Mountain sweet pitcher plant
(*Sarracenia rubra* ssp. *jonesii*)

5-Year Review:
Summary and Evaluation

U.S. Fish and Wildlife Service
Southeast Region
Asheville Ecological Services Field Office
Asheville, North Carolina

5-YEAR REVIEW
Mountain sweet pitcher plant (*Sarracenia rubra* ssp. *jonesii*)

LIST OF ABBREVIATIONS

AFO	Asheville Field Office, U.S. Fish and Wildlife Service
EOR	Element Occurrence Record (a mapping unit commonly used by Natural Heritage Programs)
ES	Ecological Services
ESA	Endangered Species Act
FR	Federal Register
NCNHP	North Carolina Natural Heritage Program
SCDNR	South Carolina Department of Natural Resources
USFWS	U.S. Fish and Wildlife Service

5-YEAR REVIEW
Mountain sweet pitcher plant /*Sarracenia rubra* ssp. *jonesii*

1.0 GENERAL INFORMATION

1.1 Reviewers

Lead Region:
Southeast Region, Erin Rivenbark (assisting in recovery), 706/613-9493 ext. 234; Kelly Bibb 404/679-7132

Lead Field Office:
Asheville Ecological Services Field Office, Asheville, North Carolina, Carolyn Wells (originating author; moved to a new office and position), Mara Alexander (new lead) 828/258-3939, ext. 238

Cooperating Field Office(s):
Charleston Ecological Services Field Office, Charleston, South Carolina, Morgan Wolf, 843/727-4707 ext. 219

1.2 Methodology used to complete the review:

Public notice of the initiation of this 5-year review was given in the *Federal Register* on July 6, 2009 (74 FR 31972) and a 60 day comment period was opened. During the comment period, we did not receive any additional information about *Sarracenia rubra* ssp. *jonesii* other than responses to specific requests for information from biologists familiar with the species (see Appendix A for a summary of peer review of this document). Information used in this report was gathered from published and unpublished reports. Records were provided by North Carolina Natural Heritage Program (NCNHP) and South Carolina Department of Natural Resources (SCDNR) Heritage Trust offices. The review was completed by the lead recovery biologist for the species in Asheville, North Carolina.

1.3 Background:

1.3.1 Federal Register Notice citation announcing initiation of this review:
July 6, 2009 (74 FR 31972)

1.3.2 Species status:
Declining. Of the extant populations, only three appear to be stable. The remaining populations have shown a decline based on monitoring.

1.3.3 Recovery achieved:
1 (1 = 0-25 percent of species' recovery objectives achieved).

1.3.4 Listing history

Original Listing
FR notice: 53 FR 38470
Date listed: October 31, 1988
Entity listed: species
Classification: endangered

1.3.5 Associated rulemakings: n/a

1.3.6 Review History:
Recovery Plan: 1990
Recovery Data Call: 2012-1998
The Service conducted a five-year review for the pitcher plant in 1991 (56 FR 56882). In this review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notice stated that the Service was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the Service would propose a rule to modify the species' status. No change in the plant's listing classification was found to be appropriate.

1.3.7 Species' Recovery Priority Number at start of 5-year review (48 FR 43098): 5C (reflects a high degree of threat and low recovery potential)

1.3.8 Recovery Plan

Name of plan:
Recovery Plan for mountain sweet pitcher plant (*Sarracenia rubra* ssp. *jonesii* [Wherry] Wherry)
Date issued: August 13, 1990

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) policy
The Endangered Species Act (ESA) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife that interbreeds when mature. This definition limits listing a DPS to only vertebrate species of fish and wildlife. Because the species under review is a plant, the DPS policy does not apply.

2.2 Recovery Criteria

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes, the species has a final, approved recovery plan. However, the criteria (which were put forth as interim criteria due to a lack of information on the species' life history and the relative importance of identified threats) are subjective and could not be objectively measured.

2.2.2 Adequacy of recovery criteria.

2.2.2.1 Do the recovery criteria reflect the best available and most up-to date information on the biology of the species and its habitat? Yes.

2.2.2.2 Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria (and is there no new information to consider regarding existing or new threats)?

Yes. The recovery criteria could not be met without adequately addressing the applicable listing factors. There is no new information to consider regarding existing or new threats, although threats such as accelerated climate change are expected to exacerbate previously identified threats.

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

The recovery plan contains two de-listing criteria, but no criteria for reclassifying the species from endangered to threatened status. The de-listing criteria are as follows:

Criterion 1: It has been documented that at least four populations within each drainage (Enoree, French Broad, and Saluda Rivers) are self-sustaining and that necessary management actions have been undertaken by the landowners or cooperating agencies to ensure their continued survival.

Not met. None of the three drainages (Saluda, Keowee, and French Broad) contain even a single population that can be objectively assessed as self-sustaining, although some populations in the Saluda and French Broad drainages are receiving varied levels of management.

Criterion 2: …All 12 of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.

Not met. However, inasmuch as self-sustaining populations cannot be ensured unless the species has been protected from threats (both present and foreseeable), this criterion is not substantively different from the first and will not be discussed further here.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 Abundance, population trends

The North Carolina Department of Agriculture's Plant Conservation Program (NCPCP) initiated a range-wide monitoring program for *Sarracenia rubra* ssp. *jonesii* (hereafter *S. jonesii*, see also Section 2.3.1.3) in 1991 (Benjamin 1992, Frost 1991). A substantive portion of this project was funded using USFWS Section 6 funds allocated to the NCPCP via its Cooperative Agreement with the USFWS. This effort spanned the 1991-1999 field seasons, and produced the single most comprehensive summary of the location, spatial extent, abundance, and trends within known (primarily protected) populations; seed collection, propagation and augmentation efforts; site-specific threat assessments; and responses of *S. jonesii* to management. Rob Sutter (formerly with NCPCP and TNC, now with Conservation Outcomes, Inc.) was the principal investigator on this monitoring effort; as such, within this review over-arching statements in reference to this collective, multi-year effort (as opposed to any specific annual report) are indicated by references to Sutter *et al.* This monitoring effort primarily assessed change over time in terms of the number of clumps, pitchers, and/or flowers present. However, the nature of the monitoring effort (in terms of the population parameters recorded and the frequency of data collection) varied among sites, depending upon population size, habitat condition, threat severity, and whether access was granted by the landowner. Although these issues complicate efforts to synthesize data among monitored populations for any given year or parameter, the USFWS has endeavored to synthesize the data reported by Sutter *et al.* for purposes of this five year review, noting caveats where necessary.

Therefore, much of the summary that follows is drawn from the body of reports produced in conjunction with the monitoring effort undertaken by Sutter *et al.* (e.g., Wally 2000, Wally 1999, Rudd and Sutter 1998, Sutter *et al.* 1996, Benjamin 1992, Frost 1991), supplemented by updated information where it exists (e.g., NCNHP *in litt*. 2010; SCDNR *in litt*. 2010; Bunch pers. comm.). In recognition of the heightened susceptibility of carnivorous plants to poaching, and in direct response to concerns expressed by conservation partners who provided peer review for this document, locations are provided only when necessary and generally only by reference to the county or watershed in which particular populations occur.

Abundance: number of known populations

Sarracenia jonesii is presumed extant at a total of 21 site-specific locations, representing a total of 12 populations of the species (NCNHP *in litt*. 2010; SCDNR *in litt*. 2010; Bunch pers. comm. 2010). Because little is known about dispersal distances for either pollen or seed, and population genetic structure remains only coarsely understood, any attempt to delimit populations must employ the use of arbitrary criteria. For purposes of this review, a "population" is herein defined as any grouping of sites located within 2km of each other, provided that they occur within the same drainage or local watershed. Sites located within 2km of each other but occurring within separate drainages have typically been regarded as occurring in separate populations, especially when separated by dispersal barriers such as perennially unsuitable habitat. Of the 12 known populations, five are in South Carolina and seven are in North Carolina. Four of the South Carolina populations each consist of more than one site-specific location that are collectively regarded as part of the same population due to their proximity and occurrence within the same drainage; one South Carolina population and all of the North Carolina populations each consist of a single, spatially discrete location.

Abundance: clumps

Sarracenia jonesii achieves its carnivorous habit by producing modified, inflated leaves ("pitchers") filled with enzymes that extract nitrogen from the exoskeletons of insects which become trapped within the pitcher. An individual *S. jonesii* plant may produce one-to-many pitchers, and one-to-many inflorescences, in a given season. In nature, pitchers tend to occur in discrete clumps (containing one-to-many inflorescences each) that may or may not be connected by an underground rhizome. Estimates of abundance in *S. jonesii* are frequently reported in terms of the number of pitchers, clumps, or both. However, neither of these metrics necessarily represents the number of individuals in the population – the number of pitchers is a metric of vegetative vigor and growth which is likely to greatly exceed the number of individuals (unique genotypes) present in the population. Because clumps which appear spatially discrete above ground may be (or may previously have been) connected through an underground rhizome, the number of clumps is also likely to exceed the number of genotypes within the population. These caveats should be kept in mind throughout the next two sections, and throughout this document.

Rudd and Sutter (1998) provide what they describe as baseline clump counts for seven populations (nine discrete monitoring sites) during the 1991 and 1992 field seasons. These data are described as complete counts of all clumps present, with the exception of two populations where clumps were too dense to census without significant trampling impact. Although a clump was not explicitly defined, as with most plant species it can be assumed to represent a cluster of leaves (pitchers) originating from a common point in the ground. As of this baseline

from the 1991-1992 field seasons, the number of clumps per site ranged from one to 345, with a total of 935 clumps counted across all seven populations. However, this should be regarded as a gross underestimate of the total number of clumps as of that time, since concerns over trampling also deterred these investigators from attempting any estimate of clumps at an eighth population which they described as containing more clumps of *S. jonesii* than any other South Carolina population known.

For the most part, the inventories conducted by Sutter *et al.* in 1991-1992 have never been repeated in a manner that allows direct comparison back to 1991-1992 baseline(s). The population containing the most clumps (n=345) in 1991 has since experienced significant declines, with a mere 5-6 clumps located in a casual survey in 2008 (NCNHP *in litt*. 2010). Another population also appears to have declined from its 1991 baseline of 266 clumps, although additional investigation is necessary to determine the extent of this decline. In 2008, the USFWS was unable to relocate 35 clumps mapped by Sutter et al., and noted significant reductions in the overall spatial extent of a "high density" area that contained clumps too dense to count in 1991 (Wells pers. obsv. 2008). However, in 2010, the USFWS expanded its surveys within this population and found vigorous flowering and abundant pitcher production in other portions not surveyed in recent years, suggesting that additional mapping and comparison back to the baseline established by Sutter *et al.* would be worthwhile to determine the spatial pattern and extent of apparent declines (Wells pers. obsv. 2010). A third population located in Greenville County, South Carolina that was reported to contain 17 clumps in 1991 may now be extirpated. Amazingly, a population in Transylvania County, North Carolina that contained no more than 15 clumps in 1992 (and was assessed as perhaps the most vulnerable during the course of Sutter et al.'s monitoring) appears to have remained somewhat stable, with 11 clumps persisting at this site when last observed in 2006 (NCNHP *in litt*. 2010).

With respect to the remaining three populations the best available and most current abundance estimates (in terms of clumps) remain those provided in Rudd and Sutter (1998), with some supplemental information provided by Wally (2000). Most of these populations were monitored at least once more during the 1991-1999 field seasons; however the data collected and frequency of visitation varies by population. During this monitoring interval, the fewest clumps recorded at any population was 31, and the maximum number of clumps was 472. Comparing the last year of data available for each population to its respective 1991-1992 baseline, two populations exhibited a net decrease and one increased over the 1991-1999 field seasons. There have been no systematic attempts to re-census any of these remaining three populations for purposes of comparison back to 1991-1992 conditions, although casual surveys have been conducted at some sites (NCNHP *in litt*. 2010; SCDNR *in litt*. 2010).

In summary, most attempts to estimate the abundance of *S. jonesii* in terms of clumps occurred over 10 years ago (pre-1999), with most of these attempts

occurring nearly 20 years ago (ca. 1991-1992). These dated, but best available, estimates suggest a total of between 500 to 1,000 clumps distributed across the known populations as of that time period. Given the continued threats to *S. jonesii* and its habitat (discussed throughout this review), updated estimates of abundance are critically needed. Although the same conclusion is generally true for other population parameters (e.g., estimates of the number of pitchers and/or flowers), a brief review of best available information is provided here to convey the nature of existing data and the relative size of known populations.

Abundance: pitchers

Sutter *et al.* counted the number of pitchers within five populations (seven discrete monitoring sites) at various intervals during 1991-1999 (Wally 2000, Rudd and Sutter 1998). Two of the five populations (both in Henderson County, North Carolina) were sampled due to their size; a complete count (census) was taken at the remaining three populations (one located in Henderson County, North Carolina and the other two in Greenville County, South Carolina). With the notable exception of a North Carolina population owned by The Nature Conservancy, there have been no subsequent attempts to directly count or estimate abundance in terms of pitchers at a scale comparable to the monitoring effort conducted by Sutter *et al.* Therefore these data generally represent the most current data on this population parameter.

Although Sutter *et al*. report data for the North Carolina populations in 1991, the most comprehensive baseline (e.g., that which included the most populations) was obtained in 1992. In 1992, these five North Carolina populations each contained more than 1,000 pitchers (the actual number of pitchers per population ranged from 1,044 to 3,034 (Wells *in litt*. 2010; Rudd and Sutter 1998). The total number of pitchers across all five populations was 8,482 that year. Pitcher abundance was last assessed in each of these five populations during the 1997-1999 field seasons, and at various years in between, with the year and frequency of observation varying by population (Wally 2000, Rudd and Sutter 1998). Taking the last available estimate for each of these five populations (obtained at some point during 1997-1999) in aggregate, the total number of pitchers was 6,692. However, this estimate is obviously problematic in that it consists of estimates obtained in different years. A comparison of the last available estimate of pitcher abundance (1997-1999, depending upon the population) to the 1992 baseline reveals that only one population increased during this time period, whereas the other four populations each exhibited decreases in this population parameter. The observed decreases in pitcher abundance ranged from 18% to 73%.

More recent, quantitative estimates of pitcher abundance are only available for one of these five North Carolina populations, at a site owned by The Nature Conservancy. Sutter *et al.* monitored this population annually from 1991 to 1997 within six permanent (5 x 5m) monitoring plots. At the end of that time period (1997), the abundance of pitchers within these plots had declined by over 61%

(from 3,034 to 1,175) from 1992 levels. In 2008, the USFWS began working with TNC to reinstate monitoring at this population in a manner that allows comparisons back to available baseline data (from Sutter *et al*.) while also enabling meaningful evaluation of ongoing management actions at this site. Data as of 2010 have revealed continued declines relative to the baseline, with the abundance of pitchers within these six permanent plots having decreased by 58% relative to 1992 (Donley *in litt.* 2010). However, interpreting these results has proven challenging, because observations in 2010 suggested that the vigor (both vegetative and reproductive) of *S. jonesii* at this site may be greater outside of these plots than within (Wells pers. obsv. 2010). These apparent trends in pitcher abundance are discussed in greater detail below (*Population Trends*, this section).

Sutter *et al.* provide several observations relevant to future estimates of pitcher abundance. Specifically, these investigators found significant correlations between pitcher abundance and clump area, suggesting that area could serve as a (more rapidly assessed) proxy for pitcher plant abundance in certain circumstances (Sutter *et al.* 1996). However, their attempts to correlate area with pitcher abundance were confined to a single field season; thus this relationship warrants further investigation. Wally (2000) stressed the importance of defining "pitchers" as only those leaves which are functionally carnivorous, and thus proposed that only leaves (pitchers) that were either already inflated or appeared likely to inflate during the current growing season be counted as pitchers. Due to her observations of seedling and juvenile mortality, Wally (2000, 1999) also proposed that counts of pitcher abundance either be restricted to pitchers > 20cm tall, or be conducted such that leaves under this height threshold be counted separately. Unfortunately, this criteria was not consistently employed during the 1991-1999 data collection undertaken by Sutter et al., therefore it is not always possible to remove pitchers in the smallest size category (< 20 cm) from earlier estimates of pitcher abundance obtained during the 1991-1998 field seasons.

Abundance: flowers

A single *S. jonesii* plant can produce one-to-many flowers at a time; thus the number of flowers is likely to greatly exceed the number of reproductive individuals. As with many or most flowering plant species in which individual plants are capable of producing more than one flower at a time, flowers may be concentrated among a few robust individuals, or widely dispersed across the population. These scenarios have considerably different implications for genetic diversity among pollen and seeds produced. The number of flowers can also suggest higher rates of seedling recruitment than are actually realized in natural populations. Despite these caveats, Sutter *et al.* provide several observations with regard to flowering rates that are worth briefly discussing here.

Sutter *et al.* counted flowers in the same five populations in which they monitored pitchers, and also counted flowers (but did not count clumps or pitchers) within a significant percentage of a sixth population from 1992-1999. In any given year,

the total number of flowers counted across all six populations ranged from 416 (in 1995, four populations) to 1,157 (in 1996, five populations). For those populations in which the number of clumps was counted alongside of the number of flowers, the percentage of flowering clumps in any given year ranged from five to 87%. Trends in flowering rates are discussed in greater detail below (*Population Trends*, this section).

Sutter *et al.* offer several valuable observations with respect to the collection and interpretation of flowering data in *S. jonesii*. As discussed by Wally (2000), Rudd and Sutter (1998) noted exceptionally high rates of flowering followed by markedly low rates of capsule production, suggesting either pollinator limitation or other problems with seed viability. Wally (2000) also observed exceedingly high rates of seedling and juvenile mortality, illustrating that the assumption that flowering (and even production of seemingly viable capsules/seeds) will result in sustained population increases may not be valid. Sutter *et al.* (1996) observed evidence of an apparent trade-off between vegetative and reproductive growth in at least one population in which pitcher abundance fell markedly in years immediately following abundant rates of flowering. Sutter *et al.* repeatedly observed marked increases in flowering (and pitcher production) following removal of encroaching woody vegetation, a consistent pattern that did not appear to depend upon the population or year in question (Rudd and Sutter 1998, Sutter *et al.* 1996). In at least one instance, flowering was seemingly induced by woody vegetation removal within a population that contained no flowering plants in two prior (but not consecutive) years. Rudd and Sutter (1998) also note that the effects of woody vegetation removal were frequently long-lived, with increases in flowering evident for years following vegetation removal (relative either to control plots within the same population, or other populations in which vegetation had not been removed). These observations factored heavily in the site-specific management recommendations developed in conjunction with this monitoring and management effort.

Seedling recruitment

Rudd and Sutter (1997, 1998) and Wally (2000) specifically looked for, and periodically reported, evidence of seedling recruitment. Only rarely was this evidence conclusive (i.e., as evidenced by the presence of cotyledons): in most cases, it was inferred through observations of small, short-statured plants (generally less than 10-15 cm in height). These observers made various attempts to standardize the definition of "seedling", but never arrived at a single definition. According to Rudd and Sutter (1997), Wally proposed the following size class definitions for immature plants based upon germination studies and other field observations conducted from 1991-1995: new seedlings (< 4 cm), yearlings (4-10cm), and juveniles (< 10 cm). However, Rudd and Sutter (1997) also state that Wally defined seedlings as plants with pitchers < 15 cm. Rudd and Sutter state that they revised this definition to plants < 10 cm in order to restrict it to plants 1-2 years old. Unfortunately, Wally (2000) provides no definition of seedlings in

her monitoring report. Despite the ambiguity among these sources as to the term "seedling", their observations of seedling recruitment are worth noting here due to the obvious implications for self-sustaining populations.

In summarizing observations from 1991-1996 field seasons, Sutter *et al*. (1996) specifically noted the presence of seedlings within two Greenville County, South Carolina populations and a third population in Henderson County, North Carolina. Both of the Greenville County populations consist of multiple subpopulations located in a common drainage, with plants concentrated within cataract bogs, bogs perched upon exposed rock outcroppings. The downstream terminus of one population occurs around the margin of a man-made lake. Sutter *et al*. (1996) speculate that this downstream subpopulation represented new colonization/establishment around the lake margin within the previous 20 years; they also reported observing "robust" recruitment in this subpopulation in 1996. The second Greenville County population was also described as possibly expanding in this and subsequent reports (Rudd and Sutter 1998). However, this population subsequently experienced significant declines in response to drought, with no seedlings and marked adult mortality observed in 1999 (Wally 2000). In the Henderson County population in which Sutter *et al.* (1996) also noted the presence of seedlings, they were only observed in one year (1992), with population declines and an absence of seedlings noted two years later (1994), and very few seedlings the following two seasons (1995 and 1996).

Additional observations continued to reveal high rates of seedling mortality at these and other populations, thus illustrating that even the presence of seedlings does not conclusively mean that populations are achieving actual recruitment. In 1998, Rudd and Sutter (1998) report marked increases in flowering, followed by an abundant cohort of seedlings at a Greenville County subpopulation in which active vegetation management was being undertaken to reduce shade. However, no juveniles could be found at this site the following year after abundant seedlings had been observed. Wally (2000) describes similar patterns at two Greenville County populations, in which she was unable to find a single juvenile two years after Rudd and Sutter (1998) initially reported them. In one of these populations, the rate of juvenile mortality suggested was particularly striking: Rudd and Sutter had observed 100-200 seedlings in 1997 followed by apparently high survival and growth (of these seedlings) into the 1998 field season. These observations further illustrate the barriers to establishing self-sustaining populations in this species, and the need to monitor over many years in order to detect legitimate, sustained increases in the adult plant population.

Population augmentation, introduction efforts

The Atlanta Botanical Garden (ABG) has augmented four natural populations of *S. jonesii* using juveniles reared from seed collected from the same location. These efforts have been conducted at two North Carolina populations (one owned by The Nature Conservancy), a population owned by the South Carolina

Department of Natural Resources (SCDNR) Heritage Preserve, and a fourth population owned by the South Carolina Forestry Commission.

At the population owned and managed by The Nature Conservancy, 100 *S. jonesii* plants were placed into discrete areas within the existing population in the spring of 2004. Forty-four of these transplants were surviving as of 2007 (Sanders *in litt.* 2008). As of 2010, transplants could no longer be reliably distinguished from resident plants, hindering efforts to continue assessing transplant survivorship independently from resident (non-transplanted) plants over the long-term. However, in 2009 ABG resumed monitoring all plants (without regard to transplant status or origin) in the general vicinity of their original transplant activities, so that the survival of these plants and their response to ongoing management can continue to be assessed (Sanders pers. comm. 2009). In 2012, there were 52 plants growing in the monitoring sites (Sutton *in litt.* 2012).

Another Henderson County population was augmented with 25 individuals in 1998; 22 of these transplanted individuals were recorded as alive in 1999 (Wally 2000). There has been no subsequent attempt to distinguish transplants from native (resident) plants, and the current size of this *S. jonesii* population is unknown.

ABG and SCDNR have conducted several augmentation efforts within a SCDNR Heritage Preserve in Greenville County, in which three areas of occupied habitat were augmented and three unoccupied sites were also selected to receive plants (Bunch *in litt*. 2010). These various activities are herein regarded as part of an attempt to augment the larger population, even though the three latter sites did not originally contain plants (and could defensibly be regarded as an introduction at some scale). Efforts to augment existing areas of occupied habitat were unsuccessful: 24 plants placed in these areas in 2004 had succumbed to drought as of May 20, 2009. At the three previously unoccupied sites planted in 2004 (one site) and 2006 (two sites), survivorship rates were 75%, 35% and 57.5% (respectively) as of January 29, 2008. The Preserve Manager attributes the higher survivorship at these latter sites to the partially shaded conditions, which she believes may have moderated the effects of the prolonged drought. However, this portion of South Carolina remains in incipient drought status, and the survivorship of these plants is far from certain.

ABG also assisted in augmenting a population in Pickens County, South Carolina after one of its 3-4 subpopulations was found to have been poached, as evidenced by freshly dug holes located where plants had previously been observed (Bunch pers. comm. 2010). All adult plants were taken by these poachers. The poaching and subsequent attempt to re-establish this subpopulation occurred 10 or more years ago; the exact date(s) are unknown, as is the number of plants reintroduced here. It is presumed that the material used to re-establish this subpopulation was propagated from material obtained from one of the other subpopulations not subject to poaching activity. Drought, road construction (seemingly affecting the

hydrology of the nearby wetlands containing *S. jonesii*) and feral hogs are threatening this population, and it is presently not known how many *S. jonesii* are remaining at this site. The threat of poaching is discussed in greater detail in Section 2.3.2 (Five Factor Analysis).

The USFWS is aware of five attempts to introduce or re-establish *S. jonesii* at locations within the historic range of the species, but outside of the boundary of existing populations. The first two efforts occurred more or less contemporaneously in 1997 and 1999, at two properties located in Henderson County, North Carolina and owned by the North Carolina Plant Conservation Program (NCNHP *in litt*. 2010; Wally 2000; Rudd and Sutter 1998). In 2007, plants were introduced at the Biltmore Estate in Buncombe County, North Carolina (Andes *in litt*. 2009). The last two attempts of which the USFWS is aware involve the introduction of plants of unknown provenance to two discrete locations in Transylvania County, North Carolina (NCNHP *in litt*. 2010). Additional information on these introductions follows.

The first introduction attempt resulted from concerns about the long-term viability of a population in Transylvania County. Deteriorating or unstable landowner relations, followed by observations of bulldozer activity around and within the site boundary, prompted the USFWS to rescue *S. jonesii* plants from this site in January 1992. Rescued material was transferred to the ABG for propagation. Propagated material from this stock was introduced to two properties, both owned by the North Carolina Plant Conservation Program (NCPCP), at various dates in 1998. As of 2010, no transplants were surviving at either of these two introduction sites (NCNHP *in litt*., 2010).

In 2007, approximately 300 *S. jonesii* were planted at the Biltmore Estate in Buncombe County, North Carolina (Andes *in litt.* 2009). The USFWS is unaware of the origin of the material used in this introduction. Although these plants were placed into areas of seemingly suitable habitat and are being cared for by the Estate's horticultural staff, the plants and their habitat are not currently subject to any form of a binding conservation agreement with the landowner (Andes pers. comm. 2009). The USFWS currently views this effort as an expansion of the gardens of the Estate, rather than a potentially self-sustaining, natural population capable of contributing to the species' long-term recovery. As of this review, the USFWS had no additional information on the number of individuals surviving within this introduced population.

In 2006, a NCNHP inventory biologist was informed of an introduction attempt in Transylvania County, North Carolina involving plants of unknown provenance introduced to privately-owned lands where they are not known to be subject to any form of conservation agreement (NCNHP *in litt*. 2010). The USFWS and its partners have very little additional information on this introduction effort; the date of the original introduction is unknown, and only two clumps were observed in a cursory survey in 2006. Until further information is acquired on the origin of the

plant material used and the landowner's willingness to commit to long-term protection of these plants and their habitat, this population is not regarded as likely to contribute significantly toward the recovery criteria (of self-sustaining, protected populations).

In 2007, the USFWS and NCNHP were made aware of a large, introduced population that contained perhaps more than 200 *S. jonesii* clumps when last observed (NCNHP *in litt*. 2010). This site occurs around the margins of a small lake located within a residential development in Transylvania County, NC. At this population, *S. jonesii* co-occurs with several other *Sarracenia* species, including *S. flava* (also introduced) and *S. purpurea*. The provenance of the introduced material is unknown; however discussions with the landowner suggest that the material was provided by Ritchie Bell (formerly with the University of North Carolina) in the mid to late 1970s. There is morphological evidence of hybridization among the *Sarracenia* species occurring at this site. The USFWS regards this occurrence of the species as part of a private garden display, as opposed to a population occurring in native habitat with potential to afford significant contribution to the long-term conservation of the species.

In summary, the USFWS is aware of four efforts to augment existing populations using seedlings reared from seed collected at the same sites, and five efforts to introduce *S. jonesii* to new locations located within the probable historic range but outside of the boundary of an existing population. Across these efforts, transplant survivorship has varied considerably, with one author reporting mortality in excess of 50% within the first year (Wally 2000). In many cases, transplants were not permanently marked in the field and can no longer be reliably distinguished from resident native plants. This, in conjunction with turnover in knowledgeable personnel, severely hinders the ability to objectively assess whether augmentation efforts are leading to sustained increases in population size, and thus assisting with the ultimate goal of self-sustaining populations. Efforts to introduce the species to qualitatively new locations (outside of the boundaries of known populations) have not proven overly successful: two of the five attempts contained no surviving transplants when last surveyed, and the other three efforts involved the use of plants of unknown provenance placed into areas not subject to any form of conservation agreement with the landowner (NCNHP *in litt*. 2010). As such, these last three introduction efforts are not currently expected to contribute toward the recovery criteria of protected, self-sustaining populations.

Population trends

At the conclusion of the 1991-1999 monitoring program for *S. jonesii* conducted by Sutter et al., Wally (2000) assessed all or significant portions of four populations as either demographically unstable or at significant risk from one or more identified threats. One of the populations assessed as demographically unstable represented an attempt to introduce *S. jonesii* to suitable, protected habitat (a North Carolina Plant Conservation Preserve) within the historic range

of the species. This effort was ultimately unsuccessful, with no transplants observed in the last survey attempt in 2007 (NCNHP *in litt*. 2010). The other population assessed as unstable by Wally is still extant, but the subpopulation that suffered catastrophic declines in 1997-1998 (and which formed the basis of her overall population assessment) has never recovered (Bunch pers. comm.). Of the two populations assessed as being at risk from known threats, one remains in private ownership with no landowner interest for conservation purchase, and no opportunities for the sort of management needed to abate threats (primarily woody vegetation encroachment). As of the last recorded observation, this site had suffered significant deterioration in overall site quality, and the *S. jonesii* population (assessed as the most pristine across the entire range by Sutter *et al.* (1996)) had declined from some 345 clumps (in 1991) to a mere 5-6 clumps in 2006 (NCNHP *in litt*. 2010). The second population assessed as vulnerable by Wally (2000) is owned by The Nature Conservancy, and continues to receive active management to control encroaching native woody vegetation and invasive exotics. However, this *S. jonesii* population has also declined from 1991-1992 baseline conditions by over 58% (Donley *in litt.* 2010).

Wally (2000) assessed five other populations (evaluated to varying degrees during the 1991-1999 monitoring effort by Sutter et al.) as stable or thriving. Her assessment included a second introduction attempt (on a second North Carolina Plant Conservation Preserve) in Henderson County, North Carolina and a newly discovered population in Pickens County, South Carolina. As of this review, the second introduction attempt has also been deemed unsuccessful, with no transplants found when the USFWS visited this site with Wally in the summer of 2005, or during a repeat search in 2007 (NCNHP *in litt.* 2010). The Pickens County population that consisted of four subpopulations in1996 has declined, with one subpopulation having apparently succumbed to either drought or hydrologic alteration resulting from a nearby road, and another subpopulation having been poached (with all adult plants removed) (Bunch, pers. comm.). The number of subpopulations remaining in this population is currently unknown, as is the fate of the transplants re-introduced to the poached location. Of the remaining three populations assessed as stable or thriving by Wally, one (located in Henderson County, North Carolina on lands owned by an Episcopal Church) is still extant despite ongoing threats from woody vegetation encroachment, but there are no updated estimates of the *S. jonesii* population. The remaining two populations (both in Greenville County on lands owned by SCDNR) are generally thought to have remained stable since the late 1990s, although no quantitative estimates of population size or spatial extent are available (Bunch, pers. comm.).

In summary, of the 12 extant populations known as of this review, only three (two in Greenville County, South Carolina on lands owned by SCDNR, and one in Transylvania County, North Carolina recently placed under conservation easement) appear to have remained relatively stable over the past two decades. However, the North Carolina population consists of fewer than a dozen clumps, and is unlikely to be self-sustaining. Three of the 12 extant populations represent

introductions of material of unknown origin onto lands not subject to conservation agreements, and are not currently expected to contribute toward the goal of protected, self-sustaining populations. The best available information for the remaining six populations suggests they have declined from baseline conditions recorded in the early 1990s by Sutter *et al.*

2.3.1.2 Genetics, genetic variation, or trends in genetic variation

Godt and Hamrick (1996) evaluated allozyme diversity within and among eight populations of *S. jonesii* (four each from North and South Carolina). They observed low levels of allozyme diversity overall, and relative to a closely-related, more widely-distributed congener (*S. purpurea*) – consistent with expectations for narrow-ranging endemics. However, these authors also note that the levels of genetic diversity reported in the literature for S. purpurea are somewhat low given that species' wider range, suggesting that *Sarracenia* spp. may be inherently genetically depauperate.

Godt and Hamrick found significant deviations from Hardy-Weinberg expectations, suggesting a deficiency of heterozygotes within populations. However, inbreeding coefficients suggested that *S. jonesii* was highly outcrossed. These authors interpret these results by noting that whereas the architecture of *Sarracenia* flowers tends to discourage self-pollination, the small population sizes and disjunct nature of remnant populations make it likely that cross-pollination is occurring among close relatives (e.g., biparental inbreeding). Overtime, this would tend to further erode the frequency of heterozygotes, and could reduce fitness through inbreeding depression. These authors knew of no published estimates of relative fitness of inbred and outcrossed *Sarracenia* species, and did not assess relative fitness in their study of *S. jonesii*.

These authors noted relatively high levels of population divergence in *S. jonesii* given the relatively small geographic range of this taxon. Consistent with patterns in other plant taxa, they also observed higher levels of genetic diversity in larger populations. These authors interpreted the lower levels of diversity found within smaller populations as evidence of reductions in population size, but did not speculate as to how recently these population bottlenecks may have occurred.

2.3.1.3 Taxonomic classification or changes in nomenclature

As noted in the recovery plan, the taxonomy within *Sarracenia rubra*, and *Sarracenia rubra* ssp. *jonesii* in particular, has received considerable attention in the literature. The USFWS listed this entity as a subspecies. Since the federal listing, most current floras (e.g., Weakley 2010) as well as the North Carolina Natural Heritage Program (NCNHP 2010) have adopted *Sarracenia jonesii* Wherry as the preferred treatment. The taxon is also listed as *S. jonesii* Wherry as a state endangered plant species under the North Carolina Plant Protection and Conservation Act (North Carolina Code Article 19B, § 106-202.12-202.22).

However, the Integrated Taxonomic Information System (ITIS) regards *S. rubra* ssp. *jonesii* as the preferred nomenclatural treatment (ITIS 2010). The USFWS supports the change to *S. jonesii*, but we have not yet made the change to the lists at 50 CFR 17.11 and 17.12.

Furches (*in litt*. 2010) has initiated a study of hybridization within the genus *Sarracenia* and more specificially, intraspecific genetic variation with the *Sarracenia rubra* complex (consisting of five subspecies, including *S. rubra* ssp. *jonesii* as recognized by some authors). This study would be expected to have additional bearing upon the question of taxonomic distinctiveness for *S. rubra* ssp. *jonesii* (i.e., whether this taxon is more appropriately recognized as a full species, *S. jonesii*). The USFWS has assisted Furches in obtaining landowner collection permits, however preliminary results were not available at the time of this review.

2.3.1.4 Spatial distribution, trends in spatial distribution

Most locations mapped by the respective state Natural Heritage Programs are depicted as a centroid referencing an approximate location, as opposed to carefully delineated boundaries encompassing the specific locations of subpopulations and the extent of occupied habitat (NCNHP *in litt*. 2010; SCDNR *in litt*. 2010). Due to justifiable concerns over poaching, many partners are reluctant to capture the specific locations of native populations in these publically accessible databases.

The recovery plan references a total of 10 extant populations: four were located within the French Broad River drainage (Henderson and Transylvania Counties North Carolina), five were within the Saluda River drainage (Greenville County, South Carolina), and one was within the Enoree River drainage (also Greenville County, South Carolina). As of this review, there are 12 extant populations: seven within the French Broad River drainage in Buncombe, Henderson, and Transylvania Counties, North Carolina; four in the Saluda River drainage in Greenville County, South Carolina; and one has been found in the Keowee River drainage in Pickens County, South Carolina. Three of the seven French Broad River drainage populations represent introduced populations; therefore the number of native, extant populations within this watershed has not changed since the recovery plan was finalized. Two populations regarded as extant in the recovery plan are now presumed extirpated: the species is no longer extant within the Enoree River drainage, and one population within the Saluda River drainage referenced in the recovery plan is herein presumed extirpated. The species' county distribution now includes Pickens County, South Carolina (a native population) and Buncombe County, North Carolina (an introduced location).

Sutter *et al.* (1996) mapped the spatial extent of six known populations during the 1991-1992 field seasons, and provided coarse estimates of the approximate area of each population. As of that time, these six populations ranged in size from less

than one square meter to more than one-half hectare. The detailed sketches of occupied habitat produced by Sutter *et al.* have never been geo-referenced, and with the exception of one subpopulation that was re-mapped in 1999 to capture significant population declines (Wally 2000), there has been no attempt to re-assess the spatial extent of these populations. The subpopulation that was re-mapped in 1999 is currently estimated at 80% of the size (in terms of abundance and spatial extent) that it was in the mid 1990s (Bunch, pers. comm.). Sutter *et al.* (1996) estimated this subpopulation as occupying 100-500 m2 in 1992. Collectively, the estimates of total area that Sutter *et al.* provided for nine populations amount to less than three acres of occupied habitat.

2.3.1.5 Habitat or ecosystem conditions

Sarracenia jonesii occurs within a subset of southern Appalachian wetlands typically referred to as "southern Appalachian bogs" (in North Carolina) and cataract bogs (in South Carolina). Mountain bogs are widely accepted as among the rarest and most imperiled habitat types in the Southeastern United States (Noss *et al.* 1995 and references therein; Richardson and Gibbons 1993 and references therein). These habitats are typically small (most are less than 20 acres, and many are less than 2 acres) and can be isolated from more extensive wetland systems, features which have contributed to their having been mostly overlooked by larger scale wetland classification systems (e.g., Cowardin *et al.* 1979) and in the interpretation of remotely sensed imagery (e.g., Landsat imagery, National Wetlands Inventory Maps). Water sources for the bogs often originate at considerable distances from the actual bogs themselves, and these (often springs) must be protected in order to preserve the integrity of the habitat. In addition, the species that inhabit bogs are often sensitive to nutrient or contaminant run-off from adjacent uplands; sphagnum or peat moss is exceptionally sensitive and can be destroyed by excessive nutrient run-off in the form of fertilizer or livestock excreta. Because sphagnum acts as a living sponge, maintaining stable water levels and forming the peat that other plants grow on, it is a keystone species in mountain bogs. If the sphagnum dies, the bog soils are exposed to desiccation and invasion by upland plants, and the integrity of the entire system is compromised. Therefore, protecting a bog without the adjacent upland buffer is impossible.

Mountain bogs are identified as a focal habitat containing several at-risk or declining species in the North Carolina State Wildlife Action Plan (NCWRC 2005), and 21 plant species listed by the North Carolina Plant Conservation Program (NCPCP). Another 41 plant species associated with mountain bog species have been proposed for state listing by NCPCP (Evans pers. comm. 2009). As of 2009, the databases of the North Carolina Natural Heritage Program contain slightly more than 150 sites with mountain bog communities and associated rare species (NCNHP *in litt*. 2009). These sites are distributed throughout the Blue Ridge Mountains and immediately adjacent portions of the North Carolina Piedmont. They vary widely in the quality and acreage of

available habitat, with many of the sites having been severely degraded by incompatible land management practices and historical changes in hydrology and/or surrounding land use. This collection of sites contains a wide array of southern Appalachian wetland habitats, much of which is likely unsuitable or located well outside of the very limited geographic distribution of *S. jonesii* (which is clustered tightly within the southwest corner of North Carolina). The databases of the SCDNR Heritage Trust do not depict locations or extent of rare habitats; the USFWS is aware of no comparable, synthetic estimate of the number of sites supporting bogs (particularly the cataract bogs to which *S. jonesii* is almost exclusively confined) in South Carolina.

2.3.2 Five-Factor Analysis -

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

S. jonesii is endemic to globally imperiled wetland habitats of the southern Appalachians (herbaceous, shrub-scrub, and cataract bogs) that have been variously estimated to have been reduced in spatial extent by more than 90%. The combined databases of the NCNHP and SCDNR depict 16 populations of *S. jonesii* that have either been confirmed or are presumed extirpated (NCNHP *in litt.* 2010; SCDNR *in litt*. 2010). The species persists in 12 extant populations across North and South Carolina, in remnant bog habitats that are subject to repeated threats from the continued alteration of the surrounding landscape, particularly the ecological processes (namely hydrologic regimes) which render these wetlands suitable for species such as *S. jonesii*. A combination of human-mediated factors continue to degrade the quantity and quality of remnant bog habitat, either through direct loss of habitat through conversion to other uses, or indirect effects resulting from land-use changes in the surrounding watershed that disrupt patterns of hydrology, nutrient dynamics, or plant and animal dispersal into (and out of) these wetland sites. Humans also affect the amount and viability of wetland habitat by altering natural disturbance regimes that historically served to create and sustain these habitats, such as beavers, native grazers/browsers, and perhaps even fire.

Beavers were largely eliminated from much of the southern Appalachian landscape by the turn of the last century. Although still active, their effectiveness at creating new wetland habitat is severely hindered by humans who regard beavers as a nuisance species, and repeatedly breach beaver impoundments. This, in conjunction with stream channelization efforts throughout the surrounding watershed, continues to work against the processes which create new wetland acreage, which in turn forces those species that are dependent upon these habitats to be confined to whatever remnant acreage that remains. This remnant acreage is in turn threatened by a multitude of factors occurring locally and more distantly throughout the watershed, such as increases in impervious surface (that divert

surface water and change the patterns of groundwater recharge); installation of wells for drinking and irrigation systems; installation of septic systems (which cumulatively affect nutrient load throughout the watershed); and construction of roads and utility corridors (which fragment habitat while creating vectors for invasive exotic species). Because many bogs are located in low-lying flat areas favored for agriculture, they often have been the focus of wetland ditching and draining efforts which have left the hydrology of these sites inherently altered. Further compounded by a nearly complete absence of natural disturbance regimes (such as grazing and/or fire) that may have played a role in keeping woody vegetation at low densities, the structure and composition of southern Appalachian wetlands faces a nearly constant and synergistic set of threats.

Periodic fire may have also played an historical role in keeping some mountain bog habitats structurally open, with the higher light levels favored by species such as *S. jonesii*. Most *Sarracenia* species occur in fire-prone habitats, and many *Sarracenia* species decline during periods of prolonged fire suppression. The historical role of fire in mountain bogs is less clear than in coastal plain habitats, but the presence of fire-adapted species such as pitch pine (*Pinus rigida*) certainly suggests a role for fire in the formation and maintenance of these habitats. However, the extent to which fire suppression may be causing or exacerbating woody vegetation encroachment in bog habitats is presently speculative, at best.

These threats, while known, are not necessarily easily managed. Mechanical removal of encroaching vegetation is labor-intensive, primarily because of the prolific re-sprouting that tends to occur in woody species and the inherently prolific nature of encroaching invasive exotic vegetation (e.g., Kiehl 2007). Various efforts have been undertaken to reduce the labor-intensive nature of this management approach, including the use of torches to kill the cambium (tissue) of cut stumps and even selective use of aquatic-approved herbicides. These techniques (particularly herbicides) have proven moderately effective, however increasingly those land managers who have faced the realities of this challenge are turning to selective use of grazers and/or browsers (Sutton *in litt.* 2008). Many conservation practitioners also believe that grazers and/or browsers are essential to providing the microhabitat conditions required by other species of conservation concern that can co-occur with *S. jonesii* in these wetland habitats – such as the bog turtle (Herman 2010, pers. comm.). Grazing presents numerous challenges with respect to rare plant species such as *S. jonesii,* most notably trampling and concerns over excessive nutrient input within the very nutrient-poor conditions that are thought to have selected for the carnivorous plant habit. Shading is associated with etiolated (pale and drawn out due to lack of light) plants, decreased flowering, even adult plant mortality and the reduction of population area and has been well documented in *S. jonesii* (Rudd and Sutter 1998, Sutter *et al.* 1996). These and other concerns have prompted several managers of mountain bog habitats to consider the use of prescribed fire as a more cost-effective (less labor intensive) means of controlling encroaching woody vegetation encroachment into these remnant habitats. Dormant season burns have been

conducted within *S. jonesii* populations in South Carolina, with good results both in terms of the control of encroaching vegetation and a favorable response in the *S. jonesii* population (Bunch pers. comm. 2010).

Efforts to address hydrologic alteration are perhaps even more challenging, if for no other reason than the lack of knowledge: sources of groundwater recharge within remnant bog sites are typically unknown, and may not be readily inferred from topography and geology alone (e.g., Sutton *in litt*. 2009). Efforts to install groundwater monitoring wells have been limited, and the data obtained from these efforts has not always revealed a straight-forward management solution (e.g., Reberg-Horton 1994). The USFWS recently began a study with the University of North Carolina – Asheville (UNCA) to obtain baseline data to understand and correct artificial alterations to hydrology in southern Appalachian mountain bogs. Jeff Wilcox from UNCA installed monitoring wells in two bogs that contain *S. jonesii* (a total of six bogs) in 2012. Groundwater and surface-water levels will be compared to precipitation measured with on-site rain gauges. This study will continue for a minimum of five years. Preliminary data will be available in late fall 2013.

2.3.2.2 Over utilization for commercial, recreational, scientific, or educational purposes:

Carnivorous plants face particularly acute stresses from illegal collection and associated commercial trade by unscrupulous plant collectors. At least two populations of *S. jonesii* have been definitively poached within the past two decades. In one instance, all adult individuals (several hundred individuals) were removed from one subpopulation in South Carolina in the mid 1990s, within one year of this population being discovered (Meyers-Rice *in litt*. 2001; Bunch pers. comm.). In another, the only location for an anthocyanin-free form of *S. jonesii* (giving the plant an overall green color) anywhere in the world was repeatedly poached from a protected preserve in North Carolina, to the point that this form is now extinct in the wild (Meyers-Rice *in litt*. 2001).

In 2000, the USFWS and its partners initiated a pilot project using Microtaggant™, a substance developed for tagging explosives (the substance enables exploded bombs to be traced back to the buyer of the original materials) (Murdock *in litt*. 2000). This project represented a collaborative effort among USFWS Ecological Services (Endangered Species Program), USFWS Office of Law Enforcement, North Carolina Department of Agriculture and Consumer Services (NCDACS) and the South Carolina Department of Natural Resources (SCDNR). Marking wild populations with Microtaggant™, a magnetic microscopic-sized particle visible under a black light, was intended as a law enforcement tool that would enable officers to scan large quantities of plants to determine if they had been taken from the wild. As of this review, it is unclear how many populations were marked, and to date no marked plants have been confiscated. However, this technique has since been extended to other carnivorous

plant species in the state (e.g., Venus fly-trap, *Dionaea muscipula*) as well as other plant species subject to poaching, such as American ginseng (*Panax quinquefolius*).

In 2003, the International Carnivorous Plant Society (ICPS) initiated a pilot project to make it possible for carnivorous plant collectors to obtain material from carnivorous plants listed under the Endangered Species Act. The primary intent of this project was to decrease poaching pressures within wild populations. The ICPS applied for and continues to hold an Endangered Species Section 10 (Recovery and Interstate Commerce) permit from the USFWS (permit number TE061005-1). Under this permit, ICPS holds and distributes seeds of three federally listed endangered Sarracenia species: *S. alabamensis*, *S. jonesii*, and *S. oreophila*. No whole plants are held by the ICPS, and seeds in the ICPS collection are donated from personal collections or institutions, and are not collected from the wild. Seed packets are sold for a nominal fee ($2/each), intended to serve as an economical alternative to poaching plants from wild populations. In recognition of the widespread desire among plant collectors to maximize the number of geographically distinct localities in their rare plant collections, the ICPS program devised the use of unique locator codes which indicate the distinct provenance of each seed lineage without revealing the location of the wild population from which it ultimately originated. Seeds are only available to ICPS members, with a quota of one seed packet (of each type) per month and a maximum of 40 packets total in any 12 month period. During 2012, 58 of the 148 seed packet orders for endangered *Sarracenia* species processed by ICPS were for *S. jonesii*. That year ICPS received 125 packets worth of donated *S. jonesii* from Barry Meyers-Rice (Brittnacher *in litt.* 2012). The previous year (2011), ICPS received 65 packets worth of donated *S. jonesii*: 45 of these packets were donated by Barry Meyers-Rice, the founder of the ICPS poaching abatement program and out-going Director of Conservation Programs for the ICPS (Brittnacher *in litt.* 2011). That year, 60 of the 306 packets (of endangered *Sarracenia* species) ordered were for *S. jonesii*.

Meadoview Biological Station also holds an ESA Section 10 (Interstate Commerce) permit for commercial trade in endangered *Sarracenia* species (permit number TE022690-30). In contrast to the ICPS, Meadowview does not sell seed, but whole plants. In 2012, Meadowview reported selling 34 *S. jonesii* plants of propagated origin (Sheridan *in litt.* 2012). The preceding year, Meadowview reported the sale of 25 *S. jonesii* plants (Sheridan *in litt.* 2011).

2.3.2.3 Disease or predation:

Wally (2000) observed an insect infestation at one Greenville County, South Carolina subpopulation during the 1999 field season. Moths (unidentified) had entered pitchers and woven openings shut with silk and/or stuffed the opening with thatch. Chewing damage on the walls of the leaves was often visible, and

pitchers collapsed at these weak points. This infestation may correlate with the low percentage (less than 10 percent) of mature pitchers being functionally carnivorous and fully photosynthetic. Wally did not report this observation for any other subpopulation. At the present time, this is not regarded as a significant threat to the survival of the species; however were this pattern to re-emerge, it has the potential to constitute a significant threat.

2.3.2.4 Inadequacy of existing regulatory mechanisms:

The North Carolina Plant Conservation and Protection Act (NC State Code Article 19B, § 106-202.12) provides limited protection from unauthorized collection and trade of plants listed under that statute. However, this statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities. There have been two attempts to introduce *S. jonesii* to suitable habitat on Preserves owned and managed by the North Carolina Plant Conservation Program, which are managed for the explicit benefit of rare plant species (like *S. jonesii*); however as noted elsewhere in this review, these introduction efforts have not succeeded. Therefore, the species does not currently occur on any state-owned properties in North Carolina.

Plant species are afforded even less protection in South Carolina, where they are protected only from disturbance where they occur on those properties owned by the state and specifically managed as South Carolina Heritage Preserves (SC State Code of Regulations Part 123 § 200-204). Significant portions of three South Carolina populations do occur on state-owned Heritage Preserves, and are afforded some protection by this state statute. The two remaining extant South Carolina populations do not occur on state-owned Heritage Preserves: one occurs on private lands not subject to any form of protective ownership and the other occurs on lands recently acquired by the South Carolina Forestry Commission. The nature of protection afforded by this form of state ownership is unclear.

All *Sarracenia* species are listed under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). CITES is an international agreement among governments that is intended to ensure that international trade in those species recognized under this Convention does not threaten the continued survival of these species. The agreement is voluntary, but those parties that are signatories (like the U.S.) agree to implement the Convention through domestic legislation. Species covered by CITES are listed in three Appendices, depending upon the level of protection needed. Appendix I consists of species threatened with extinction for which only limited trade is authorized; Appendix II contains those species not yet threatened with extinction, but for which trade must be controlled (regulated) in order to prevent such an extinction threat; and Appendix III lists species that are protected in at least one country that has requested assistance in controlling foreign trade in that species. Signatories to CITES will only authorize specimens of CITES-listed species to be imported into or exported (or re-exported) with appropriate documentation that must be presented for

clearance at the port of entry or exit.

There are no other federal or state statutes that afford significant protections to *Sarracenia jonesii*.

2.3.2.5 Other natural or manmade factors affecting its continued existence:

None beyond those already addressed.

2.4 Synthesis –

The current federal status of endangered remains appropriate for *Sarracenia rubra* ssp. *jonesii* (=*Sarracenia jonesii* in this review). The recovery criteria for *S. jonesii* have not been met. This narrow-ranging endemic has been extirpated from 16 populations, and now remains extant at 12 populations located in three North Carolina counties (Buncombe, Henderson and Transylvania) and two South Carolina counties (Greenville and Pickens). North Carolina populations are confined to the French Broad River drainage; South Carolina populations occur primarily in the Saluda River drainage (four populations) with one population (discovered since the recovery plan) located in the Seneca River drainage. Since the recovery plan, the species has become extirpated from the Enoree River drainage in South Carolina (within which the recovery plan identified a single population of the species). Of the 12 extant populations known, only three (two in Greenville County, South Carolina on lands owned by SCDNR; and one in Transylvania County, North Carolina recently placed under conservation easement) appear to have remained relatively stable over the past two decades. However, the North Carolina population consists of fewer than a dozen clumps, and is unlikely to be self-sustaining. Three of the 12 extant populations represent introductions of material of unknown origin onto lands not subject to conservation agreements, and are not currently expected to contribute toward the goal of protected, self-sustaining populations. The best available information for the remaining six populations suggests they have declined from baseline conditions recorded in the early 1990s. Some of these declines have occurred despite active attempts to manage against known threats (such as woody vegetation encroachment and invasive exotic plant species), suggesting that additional factors (such as low seedling recruitment or high mortality in juvenile age classes) may be limiting the species' recovery.

3.0 RESULTS

3.1 Recommended Classification:

__X__ No change is needed

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

These actions are cross-walked to tasks identified in the recovery plan, where appropriate.

Recovery Task 2.1: Determine population size and stage class distribution for all populations

- Map the spatial extent of each population, assess flower abundance and (of lower priority, only if time permits) the abundance of pitchers/clumps. Perform these assessments in a manner that ensures comparability to the baseline maps and other data obtained for these sites in 1991 and 1992 (Rudd and Sutter 1998 and references therein). Assess whether the spatial extent and/or abundance of populations has remained stable, increased or decreased since that time, accounting for any increases due to population augmentation efforts. Record information on environmental parameters that can impact the plant (e.g., light availability and depth to water table) to examine possible correlations with these parameters and the population size and stage class distribution for all populations.

Recovery Task 2.7: Develop techniques and re-establish populations in suitable habitat within the species' historic range.

- Work with the Atlanta Botanical Garden (ABG) to summarize prior reintroduction, augmentation and introduction activities across all populations. Using this information, conduct site visits as needed to obtain current estimates of transplant survivorship for prior augmentation efforts.
- Use this information, supplemented by updated data on overall spatial extent (obtained from mapping) and estimates of flower/pitcher abundance, to assess each population for its current potential to be self-sustaining without augmentation. For populations where augmentation is deemed necessary (this may currently be most populations), establish preliminary population objectives clarifying the minimum desired number of plants at each location, and a strategy and timeline for meeting this objective through augmentation. Work with ABG and landowners to implement actions required to meet this objective at as many sites as possible, and then discontinue additional augmentation while monitoring is undertaken to determine transplant survivorship and population trends at the new (augmented) baseline.

Recovery Task 3: Develop a cultivated source of plants and provide for long-term seed storage

- Review the provenance of material currently held as seeds or otherwise represented in ex-situ holdings at botanical gardens (esp. ABG but also the North Carolina Botanical Garden) to ensure that all known extant populations are represented.
- Work with ABG to assess the viability of seed collections, and the longevity of seeds held in long-term storage.

Recovery Task 6: Annually assess success of recovery efforts

- The two existing recovery criteria (for de-listing) are largely redundant; revise criteria that are more specific, objective, and measurable.
- Establish down-listing criteria (for reclassification from endangered to threatened).

- Finalize technical revision to the federal list of threatened and endangered plant species, changing taxonomy from *Sarracenia rubra* ssp. *jonesii* to *Sarracenia jonesii*.

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of *Sarracenia rubra* ssp. *jonesii* (mountain sweet pitcher plant)

Current Classification: Endangered

Recommendation resulting from the 5-Year Review:

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

Appropriate Listing/Reclassification Priority Number, if applicable:

Review Conducted By: Carolyn Wells (originally) and Mara Alexander (completed final document), Asheville Ecological Services Field Office, Asheville, NC.

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve _____ Date 4/15/13

REGIONAL OFFICE APPROVAL:

for **Lead Regional Director, Fish and Wildlife Service**

Approve _____ Date 5/21/13

Appendix A: Peer Review

Summary of peer review for the five-year review of *Sarracenia rubra* ssp. *jonesii* (mountain sweet pitcher plant)

A. Peer Review Method:

A draft of this document was circulated to those with direct and substantive knowledge of *Sarracenia rubra* ssp. *jonesii*, including staff from the North Carolina Natural Heritage Program (Mr. Ed Schwartzman, Mrs. Misty Buchanan, Mrs. Susan Mason); the North Carolina Plant Conservation Program (Mr. Rob Evans); the South Carolina Department of Natural Resources (Ms. Mary Bunch); the Atlanta Botanical Garden (Dr. Jenny Cruse Sanders); The Nature Conservancy (Mrs. Megan Sutton and Ms. Kristin Austin); and Clemson University (Dr. Patrick McMillan).

B. Peer Review Charge:

Peer reviewers were asked to conduct a scientific review of technical information presented. Reviewers were not asked to review the legal status determination.

C. Summary of Peer Review Comments:

Comments were received from NCNHP (3 reviewers) and TNC (1 reviewer). The NCNHP reviewers provided or sought clarification on the level of protection at select populations/colonies, and inquired as to the specific location of some populations/colonies referenced in the draft review. One NCNHP reviewer suggested editorial revisions to the text to clarify the difference between pitchers and clumps (as opposed to individual plants) in *S. jonesii*. TNC registered concerns over statements (in the draft) which might make it possible for poachers to identify the location of the population owned by that organization.

D. Response to Peer Review:

All comments received were evaluated and incorporated into a revised version of this review.