BEFORE THE SECRETARY OF THE INTERIOR

PETITION TO PROTECT THE HICKORY NUT GORGE GREEN SALAMANDER (*Aneides caryaensis*) UNDER THE ENDANGERED SPECIES ACT AND TO DESIGNATE CRITICAL HABITAT

Todd Pierson

CENTER FOR BIOLOGICAL DIVERSITY

DEFENDERS OF WILDLIFE

JUNE 13, 2022

Notice of Petition

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Petitioners

The **Center for Biological Diversity** ("Center") is a nonprofit, public interest environmental organization dedicated to the protection of imperiled species and the habitat and climate they need to survive through science, policy, law, and creative media. The Center is supported by more than 1.7 members and activists throughout the country. The Center works to secure a future for all species, great or small, hovering on the brink of extinction.

Defenders of Wildlife ("Defenders") is a non-profit conservation organization dedicated to the protection of all native animals and plants in their natural communities. Defenders, which has 2.2 million members and supporters, maintains a staff of wildlife biologists, attorneys, educators, research analysts, and other conservationists. Defenders uses education, litigation, and research to protect wild animals and plants in their natural communities.

Submitted this 13th day of June, 2022:

Pursuant to Section 4(b) of the Endangered Species Act ("ESA"), 16 U.S.C. § 1533(b), Section 553(3) of the Administrative Procedures Act, 5 U.S.C. § 553(e), and 50 C.F.R. §§ 424.14 and 424.20, Center for Biological Diversity and Defenders of Wildlife formally petition the Secretary of Interior to list the Hickory Nut Gorge green salamander ("Salamander") as a threatened or endangered species and to designate critical habitat concurrent with listing pursuant to 16 U.S.C. § 1533(a)(3)(A) and 50 C.F.R. § 424.12.

The Service has jurisdiction over this petition. This petition sets in motion a specific statutory process, placing definite response requirements and time restraints on the U.S. Fish and Wildlife Service ("Service"). Specifically, the Service must issue an initial finding as to whether the petition "presents substantial scientific or commercial information indicating that the petitioned action may be warranted." 16 U.S.C. § 1533(b)(3)(A). The Service must make this initial finding "[t]o the maximum extent practicable, within 90 days after receiving the petition." *Id.* Petitioners also request that critical habitat be designated for the Hickory Nut Gorge green salamander concurrently with the species being listed, pursuant to 16 U.S.C. § 1533(a)(3)(A) and 50 C.F.R. § 424.12.

As required by 50 C.F.R. § 424.14(b), Petitioners have provided written notice (via email) to the state agencies responsible for the management and conservation of the Salamander 30 days prior to the submission of this petition. In compliance with 50 C.F.R. § 424.14(c)(9), an electronic copy of the notice accompanies this Petition. All literature cited in this petition is listed in the References section, and electronic copies of these documents accompany this Petition. *See* 50 C.F.R. § 424.14(c)(5)-(6).

On behalf of Petitioners, thank you for your time and attention to this petition. If you have any questions, please feel free to reach us via the contact information contained in the signature blocks below.

Sincerely,

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I. EXECUTIVE SUMMARY

The Hickory Nut Gorge green salamander, a critically imperiled amphibian found only in its namesake gorge in North Carolina, was first described as a unique species in 2019. Formerly considered part of the imperiled green salamander species, the Hickory Nut Gorge green salamander is even more rare and limited in range than previously thought. Species experts estimate between 200 and 500 individual salamanders remain in the wild, and populations for which long-term data exist have declined precipitously since the early 2000s. These individuals are critically threatened by myriad threats, most critically habitat destruction and overcollection.

Congress enacted the Endangered Species Act (ESA) in 1973 to provide "a program for the conservation of . . . endangered species and threatened species" and "a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved."[1] As the first step in the protection of these species, Section 4 of the ESA requires the Secretary to list species as "endangered" or "threatened" when they meet the statutory listing criteria.[2] An "endangered" species is one "in danger of extinction throughout all or a significant portion of its range," and a "threatened" species is "likely to become endangered in the near future throughout all or a significant portion of its range."[3]

Once a species is listed, the ESA provides a variety of procedural and substantive protections to ensure not only the species' continued survival, but also its ultimate recovery. "Congress has spoken in the plainest words, making it clear that endangered species are to be accorded the highest priorities."[4]

The best available scientific information indicates that the Hickory Nut Gorge green salamander is threatened with extinction. Already rare and restricted to a narrow range, the species faces ongoing and imminent habitat destruction and degradation from urban development and human activity. The Hickory Nut Gorge green salamander's unique appearance and rarity also put it at risk of overcollection for the pet trade. The species is also threatened by disease, road mortality, pollution, climate change, and catastrophic events such as fires, rockslides, landslides, and severe weather. The U.S. Fish and Wildlife Service (Service) must review this petition and protect the species under the ESA.

Petitioners submit substantial scientific information in this petition indicating that listing the Salamander is warranted; however, because overcollection is a significant threat to the Salamander, this petition does not include the exact locations of populations or individuals. Instead, the petition cites publicly available information regarding the location of Salamanders and details the threats that put it at risk of extinction. For exact population location information, and for any other questions about the petition, please contact Will Harlan at [wharlan@biologicaldiversity.org or 828-230-6818. Petitioners request and expect that location information about the Salamander will be protected from disclosure int eh event of a Freedom of Information Act request and in any future rulemakings regarding the species.

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[1] 16 U.S.C. § 1531(b).
[2] *Id.* § 1533.
[3] *Id.* § 1532(6) and (20).
[4] *TVA v. Hill*, 437 U.S. 153, 155 (1978).

II. INTRODUCTION

Austin Patton

The Hickory Nut Gorge green salamander is a moderate-sized salamander with a dark body and bright green to yellowish patches across its back. It is one of only two climbing salamander species in the eastern United States, along with the closely related green salamander, which until a recent reclassification was considered to be the same species. Found in hardwood and cove forests in Hickory Nut Gorge in western North Carolina, this salamander is imminently threatened by habitat destruction and degradation, in addition to myriad other threats.

To provide greater protection for this rare salamander and its unique habitat in the Hickory Nut Gorge, the Center for Biological Diversity and Defenders of Wildlife hereby petition to list the Hickory Nut Gorge green salamander as threatened or endangered under the Endangered Species Act.

III. GOVERNING PROVISIONS OF THE ENDANGERED SPECIES ACT

A. Endangered and Threatened Species

The ESA defines the term "species" to include "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature." 16 U.S.C. § 1532(16). The ESA defines an "endangered species" as any species that is "in danger of extinction throughout all or a significant portion of its range," *id.* § 1532(6), and a "threatened species" as one that "is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range," *id*. § 1532(20). The ESA requires the Service to determine whether a species is endangered or threatened, and if it is, to list it as such. *Id*. § 1533(a). The Service may only list a species as threatened after it has determined (1) that it is not endangered throughout all of its range and (2) that it is not endangered throughout a significant portion of its range. *Ctr. for Biological Diversity v. Everson*, 435 F. Supp. 3d 69, 92–93 (D.D.C. 2020), *appeal dismissed sub nom. Ctr. for Biological Diversity v. Skipwith*, No. 20-5075, 2020 WL 5822535 (D.C. Cir. May 13, 2020*), and appeal dismissed sub nom. Ctr. for Biological Diversity v. Skipwith*, No. 20-5075, 2020 WL 4106889 (D.C. Cir. July 15, 2020) (citing 16 U.S.C. § 1533(a)).

B. Listing Factors

The Service must make its listing determination based solely on the following five factors set forth in 16 U.S.C. § 1533(a)(1):

A. The present or threatened destruction, modification, or curtailment of its habitat or range;

B. Overutilization for commercial, recreational, scientific, or educational purposes;

C. Disease or predation;

D. The inadequacy of existing regulatory mechanisms; and

E. Other natural or manmade factors affecting its continued existence.

To be listed, a species need only face a sufficient threat under a single factor. *See Humane Soc'y of the U.S. v. Pritzker*, 75 F. Supp. 3d 1, 7 (D.D.C. 2014) (citing *Sw. Ctr. For Biological Diversity v. Babbitt*, 215 F.3d 58, 60 (D.C. Cir. 2000)). Any combination of threats, considered cumulatively under multiple factors, will also support listing. As discussed in detail in this Petition, the Salamander faces threats under Factors A, B, C, and E and clearly warrants listing.

C. Best Available Scientific and Commercial Data

The Service is required to make an ESA listing determination for the Salamander under the listing factors "solely on the basis of the best scientific and commercial data available." *See* 16 U.S.C. § 1533(b)(1)(A); 50 C.F.R. § 424.11(b). The Service cannot avoid its listing responsibility merely because there is little information available or that information is uncertain.[5] Because the ESA limits the Service's analysis exclusively to the best scientific and commercial data available, it prohibits the Service from denying listing on the basis of economic or political factors.

D. 90-Day and 12-Month Findings

"To the maximum extent practicable," the Service is required to determine "whether the petition presents substantial scientific or commercial information indicating that the petitioned action may be warranted" within 90 days of receiving a petition to list a species. 16 U.S.C. § 1533(b)(3)(A). This is referred to as a "90-day finding." A "negative" 90-day finding ends the listing process and is a final agency action subject to judicial review. *Id.* § 1533(b)(3)(C)(ii). A "positive" 90-day finding leads to a formal, more comprehensive "status review" and a "12-month finding" determining, based on the best available science, whether listing the species is warranted, not warranted, or warranted but precluded by other pending listing proposals for higher priority species. *Id.* § 1533(b)(3)(B). "Not warranted" and "warranted but precluded" 12-month findings are also subject to judicial review. *Id.* § 1533(b)(3)(C)(ii).

The Service's regulations define "substantial information," for purposes of 90-day petition findings, as "credible scientific or commercial information in support of the petitions claims such that a reasonable person conducting an impartial scientific review would conclude that the action proposed in the petition may be warranted." 50 C.F.R. § 424.14(h)(1). In making a finding as to whether a petition presents "substantial information" warranting a positive 90–day finding, the Service considers whether the petition contains the following information:

1. Information on current population status and trends and estimates of current population sizes and distributions, both in captivity and the wild, if available;
2. Identification of the factors under section 4(a)(1) of the Act that may affect the species and where these factors are acting upon the species;
3. Whether and to what extent any or all of the factors alone or in combination identified in section 4(a)(1) of the Act may cause the species to be an endangered species or threatened species (i.e., the species is currently in danger of extinction or is likely to become so within the foreseeable future), and, if so, how high in magnitude and how imminent the threats to the species and its habitat are;

[5] *See City of Las Vegas v. Lujan*, 891 F.2d 927, 933 (D.C. Cir. 1989) ("[Section 4] merely prohibits the Secretary from disregarding available scientific evidence that is in some way better than the evidence he relies on. Even if the available scientific and commercial data were inconclusive, he may—indeed must—still rely on it at this stage . . . ."); *In re Polar Bear Endangered Species Act Listing and 4(d) Rule Litigation*, 794 F. Supp. 2d 65, 106 (D.D.C. 2011) ("As this Court has observed, 'some degree of speculation and uncertainty is inherent in agency decision-making' and 'though the ESA should not be implemented 'haphazardly' . . . an agency need not stop in its tracks when it lacks sufficient information.'") (quoting *Oceana v. Evans*, 384 F. Supp. 2d 203, 219 (D.D.C. 2005); *Trout Unlimited v. Lohn*, 645 F. Supp. 2d 929, 950 (D. Or. 2007) ("[T]he agency 'cannot ignore available biological information'") (quoting *Kern Co. Farm Bureau v. Allen*, 450 F.3d 1072, 1080–81 (9th Cir. 2006)).

4. Information on adequacy of regulatory protections and effectiveness of conservation activities by States as well as other parties, that have been initiated or that are ongoing, that may protect the species or its habitat; and
5. A complete, balanced representation of the relevant facts, including information that may contradict claims in the petition.

50 C.F.R. § 424.14(d).

When establishing the "reasonable person" standard for the substantial information determination "a petition need not establish a 'strong likelihood' or a 'high probability' that a species is either threatened or endangered to support a positive 90-day finding." *Humane Soc'y of the U.S.*, 75 F. Supp. 3d at 10 (quoting 79 Fed. Reg. 4,877 (Jan. 30, 2014)) (internal quotations omitted); *see also* 50 C.F.R. § 424.14(h)(1); *Am. Stewards of Liberty v. U.S. Dept. of the Interior*, 370 F. Supp. 3d 711, 717, 726 (W.D. Tex. 2019) ("Though 'substantial scientific and commercial information' may seem like a high bar . . . , the Service's regulations indicate otherwise . . . ."). The 90-day finding determination is a mere "threshold determination" and that contemplates a "lesser standard by which a petitioner must simply show that the substantial information in the Petition demonstrates that listing of the species may be warranted." *See Pritzker*, 75 F. Supp. 3d at 15 (quoting C*olo. River Cutthroat Trout v. Kempthorne*, 448 F. Supp. 2d 170, 176 (D.D.C. 2006)); *Ctr. for Biological Diversity v. Kempthorne* ("*Kempthorne II*"), No. CV 07- 0038-PHX-MHM, 2008 WL 659822, at *8 (D. Ariz. Mar. 6, 2008) ("[T]he 90-day review of a listing petition is a cursory review to determine whether a petition contains information that warrants a more in-depth review.").

IV. NATURAL HISTORY

Chris Wilson

A. Common Name

This Petition refers to the Hickory Nut Gorge green salamander (*Aneides caryaensis*), by the short-form name "Salamander" throughout. This species is also known to be referred to as the "HNG green salamander" and the "HNG green."

B. Taxonomy

The taxonomy of *Aneides caryaensis* is as follows:

Kingdom	*Animalia*
Phylum	*Chordata*
Subphylum	*Vertebrata*
Class	*Gnathostomata*
Order	*Amphibia*
Family	*Plethodontidae*
Subfamily	*Plethodontinae*
Genus	*Aneides*
Subgenus	*Castaneides*
Species	*caryaensis*

Researchers confirmed the identity of the Salamander as a unique species in 2019 when examining spatial genetic patterns across the western North Carolina portion of the green salamander's (*Aneides aeneus*) range (Patton et al. 2019, at 749). The Salamander and the green salamander are currently the only two species in the *Castaneides* subgenus (Patton et al. 2019, at 755).[6] Green salamanders occurring in the Blue Ridge escarpment in North Carolina ("BRE green salamanders") are located only 25 kilometers from the Salamander (Patton et al. 2019, at 758). Patton et. al. confirmed that the Salamander is a separate species from the green salamander on the basis of molecular and preliminary morphological differentiation (Patton et al. 2019, at 755). Although the green salamander is a genetically distinct species, it is the most closely related to the Salamander and may offer insight into the Salamander's behavior.

In 2022, Niemiller et al. confirmed Patton's 2019 findings that the Hickory Nut Gorge green salamander is a distinct species by extending the genetic and genomic examination of the *Castaneides* species complex (2022, entire). They sampled additional populations and employed mtDNA and RADseq species delimitation approaches to delineate cryptic diversity and boundaries in the Southern Appalachian Highlands region (2022, entire). Their 2022 genomic analysis supported the previous findings of Patton et al. that *Aneides caryaensis* is genetically distinct. Neimiller et al. also identified the Blue Ridge green salamander (BRE green salamander) and two additional cryptic in the species complex lineages: a northern and southern green salamander (2022, entire).

The Hickory Nut Gorge green salamander likely diverged from other members of its lineage at most 12 million years ago (Patton et al. 2019, at 758). Because the Salamander was only recently identified as an independent species, a smaller body of research exists than that for the green salamander, which has been studied for nearly 100 years (*see* Pope 1928, entire). Thus, decades

[6] The fate of the green salamander similarly hangs in the balance (Patton 2019, at 749). The IUCN added the species to the Red List in 2005 as a Near Threatened species experiencing decreasing populations (*Id*.). However, its status is likely in need of recategorization since it was last assessed 16 years ago (*Id*). NatureServe listed the green salamander as Vulnerable in 2008 (Patton 2019, at 749). This status, too, must be revisited because 13 years have passed since this designation (Patton 2019, at 749). Corser (2001) determined that green salamander populations in the Blue Ridge Escarpment experienced a 98% decline since 1970, and North Carolina Wildlife Resources Commission surveys indicate that populations in the area declined from 2004 and 2019.

of research on green salamanders can be extrapolated to understand the traits and habitat needs of the Salamander, a sister to the *A. aeneus* complex.

Carya is Greek for 'nut' and the genus name for hickory trees, a reference to the Hickory Nut Gorge of North Carolina where this species is found.

C. Physical Characteristics

The Salamander is moderate sized with a body adapted for climbing (Patton et al . 2017, at 755–57). The Salamander generally ranges from brown-black to yellow-green in color (Patton et al. 2019, at 756). The ground color of the species' dorsal surfaces is dark brownish black (Patton et al. 2019, at 756). Its dorsum, however, is marked by bright-green to yellowish-green, lichen-like patches, which are smaller and less connected than those of green salamanders (Patton et al. 2019, at 756). The Salamander's flanks have a light grayish-yellow ground color, and its venter appears lighter than the other surfaces (Patton et al., at 756).

Figure 1 – Images of the Hickory Nut Gorge green salamander

Austin Patton

The salamander is one of only two climbing salamander species in the eastern United States, the second being the green salamander, and its physical traits are adapted to this activity. It has particularly long limbs and digits, which are slightly longer than those of the green salamander in relation to body size (Patton et al. 2019, at 755, 757). Its legs typically extend laterally from the body, overlapping by 2.5 to 4.0 costal interspaces when adpressed to the sides of the trunk (Patton et al. 2019, at 755). The toe pads of the Salamander are broad and squared, which also facilitate climbing (Patton et al. 2019, at 748, 755). The Salamander also exhibits a slender, whip-like prehensile tail that is capable of gripping surfaces (Patton et al. 2019, at 748, 755). The species' tail is capable of regeneration, and the tails of the Salamander samples studied in Patton 2019 evinced a standard length of .93–1.07 mm (Patton et al. 2019, at 748, 755).

The salamander is not significantly longer than the green salamander, but it appears to be broader (Patton et al. 2019, at 757). Males tend to be smaller than females. The standard lengths of three sexually mature male salamanders sampled in Patton et al. 2019 were 48.5, 52.4, and 58.4 mm (Patton et al. 2019, at 755). The standard lengths of four sampled females were 52.8, 57.8, 58.9, and 59.8 mm (Patton et al. 2019, at 755). The species likely has fifteen trunk vertebrae (Patton et al. 2019, at 757). While the Salamander is relatively modest in size, its shape is broad (Patton et al. 2019, at 757). Its head and shoulders, in particular, are broader than those of green salamanders (Patton et al. 2019, at 757). The Salamander's eyes are large and prominent, and its head is more elongated than that of the green salamander (Patton et al. 2019, at 755). Despite being broad, the species is capable of flattening against rocks, allowing it to live in crevices of outcrops (Patton et al. 2019, at 757).

As a member of the family *Plethodontidae*, the Salamander does not possess lungs (Beane et al. 2018, at 2). It instead achieves respiration through moist skin and through the roof of its mouth and pharynx (Beane et al. 2018, at 2).

D. Feeding

The Salamander's feeding behavior can be discerned from limited existing information about the feeding behavior of its sister species, the green salamander. Salamanders are carnivorous (Clipp and Anderson 2014, at 2681), and green salamanders can be opportunistic feeders (AmphibiaWeb 2020, at 5). Green salamanders primarily eat live insects and other small arthropods (Beane et al. 2018, at 2). Ants and beetles have been described as having particular importance in the species' diet (Beane et al. 2018, at 2). Evidence suggests that, while green salamander hatchlings consume more mites than other invertebrates, generally all classes and ages of green salamanders consume the same prey (Canterbury 1991, at 69). In a study of feeding behavior found within the green salamander complex, the stomach contents of one HNG green individual from Rutherford County, North Carolina, contained 53% ants, 32% spiders, 13% shed salamander skin, and 2% unidentified insect larvae (Lee and Norden 1973, at 53) (citing Rubin 1969, at 104).

In early spring and late fall periods, the green salamander spends daytime hours occupying crevices of rock outcrops and generally only consumes prey species that make their way into the crevices (Cupp 1991, at 173). The green salamander primarily forages when it exits its crevice at times when it is less likely to lose body moisture, including at night and during periods of high humidity (John 2016, at 1; Cupp 1991, at 173; Snyder 1991, at 165). After emerging from crevices, the green salamander is generally known to forage on exposed rock faces (Cupp 1991, at 173; Snyder 1991, at 165). Brooding females likely do not eat because they typically do not leave their nests in rock crevices (Gordon 1952, at 687). The stomach and intestines of two female green salamander samples taken at the end of a brooding period were found to be particularly thin when compared to males (Gordon 1952, at 687).

Historically, researchers believed the green salamander primarily foraged on the faces of rock outcrops, but more recent research indicates the species likely spends more time foraging in forest canopies (Wilson 2003; Waldron and Humphries 2005).

During warmer weather, green salamanders climb up into forest canopies to feed, likely to avoid competition on the ground and to take advantage of larger and more abundant insect prey, particularly in mature broadleaf forests close to the rock outcrops (Wilson 2003; Waldron and Humphries 2005). Similarly, the Salamander also exhibits arboreal behavior, presumably for the same reasons (Lane 2020, entire; Apodaca pers. comm. 2020)

E. Life Cycle

While the life cycle of the Salamander is not fully known, inferences can be drawn from knowledge of the green salamander, including green salamanders from the Blue Ridge Escarpment ("BRE green salamanders"). The annual life cycle of the green salamander, and likely the Salamander, is composed of four periods (Cupp 1991, at 172-73; Gordon 1952, at 698). The first period is the breeding period (Cupp 1991, at 172; Gordon 1952, at 698). Following the breeding season, the green salamander engages in pre-hibernation dispersal and aggregation (Cupp 1991, at 173; Gordon 1952, at 698; Canterbury 1991, at 96). Next is the hibernation period itself (Cupp 1991, at 173; Gordon 1952, at 698). After hibernation, the green salamander engages in a period of aggregation and dispersal before beginning the cycle again (Cupp 1991, at 173; Gordon 1952, at 698).

The breeding period for the Salamander likely occurs from April until September. The green salamander reaches sexual maturity after three years (Canterbury 1991, at 96). Male green salamanders possess well-developed secondary sex characteristics, such as relatively large jaws and teeth and yellowish-orange mental glands, both of which are important during the courtship process (Cupp 1980, at 466). In June, female salamanders descend from the treetops to claim and guard their egg deposition and brooding sites (Apodaca pers. comm. 2021). The Salamander likely breeds in late summer or early fall in crevices of the rock faces (Apodaca pers. comm. 2021).

The Salamander is very specific about the microhabitat where it broods (Williams et al. 2020; Apodaca pers. comm. 2021). Rock outcrop crevices used by brooding female green salamanders are moist but not wet (Snyder 1991, at 165; Gordon 1952, at 675). They also admit little or no water from surface runoff (Gordon 1952, at 675). Female BRE green salamanders abandoned every site invaded by moss (Gordon 1952, at 675). The Salamander returns to its nest sites in subsequent years, possibly because it is faced with limited options for locations where incubation can successfully occur (Apodaca pers. comm. 2020; Corser 2001, at 120; Cupp 1991, at 173).

Female green salamanders deposit their eggs on the roof of rock crevices, which adhere to one another and are suspended by strands of mucus (Gordon 1952, at 678, 681). Green salamander broods have also been located beneath exfoliating bark and within tree cavities (see review in Wilson 2003). A typical clutch of Hickory Nut Gorge green salamanders consists of 10–30 eggs (Apodaca pers. comm. 2020). The Salamander may nest similarly to BRE green salamander, which generally deposit their eggs at the maximum depth of crevices (Gordon and Smith 1949, at 174).

Female green salamanders guard their eggs for the duration of incubation, never leaving them unless they are entirely abandoned (Gordon 1952, at 683). The mother guards her nest by either coiling around the nest or otherwise remaining adjacent to it (Gordon and Smith 1949, at 174). Brooding allows eggs to maintain water balance, protects them from predators, and provides a possible antifungal effect (Cupp 1991, at 173). A female green salamander's presence with the clutch has been linked to successful hatching (Williams et al. 2020; Cline undated, at 3; Gordon 1953 at 683). Gordon notes that a female green salamander's eggs, "if left unguarded or deserted, either disappear all at once or several at a time. Ten eggs were reduced to four after 31 days without the protection of the female. A growth of mold on the eggs was observed after 26 days" (1952, at 683).

The incubation period for the Salamander lasts roughly 72-82 days, with an average of 77 days (Williams unpublished data 2022). Following incubation, the mother remains with her hatchlings for three to five weeks (Cupp 1991, at 173). Evidence suggests that female green salamanders reproduce every other year, (Canterbury 1991, at 75 (studying green salamanders in West Virginia)). This finding may be limited to green salamanders that occupy the northern part of the species' range, but there is photographic evidence of green salamanders in North Carolina who have skipped years of breeding (Williams unpublished data 2022).

The pre-hibernation aggregation period for the salamander may be similar to that of the BRE green salamander, occurring at the end of the breeding period, typically from late September to November (Gordon 1952, at 699; Canterbury 1991, at 58). During this time, male, female, and juvenile salamanders aggregate in deep interconnected crevices of rock outcrops (Gordon 1952, at 688; Wilson 2003, at 1).

Following aggregation, the green salamander enters the hibernation phase of its life cycle. For the BRE green salamander, hibernation occurs from November through March or April (Gordon 1952, at 699).

While Gordon (1952) only identified four BRE green salamanders between the months of November and April during this study period, he posited that they hibernated during this period by aggregating in deep interconnecting rock crevices to hibernate during winter (Gordon 1952, at 688; Wilson 2003, at 1). Recent surveys within the Hickory Nut Gorge indicate the timing of hibernation for the BRE salamander is similar for the Hickory Nut Gorge green salamander (Apodaca pers. comm. 2021).

BRE salamanders emerge from hibernation in mid-March onward (Williams unpublished data 2022). Hickory Nut Gorge green salamanders also have been observed emerging as early as March (Apodaca pers. comm. 2021). They congregate in deep interconnected crevices, and from March to early June, they disperse and begin a new breeding period (Gordon 1952, at 688, 699).

Austin Patton

F. Habitat and Range

The Salamander is a microhabitat specialist confined to an extraordinarily limited range within the Hickory Nut Gorge in western North Carolina, approximately 35 km east of Asheville, North Carolina, in parts of Buncombe, Henderson, Polk, and Rutherford counties (NCWRC 2020, at 3A1-2). The species' primary habitat requirements are a dense canopy that traps moisture and regulates temperature, along with available rock outcrops. Because the Salamander was only recently identified as a distinct species, there is a smaller body of research on the species' habitat requirements than that of the green salamander. However, the Salamander's habitat requirements likely mirror those of the BRE green salamander, which is located only 25 km away.

The Salamander's roughly 35-square-km range is entirely within the Hickory Nut Gorge in southwestern North Carolina, on the edge of the Blue Ridge Escarpment of the southern Appalachian Mountains. The Southern Appalachian Mountain range extends from northern

Alabama to Northern Virginia (NCDENR 2011, at 1-1). During the last ice age, these mountains avoided glaciation, making them some of the oldest continuously exposed mountains on the planet (NCDENR 2011, at 3-1; Patton et al. 2019, at 748). As a result, this region has harbored plant and animal life for millions of years (NCDENR 2011, at 3-1) and exhibits significant biodiversity and endemism (Patton et al., 2019, at 748; Pickering et al. 2003). Aside from the Pacific Northwest, the Southern Appalachians feature the country's highest annual precipitation averages, making it the second wettest region of the United States (NCDENR 2011, at 3-1, 3-6).

The Blue Ridge Escarpment of the Southern Appalachian Mountain Range is a physiographic boundary that divides the Blue Ridge Province to the west from the Piedmont of the Eastern United States (Racine and Hardin, 1975 at 319). A network of river gorges falls within the Blue Ridge Escarpment, one of which is the Hickory Nut Gorge. The Rocky Broad River carved the eight-mile gorge between the cliffs and exposed granite domes of Chimney Rock Mountain and Round Top Mountain (NCDENR 2011, at 1-1, 1-8). The gorge provides "excellent landscape connections southward along the Blue Ridge Escarpment towards South Carolina, as well as northward and eastward toward the South Mountains" (NCDENR 2011, at 1-1).

Although the Hickory Nut Gorge hosts many habitats, (NCDENR 2011, at 3-22), the types of habitats on which the Salamander primarily relies include: acidic cove forest, Appalachian hemlock-hardwood forest, central and southern Appalachian montane oak forest, south-central interior small stream and riparian, southern and central Appalachian cove forest, southern and central Appalachian xeric oak forest, southern Appalachian low mountain pine forest, southern Appalachian montane cliff, and southern piedmont dry oak (pine) forest (Apodaca, unpublished research, 2022).

Acidic cove forests, in particular, are some of the most biologically diverse ecosystems in the United States, known for "support[ing] rich mammalian, avifaunal, and herpetofaunal communities, several of which are rarely found in other forest types" (Greenberg et al. 1997, at 1, 5). Acidic cove forests generally occur in North Carolina's mountainous regions and are found in low gentle ridges within coves, steep ravines, and primarily narrow, rocky gorges (Schafale and Weakley 1990, at 36; Corser 2001, at 120). They generally exist at low and moderate elevations (Schafale and Weakley 1990, at 36) and in western North Carolina, they are typically located in patches (USFS 2014, at 112). Acidic cove forest soils are relatively rocky, acidic, and lacking in nutrients (NCDENR 2011, at 3-22; Schafale and Weakley 1990, at 36). Hickory Nut Gorge acidic cove forests primarily feature eastern hemlocks (*Tsuga canadenis*), known for their canopy dominance, along with tulip poplars (*Liriodendron tulipifera*) sweet birch (*Betula lenta*), and red maples (*Acer rubrum*).

The dense forest canopies in the Hickory Nut Gorge are integral to the Salamander's survival because they facilitate a relatively moist atmosphere and regulate temperature. For example, many habitats the Salamander uses feature hemlocks, including the Appalachian hemlock-hardwood forest and acidic cove forests, (NCDENR 2011, at 3-22), and southern and central Appalachian cove forests, (NatureServe 2021). Dense, closed canopies seal moisture within the ecosystem (DeFosset 2017, at 33). Known to grow to heights exceeding 170 feet, Eastern hemlocks have been referred to as the "redwood of the East" (DeFosset 2017, at 33). The dense canopies formed by Eastern hemlocks result in hemlock groves exhibiting a moister atmosphere relative to surrounding areas (DeFosset 2017, at 33). For the Salamander, this trapped moisture facilitates the species' cutaneous respiration process and creates more successful brooding conditions within rock crevices.

The shade cast by Eastern hemlocks' dense forest canopies also regulates temperature, providing a microclimate with a distinctly cooler atmosphere within hemlock coves (DeFosset 2017, at 33–34), which allows the Salamander to maintain moist skin necessary for it to breathe. Shade is critical for the Salamander because of hotter temperatures in the Hickory Nut Gorge. Research demonstrates that the closely related BRE green salamander occupies rock outcrops primarily located in shaded areas (Bean et al. 2018, at 1; Wilson 2003, at 1) and cannot thrive on rock faces that lack protection from prolonged exposure to the direct sun (Snyder 1991, at 165).

Dense and mature forest canopies are also crucial to the Salamander's survival because, as research has recently demonstrated with green salamanders, the Salamander spends a notable portion of its life cycle in forest canopies eating insects when not hibernating (Apodaca 2018, at 2 (discussing BRE green salamanders) and is known to use arboreal habitats for brooding (Lane 2020, entire; Wilson 2003; Waldron and Humphries 2005). They likely do so in large part because it provides them with access to insects for foraging. Green salamanders are known for abandoning rock crevice sites if canopy coverage is removed (Snyder 1991, at 167).

The Salamander likely also makes use of portions of trees other than their canopies. Habitats used by the Salamander in the Hickory Nut Gorge harbor a mix of hardwood and hemlock trees (Apodaca pers. comm. 2021). One study observed that green salamanders more frequently use hardwood trees than coniferous trees such as hemlock and do so at a higher rate than the rate of the hardwood trees' abundance within the study area (Waldron and Humphries 2005, at 489).

American chestnut trees (*Castanea dentata*) once dominated the Eastern landscape, and it is believed that green salamanders heavily occupied chestnut trees, relying on their bark cover as well as canopy (Wilson 2003, at 1). Wilson suggests that the rarity of the green salamander is linked to the loss of the American chestnut and old-growth forests (2003, at 1).

Green salamanders at times have been identified within slabs of bark in the Appalachian Mountains (Wilson 2003 at 1; Patton et al. 2019, at 749). Bark provides green salamanders with substrate for foraging on insects (Brodman 2004, at 2). Although rare, members of the species have been found beneath loose bark and logs (Beane et al. 2018, at 2; Wilson 2003 at 1) and in cracks of fallen cove hardwoods (NatureServe 2011, entire; Wilson 2003, at 1). BRE green salamanders have been observed under the bark of downed logs and fallen trees in North Carolina (Williams unpublished data 2022). Research has also found that green salamanders prefer using trees that are closer to rock outcrops (Smith et al 2017; Waldron and Humphries 2005, at 486).

Hickory Nut Gorge green salamander habitat must contain rock outcrops (Rossell et al. 2019; Apodaca pers. comm. 2020), which are a predominant feature of the Hickory Nut Gorge region (NCDENR 2011, at 3-5). The species makes use of hollows, faces, and shady crevices in these outcrops for important life stages including brooding and hibernating (Patton et al. 2019, at 749). Green salamanders generally confine themselves to rock crevices during daylight hours, typically only emerging from those crevices at night or at times of high humidity (Wilson 2003, at 1; Cupp 1991, at 171; Snyder 1991, at 165). For example, in Patton et al. 2019, researchers collected specimens of Salamander holotypes in tight rock crevices late in the afternoon, whereas at night an individual was collected from a rock face (Patton et al. 2019, at 757). The BRE green salamander also feeds on insects on rock outcrops, such as slugs, which are frequently found on rock faces in the Blue Ridge Escarpment (Gordon 1952, at 677). Rock types that the BRE green salamander has been known to occupy include granite, noncalcareous sandstone, schists, gneiss and occasionally limestone (Snyder 1991, at 165; Williams unpublished data 2022).

Salamanders are particular about the crevices they occupy (Rossell et al. 2009; Rossell et al. 2019, entire) . Male green salamanders have been observed to be more territorial, aggressively defending their rock crevices (Cupp 1980, at 464).

Green salamanders are spottily distributed, even in areas where they are known to occur, due to their strict needs for suitable rock substrates (Snyder 1991, at 165). Green salamanders' presence in rock crevices is very ephemeral in nature, making the species difficult to detect in surveys (Apodaca 2018, at 1; Williams et al. 2020, entire). However, studies have shown that for the BRE green salamander, crevices in rock outcrop formations must be moist but not wet (Gordon 1952, at 675; Waldron and Humphries 2005, at 486; Snyder 1991, at 165; Beane et al. 2018, at 1). Thus, they must generally be capable of admitting little or no water from surface runoff (Gordon 1952, at 75).

The green salamander also prefers that crevices are narrow (Beane et al. 2018) and relatively clean and lacking in dirt (Snyder 1991, at 165). Gordon 1952 observed that female BRE green salamanders abandoned every site invaded by moss, but when young dispersed following hatching, they sought out moss-filled crevices (Gordon 1952, at 675, 699). The BRE green salamander also appears to avoid crevices that are entirely exposed to sunlight or are too shallow to support a cooler interior (Gordon 1952, at 675). The BRE green salamander commonly occupies crevices so dark that the species is only visible through use of a flashlight (Gordon 1952, at 675). Evidence also indicates rock crevices used for hibernation must be deep and interconnected (Gordon 1952, at 688).

G. Population Status and Trend

Species experts estimate between 250 and 500 individual Salamanders are remaining in the wild. (Apodaca unpublished data, pers. comm. 2021). Most of the Salamander populations for which long-term data exist have declined precipitously since early 2000. *Id.* North Carolina Wildlife Resources Commission surveys indicate that populations in the area declined from 2004 and 2019 (Williams pers. comm. 2021).

The BRE population of green salamander experienced a dramatic decline during the 1970s (Snyder, 1991). Snyder (1971) reported nearly 200 clutches from 13 sites in 1970, with one site containing 55 clutches. Snyder (1971) described the BRE green salamander as "common and sometimes dense." In the late 1980s, only eight of 37 known sites were occupied and densities within those sites were a fraction of their former abundance (USFWS, 1987).

Corser (2001) monitored 13 sites annually between 1990 and 1999 and found no more than 4 clutches from a single site and no more than 13 clutches in a single year. Seven of these sites contained a total of 95 clutches in 1970 (Snyder, 1971) but averaged only 1.67 clutches between 1990 and 1999, demonstrating a 98% decline.

Status surveys of the BRE Green salamander conducted by Wilson (2001) during 2000 and 2001 showed densities at 38 occupied sites continued to be dramatically lower than those reported by Snyder (1971). Among 20 historic sites visited, fewer than expected breeding populations were observed and the number of breeding populations decreased between 1991 and 2001. Using IUCN Red List Categories (IUCN, 2001) provided by the World Conservation Union Red List Categories, Wilson (2001) suggested that Hickory Nut Gorge populations qualify as Critically Endangered and the BRE populations qualify as Endangered.

V. IDENTIFIED THREATS TO THE PETITIONED SPECIES: FACTORS FOR LISTING

Chris Wilson

A. The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range

Habitat loss and fragmentation within the Hickory Nut Gorge is likely the greatest direct threat to the Hickory Nut Gorge green salamander's long-term survival (Patton et al. 2019, at 759). Habitat fragmentation and loss can easily occur because the Salamander's preferred habitat features tend to be distributed in patches across the landscape and are susceptible to disturbance from human activities (Patton et al. 2019, at 759).

1. Development

The largest direct conservation threat to the Salamander is habitat destruction and degradation from rapid real estate, tourism, transportation, and energy infrastructure development in the Hickory Nut Gorge (Patton et al. 2019, at 748, 759). Already, development has destroyed one of the only known Hickory Nut Gorge green salamander sites in Polk County (Williams unpublished data 2022).

As the human population continues to grow, residential, commercial, and industrial development will grow in pace. Between 2010 and 2020, North Carolina's population grew by 903,905 individuals, representing an increase of 9.5%, which is faster than the national growth rate of 7.3% (Tippett 2021, at *1).

Commercial and residential development has significantly expanded in the Salamander's habitat in previous years and continues to grow. The area is known to be a popular retirement destination (HNG Chamber 2022, entire). Outdoor recreation in the Hickory Nut Gorge draws hundreds of thousands of visitors each year. For example, more than 412,000 people visited Chimney Rock State Park in 2021, a 35% increase from 2020 (Lacey 2022, entire). Before the pandemic, 13 times as many visitors flocked to the area in the summer than there were full-time residents (Reardon 2020, entire). At the time of this petition's submission, many empty lots in the species' habitat either are currently on the market or were recently sold (e.g., Property Shark 2022a, b, c and d, entire). Land for sale in the area is commonly found in growing residential developments and gated communities (e.g., Carolina Properties 2022).

Population growth and associated development threatens biodiversity through increased demand for land, water, and other natural resources. Habitat loss and degradation caused by development is generally permanent and poses an increasing threat to imperiled species like the Salamander. Because of the impending destruction of its habitat discussed above, the Salamander warrants immediate protection under the Endangered Species Act

2. Roads

Roads further degrade and fragment the Salamander's habitat. Though roads have a relatively small footprint, their impacts can be far-reaching (Andrews et al. 2006, entire), fragmenting otherwise continuous forested habitat (Semlitsch et al. 2006, at 160). Habitat fragmentation negatively affects wildlife, particularly salamanders, in various ways, including by changing individuals' behaviors, decreasing movement, and genetically isolating populations (Holderegger and Di Giulio 2010, entire; Lima et al. 2013, entire; Clipp and Anderson 2014, at 2690).

Roads also have edge effects, which result in unsuitable habitat along their boundaries (Marsh and Beckman 2004, entire; Clipp and Anderson 2014, at 2690). For instance, microhabitat, soil moisture, and cover objects tend to decrease near roads (Marsh and Beckman 2004, entire; Clipp and Anderson 2014, at 2690). These edge effects can result in altered rates of predation and competition and shifting community structure (Clipp and Anderson 2014, at 2690). The North Carolina Wildlife Resources Commission designates transportation and service corridors as a "high" threat to green salamanders (*A. aeneus*) (NCWRC 2015 at 700–701).

Road mortality is particularly high for amphibians and especially salamanders (Gibbs and Shriver 2005; Holderegger and Di Giulio 2010). *The BRE green salamander* has been observed crossing roads on rainy nights (Williams and Gordon, 1961).

Recreational, commercial, and residental development within HNG will continue to increase vehicular traffic and road density leading to direct impact of occupied rock outcrops, greater habitat fragmentation, increased traffic and direct mortality of the Salamander.

3. Deforestation and Logging

Large-scale habitat conversion via logging is ongoing in the Blue Ridge escarpment, fragmenting habitat and isolating green salamander populations (Corser 2001 at 124). Logging can impact Salamanders by limiting dispersal, decreasing leaf litter depth and canopy cover (Clipp and Anderson 2014, at 2687). Logging can also increase exposure, air and water temperature, instability of microclimatic conditions, and soil compaction (Clipp and Anderson 2014, at 2687). Some salamander species prefer older forests, which may be destroyed by deforestation (Clipp and Anderson 2014, at 2688). For instance, Ford et al. (2002) (entire) found that stand age following clear-cutting in cove hardwoods was an important factor in explaining salamander abundance and community composition, with the species richness and diversity of certain salamander species highest in the oldest stands. Observational and experimental studies have shown reduced salamander populations following timber harvest (Clipp and Anderson 2014, at 2687–2688).

Because the Salamander requires shade provided by forest canopies, canopy removal causes the death or, otherwise, the evacuation of the species that use the area (Snyder 1991, at 167) (discussing impacts to BRE green salamander habitat). Once an area is cleared, it can take decades for a closing canopy to provide enough shade for the species to recolonize (Snyder 1991, at 167) (discussing the BRE green salamander).

Large scale timber harvest is not common in the Hickory Nut Gorge, but even small operations can have an impact on the Salamander given the small number of occupied sites. Logging and clearing activities from construction, transportation, and energy infrastructure are common in the Hickory Nut Gorge and can have a disproportionately large impact on the species.

The Salamander needs moist shaded forested conditions to prevent desiccation; complex structural conditions for arboreal foraging; and tree cavities and woody debris in various decay classes for refuge and breeding. All of these conditions occur more frequently in mature and old growth forests. Continued and increasing commercial, residential, and recreational development, as well as commercial forestry practices, will lead to greater direct impacts on Salamander and its forest habitat, reducing dispersal capacity and increasing fragmentation.

4. Loss of Hemlocks

The Salamander's habitat is also negatively affected by the widespread loss of hemlock trees. The Hickory Nut Gorge is home to two species of hemlock: the Eastern hemlock (*Tsuga canadensis*) and the Carolina hemlock (*T. caroliniana*) (DeFosset 2017, at 33). The Carolina hemlock has an already extremely limited range in the southern Appalachians, occurring primarily in western North Carolina (DeFosset 2017, at 33). Both hemlock species are threatened by changing climate, including increased drought and rising temperatures, as well as pests including an exotic and invasive insect called the hemlock woolly adelgid (HWA) (*Adelges tsugae*) (DeFosset 2017, at 31). These factors have caused significant and rapid declines in hemlocks in Hickory Nut Gorge (DeFosset 2017, at 32).

The HWA is known to cause especially severe decline of hemlock populations (Evans and Gregoire 2007, entire; Krapfl et al. 2011, entire). HWA-induced mortality can be explosive, exceeding 80% within four years of infestation (Orwig et al. 2002, entire; Small et al. 2005, entire). HWA has been particularly destructive in the Southern Appalachian region (Vose et al. 2013, at 210, 213). The loss of both Eastern and Carolina hemlocks in North Carolina is expected to have numerous ecosystem impacts, including potentially drastic changes to forest community structure, understory composition, nutrient cycling, soil pH, hydrologic processes, microclimate, and wildlife assemblages (Vose et al. 2013, at 213–215; Potter et al. 2017, at 2–3).

5. Invasive Plant Species

The acidic soil and abundant rain make Hickory Nut Gorge a haven for invasive plant species. Acidic cove forests are particularly vulnerable to invasive plants like garlic mustard and oriental bittersweet, which have already greatly altered the vegetation composition and structure (NCWRC 2015, at 404–406). The North Carolina Wildlife Resources Commission has identified invasive plants as a threat to native wildlife in North Carolina, and studies indicate amphibian declines may be attributed to invasive species becoming established in their habitats (NCWRC 2015, at 710–711, 713). Species like kudzu (*Pueraria montana*) and Chinese privet (*Ligustrum sinense*) can drastically change the ecosystem by outcompeting native species are most likely to negatively affect the Salamander (Apodaca pers. comm. 2021).

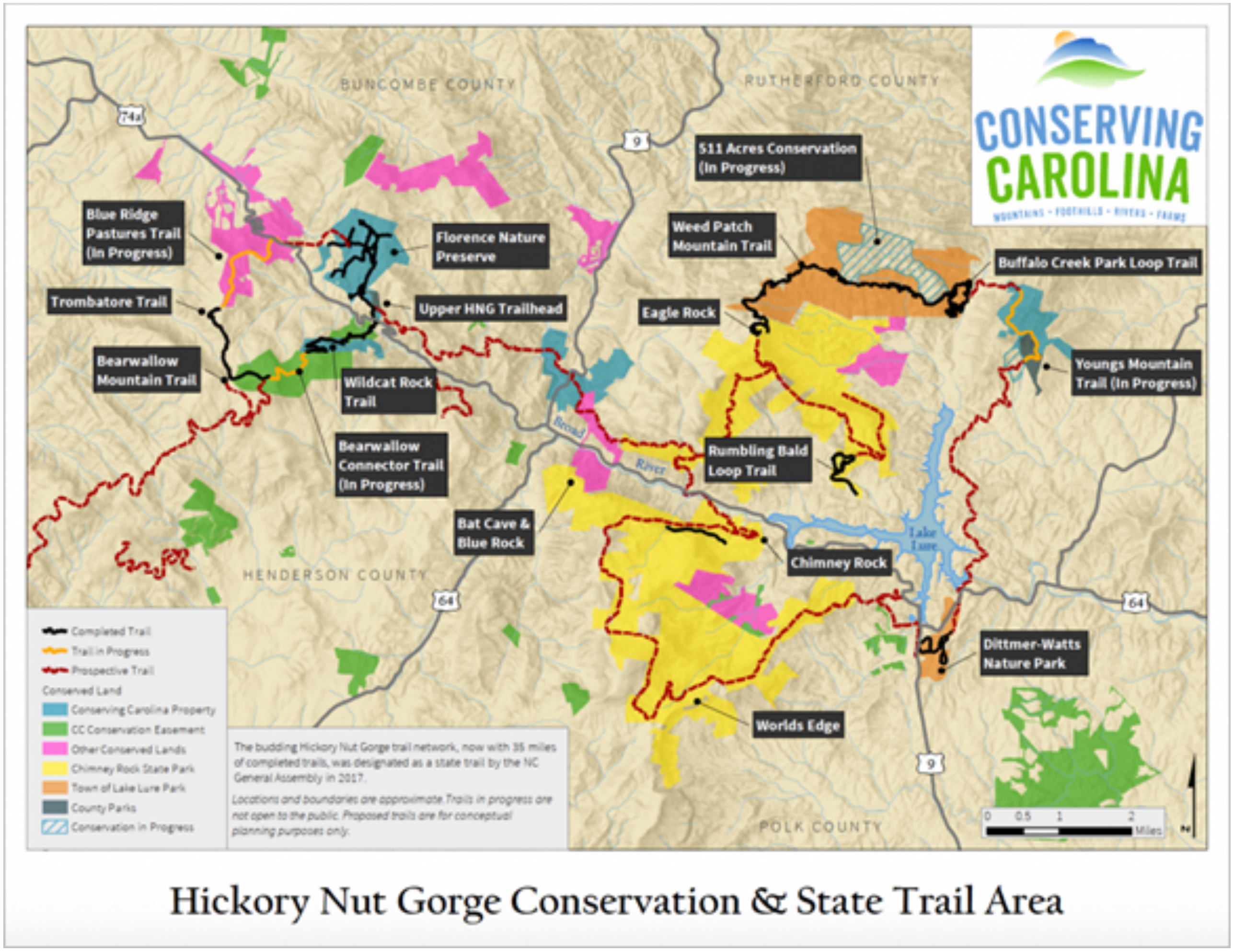
6. Recreation

Recreational activities in Hickory Nut Gorge may also cause habitat degradation or destruction. The greatest contemporary impacts to cliff biota are recreational activities such as hiking and technical rock climbing (Clark and Hessl 2015, at 1). Climbers can degrade rock face ecosystems by removing soils and vegetation on cliff faces (Clark and Hessl 2015, at 2), introducing exotic species (Apollo 2014, entire), and disturbing wildlife (Brambilla et al. 2004, at 428–429; Schmera et al. 2018, entire; Baur et al. 2017, entire). Rock climbing is popular in Hickory Nut Gorge (Reardon 2019, entire), and rogue rock climbers are likely causing some level of degradation to the rock outcroppings inhabited by the Salamander by cleaning rocks, removing vegetation, and covering rocks with chalk (Wilson pers. comm. 2020). For example, Rumbling Bald, which is part of Chimney Rock State Park in the Hickory Nut Gorge, is one of the most popular climbing destinations in the country and is featured regularly in national outdoor media (Carolina Climbers' Coalition undated, entire). Eagle Rock is another popular climbing and recreation spot on public land in the Hickory Nut Gorge, which now includes 30 climbing routes and hiking and biking trails (North Carolina State Parks 2018). Signs of unauthorized hiking and climbing have been documented in Chimney Rock State Park (Chimney Rock State Park Master Plan 2011, at 5–6). Intensive rock-climbing activity at colony sites may prove detrimental to the Salamander (PNHP undated, entire). Hiking and cycling are also popular in Hickory Nut Gorge and may disturb the Salamander's habitat (Averill 2018, entire).

Recreational activities within the Salamander's range are increasing. In 2019, Chimney Rock reportedly received approximately 250,000 visitors (Jobe 2019, entire). Lake Lure now hosts triathlons and multisport competitions that attract more recreational users (e.g., Lake Lure Olympiad, entire). New trail development like the Hickory Nut Gorge State Trail (currently under development) and Weed Patch Trail will increase access to habitat in the Salamander's range for hikers, mountain bikers, and climbers (Chávez 2019, entire; Averill 2019, entire).

A new bike trail near Lake Lure was built directly beside known green salamander habitat on the site. No green salamanders have been observed at the site since 2016 (Williams unpublished data 2022).

Figure 2 – Map of existing and proposed trails in Hickory Nut Gorge State Trail



Conserving Carolina

B. Overutilization

Given their rarity and unique appearance, Salamanders are also threatened by members of the public collecting them from the wild for use as pets. Overcollection has been identified as a likely contributing factor in the sharp decline of green salamanders (Corser 2001, at 119; Snyder 1991, at 176; FWS 2016, at 1; Cline undated, at 3; Amphibians and Reptiles of North Carolina undated, at 1). A crevice salamander (*Plethodon longicrus*), a state-listed species which co-occurs with the Hickory Nut Gorge green salamander in a small and highly specific habitat, was found for sale in Germany and was likely poached by collectors (NCRWC unpublished data 2022).

More generally, overcollection, including for the pet trade, is a "significant threat" to salamander species (Bishop 2020, at 4). The demand for amphibians in the United States is relatively high, and between 2000 and 2009, amphibians were the third-most imported species into the United States (Herrel 2014, at 104). However, quantitative data regarding the legal amphibian pet trade is lacking, making it difficult for researchers to fully analyze its impacts (Herrel 2014, at 104). Moreover, a Service biologist acknowledged that "[t]he illegal trade of endangered salamanders, especially the prettiest and most brightly colored species, has been going on for years — and the U.S. is a 'hot spot' for the illegal market" (Ossola 2016, entire). Unfortunately, it is even more difficult to quantify data associated with the illegal wildlife trade than the legal wildlife trade, given its covert and complex nature (Esmail et al. 2019, 2).

C. Disease or Predation

1. Disease

The Hickory Nut Gorge Green Salamander is vulnerable to diseases including Ranavirus, *Batrachochytrium dendrobatidis* (*Bd)* and *Batrachochytrium salamandrivorans* (*Bsal*). The Salamander also faces increased mortality risk due to potential co-infection with two or all three diseases.

Ranavirus

Disease caused by Ranavirus are responsible for amphibian die-offs throughout North America, including the southeastern United States, and may contribute to population declines (Green et al. 2002, entire; Gray et al. 2009, entire; Miller et al. 2011 at 2352; Hoverman et al. 2012, at 36–37; Blackburn et al. 2015, at 357). Ranavirus has been detected in the closely related green salamander (*A. aeneus*) in Virginia (Blackburn et al. 2015, entire).

Batrachochytrium dendrobatidis (Bd)

Chytridiomycosis, the disease caused by *Bd* (or amphibian chytrid fungus), has also caused amphibian declines and extirpations worldwide (Lips et al. 2006, entire; Lötters et al. 2009, entire; Blackburn et al. 2015, at 357). Infection rates of Bd vary throughout the southeastern United States, with 17 species of plethodontid salamanders testing positive for *Bd* in past studies, and an additional 23 species not infected (Hughey et al. 2014, entire; Blackburn et al. 2015, at 357). However, *Bd* is believed to have played a role in the declines of plethodontid salamanders in Central America and has been shown to be lethal to plethodontid salamanders in the western United States (Lips et al. 2006, entire; Weinstein 2009, entire; Cheng et al. 2011, entire; Blackburn et al. 2015, at 357).

At least one Hickory Nut Gorge green salamanders has tested positive for *Bd* (Williams unpublished data 2022). *Bd* also has been detected in the closely related green salamander (*A. aeneus*) in Virginia (Blackburn et al. 2015, entire), and Moffitt et al. (2015) found one Bd positive BRE green salamander in Transylvania County, North Carolina. Since then, Bd cases in BRE green salamanders have increased. 23 additional BRE green salamanders have tested positive (Williams unpublished data 2022). The prevalence rate of *Bd* among BRE green salamanders is now 11.3% (Williams unpublished data 2022).

Batrachochytrium salamandrivorans (*Bsal*)

All salamanders in the United States are threatened by the potential introduction of *Bsal*, a highly pathogenic chytrid fungus originating in Asia that was recently discovered as a novel cause of the amphibian disease chytridiomycosis (Martel et al. 2013, entire). The invasion of *Bsal* into North America could lead to rapid epizootic declines and extinctions of salamanders, as there are no effective means of controlling its spread once it is established in wild populations (Yap et al. 2015, at 481). This disease caused a dramatic mortality event in fire salamanders (*Salamandra salamandra*) in the Netherlands, and it has already spread to Belgium (Martel et al. 2013, at 15,325; Burke 2015, entire). A mass mortality event of four species of captive fire salamanders was recently reported in Germany (Sabino-Pinto et al. 2015, entire). And there is also evidence of its spread in international trade (Cunningham et al. 2015, entire). Although, to date, *Bsal* has not been reported in the United States, few studies have been published since *Bsal* was described, and infection experiments show that the United States is home to numerous species from two of the most *Bsal*-susceptible families (Plethodontidae and Salamandridae) (Martel et al. 2014, entire).

There is a high risk of *Bsal* introduction into the United States, given the magnitude of international salamander trade originating from Asia and containing potential *Bsal* reservoirs (Yap et al. 2015, at 481). In addition, North American newts may act as superspreaders of *Bsal* by greatly increasing *Bsal* transmission due to their large, vagile populations and high levels of infection (Yap et al. 2015, at 482). Given the high likelihood of *Bsal* introduction into and spread throughout the country and the virus's high level of virulence to salamanders, *Bsal* should be considered a significant risk to the survival of all salamander species in the United States. This risk furthers the need to protect already rare salamanders, such as the Salamander under the Endangered Species Act.

Southern Appalachia is home to more species of plethodontids than anywhere else in the world, and the Hickory Nut Gorge green salamander is one of the most vulnerable plethodontids to *Bsal* (Soto, McKee, and Newman 2021, at 7). In a 2019 publication on the green salamander (*A. Aeneus*), the Service found that *Bsal* could greatly reduce the salamander's long-term viability (USFWS 2019, entire). Green salamanders, including the Salamander, are in the family Plethodontidae, one of the most *Bsal*-susceptible families of salamander (Martel et al. 2014, entire). Published predictive models of *Bsal* host vulnerability in North America identified the southern Appalachian Mountains as a zone of high risk (Yap et al. 2015, at 481–82; Richgels et al. 2016, at 4–8).

An ongoing study by the University of Tennessee Institute of Agriculture *Bsal* Project found the green salamander to be susceptible, developing clinical *Bsal* chytridiomycosis and mortality (Piovia-Scott et al. 2019, entire). Miller and Gray at the Amphibian and Disease Laboratory at the University of Tennessee conducted clinical trials with multiple species and genera with *Bsal* susceptibility. Results indicate that green salamanders have a fairly high risk of mortality from

Bsal, while other plethodontids were able to live with infection or rid themselves of it (Miller and Gray unpublished data 2022). Further, green salamanders changed their behavior with *Bsal* infection, remaining exposed and out of cover rather than seeking shelter.

2. Predation

Predators of the Salamander are likely similar to those of the green salamander (*A. aeneus*). Predators of the green salamander include snakes that are small enough to get into crevices of trees and rocks, such as ringneck snakes, common garter snakes, and young black rat snakes (Williams 2022; Brodman 2004, at 4; AmphibiaWeb 2020, at 5; Cline undated, at 3). Spiders also prey on green salamanders (John 2016, entire). Slugs may eat the Hickory Nut Gorge green salamander's eggs, but presumably the female salamander would guard them from potential predators (Wilson pers. comm. 2020; Beane et al. 2018, at 2).

D. Inadequacy of existing regulatory mechanisms

Existing federal, state, and local regulatory mechanisms are inadequate to protect against threats to the Hickory Nut Gorge green salamander, which include habitat destruction, degradation, and fragmentation; overutilization; disease; road mortality; pollution; severe weather; catastrophic events; and climate change. These existing mechanisms have not slowed or prevented the decline of the species from the individual and combined impact of these ongoing threats.

1. State Regulatory Mechanisms

The North Carolina Wildlife Resources Commission (NCWRC) lists the Hickory Nut Gorge green salamander as endangered, which prohibits unpermitted direct take, but fails to provide any protections for the salamander's habitat. 15A N.C. Admin. Code 10I.0102, 10I.0103(b)(1)(B); N.C. Gen. Stat. §§ 113-331, *et seq.* In 2020, the NCWRC added the Salamander to the 2015 Wildlife Action Plan via addendum, specifically adding it to the "Species of Greatest Conservation Need" list, the "Knowledge Gap Research Priority" list, and the "Management Needs/Concerns" list (NCWRC 2015, entire; NCWRC 2020b, at 3A1-2–3A1-3). NCWRC and local partners have also undertaken important research to better understand the Salamander's range and population status.[7]

Chimney Rock State Park encompasses part of the Salamander's range. While the state park designation protects some of the Salamander's habitat from direct, permanent habitat destruction caused by development, it does not protect the species and its habitat from habitat degradation caused by human recreational activities (Lacey 2022, entire; Chimney Rock State Park Master Plan at 5-6). State mechanisms in North Carolina have been inadequate to protect the Hickory Nut Gorge green salamander from ongoing threats and continued declines.

[7] For example, in fall 2020, NCWRC and partners conducted a focused rock outcrop survey for green salamanders and Hickory Nut Gorge green salamanders, completing the most surveys ever in a single season—194 in the Hickory Nut Gorge in Henderson, Buncombe, and Rutherford counties (NCWRC 2020, at 18–20). 44 surveys (22%) produced at least one Salamander, with six new sites discovered (NCWRC 2020, at 20).

2. Federal Regulatory Mechanisms

The Hickory Nut Gorge green salamander does not occur on any land protected under federal laws such as the National Park Service Organic Act (54 U.S.C. § 100101 *et seq.*), Wilderness Act (16 U.S.C. §§ 1131 *et seq.*), the National Wildlife Refuge System Improvement Act (16 U.S.C. §§ 668dd), or National Forest Management Act (16 U.S.C. §§ 1600 *et seq.*) and implementing regulations.

The National Environmental Policy Act, 42 U.S.C. §§ 4321 *et seq.*, and federal regulatory mechanisms are inadequate to protect the Hickory Nut Gorge green salamander from extinction. NEPA requires federal agencies to analyze the effects of their actions on the environment through environmental assessments and environmental impact statements. These analyses include adverse impacts to rare and imperiled species and habitats, and potential alternative actions that may be less adverse. However, NEPA ultimately contains no substantive requirements that would require federal agencies to choose less adverse alternatives, and in most cases, development that destroys the salamander's habitat is not subject to NEPA because of a lack of a federal nexus. Accordingly, NEPA does not guarantee that the Salamander or its habitat will be protected from adverse federal actions.

U.S. policy is also inadequate to protect the Hickory Nut Gorge green salamander from threats stemming from climate change. Specifically, U.S. climate policy is inadequate to meet the international Paris Agreement 1.5°C climate limit and avoid the worst damages of the climate crisis. The U.S. is the world's largest cumulative emitter of greenhouse gas pollution, responsible for 25% of cumulative global CO2 emissions since 1870 (Global Carbon Project 2021, at 85), and is currently the world's second highest emitter on an annual basis and highest emitter on a per capita basis (Global Carbon Project 2021, at 19–20). Estimates of an equitable U.S. "fair share" of emissions reductions needed to meet a 1.5°C climate limit require cutting U.S. domestic emissions by at least 70% below 2005 levels by 2030 and reaching near zero emissions by 2040, paired with financial and technological support for largescale emissions reductions internationally (Mutitt and Sivan, entire; U.S. Climate Action Network 2020, entire; ActionAid USA et al. 2021, entire). However, the United Nations Emissions Gap Report and the Climate Action Tracker consortium warned that U.S. policy is significantly off-track to limit warming to 1.5°C or even 2°C and must greatly accelerate greenhouse gas emissions reductions (Climate Action Tracker 2021, entire; UNEP 2021, at 15).

As summarized by the Fourth National Climate Assessment, U.S. efforts to mitigate greenhouse gas emissions do not approach the scale needed to avoid "substantial damages to the U.S. economy, environment, and human health and well-being over the coming decades":

> Climate-related risks will continue to grow without additional action. Decisions made today determine risk exposure for current and future generations and will either broaden or limit options to reduce the negative consequences of climate change. While Americans are responding in ways that can bolster resilience and improve livelihoods, neither global efforts to mitigate the causes of climate change nor regional efforts to adapt to the impacts currently approach the scales needed to avoid substantial damages to the U.S. economy, environment, and human health and well-being over the coming decades (USGCRP 2018, at 34).

Importantly, to meet a 1.5°C limit, most U.S. and global fossil fuels must remain undeveloped, including an immediate halt to new fossil fuel production and infrastructure, paired with a phase-out of existing production and infrastructure within the next several decades (IPCC 2018, entire; Oil Change International 2019, entire).

U.S. policies that promote fossil fuel production and infrastructure include enabling fracking by exempting it from the Safe Drinking Water Act, lifting the crude oil export ban, and providing billions in government subsidies to the fossil fuel industry (Erickson et al. 2017, entire; Oil Change International and Greenpeace 2020, entire; SEI, IISD, ODI, E3G and UNEP 2021, at 39). For example, after Congress lifted the 40-year-old crude oil export ban in December 2015, U.S. crude oil exports increased by 750% so that by 2019, one quarter of all U.S. oil production was exported (Oil Change International and Greenpeace 2020, entire). Exports today continue to average more than three million barrels per day (U.S. Energy Information Administration, 2022, entire).

In January 2021, President Biden issued a "whole of government" directive ordering every federal agency to "deploy [their] full capacity" to combat the climate crisis in their decision-making as a matter of both foreign policy and national security," noting the "narrow moment" to take action on the "profound climate crisis" (White House 2021, entire). The President immediately paused oil and gas leasing on federal lands and launched a review of the fossil fuel leasing and permitting program (White House 2021, entire). The administration also announced the goal of reaching net-zero emissions in the electricity sector by 2035 and recognized the need to "secur[e] environmental justice" (White House 2021, entire).

However, in practice, President Biden is failing to take the necessarily ambitious actions needed to combat the climate crisis, and his administration is instead promoting fossil fuel production that undercuts his plans to deploy renewable energy and secure environmental justice. In his first year in office, President Biden approved more oil and gas drilling permits on public lands than President Trump, approving about 3,700 drilling permits through November 2021, 35% more than the Trump administration approved in its first year in office (Public Citizen 2021, entire). The Biden administration is supporting additional coal mining on public lands and drilling projects in the vulnerable Arctic, including offshore drilling in Cook Inlet and onshore drilling in the Western Arctic Reserve. Additionally, while President Biden canceled the Keystone XL oil pipeline from Canada, he continues to support the buildout of fossil fuel infrastructure, including the controversial Line 3, Dakota Access, and Mountain Valley Pipelines, and multiple liquefied gas export terminals (Civil Society Equity Review 2021, at 54–55); Global Witness 2021, entire).

In November 2021 President Biden scheduled an oil and gas lease sale across 80 million acres of the Gulf of Mexico and auctioned the right to drill offshore on 1.7 million acres, locking in more dangerous drilling—and carbon emissions—for decades (BOEM 2021, entire). The Biden administration also planned to offer 734,000 acres of public lands for oil and gas leasing, with the fossil fuels in these leases containing up to 246 million tons of climate pollution—as much pollution as 62 coal-fired power plants emit in one year (Center for Biological Diversity et al. 2021, entire). Further, the administration's delayed final report on the federal oil and gas leasing program was a meager 12 pages long, failed to address the possibility of ceasing new leasing, and instead offered recommendations to raise royalty rates for onshore and offshore leasing—actions that will have no impact on fossil fuel production whatsoever (U.S. Department of the Interior 2021, entire).

Rising gas prices associated with the Russia-Ukraine War may also spur increased domestic oil and gas production in the United States. In response to Russia's unjustified invasion of Ukraine on February 24, 2022, and ongoing attacks, the United States banned importation of Russia's fossil fuels (Al Jazeera 2022, entire; White House 2022, entire). Executive Order number 14066 prohibits, among other things, "the importation into the United States of the following products of Russian Federation origin: crude oil; petroleum; petroleum fuels, oils, and products of their distillation; liquefied natural gas; coal; and coal products." 87 Fed. Reg. 13,625 (Mar. 8, 2022). Although the Biden Administration has emphasized the need to gain energy independence through a transition to clean, renewable energy, President Biden recently committed to do "everything in his power" to maintain access to oil and gas while the importation ban is in place, "including through greater U.S. domestic production that is expected to hit record highs next year" (White House 2022, entire).

Greater U.S. domestic production of oil and gas, facilitated through various domestic policies, will contribute greenhouse gas emissions that undercut efforts to meet the international Paris Agreement 1.5°C climate limit and avoid the worst damages of the climate crisis.

3. International Regulatory Mechanisms

The Convention on International Trade in Endangered Species (CITES) has been ineffective at curbing the significant, direct threat of poaching for the Hickory Nut Gorge green salamander. CITES is an international agreement between governments aimed at ensuring the international trade in wildlife and plants does not threaten the survival of species through trade monitoring and regulation (CITES Secretariat, undated, entire). The Salamander is not currently listed under the CITES appendices and therefore does not receive any protection. CITES also does not address domestic poaching and trafficking, or other threats such as habitat destruction and degradation that threatens the species.

E. Other Natural or Manmade Factors Affecting its Continued Existence

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1. Climate Change

The Salamander is highly vulnerable to climate change (NCWRC 2015 at 728). Barrett et al. modeled the climate change vulnerabilities of 21 high-priority amphibian species in the southeastern U.S. and forecasted that the green salamander could lose 93% of its climatically suitable habitat by 2050 compared to 2011 (Barrett et al. 2014, at 287). Regions in the Appalachian Mountains are projected to experience particularly high losses of climatically suitable habitat (Barrett et al. 2014, at 290–292). Because the Salamander is a higher altitude microhabitat specialist, it is particularly vulnerable to climate change effects on its habitat because it has few alternative options available for migration (Böhm et al. 2016, at 3–4). Its vulnerability is compounded by its low dispersal (Böhm et al. 2016, at 4–5).

Amphibians like the Salamander are highly sensitive to climate change in myriad ways (Corn 2005, entire; Blaustein et al. 2010, entire; Li et al. 2013, entire; Tuberville et al 2015, entire). As ectothermic animals, all aspects of their life history are strongly influenced by the external environment, particularly temperature and moisture (Carey and Alexander 2003, at 113). In northwestern North America, for example, amphibians and reptiles were ranked as the most sensitive group to climate change out of 195 plant and animal species assessed (Case et al. 2015, entire; Wiens 2016, at 10). In fact, geological evidence points towards historical shifts in climate having detrimental effects on ectotherm biodiversity as these species are unable to shift into new niches as quickly as endotherms (Rolland et al. 2018, entire). Amphibians were also determined to be vulnerable to climate change due to their physiological sensitivity (e.g., highly water-permeable skin) (Blaustein et al. 2010, at 287).

Climate change is expected to affect amphibians at the individual and population levels through a number of pathways including shifts in phenology and range; habitat alterations including changes in hydrology, vegetation, and soil; changes in pathogen-host dynamics, predator-prey relationships and competitive interactions which can alter community structure; and interactions with other stressors such as UV-B radiation and contaminants, all of which can affect survival, growth, reproduction and dispersal capabilities (Corn 2005, entire; Blaustein et al. 2010, entire; Li et al. 2013, at 149; Wright et al. 2015, entire; Ficetola 2016, entire).

For amphibians, water availability is a key resource that affects survival, reproduction, activity levels, and dispersal, while temperature can affect timing of breeding, hibernation, and the ability to find food (Corn 2005, at 61; Blaustein et al. 2010, at 286–294; Lawler et al. 2010, at 39; Tuberville et al 2015, at *4; Amburgey et al. 2018, entire). Climate change is driving greater variability in precipitation, increasing the frequency of extreme weather events and increasing surface water temperatures (Melillo et al. 2014, at 7–13, 32–44; Cayuela et al. 2016, entire; Clark et al. 2016, entire). As a result, climate changes-related changes in hydrological regimes (i.e., alterations in stream flow, lake depth, amount and duration and winter snowpack, pond hydroperiods, soil moisture, drought) and warming temperatures are predicted to have largely negative effects on amphibian breeding success and survival, dispersal, and habitat suitability (Blaustein et al. 2010, at 285–289; Walls et al. 2013, entire; Barrett et al. 2014, entire).

Numerous studies have documented climate-associated shifts in amphibian phenology, range, and pathogen-host interactions (Corn 2005, entire; Blaustein et al. 2010, at 285–290, 294–295; Li et al. 2013, entire; Campos-Cerqueria and Aide 2017, entire; Struecker and Milanovich 2017, entire) with emerging evidence for climate change-related declines (i.e., Lowe 2012, entire; Hossack et al. 2013, entire; Rohr and Palmer 2013, entire). Li et al. (2013) reported the results of 14 long-term studies of the effects of climate change on amphibian timing of breeding in the temperate zone of the US and Europe (entire). This meta-analysis indicated that more than half of studied populations (28 of 44 populations of 31 species) showed earlier breeding dates, while 13 showed no change, and 3 populations showed later breeding dates, where spring-breeding species tended to breed earlier and autumn-breeding species tended to breed later (Li et al. 2013, at 148). Several studies indicate that shifts in timing of breeding can have fitness and population-level consequences (Li et al. 2013, at 149; Chandler et al. 2016, entire). For example, amphibians that emerge earlier in the spring can be vulnerable to winter freeze events or desiccation if they arrive at breeding sites prior to spring rains (Li et al. 2013, at 149).

Climate-associated shifts in amphibian ranges can be particularly problematic for restricted range and high-elevation species, particularly salamanders, that have specific habitat requirements and limited options for movement (Li et al. 2013, at 149; Milanovich 2010, entire; Sutton et al. 2015, at 3; Jacobsen et al. 2020, entire). As greenhouse gas emissions continue to grow, studies project high turnover of amphibian species as habitats become climatically unsuitable. For example, Lawler et al. (2010) projected 50% or greater climate-induced turnover of amphibian species in many regions of the U.S. by the later part of the century (Lawler et al. 2010, at Figure 3). Sutton et al. (2015) predicted that 14 out of 24 northeastern salamander species would lose at least 50%

of their climatic niche by the year 2050, with 4 species losing at least 97% (Sutton et al. 2015, at 19, 21).

Climate change has also been implicated in stimulating the emergence of infectious amphibian diseases at the local and global scale. Increases in climate variability and extreme weather events resulting from climate change appear to provide an advantage to pathogens, such as chytridiomycosis (chytrid fungus), which is driving amphibian declines worldwide (Kupferberg 2009, entire; Rohr and Raffel 2010, entire; Li et al. 2013, entire; Raffel et al. 2013, entire; Campos-Cerqueria and Aide 2017, entire). Raffel et al. (2013) found a causal link between increased temperature variability and chytrid-induced mortality in frogs, which in the context of other studies linking chytrid outbreaks to temperature shifts, provides compelling evidence for a climate-change role in amphibian mortality from chytrid fungus (Raffel et al. 2013, entire). Several recent studies indicate a role of climate change in amphibian population declines, in combination with other stressors (i.e., Lowe 2012, entire; Li et al. 2013, at 156; Rohr and Palmer 2013, entire; Campos-Cerqueria and Aide 2017, entire).

The Hickory Nut Gorge is part of a unique climate phenomenon: the thermal belt of western North Carolina and upstate South Carolina. Because of its location on the leeward and south-facing side of the Blue Ridge Mountains, this region naturally experiences warmer and drier temperatures (Polk County Cooperative Extension, 2013). Climate change could exacerbate these warmer and drier conditions.

2. Road Mortality

Road mortality via existing and future roads built to support ongoing population growth and development in Hickory Nut Gorge threaten the Salamander. Road mortality has been documented in the closely related green salamander from individuals crossing roads during the post-hibernation migration from their hibernation crevices (Cupp 1991 at 173). Road mortality is also a widely documented threat for amphibians including salamanders (Marsh et al. 2005, entire; Andrews et al. 2006, at 17–40; Andrews et al. 2008, entire; Beebee 2013, entire; Hobbs 2013, entire; Clipp and Anderson 2014, at 2690). In a study of salamanders in the Nantahala National Forest, North Carolina, Semlitsch et al. (2006) found the presence of roads have a negative effect on forest-dependent salamander species. Their results showed that that the effect of roads reached well beyond their boundary, and that abandonment or the decommissioning of roads did not reverse detrimental ecological effects; rather, their results indicated that management decisions have significant repercussions for generations to come (Semlitsch et al. 2006, entire). Road mortality may be particularly detrimental to populations of species with slow reproductive rates like the Salamander (Andrews et al. 2006, at 21). Many new roads for second home developments are being built in the Hickory Nut Gorge in or near habitat for the Hickory Nut Gorge green salamander (Blue Ridge Forever, 2020).

3. Pollution

Acid precipitation may represent a serious threat to the Salamander (Beane et al. 2018, at 1). In the 1980s, green salamander populations plummeted dramatically, possibly due in part to acid precipitation (Snyder 1991, at 167–168; Beane et al. 2018, at 1). Amphibians like the Salamander are particularly sensitive to direct and indirect effects of acid precipitation because adults are high in the food chain and amphibian skin is highly permeable to toxic substances (Pierce 1993, at 66). Embryos and larvae are also particularly sensitive to developmental effects from acid precipitation (Pough 1976, entire; Pierce 1993, at 67–73). Salamanders appear to be vulnerable to declines and mortality from the effects of acid precipitation (Pough 1976, entire; Harte and Hoffman 1989; entire; Pierce 1993, at 71–72; Pough and Wilson 1997, entire; Green and Peloquin 2008, entire).

The Salamander is also vulnerable to pollution from roads including heavy metal contamination from tires, gasoline, motor oil, and subsequent residues; de-icing products; vehicle emissions; and roadside herbicide applications (Andrews et al. 2006, at 13, 49–51). High skin permeability exacerbates the susceptibility of amphibians in particular to the alteration of microhabitat conditions on roads and in adjacent habitats (Andrews et al. 2006, at 13). Toxic chemicals emitted from vehicles and compounds used during road maintenance may act as endocrine disruptors in amphibians, reducing reproductive abilities and survivorship (Andrews et al. 2006, at 13; e.g., Lodé 2000, entire; Hayes et al. 2006, entire; Rohr et al. 2006, entire).

4. Severe Weather

The Salamander may also be threatened by severe weather events, especially drought and cold (Snyder 1991, at 168). Amphibians like the Salamander are particularly vulnerable to changes in temperature and precipitation. Snyder (1991) posits that the late 1970s—early 1980s population crash of green salamanders in the Blue Ridge escarpment may have been caused by instances of drought or by periods of unusually low winter temperatures that persisted for unusually long periods of time (Snyder 1991, at 168). The effects of these population crashes have persisted for decades, and green salamander populations have never fully recovered (Apodaca pers. comm.). If drought periods were prolonged enough, they could have eliminated any refuge microhabitats where water loss was a manageable problem (Snyder 1991, at 168). The unusually cold conditions could have "caught" many of the hibernating green salamanders in a torpid condition that prevented them from rousing to move into deeper and warmer recesses of their hibernacula, causing them to freeze (Snyder 1991, at 168). As explained above, climate change may increase the incidence of severe weather episodes, creating synergistic negative effects on the Salamander.

5. Catastrophic Events

The Salamander is threatened by catastrophic events such as fires, rockslides, and landslides, which can kill large numbers of Salamanders and destroy habitat. Human-caused fires can kill individual Salamanders or entire populations, depending on the size of the fire. They can also destroy and degrade critical canopy habitat for the Salamander. Indeed, hemlock forests generally are not considered to be fire adapted (NCDENR 2011, at 3–34). Although there is a natural fire cycle in the Blue Ridge Mountains (Lafon et al. 2017, entire), a history of unnatural fire suppression has created reserves of unburned fuel that cause fires to spread faster and burn hotter and longer (Gavazzi and McNulty 2013, at 26; NCPFC undated, at *2). Catastrophic fires have occurred in the Hickory Nut Gorge. For instance, in 2016, the Party Rock Fire burned more than 7,000 acres in and around Lake Lure, Chimney Rock, and Bat Cave (WLOS Staff 2017, entire). This fire caused significant HNG mortality and permanently altered the habitat. Shaded rock outcrops that previously were home to HNG salamanders have become exposed outcrops inhabited by snakes and other xeric-tolerant species (NCWRC, pers. comm).

The Hickory Nut Gorge has also experienced massive rockslides and landslides, including in 1994, 1996, 2008, 2012, and 2014 (Frankel 2014, entire; Chávez 2017, entire; Wooten 2017, at 365). The gorge's walls have been subject to many Quaternary landslides (Wooten 2017, at 364–65). Rockslides and landslides can instantaneously destroy the limited number of rock outcrops inhabited by the Salamander (Apodaca pers. comm. 2020).

6. Inherent Vulnerability of Habitat Specialists

The Salamander is a habitat and microhabitat specialist, which makes it particularly vulnerable to habitat loss and fragmentation (Patton et al. 2019, at 749). Because rock outcrops are generally poorly represented in the landscape, Salamander populations are highly susceptible to activities that destroy or degrade these rock outcrops and the surrounding forest (Kingsbury and Gibbons 2012, at 31, 99).

In addition, their tendency to restrict themselves to areas of rock outcrops may lead to breeding populations being patchily distributed (Patton et al. 2019, at 749). Specialization is understood to contribute strongly to species extinction risk (Colles et al. 2009, at 849). Females return to their preferred breeding sites, presumably because there are limited options for alternate locations (Apodaca pers. comm. 2020). Their reliance on past sites is complicated by the fact that woody habitat supporting reproduction is unreliable and the conditions of outcrop crevices can change due to factors such as sediments filling crevices and shading (Apodaca pers. comm. 2020). Range-restricted specialists with low vagility like the Salamander are particularly vulnerable to habitat fragmentation (Corser 2001, at 124; Henle et al. 2004, at 222, 227–231; Charrette et al. 2006, entire; Crooks et al. 2017, at 7636).

Accelerating development and road construction in the Hickory Nut Gorge is already leading to increased fragmentation of the Salamander's habitat. Migration will become even more difficult and could lead to increased road mortality (Cushman 2006).

To the extent the Salamander is able to migrate to nearby suitable habitat, it may experience interspecific aggression as available habitat becomes increasingly limited. Male green salamanders are territorial and will exhibit aggressive behavior when a male is introduced into an area already inhabited by another male (Cupp 1980, entire).

7. Inherent Vulnerability of Small Isolated Populations

The Salamander is also more vulnerable to extinction because of its small populations, small number of populations, and extremely small geographic distribution, which undermine its overall viability (Patton et al. 2019, at 758, 759; NCWRC 2015, at 406–407). Generally, species with smaller or fewer populations are more likely to become extinct (Shaffer and Stein 2000, at 307; Wolf et al. 2015, at 5). For a species to be viable, it should have stable population sizes and growth rates (resiliency), a number of resilient populations over a broad geographic range (redundancy), and diverse populations of adequate size (representation) (USFWS 2016, at 6). The Salamander is found across approximately 3,625 ha (35 square miles) in fewer than 25 known localities with small populations (Patton et al. 2019, at 758, 759). This small number of small populations over a small range represents low resiliency, redundancy, and representation, which in turn makes the Salamander more vulnerable to extinction (Shaffer and Stein 2000, at 307; Wolf et al. 2015, at 5). For instance, because of its small range and clumped distribution, the Salamander is more susceptible to stochastic or genetic population declines or local extirpations (NCWRC 2015, at 452).

The Hickory Nut Gorge salamander is also experiencing a high level of inbreeding, which can have detrimental effects on populations, including a decrease in fecundity that leads to lower population sizes and increased inbreeding, a feedback cycle referred to as “the extinction vortex” (Patton et al. 2019, at 759; Blomqvist et al. 2010, entire).

VI. REQUEST FOR CRITICAL HABITAT

Petitioners request the designation of critical habitat for the Salamander concurrent with final listing. Critical habitat designation would provide significant conservation benefits to the Salamander, which faces significant threats to its limited remaining habitat (Patton et al. 2019, at 759). Such designation should not only protect existing, known habitat areas but also currently unoccupied areas that could be important for facilitating habitat movement for the Salamander in response to development and climate change (Patton et al. 2019, at 759). Deliberate repopulation or reintroduction of species into areas may also help restore species' viability (Seddon et al. 2014, entire).

Critical habitat should include all 20,000 acres of the 14-mile Hickory Nut Gorge, including rock outcrops and surrounding canopy cover (Patton et al. 2019, entire; Waldron and Humphries 2005, entire). Protection of this entire area is necessary to protect the remaining, unfragmented physical and biological features essential to the conservation of the salamander. To the extent portions of this area are not currently occupied by the Salamander, these areas are essential to the conservation of the species because they provide necessary habitat connectivity for migration and areas for facilitating habitat movement for the salamander in response to development.

A. A finding of "not determinable" will not be defensible

The Service must publish a final listing decision within one year of publishing the proposed listing decision. 16 U.S.C. § 1533(b)(5)(A), (b)(6)(A). When the final listing decision is issued, the Service must designate critical habitat for the species concurrently "to the maximum extent prudent and determinable." *Id.* § 1533(a)(3). A "not determinable" finding allows the Service to extend the time for designating critical habitat under the ESA. *Id.* § 1533(b)(6)(C)(ii); 50 C.F.R. § 424.17(b) (If critical habitat is not determinable, the Service "may extend the 1-year period specified in paragraph (a) of this section by not more than one additional year."). This means that when critical habitat is "not determinable," the Service has one year from the date of the final listing decision (i.e., two years from the proposed listing decision) to designate critical habitat. At or before the end of the one- year extension, "the Secretary *must* publish a final regulation, based on *such data as may be available at that time*." 16 U.S.C. § 1533(b)(6)(C)(ii) (emphasis added).

That final deadline applies even if a longer deliberative process might produce a "better" critical habitat designation. *See Enos v. Marsh*, 616 F. Supp. 32, 61 (D. Haw. 1984), *aff'd*, 769 F.2d 1363 (9th Cir. 1985); *N. Spotted Owl v. Lujan*, 758 F. Supp. 621, 625–26 (W.D. Wash. 1991) ("In no event may the secretary delay the designation of critical habitat for more than twelve months . . . "); *Colo. Wildlife Federation v. Turner*, Civ. No. 92-F-884, 1992 U.S. Dist. LEXIS 22046, at *13–14 (D. Colo. Oct. 27, 1992); *see also Ctr. for Biological Diversity v. Evans*, No. C 04-04496 WHA, 2005 WL 1514102 (N.D. Cal. June 14, 2005) ("Congress did not contemplate paralysis while critical habitat issues were studied to death."). Indeed, "not determinable" findings should rarely be made. It is expected that the Service will make "the strongest attempt possible to determine critical habitat within the time period designated for listing." H.R. Rep. No. 97-597 (1982), reprinted in 1982 U.S.C.C.A.N. 2807, 2819–2820 (emphasis added); *see also*

N. Spotted Owl, 758 F. Supp. at 625. The Service is to use the best available science in determining critical habitat. That "optimal conditions" are unknown is not a barrier to designating. Similarly, it is not the Service's task to understand what data about features of occupied habitat are currently lacking. Instead, the Service should synthesize information about what is known about the species and its habitat needs.

B. A finding of "not prudent" will not be defensible

The best available science regarding the Salamander's status and threats demonstrates that designating critical habitat will help the species survive and recover in the face of significant habitat loss and degradation. The designation and protection of critical habitat is one of the primary ways to achieve the fundamental purpose of the ESA: "to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved." 16 U.S.C. § 1531(b). Critical habitat includes areas occupied by the species that have "physical and biological features . . . essential to the conservation of the species" that require special management, as well as areas that are unoccupied by the species but nonetheless "essential for the conservation of the species." *Id.* § 1532(5). Areas of critical habitat receive protection through Section 7 of the ESA, which prohibits federal agencies from destroying or adversely modifying them. *Id.* § 1536(a)(2). This is in addition to prohibitions against "taking" species or jeopardizing their existence. *Id.* §§ 1539; 1536(a)(2). As explained in the foregoing, habitat loss and fragmentation are significant threats to the Salamander. For these reasons, protecting its remaining habitat in the Hickory Nut Gorge is essential to its conservation.

Moreover, the threat from collection does not justify a "not prudent" finding. Although the Service "*may* . . . determine that a designation would not be prudent" where a species "is threatened by taking or other human activity and identification of critical habitat can be expected to increase the degree of such threat," 50 C.F.R. § 424.12(a)(1), such is not the case for the salamander. Due to the Salamander's limited range, its location is already evident to potential poachers (Wilson pers. comm. 2020), and poachers may already be collecting them from their relatively small range (Wilson pers. comm. 2020). Although exact location data were not published, descriptions of the species' habitat and range are publicly available in published scientific literature (Patton et al. 2019 at 753–55, 757). Poachers often use scientific literature to target species for collection (Stuart et al. 2006, entire; Lindenmayer and Scheele 2017, entire; Esmail et al. 2020, at 5). Consequently, designation of critical habitat cannot be expected to increase the degree of threat from collection. Moreover, any potential concern about collection is substantially outweighed by the benefits critical habitat will provide for the species, which faces imminent habitat loss and destruction from development and other threats.

VII. CONCLUSION

Chris Wilson

The Salamander merits listing as an endangered, or alternatively as a threatened, species under the ESA. The species is declining throughout its entire range, or at least throughout a significant portion of its range, and continue to face overwhelming threats from rapid habitat destruction from development, deforestation, and road construction; widespread loss of hemlock forest habitat; overutilization and harvest in the pet trade; expanding recreational impacts; three fungal disease pandemics; increased road mortality and pollution from development; increased acid deposition; increased predation due to habitat disturbance and alteration; inbreeding and isolation; and the compounding effects of climate change.

The Salamander currently receives inadequate regulatory protections throughout its range and requires ESA listing to ensure its survival. Without adequate protection, the Hickory Nut Gorge green salamander will become extinct because of the combined threats to the species. Therefore, Petitioners request that Service list the salamander throughout its range as an endangered, or alternatively as a threatened, species under the ESA. If the Service determines that certain populations of the species qualify as DPSs, but that the species does not qualify as endangered or threatened throughout all or a significant portion of its range, then the Petitioners request that Service list those DPSs as either endangered, or alternatively as threatened, DPSs under the ESA. Should the Service list the Salamander, Petitioners request that Service concurrently designate critical habitat for the species in Hickory Nut Gorge as required by law.

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