Hairy Rattleweed
(*Baptisia arachnifera*)

5-Year Review:
Summary and Evaluation

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U. S. Fish and Wildlife Service
Southeast Region
Georgia Ecological Services Field Office
Athens, Georgia

5-YEAR REVIEW
Hairy Rattleweed (*Baptisia arachnifera*)

I. GENERAL INFORMATION

A. Methodology used to complete the review:

This review was completed by the U.S. Fish and Wildlife Service's (Service) lead recovery biologist for this species who is located in the Georgia Ecological Services Field Office, Athens, Georgia. None of the review was contracted to outside parties. All literature and documents used in this review are on file at the Georgia Field Office and are cited in the Literature Cited section. We used information gathered from peer-reviewed publications, gray literature and from meeting with persons involved with on-going work for the conservation of these plants and direct meetings with involved land management agencies; principally, Georgia Department of Natural Resources (DNR). Public notice of this review was given in the *Federal Register* on July 26, 2005, and a 60-day comment period was opened (70 FR 43171). The draft of this document was distributed for peer review (see Appendix A) and comments received were addressed as appropriate.

The following is a list of people that provided significant information to this review:
Jennifer Ceska, Georgia Plant Conservation Alliance, The State Botanical Garden
Dr. Lissa Leege, Georgia Southern University, Department of Biology
Alison McGee, Southeast Georgia Conservation Manager, The Nature Conservancy
Malcolm Hodges, The Nature Conservancy
Jim Candler, Georgia Power Company, Environmental Lab
Bret Estep, Georgia Power Company, Environmental Lab
Chris Carey, District Technical Supervisor, Altamaha District, Rayonier-Southeast Forest Resources
Rob Hicks, Plum Creek Timberlands
Tom Patrick, Georgia DNR, Natural Heritage Program

B. Reviewers

Lead Region– Southeast Region: Kelly Bibb, (404) 679-7132

Lead Field Office – Georgia Ecological Services Field Office, James Rickard, (706) 613-9493 and Strant Colwell, (912) 265-9336

C. Background

1. Federal Register Notice citation announcing initiation of this review:

July 26, 2005; 70 FR 43171

2. Species status:

Declining (2011 Recovery Data Call). Overstocking of trees, lack of fire management and seed predation by insects are the

factors driving the species' decline. A conservation easement for a critical population was secured in 2009.

3. Recovery achieved: 1 (1=0-25% recovery objectives achieved)

4. Listing history:
Original Listing
FR notice: 43 FR 17910
Date listed: April 26, 1978
Entity listed: species
Classification: endangered

5. Associated rulemakings: N/A

6. Review History:

Recovery Plan: 1984
Recovery Data Call: 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2002, 2001, 2000, 1999, and 1998
Five-year review: Hairy rattleweed has had several 5-year reviews (December 12, 1983 (48 FR 55100); July 22, 1985 (50 FR 29900); and November 6, 1991)

In the 1991 five-year review (56 FR 56882), different species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors as they pertained to the different species' recovery. In particular, no changes were proposed for the status of this plant in the review.

7. Species' Recovery Priority Number at start of review (48 FR 43098):
The Recovery Priority Number for hairy rattleweed is 8, which means degree of threat is moderate, but recovery potential is high.

8. Recovery Plan:
Name of Plan: Recovery Plan for Hairy Rattleweed (*Baptisia arachnifera*)
Date issued: March 19, 1984

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

The Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, the DPS policy to the species listing is not addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved recovery plan containing objective, measurable criteria? Yes

2. Adequacy of recovery criteria.

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat?
The recovery criteria are more than 23 years old. There is new genetic information, better habitat information and better information on the biology of this plant; however, the same population-limiting problems that were mentioned in the recovery plan exist and the population continues to decline because of land management practices in intensively managed timber stands and housing developments.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria?
Yes, the recovery plan adequately addresses the threats to this species and there is no new information concerning threats to this species.

3. List the recovery criteria as they appear in the recovery plan, and discuss how each criterion has or has not been met, citing information.

The Recovery Plan identifies the hairy rattleweed could be considered for delisting when the following conditions are met: (1) there are at least eight self-sustaining populations secured and maintained within its historic or current range (eight would provide a reasonable degree of security against catastrophic loss and/or site alteration); (2) the number of individuals in the various populations has reached an optimum level or cover percentage and frequency occurrence, as established by management studies; (3) its biology is sufficiently understood to allow perpetuation of the species should circumstances require immediate or drastic alteration of populations and/or sites; (4) continuing protection and management after delisting are assured (U.S. Fish and Wildlife Service 1984).

The Recovery Plan describes that reclassification of the hairy rattleweed from federally endangered to threatened status could be considered when four self sustaining populations are secured.

None of these criteria have been accomplished.

1. There are at least eight self-sustaining populations secured and maintained within its historic or current range.

In 2008, Georgia Department of Natural Resources was awarded a section 6 Recovery Land Acquisition grant by the Service to secure a conservation easement on the Lewis Tract in Brantley County, Ga. In 2009, a State conservation easement with TNC as the Grantor was established to cover this population of hairy rattleweed. The conservation easement on 339 acres of the property provides for permanent protection and appropriate management for the best known site of hairy rattleweed. A management plan for this site has been written and implemented to ensure that fire management continues and that other management or maintenance activities are protective of the habitat. Only 15 acres of the Lewis Tract are currently occupied, however, active management should improve habitat conditions and allow hairy rattleweed to occupy more of this area.

The Georgia Power Company is aware that there are populations within their rights-of-way and attempt to avoid mowing during the growing season and avoid the use of herbicide at known locations (Jim Candler, pers. comm., Georgia Power Company, 2005). Georgia Department of Transportation needs to make a similar effort for populations in their rights-of-way and attempt to avoid mowing during the growing season and avoid the use of herbicide at known locations. Both Plum Creek (Rob Hicks, Plum Creek, pers. comm., 2005) and Rayonier (Chris Carey, Rayonier-Southeast Forest Resources, pers. comm., 2005) have multiple populations of hairy rattleweed that occur on their timber plantations.

2. The number of individuals in the various populations has reached an optimum level of cover percentage and frequency occurrence, as established by management studies.

No management studies are being conducted to indicate the number of individuals that is an optimum level of cover percentage and frequency occurrence. However, from the original collection of hairy rattleweed by Duncan in1942 until the recovery plan was published, a trend was suggested that the populations were declining (U.S. Fish and Wildlife Service 1984, Duncan 1944). More recent studies established by the Georgia DNR in 1987 (Humphrey 1987), revisited by the Nature Conservancy in 1997 (Tassin and McGee 1999), and again by Leege and Squire (2006), have demonstrated a decline in populations of hairy rattleweed.

3. Its biology is sufficiently understood to allow perpetuation of the species should circumstances require immediate or drastic alteration of populations and/or sites.

Although there are still questions about the life history, it is probably understood well enough that if natural habitats were available and maintained, the species could be perpetuated (U.S. Fish and Wildlife Service 1984, Humphrey 1988, ESIS 1996). Humphrey (1987) planted 116 greenhouse grown plant plants in 1986 on timberland and reported that 39 survived the first year. Humphrey speculated that dry weather when they were planted could have been an issue. In 1999, 20 of these plants had survived (Alison McGee, TNC, pers. comm., 2005). The State Botanical Garden (SBG) grows hairy rattleweed from seed for restoration. They are now establishing an outdoor propagation area for restoration and temporary safeguarding (Jennifer Ceska, SBG, pers. comm., 2006). At Valdosta State University, over 400 individuals have been planted and after 2 years most had survived while some began flowering and producing seed (John Pascarella, VSU, pers. comm., 2005). The potential for augmenting this species exists; however, natural communities to place plants may be the primary limiting factor. Leege and Estep began a project to measure germination rates under a variety of field settings in 2011, however, the results of that study are not available at this time.

4. Continuing protection and management after delisting are assured.

Most known extant populations currently are privately-owned and occur in habitats that are not in a natural condition (except the Lewis property mentioned above). All populations have suffered from fire exclusion and at least 60% of the populations are in intensively-managed pine plantations, along roads or powerline rights-of-way, which has likely affected plant vigor and influence field observations (GDNR 2006). Currently, protection of this plant would be strictly voluntary through conservation easements or private stewardship grants. It is likely that prescribed fire would need to be used as a management tool in perpetuity in order to maintain the forest structure with a sparse canopy and vigorous herbaceous community. While safeguarding (planting hairy rattleweed on protected properties where it does not currently occur) is a good option for this plant, there need to be more protected properties with suitable habitat that are actively managed.

C. Updated Information and Current Species Status

1. Biology and Habitat

Hairy rattleweed (*Baptisia arachnifera*) is an herbaceous perennial legume (family Fabaceae) (Humphrey 1987, Patrick et. al. 1995, ESIS 1996, Chafin 2007). It grows from 4 to 8 dm (16 to 31 in) tall with a stout stem, widely branched with the branches ascending and arising alternately from the primary stem or stems (Duncan 1944). Leaves are simple, entire, mostly cordate 2 to 8 cm long and ashy green (Duncan 1944, Patrick et. al.

1995, Chafin 2007). The entire plant except the flowers is covered with grayish-white, closely-appressed hairs (Duncan 1944, U.S. Fish and Wildlife Service 1984, Patrick et al. 1995, Chafin 2007). The flowers are in terminal racemes, 3 to 20 cm long, usually on secondary branches (Duncan 1944, Patrick et al. 1995). Flowers are on pedicels 1 to 5 mm long with the lower flowers subtended by foliaceous bracts up to 10 mm long; the uppermost are subtended by much smaller bracts (about 3 mm) (Duncan 1944, Patrick et al. 1995, ESIS 1996). Petals are yellow with an average length of about 11 mm and width of 10 mm. The wings and keel are about 13 mm long and 5 mm wide. The fruit is subglobose to ellipsoid, 8 to 15 mm long (Duncan 1944, Patrick et al. 1995).

The earliest known age for a plant to flower occurred in 2-year old plants at Valdosta State University (John Pascarella, VSU, pers. comm. 2005). Mature plants possess a large perennial root crown, which may indicate that the potential life span of an individual plant is rather long (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Tassin and McGee (1999) reported individual plants that were at least 13 years old. Examinations of the roots in one plot suggested that plants may sprout from different points on the root stock each year, so root collar diameter may not be an indicator of age, as was thought by Humphrey (Alison McGee, TNC, pers. comm., August 2005).

There is considerable variation in the time of flowering for hairy rattleweed with flowering from June into August. Flowers produce at least moderate amounts of viable seeds (U.S. Fish and Wildlife Service 1984, Humphrey 1987). New plants can also appear from cut or otherwise disturbed roots (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Fruiting occurs from August thru September with seed and fruit dispersal occurring from September to March (U.S. Fish and Wildlife Service 1984, Humphrey 1987, ESIS 1996). Humphrey (1988) reported that seed planted in-situ in the spring did not germinate. Seeds apparently germinate in the fall (Amy Squire, graduate student, pers comm., 2005).

In fall and winter, plants will easily break off in the wind and may disperse some distance in a tumbleweed fashion with many seeds still on the plant (Humphrey 1987, ESIS 1996). Pollen dissemination agents are presumably insects. The weevil *Apion rostrum* Say (Say's weevil) is possibly a major pollinator (U.S. Fish and Wildlife Service 1984, Humphrey 1987, ESIS 1996). The habit of hairy rattleweed appears to be influenced by its habitat and therefore may affect dispersal of seeds. Shade-grown plants tend to elongate with lax branches while plants from more open habitats tend to be shorter, with stouter, rounded branches which may better facilitate dispersion (Humphrey 1987).

Humphrey (1987) estimated that 25% of plants reproduce and found the number of fruit per individual plant is highly variable, with a mean of 52 seeds per fruiting plant per year; therefore, the seed production per 100 plants has been estimated as 1300. Young et al. (2007) found 37% of flowers produced seed pods and that plants grown with more light tend to produce more flowers. The fruits are frequently infested with widespread Say's weevil and the number of seeds per fruit can range from zero to seven; the average being two (U.S. Fish and Wildlife Service 1984, Humphrey 1987, Leege and Squire 2006). The weevil deposits eggs in the flower buds; the larvae feed on the developing seeds, and mature in the capsules (U.S. Fish and Wildlife Service 1984). Data from three sites indicated that an average of 30% of the fruits were infested with the weevil (U.S. Fish and Wildlife Service 1984). Leege and Squire (2006) found 26% of fruiting plants had experienced seed predation by Say's weevil by mid-September of 2005. Young et al. (2007) found 52% of seed pods had experienced seed predation. Predation levels may have been higher if fruits were sampled at a later date.

The State Botanical Garden grows hairy rattleweed from seed for restoration (Jennifer Ceska, SBG, pers. comm., 2006). They are now establishing an outdoor propagation area for restoration and temporary safeguarding (ex-situ conservation). Seeds from two populations on Rayonier property were acquired for life history studies, education, and safeguarding. Although they are trying to safeguard this endangered plant through these efforts, the plant is hard to keep long-term due to rot in artificial soils. Dr. Duncan historically kept the plant growing on his private property for 7 to 10 years. The plants rot and become infested with insect pests after one year in the greenhouse. SBG is now moving all the plants from the greenhouse when maintaining a collection for more than one season because the plants do not go dormant, become weaker and susceptible to disease and pest pressures. SBG has recreated a sandhill habitat and is able to maintain plants in this artificial sandhill for 3 to 5 years. Hairy rattleweed planted in raised beds with full sun, flower and fruit with no insect predation observed. SBG tested germination in seed for several years and reported good results. Under greenhouse conditions, selecting for viable seeds, with seeds obtained under moist conditions and cold stratified for 15 days, germination has been reported as 70 to 80% (U.S. Fish and Wildlife Service 1984, ESIS 1986). These seeds apparently did not require light to germinate (ESIS 1986). SBG does not have seeds in storage now, but can collect seeds from their outdoor collections for research and education purposes (Jennifer Ceska, SBG, pers. comm., 2006). The seeds carry several species of fungus within the seed coat which can lower percent germination. The plant has a hard seed coat, but germinates and stores well for 2 to 3 years. However, this is not a plant the botanical garden can safeguard long term.

a. Taxonomic classification or changes in nomenclature:
Duncan (1944) described hairy rattleweed and its current status as a species has not changed. The species is also known by the common name "hairy wild-indigo", but "hairy rattleweed" is more commonly used (U.S. Fish and Wildlife Service 1984). The type specimen (sandy soil in open, pine woods, July 4, 1943, Duncan 5693) is deposited at the Gray Herbarium, Cambridge, Mass., U.S.A (Duncan 1944). Other specimens are deposited at the Herbarium of the University of Georgia, Athens, and the Herbarium of Valdosta State College, Valdosta, Georgia (Humphrey 1987).

b. **Genetics, genetic variation, or trends in genetic variation:**
Ceska et al. (1997) found a substantial genetic diversity and relative uniformity in ten sampled plots. Ten populations across the range were sampled with 10 to 48 separate individual plants. Ninety percent of the genetic variation present in the species could be found in an individual plot. Therefore, collections from just two populations could capture 99% of the genetic variation. The genetic analysis provides evidence suggesting that plants are cross pollinating. Furthermore, current populations likely represent fragments of a historic contiguous genetic pool.

c. **Spatial distribution, trends in spatial distribution, or historic range (e.g., corrections to the historical range, change in distribution of the species' within its historic range, etc.):**

The 22 extant populations of hairy rattleweed occur entirely within the Lower Coastal Plain of Georgia (GDNR 2006) and at least one population appears extirpated. The entire range covers approximately 125 square miles in two counties, the southeastern corner of Wayne County and the extreme northern portion of Brantley County (U.S. Fish and Wildlife Service 1984). The map of hairy rattleweed in the recovery plan appears to display a continuous population and is misleading (Tom Patrick, GADNR, pers. comm. 2005). The populations are not continuous, although the genetics appear to be relatively uniform suggesting that there was historically a contiguous distribution (Ceska et al. 1997). At least 16 of the populations occur in habitat that has been severely altered through silvicultural activities in intensively managed pine plantations or occur along roads or powerline rights-of-way (GDNR 2006). Only the location known as the Lewis Tract is considered a natural community; however, even this site has suffered from fire exclusion, which has likely affected plant vigor and influenced field observations.

Predictive polygons placed around extant populations estimate as much as 3075 acres of potential habitat range wide, however, plants

are widely scattered in these polygons (USFWS data). Approximately 2741 acres of occupied habitat occur on industrial timber land, 15 acres are in conservation, 45 acres occur in power line right-of-ways, and 274 acres occur on privately owned land.

Nine populations have had some sustained sampling effort that has demonstrated a trend of declining numbers and poor recruitment. Humphrey (1987) established seven plots located on industrial timberlands and an additional plot was established in a power line right-of-way. Individual plants within each plot were counted and classified according to life stage (seedling, juvenile, mature) and flowers and fruits were counted for each plant. Data on plant community composition were recorded for each plot. Tassin and McGee (1999) re-sampled eight permanent monitoring plots and found that the population declined in seven of eight plots. From 1986 to 1999, declines ranged from 22 to 89% and the distribution across life stages shifted toward the less vigorous seedling stage. Tagged plants indicated that individuals can survive at least 13 years. In more open canopy structures, a higher proportion of plants flowered. Sites with thick canopy cover demonstrated declines in the number of individual plants. It is possible that the decline in the number of individuals was due to dormancy, the plants have substantial root stocks, so it is thought that the plant may persist after extensive site preparation, or declines could be due to canopy closure, soil disturbance and/or drought (Alison McGee, TNC, pers. comm., August 2005).

An additional monitoring plot was added at the Lewis Tract (Malcolm Hodges, TNC, pers. comm., August 2005). There are some wet swales in the area that potentially could sustain hairy rattleweed if the plants received good sunlight. Prescribed burning could facilitate the spread of hairy rattleweed in this population.

In 2005, Leege and Squire (2006) also re-sampled the eight sites established in 1986/1987, and the additional sample site that had been established by the Nature Conservancy in 1997. They found that the species declined at all forested monitoring sites after 1986/1987 (Table 1). In sites where timber had been harvested, nearly 80% of the individuals in populations were lost since 1986. Reproduction in young pine stands with limited canopy cover was proportionally greater than reproduction in older plantations (>10 years old). Seedling recruitment was nearly absent in all plantations regardless of the age of the plantation. Neither the Lewis Tract nor the Oilwell Road site experienced a timber harvest during the study, these represent the largest forested populations with the least decline. Both sites appear to have benefited from management that increased the available sunlight. The Oilwell Road stand was thinned and burned

during the monitoring period, allowing increased light penetration. At the Lewis Tract, small hardwood removal occurred between the 2002 and 2005 census, and may have contributed to increased population size. Both these sites housed significantly greater plant diversity than the other sites monitored. The Georgia Power site on Needmore Road has been mowed regularly and has retained 100% of its original 1986 population.

Table 1. Population size over 19 years of monitoring. Data for Lewis tract collected in 1997, 2002 and 2005 by The Nature Conservancy (Malcolm Hodges, TNC, pers. comm., August 2005). Taken from Leege and Squire, 2006, Report to USFWS.

Location	*1986*	*1999*	*2005*	*% of 1986 population remaining in 1999*	*% of 1999 population remaining in 2005*
Straight Road	117	12	5	4.3	41.7
Wire Road N.	65	32	16	24.6	50
Wire Road S.	42	12	17	40.5	141.7
Longbranch Rd.	482	137	30	6.2	21.9
Oilwell Rd	196	54	173	88.3	320.4
Hwy 110 W.	313	202	119	38.0	59
Hwy 110 E.	155	79	24	15.5	30.4
Needmore Rd.	98	100	-		
Natural site	*1997*	*2002*	*2005*	*% of 1997 population remaining in 2002*	*% of 2002 population remaining in 2005*
Lewis Tract	172	97	113	65.7	116.5

During surveys conducted in 2000 associated with a bridge replacement project over Mill Branch in Brantley County, the Georgia Department of Transportation (GADOT) identified a new population of hairy rattleweed 12 m (40 ft) from the existing right-of-way for State Route 32. The population was located in a mesic scrub habitat in a powerline easement (GDNR 2003, GADOT 2000).

d. Habitat or ecosystem conditions:

Hairy rattleweed has a conspicuous appearance and is a readily-apparent component of the community; however, it generally constitutes less than 5 percent of the vegetative community (Humphrey 1987). Because the plants are widely-spaced and have widely spreading root systems, their below-ground influence on the community may be greater than their above-ground abundance indicates. For this reason, the species could perhaps be considered a subdominant on the sites where it is more abundant (ESIS 1996).

Populations are largely limited by availability of suitable open habitat and competition from other species (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Shading and competition; often, as a result of fire suppression, are considered common causes of mortality and reduced recruitment (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Density varies considerably among sites; values of 33 to 980 individuals per 0.25 ha were recorded (Humphrey 1987). Although intermediate-aged plants and older plants may be well-represented in populations of hairy rattleweed, there are often low to moderate numbers of younger individuals and limited recruitment appears to be an ongoing problem (Humphrey 1987, GDNR 1992, Tassin and McGee 1999, Leege and Squire 2006). The lack of recruitment appears to be related to habitat conditions that lack the appropriate forest structure, a vigorous herbaceous layer, a limited shrub layer, no midstory and an open canopy (Leege and Squire 2006; Malcolm Hodges, TNC, pers. comm., August 2005).

The preferred habitat of hairy rattleweed occurs in longleaf-slash pine flatwoods with a sparse canopy, fewer larger shrubs, greater light penetration and greater cover of herbs (mainly wiregrass) and low shrubs of the lower Coastal Plain of Georgia (Duncan 1944, U.S. Fish and Wildlife Service 1984, Humphrey 1987, Tassin and McGee 1999). More specifically, the habitat can be classified as mesic pine lowland forest or pine flatwoods as described by Wharton (Wharton 1977). It also occurs in floristically similar but more open pine-wire grass (*Aristida stricta*) shrub woodlands with occasional oaks (*Quercus laevis*, *Q. virginiana* and *Q. nigra*) (U.S. Fish and Wildlife Service 1984, Humphrey 1987). These are considered to be fire-adapted communities that must be fire-maintained and naturally would have burned approximately every two to four years. Frequent fires would have kept the woodlands open and controlled shrubby vegetation, benefiting the herbaceous plant community. (U.S. Fish and Wildlife Service 1984, Harper 1921, Hough 1965, Wharton 1977, Tassin and McGee 2006). Hairy rattleweed is most abundant in communities with the early successional characteristics of open canopy and low abundance of larger shrubs (Humphrey 1987, U.S. Fish and Wildlife Service 1984). Hairy rattleweed abundance declines and the species may be eliminated in later successional communities (Humphrey 1987).

Presently, most hairy rattleweed populations occur in slash pine plantations, within its range, it also frequently occurs along highway rights-of-way, logging roads and utility line rights-of-way (U.S. Fish and Wildlife Service 1984, Humphrey 1987, GDNR 2006). The species is known to occur on a few sites in longleaf pine-wiregrass-shrub communities that exist in more-or-less natural conditions

(though fire has probably been largely excluded) (Humphrey 1987). A small portion of the range of hairy rattleweed is in farmland (Humphrey 1987). Although the habitat best suited for hairy rattleweed is poorly suited for most agriculture (U.S. Dept. of Agriculture 1965), the species occurs near the margins of some of this cultivated land which generally supports corn, tobacco and pasture land.

Hairy rattleweed occurs on level to gently sloping land (U.S. Fish and Wildlife Service 1984, Humphrey 1987, ESIS 1996). Soils are sandy groundwater spodosols (suborder: aquods) and are underlain by an organic hardpan (Wharton 1977,U.S. Fish and Wildlife Service 1984, ESIE 1996,). They are poorly drained with moisture levels ranging from near saturation in early spring to dry in late summer or fall (U.S. Dept. of Agriculture 1965, ESIS 1996). This type of habitat often occurs adjacent to and grades into pocosin or bay swamp habitats scrub-shrub wetlands toward the wetter end of the spectrum and habitats typical of longleaf pine-turkey oak (Q. laevis) communities toward the drier end of the spectrum (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Elevations of the sites of known populations range from 17 to 26 m (55 to 85 ft) (Humphrey 1987). Hairy rattleweed occurs on the Penholoway Shoreline Deposit Complex formation within the Barrier Island Sequence Physiographic District (Clark and Zisa, 1976). Soils that have been identified include the following soil series names: Mascotte Sand, Rigdon Sand, Sapelo Fine Sand, Pottsburg Sand, and Olustee Sand (ESIS 1996). These soils are sandy to a depth of 0.91 m (3 ft) or more and have spodic horizons (accumulation of iron and organic matter that often forms a cemented pan) that usually occur within 51 cm (20 in) of the surface (ESIS 1996). These soils are acidic (pH 4.2 to 5.1) and low in fertility. The water table is within 25 to 102 cm (Kral 1980) of the surface during dry seasons. These soils are poorly drained to somewhat poorly drained and moderately permeable with Rigdon sand being the best drained (ESIS 1996). Runoff is slow and internal drainage is impeded by the shallow water table. Hairy rattleweed is apparently adapted to the wide variation in soil moisture that occurs on these sites (Humphrey 1987, ESIS 1996).

2. Five-Factor Analysis

Over time, the range of hairy rattleweed has remained essentially the same but the population sizes have declined (U.S. Fish and Wildlife Service 1984, Tassin and McGee 1999, Leege and Squire 2006). Habitat alteration and destruction are the primary contributors to declining populations. Most populations of hairy rattleweed occur on land owned by forest products companies. Because the total range of hairy rattleweed

is and has been quite small, detrimental land management practices that are commonly used throughout this small area could genuinely threaten the species with extinction (U.S. Fish and Wildlife Service 1984, Humphrey 1987).

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Silvicultural practices in the timber industry have altered approximately 2741 acres of hairy rattleweed habitat and directly destroyed individual plants. Hairy rattleweed populations are able to survive clear-cutting, but site preparation and replanting severely impact populations (U.S. Fish and Wildlife Service 1984, Humphrey 1987, Kral 1980). The effects of bedding, unnaturally high stocking densities of seedlings and fire exclusion in pine plantations are dramatically impacting this species (U.S. Fish and Wildlife Service 1984, Tassin and McGee 1999, Humphrey 1988, Leege and Squire 2006).

Bedding is the mounding of mineral soil with the objective of raising the newly planted seedlings above the winter water table. Bedding of sites is a common soil treatment on wet coastal plain sites in the southeastern U.S. In wet sites, the water table will rise following logging and during the winter months. Under these circumstances young seedlings may be submerged. To form beds, a bedding harrow is most often used followed by an "hourglass" shaped drum to shape the beds. Seedlings are then planted directly on top of these beds.

The practices of bedding and double bedding directly disturb the roots of hairy rattleweed and, although some root sprouts may survive, most root stock is exposed to desiccation or the roots are buried; either event is deleterious to the plant. Populations survive this procedure but with reduced numbers. The surviving plants appear to be stressed and have reduced flowering (Humphrey 1987). Plum Creek started double bedding in early 1970s (Rob Hicks, Plum Creek Timberlands, pers. comm., 2005). During the application of bedding practices, Plum Creek tries (if conditions allow) to pull beds early in summer, evaluate the site and if needed will re-pull the bed in September. There is some evidence to suggest that many plants survive these practices (Humphrey 1987).

High stocking densities are used to maximize the Net Present Value on industrial timber land. As a result, canopy closure is achieved and growing space is fully occupied, resulting in shading and elimination of the herbaceous ground cover, including hairy rattleweed. Following timber harvest, populations do not respond to the release from shading and competition with increased recruitment, as might be expected

(Humphrey 1987). Currently, when replanting trees, Plum Creek and Rayonier have a target of planting over 600 trees per acre (Rob Hicks, Plum Creek Timberlands, pers. comm., 2005; Chris Carey, Rayonier, pers comm., 2005). As a stand moves toward canopy closure, populations of hairy rattleweed generally decline until the plantation is harvested (Chris Carey, Rayonier, pers comm., 2005). The loss of ground cover contributes to a change in the fire community and reduces the opportunity for natural fires to play a role in the ecology to the site. In the past, wildfires and use of fire by man maintained habitat suitable for hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987).

Suppression of fire has resulted in increased competition from shrubs, which is considered to be a major factor responsible for reduction in abundance of hairy rattleweed (U.S. Fish and Wildlife Service 1984). Fire is still used for forest management, but the frequency and time of year of burning may not be beneficial to hairy rattleweed (U.S. Fish and Wildlife Service 1984, Humphrey 1987). Rayonier historically used fire only for site prep to burn off logging slash; however, due to recent burning conditions and liability they have mostly abandoned the use of fire (Chris Carey, Rayonier, pers comm., 2005).

The use of herbicides in powerlines and road rights-of-way could adversely affect populations of hairy rattleweed, although, the effects of herbicides are solely based on field observations. Several small and disjointed populations occur along a 4 to 5 mile stretch of highway and powerline right-of-way paralleling State Highway 32. Georgia Power Company manages transmission lines through many different easement holders which complicates the management of these habitats (Jim Chandler, Georgia Power, pers. comm., 2005). Both Rayonier and Plum Creek have mapped populations of hairy rattleweed, have trained foresters to identify hairy rattleweed and have removed known populations of hairy rattleweed from herbicide treatment as site prep (Rob Hicks, Plum Creek, pers. comm., 2005; Chris Carey, Rayonier, pers comm., 2005).

Drainage of adjacent wetlands that in turn, affects the hydrology of hairy rattleweed sites and application of fertilizer in pine plantations could also be a possible threat (Humphrey 1987). Draining of wetlands and use of fertilizer has occurred in this area in recent years, but field observations have documented no adverse effects on hairy rattleweed thus far.

Two extant populations occur on 274 acres of hairy rattleweed habitat in areas where rural housing development has occurred. The houses and surrounding landscaping directly destroy hairy rattleweed.

Furthermore, the habitat surrounding housing development suffers from a lack of timber thinning or fire management. The lack of thinning results in overstocked trees that eliminate the understory habitat of hairy rattleweed. Housing development fragments the land ownership into small parcels with multiple owners, making fire management impractical in this habitat.

b. Over utilization for commercial, recreational, scientific, or educational purposes:

This plant has no known economic value and is not harvested by collectors. Scientists studying this plant are careful not to over harvest at any stage in its life history.

c. Disease or predation:

Leege and Squire (2006) found that 26% of the plants were infected by Say's weevil, *Apion rostrum*. The Services Recovery Plan (1984) showed that the weevil potentially destroyed up to 35% of seed. This is the only known predator for the hairy rattleweed and reduces reproduction of the species.

d. Inadequacy of existing regulatory mechanisms:

Under the provisions of Georgia's Wildflower Preservation Act, hairy rattleweed is a legally-protected species (Patrick et al. 1995). This law protects State-listed plant species by regulating their removal from State-owned lands. It further requires that any removal of State-protected plants from private land be with the written permission of the landowner, and it also regulates any traffic in these plants by requiring both transport tags and permits to sell or collect in Georgia. Whenever federally-listed plant species are involved, provisions of this law (or any other State law or regulation, including State criminal trespass laws), are enforceable by Federal agents under section 9 of the Endangered Species Act of 1973, as amended. The Georgia Wildflower Preservation Act has not had a significant effect upon retarding habitat loss, the primary threat to the listed species.

An additional Georgia State law affording some protection to these and other listed species is the Georgia Environmental Policy Act (GEPA). Modeled after the National Environmental Policy Act (NEPA), this 1991 law established requirements and procedures for assessing the environmental effects of all proposed State government actions that "may significantly adversely affect the quality of the environment." Guidelines for implementation of GEPA, as promulgated by the Georgia Department of Natural Resources, Environmental Protection Division, describe certain types of activities as "clearly significant", among these being any "action that affects threatened or endangered species or their habitats" (Georgia DNR 2005).

e. Other natural or manmade factors affecting its continued existence:

There are no other natural or manmade events with known impacts to hairy rattleweed's existence. However, it is expected that severe drought could be a threat to small populations and would likely reduce recruitment into the population.

D. Synthesis

With 22 extant populations and at least one population extirpated, declines are indicated across the range of hairy rattleweed. Predictive polygons around extant populations estimate as much as 3075 acres of potential habitat range wide; however, plants are widely scattered in these polygons. There are no populations of hairy rattleweed where the habitat is unaltered by human influences. However, three populations of hairy rattleweed are in good condition; 15 acres of occupied habitat are in conservation on the Lewis Tract and two populations (45 acres) in power line rights-of-way. The remaining 19 populations suffer significant impacts from human activities. Intermittent monitoring of nine plots for 19 years has shown a significant decline in hairy rattleweed numbers and density in populations where industrial timber production is practiced.

Approximately 2741 acres (17 populations) of habitat occur on industrial timber land, where monitoring plots have demonstrated that 80% of the individuals in populations were lost between 1986 and 2007. An additional 274 acres of habitat (two populations) occur on privately-owned land that is impacted by housing development and lack of management. Hairy rattleweed faces severe habitat degradation due to industrial timber operations and development on 98% of its potential range. Most of the populations have become isolated along road sides and hairy rattleweed rarely persists in the interior of the forest.

The plant is threatened by habitat degradation due to urban development, fire exclusion, silvicultural site preparation, and overhead canopy development, and also by one major parasite (Says's weevil). The limited range and population numbers of this species make it highly vulnerable to human-caused changes in habitat. Hairy rattleweed is threatened with extinction throughout its range and continues to meet the definition of an endangered species under the Endangered Species Act.

III. RESULTS

A. Recommended Classification

Hairy rattleweed is endangered; no change in status is recommended at this time.

B. New Recovery Priority Number

Due to the few remaining populations, the decline in population sizes of existing populations, and over 70% of the extant populations occur in habitat that has been severely altered by multiple uses like silviculture, the degree of threat is "high". In order to achieve recovery, conservation agreements will have to be implemented or habitat purchased outright along with transplanting into unoccupied and possibly artificial habitat. Most known populations are in private ownership and not in a natural condition. All populations have suffered from fire exclusion and the majority is in sites that have been severely altered which have likely affected plant vigor. Due to these reasons, the recovery potential is "low". The "high" degree of threat with a "low" recovery potential should result in a RPN of 5.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

I. Conservation/Management Strategies

1. Investigate potential for longleaf pine planting on private land. Projects could be partially funded by the US Fish and Wildlife Service.
2. Secure funding for land acquisition to facilitate permanent protection for recovery of populations.
3. Implement conservation easements where possible.
4. Develop and distribute an information factsheet on hairy rattleweed.
5. Share with the local Natural Resource Conservation office information about the distribution and best management practices of hairy rattleweed.
6. Contact and cooperatively work with Okefenokee Electric Membership Cooperation/Georgia Department of Transportation regarding rights-of-way management (broadcast spraying along right-of-ways) (e.g., Georgia Power – mowing).
7. Document change in industrial timber management over time and relate the change in management to the change in habitat.
8. Work with partners to help secure funding for protection and management efforts
9. Reintroduce fire on select industrial timberland sites to study effects.
10. Create demonstration sites to establish effective hairy rattleweed habitat management (reflective of management guidelines that will be established and further researched).
11. Investigate and provide incentives for hairy rattleweed management on private lands (e.g., appropriate mowing regimes or other management options)
12. Prioritize tracts/sites for different purposes – acquisition/conservation, research plots, seedling recruitment, vulnerability to development, etc.
13. Identify safeguarding sites (Sansavilla, others) for reintroduction efforts and potential expansion of the currently recognized distribution within historical area.

II. Research Priorities

Research needs and priorities should emphasize three basic biological components: reproduction, habitat requirements, and management implications.

1. Conduct germination studies with recruitment in the field.
2. Determine fire effects to see if fire can promote seed production, predator control and reduce competition.
3. Re-survey long-term monitoring plots and GPS each site to document status across the range of hairy rattleweed.
4. Determine canopy cover relationships to vigor of plants and reproduction.
5. Determine seed predator relationships (fire, weevil survivability, etc.) to vigor of plants and reproduction.
6. Determine changes in timber bedding practices (single versus double) over time.
7. Determine effects of backpack herbicides and bush hogging to see if there is a fire surrogate that can be used on industrial timber land to promote hairy rattleweed habitat.
8. Establish seedlings at pre-determined sites.
9. Characterize vegetation and habitat requirements.
10. Conduct additional inventory/surveys to more accurately predict the size of occupied polygons and the distribution of the species.
11. Characterize hydrology of hairy rattleweed sites.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Hairy Rattleweed (*Baptisia arachnifera*)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

_X_ No change needed

REVIEW CONDUCTED BY: Jimmy Rickard, Strant Colwell; Georgia Ecological Services Field Office

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve: Sandra S. Tucker Date: 8/8/2011

The lead Field Office must ensure that other offices within the range of the species have been provided adequate opportunity to review and comment prior to the review's completion. The lead field office should document this coordination in the agency record.

REGIONAL OFFICE APPROVAL:

The Regional Director or the Assistant Regional Director, if authority has been delegated to the Assistant Regional Director, must sign all 5-year reviews.

Lead Regional Director, Fish and Wildlife Service

Approve: Date: 12/1/11

APPENDIX A: Summary of peer review for the 5-year review of Hairy Rattleweed (*Baptisia arachnifera*)

A. Peer Review Method: Professionals (identified under I.A.) familiar with this species and outcrop habitats were provided a copy of this draft 5-year review document and asked to provide peer review comments on the contents.

B. Peer Review Charge: The following instructions were provided to individuals that conducted a peer review of this document. We ask for comments on the validity of the data used, and identification of any additional new information on the species that has not been considered in this review. Please note that we are not seeking your opinion of the legal status of these species, but rather that the best available data and analyses were considered in reassessing its status.

C. Summary of Peer Review Comments/Responses –

Comment: pg. 3; 3(1) Though GA Power may be attempting to avoid mowing during the growing season, the land owner near the Needmore Rd. population in the powerline right of way mowed the population as recently as 2005 during the growing season, which precluded sampling of the population.

Response: The Service has noted that right-of-ways occupied by hairy rattleweed are occasionally mowed.

Comment: pg. 4; 3(3) Where were the greenhouse grown plants planted -in a natural site or on timber land? Has the site been burned or managed in any way?

Response: Greenhouse plants were planted in a timber plantation, managed to maximize timber production. This site was not burned or managed in any way for hairy rattleweed.

Comment: At the GPCA meeting, it was reported that there is a potential problem with *Baptisia* crossing with a native congener at Valdosta State. This should be mentioned in this report.

Response: Hairy rattleweed planted at Valdosta State is well outside of its natural range. These two species of *Baptisia* do not have overlapping range. While this is an interesting occurrence, it has no bearing on natural populations of hairy rattleweed. However, before any restoration efforts are considered, careful consideration would be given to the source stock to ensure protection of the natural populations.

Comment: pg. 5; (1) Young et al. 2007. Reproductive ecology of a federally endangered legume, *Baptisia arachnifera*, and its more widespread congener, *B. lanceolata* (Fabaceae). Am. J. Bot. 94(2):228-236. (an AJB publication from Amy Squire's thesis – now Amy Young) provides additional information on flower production, pollen viability, fruit initiation, fruit production, pre-dispersal seed predation, seed production, seed size,

and seed abortion for *Baptisia arachnifera* relative to a common congener, *Baptisia lanceolata*. In addition, seed viability is evaluated under control and 5 heat treatments, to assess the ability of the seeds to germinate following fire.

Response: Some of this information has been incorporated into this document.

Comment: pg.6; Additional information on reproduction is present in Leege report as well.

Response: This information is considered.

Comment: Why is this not a plant the garden can safeguard long-term?

Response: Botanical gardens have reported that plants suffer from root rot in artificial settings.

Comment: pg. 8 (b); How large were the plots sampled to determine genetic diversity?

Response: Ten populations across the range were sampled with 10 to 48 separate individual plants.

Comment: pg. 8 (c); Rayonier publication indicates smaller range.

Response: All extant populations have been visited and confirmed by Service personnel.

Comment: Under spatial distribution, the sentence regarding "In more open canopy structures" – should state "a higher proportion of the plants flowered" – not always more plants because numbers were low in open sites post harvest.

Response: This change has been noted.

Comment: pg. 8, 1st paragraph; An additional monitoring plot was added in 1997 at the Lewis Tract. Next paragraph refers to this same plot. Sounds like they are different the way it is written. 2nd paragraph: "Neither the Lewis Tract nor the Oil well Rd….. These represent the largest populations with the least decline" – add: **among forested sites**.

Response: This comment has been incorporated.

Comments received regarding data or relevant data not used by FWS.

Comment: a. as stated above: Young et al. 2007. Reproductive ecology of a federally endangered legume, *Baptisia arachnifera*, and its more widespread congener, *B. lanceolata* (Fabaceae). Am. J. Bot. 94(2):228-236. (an AJB publication from Amy Squire's thesis – now Amy Young) provides additional information on flower production, pollen viability, fruit initiation, fruit production, pre-dispersal seed predation, seed production, seed size, and seed abortion for *Baptisia arachnifera* relative to a common

congener, *Baptisia lanceolata*. In addition, seed viability is evaluated under control and 5 heat treatments, to assess the ability of the seeds to germinate following fire.

Comment: b. Additionally, Leege 2007 Final report *Baptisia arachnifera* in natural and managed habitats. US Fish and Wildlife Service Grant Agreement #401815G175 9pp. This is an updated version of the interim report, heavily cited in the review. Additional information provided includes survivorship data for plants of different life stages, as well as their transition probabilities to larger or smaller life stages. In addition, field recruitment data for reproductive plants are included.

Comments received regarding validity and adequacy of data.

Comment:
Validity - The data presented here appear to be valid; additional information needed to evaluate the experimental design is indicated in part 1 above.

Adequacy - Significantly more data need to be collected, particularly with regards to germination and response to fire. Additional studies were listed as research priorities in the 5-year review document.