Red Hills Salamander
(*Phaeognathus hubrichti*)

5-Year Review:
Summary and Evaluation

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

February 2024

5-YEAR REVIEW
Red Hills Salamander (*Phaeognathus hubrichti*)

I. GENERAL INFORMATION

A. Methodology used to complete the review:

In conducting this 5-year review, we relied on the best available information pertaining to historical and contemporary distributions, life histories, genetics, habitats, and threats of this species. We announced initiation of this review and requested information in a published *Federal Register* notice with a 60-day comment period on June 20, 2019 (84 FR 28850). One comment was received and is addressed in Appendix A of this document. We used a variety of information resources, including the Red Hills Salamander (RHS) final listing rule under the Endangered Species Act (ESA; 41 FR 53032); Recovery Plan (U.S. Fish and Wildlife Service [Service] 1983), the 2013 5-Year Review, the RHS Recovery Plan Amendment (Service 2019), peer reviewed scientific publications, incidental take permits, habitat conservation plans, unpublished field observations and reports by Federal, State and other experienced biologists, and notes and communications from other qualified individuals.

B. Reviewers

Lead Region: Southeast Region, Atlanta, Georgia: Carrie A. Straight, (404) 679-7226

Lead Field Office: Alabama Ecological Services Field Office, Jason Ross, (251) 298-4122

C. Background:

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

June 20, 2019. 84 FR 28850.

2. Listing history:

Original Listing
FR notice: 41 FR 53032
Date listed: January 3, 1977
Entity listed: Species
Classification: Threatened

3. Associated rulemakings:

None.

4. Review History:

Recovery Plan: The recovery plan was released in 1983.

Each year, the U.S. Fish and Wildlife Service (Service) reviews and updates listed species information to benefit the required Recovery Report to Congress. Through 2013, we performed a recovery data call that included status recommendations, such as "Stable" for this species. We continue to show this species' status recommendation in 5-year reviews. The last review conducted in 2013 showed this species as Improving.

Five-year reviews:
November 6, 1991 (56 FR 56882)

In the 1991 review, multiple species were simultaneously evaluated with no species-specific, in-depth assessment of the five factors or threats as they pertained to each species' recovery. No changes were proposed for the status of RHS in the review.

May 6, 2013 (71 FR 53127)

In the 2013 review, the RHS was evaluated with a species-specific, in-depth assessment of the five factors or threats as they pertained to species recovery and subjected to peer review by six individuals. No changes were proposed for the status of RHS in the review.

5. Species' Recovery Priority Number at start of review (48 FR 43098):

7

Degree of Threat: Medium
Recovery Potential: High
Taxonomy: Species of a monotypic genus

6. Recovery Plan

Name of Plan: Red Hills Salamander Recovery Plan (with 2019 Amendment)
Date Issued: November 23, 1983 (with September 27, 2019 Amendment)

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?

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? Yes. The previous 5-year review (Service 2013) noted the presence of five "distinct and well supported" genetic demes identified by Apodaca et al. (2012a) across the current species range of the RHS. The term "deme" is commonly used as a synonym for subpopulation but utilized by population geneticists in a more restricted sense. Therefore, in the interest of clarity and to avoid confusion, the term genetic "deme" will hereinafter be replaced in this review with genetic "unit" at the suggestion of peer review. The Service's recovery plan amendment criteria (Service 2019) identified the long-term protection (acquisition or conservation easement) of fifty percent of RHS habitat within each genetic unit, as suitable for the sufficient protection/conservation of genetic differences to preclude potential future individual unit re-listing so long as each unit exhibits a stable or increasing trend, evidenced by natural recruitment and the presence of multiple age classes. Threats should be addressed and/or managed so that the species remains viable.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? Yes. The recovery plan and amendment address threats from habitat destruction/modification (Factor A), overutilization (Factor B), inadequacy of regulatory mechanisms (Factor D), and natural or manmade factors (Factor E). There are currently no known threats from either disease or predation (Factor C); however, disease surveillance has not been implemented for the RHS.

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:

<u>The three criteria as listed in the Recovery Plan Amendment (Service 2019) are provided and addressed below</u>:

1. The five (5) delineated units exhibit a stable or increasing trend, evidenced by natural recruitment, and multiple age classes.
This recovery criterion has not been met because population and age class data is largely unavailable due to the difficulty in efficiently capturing this largely nocturnal, fossorial amphibian. The best-known method of surveying relies on determining the amount or density of burrows. Burrow density, an index for salamander density, has been estimated at a subset of known sites, ranging from 0.03 to 0.55 per m^2 (Dodd 1990; Godwin 2003, 2008). However, limitations exist in current population data to confirm occupancy and population sizes in historical populations. A range-wide survey has not been completed since 1991 (Dodd

1991) when 144 known sites, documented from 1976-1988, were surveyed. The presence/absence of historical or as yet undiscovered populations within the five (5) genetic units continues to remain in doubt or unknown due to the lack of recent survey documentation. Nearly half of known populations range-wide have no recent extant occurrence records (since 1998) to indicate whether RHS persist or not (Godwin 2008, Apodaca et al. 2010, et al. 2012a, Steen et al. 2014).

As recently as 2006 (Bailey and Miller) and 2012 (Apodaca et al. 2012b), additional populations were discovered in Wilcox County in the Nanafalia geological formation, outside the previously known range of the RHS. Additionally, in August and September 2020, a presence/absence survey by the Alabama Department of Conservation and Natural Resources (ADCNR) on privately-owned land in the Nanafalia geological formation documented multiple, previously unknown occurrences of RHS in both Wilcox and Butler counties (M. Bailey, pers. comm. 2020, Bailey and Jenkins 2020). Evidence of stable or increasing abundance trends as shown by natural recruitment and the presence of multiple age classes will be difficult to establish without future survey efforts.

2. **At least 50 percent of habitat is occupied within each unit (as defined in Criterion 1) and protected via a long term conservation mechanism.** This recovery criterion has not been met due to the inability to adequately determine/classify and/or protect habitat within each of five (5) genetic units. Approximately 98% of RHS habitat is privately owned (Service 2013). Acquisition (through fee simple purchase) and/or long-term protection of land through conservation easements is needed to ensure enduring persistence and viability of the species (Godwin 2008). Recent modeling efforts are underway to better identify RHS habitat across the species range, particularly within identified units. Habitat modeling has identified areas possessing appropriate topography and forest structure lying outside of the historical, known range for potential future survey investigation (Apodaca et al. 2012b; Robinson et al. 2016).

   Currently, only about 11,682 acres (4,727.4 hectares or approximately 19.5% percent) within the approximately 60,000 acres (24,281.1 hectares) RHS range exists under long term conservation protection through Federal or State ownership. Suitably protected acres occur only in Unit 1 (U.S. Army Corps of Engineers – Haines Island tract, ~ 500 acres, and McDuffie Landing, 119 acres, 250.5 hectares or 1.03 % of RHS range) and Unit 2 (Forever Wild Land Trust purchase in Monroe County – State of Alabama, ~ 11,063 acres, 4478.9 hectares or 18.4% of RHS range)(Holt et al. 2021). Units 3 -5 do not contain Federal or State protected lands. Although total acres of RHS habitat for individual units have not been definitively identified, neither of the Federal or State protected lands in either Unit 1 or Unit 2 are anticipated to approach the 50% habitat occupancy objective listed under Criteria 2.

3. **Threats to the RHS have been addressed and/or managed to extent that the species will remain viable into the foreseeable future**.

Threats to the RHS have not been adequately addressed or managed to the extent that the species will remain viable into the foreseeable future (A, D, and E); therefore, this recovery criterion has not been met.

Loss/degradation of habitat and/or fragmentation of habitat continues to remain a threat. The majority of RHS habitat was owned by timber industry landowners at the time of listing (Service 2013) and remains a significant percentage of habitat ownership. While not a known threat at this time, divestiture of timberlands, fueled by market forces and tax policies, remains a potentially serious future threat (see Section C.2. for additional details). If timber industry divestiture occurs, new landowners may not be aware of the RHS and its habitat needs or may choose not to continue forest management (habitat fragmentation), not to protect RHS habitat (habitat loss) to forest industry certification standards, or not to continue RHS HCP/ITP planning (habitat management) currently present on many forest industry timberlands.

The Endangered Species Act (ESA) of 1973 and the National Environmental Policy Act of 1969 (NEPA) provide Federal protection for the RHS. State protections exist for the salamander through non game species regulation 220-2-92 and forestry Best Management Practices (BMPs) (Alabama Forestry Commission 2007) designed for water quality protection.

For other natural or manmade factors affecting its continued existence, there is evidence that species across the world have been affected by climate change (Parmesan 2006). The impact that increasing global temperatures will have on the RHS is unknown at this time.

C. Updated Information and Current Species Status

1. Biology and Habitat

The 2013 5-year review provided detailed information on the biology and life history of RHS (Service 2013). Any new information since that review is noted below.

a. New information on the species' biology and life history:

Age. Estimates of skeletochronological age in RHS by Parham et al. (1996) were previously documented for 11 captured specimens with a finding of ranges from 5 to 11 years (Service 2013). It is difficult to estimate salamander species longevity in the wild, much less the RHS; however, new information from a more recent comparison of aging methods in plethodontid salamanders by Staub (2016) determined that estimates using skeletochronological methodology produced lower maximum ages than either recapture or size-frequency methodology. Therefore, it may be reasonably assumed that the maximum life expectancy of the RHS is significantly longer. Additionally, Staub (2016) documented the age and presence of a captive > 36-year-old RHS individual from the Cincinnati Zoo. This new information substantially improves our understanding of RHS longevity.

Age at sexual maturity for the RHS is currently unknown but due to larger body size, has been speculated as being longer than the 3-4 years of age needed for smaller, but closely-related *Desmognanthus* species. Successfully aging older individuals is important in understanding and identifying multiple age structures within known populations for future conservation efforts and helps to address recovery criteria. Although age at sexual maturity is unknown, Bakkegard and Guyer (2004) used data obtained from Brandon (1965) and Mount and Schwaner (1970) to develop criteria on the size (length) at which sexual maturity occurs in the RHS – males >81 mm SVL (snout-ventral length) with glands and females >100 mm SVL without glands. This information was undocumented in the previous 5-year review (Service 2013).

Reproduction. The previous 5-year review (Service 2013), documented Means (2003), observing RHS reproductive biology in Butler County, AL through observation and capture of a brooding female with an egg clutch (containing six eggs attached to the burrow ceiling), that developed directly into adults with no aquatic larval stage. However, an earlier reference noted the only documented instance of captive egg disposition for RHS occurred in a 115-millimeter (mm) female at the Cincinnati Zoo. This female, who had been kept in the dark at the Cincinnati Zoo for nearly six years, produced a clutch of 16 eggs on July 1, 1976, after exposure to fluorescent lighting that simulated the Cincinnati photoperiod (Brandon and Maruska 1982). These are the only two documented instances of RHS reproduction and the new reference does not change our current understanding of RHS reproduction (Service 2013).

Diet. Previous foraging and prey information consisted of two instances of prey foraging observed at a burrow entrance by Jordan (1975) and a diet examination of the stomach and fecal content of preserved specimens (Gunzburger 1999). In new information, Bakkegard (2007), using video over an approximate 18-month period, observed RHS foraging behavior at burrow entrances that documented prey abundance and variety, a 33% prey-capture success rate, and evidence of selective prey foraging. This information substantially expands our current understanding of RHS diet and foraging ability and improves understanding of RHS diet since the previous 5-year review (Service 2013). Given the RHS ambush style of predation and a low prey-capture rate compared to other plethodontid salamanders (Bakkegard 2007), this information highlights the importance of and need for a diverse and abundant invertebrate prey population maintained by high-quality, habitat availability for both invertebrates and salamanders across the range of the RHS.

Dispersal. The breeding system of the RHS remains unknown. Evidence of heavier scarring on males than females supports the hypothesis that males compete via combat (Bakkegard and Guyer 2004). However, more recently, Bakkegard et al. (2012) documented females moved more than males among members of a passive-integrated transponder (PIT)-tagged population and further, that females engaged in four out of six long-distance dispersals (> 10 meters or 32.8 feet) including one 173 meter (566 feet) dispersal event.

This dispersal information is significant in that RHS were previously thought to complete virtually their entire life cycle within the confines of their burrow with only limited exposure at the burrow entrance (Bakkegard 2002, Brandon 1965, Gunzburger and Guyer 1998, Jordan 1975, Means 2003, Mount and Schwaner 1970), but this new information confirms greater RHS movement outside the burrow than previously reported. Greater than expected movement for the RHS has implications for our understanding of potential gene flow and spread within and among isolated populations as well as RHS potential ability to occupy habitat and withstand potential habitat changes due to environmental stressors. Without further research concerning dispersal and movement, our current understanding of RHS mobility and dispersal remains unchanged from the previous 5-year review (Service 2013).

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

Due to difficulties in accessing private lands and burrow sites, efficiently capturing specimens, and the dispersed, patchy distribution of known populations even in available habitat, no standardized sampling for the species has been completed to form valid conclusions about population or demographic trends. Caution should be used in assessing conclusions regarding baseline population data lacking a rigorous sampling design (Loehle and Weatherford 2017, Fournier et al. 2019); particularly in regard to repeated surveying of sites containing known previous occurrences of rare or cryptic species (Loehle and Weatherford 2017), such as the RHS. In some of the best remaining habitat, Godwin (2003, 2008) found a significant decline (42%) in burrow densities at sites (n=12) that were surveyed in 2002-2003 and again in 2006-2007; leading to a conclusion that some previously documented populations may now be extirpated.

Gaps in the known distribution are a mixture of true absences, non-detection of salamanders, and a lack of search effort. Recent discoveries of RHS on multiple sites in the Nanafalia Formation (Bailey and Miller 2006, Apodaca et al. 2012*b*, Bailey and Jenkins 2020) have increased known RHS locations; however, without systematic surveys, trends and population abundances are difficult to determine. Therefore, our current understanding of the species abundance and population trends remains unchanged since the last 5-year review (Service 2013).

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

There is no new information to consider regarding genetics, genetic variation, or trends in genetic variation regarding the RHS. Much of the current information is based on knowledge of other *Desmognanthus* species and has been previously described in the previous 5-year review (Service 2013). However, with previously unknown locations of RHS being recently found in the Nanafalia Formation, the need exists for a current genetic study using modern techniques for the detection of genetic variation, trends, and/or the creation of new genetic unit(s) pending further funding and investigation.

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.

Recent morphological, nuclear, and mitochondrial analyses have confirmed that RHS is the sister lineage to the entire genus *Desmognanthus* (Chippindale 2004, Pyron and Wiens 2011). Current whole genome sequencing by the University of California may result in some nomenclature changes but this will likely not change our understanding of the evolutionary relationships within and among the *Phaeognanthus* and *Desmognanthus* genera (Pyron et al. 2020, Wake 2012).

e. Spatial distribution, trends in spatial distribution, or historical range:

Early RHS surveys (e.g. Valentine 1963, Jordan and Mount 1975, French and Mount 1978) noted that RHS are not uniformly distributed across the landscape. Dodd (1991) likewise pointed out that while RHS habitat is depicted as a continuous band across the species range, it is actually fragmented by non-habitat, streams, roads etc.

Originally thought to be confined to the Hatchetigbee and Tallahatta geological formations, RHS was first documented in the Nanafalia Formation (Wilcox County, AL; Bailey and Miller 2006) in 2006 and reported in the previous 5-year review (Service 2013). By 2012, unreported in the previous 5-year review, the discovery of an additional 14 RHS sites highlighted the renewed need to survey all potential areas containing appropriate topography and vegetative structure regardless of previous historical detections (Apodaca et al. 2012b). Additionally, Robinson et al. (2016) produced a habitat model identifying "beneficial" areas outside the known species range that could potentially harbor unknown populations of RHS. Apodaca et al. (2012a) has noted that some areas of marginal, sub-optimal, or non-habitat may play a vital role to maintain gene flow between populations.

As additional funding allows and private landowner permission is obtained, ADCNR conducts periodic RHS surveys in potential habitat. In August and September 2020, a presence/absence survey by the ADCNR on privately-owned land documented multiple, previously unknown occurrences of RHS in both Wilcox and Butler Counties, also in the Nanafalia Formation (M. Bailey, pers. comm. 2020). These previously unknown detections outside the known RHS range may slightly increase redundancy but without further research, it is unknown whether these sites will represent an increase in RHS resiliency and representation.

Future surveys in these areas could reveal additional populations and/or units in some of these or other unexplored habitats. Without a better understanding of RHS population sizes and health, RHS occurrence sites have been treated as individually-occurring populations within units. More research is needed for

better definition in this area. Our current understanding of the spatial distribution, historical range, or trends thereof remain unchanged since the last 5-year review (Service 2013).

f. Habitat:

No recent assessment of habitat conditions have been conducted. Crucial information needs exist to delineate quantity and quality of RHS habitat (particularly within units) for accurately estimating range-wide abundance. These needs include 1) accurately identifying, modeling, and mapping habitat acres of optimal, suboptimal, and marginal classifications across the species range/units, 2) survey these habitat classifications to establish presence/absence of RHS presence, and 3) determine differing densities of salamanders contained for each habitat classification. Our understanding of habitat needs remain unchanged from the last 5-year review (Service 2013).

2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The purpose of a 5-Year Review is to recommend whether a listed taxon continues to warrant protection under the ESA and, if so, whether it should be reclassified (from threatened to endangered or from endangered to threatened). This task requires that the analysis of the threats to the species be performed while assuming that the species is not receiving the regulatory protections, funding, recognition, and other benefits of ESA listing. Summaries of ongoing applications of ESA protections may shed light on some future activities that constitute threats to the species. However, the analysis under Factor D (Inadequacy of existing Regulatory Mechanisms) focuses on the adequacy of existing alternative (i.e., non-ESA) mechanisms to address the continuing and foreseeable threats.

A detailed discussion of threats was presented in the 2013 5-year review (Service 2013). The threats discussed in the 2013 review still remain valid and any updates related to those threats are presented below.

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

Without continuing ESA protections since listing (1977), RHS habitat destruction and loss would likely have continued unabated as the drier, upland mixed pine-hardwood forest was largely converted to loblolly pine plantations on ridgetops while the mesic, steep mixed hardwood ravines and draws of the Red Hills region would likely have been harvested as much as mechanical efficiency and safety concerns allowed. As it stands, Apodaca (et al. 2012a) estimated a loss of 69.5 to 86.1% of original RHS habitat (Service 2013).

Future development and urbanization are not predicted to be major threat influences on the species in the future because optimal Red Hills salamander habitat occurs on steep slopes not easily developed. Soils, topography, and land ownership patterns in the Red Hills suggest that forestry practices remain the most

likely influences on the landscape. Continued forestry practices overall are anticipated to more likely influence suboptimal and poor habitat than optimal habitat, because timber harvesting of steep slopes elevates efficiency and safety concerns. However, harvesting of loblolly pine plantations established on the flatter ridgetops above occupied or high-quality salamander habitat without adequate buffer zones affects salamander body conditions, genetics, burrow densities (Apodaca and Godwin 2015), and contributes to detrimental drying effects on the slope below due to loss of shade and moisture from canopy removal (Dodd 1991, French and Mount 1978). Further, Dodd (1991) noted correlations between burrow location positioning on the slope and forestry (land-use) activity on the ridgetop. When no timber harvest had occurred, burrow locations were most often observed on the upper two-thirds of the slope; however, when timber harvesting activity was present on the ridgetop, burrow locations were most often found in the middle of the slope.

As a result of both internal and external forest industry pressures over the last 20 years, past detrimental forest management practices detailed in the previous 5-year review (2013) are not typical of nor do they reflect the majority of contemporary forest management in the Red Hills; particularly site conversion of deciduous hardwood forests to loblolly pine plantations and soil erosion/loss of soil moisture resulting from the harvesting of steep slopes. Contemporary forest management promotes sustainable forestry using responsible forest practices; particularly those that protect and maintain forest and soil productivity (such as BMPs to protect water quality) and that avoid excessive soil disturbance. A limited number of timber industry landowners control (own or lease) a large estimated percentage (60% or more) of available RHS habitat (41 FR 53033, McDearman and LaClaire 2001), largely occurring in Units 3-5 located in the middle and eastern portions of the species known range. These larger industry landowners, using contemporary forest management in a manner that is protective of habitat for listed and at-risk species, are participating members of forest certification programs such as the American Tree Farm System (ATFS), Sustainable Forestry Initiative (SFI), and Forest Stewardship Council (FSC) and fiber-sourcing standards. Such forest certification programs require annual audits by independent accredited bodies to maintain certification status. A substantial portion of wood procurement program certification within the range of the RHS is through SFI, whose accreditation affects virtually all area landowners (large and small) producing wood fiber (Dwivedi et al. 2018). Protective requirements of the SFI forest certification standard include water quality, biodiversity, wildlife habitat, species at risk, and Forests with Exceptional Conservation Value.

Englund and Berndes (2015) assessed forest sustainability standards through use of seven principles relating to biodiversity including - endangered species, habitat destruction and fragmentation, habitat degradation and modification, overexploitation, invasive species and GMOs, energy use and GHG emissions, and research. From a biodiversity standpoint, their conclusion was that the SFI standard was determined to be “stringent” (Englund and Berndes 2015). For these private landowners (large and small) that wish to engage in or provide wood

fiber production for forest industry, BMPs and HCP conservation measures are not voluntary – use of state BMPs and HCP measures (for enrolled landbases) are mandatory (see C. 2. d below for more detail).

The number of cooperative large private landowners enrolling large acreages of Red Hills salamander habitat in forest certification programs and voluntarily utilizing BMPs and/or HCPs, while not providing permanent protection, provide credible assurance of a base-level conservation benefit to Red Hills salamander across its range from contemporary forest management practices with the backing of the ESA. The threat level remains unchanged from the previous 5-year review (Service 2013).

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

Over-collection of this species for museum specimens and scientific purposes was considered a main threat between discovery in 1960 and listing in 1977; however, ESA protection controlling the amount of take for scientific purposes largely eliminated this threat by the early 1980's (Service 1983). Since that time, museums and research collections have largely reduced whole animal preservation collection in favor of non-lethal methodology (tail snip tissue samples, photo vouchers etc.). Any museum or scientific research project demonstrating a need for collection and preservation of RHS would undergo an evaluation process thru the State of Alabama at minimum and would require a Service ITP.

However, in recent years, the recreational threat of illegal collection for the pet trade has significantly increased (Herrel and van der Meijden 2014; JJ Apodaca, pers. comm. 2021). The desire for any rare amphibian by hobbyists has become a legitimate, increased threat to the RHS. Without ESA protection, in a change from the previous 5-yr review (Service 2013), overutilization is considered a current threat.

c. Disease or predation:

No pathogens have been identified in RHS; however, no known pathogen surveillance has occurred (Service 2013a). *Batrachochytrium dendrobatidis* (*Bd*), a chytrid fungal pathogen causing the infectious fungal disease chytridiomycosis (Vredenburg et al. 2010, Scheele et al. 2019), has been associated with global mortality events of amphibians and with amphibian population collapses in North America (Vredenburg et al. 2010). With implications for the RHS, *Bd* has been documented in other Alabama salamanders (Bakkegard and Pessier 2010), found in terrestrial amphibian species lacking an aquatic larval stage (direct – development) (Wake and Vredenburg 2008, Cheng et al. 2011), and detected in habitat specialist salamander species with limited range in areas of protected cave habitat (Olivares-Miranda et al. 2020). There is no data on how susceptible RHS is to *Bd*; however, if the RHS is susceptible, it could pose a significant impact to an already rare amphibian. Research including the surveillance for pathogens in

Red Hills salamanders could assist in determining if any risks exist for this species. Researchers could then determine what intervention strategies to implement to reduce impacts. As with any field research, biosecurity measures must be instituted before accessing Red Hills salamander sites to reduce the risk of transferring any pathogens to these animals or their habitats (Gray et al. 2017).

It is likely that adult RHS and their eggs are eaten by a variety of predators, including beetles, snakes, armadillos (*Dasypus novemcinctus*), and wild pigs (*Sus scrofa*), but there is no evidence that predation is a limiting factor for the species (Dodd 1991, Means 2003, Bakkegard 2005). The threat level from disease or predation remains unchanged from the previous 5-year review (Service 2013).

d. Inadequacy of existing regulatory mechanisms:

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. Through State of Alabama forestry Best Management Practices (BMPs) (Alabama Forestry Commission 2007) for water quality protection, RHS and their habitat are protected, especially where RHS are found on steep slopes directly above streams.

The threat of habitat or potential habitat loss has been partially mitigated by contemporary forest industry management practices that include forest certification programs and fiber sourcing standards. Contemporary forest management certification and fiber sourcing standards require member landowners to implement state-approved BMPs, conserve biodiversity, and protect special sites; including slope habitat for the Red Hills salamander. Although not all private forest landowners are certified, fiber sourcing standards require certified mills to use wood harvested using state-approved BMPs; therefore, small, non-industrial private landowners who want to sell or supply wood to a mill, and are not third-party certified, must provide verification that harvest occurred in accordance with state-approved BMPs. Accordingly, this process contributes to overall high BMP implementation rates in Alabama, including the Red Hills region. Contemporary forest management, abiding by strict forest industry certification standards as commonly practiced by timber industry ownership within the RHS range, supports and maintains biodiversity (Miller et al. 2009, Demarais et al. 2017), identifies special sites for protection from state natural heritage data or stakeholder consultation, and then proactively manages these special sites for conservation.

In Alabama, this BMP utilization most often occurs in the form of a streamside management zone (SMZ) guideline of maintaining a minimum width of 35’ on either side of the channel for intermittent and perennial streams. However, due to topography, slope, and nearby activities, SMZ widths may vary and must always accommodate a width necessary to maintain water quality. Although strongly encouraged, state BMPs remain voluntary, non-regulatory guidelines except when forestry operations cross streams or any other wetlands (when federal BMPs are mandatory). Alabama BMP compliance is quite high – above 90% in 2013, 2016, and 2019 (https://forestry.alabama.gov/Pages/Management/BMP_Practices.aspx).

Although coordination under the Fish and Wildlife Coordination Act (FWCA) does not require a species to be federally listed, protections under the FWCA are only provided as recommendations, which may or may not be implemented, to the U.S. Army Corps of Engineers (USACE). For the RHS, such recommendations would apply to a combined ~ 620 acres for the USACE-owned Haines Island Park and McDuffie's Landing tracts, the only federal land that presently hosts RHS.

While protected under the ESA, the RHS is considered for some activities under National Environmental Policy Act (NEPA) of 1969. RHS are afforded limited protection across all units through private landowner HCPs under the Service's Incidental Take Permit Program (ITP). Although HCP lands have frequently changed ownership since the time of listing, these acres have historically been, and are currently owned by, a relatively few timber industry companies and private landowners (Service 2013). Multiple HCPs have been voluntarily transferred with land ownership between landowners within the range of the RHS, indicating both a willingness to conserve RHS and a desire to partner with conservation agencies. However, because HCPs have expiration dates, are difficult to enforce, and can expire early if land changes ownership, they provide no long-term guarantee that salamander populations will be protected (Service 2013). Additionally, the measurable effectiveness of HCPs in protecting RHS is currently unknown.

Due to the difficulty in estimating RHS populations, protection of RHS habitat acres from habitat-modification resulting from forest management operations is used by HCPs as a substitute conservation measure. Compliance with and effectiveness of the HCP is gauged by monitoring habitat conditions. ESA-related conservation measures contained in HCPs/ITPs that allow ongoing commercial forest management while still protecting the RHS and its habitat include: updated mapping and classification of habitat into optimal, suboptimal, and marginal categories, protected areas from timber-harvesting or that contain thinning restrictions, minimum buffer widths (usually 50 feet or 15.2 meters) above and below slopes in optimal/suboptimal RHS habitat (beginning when slope decreases below a certain percentage), retaining minimum canopy cover percentages, herbicide application restrictions, monitoring of RHS habitat conditions, and periodic reporting.

Over 49,000 acres of land within the RHS range (not all of which is salamander habitat) are protected by voluntary HCPs under the Service's Incidental Take Permit (ITP) program. Divestiture by one or more of these large timber industry landowners due to market forces and/or tax policies, potentially leading to ownership fragmentation and the potential for new landowners to not agree to the terms of the HCPs and ITPs currently in place, constitutes a potentially serious habitat loss or fragmentation threat to RHS (Service 2013). Additionally, some of these large private landowners only hold (own or lease) land for 20- to 25-year periods by design. The loss of one or more such landowners could mean potential removal of thousands of acres from HCP/ITP protections and their partnering efforts with conservation agencies within the range of the RHS. These HCP/ITP

enrolled acres are a direct result and product of ESA protection and also the result of a successful partnership between the forest industry and conservation agencies. Without backing of the ESA, conservation measures may not continue to be implemented by private landowners.

In the absence of the ESA, elimination or erosion of these protective conservation measures currently in place would likely occur. The threat level of habitat loss and/or threat of potential habitat loss remains essentially unchanged from the last 5-year review (Service 2013).

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

There is evidence that species across the world have been affected by climate change (Parmesan 2006). The impact that increasing global temperatures will have on the RHS is unknown at this time and the threat level of climate change remains unchanged from the previous 5-year review (Service 2013). 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 temperature, precipitation, and humidity (Blaustein et al. 2010). While other species of salamander have or are anticipated to respond to climate change with shifts in breeding phenology (Todd et al. 2011) or habitat (Raxworthy et al. 2008; Milanovitch et al. 2010); and reductions in body size (Reading 2007; Caruso et al. 2015), it would likely be impossible for the RHS to either effect or survive a habitat shift due to its life-cycle requirement dependence on subterranean burrows located in localized geologic formations (Gunzburger and Guyer 1998, Means 2003) and its assumed, but largely unknown, low dispersal abilities (Bakkegard et al. 2012).

D. Synthesis

Consistent with findings from the previous 5-year review (Service 2013), the degree of threat to species persistence remains moderate. Forest management operations have impacted habitat and local populations in the past (Jordan and Mount 1975, Dodd 1991, deMaynadier and Hunter 1995, Harpole and Haas 1999). Further investigation is needed to document if, and to what extent, forest management operations continue to affect RHS habitat. However, contemporary forest management, as currently practiced by a majority of timber industry private landowners within the range of the RHS, requires participating landowners to conserve and promote biological diversity and special sites, including those occupied by RHS, through the mandatory use of BMPs, required by forest certification programs and fiber sourcing standards. Timber industry participants (timber industry landowners, timber corporations, timber investment management organizations, and individual landowners), to their credit, have increased cooperation and voluntary participation in landscape level conservation agreements with the Service for the benefit of RHS, but it is unknown if these practices would continue in the absence of ESA protections.

Because of the RHS protections under the ESA, over 49,000 acres of land within the RHS range (not all of which is salamander habitat) are protected through HCPs under the

Service's Incidental Take Permit Program (ITP). Other timber operators, while not requesting ITPs, continue to consult with the Service and modify their timber harvest so that take will not occur. Short of conservation easements and/or acquisition, these voluntary private landowner agreements and partnerships provide a level of RHS conservation virtually impossible to achieve otherwise. Divestiture of lands due to market forces by these industry private landowners, always a potentially serious concern, remains at a threat level unchanged from the previous 5-year review (Service 2013).

Despite the positive conservation efforts from forest industry landowners, the continued lack of data regarding the species' status on most private lands remains extremely troubling. Most notably, the presence/absence of populations within the five (5) units due to the lack of recent survey documentation remains unknown. Nearly half of known (historical) populations have no recent extant occurrence records (since 1998) to indicate whether RHS persist or not (Godwin 2008, Apodaca et al. 2010, et al. 2012a, Steen et al. 2014). Given Godwin's observance of short-term declines (42%) in burrow densities surveyed four (4) years apart in some of the best remaining habitat (Godwin 2003, 2008), it is likely that RHS presence is extirpated from many historical populations unvisited since 1998. However, additional RHS occurrences (2012, 2020) continue to be located outside the known range in surveys on private land when habitat is identified, particularly on the Nanafalia geological formation. Assessing the status of stable or increasing trends and range-wide abundance required as part of the recovery criteria depends on additional survey information.

More research is needed to follow-up on movement and dispersal capabilities within and between known occurrences of the RHS. This 5-year review contains documentation of one long distance movement (173 meters or 566 feet) by a female RHS (Bakkegard et al. 2012) when previously it was thought that the RHS conducted its entire life history largely within the confines of its burrow (Bakkegard 2002, Brandon 1965, Gunzburger and Guyer 1998, Jordan 1975, Means 2003, Mount and Schwaner 1970).

Likewise, crucial information and research needs exist for the delineation of amounts and quality of RHS habitat for accurately estimating habitat classifications. These needs include 1) accurately identifying, modeling, mapping, and ground-truthing RHS habitat acres of optimal, suboptimal, and marginal classifications across the species range/units and 2) surveying these habitat classifications range-wide to establish presence/absence of RHS, and if present, 3) determining the densities of salamanders contained for each habitat classification. Once mapped, acres of total RHS habitat and acres of RHS habitat within each of the five (5) units will permit surveys to define and determine 50% occupancy of habitat within each unit. Key areas can then be identified for future protection through a long-term funding mechanism. Many HCP/ITP permittees currently possess extremely accurate estimates of RHS habitat acres delineated into optimal, moderate, suboptimal, and marginal classifications within enrolled landbases.

Overutilization, predation, inadequacy of existing regulatory mechanisms are presently not major threats. Disease pathogens have not been identified in RHS and there has been no documented RHS pathogen surveillance to date. Although *Bd*, a chytrid fungal pathogen associated with mass declines in worldwide amphibian populations, has been documented in Alabama; there is no indication that RHS has been affected. Climate

change is troubling for a lungless, burrowing endemic species with a potentially limited migratory ability, tied to underground geologic formations. RHS would likely not be able to succeed in shifting their habitat to account for climate changes, if required. While both are potential concerns, disease and climate change are likely not major threats in the immediate future. At this time, RHS continues to meet the definition of a threatened species under the Act.

III. RESULTS

A. Recommended Classification:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
_X_ No change needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

- Develop a systematic survey protocol to assess the species condition throughout its range and within the 5 Units addressed in the recovery plan.
    - Continue additional surveys/monitoring efforts. Not only have approximately half of known populations not been visited in over 20 years, there is a need to determine how many additional populations exist across the species range, similar to the 2006, 2012, and now 2020 discoveries on industry private landowners in the Nanafalia formation. Besides presence/absence surveys, there is a continued need for burrow density estimates stratified by habitat type/classification. A comprehensive range wide survey needs to be conducted to measure current population trends.
- Continue to develop GIS-based habitat layers and the coordination of predictive habitat modeling efforts between researchers, private landowners, and conservation agencies for prioritizing new population determination. The Service and its partners should gather all available point and polygon data into one, inclusive ArcGIS™-based data layer (i.e., shapefile). Ideally, the habitat layer would also depict habitat quality (i.e., categorize habitat – optimal, moderate, suboptimal, marginal) and land ownership.
- Continue to identify, pursue, and support land acquisition and/or conservation easement from willing sellers and/or enrollees. This effort would be supported and enhanced by a coordinated GIS-based habitat layer. The Service and its partners should continue to pursue funding for land acquisition and conservation easement benefiting the salamander.
- Conduct additional dispersal/genetic research investigations within and between populations. Very little continues to be known about dispersal and the interrelatedness of seemingly disjunct populations. More dispersal information is needed within and between populations in order to adequately protect the salamander.

- Continue public outreach/education efforts. 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.

- Continue enforcement of existing laws. The Service continues to receive anecdotal reports of otherwise lawful timber harvesting activities on private land resulting in take and destruction of RHS habitat. Further evaluation is warranted.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Red Hills Salamander (*Phaeognathus hubrichti*)

Current Classification:

Recommendation resulting from the 5-Year Review:

_____ Downlist to Threatened
_____ Uplist to Endangered
_____ Delist
_X_ No change needed

Appropriate Listing/Reclassification Priority Number, if applicable: Not applicable. Or refer to 48 FR 43098 for this number.

Review Conducted By: Jason Ross, Alabama Ecological Services Field Office.

FIELD OFFICE APPROVAL:

Field Supervisor, Alabama Ecological Services Field Office, U.S. Fish and Wildlife Service

Approve: WILLIAM PEARSON Digitally signed by WILLIAM PEARSON Date: 2024.02.16 13:40:59 -06'00' Date: _____

REGIONAL OFFICE APPROVAL:
For status change recommendations only.
Assistant Regional Director – Ecological Services, U.S. Fish and Wildlife Service

Approve: _____ Date: _____

Appendix A. Summary of public comments related to the notice initiating the 5-year review of the Red Hills salamander (*Phaeognathus hubrichti*)

Because no substantive information was included in this review, no peer review was undertaken for this document. One comment during the 60-day open comment period was received from the National Council for Air and Soil Improvement, Inc. (NCASI) dated August 19, 2019 stating that privately-owned, working forests, as a primary land use in the Red Hills area of Alabama, and contemporary forest management are compatible with Red Hills salamander (RHS) conservation, as shown through the incorporation of Habitat Conservation Plans (HCPs) which promote forest industry best management practices (BMPs) and conservation objectives. HCPs are planning documents required under the application process for obtaining an Incidental Take Permit (ITP) under section 10(a)(1)(B) of the ESA as part of a partnership. NCASI provided additional technical forest management information along with seventeen (17) relevant sources not included in the previous 5-year review (Service 2013).

Comments for this review submitted by NCASI urge the Service to use caution in assessing conclusions regarding baseline population data lacking a rigorous sampling design. Recent studies are cited in regard to the risk of false inferences associated with repeatedly sampling known areas of species abundance; especially in regard to drawing an incorrect conclusion that a species may be declining (Loehle and Weatherford 2017, Fournier et al. 2019). This assessment may particularly apply to RHS sampling, given the relative lack of access to most RHS habitat located on private lands and only highlights the continued need for a range wide survey (last completed by Dodd in 1991).

Similarly, the Service remains cautious regarding additional review comments suggesting that "the species is able to recolonize previously harvested areas and persist on a landscape scale" due to the relative lack of previously unharvested areas and a 2006 description of second-growth forest for a newly discovered RHS site (Bailey and Miller 2006). As a comment basis, the finding of a meta-analysis for effects of canopy removal on salamanders by Tilghman et al. (2012) on analyzed studies (e.g., Homyack and Haas 2009) produced evidence that although terrestrial salamander populations decreased following timber harvest, they were not extirpated and experienced population increases as forests began the regeneration process.

There remains no documented evidence of RHS recolonization of previously harvested areas absent natural regeneration of a full hardwood tree canopy. Additionally, historical sites exhibiting burrow presence improvement in relation to past harvest practices, did so using natural hardwood regeneration absent mechanical site-prep implementation (Jordan and Mount 1975, French and Mount 1978, Dodd 1991).