh to oligohaline conditions, while still within tidal range. These marshes most often occur well inside the mouths of tidal creeks and rivers. Elevation differences within the marsh correspond to the occurrence of different vegetation types.

This Ecological System covers just over 1000 acres in the Kings Bay vicinity, and 220 acres on the base itself. The vast majority of the marsh in the area is salt marsh, but there are blocks of the freshwater type, especially above some type of barrier to tidal movement.

Southern Coastal Plain Seepage Swamp and Baygall (CES203.505)

Description from Comer et al. (2003): “This wetland system consists of forested wetlands in acidic, seepage-influenced habitats of the East Gulf Coastal Plain, extending into central Florida. These are mostly evergreen forests generally found at the base of slopes or other habitats where seepage flow is concentrated. Resulting moisture conditions are saturated or even inundated. The vegetation is characterized by *Magnolia virginiana* and *Nyssa biflora*. Examples occur in the outer portions of the Coastal Plain within the range of *Persea palustris*, and where *Magnolia virginiana* is an important or even dominant species. To the north this system grades into ~East Gulf Coastal Plain Northern Seepage Swamp (CES203.554), where evergreen species are largely replaced by deciduous species in the canopy. Due to excessive wetness, these habitats are normally protected from fire except those which occur during extreme droughty periods. These environments are prone to long-duration standing water, and tend to occur on highly acidic, nutrient-poor soils.”

As mapped, this Ecological system covers only 62 acres in the Kings Bay vicinity, 20 acres on the base itself. However, during Phase 2 of the project four examples were found in transition areas between uplands and wetlands, leading to the likely conclusion that it is presently under-mapped.

Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)

Description from Comer et al. (2003): “This system of pine-dominated savannas and/or flatwoods ranges from southern South Carolina to northeastern Florida where it was the former matrix system, centered in southeastern Georgia, near the coast. This general area has been referred to as the Longleaf Pine Wiregrass Savannas region (Platt 1999) and the Sea Island Flatwoods sub-Ecoregion (75f of Griffith et al. (2001, 2002)). Examples of this system and component community associations share the common features of wet, seasonally saturated, mineral soils and historic exposure to frequent low-intensity fire. They occur on a wide range of soil textures, which is an important factor in distinguishing different associations. The vegetation is naturally dominated by *Pinus palustris* or, on wetter sites, *Pinus elliottii* or less commonly *Pinus serotina*. Understory conditions may be dramatically altered by fire frequency and seasonality. In natural condition (frequent fires, including a growing-season component) there tends to be a dense ground cover of herbs and low shrubs; grasses can dominate, but there is often a large diversity of other herbs and shrubs.”

This Ecological system presently covers around 1900 acres (1.5%) of the Kings Bay vicinity, only 56 of which are on the Sub Base. Historically this would have been the dominant ecosystem in much of the area (Wharton 1978), but most examples have been converted to planted pine monocultures, or lost to hardwoods due to fire suppression. The best remaining examples are on Crooked River State Park, just to the north of the base.

Atlantic Coastal Plain Southern Maritime Forest (CES203.537)

Description from Comer et al. (2003): “This system encompasses a range of woody vegetation present on stabilized upland dunes of barrier islands and near-coastal strands, from central South Carolina (approximately Cooper River) southward to approximately Volusia County, Florida. It includes vegetation whose structure and composition are influenced by salt spray, extreme disturbance events, and the distinctive climate of the immediate coast. Examples are known from the barrier islands of Georgia and Florida, such as Big Talbot Island, Florida, and probably Sapelo Island, Georgia. Vegetation may include different woodland communities often dominated by southern pine species. *Pinus palustris*, *Pinus serotina*, and *Pinus elliottii* var. *elliottii* are all important in documented examples. These examples tend to have densely shrubby subcanopies and understories with species such as *Quercus virginiana*, *Quercus geminata*, *Quercus hemisphaerica*, *Quercus chapmanii*, *Quercus myrtifolia*, and *Magnolia grandiflora*. Unlike maritime vegetation to the north, this system may be more heavily influenced by natural fire regimes that may help to explain the predominance of the fire-tolerant pine species. It has been postulated that the natural fire frequency is from 20-30 years.”

This Ecological System covers nearly 10,000 acres of the Kings Bay vicinity, or 7.9% of the total. On the base itself it covers 928 acres, 6.8% of the total. In both cases it is the dominant upland natural vegetation type. Very large and high quality examples of this forest type are protected in Cumberland Island National Seashore and Crooked River State Park. Other high quality examples may be found on private lands near Point Peter in the Cumberland Harbour development and near the junction of Hwy. 40 and St. Mary’s Road, and on the Sub Base near Cherry Point.

Fort Benning

Background:

For the purposes of this project, the Fort Benning vicinity includes all of the Army base as well as a 10km buffer (within Georgia and Alabama), a total area of just under 570,000 acres. The Army base itself is near Columbus, GA in Muscogee and Chattahoochee Counties, GA and Russell County, AL, on the Fall Line (division between the Piedmont and Southeastern Plains ecoregions) (Griffith et al. 2001), and covers over 175,000 acres (156,000 in Georgia). In addition to the above counties, the buffer area also includes portions of Stewart, Schley, Marion, Talbot, and Harris Counties, GA. The landscape in general is hilly on both sides of the Fall Line and highly dissected by small streams. A good deal of both the Army base and its buffer contains Fall Line sandhills habitats. Drainages contain mesic hardwoods and a variety of wetlands. The northwestern portion of the mapping area is dominated by metropolitan Columbus, GA/Phenix City, AL, which contains over 280,000 residents (U.S. Census Bureau 2001), as well as urban developments on Fort Benning itself. There are several private conservation lands in the buffer area. These include The Nature Conservancy’s recent ACUB MeadWestvaco purchases (870 acres), and two large conservation easements in Muscogee County (378 acres, held by Georgia Land Trust) and Talbot/Muscogee County (1100 acres, held by The Nature Conservancy).

Methods:

SSURGO soil maps (U.S. Department of Agriculture 2008) were used in identification of sandhills and other soil-dependent communities. These communities were often further divided by spectral signature (i.e. evergreen vs. deciduous, etc.). Topographic/landform models, especially a Topographic Relative Moisture Index (Parker 1982) were developed from the National Elevation Database (U.S. Geological Survey 2005), and applied to a variety of natural vegetation types across a moisture gradient (mesic to xeric). This was especially useful in delineating areas of mesic hardwood forests or slope forests. Other Ecological Systems, especially non-riverine wetlands, were identified using aerial photographs and manually classified by their position in the landscape or other factors.

Results:

The Fort Benning Ecological Systems map is shown in Figure 14 and classifications and their acreages and relative coverages are given in Table 8.

Class	Acres	Percent
Open water	7040.91	1.24
Developed open space	32701.44	5.74
Low intensity developed	26566.18	4.67
Medium intensity developed	9382.84	1.65
High intensity developed	4388.87	0.77
Successional shrub/scrub (clearcut)	41557.21	7.30
Unconsolidated shore (lake, river, pond)	32.23	0.01
Quarries, mines	165.39	0.03
Evergreen plantations	96157.87	16.89
Successional shrub/scrub (other)	12164.70	2.14
Grassland/herbaceous (clearcut)	6718.80	1.18
Pasture/hay	19902.30	3.50
Row crop	16866.57	2.96
Utility swath	1739.50	0.31
Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier	14606.00	2.57
Southern Piedmont Dry Oak-(Pine) Forest - Loblolly Pine Modifier	1365.81	0.24
Southern Piedmont Mesic Forest	2591.35	0.46
Southeastern Interior Longleaf Pine Woodland	2.22	0.00
Southern Piedmont Small Floodplain and Riparian Forest	1479.06	0.26
Southern Piedmont Granite Flatrock	26.01	0.00
Atlantic Coastal Plain Sandhill Seep	91.14	0.02
Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland -herbaceous	4758.11	0.84
Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland -deciduous	21692.92	3.81
Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland -evergreen	6522.95	1.15
Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland -mixed	20643.00	3.63
East Gulf Coastal Plain Interior Shrub Bog	76.92	0.01
East Gulf Coastal Plain Southern Mesic Slope Forest	16189.89	2.84
East Gulf Coastal Plain Southern Mesic Slope Forest-mixed	1645.91	0.29
East Gulf Coastal Plain Large River Floodplain Forest	3922.48	0.69
East Gulf Coastal Plain Large River Floodplain Forest- evergreen	46.02	0.01
East Gulf Coastal Plain Large River Floodplain Forest- mixed	150.27	0.03

Southern Coastal Plain Blackwater River Floodplain Forest	39925.75	7.01
Southern Coastal Plain Blackwater River Floodplain Forest-evergreen	1042.36	0.18
Southern Coastal Plain Blackwater River Floodplain Forest-mixed	1616.34	0.28
East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - offsite species	38030.42	6.68
East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland	38030.19	6.68
Southern Coastal Plain Seepage Swamp and Baygall	2280.35	0.40
East Gulf Coastal Plain Northern Depression Pondshore	283.88	0.05
East Gulf Coastal Plain Small Stream and River Floodplain Forest	6584.53	1.16
Southern Coastal Plain Dry Upland Hardwood Forest	25669.87	4.51
Southern Coastal Plain Dry Upland Hardwood Forest-evergreen	41290.00	7.25
Southern Coastal Plain Dry Upland Hardwood Forest-mixed	3387.85	0.60
Total	569336.40	

Table 8. Vegetation/land cover classes for Fort Benning and vicinity, 2005.

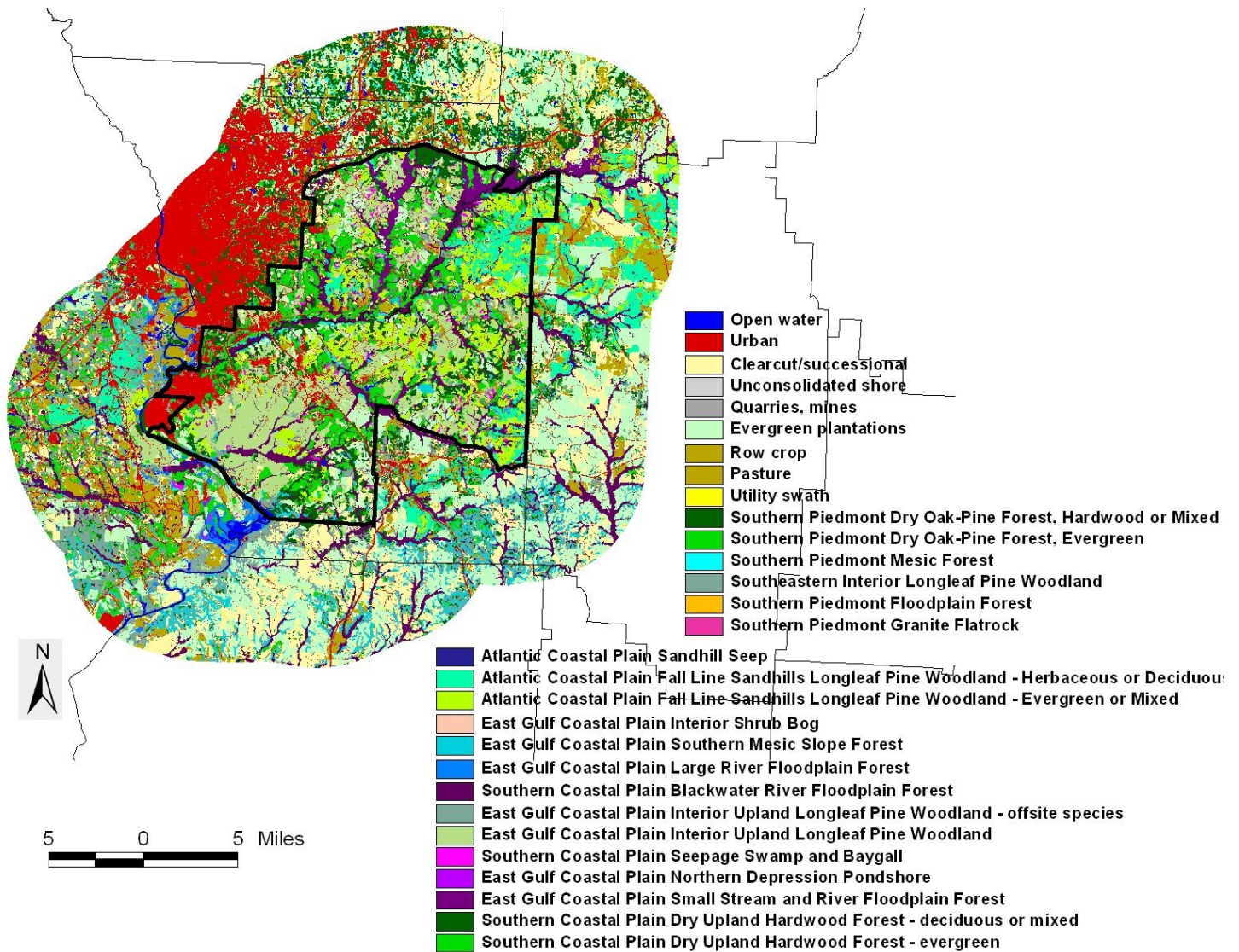


Figure 14. Ecological Systems map for Fort Benning and vicinity, 2005.

As of 2005, 12.8% of the Fort Benning vicinity is developed (urban cover type); on the base itself the figure is 8.3%. Development is highly concentrated in the Columbus-Phenix City metropolitan area. 52% of the Benning vicinity is in a “natural vegetation” type (Elliott and Kramer 2005), while on the Army base itself the figure is 79%. The dominant anthropogenic cover types are evergreen tree plantation, low density urban, and early successional forest stages associated with timber harvest.

Following is a discussion of the “natural vegetation” types of the Fort Benning vicinity – the Ecological Systems.

Southern Piedmont Dry Oak-(Pine) Forest (CES202.339)

Description from Comer et al. (2003): “This system encompasses the prevailing upland forests of the southern Piedmont. High-quality and historic examples are typically dominated by combinations of upland oaks, sometimes with pines as a significant component, especially in the southern portions of the region. These forests occur in a variety of habitats and, under natural conditions, were the matrix vegetation type covering most of the landscape. Much of this system is currently composed of successional forests that have arisen after repeated cutting, clearing, and cultivation of original oak-hickory forests.”

This Ecological System covers nearly 16,000 acres in the Fort Benning vicinity (2.8% of the total), all off-post in the Piedmont ecoregion of Muscogee, Harris, and Talbot Counties. It is the dominant upland natural vegetation type for the Piedmont. High-quality, though not large, examples are permanently protected on a Nature Conservancy conservation easement in Muscogee and Talbot County, and on Muscogee County greenspace property.

Southern Piedmont Mesic Forest (CES202.342)

Description from Comer et al. (2003): “This system encompasses mixed deciduous hardwood or occasionally hardwood-pine forests of mesic sites in the Piedmont (TNC Ecoregion 52) of the southeastern United States. Most examples occur on lower or north-facing slopes where topography creates mesic moisture conditions. A mix of a small number of mesophytic trees is usually dominant, with *Fagus grandifolia* most prominent. Both acidic and basic substrates are currently included in this concept, as are certain heath bluffs, where dense shrub layers of mesophytic ericaceous shrubs may occur beneath an open tree canopy. Fire is naturally infrequent in this system, due to the slopes and moist conditions. If fire does penetrate, it is likely to be low in intensity and may not have significant ecological effects.”

This Ecological System covers nearly 2600 acres in the Fort Benning vicinity, essentially all off-post in the Piedmont ecoregion of Muscogee, Harris, and Talbot Counties. As with the

above System, intact examples are protected on a Nature Conservancy conservation easement in Muscogee and Talbot County, and on Muscogee County greenspace property.

Southeastern Interior Longleaf Pine Woodland (CES202.319)

Description from Comer et al. (2003): “This system encompasses the fire-maintained woodlands and forests of the outer Piedmont of Georgia and the Carolinas and the Talladega upland region (quartzite-slate transition) of Alabama, where *Pinus palustris* is a dominant or codominant canopy species. Examples occur on rolling to somewhat mountainous upland slopes in North Carolina, South Carolina, Georgia, and Alabama. They are believed to naturally be open woodlands with grassy ground cover, but many are now closed forests with dense shrubs or with little ground cover.”

As mapped, this Ecological System covers just over 2 acres in scattered pixels off-post in the Piedmont ecoregion. However, it is likely that these occurrences are erroneously mapped. This ecosystem still occurs just north of the mapping area on Pine Mountain in Harris and Talbot Counties, GA, and it no doubt was historically more widespread throughout the Piedmont sections of the mapping area, but has been lost to agriculture, urban development, and fire suppression (Wharton 1978).

Southern Piedmont Small Floodplain and Riparian Forest (CES202.323)

Description from Comer et al. (2003): “This system consists of vegetated communities along streams and small rivers in the Piedmont of the southeastern United States where flooding and flood-related environmental factors affect vegetation composition and dynamics. The vegetation includes both non-forested bar and scour communities and the more extensive forested floodplain communities. The forests of these smaller floodplains and bottomlands are not differentiated by depositional landforms such as levees, sloughs, ridges, terraces, and abandoned channel segments, because these features are small and flooding regimes are variable. The system is affected by flooding through wetness, scouring, deposition of material, and input of nutrients.”

This Ecological System covers about 1480 acres in the Fort Benning vicinity, all off-post in Muscogee, Harris, and Talbot Counties on the floodplain of medium-sized streams like Dry Creek, Scroggins Branch, and Flatrock Branch.

Southern Piedmont Granite Flatrock (CES202.329)

Description from Comer et al. (2003): “: This system consists of smooth, exfoliated outcrops of massive granite and related rocks in the eastern and central Piedmont of the southeastern United States, and rarely in the adjacent Atlantic Coastal Plain (confined to the Fall-Line where erosion has exposed underlying rocks). Examples occur from Virginia south to Alabama, but are found most abundantly in the upper Piedmont of Georgia. Depending upon the location, examples may rise above the surrounding landscape by as much as 200 m, or lie flush with the surrounding land surface. The vegetation is a complex of small-patch communities of different species and structure

occupying different microhabitats present on the outcrops, ranging from moss and lichens to herbs to shrubs and trees. In some areas, these microhabitats include solution pits or depressions that retain water and form a distinctive wetland community. This outcrop system supports a relatively high degree of endemic plants. Some noteworthy examples in central Georgia include Stone Mountain and Arabia Mountain, in DeKalb County.”

This Ecological System is known from two locations (covering a total of 26 acres) in the Fort Benning vicinity. One is from a Muscogee County park (“Flatrock Park”); the other in southern Harris County near the Muscogee County line.

Atlantic Coastal Plain Sandhill Seep (CES202.253)

Description from Comer et al. (2003): “This sandhill seep system occurs in small patches on slopes in dissected terrain, where a clay lens or other impermeable layer forces groundwater to the surface as seepage. This type occurs largely in the Fall-line Sandhills region of the Carolinas and Georgia but also rarely in other parts of the Atlantic Coastal Plain. Soils are seasonally to permanently saturated by seepage and range from sandy or clayey to mucky. Vegetation is variable and complex in composition and structure, consisting of a mixture of plants of pine savannas and streamhead pocosins, but contrasting with both in structure and proportions. The tree canopy may be open or absent, and patches of dense shrubs, dense grass, ferns, and various mixtures may be present. Fire is a crucial determinant of structure and composition; it tends to occur in a variable and patchy pattern that is driven by both the fire regime of the surrounding system and the wetness of the seep vegetation at the time.”

This Ecological System as mapped covers nearly 100 acres in the Fort Benning vicinity, 88 of which are on the Army base itself. Examples on-base are found near Pope Pond and on several steep slopes in Muscogee County that drain to the south into Upatoi Creek. Off-base there are two small examples in northern Marion County off of County Road 64. This is a small patch system that is difficult to map remotely, and there may be other examples not identified in this project.

Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)

Description from Comer et al. (2003): “This system occurs in the Fall-line Sandhills region of central North Carolina extending into central Georgia. It is the predominant system in its range, covering most of the natural landscape of the region. It occurs on upland sites ranging from gently rolling, broad ridgetops to steeper side slopes, as well as locally in mesic swales and terraces. Most soils are well- to excessively drained. The vegetation is naturally dominated by longleaf pine (*Pinus palustris*). Most associations have an understory of scrub oaks (*Quercus laevis*, *Quercus marilandica*, *Quercus incana*, and *Quercus margarettiae*). The herb layer is generally well-developed and dominated by grasses. Wiregrass (*Aristida stricta* in the north, *Aristida beyrichiana* in the south) dominates in most of the range, but other grasses dominate where it is absent. Forbs, including many legumes, are also abundant. Frequent, low-intensity fire is the dominant natural ecological force.”

This Ecological System covers over 50,000 acres in the Fort Benning vicinity (9.4% of the total land area), including over 30,000 acres (17%) of the base itself. It is the dominant upland ecosystem in most of the mapping area, especially over Lakeland or Troup soil types. No high-quality examples are currently permanently protected in this area, but a potential restoration site is located in the Mead/ACUB TNC lands in Marion County. The highest-quality example of this ecosystem found during Phase 2 of the project is located in northern Marion County near Bethany Church and the junction of Highway 41 and County Road 64. Most off-post areas of this system have been impacted by industrial silviculture and/or fire suppression. There are numerous high-quality examples of this cover type on Fort Benning, especially in the northeast quadrant of the base.

East Gulf Coastal Plain Interior Shrub Bog (CES203.385)

Description from Comer et al. (2003): “This ecological system includes wet, shrub-dominated seepage communities in the Upper East Gulf Coastal Plain of Alabama, adjacent Georgia, and possibly Mississippi. These wetlands generally occur in small patches on slopes within a matrix of longleaf pine-dominated vegetation. Wetland conditions are maintained by seepage flow from adjacent uplands. Examples of this system can vary between densely shrubby and fairly open and herbaceous, depending on frequency of fire and amount of elapsed time since the previous fires. However, this system tends to be much shrubbier due to topographic isolation than related seepage bog system of the Outer Coastal Plain such as ~Southern Coastal Plain Herbaceous Seepage Bog (CES203.078). The globally rare pitcher plant *Sarracenia rubra ssp. alabamensis* may be present in some examples of this system.”

This Ecological System as mapped covers nearly 80 acres in the Fort Benning vicinity, all on the Army base. Examples are found in Chattahoochee County along Long Branch, Randall Branch, Wolf Creek, and tributaries.

East Gulf Coastal Plain Southern Mesic Slope Forest (CES203.276)

Description from Comer et al. (2003): “: This forested system of the southern East Gulf and Atlantic Coastal Plains occurs on steep slopes, bluffs, or sheltered ravines where fire is naturally rare, generally within the natural range of *Pinus glabra* as mapped by Kossuth and Michael (1990) and *Magnolia grandiflora* as mapped by Outcalt (1990). Stands are mesic, and vegetation typically includes species such as *Fagus grandifolia*, *Magnolia grandiflora*, *Illicium floridanum*, and other species rarely encountered outside this system in the region. Related forests which occur on deep loess soils along the western margin of the region are classified as ~East Gulf Coastal Plain Southern Loess Bluff Forest (CES203.556). Some component associations are also found in temporarily flooded floodplains adjacent to these slopes, but this is primarily an upland system. The system also includes essentially upland vegetation of Pleistocene terraces, although these are conceptually transitional to creek floodplain systems.”

This Ecological System covers nearly 18,000 acres (3.1%) of the Fort Benning vicinity, over 2300 (1.3%) of which are on the base itself. It is most common in steep ravines of Chattahoochee and Stewart Counties, especially extending southward from the far southwestern corner of the Army base. Very high quality examples may be found on former (?) MeadWestvaco lands both in Stewart County near Hannahatchee Creek and in Chattahoochee County near Hitchitee Creek. Another outstanding example is located on private lands near Slaughter Creek in Stewart County. None are permanently protected.

East Gulf Coastal Plain Large River Floodplain Forest (CES203.489)

Description from Comer et al. (2003): “This system represents a geographic subset of Kuchler's (1964) Southern Floodplain Forest. Examples may be found along large rivers of the East and Upper East Gulf Coastal Plain, especially the Apalachicola, Alabama/Cahaba, Tombigbee, Pascagoula, and Pearl rivers, all of which ultimately drain into the Gulf of Mexico. Several distinct plant communities can be recognized within this system that may be related to the array of different geomorphologic features present within the floodplain. Some of the major geomorphic features associated with different community types include natural levees, point bars, meander scrolls, oxbows, and sloughs (Sharitz and Mitsch 1993). Vegetation generally includes forests dominated by bottomland hardwood species and other trees tolerant of flooding. However, herbaceous and shrub vegetation may be present in certain areas as well.”

This Ecological System covers over 4100 acres in the Fort Benning vicinity (<1% of the total area), and just over 2000 acres (1% of total) on the base itself. It is found along the Chattahoochee River, especially on the Alabama side near the southern end of the base.

Southern Coastal Plain Blackwater River Floodplain Forest (CES203.493)

Description from Comer et al. (2003): “This system occurs along certain river and stream drainages of the Southern Coastal Plain of Florida, Alabama, Mississippi, and southwestern Georgia that are characterized by dark waters high in particulate and dissolved organic materials, and that generally lack floodplain development. In most cases these are streams that have their headwaters in sandy portions of the Outer Coastal Plain. Consequently, they carry little mineral sediment or suspended clay particles and are not turbid except after the heaviest rain events. The water is classically dark in color due to concentrations of tannins, particulates, and other materials derived from drainage through swamps or marshes (FNAI 1990). In comparison with brownwater rivers of the region, this system tends to be much more acidic in nature and generally lacks extensive and continuous floodplain and levees; steep banks alternating with floodplain swamps are more characteristic (FNAI 1990).”

As mapped this Ecological System covers over 42,000 acres in the Fort Benning vicinity (7.5% of total), and nearly 17,700 acres (10%) of the base itself. However, during Phase 2 of this project it was observed that, even when small streams originate within the Coastal Plain, in this part of the state their floodplain forests often may more closely resemble the East Gulf Coastal Plain Small Stream and River Floodplain Forest

Ecological System (CES203.559), although distinctions are fine. Tom Govus observed: “Southern Coastal Plain Blackwater River Floodplain Forests tend to be dominated by species such as *Taxodium distichum* (bald-cypress), *Nyssa aquatica* (water tupelo) and *Chamaecyparis thyoides* (Atlantic white-cedar). The small stream forests sampled during this study tended to be dominated by *Liquidambar styraciflua*, *Liriodendron tulipifera*, *Quercus laurifolia*, *Quercus nigra*, *Quercus michauxii* and *Quercus phellos* and had a bottomland hardwood floodplain character that is more appropriately attributed to East Gulf Coastal Plain Small Stream and River Floodplain Forests” (Appendix A). There are several Atlantic white-cedar swamps in the mapping area, and doubtless bald-cypress and water tupelo occur as well, so perhaps the distinction needs further study. At any rate, outstanding white-cedar swamps may be found within the mapping area east of Fort Benning in Marion County along Fort Perry and Juniper Creeks.

East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland (CES203.496)

Description from Comer et al. (2003): “This system represents longleaf pine forests of rolling, dissected uplands of the East Gulf Coastal Plain. These stands occur primarily in Ecoregion 65 (EPA 2004). It is found inland of the coastal flatlands (*sensu* Peet and Allard (1993); Ecoregion 75a (EPA 2004)) and extends landward into the Upper East Gulf Coastal Plain Ecoregion (*sensu* TNC) by about 80 km (50 miles). It potentially occupies a much larger geographic area than the related longleaf pine woodlands of the outer coastal area. The characteristic species is *Pinus palustris*, although many stands may support only relict individuals following a long history of exploitation, harvest, and stand conversion, primarily to *Pinus taeda*. This system includes stands with a range of soil and moisture conditions. Mesic stands on medium- to fine-textured soils are more typical of the system, although limited xeric areas on deep sands are also present. In natural condition, fire is believed to have been frequent enough to limit development of intolerant species of hardwoods and both *Pinus taeda* and *Pinus echinata*. Although such species may be present or even common in the most mesic stands, they generally do not share dominance in the overstory unless the system has been fire-suppressed.”

This Ecological System covers approximately 76,000 acres (13.4%) of the Fort Benning mapping area, although half of this acreage is presently dominated by offsite species, especially hardwoods and loblolly pine. Nearly all the woodland that presently contains longleaf is found on Fort Benning, although there are scattered small exceptions in Stewart County. Fire suppression and conversion to pine plantation have displaced most off-post examples.

Southern Coastal Plain Seepage Swamp and Baygall (CES203.505)

Description from Comer et al. (2003): “This wetland system consists of forested wetlands in acidic, seepage-influenced habitats of the East Gulf Coastal Plain, extending into central Florida. These are mostly evergreen forests generally found at the base of slopes or other habitats where seepage flow is concentrated. Resulting moisture conditions are saturated or even inundated. The vegetation is characterized by *Magnolia virginiana* and *Nyssa biflora*. Examples occur in the outer portions of the Coastal Plain within the range of *Persea palustris*, and where *Magnolia virginiana* is an important or even dominant

species. To the north this system grades into ~East Gulf Coastal Plain Northern Seepage Swamp (CES203.554), where evergreen species are largely replaced by deciduous species in the canopy. Due to excessive wetness, these habitats are normally protected from fire except those which occur during extreme droughty periods. These environments are prone to long-duration standing water, and tend to occur on highly acidic, nutrient-poor soils.”

This Ecological System covers nearly 2300 acres in the Fort Benning vicinity, nearly all on the base itself (1.2% of base total acreage). Examples on-post may be found along Oswichee Creek, and were noted during Phase 2 of this project off-post along Little Hichitee Creek in Chattahoochee County and Kinchafoonee Creek in Marion County.

East Gulf Coastal Plain Northern Depression Pondshore (CES203.558)

Description from Comer et al. (2003): “This system consists of a variety of upland depression pondshores of the northern East Gulf Coastal Plain. Included here are shallow ponds of various geomorphic origins in a variety of substrates (e.g., limesinks, Grady Ponds) which are not separately distinguished as systems. These are generally in isolated upland situations, and are not part of a stream system, although they may serve as the origin of a stream system in a general way, releasing water gradually into the stream drainage system during periods of wet weather. In some examples, a distinct zonation of vegetation is present, in others the zones are not distinct or the differing associations are present in a complex mosaic. Most seasonal depression ponds are usually composed of mosaics of several plant associations. The vegetation includes various zones which become exposed as water levels decline, as well as emergent (rising out of the water) or submergent/floating plants. Some typical associations include ones dominated by species such as *Dichantheium wrightianum*, *Dichantheium erectifolium*, *Eleocharis equisetoides*, *Eleocharis microcarpa*, *Juncus effusus*, *Juncus repens*, *Rhynchospora corniculata*, *Rhynchospora inundata*, *Panicum hemitomon*, *Proserpinaca* spp., *Pluchea* spp., *Ludwigia* spp., *Saccharum* spp., *Panicum verrucosum*, *Rhexia* spp., and *Sabatia angularis*. In addition, associations dominated by *Polygonum* spp., *Leersia* spp., and *Typha* spp. may be present but are not characteristic.”

This small patch Ecological System covers 284 acres in the Fort Benning vicinity, 227 of which are on the base itself. Ecologically significant ponds are located amongst sandhills along the eastern border of Fort Benning in Chattahoochee County.

East Gulf Coastal Plain Small Stream and River Floodplain Forest (CES203.559)

Description from Comer et al. (2003): “This is a predominantly forested system of the East Gulf Coastal Plain associated with small brownwater rivers and creeks. In contrast to ~East Gulf Coastal Plain Large River Floodplain Forest (CES203.489), it has fewer major geomorphic floodplain features typically associated with large river floodplains. Those features that are present tend to be smaller and more closely intermixed with one another, resulting in less obvious vegetation zonation. Bottomland hardwood tree species are typically important and diagnostic, although mesic hardwood species are also present

in areas with less inundation, such as upper terraces and possibly second bottoms. As a whole, flooding occurs annually, but the water table usually is well below the soil surface throughout most of the growing season. Areas impacted by beaver impoundments are also included in this system.”

This Ecological System as mapped covers just under 6600 acres in the Fort Benning vicinity (1.2%), of which nearly 3600 (2%) are on the base itself. As noted above, there may have been confusion between this system and Southern Coastal Plain Blackwater River Floodplain Forest (CES203.493); it is quite like that East Gulf Coastal Plain Small Stream and River Floodplain Forest was under-mapping by this project. Outstanding examples of this forest type are found both on- and off-base along Randall Creek and Upatoi Creek. One stand along Upatoi Creek is permanently by a Nature conservancy conservation easement.

Southern Coastal Plain Dry Upland Hardwood Forest (CES203.560)

Description from Comer et al. (2003): “This is one of three hardwood-dominated systems found in the East Gulf Coastal Plain and adjacent areas of central Florida. This type is found in the Southern Coastal Plain and Southeastern Plains (EPA Level III Ecoregion 75 and parts of 65). Examples attributable to this type are typically deciduous or mixed evergreen oak-dominated forests, often with a pine component present. Although the southern portion of the range of this system overlaps ~Southern Coastal Plain Oak Dome and Hammock (CES203.494), the latter is dominated by evergreen oak species, and the two should not be confused. The core range of this type extends northward to the approximate historical range of longleaf pine; although most deciduous species do not mimic this range, this boundary does appear to be a reasonable demarcation boundary north of which *Quercus alba* becomes more abundant and south of which *Quercus hemisphaerica* is more diagnostic. Like all hardwood systems of this region, examples occur within a landscape matrix historically occupied by pine-dominated uplands and consequently only occurred in fire-sheltered locations in naturally small to large patches. Examples of this system tend to occur on sites intermediate in moisture tendency (mostly dry to dry-mesic), although occasional xeric stands may also be included. Toward the northern range limits of this system, it may have been less restricted to small patches in fire-protected locations, and may have been formerly more prevalent on the landscape even in areas heavily influenced by fire.

Important tree species vary geographically and according to previous disturbance. *Quercus hemisphaerica* is a typical species in many examples, with *Quercus stellata*, *Quercus falcata*, and *Quercus alba* less frequently encountered, but dominant in some stands. The overstory of some examples may be quite diverse, with hickories and other hardwood species often present. Typically mesic sites, as indicated by species indicative of these conditions, are covered under other systems. *Pinus taeda* is sometimes present, but it is unclear if it is a natural component or has entered only as a result of past cutting. *Pinus glabra* may also be present in some examples. Stands may be found on slopes above rivers and adjacent to sinkholes, as well as other fire-infrequent habitats.”

This Ecological System covers over 70,000 acres in the Fort Benning vicinity (12.3%), over 40,000 of which are found on the base itself (22.7% of base total). It is the dominant ecosystem on many upland clay soils on the Army base, and likely would be to the south as well, especially in Stewart County (Wharton 1978). However, most examples in Georgia have been replaced by intensive pine silviculture. Extant examples may be found in Alabama; none are permanently protected.

Field Verification

Phase 2 of this project involved visiting a subset of important Ecological Systems associated with each military base, usually off of the base itself. The ecological condition of individual examples was evaluated, especially with regard to how they might provide suitable habitat for rare species, in particular Species at Risk.

Methods:

Phase 2 was contracted out to Tom Govus, a consulting vegetation ecologist who works throughout the Southeast. He has been frequently utilized by both Georgia DNR and NatureServe. The following discussion will describe Mr. Govus' evaluations at each military base. His final reports to Georgia DNR are shown in their entirety in Appendix A and Appendix B.

Govus pre-determined a number of field days that could be devoted to each military installation and selected sites to visit based on their potential for Species at Risk and their appearance on aerial photographs. Since nearly all sites were on private lands, accessibility was a major issue, and not all sites selected could be visited. Occasionally, outstanding communities were observed while in the field, and site data were gathered opportunistically. At each field site, vegetation data, especially Quickplots (developed by NatureServe) were taken. These data were matched to existing vegetation types to the Ecological systems and Association level and sites were assigned a community type, which may or may not have matched the original map. In many cases, rare species were also recorded during these site visits; some of these were actually Species at Risk, discussed in more detail in Appendix A and Appendix B.

Since the field sites selected were not randomly chosen and not stratified by areal extent, true error rates cannot be reported. However, they can be used as general indicators of certain strengths or weaknesses of the Ecological Systems maps.

Results:

Results of Phase 2 are reported in the following six sections by military installation.

Fort Gordon

A total of 37 field sites representing six Ecological system types were visited during Phase 2 of this project. These are described in Table 9 and illustrated in Figure 15.

Id	Class	CES Code	Rank	Correct ID?
1	Atlantic CP Brownwater Stream Floodplain Forest	203.248	Good	No
22	Atlantic CP Brownwater Stream Floodplain Forest	203.248	Excellent	Yes
3	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Good	Yes
4	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Good	No
5	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Good	Yes
6	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Fair	No
7	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Poor	No
11	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Good	No
19	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Poor	Yes
23	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Fair	Yes
26	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Very good	Yes
27	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Very good	Yes
28	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Very good	Yes
29	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Fair	Yes
30	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Fair	Yes
32	Atlantic CP Fall-line Sandhills LLP Woodland	203.254	Poor	No
2	Atlantic CP Mesic Hardwood Forest	203.242	Poor	Yes
12	Atlantic CP Mesic Hardwood Forest	203.242	Good	No
21	Atlantic CP Mesic Hardwood Forest	203.242	Good	No
25	Atlantic CP Mesic Hardwood Forest	203.242	Good	No
37	Atlantic CP Mesic Hardwood Forest	203.242	Good	No
8	Atlantic CP Mesic Hardwood Forest	203.242	Fair	No
9	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Good	Yes
16	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Fair	Yes
17	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Fair	Yes
18	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Poor	Yes
10	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.505	Excellent	No
14	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.252	Good	No
15	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.252	Good	No
24	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.252	Excellent	No
31	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.252	Good	No
33	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.252	Good	No
36	Atlantic CP Streamhead Seepage Swamp, Pocosin, & Baygall	203.252	Excellent	No
13	Evergreen plantation	None	Poor	No
20	Southern Atlantic CP Depression Pondshore	203.262	Good	No
34	Southern Atlantic CP Depression Pondshore	203.262	Poor	No
35	Southern Atlantic CP Depression Pondshore	203.262	Good	No

Table 9. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Gordon.

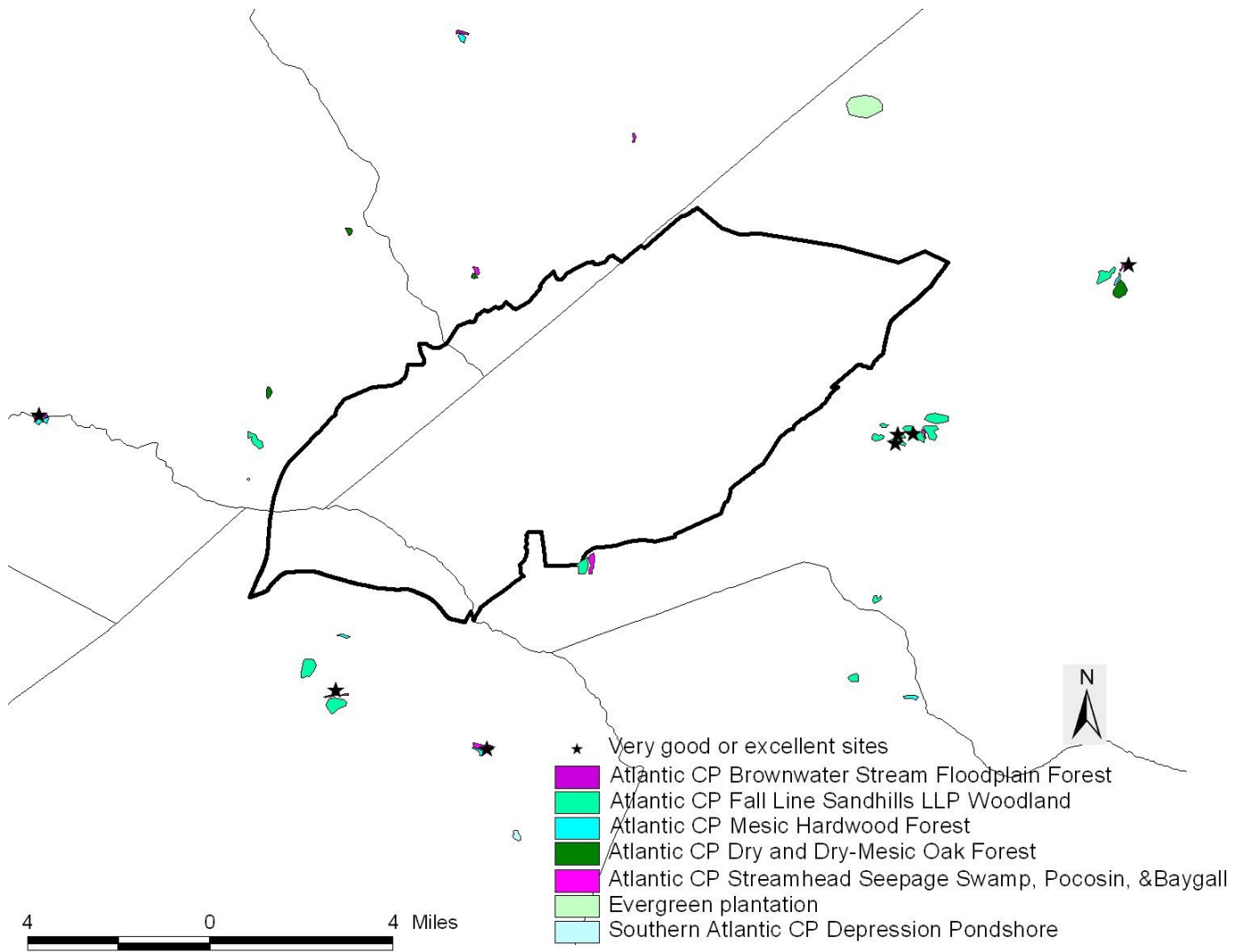


Figure 15. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Gordon.

A total of 22 of the field sites visited were judged to be in error. However, a majority of these errors were not in likely to be of importance to Species at Risk. Four sites visited were judged to be of excellent quality, and two very good. None of these high quality sites are permanently protected. These are discussed in more detail in Appendix A.

Fort Stewart

A total of 103 field sites representing 13 Ecological system types were visited during Phase 2 of this project. These are described in Table 10 and illustrated in Figure 16 and 17.

Id	Class	ES Code	Rank	Correct ID?
24	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Good	Yes
26	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Poor	Yes
30	Atlantic CP Blackwater Stream Floodplain Forest	203.247	OK	No
91	Atlantic CP Clay-Based Carolina Bay Wetland	203.245	Good	Yes
18	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Good	No
42	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Excellent	No
43	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Excellent	No
41	Atlantic CP Small Blackwater River Floodplain Forest	203.249	Excellent	Yes
54	Atlantic CP Small Blackwater River Floodplain Forest	203.249	Good	Yes
56	Atlantic CP Small Blackwater River Floodplain Forest	203.249	Good	No
73	Atlantic CP Small Blackwater River Floodplain Forest	203.249	Excellent	No
1	Atlantic CP Upland Longleaf Pine Woodland	203.281	Excellent	No
2	Atlantic CP Upland Longleaf Pine Woodland	203.281	Poor	Yes
3	Atlantic CP Upland Longleaf Pine Woodland	203.281	Poor	Yes
5	Atlantic CP Upland Longleaf Pine Woodland	203.281	Good	No
11	Atlantic CP Upland Longleaf Pine Woodland	203.281	Good	No
44	Atlantic CP Upland Longleaf Pine Woodland	203.281	Poor	No
49	Atlantic CP Upland Longleaf Pine Woodland	203.281	Excellent	Yes
50	Atlantic CP Upland Longleaf Pine Woodland	203.281	Poor	No
55	Atlantic CP Upland Longleaf Pine Woodland	203.281	Poor	Yes
57	Atlantic CP Upland Longleaf Pine Woodland	203.281	Fair	No
58	Atlantic CP Upland Longleaf Pine Woodland	203.281	Fair	No
63	Atlantic CP Upland Longleaf Pine Woodland	203.281	Poor	No
64	Atlantic CP Upland Longleaf Pine Woodland	203.281	Good	No
98	Atlantic CP Upland Longleaf Pine Woodland	203.281	Excellent	Yes
99	Atlantic CP Upland Longleaf Pine Woodland	203.281	Fair	No
102	Atlantic CP Upland Longleaf Pine Woodland	203.281	Good	Yes
17	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
19	Atlantic CP Xeric River Dune	203.497	Good	Yes
21	Atlantic CP Xeric River Dune	203.497	Good	Yes
22	Atlantic CP Xeric River Dune	203.497	Good	Yes
23	Atlantic CP Xeric River Dune	203.497	Good	Yes
28	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
29	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
32	Atlantic CP Xeric River Dune	203.497	Fair	Yes
36	Atlantic CP Xeric River Dune	203.497	Fair	Yes
37	Atlantic CP Xeric River Dune	203.497	Good	Yes
46	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
69	Atlantic CP Xeric River Dune	203.497	Good	Yes
70	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
72	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
74	Atlantic CP Xeric River Dune	203.497	Excellent	No
88	Atlantic CP Xeric River Dune	203.497	Good	No
77	Central Atlantic CP Salt and Brackish Tidal Marsh	203.270	Good	No

4	Not a natural system		Poor	No
6	Not a natural system		Poor	No
8	Not a natural system		Poor	No
14	Not a natural system		Poor	No
20	Not a natural system		Poor	No
38	Not a natural system		Poor	No
39	Not a natural system		Poor	No
52	Not a natural system		Poor	No
53	Not a natural system		Poor	No
65	Not a natural system		Poor	No
75	Not a natural system		Poor	No
76	Not a natural system		Poor	No
78	Not a natural system		Poor	No
82	Not a natural system		Poor	No
87	Not a natural system		Poor	No
7	Southern Atlantic CP Depression Pondshore	203.262	Fair	Yes
10	Southern Atlantic CP Depression Pondshore	203.262	Fair	Yes
12	Southern Atlantic CP Depression Pondshore	203.262	Fair	Yes
16	Southern Atlantic CP Depression Pondshore	203.262	Good	Yes
27	Southern Atlantic CP Depression Pondshore	203.262	Poor	Yes
35	Southern Atlantic CP Depression Pondshore	203.262	Good	No
59	Southern Atlantic CP Depression Pondshore	203.262	Poor	No
60	Southern Atlantic CP Depression Pondshore	203.262	Poor	No
61	Southern Atlantic CP Depression Pondshore	203.262	Good	Yes
96	Southern Atlantic CP Depression Pondshore	203.262	Excellent	Yes
100	Southern Atlantic CP Depression Pondshore	203.262	Fair	Yes
9	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
13	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
15	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	No
25	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
31	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
33	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
34	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
40	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	Yes
45	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
48	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
51	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	Yes
62	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	Yes
67	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
68	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
79	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	Yes
80	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
81	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
83	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
84	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
85	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	Yes
86	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes

89	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
92	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
93	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
94	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	Yes
101	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
103	Southern Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
66	Southern CP Dry Upland Hardwood Forest	203.560	Poor	Yes
90	Southern CP Nonriverine Cypress Dome	203.251	Good	Yes
97	Southern CP Nonriverine Cypress Dome	203.251	Good	Yes
95	Southern CP Oak Dome and Hammock	203.494	Good	Yes
71	Southern CP Seepage Swamp and Baygall	203.505	Good	No
47	Southern CP Seepage Swamp and Baygall	203.505	Good	No

Table 10. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Stewart.

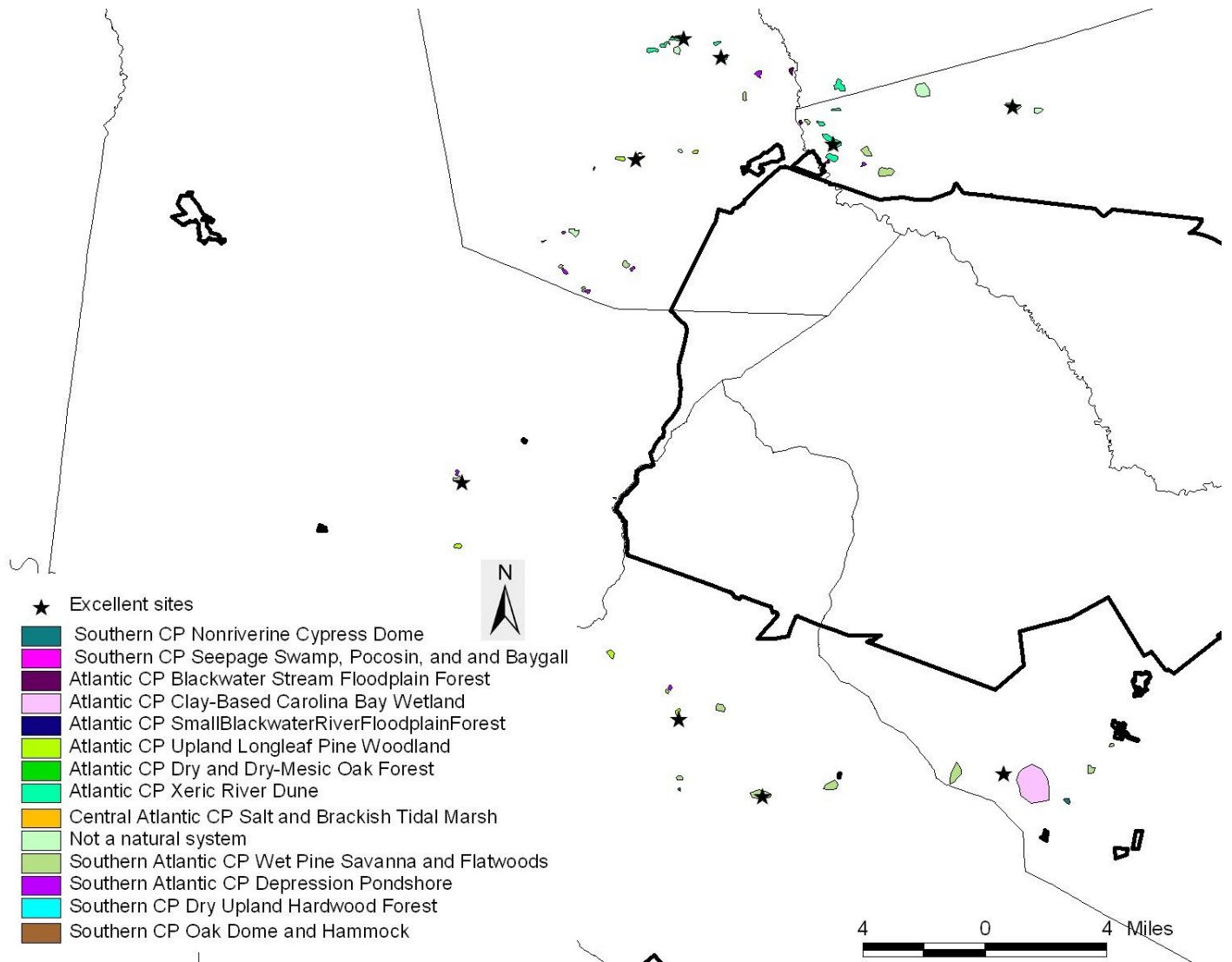


Figure 16. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Stewart - West.

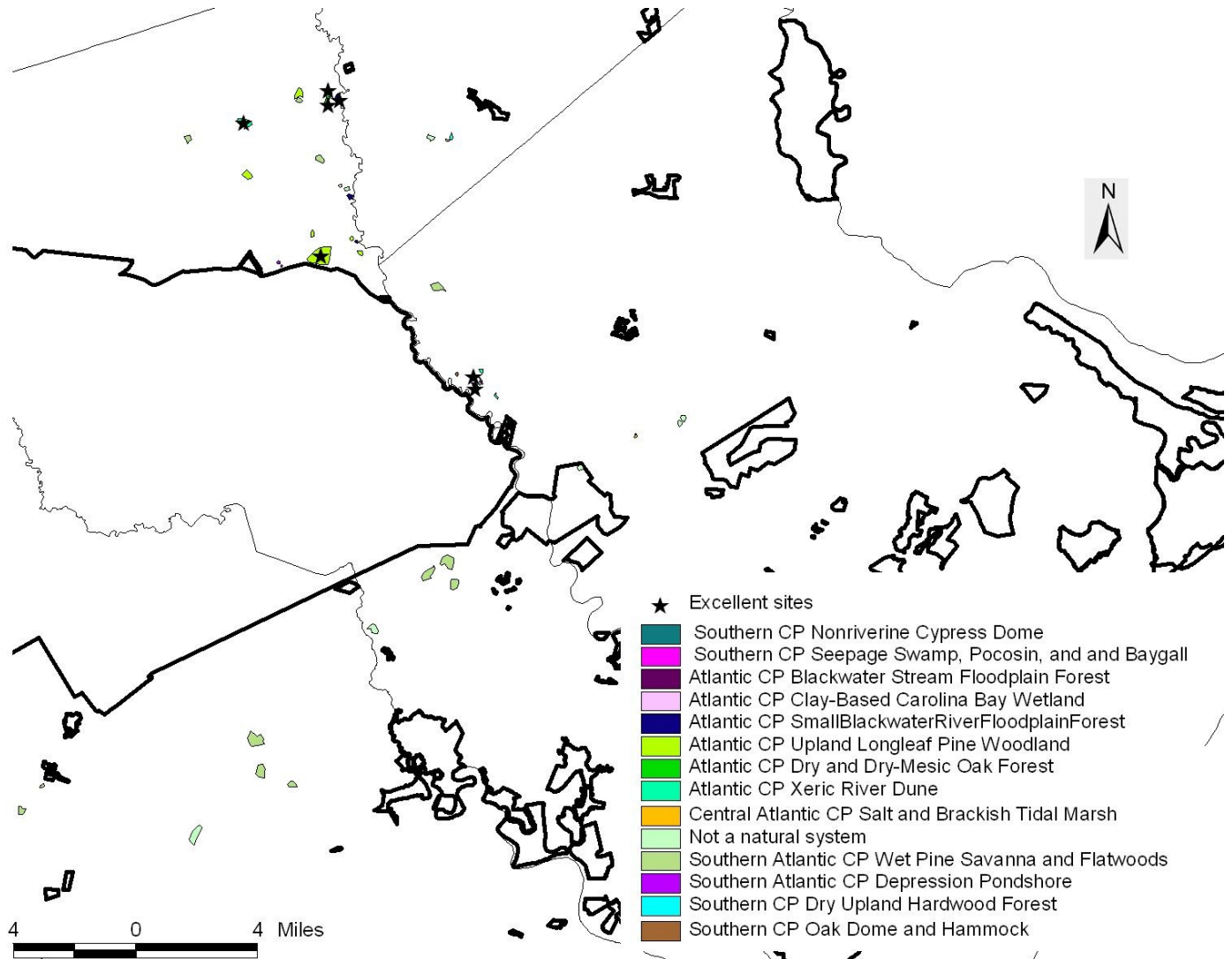


Figure 17. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Stewart - East.

63 of the 103 field sites visited were judged to be accurate. 18 sites visited were judged to be of excellent quality. Only one of these is permanently protected – a xeric sand ridge that is part of the S&O Canal property recently purchased by Chatham Co. These are discussed in more detail in Appendix A.

Robins Air Force Base

A total of 46 field sites representing 7 Ecological System types were visited during Phase 2 of this project. These are described in Table 11 and illustrated in Figure 18.

Id	Class	ES code	Rank	Correct ID?
28	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Good	No
44	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Excellent	Yes
36	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Good	No
26	Atlantic CP Mesic Hardwood Forest	203.242	Excellent	Yes
1	Atlantic CP Mesic Hardwood Forest	203.242	Good	Yes
2	Atlantic CP Mesic Hardwood Forest	203.242	Excellent	Yes
3	Atlantic CP Mesic Hardwood Forest	203.242	Fair	No
5	Atlantic CP Mesic Hardwood Forest	203.242	Good	Yes
8	Atlantic CP Mesic Hardwood Forest	203.242	Excellent	No
9	Atlantic CP Mesic Hardwood Forest	203.242	Good	No
11	Atlantic CP Mesic Hardwood Forest	203.242	Excellent	No
13	Atlantic CP Mesic Hardwood Forest	203.242	Fair	No
14	Atlantic CP Mesic Hardwood Forest	203.250	Excellent	No
17	Atlantic CP Mesic Hardwood Forest	203.242	Good	No
18	Atlantic CP Mesic Hardwood Forest	203.242	Fair	Yes
24	Atlantic CP Mesic Hardwood Forest	203.242	Excellent	Yes
30	Atlantic CP Mesic Hardwood Forest	203.242	Fair	No
29	Atlantic CP Mesic Hardwood Forest	203.242	Good	Yes
31	Atlantic CP Mesic Hardwood Forest	203.242	Good	Yes
32	Atlantic CP Mesic Hardwood Forest	203.242	Good	Yes
35	Atlantic CP Mesic Hardwood Forest	203.242	Very good	Yes
39	Atlantic CP Mesic Hardwood Forest	203.242	Poor	Yes
40	Atlantic CP Mesic Hardwood Forest	203.242	Fair	Yes
41	Atlantic CP Mesic Hardwood Forest	203.242	Fair	Yes
42	Atlantic CP Mesic Hardwood Forest	203.242	Poor	Yes
45	Atlantic CP Mesic Hardwood Forest	203.242	Fair	Yes
46	Atlantic CP Mesic Hardwood Forest	203.242	Fair	Yes
19	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Excellent	No
7	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Excellent	No
10	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Poor	Yes
16	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Excellent	Yes
22	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Good	Yes
33	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Good	Yes
34	Atlantic CP Small Brownwater River Floodplain Forest	203.250	Excellent	Yes
43	Southern Atlantic CP Depression Pondshore	203.262	Good	Yes
4	Southern CP Blackland Prairie & Woodland	203.478	Excellent	Yes
6	Southern CP Blackland Prairie & Woodland	203.478	Fair	Yes
12	Southern CP Blackland Prairie & Woodland	203.478	Poor	No
20	Southern CP Blackland Prairie & Woodland	203.478	Good	Yes

25	Southern CP Blackland Prairie & Woodland	203.478	Excellent	Yes
27	Southern CP Blackland Prairie & Woodland	203.478	Poor	No
37	Southern CP Blackland Prairie & Woodland	203.478	Poor	No
38	Southern CP Blackland Prairie & Woodland	203.478	Excellent	No
23	Southern CP Mesic Slope Forest	203.476	Good	Yes
21	Southern CP Mesic Slope Forest	203.476	Excellent	Yes
15	Southern CP Mesic Slope Forest	203.476	Good	Yes

Table 11. Sites visited during Phase 2 of Georgia Species at Risk project at Robins Air Force Base.

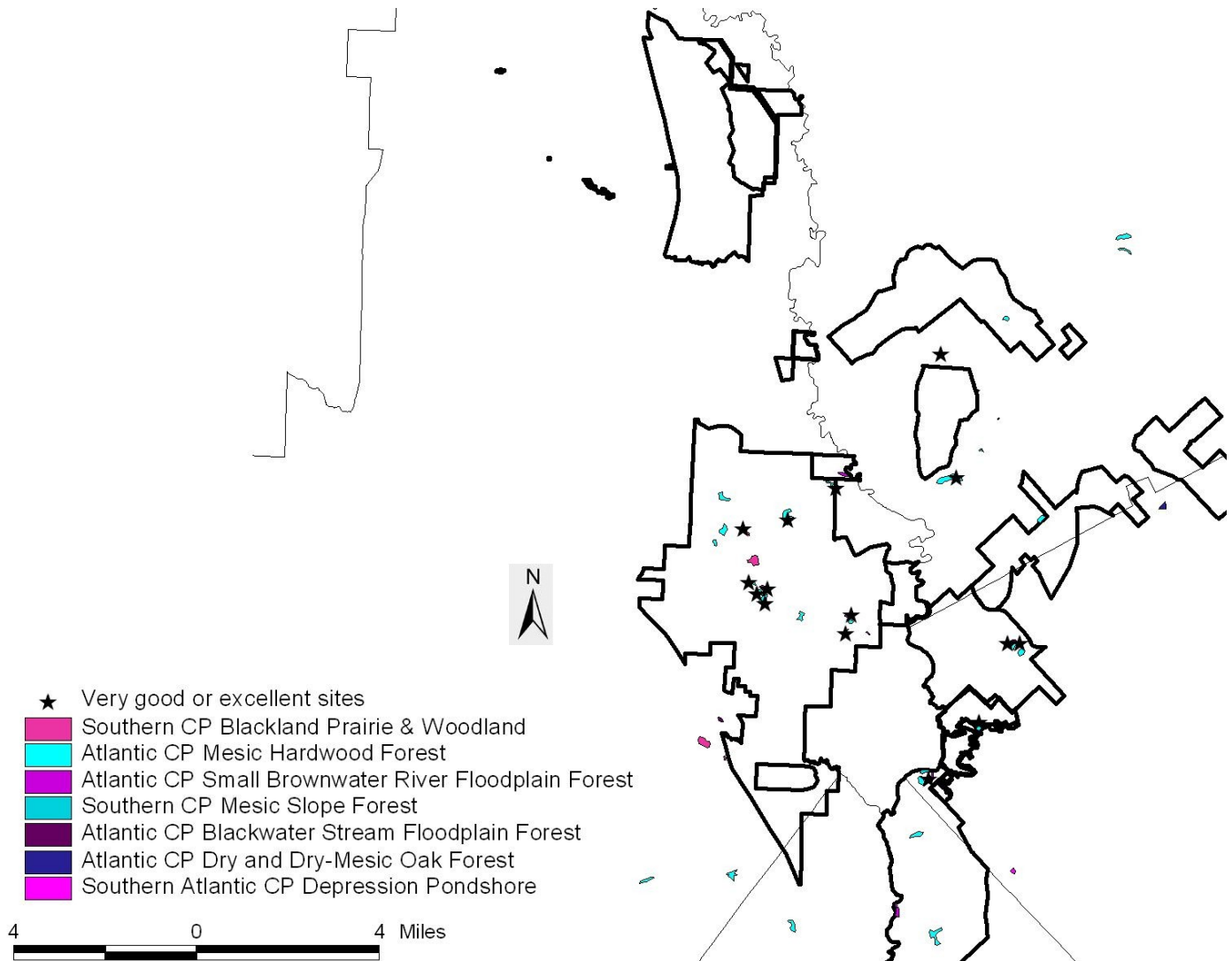


Figure 18. Sites visited during Phase 2 of Georgia Species at Risk project at Robins Air Force Base.

30 of the 46 field sites visited were judged to be accurate. 15 sites visited were judged to be of excellent quality. Four of these are permanently protected on state-owned portions of Ocmulgee WMA. These are discussed in more detail in Appendix A.

Townsend Bombing Range

A total of 57 field sites representing 10 Ecological System types were visited during Phase 2 of this project. These are described in Table 12 and illustrated in Figure 19.

Id	Class	ES Code	Rank	Correct ID?
4	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Excellent	Yes
6	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Good	Yes
19	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Good	Yes
31	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Good	Yes
28	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Good	No
42	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Fair	No
45	Atlantic CP Dry and Dry-Mesic Oak Forest	203.241	Good	No
41	Atlantic CP Large River Floodplain Forest	203.066	Excellent	Yes
55	Atlantic CP Large River Floodplain Forest	203.066	Good	Yes
20	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Good	No
30	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Good	No
38	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Poor	No
39	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Poor	No
36	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Good	Yes
35	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Good	Yes
43	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Fair	No
44	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Good	No
46	Atlantic CP Streamhead Seepage Swamp Pocosin & Baygall	203.252	Poor	No
1	Atlantic CP Upland Longleaf Pine Woodland	203.281	Fair	No
50	Atlantic CP Upland Longleaf Pine Woodland	203.281	Good	No
11	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
12	Atlantic CP Xeric River Dune	203.497	Poor	Yes
15	Atlantic CP Xeric River Dune	203.497	Fair	Yes
14	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
13	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
18	Atlantic CP Xeric River Dune	203.497	Excellent	Yes
26	Atlantic CP Xeric River Dune	203.497	Good	Yes
34	Atlantic CP Xeric River Dune	203.497	Good	Yes
32	Atlantic CP Xeric River Dune	203.497	Poor	Yes
48	Atlantic CP Xeric River Dune	203.497	Poor	Yes
2	Not a natural system		Poor	No
5	Not a natural system		Poor	No
16	Not a natural system		Poor	No

8	S Atlantic CP Depression Pondshore	203.262	Good	No
10	S Atlantic CP Depression Pondshore	203.262	Poor	Yes
17	S Atlantic CP Depression Pondshore	203.262	Good	No
21	S Atlantic CP Depression Pondshore	203.262	Good	Yes
22	S Atlantic CP Depression Pondshore	203.262	Good	No
27	S Atlantic CP Depression Pondshore	203.262	Good	Yes
33	S Atlantic CP Depression Pondshore	203.262	Poor	Yes
37	S Atlantic CP Depression Pondshore	203.262	Good	Yes
40	S Atlantic CP Depression Pondshore	203.262	Good	Yes
47	S Atlantic CP Depression Pondshore	203.262	Good	No
49	S Atlantic CP Depression Pondshore	203.262	Fair	Yes
3	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	Yes
7	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
9	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	Yes
29	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	No
24	Southern Atlantic CP Tidal Wooded Swamp	203.240	Fair	No
23	Southern CP Oak Dome and Hammock	203.494	Excellent	No
25	Southern CP Oak Dome and Hammock	203.494	Good	No
51	Southern CP Oak Dome and Hammock	203.494	Excellent	Yes
52	Southern CP Oak Dome and Hammock	203.494	Good	Yes
53	Southern CP Oak Dome and Hammock	203.494	Good	Yes
54	Southern CP Oak Dome and Hammock	203.494	Good	Yes
56	Southern CP Oak Dome and Hammock	203.494	Poor	Yes
57	Southern CP Oak Dome and Hammock	203.494	Excellent	No

Table 12. Sites visited during Phase 2 of Georgia Species at Risk project at Townsend Bombing Range.

33 of the 57 field sites visited were judged to be accurate. 11 sites visited were judged to be of excellent quality. Three excellent examples of xeric river dunes are permanently protected by a Nature Conservancy conservation easement on property belonging to the Barrington Hunt Club. Two excellent examples of oak domes/hammocks are targets for purchase by the State of Georgia. Field sites are discussed in more detail in Appendix A.

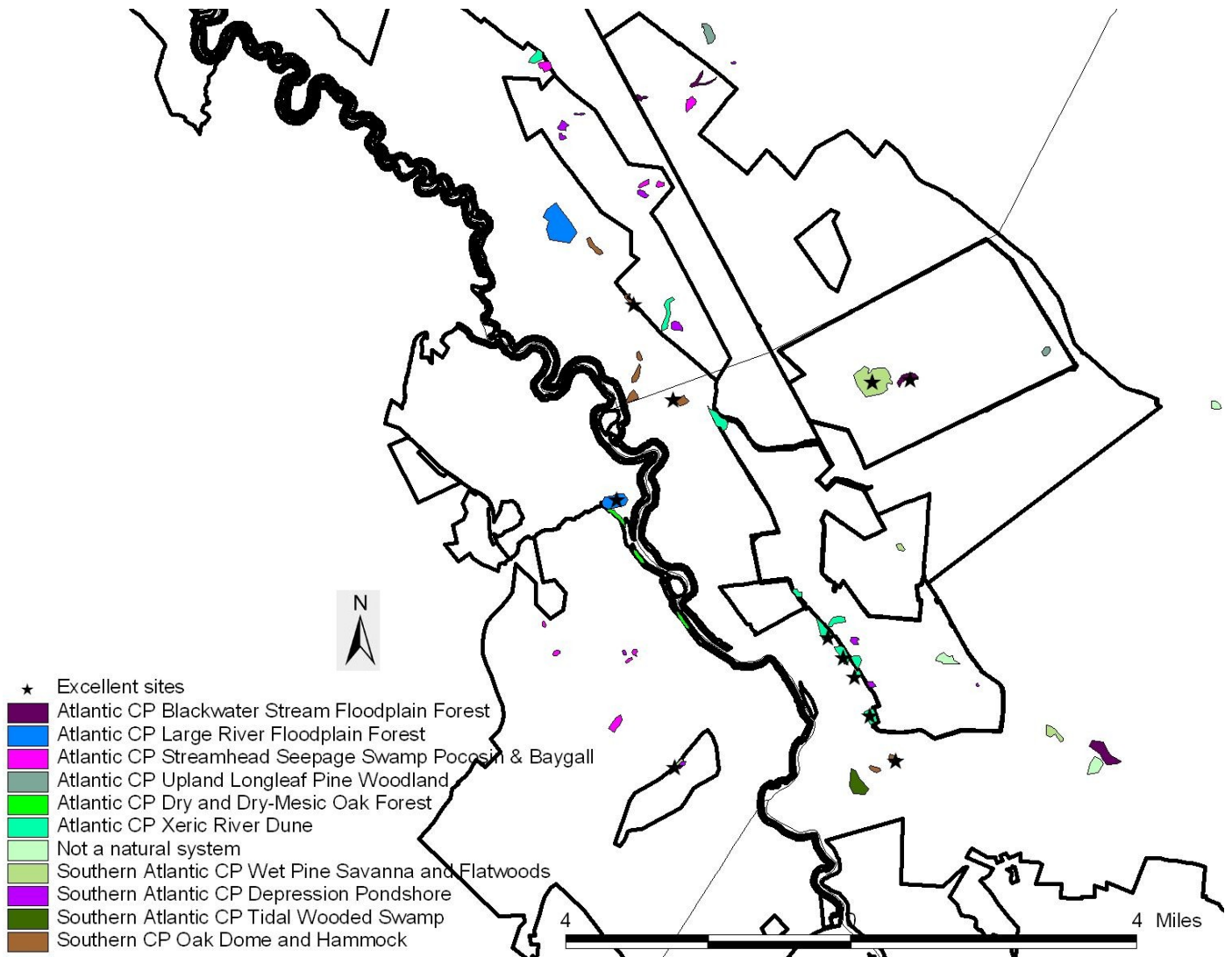


Figure 19. Sites visited during Phase 2 of Georgia Species at Risk project at Townsend Bombing Range.

Kings Bay Submarine Base

A total of 44 field sites representing 8 Ecological System types were visited during Phase 2 of this project. These are described in Table 13 and illustrated in Figure 20.

Id	Class	ES code	Rank	Correct ID?
33	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Excellent	No
36	Atlantic CP Blackwater Stream Floodplain Forest	203.247	Excellent	No
19	Central Atlantic CP Salt and Brackish Tidal Marsh	203.270	Good	No
26	Central Atlantic CP Salt and Brackish Tidal Marsh	203.270	Good	No
30	Central Atlantic CP Salt and Brackish Tidal Marsh	203.270	Good	Yes

23	Not a natural system		N/A	No
28	Not a natural system		Poor	No
7	S Atlantic Coastal Plain Depression Pondshore	203.262	Good	No
4	S Atlantic CP Maritime Forest	203.537	Excellent	Yes
9	S Atlantic CP Maritime Forest	203.537	Excellent	Yes
11	S Atlantic CP Maritime Forest	203.537	Good	Yes
14	S Atlantic CP Maritime Forest	203.537	Good	Yes
15	S Atlantic CP Maritime Forest	203.537	Good	Yes
16	S Atlantic CP Maritime Forest	203.537	Fair	No
17	S Atlantic CP Maritime Forest	203.537	Fair	No
18	S Atlantic CP Maritime Forest	203.537	Poor	No
22	S Atlantic CP Maritime Forest	203.537	Excellent	Yes
25	S Atlantic CP Maritime Forest	203.537	Good	Yes
27	S Atlantic CP Maritime Forest	203.537	Good	No
42	S Atlantic CP Maritime Forest	203.537	Good	Yes
43	S Atlantic CP Maritime Forest	203.537	Excellent	Yes
35	S Atlantic CP Tidal Wooded Swamp	203.240	Excellent	No
39	S Atlantic CP Tidal Wooded Swamp	203.240	Good	Yes
44	S Atlantic CP Tidal Wooded Swamp	203.240	Good	Yes
1	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	No
2	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	No
5	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	Yes
6	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	No
8	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	No
13	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
20	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
21	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
24	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Excellent	No
32	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
34	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
37	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
38	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Poor	Yes
40	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Fair	Yes
41	S Atlantic CP Wet Pine Savanna and Flatwoods	203.536	Good	Yes
3	Southern CP Dry Upland Hardwood Forest	203.560	Fair	Yes
10	Southern CP Seepage Swamp and Baygall	203.505	Good	No
12	Southern CP Seepage Swamp and Baygall	203.505	Good	No
29	Southern CP Seepage Swamp and Baygall	203.505	Good	No
31	Southern CP Seepage Swamp and Baygall	203.505	Excellent	No

Table 13. Sites visited during Phase 2 of Georgia Species at Risk project at Kings Bay Submarine Base.

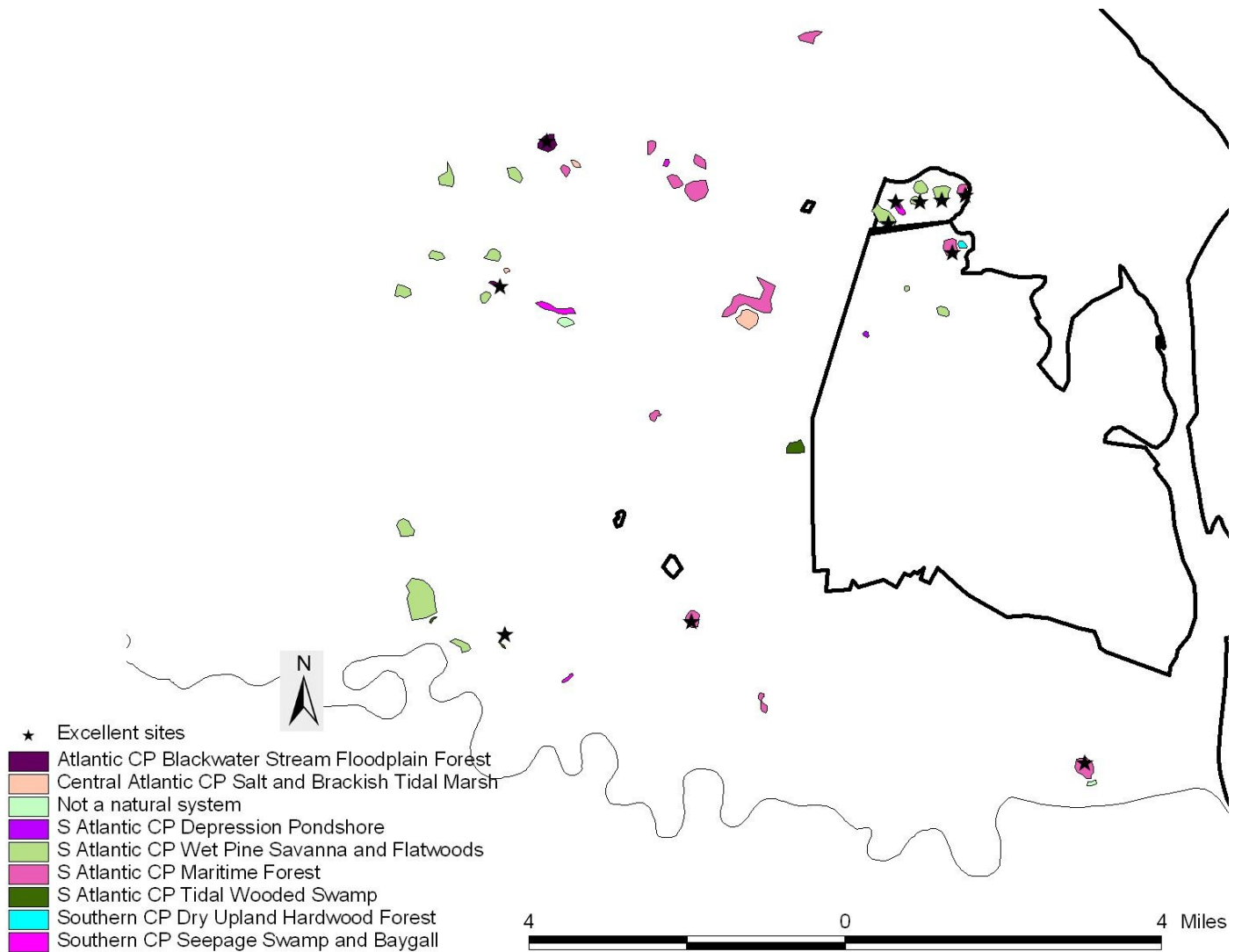


Figure 20. Sites visited during Phase 2 of Georgia Species at Risk project at Kings Bay Submarine Base.

23 of the 44 field sites visited were judged to be accurate, relatively low for this project. However, the most important communities for Species at Risk, maritime forest and wet pine flatwoods, were both found to be relative accurate (9/13 and 10/15, respectively). 11 sites visited were judged to be of excellent quality. Five of these are permanently protected in Crooked River State Park; one maritime forest of excellent quality was visited on the Sub Base. Field sites are discussed in more detail in Appendix A.

Fort Benning

A total of 41 field sites representing 6 Ecological System types were visited during Phase 2 of this project. These are described in Table 14 and illustrated in Figure 21.

Id	Class	ES Code	Rank	Correct ID?
5	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Fair	Yes
7	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Poor	Yes
8	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Poor	Yes
10	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Poor	Yes
13	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Fair	Yes
29	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Fair	Yes
33	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Fair	No
37	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Poor	Yes
38	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Excellent	Yes
39	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Fair	Yes
40	Atlantic CP Fall Line Sandhills Longleaf Pine Woodland	203.254	Good	Yes
30	Atlantic CP Sandhills Seep	203.253	Good	Yes
31	Atlantic CP Sandhills Seep	203.253	Good	Yes
2	E Gulf CP Interior Upland Longleaf Pine Woodland	203.496	Fair	Yes
9	E Gulf CP Interior Upland Longleaf Pine Woodland	203.496	Fair	Yes
22	E Gulf CP Interior Upland Longleaf Pine Woodland	203.496	Fair	No
26	E Gulf CP Interior Upland Longleaf Pine Woodland	203.496	Fair	Yes
4	E Gulf CP Small Stream & River Floodplain Forest	203.559	Excellent	No
15	E Gulf CP Small Stream & River Floodplain Forest	203.559	Good	No
16	E Gulf CP Small Stream & River Floodplain Forest	203.559	Excellent	No
18	E Gulf CP Small Stream & River Floodplain Forest	203.559	Fair	No
28	E Gulf CP Small Stream & River Floodplain Forest	203.559	Good	No
36	E Gulf CP Small Stream & River Floodplain Forest	203.559	Excellent	No
41	E Gulf CP Small Stream & River Floodplain Forest	203.559	Excellent	Yes
1	E Gulf CP Southern Mesic Slope Forest	203.467	Excellent	Yes
3	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
6	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
12	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
14	E Gulf CP Southern Mesic Slope Forest	203.467	Excellent	No
17	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
19	E Gulf CP Southern Mesic Slope Forest	203.467	Poor	No
20	E Gulf CP Southern Mesic Slope Forest	203.467	Excellent	Yes
21	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
23	E Gulf CP Southern Mesic Slope Forest	203.467	Fair	Yes
24	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
27	E Gulf CP Southern Mesic Slope Forest	203.467	Good	Yes
32	E Gulf CP Southern Mesic Slope Forest	203.467	Poor	Yes
34	E Gulf CP Southern Mesic Slope Forest	203.467	Poor	Yes
11	Evergreen Plantation		Poor	No
25	Southern CP Seepage Swamp and Baygall	203.505	Good	No
35	Southern CP Seepage Swamp and Baygall	203.505	Good	No

Table 14. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Benning.

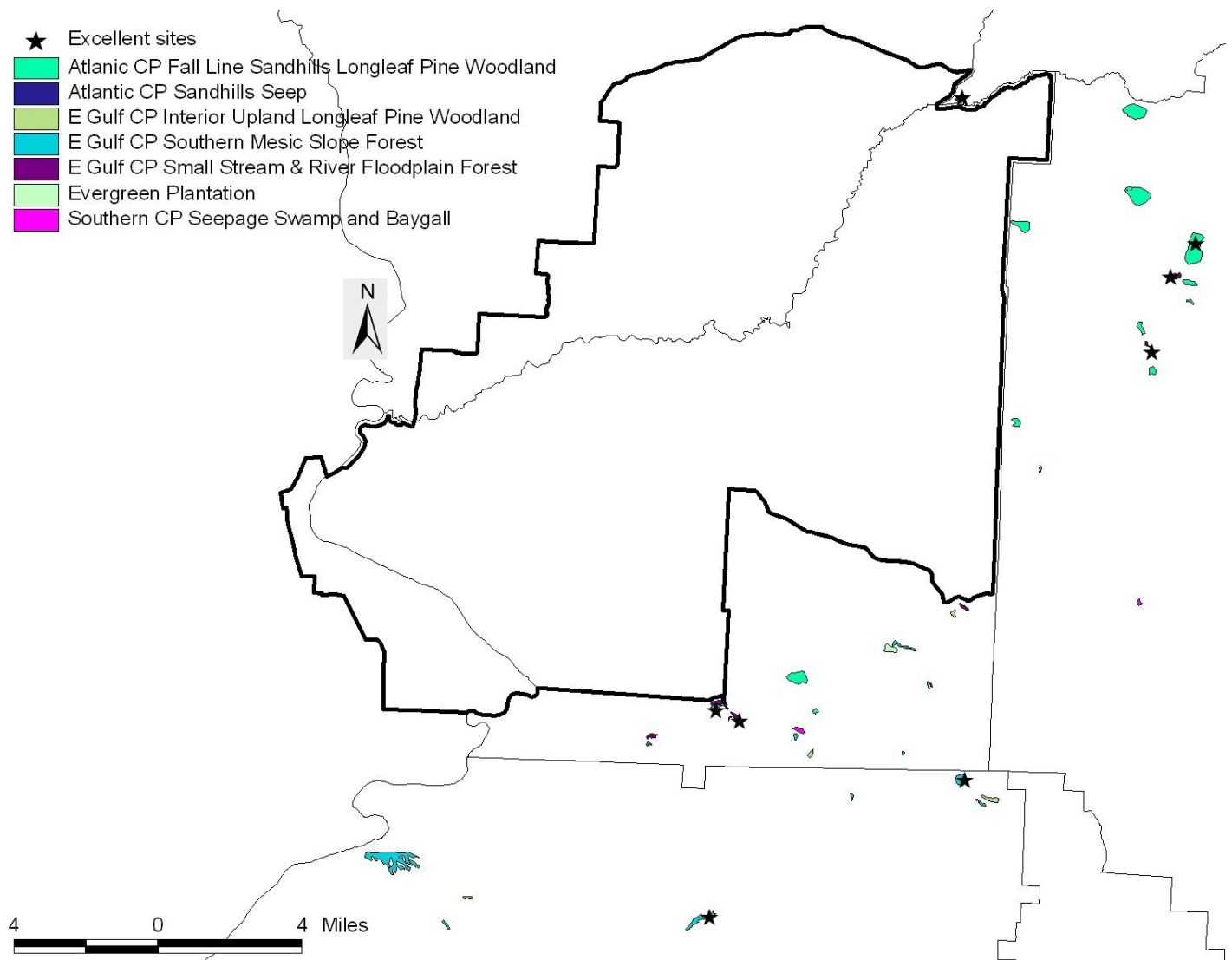


Figure 21. Sites visited during Phase 2 of Georgia Species at Risk project at Fort Benning.

28 of the 41 field sites visited were judged to be accurate. Accuracy was best for sandhills-associated Ecological Systems, important for many Species at Risk; most map error was associated with the differentiation between blackwater and brownwater stream floodplain forests. Eight sites visited were judged to be of excellent quality; just one of these is permanently protected. Field sites are discussed in more detail in Appendix A.

Species at Risk – Ecological Systems Relationships and Management Recommendations

This section presents a discussion of the Ecological Systems map as it relates to the Species at Risk. Specifically, its utility in predicting locations for these species will be discussed and, where appropriate, management recommendations for these Systems will be given.

Fort Gordon

Elassoma okatie, Bluebarred pygmy sunfish

This fish is heavily associated with streams covered by the *Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)* Ecological System, although it may also occur in other aquatic environments. An analysis of the Fort Gordon Ecological Systems map indicates that this System could be definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *CES203.247* with respect to the bluebarred pygmy sunfish include:

- Minimize military traffic through wetlands.
- Configure road crossings to permit fish passage.
- If possible avoid timber harvest.
- If timber harvest is necessary, observe Best Management Practices (BMP's) (Georgia Forestry Commission 1999).

Gopherus polyphemus, Gopher tortoise

This reptile is heavily associated with the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* Ecological System. An analysis of the Fort Gordon Ecological Systems map indicates that this System could be definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *CES203.254* with respect to the gopher tortoise include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic (Guyer et al. 2006).

Much of the above information is taken from Bailey et al. 2006.

Heterodon simus, Southern hognose snake

This reptile is, like the gopher tortoise, heavily associated with the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* Ecological System. An analysis of the Fort Gordon Ecological Systems map indicates that this System could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *CES203.254* with respect to the southern hognose snake include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills.
- Avoid soil-disturbing site preparation techniques. Soil disturbance is positively correlated with the distribution of non-native fire ants (Hill and MacGown 2008, Graham et al. 2004), which have been implicated in declines of the southern hognose snake (Tuberville et al. 2000).
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic.

Much of the above information is taken from Bailey et al. 2006.

Macbridea caroliniana, Carolina bogmint

At Fort Gordon this plant is associated with the transition zone between the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* and *Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)* Ecological Systems. Although it is quite rare, a model could be developed from the Fort Gordon Ecological Systems map to guide future survey efforts for this species. Management recommendations for *CES203.254* and *CES203.254* with respect to this species on and around Fort Gordon include:

- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills – and allow these fires to creep into wetlands (Chafin 2007).
- Avoid soil-disturbing site preparation techniques.
- If possible avoid clearcutting.
- If clearcutting is necessary, observe BMP's (Georgia Forestry Commission 1999).
- Keep out livestock.

Stylisma pickeringii var pickeringii, Pickering's morning-glory

This plant is heavily associated with the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* Ecological System. An analysis of the Fort Gordon Ecological Systems map indicates that this System could definitely be used to guide survey efforts and potentially management activities for this species both on and

off-base. Management recommendations for *CES203.254* with respect to the Pickering's morning-glory include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic.

Fort Stewart

Balduina atropurpurea, Purple balduina

This plant is strongly associated with the *Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)* Ecological System, although it may occur in some other types. An analysis of the Fort Stewart Ecological systems map indicates that this System could be helpful in guiding survey efforts for this species both on and off-base. Management recommendations for *CES203.536* with respect to purple balduina include:

- Where possible, convert off-site pine species (especially loblolly) to longleaf (preferable in most cases) or slash.
- Thin stands regularly and extend rotation age.
- If possible, manage as uneven-aged stands.
- Restore and maintain natural fire regime – generally 1-2 year interval for most sites, including occasional growing season fire.
- Avoid soil-disturbing site preparation techniques.
- Conduct timber harvest during dry periods. Observe BMP's.
- If natural groundcover (especially wiregrass) is depleted some replanting or reseeding can speed the restoration process.
- If possible, minimize tracked vehicle traffic.

Some of the above information is taken from Bailey et al. 2006.

Calopogon multiflorus, Many-flowered grass-pink

This plant is associated with the *Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)* Ecological System, although it is so rare around Fort Stewart that a map of the System is not of much use in predicting the species' occurrence. However, the distribution of the Ecological System may be useful in targeting areas for survey, and general management guidelines for *CES203.536* will benefit this species:

- Where possible, convert off-site pine species (especially loblolly) to longleaf (preferable in most cases) or slash.
- Thin stands regularly and extend rotation age.

- If possible, manage as uneven-aged stands.
- Restore and maintain natural fire regime – generally 1-2 year interval for most sites, including occasional growing season fire.
- Avoid soil-disturbing site preparation techniques.
- Conduct timber harvest during dry periods. Observe BMP's.
- If natural groundcover (especially wiregrass) is depleted some replanting or reseeding can speed the restoration process.
- If possible, minimize tracked vehicle traffic.

Some of the above information is taken from Bailey et al. 2006.

Elliottia racemosa, Georgia-plume

This Georgia endemic plant is associated with mesic portions of the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* Ecological System, especially where this System transitions towards wetland communities. An analysis of the Fort Stewart Ecological systems map indicates that this System could be helpful in predicting occurrence for this species both on and off-base. Because it is found in ecotonal areas, management recommendations for this species will be somewhat different than those typical for *CES203.497*.

- Avoid clearcutting.
- Avoid development of bluff habitats.
- Periodic low-intensity fire will benefit this species.

Gopherus polyphemus, Gopher tortoise

This reptile is heavily associated with the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* Ecological System at Fort Stewart and moderately associated with the *Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)* Ecological System. An analysis of the Fort Stewart Ecological Systems map indicates that these Systems could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *203.497* and *CES203.254* with respect to the gopher tortoise include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-5 year interval for *CES203.497* and 1-2 year interval for *CES203.254*.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic (Guyer et al. 2006).

Much of the above information is taken from Bailey et al. 2006.

Heterodon simus, Southern hognose snake

Like the gopher tortoise, this reptile is associated with both the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* and *Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)* Ecological Systems at Fort Stewart. An analysis of the Fort Stewart Ecological Systems map indicates that these Systems could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *CES203.497* and *CES203.254* with respect to the southern hognose snake include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-5 year interval for *CES203.497* and 1-2 year interval for *CES203.254*.
- Avoid soil-disturbing site preparation techniques. Soil disturbance is positively correlated with the distribution of non-native fire ants (Hill and MacGown 2008, Graham et al. 2004), which have been implicated in declines of the southern hognose snake (Tuberville et al. 2000).
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic.

Much of the above information is taken from Bailey et al. 2006.

Illicium parviflorum, Yellow anise-tree

The occurrence of this shrub on and around Fort Stewart is not presently considered to be of natural origin (Tom Patrick, *personal communication*), so management recommendations will not be given.

Lobelia boykinii, Boykin's lobelia

This plant is associated with both the *Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)* and *Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)* Ecological Systems, although it is rare enough in comparison to the occurrence of these ponds that a map generated from Fort Stewart Ecological systems data may not be of much use in predicting the species' occurrence.. However, the distribution of the Ecological System may be useful in targeting areas for survey, and general management guidelines for *CES203.262* and *CES203.251* will benefit this species:

- Avoid ditching and draining.
- Restore natural hydroperiod if it has been altered.
- Allow prescribed fire to burn into wetlands when they are naturally low.
- Do not allow dense tree canopy or shrub layers to develop.
- Avoid diverting surface water from roads into ponds.
- If possible, maintain ponds within a natural context, thinning and burning surrounding uplands regularly.

Much of the above information is taken from Bailey et al. 2006.

Notophthalmus perstriatus, Striped newt

This upland-dwelling but pond-breeding amphibian is strongly associated with both the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* and *Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)* Ecological Systems, but also requires *Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)* and *Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)* for breeding. Its presence at a specific site would be difficult to predict without actually looking for it, but the distribution of these Ecological Systems may be useful in targeting areas for survey, especially off-base (where it has not been surveyed as intensively as on-base), and management guidelines for both the uplands and wetlands will definitely benefit this species.

For *CES203.497* and *CES203.281*:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-5 year interval for *CES203.497* and 1-2 year interval for *CES203.254*.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic

For *CES203.262* and *CES203.251*:

- Avoid ditching and draining.
- Restore natural hydroperiod if it has been altered.
- Allow prescribed fire to burn into wetlands when they are naturally low.
- Avoid diverting surface water from roads into ponds.

Much of the above information is taken from Bailey et al. 2006.

Pteroglossapsis ecristata, Crestless plume orchid

This plant is strongly associated with the *Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)* Ecological System. An analysis of the Fort Stewart Ecological systems map indicates that this System could be helpful in guiding survey efforts for this species both on and off-base. Management recommendations for *CES203.536* with respect to crestless plume orchid include:

- Where possible, convert off-site pine species (especially loblolly) to longleaf (preferable in most cases) or slash.
- Thin stands regularly and extend rotation age.
- If possible, manage as uneven-aged stands.
- Restore and maintain natural fire regime – generally 1-2 year interval for most sites, including occasional growing season fire.
- Avoid soil-disturbing site preparation techniques.
- Conduct timber harvest during dry periods. Observe BMP's.

- If natural groundcover (especially wiregrass) is depleted some replanting or reseeding can speed the restoration process.
- If possible, minimize tracked vehicle traffic.
- Eradicate invasive exotics such as cogon grass.

Some of the above information is taken from Bailey et al. 2006.

Sideroxylon thornei, Swamp buckthorn

This shrub is associated with hardwood swamps that would most often be classified within the *Atlantic Coastal Plain Blackwater Stream Floodplain Forest (CES203.247)* Ecological System, although it is so rare within the Fort Stewart environs that a map could not be used to predict its occurrence. However, management recommendations for *CES203.247* will clearly benefit this species.

- Avoid ditching or draining of wetlands.
- Avoid construction of impoundments.
- Avoid clearcutting.
- If timber harvest is necessary, observe Best Management Practices (BMP's) (Georgia Forestry Commission 1999).
- Minimize tracked vehicle traffic.
- Eradicate invasive exotic plants such as Chinese privet and Chinese tallow, and animals such as feral hogs.

Robins Air Force Base

Lobelia boykinii, Boykin's lobelia

This plant is associated with both the *Atlantic Coastal Plain Southern Depression Pondshore (CES203.262)* and *Southern Coastal Plain Nonriverine Cypress Dome (CES203.251)* Ecological Systems, both quite rare around Robins. The Robins Ecological Systems map may be very useful in targeting areas for survey, and general management guidelines for *CES203.262* and *CES203.251* will benefit this species:

- Avoid ditching and draining.
- Restore natural hydroperiod if it has been altered.
- Allow prescribed fire to burn into wetlands when they are naturally low.
- Do not allow dense tree canopy or shrub layers to develop.
- Avoid diverting surface water from roads into ponds.
- If possible, maintain ponds within a natural context, thinning and burning surrounding uplands regularly.

Much of the above information is taken from Bailey et al. 2006.

Scutellaria ocmulgee, Ocmulgee skullcap

This plant is strongly associated with both the *Atlantic Coastal Plain Mesic Hardwood Forest (CES203.242)* and *Southern Coastal Plain Mesic Slope Forest (CES203.476)*

Ecological Systems. The Robins Ecological Systems map could provide an extremely useful template in designing surveys for this species. Management recommendations for *CES203.242* and *CES203.476* include:

- Avoid clearcutting of river bluffs.
- Avoid development of river bluffs.
- Eradicate exotic invasives such as Japanese honeysuckle, Chinese privet, autumn olive, and feral hogs.

Townsend Bombing Range

Dicerandra radfordiana, Radford's mint

This McIntosh County, GA endemic plant is known from only two locations in the world. New sites may be potential but are unlikely. It is strongly associated with the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* Ecological System. Management recommendations for this System in relation to Radford's mint include:

- Remove exotic sand pines and replant with longleaf.
- Avoid disturbance to plants during harvest of sand pine.
- Keep habitat open through regular (2-5 year interval) application of prescribed fire.
- Avoid soil disturbance, including site preparation.
- Keep all terrain vehicles (ATV's) off of sand ridges.
- Use caution not to disturb plants during road maintenance.
- Monitor this species annually.

Gopherus polyphemus, Gopher tortoise

This reptile is heavily associated with the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* Ecological System near Townsend and moderately associated with the *Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)* Ecological System. An analysis of the Townsend Ecological Systems map indicates that these Systems could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *203.497* and *CES203.254* with respect to the gopher tortoise include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-5 year interval for *CES203.497* and 1-2 year interval for *CES203.254*.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- Keep ATV's off of sand ridges.

Much of the above information is taken from Bailey et al. 2006.

Kings Bay Submarine Base

Forestiera godreyi, Godfrey's privet

This plant is known from a single occurrence in the *Atlantic Coastal Plain Southern Maritime Forest (CES203.537)* Ecological System. The Kings Bay Ecological Systems map could prove valuable in targeting areas for survey, especially if combined with locations of known shell middens. Recommendations for management for *CES203.557* with respect to Godfrey's privet include:

- Avoid clearing or development.
- Avoid the use of prescribed fire.
- Eradication of invasive exotics if they appear.

Gopherus polyphemus, Gopher tortoise

This reptile is associated with the *Atlantic Coastal Plain Xeric River Dune (CES203.497)* and *Atlantic Coastal Plain Upland Longleaf Pine Woodland (CES203.281)* Ecological Systems in the Kings Bay vicinity. An analysis of the Kings Bay Ecological Systems map indicates that these Systems could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *203.497* and *CES203.254* at Kings Bay with respect to the gopher tortoise include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-5 year interval for *CES203.497* and 1-2 year interval for *CES203.254*.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.

Much of the above information is taken from Bailey et al. (2006).

Pteroglossapsis ecristata, Crestless plume orchid

Normally this plant is associated with the *Atlantic Coastal Plain Southern Wet Pine Savanna and Flatwoods (CES203.536)* Ecological System. At Kings Bay it is known from a single location in a rather unnatural setting (a Bahia grass field). Nevertheless, the Kings Bay Ecological systems map could be used to target other areas for survey, and management recommendations for *CES203.536* would clearly benefit this species.

- Where possible, convert off-site pine species (especially loblolly) to longleaf (preferable in most cases) or slash.
- Thin stands regularly and extend rotation age.
- If possible, manage as uneven-aged stands.
- Restore and maintain natural fire regime – generally 1-2 year interval for most sites, including occasional growing season fire.

- Avoid soil-disturbing site preparation techniques.
- Conduct timber harvest during dry periods. Observe BMP's.
- If natural groundcover (especially wiregrass) is depleted some replanting or reseeded can speed the restoration process.

Fort Benning

Aesculus parviflora, Bottlebrush buckeye

This shrub is strongly associated with the *East Gulf Coastal Plain Southern Mesic Slope Forest (CES203.276)* Ecological System around Fort Benning. The Fort Benning Ecological Systems map could be most useful in targeting areas for survey and in implementing management strategies. Management recommendations for *CES203.276* with respect to the bottlebrush buckeye at Fort Benning include:

- Avoid clearcutting.
- Eradicate invasive exotic species, including Chinese privet, Japanese honeysuckle, and feral hogs.

Arabis georgiana, Georgia rock-cress

This plant is not strongly associated with a particular Ecological system at Fort Benning, although it might be found most likely in *East Gulf Coastal Plain Southern Mesic Slope Forest (CES203.276)*, *Southern Piedmont Mesic Forest (CES202.342)*, *Southern Coastal Plain Dry Upland Hardwood Forest (CES203.560)*, or *Southern Piedmont Dry Oak-(Pine) Forest (CES202.339)*. Rather, it is associated with steep, rocky slopes along streams. Management recommendations for these areas with respect to Georgia rock-cress include:

- Avoid clearcutting.
- Avoid road construction.
- Eradicate invasive exotic species, including Chinese privet, Japanese honeysuckle, and feral hogs.

Brickellia cordifolia, Heartleaf brickellia

This plant is associated most often with the *Southern Coastal Plain Dry Upland Hardwood Forest (CES203.560)* Ecological System. Although this System is rather widespread and the plant rare, making prediction of specific occurrences difficult, the Fort Benning Ecological Systems map could be useful in targeting areas for survey. Management recommendations for *CES203.560* with respect to heartleaf brickellia include:

- Avoid conversion to pine plantation.
- Keep livestock out
- Maintain occasional prescribed burning regime, generally on three to five year rotation.

Cyprinella callitaenia, Bluestripe shiner

This fish is found in large streams and is not associated with any particular Ecological System. In stream habitats, it is most often found in riffle areas. Management recommendations for this species are best applied at the watershed scale.

- Avoid siltation during land-disturbing activities.
- Avoid impoundment of large streams.
- Avoid direct discharge of pollutants into streams.
- Follow Best Management Practices during timber harvest (Georgia Forestry Commission 1999).
- Follow agricultural best management practices (U.S. Department of Agriculture 1997, University of Georgia 2000).

Gopherus polyphemus, Gopher tortoise

This reptile is heavily associated with the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* Ecological System. An analysis of the Fort Benning Ecological Systems map indicates that this System could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *CES203.254* with respect to the gopher tortoise include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic (Guyer et al. 2006).

Much of the above information is taken from Bailey et al. 2006.

Graptemys barbouri, Barbour's map turtle

This aquatic turtle is not associated with any particular Ecological System. It prefers clean streams with healthy mollusk populations (although it will forage on non-native Asiatic clams) and plenty of rocks for basking. Like the bluestripe shiner, management recommendations for this species are best applied at the watershed scale.

- Avoid siltation during land-disturbing activities.
- Avoid impoundment of large streams.
- Avoid direct discharge of pollutants into streams.
- Follow Best Management Practices during timber harvest (Georgia Forestry Commission 1999).
- Follow agricultural best management practices (U.S. Department of Agriculture 1997, University of Georgia 2000).

Helianthus smithii, Smith's sunflower

This plant is known from only a single location on Fort Benning, within the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* Ecological System. Potential also exists for this species in the *East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland (CES203.496)* Ecological System. The species is not well-known and appears to be quite rare even in suitable habitat, but the Ecological systems map could provide a valuable template for surveys. Management recommendations for *CES203.254* and *CES203.496* with respect to Smith's sunflower include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills; perhaps 2 years for upland longleaf.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic.

Macbridea caroliniana, Carolina bogmint

This plant is associated with the transition zone between the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* and the *East Gulf Coastal Plain Small Stream and River Floodplain Forest (CES203.559)* Ecological Systems. Potential also exists for it to be found within the *Atlantic Coastal Plain Sandhill Seep (CES202.253)* and *East Gulf Coastal Plain Interior Shrub Bog (CES203.385)* Systems. A useful predictive model, especially for targeting potential survey areas, could be developed from these habitat associations. Management recommendations for *CES203.254*, *CES203.559*, *CES202.253*, and *CES203.385* with respect to Carolina bogmint include:

- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills – and allow these fires to creep into wetlands (Chafin 2007).
- Avoid soil-disturbing site preparation techniques.
- Observe Forestry BMP's (Georgia Forestry Commission 1999).
- Keep out livestock.
- If possible, keep tracked vehicles out of wetland areas.

Stylisma pickeringii var. *pickeringii*, Pickering's morning-glory

This plant is heavily associated with the *Atlantic Coastal Plain Fall Line Sandhills Longleaf Pine Woodland (CES203.254)* Ecological System. An analysis of the Fort Benning Ecological Systems map indicates that this System could definitely be used to guide survey efforts and potentially management activities for this species both on and off-base. Management recommendations for *CES203.254* with respect to the Pickering's morning-glory include:

- Where possible, convert off-site or out-of-range pine species (especially sand and loblolly pines) to longleaf.
- Restore and maintain natural fire regime – generally 2-3 year interval for most sandhills.
- Avoid soil-disturbing site preparation techniques.
- Keep out livestock.
- Minimize development.
- If possible, minimize tracked vehicle traffic.

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