Red Hills Salamander
(*Phaeognathus hubrichti*)

5-Year Review:
Summary and Evaluation

USFWS photo: Emmett Blankenship

U.S. Fish and Wildlife Service
Southeast Region
Alabama Ecological Services Field Office
Daphne, Alabama

5-YEAR REVIEW
Red Hills salamander/*Phaeognathus hubrichti*

I. GENERAL INFORMATION

A. Methods used to complete the review

This review was completed by our Alabama Ecological Services Field Office in Daphne, Alabama. Information sources include the Red Hills Salamander Recovery Plan (Service 1983), peer reviewed scientific publications, incidental take permits, habitat conservation plans, and unpublished reports. Public notice was given in the *Federal Register* on September 8, 2006 (71 FR 53127) and a 60-day comment period was opened. We did not receive any new information during this comment period. All information used in the review is on file at the Alabama Field Office. The recommendations resulting from this review are the result of thoroughly reviewing the best available information on the species.

Six individuals peer reviewed this document. A summary of the peer review is provided in Appendix A.

B. Reviewers

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

Lead Field Office: Daphne, Alabama Ecological Services Field Office – Rob Tawes (former Deputy Field Supervisor) and Matthias Laschet, 251-441- 5842

Cooperating Field Office: Jackson, Mississippi Ecological Services Field Office – Linda LaClaire, 601-321-1126

C. Background

1. Federal Register Notice citation announcing initiation of this review: September 8, 2006; 71 FR 53127

2. Species status: Improving; Several projects have been funded to study burrow occupancy rates (study site: Haines Island); movement, burrow fidelity, and fine-scale genetics (study site: SR-21 Falkenberry Hill); population structure between disturbed and undisturbed sites; and effect of slope on population structure (using previously collected data). A letter highlighting several voluntary conservation opportunities was mailed to 379 landowners throughout the species' range. A newly developed fact sheet was included with the letter. An article highlighting similar information was published in the Alabama's Treasured Forests magazine. These outreach activities contributed to increased public knowledge about the salamander and resulted in possible opportunities with willing landowners.

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

4. Listing history
Original Listing
FR notice: 41 FR 53032
Date listed: January 3, 1977
Entity listed: species
Classification: threatened

5. Review History
Recovery Plan: November 23, 1983
Recovery Data Calls: 2012-2000

A previous 5-year review for this species was noticed on November 6, l991 (56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors, threats, etc. as they pertained to the individual species. The notices summarily listed these species and stated that no changes in the designation of these species were warranted at that time. In particular, no changes were proposed for the status of the species in this review.

6. Species' Recovery Priority Number at start of review (48 FR 43098): 7 (monotypic genus with medium degree of threat and high recovery potential). The Red Hills salamander is the sole member of the genus *Phaeognathus*. The species has been classified as facing moderate threats (primarily from forest resource extraction). However, it has a high recovery potential because it is typically found on steep slopes or within streamside management zones easily delineated and avoided by timber operators, and low development pressure.

7. Recovery Plan
Name of plan: Red Hills Salamander Recovery Plan
Date issued: November 23, 1983

II. REVIEW ANALYSIS

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

1. Is the species under review listed as a DPS? No.

2. Is there relevant new information that would lead you to consider listing this species as a DPS in accordance with the 1996 policy? No.

B. Recovery Criteria

1. **Does the species have a final, approved recovery plan containing objective, measurable criteria?** No. There is a final approved plan but it does not contain recovery criteria. However, the plan does contain objectives and tasks stressing the importance of habitat protection (through habitat conservation plans, easements, or fee simple purchase), habitat mapping, additional surveys, landowner and public outreach/education, and monitoring of both populations and known habitat. The recovery plan basically states an objective toward delisting but indicates it is likely not possible for this animal in the near future due to the animal's small range, limited habitat, and other considerations.

   Since the last review, improvements in GIS and the willingness of some land owners to create detailed maps of their lands, provide a more accurate acreage of Red Hills Salamander habitat. Land purchases through the Forever Wild program, The Nature Conservancy (TNC), and Alabama Department of Conservation and Natural Resources (ALDCNR) have also contributed to efforts in striving to recover the Red Hills salamander.

C. Updated Information and Current Species Status

1. Biology and Habitat

The Red Hills salamander (RHS) is a large, fossorial (burrowing), lungless salamander first collected in Butler County, Alabama, in 1960 by the late Leslie Hubricht. The species, distinct from other plethodontid salamanders because of its large size, elongated trunk, and short legs, was described the following year under the monotypic genus *Phaeognathus* (Highton 1961). The RHS, based on current scientific information, is restricted to the Red Hills physiographic province in Conecuh, Covington, Crenshaw, Butler, Monroe, and Wilcox Counties, Alabama (Figure 1). The Alabama River to the west and the Conecuh River to the east delimit the known range of the species. Within this area, the RHS is typically found in areas of relatively undisturbed forested slopes and moist ravines with surface exposures of the siltstones, claystones, sandstones, and clays of the Tallahatta and Hatchetigbee geologic formations. However, salamanders have been found outside of these formations, as evidenced by the 2005 discovery of a possibly disjunct population of RHS on private timberlands in Wilcox County (Bailey & Miller 2006). Additional surveys may reveal other such populations.

RHS occupy subterranean burrows, often located within the fissures and channels of the referenced geologic formations. Burrow entrances are small, oval, and typically possess smooth, rounded edges. The salamanders rarely leave their burrows, and prey on invertebrates and land snails both inside the burrow and near the burrow entrance (Gunzburger 1999). Evidence from field and laboratory research indicates the entire RHS life cycle, including breeding, oviposition, hatching and larval development, may occur entirely within these burrows (Gunzburger and Guyer 1998, Guyer undated, Bakkegard 2002, Means 2003).

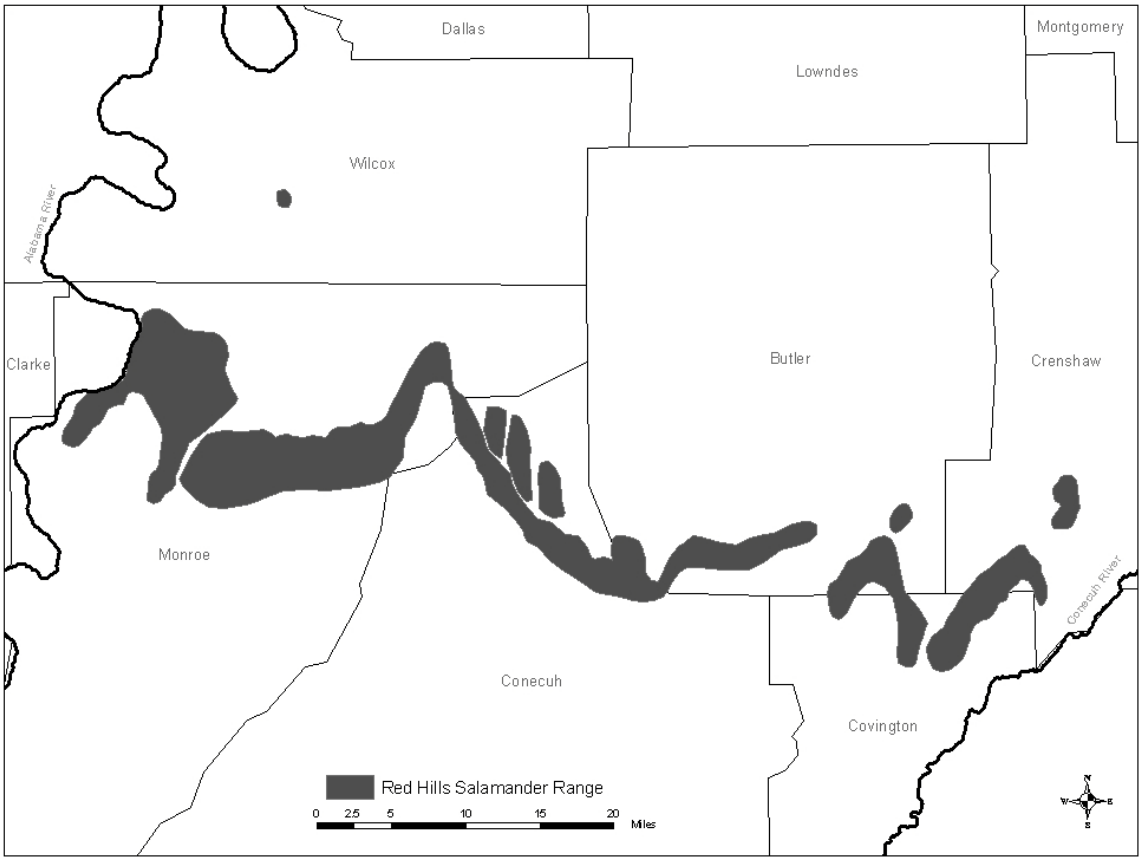

FIGURE 1: Range of Red Hills Salamander (Adapted from Dodd 1988, 1991)

RHS burrows occur in relatively undisturbed mesophytic forest habitat on moderately steep to steep slopes. The subterranean clays, claystones, and siltstones are an important element in maintaining the suitable moisture required for these amphibians. In addition, loamy soils, deciduous leaf litter, and a forest canopy cover providing shade and moisture are important habitat elements preventing the dessication of the forest floor and micro-environment occupied by the species (Service 1983). Burrows are typically more abundant on the upper portion of steep (greater than [>] 27º), north-facing slopes and ravines, under the shade of mature undisturbed forest (Jordan and Mount 1975; French and Mount 1978; Service 1983; Dodd 1988, 1991; Godwin 2003). However, active burrows are also found on the lower portions of slopes, and occasionally on slopes with eastern, northeastern, northwestern, and western aspects (Dodd 1988, Godwin 2003). Typical overstory plant species found in RHS habitat include tuliptree (*Liriodendron tulipifera*), beech (*Fagus grandifolia*), mountain laurel (*Kalmia latifolia*), oaks (*Quercus* spp.), hickories (*Carya* spp.), Anise (*Illicum floridanum*) and several species of magnolia (*Magnolia* spp.).

a. Species' biology and life history:

Some basic biological research has been conducted on the species since the 1983 recovery plan. Parham et al. (1996) studied the skeletochronological age of 11 RHS specimens. Age estimates for these individuals ranged from 5 to 11 years, with the largest specimen estimated to be the oldest. Gunzburger (1999) examined RHS food sources and found, through examination of stomach contents from preserved specimens and fecal samples from live RHS that prey consists mainly of various arthropods (68%) and gastropods (20%). New food sources identified in this study included shed skin, spiders, hemipterans, and annelids (earthworms). Bakkegard (2002) studied the seasonal and daily activities of RHS at their burrow entrances, and found air temperature was the most influential abiotic variable. Salamanders spent more time at burrow entrances during warmer parts of the year. Additionally, activity increased in the afternoon and was typically high through the evening into the early morning and moonlight had no discernible effect on nighttime activity. The study also found salamanders at active burrow entrances 28% of the time. Means (2003) investigated RHS reproductive biology. He observed the behavior of a brooding female and examined her egg clutch (containing six eggs attached to the ceiling of a burrow). As suspected, juvenile RHS in the study developed directly into adults with no aquatic larval stage. Based on the study, female RHS may oviposit in late June through early July and incubate in July and August. Bakkegard and Guyer (2004) examined sexual size dimorphism in 92 preserved RHS specimens and found that males were both larger and bulkier than females. The authors theorized this may have evolved as a result of male-male combat (males also had more bite scars than females). Finally, Bakkegard (2005) studied RHS response to predators (snakes) and documented a number of protective behaviors, including mouth gaping, writhing, and head flattening. These antipredator behaviors were very similar to those documented for the related *Desmognathus* salamander genus.

b. Abundance, population trends, demographic features, or demographic trends

It is extremely difficult to capture RHS without harming individuals and habitat and therefore status and take (e.g., Service incidental take permits) have been determined by monitoring habitat rather than population levels. Perhaps the best known method of surveying for individual salamanders (and the most efficient) is to determine the amount or density of burrows.

Several studies have attempted to determine RHS burrow density. Dodd (1988, 1990) calculated burrow density (using a line-transect method) at a number of sites. Estimates ranged from 2.6 to 9.4 burrows per 100 m^2, with a mean burrow density of 5.05 burrows per 100 m^2. Godwin (2002), also employing the line transect method, sampled several sites throughout

the range of the species (including two sites surveyed in Dodd's studies) and produced range estimates of 6.6 to 45.5 burrows per 100 m^2.

Gunzburger and Guyer (1998) conducted a study examining burrow occupancy and estimated an RHS burrow occupancy rate of 0.8 salamanders per burrow at their study site in Haines Island Park, Monroe County. It is important to note this was a short term study focused on a single, protected salamander population.

Four studies have combined burrow density estimates and burrow occupancy rates to estimate salamander density or local population estimate. Jordan (1975) estimated a population of 43 salamanders for a 2.3 hectare (ha) study site. Carroll et al. (2000) estimated a density of 0.5 salamanders per m^2 at Haines Island Park in Monroe County. While this was much denser than the estimate produced by Jordan (1975), the authors cautioned that Haines Island contains high quality habitat and therefore this density figure should be considered an "upper bound." Guyer (undated) suggested that salamander densities in prime habitat may approach one animal per m^2. Godwin (2002) estimated salamander densities ranging from 2.0 to 36.4 (Kalmia Ravines, Monroe County) salamanders per 100 m^2 for various locations throughout the range of the species. Both Godwin (2002) and Carroll et al. (2000) used burrow occupancy estimates from Gunzburger and Guyer (1998) in their calculations.

Based on this information, it seems possible to estimate range wide salamander population by the following formula:

(Burrows/m^2) x (# salamanders/burrow) x (10,000 m^2/hectare) x (# hectares/RHS range) = # salamanders/range

However, we have not attempted to use this formula because at this time we still lack crucial information on the amount and quality of salamander habitat. In order to attempt such a range wide population estimate we would need to: 1) stratify habitat into different types, each supporting different densities of salamanders, 2) have accurate data regarding the acreage of each habitat type, 3) have accurate information regarding the density of salamanders in each habitat type, and 4) develop a method to account for areas nested within habitat that are unsuitable (see Section IV: Recommendations for Future Actions for more information).

c. Genetics, genetic variation, or trends in genetic variation

The recovery plan (Service 1983) does not specify a need for genetic studies, but does assign high priority to the study and assessment of "population structure and dynamics" (Task 3.1). Current advances in conservation biology allow researchers to better understand population structure and relatedness through mitochondrial and nuclear DNA

analysis. McKnight et al. (1991) examined mitochondrial DNA and allozymes (alternate forms of protein present at gene loci) in 14 individuals collected throughout the range of the species. They found no mitochondrial diversity but did identify variation in the protein of nuclear loci (i.e., gene locations within nuclear DNA). The authors posited the low mitochondrial variation could be the result of population bottlenecks in the past. They also identified two distinct RHS "forms" based on the allozyme variation, divided geographically by the Sepulga River, and recommended that conservation efforts include both of these forms. Apodaca et al. (2012) found that the RHS exhibited a strong pattern of genetic structuring and that there are five distinct and well supported demes. They also report that multiple populations have undergone recent bottlenecks. Titus and Larson (1996) investigated the phylogenetic relationships of southeastern desmognathine salamanders, including one museum specimen of RHS, using mitochondrial DNA. They found RHS to be distinct from other related salamanders. Leslie Rissler, University of Alabama, was awarded State Wildlife Grant monies in 2006 to analyze genetic diversity within and among various RHS populations (as well as develop a predictive habitat model and other tasks). The research will feature a larger sample size and utilize microsatellite (non-coding regions of nuclear DNA) as well as mitochondrial analysis. These efforts should provide us with more quantitative information regarding population structure and genetic diversity, allowing us to better prioritize future conservation actions.

d. Taxonomic classification or changes in nomenclature

This taxon is the sole member of its genus (Highton 1961). Titus and Larson (1996) re-examined the taxonomy of the subfamily Desmognathinae through mitochondrial DNA analysis and reaffirmed this monotypic genus classification.

More recent morphological, nuclear, and mitochondrial analyses have confirmed that RHS is the sister lineage to the entire genus *Desmognathus* (Chippendale et al. 2004). Current whole genome sequencing by the University of California may result in some nomenclatural changes but this will likely not change our understanding of the evolutionary relationships within and among the *Phaeognathus* and *Desmognathus* genera (Rissler, pers. comm. 2007).

e. Spatial distribution, trends in spatial distribution, or historic range

Jordan and Mount (1975) estimated that 63,000 acres of suitable habitat may be present throughout the RHS range. At the time of listing approximately 60,000 acres of suitable RHS habitat was thought to exist (Service 1976). French and Mount (1978) estimated rangewide salamander habitat by reviewing geologic maps and slope aspect and

steepness on topographic maps. They suggested that 54,900 acres were occupied by RHS. They did not, however, differentiate between the various types of salamander habitat (e.g., optimal versus marginal). McDearman et al. (undated) attempted to refine habitat mapping techniques, using a study area in Monroe County, but were challenged by available topographic information and slope algorithms.

The 1983 recovery plan reviewed species biology, literature and threats, but did not provide new status information. Dodd (1988, 1991) surveyed 144 known RHS sites documented from 1976-1988 but did not provide estimates of rangewide acreage. The author recommended maintaining RHS classification as threatened. While the status of individual salamander populations have been conducted (e.g., Guyer undated, Guzburger & Guyer 1998, Godwin 2002), no comprehensive review has been undertaken since Dodd (1991).

f. Habitat

Early RHS surveys (e.g., Valentine 1963, Jordan & Mount 1975, French & Mount 1978) noted that RHS are not uniformly distributed across the landscape. Salamanders are typically more numerous on steep north-facing slopes and ravines, under the shade of mature undisturbed forest (Jordan and Mount 1975; French and Mount 1978; Service 1983; Dodd 1988, 1991; Godwin 2003). Dodd (1991) pointed out that while RHS habitat is often depicted as occurring in a continuous band, it is actually fragmented by unsuitable habitat, streams, roads, etc. The Service and timber companies have used various descriptors for habitat including "optimal," "preferred," "suboptimal," and "marginal." McDearman et al. (undated) estimated that 28,548 acres of "optimal" (typically habitat with mature forested canopy and >27° slopes) are present within the range of the salamander. Unfortunately, we do not have current information on the total available habitat or quality of the habitat remaining.

TABLE 1: Current Section 10(a)(1)(B) Permits (ITPs) for the Red Hills Salamander

Permittee	Acreage	Permit #	Expiration
Blackwell, William	380	TE-114702-0	2025
Hancock Forest Management	3,561	TE029614-0	2031
International Paper*	1,107	PRT-780914-1	2024
International Paper*	3,810	PRT-821527	2027
Weyerhaeuser	3,420	TE-811415-3	2016
Wilmon Timberlands	2,970	PRT-824543	2027
Total	**15,248**		

* In the process of being transferred with same conditions to Red Mountain Timber Company, LLC.

2. Five-Factor Analysis

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

At the time of listing, approximately 60% of the estimated 60,000 acres of suitable RHS habitat was owned by timber companies (Service 1976). French and Mount (1978) suggested that of the estimated 54,900 acres of habitat, about 3,075 acres were detrimentally impacted by forestry operations. They further estimated that about 3670 acres of RHS habitat had been eliminated due to logging. Dodd (1988, 1991) surveyed 144 RHS sites and found that conditions had deteriorated at 32 (22%) of them due to selective or clear cutting. Godwin (2002) resurveyed 10 of Dodd's study sites and found them to be in good condition. About 98% of RHS habitat is in private ownership (McDearman & LaClaire 2001). While 15,248 acres are protected through habitat conservation plans under the Service's ITP program (Table 1), we continue to receive reports of logging activity in RHS habitat. Logging (and related site preparation) continue to be the major threat facing the species. In addition, because HCPs can expire when land changes ownership, they provide no long-term guarantee that RHS populations will be protected.

Conversion of deciduous forest to pine plantation, and/or severe soil disturbance associated with logging on private lands not covered by incidental take permits, continue to be the major threats to RHS populations. French & Mount (1978) noted that salamanders did not persist in areas where the tree canopy was completely removed. Many studies have noted declines or local extirpation of salamander populations following intensive logging operations (Jordan & Mount 1975; Dodd 1988, 1991). There is some indication that the sub-optimal slopes (less than 28°) may be vital to gene flow between populations of *P.* hubrichti (Apodaca et al.2012). Fragmentation analysis indicates loss of 69.5 to 86.1% of original RHS habitat. Unfortunately, we do not have current information on the amount of habitat impacted by logging operations.

The divestiture of timberlands, fueled by market forces (such as cheaper overseas labor) and tax policies (Little 2006) also constitutes a major threat. When timberland is divested, ownership is often fragmented, resulting in more landowners. It is more difficult for conservation groups and State and Federal resource agencies to identify and work with multiple landowners than with a large, single owner. Land ownership for much of the areas under habitat conservation plans has changed during the duration of the plan. Fortunately, many new landowners agree to the terms of the

habitat conservation plans (HCP) and associated incidental take permits (ITPs).

Other notable developments in this area:

- The discovery of a new population of RHS on Weyerhauser, Inc. timberlands in Wilcox County (Bailey & Miller 2006). Weyerhauser, Inc. has not expanded their HCP to include these areas but is managing the habitat to avoid take (Hughes 2007).

- The formation of a *Phaeognathus* working group in 2006. This group, consisting of representatives from USGS, the Alabama Natural Heritage Program, the Service, Alabama Department of Conservation and Natural Resources (ADCNCR), The Nature Conservancy, and others, is working to identify conservation needs for the species, including targeting areas for easement development or fee simple purchase.

- In 2006, ALDCNR received Recovery Land Acquisition Section 6 funding from the USFWS to help with the purchase of high quality salamander habitat in Monroe County.

- The realignment of S.R. 21 at Falkenberry Hill in Monroe County, Alabama. This project will directly destroy approximately six RHS burrows, and indirectly impact as many as 21 others (Service 2003). Salamanders found in the alignment prior to construction were to be relocated to adjacent suitable habitat. This led to a research study, conducted by Auburn University, investigating the efficacy of salamander relocation. The salamanders were returned to their burrows after difficulties occurred in keeping the salamander alive in captivity and continuous changes in construction plans.

- The divestment of all International Paper Company (IPC) landholdings in Alabama. The new owner of the former IPC RHS habitat is the Red Mountain Timber Company I, LLC. They have agreed to continue to manage the habitat under the terms and conditions of the former ITPs.

- ADCNR has applied for funding from NOAA's Coastal and Estuarine Land Protection Program, and the Fish and Wildlife Service's Habitat Land Acquisition Program, in order to purchase high quality RHS habitat. In 2010, 4,376 acres in Monroe County were purchased through the Alabama chapter of TNC and with funds from the USFWS Endangered Species program grant.

- Habitat destruction and fragmentation have contributed to genetic bottlenecking. Apodaca et al. 2012 indicated that harvesting along suboptimal habitats, which may not harbor the highest numbers or densities of Red Hills salamanders, is believed to play a vital role in limiting gene flow between populations.

b. Overutilization for commercial, recreational, scientific, or educational purposes

The discovery of this species in 1960 and subsequent description (Highton 1961) led to increased collection of this species for scientific purposes (Valentine 1963, Jordan & Mount 1975). Over-collection of RHS for museum specimens was one of the main threats cited in the listing determination (Service 1976). Federal protection benefited the species by controlling the amount of take for scientific purposes, and by the early 1980s over collection was no longer considered "a significant limiting factor" (Service 1983). Presently, collection is not a threat for the species. We completed a section 10(a)(1)(A) programmatic biological opinion (Service 2006b) to monitor the take of salamanders for scientific purposes. This document provides RHS capture and handling protocol and allows the incidental take of up to three salamanders per calendar year.

c. Disease or predation

RHS predation has not been documented in the published or unpublished literature but likely occurs from a variety of sources. Dodd (1991) suggested that feral pigs (*Sus scrofa*) and armadillos (*Dasypus novemcinctus*) were major RHS predators and recommended the removal of feral pigs from Haines Island Park, where they were damaging habitat. Means (2003) suggested that carabid beetles could eat RHS egg clusters or juveniles in burrows (several were found in the burrow of the female studied), however there is no proof of this assumption. It is likely that both salamanders and eggs are eaten by a variety of predators, ranging from beetles to snakes, armadillos, and hogs, but there is no evidence that predation is a limiting factor for the species.

No pathogens have been identified in RHS. Chytrid fungi, *Batrachochytrium dendrobatidis*, commonly found in water and moist soil, has been implicated in amphibian declines worldwide. *Janthinobacterium lividum*, the antifungal bacterial species found on several amphibian species, has been shown to prevent the effects of the pathogen. At this time we do not know if the RHS carries *Janthinobacterium lividum.* For this reason, we request that salamander researchers disinfect their field equipment (including boots) when traveling between RHS sites in order to reduce the risk of transferring pathogenic chytrid fungal spores (Service 2006b).

d. Inadequacy of existing regulatory mechanisms

The Endangered Species Act of 1973 continues to be the main regulatory mechanism protecting RHS. The State of Alabama does not have a state endangered species act; however the RHS is protected under the non game species regulation 220-2-92. The RHS is also considered under National Environmental Policy Act of 1969, and Fish and Wildlife Coordination Act on Army Corps of Engineers lands in the listed range (Haines Island, McDuffie Landing, and Bells Landing Park). Salamanders are afforded some protection through forestry Best Management Practices (BMPs) (Alabama Forestry Commission 2007), especially in areas where salamanders are found on steep slopes directly above streams. Federal tax policies and low cost of overseas labor have been implicated as forces in the large scale timber divestment underway in the U.S. (Little 2006). This fragmentation of ownership constitutes a major threat to RHS.

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

Hurricanes and tornados can affect forests by blowing down trees and changing canopy gap dynamics (and therefore light, temperature, moisture, and humidity regimes). Hurricane Ivan (2004) impacted forests throughout much of the Red Hills physiographic province (Hutcheson 2007). However, the extent of damage to RHS habitat is unknown.

There is also evidence that species across the world have been affected by climate change (Parmsan 2006). The impact that increasing global temperatures will have on the RHS is unknown at this time. It is likely that amphibians, especially lungless salamanders that breathe through their skin and require moisture to do so, will be particularly sensitive to any associated changes in precipitation or humidity.

D. Synthesis

The degree of threat to its persistence remains moderate. Timber operations have impacted habitat in the past (Jordan & Mount 1975, French & Mount 1978, Dodd 1988, 1991) and still occurs at some level. Timber corporations, timber management organizations, and individual landowners have also entered into landscape level conservation agreements with the Service to the benefit of RHS. Other timber operators, while not requesting ITPs, have consulted with the Service and modified their timber harvest so that take will not occur. Permanent conversion of RHS habitat for residential or commercial development is presently not a major threat.

While there is no indication the species is at risk of extinction throughout all or a portion of its range, the paucity of data regarding the species' status on many private lands is troubling. A rangewide re-survey of RHS habitat, in conjunction with the creation of modern geographic information system (GIS) coverages (including recent aerial imagery and RHS habitat, total RHS habitat, and RHS habitat quality), is of paramount

importance. Unverified reports of logging in RHS salamander habitat (by non-ITP holders) and ongoing timber divestiture hint at potentially serious problems. It is imperative that the Service maintain a presence in the area to engage and partner with more timberland operators and owners in order to effect recovery of the species, and to ensure conservation measures are enacted.

No change is recommended to the classification or priority ranking of the threatened Red Hills salamander. The Service believes that continued habitat destruction/fragmentation due to logging activities is a threat to RHS, in addition to other land management practices. A rangewide survey of RHS has not been done since 1991, so there is a lack of data to support how the population is responding to habitat destruction and fragmentation. Therefore, we believe the species still meets the definition of Threatened under the ESA.

III. RESULTS

A. Recommended Classification

__X__ No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

A. Revise Recovery Plan
The 1983 Recovery Plan should be revised to reflect the current status and threats to the salamander, recent and ongoing research (e.g., genetic studies), and new occurrence data (such as the population from Wilcox County). The new plan should also contain measurable and objective recovery criteria to inform many of the Red Hills conservation efforts underway.

B. Develop GIS-based Habitat Layers for RHS.
Researchers from the University of Alabama are presently developing predictive habitat models. These models will allow the Service and other interested parties to prioritize surveys for new populations. The Service and its partners should also gather all available point and polygon data (currently found as hard copies distributed throughout RHS files in various locations) into one, all-inclusive, ArcGIS™-based data layer (i.e., shapefile). Ideally, the habitat layer would also depict habitat quality (i.e., categorize habitat) and land ownership. Such spatial data would greatly facilitate the recovery planning process.

C. Land Acquisition and Easement Establishment
Appropriate parcels for land acquisition from willing sellers or enrollment in perpetual conservation easements should be identified by all interested parties, including the Service. This will entail keeping track of landholding divestment by timber companies and the use of improved habitat mapping. The Service and its

partners should continue to pursue funding for land acquisition and conservation easements benefiting the salamander.

D. Outreach/ Education

Opportunities to convey the importance of unique Red Hills plant and animal communities to the public and local government should be sought and pursued. The Service should seek out new cooperative partnerships with landowners to conserve RHS.

E. Study movement/genetic exchange within and between populations

RHS spend the vast majority of life in their burrows. Very little is known about dispersal and interrelatedness of seemingly disjunct populations. While genetic studies of between-population genetic relatedness were recently done, we still need more information on dispersal within and between populations in order to adequately protect the salamander.

F. Additional surveys/monitoring

RHS can be found outside of the Tallahatta and Hatchetigbee geologic formations, as evidenced by occurrences in portions of Crenshaw County and the recent discovery in Wilcox County. Additional surveys need to be conducted to determine if other "outlier" populations exist. We also need to establish a stratified (by different habitat types) random sampling method to consistently estimate rangewide RHS population and trends. This will also entail the development of burrow density estimates for each habitat type. A comprehensive range wide survey needs to be conducted to measure current population trends.

G. Continued enforcement of existing laws

The Service has received several anecdotal reports in recent years of otherwise lawful logging activities on private land resulting in the take of RHS and destruction of RHS habitat. We have also received reports of individuals purchasing divested timberland, devalued because of RHS presence, and reselling these properties for profit by not disclosing the presence of RHS and possible logging restrictions. Further evaluation (coupled with review of aerial imagery and creation of a current habitat map (IV.B)) is warranted to separate fact from fiction in these accounts, and to aid recovery efforts.

V. REFERENCES

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U.S. FISH AND WILDLIFE SERVICE
5-Year Review of the
Red Hills salamander (*Phaeognathus hubrichti*)

Current Classification ___Threatened_____
Recommendation resulting from the 5-Year Review

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change is needed

Review Conducted By: Rob Tawes, (formerly with) and Matthias Laschet with Alabama Ecological Services Field Office

FIELD OFFICE APPROVAL:

Field Supervisor, Alabama Ecological Services Field Office

Approve _____ Date 4/11/2013

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve _____ Date 5/6/13

APPENDIX A: Summary of peer review for the 5-year review of the Red Hills salamander (*Phaeognathus hubrichti*)

A. Peer Review Method: Peer review was sought from six individuals (two from State government, three from academia, and one from the private sector). Peer reviewers were given the entire draft document via email and given two weeks for review. All peer reviewers commented.

B. Peer Review Charge: Reviewers were open to comment on all aspects of the document but specifically requested to closely review areas in their field. For example, a geneticist was asked to pay special attention to genetic information presented in the document.

C. Summary of Peer Review Comments/Report: Most comments regarded small omissions from the document (e.g., Monroe County was accidentally left out of a discussion on the range of the species (II.C.1)), or requested better explanation of statements contained within the document. Two peer reviewers disagreed with the contention that RHS are difficult to capture. These reviewers suggested that they be captured readily but that this practice is time consuming using the current capture protocol. One reviewer provided additional citations and information regarding RHS phylogeny and suggested climate change as a new threat. The remainder of the comments were not substantive.

D. Response to Peer Review: All substantive (and most non-substantive) comments were evaluated and addressed in this document where appropriate.

A list of peer reviewers and their comments is on file at the Alabama Ecological Services Field Office.