Virginia Round-Leaf Birch

Betula uber (Ashe) Fernald

5-Year Review:
Summary and Evaluation

Prepared by

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5-YEAR REVIEW
Species reviewed: Virginia round-leaf birch (*Betula uber*)
September 2006

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U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW OF
Virginia round-leaf birch / *Betula uber* (Ashe) Fernald (Betulaceae)

September 2006

1.0 GENERAL INFORMATION

1.1 Reviewers:

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Cooperating Field Office(s): None

Cooperating Region(s): None

1.2 Methodology Used to Complete This Review:

This 5-year review was conducted as an individual effort by the lead endangered species biologist for the birch. It summarizes and evaluates information provided in the biological status review conducted by Ogle (2003).

1.3 Background:

1.3.1 FR Notice announcing initiation of this review: July 6, 2005 (Vol. 70, No. 128, Page 38,976)

1.3.2 Listing history

Original Listing
FR notice: June 16, 1976
Date listed: April 26, 1978
Entity listed: Species
Classification: Endangered

Revised Listing
FR notice: December 6, 1993
Date listed: November 16, 1994
Entity listed: Species
Classification: Threatened

1.3.3 Associated rulemakings: None

1.3.4 Review history: In 2003, Region 5 funded a review (Ogle 2003) to assess the biological status of the species as a precursor to determining if delisting was warranted. The review indicated a lack of natural reproduction in the two natural populations as well as in the introduced populations. The last documented case of natural reproduction was in 1981-1982. See the attached history (Attachment 1).

1.3.5 Species' Recovery Priority Number at start of review: 14

1.3.6 Recovery Plan:

Name of plan: Virginia Round-Leaf Birch (*Betula uber*) Recovery Plan
Date issued: September 24, 1990
Dates of previous revisions: March 1982 and September 1985

2.0 REVIEW ANALYSIS

2.1 Application of the 1996 Distinct Population Segment (DPS) Policy

2.1.1 Is the species under review a vertebrate? No. The species is a plant, and, as such, it does not qualify for consideration as a DPS.

2.2 Recovery Criteria

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

2.2.2 Adequacy of recovery criteria:

2.2.2.1 Do the criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? No. Explanation provided below.

The target number of 500-1000 individuals in each of 10 self-sustaining populations reflects the best available information; however, the estimated date of recovery by 2010 appears unrealistic given the

difficulties in natural reproduction. In addition, the criteria do not adequately address threats to the species (i.e., the 5 listing factors).

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 primary objective of the round-leaf birch recovery plan is to increase the number of individuals in the wild to a level where the species can be delisted, currently estimated at 500-1000 individuals in each of 10 self-sustaining populations. The populations may include individuals of sweet birch which carry the round-leaf trait in a cryptic (heterozygous) state.

The number of individuals required in each population for the maintenance of the round leaf and associated traits of round-leaf birch cannot be determined with a high degree of certainty, given the fact that the allelic frequency at a particular gene locus determining these traits in the dark-barked birch population is not known. The 500-1000 individuals per population represents a conservative estimate (Nainkoong 1980), given the assumptions based on previous studies that only a single gene locus is involved and that the frequency of the rare allele in the dark-barked birch population is at least 5 percent.

Any population of round-leaf birch, whether established naturally or through plantings, will be considered self-sustaining when it produces through natural regeneration 500-1000 individuals greater than 2 in tall."

There has been no natural reproduction in the original population since 1981-1982. Although the survival rate in the introduced populations was high, there is no evidence of natural reproduction in these populations to date. Thus, the biological recovery objective and criteria for the round-leaf birch have not been met. Threats-reduction criteria related to the five listing factors have not been developed for the round-leaf birch.

2.3 Updated Information and Current Species Status

2.3.1 Biology and Habitat

2.3.1.1 New information on the species' biology and life history:

Information on the birch that has become available since its reclassification is summarized in Attachment 2, Status Assessment of the Virginia Round-leaf Birch (Ogle 2003).

2.3.1.2 Abundance, population trends, demographic features and/or trends:

Overall, the population is stable. There are three basic groupings of round-leaf birch populations to consider when evaluating population trends.

1) The last census (Ogle 2003) showed that only eight (four adult) plants in the population rediscovered in 1975 were extant. Clearly, these four trees are the most important plants.

2) The next group in importance includes those plants that naturally reproduced following habitat management (creating clearings and exposing mineral soil) in 1981. This management resulted in the only documented natural reproduction for the species. There were 81 plants in this cohort, but all are believed extirpated, many as a result of vandalism.

3) The third group results from sexual reproduction *ex situ*. In 2003, there were 953 extant plants produced sexually but *ex situ*.

The population peak for the species occurred in the mid-1990s following the planting of greenhouse-grown seedlings that raised total numbers to 1,400 plants in 20 populations. Of the 961 plants known to occur in the wild in 2003, however, only 8 are truly natural. Although plants of group two would be considered natural, none have survived.

The species is both wind pollinated and seed dispersed. Though capable of sprouting, it relies on sexual reproduction with other individuals (it is self-sterile). Like most wind pollinated tree species, 90% of the pollen is deposited within 100 meters of the father plant. Two thirds of the seeds fall within 30 meters of the mother plant, and less than 5% are dispersed more than 100 meters (Ogle 2003).

When the species was rediscovered by Ogle in 1975 (it had not been observed since 1914), the age of the population was bimodal, indicating two previous colonizing events. A third colonizing event occurred in 1981-1982 after habitat was managed. No sexual reproduction has occurred in the wild since 1981-1982. The tree, which produces an abundance of seeds every three to four years, needs mineral soil and forest openings to establish itself. It appears that reproduction occurs naturally when one of these mast years coincides with suitable habitat availability, an event that seems to be rare.

2.3.1.3 Genetics, genetic variation, or trends in genetic variation: While there are genetic concerns with any population this small, no trends in genetic variation have been detected. While all of the reproduction since 1981-1982 has occurred *ex situ*, the new individuals have been a result of sexual reproduction, not vegetative propagation. For that reason, potential genetic concerns in the planted populations are minimized.

2.3.1.4 Taxonomic classification or changes in nomenclature: Available information indicates that, despite some taxonomic ambiguity, *Betula*

uber (Ashe) Fernald can be considered a valid entity regarding its listing under the ESA. Ashe, who discovered the species in 1914, believed it was a variety of the common sweet birch, and he named it *Betula lenta* L. var. *uber* Ashe in 1918. Fernald, after reviewing herbaria specimens, elevated it to species status in 1945 as *Betula uber* (Ashe) Fernald. Some botanists believe it is most likely a variety. Feret submitted a paper to a scientific, peer-review journal, but it was rejected for lack of scientific rigor (Ogle 2003); unfortunately, Feret died before he could resubmit the manuscript. While it is possible that the Virginia round-leaf birch is a striking Mendelian variant with a homozygous recessive gene for round leaves, there is no scientific evidence to support the hypothesis. Sweet birches are common where the round-leaf birch grows, and they have reproduced since 1981-1982 without producing new round-leaf birches. If the round-leaf birch were a homozygous recessive of the sweet birch, one would have expected some new round-leaf birches produced since 1982. On the other hand, no scientific studies have clearly validated the species. The Virginia round-leaf birch appears very close to the line between variety and species. Without definitive evidence warranting a change, the plant's status as a species should be retained.

2.3.1.5 Spatial distribution, trends in spatial distribution, and/or historic range: The current natural population site is the only site the species is ever believed to have been found (botanists believe Ashe mistakenly identified an adjacent creek in his 1918 paper). The tree may thus have always been rare, and it may even be speciating from the sweet birch. There is very little other historical evidence regarding distribution. After a few records from 1914, the species was believed extirpated until it was rediscovered in 1975 by Ogle (Ogle 2003). Most recovery work occurred between 1977 and 1995, during which time 20 populations were created on U.S. Forest Service lands. By 1995, the species no longer appeared to be on the brink of extinction (thus, it was reclassified to threatened), and botanists were largely waiting for a natural reproduction event.

2.3.1.6 Habitat or ecosystem conditions (e.g., amount, distribution, and suitability of the habitat or ecosystem): All plants occur along a 700-meter stretch of highly disturbed stream bank surrounded by agricultural land. This riparian forest occurs along Cressy Creek in Smyth County, Virginia.

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

2.3.2.1 Present or threatened destruction, modification or curtailment of its habitat or range: The species needs small forest openings, especially

during years that it produces abundant seed. Rarely do these two factors coincide. Thus, natural reproduction is rare; it has only been documented once – in 1981-1982. The natural population is surrounded by agricultural land. Because the species relies on wind for pollination and seed dispersal, opportunities for range expansion are limited. The species has not been subject to section 7/10 consultation in at least five years. While expansion of the plant's habitat is constrained to riparian areas, its extant habitat does not appear to be threatened. Establishment of additional populations (20 on protected Forest Service land) has eased concerns of extinction. The two populations on private land have not been monitored in over ten years.

2.3.2.2 **Overutilization for commercial, recreational, scientific, or educational purposes:** Overcollection for cultivation and research was a problem until the 1990s, when seeds that were germinated in captivity provided ample seedlings. In addition, providing propagated plants to the nursery trade created a supply of commercially available round-leaf birches that has virtually eliminated the demand for the wild plants.

2.3.2.3 **Disease or predation:** Disease is not a threat, but herbivory by deer, rabbits, mice, and domestic livestock has been a problem. Cages placed around seedlings have proven effective in reducing herbivory.

2.3.2.4 **Inadequacy of existing regulatory mechanisms:** Plants on U.S. Forest Service property are protected by the ESA, but the plants on private property are not protected unless an action has Federal involvement.

2.3.2.5 **Other natural or manmade factors affecting its continued existence:** The availability of greenhouse-grown seedlings appears to have reduced vandalism, perhaps because the tree is no longer perceived as highly rare.

2.4 Synthesis

Although the number of trees (961) currently living in the wild is impressive (given that the species was not seen in the wild from 1914-1975), natural reproduction is exceedingly rare. Like most birches, this birch is a pioneer species, and establishment seems to be the weak point in its life cycle. Establishment appears to rely on the rare timing of abundant seed production with suitable habitat for seeds and seedlings. Until natural reproduction occurs, indicating fully successful establishment of the introduced populations, delisting is inappropriate.

The criterion of natural reproduction has clearly not been met; however, the issue of what constitutes a natural population is less clear. Even though the 953 plants produced *ex situ* were produced sexually, the interactions between individuals and the environment have been compromised. Are captive-reared individuals truly wild? Captive-rearing was

vitally important to prevent extinction, and sexual reproduction rather than vegetative propagation lessens the concerns of artificiality. Management actions in the field to create habitat appropriate for seedling recruitment and establishment can be considered natural; however, *ex situ* reproduction, even sexual, should be considered unnatural. Delisting is not warranted until at least ten populations reproduce naturally, *in situ*.

3.0 RESULTS

3.1 Recommended Classification: No change is warranted.

Rationale: The species should not reclassified to endangered because it is not in immediate danger of extinction, nor should it be delisted. Its only documented natural reproduction to date occurred in 1981-1982 after the habitat was managed to increase available habitat for seedling recruitment and establishment. The species' taxonomy should not be changed without scientific evidence. In conclusion, the species should retain its classification as threatened.

3.2 New Recovery Priority Number: 14 (no change)

Rationale: *Betula uber* is subject to a low degree of threat and has a high potential for recovery, since most plants occur on protected public lands and management conducive to natural regeneration is possible. It is considered by FWS to be a valid species, and no conflict with economic development is anticipated.

3.3 Listing and Reclassification Priority Number: Not applicable

4.0 RECOMMENDATIONS FOR FUTURE ACTIONS

1) The recovery plan should be revised to include required threats-reduction criteria and to focus on actions conducive to achieving *in situ* reproduction.

2) The taxonomy of the birch is not universally agreed upon. Scientific evidence to date has been inconclusive, as some evidence points to the species level and some points to the variety level. If the plant is determined to be a variety, the variety should remain listed under the ESA until revised recovery criteria are met.

3) Natural reproduction is the most essential recovery criterion not yet met. The U.S. Forest Service should conduct management activities to expose mineral soil and remove other nearby birch species as they did in 1981. The management actions need to occur until a year when the Virginia round-leaf birch produces abundant seeds. Once ten populations reproduce naturally (*in situ*), delisting may be warranted.

5.0 REFERENCES

References are located with the U.S. Fish and Wildlife Service's Virginia Field Office, 6669 Short Lane, Gloucester, Virginia 23061.

Namkoong, G. 1980. Genetic considerations in the management of rare and local tree populations. pp. 59-66 in Feret, P.P. and T.L. Sharik (eds.). Proc. Conf. Dendrology in the Eastern Deciduous Forest Biome. September 11-13, 1979, Blacksburg, VA. Virginia Tech University, School of Forestry and Wildlife Resources Publication No. FWS-2-80.

Ogle, D.W. 2003. Status assessment of the Virginia round-leaf birch, *Betula uber* (Ashe) Fernald, with recommendations for delisting. Glade Spring, VA. 13 pp.

U.S. Fish and Wildlife Service. 1990. Virginia round-leaf birch recovery plan. Newton Corner, MA. 43 pp.

U.S. FISH AND WILDLIFE SERVICE

5-YEAR REVIEW of the Virginia round-leaf Birch, *Betula uber* (Ashe) Fernald

Current classification: Threatened

Recommendation resulting from the 5-Year Review:

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

Review conducted by: Mr. Eric Davis

FIELD OFFICE APPROVAL

Lead Field Supervisor, Fish and Wildlife Service

Approve /Lynn J. Mayne Date 9/26/2006

REGIONAL OFFICE APPROVAL

Lead Regional Director, Fish and Wildlife Service

Approve Acting Date 10/4/06

ATTACHMENT 1:

HISTORY OF EVENTS RELATING TO THE VIRGINIA ROUND-LEAF BIRCH

History of Events Relating to the Virginia Round-leaf Birch

1914 Plant first collected

1918 Ashe names it as a variety of the sweet birch, *Betula lenta* L. var. *uber* Ashe

1945 Fernald elevates it to species status, *Betula uber* (Ashe) Fernald

1975 Ogle rediscovers the plant in the wild (not seen since 1914); 41 individuals [18 adults]

1975 National Arboretum begins germplasm efforts

1977 Fences prove effective in combating herbivory

1978 Federally listed as endangered (first tree listed under the ESA)

1979 State listed as endangered

1981 U.S. Forest Service and private land management results in first (and only) documented occurrence of natural reproduction; 81 seedlings

1981 Sexual propagation efforts begin

1982 Recovery Plan published

1984 Natural population down to 11 individuals [4 adults]

1984 Greenhouse-grown seedling planting effort begins, ends in 1987; 20 populations of 96 seedlings each planted on U.S. Forest Service land

1985 All 81 seedlings from the natural reproduction event were stolen

1985 Recovery Plan, First Revision published

1988 Sexually produced seedlings made available to the public, larceny effectively ended

1990 Recovery Plan, Second Revision published

1994 Federally reclassified as threatened

1999 Population peaks at 1,400 individuals

2003 Population at 961 (only 8 remaining plants from 1975 [4 adults])

2005 FWS initiates status review

ATTACHMENT 2:

STATUS ASSESSMENT OF THE VIRGINIA ROUND-LEAF BIRCH (OGLE 2003)

Status Assessment of the Virginia Round-leaf Birch, *Betula uber* (Ashe) Fernald, with Recommendations for De-listing (2003)

Abstract:

A review of published research, information from public records, as well as interviews and correspondence with landowners and individuals directly involved in research or recovery were compiled. Since 1995, research and maintenance efforts have effectively ceased. Mount Rogers National Recreation Area (MRNRA) staff have maintained complete records and monitored the 20 out-planting sites on Federal property, but individual plants on private property have not been monitored for over ten years. The regional office of the Virginia Department of Agriculture and Consumer Services (VDACS) maintained records of their involvement in recovery efforts. In 2003, eight, out of the original 41 natural population plants are alive, along with 953 reproduced population plants of phenotypic RLB out-planted on public land (TOTAL 961). Though an important de-listing criterion, natural reproduction has only been recorded in one year (1981). The weak link in the cycle appears to be establishment, and before de-listing this should be addressed in existing populations. The results of controlled experimental crosses did not refute the "striking Mendelian variant" hypothesis. This hypothesis says that *B. uber*'s round-leaf phenotype is caused by a homozygous recessive genotype. This mutant (round-leaf) gene can be present in heterozygous condition within *B. lenta*, which normally has a genetically dominant trait producing phenotypic ovate leaves. These impressions were widely quoted, but are not statistically sound enough to merit unquestioned acceptance, and were not published in a peer reviewed journal. *B. uber* has several phenotypic traits, other than round leaves, that would not easily be explained by a single gene mutation. DNA tests, specifically RFLP or something comparable, should be easy and economical to use to examine this hypothesis. *B. uber* has come to be treated as an aberrant genetic entity, rather than an organism with Darwinian adaptations and an evolutionary history. Before de-listing, establishment should be enhanced in the populations and direct genetic investigations should be completed and the results evaluated.

Species History

Introduction:

I have tried to separate the accumulated materials into data known with a high degree of dependability **(bold),** along with included data either hypothetical or suspect. If a reference is not cited in text it is derived from VDACS or USFS records deposited and maintained at Mount Rogers National Recreation Area Headquarters in Marion. After this report has been submitted to USFWS, all materials used or cited will be deposited in these records at MRNRA Headquarters.

Terms and abbreviations used: RLB= *Betula uber* (Ashe) Fern.

SB= *Betula lenta* L.

MRNRA = Mt. Rogers National Recreation Area

USFS=U.S. Forest Service

USFWS=U.S. Fish and Wildlife Service

natural population= *B. uber* plants found in the original discoveries 1976

reproduced population= *B. uber* plants grown from seed or cloned materials

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The plant was first collected in 1914 . Described in 1918 as small tree and variety of SB. No population data given. (Ashe, 1918) **Two localities were vouchered, by two different foresters, on Dickey Creek and Cressy Creek** (Mazzeo, 1974). A hypothesis was suggested by Ogle (IN Kinkead, 1976), and investigated by Sharik and Ford (1984) that Ashe may have cited Dickey Creek in error, still lacks definitive evidence. Ashe was probably working on the same tract as Ayers, but in the early 1900's timber tracts were very extensive, and one tract may well have encompassed both drainages.

M. L. Fernald raised RLB status from variety of SB to species (Fernald, 1941).

Plant re-discovered in 1975 along 1500 meter section of Cressy Creek. The natural population was then comprised of 18 reproductively mature adults and 23 sub-adults (TOTAL 41) (Ogle, and Mazzeo, 1976). Of these 23 sub-adults, approximately 3 were saplings and the remaining 20 were seedlings. **The seedlings were approximately the same size and found clustered within a small area (ca. 10 x 30 meters) on top of old mine works later used as a community baseball field. Five seedlings were removed by one landowner who transplanted three into his yard, and gave two others to be planted on private property in an adjacent County. All saplings and adults were located in the floodplain of Cressy Creek, and despite wide searches were never found in any other locality. RLB had maintained a viable reproducing, dispersing, and establishing population and it's distinctly recognizable phenotype for over 60 years.**

Recovery work began in earnest in 1977 and continued regularly until 1995. The tasks consisted of formation of a protection committee, federal and state endangered species status, approved recovery plans, research into propagation, diseases, genetics, dispersal, and systematics of the species, out-plantings of reproduced populations to increase numbers of individuals, Reynolds Homestead and National Arboretum propagation and out-planting orchard for use in re-establishing native site plantations, massive distribution programs to private nursery firms, public arboreta, and other institutions, as well as interested private individuals, and monitoring activities on both public and private lands where the original population occurred. How many reproduced individuals are still extant in private nurseries, public arboreta or institutions is unknown, including both Reynolds Homestead and the National Arboretum. The recipients of these seedlings were very numerous, and there are certainly many still extant in cultivation.

The natural population has consistently decreased. From 18 adults and 23 sub-adults (TOTAL= 41) in 1975, to half original size in 1979, to 4 adults and 7 sub-adults (TOTAL 11) in 1987. In the fall of 2003, I was able to re-locate 4 adults, and 4 saplings (TOTAL 8) of the original 41, on all tracts. The two natural individuals (2 adults) on public lands have

done exceptionally well, with mortality on private lands account for the majority of population decrease.

In the late 1970's and early 1980's, a series of mistakes and misunderstandings caused tremendous ill will and hard feelings between the scientists and landowners interested in the species. These problems, beginning with a published report by Reed, stating first re-discovery of the species, and culminating in an 1989 lawsuit between the two private landowners settled by the Circuit Court of Smyth County (Book 392, page 583), lead to many unfounded rumors that persist to recent times. Czech, et. al. (2000) stated "species...are sometimes vandalized by landowners attempting to evade the provisions of ESA's section 9.....Evasion of section 9 may be the motives, for example, of vandals who have repeatedly destroyed Virginia Round-leaf Birch trees and seedlings". Many statements were both careless and not based in fact.

Some of the divisiveness resulted from the fact that one landowner owned every one of the original seedlings. If one wanted a voucher, it was possible to clip adult trees, but if one wanted a seedling there was only one place to dig. The consistent loss of seedlings fueled this landowner's desperate attempt to move several seedlings near his residence and into an adjacent County so that they would be "safe" and secured. It was my understanding that this landowner looked after his Mother, in her old age, in order to receive her property, which he had farmed for years in their mutual support. When The Nature Conservancy bought this property at auction, high dollar was bid. When, by original agreement, it wasn't supposed to be sold. However, as is typical in many such cases, no formal document to this agreement was ever produced. This landowner saw his valued seedlings disappearing. They were dug up and carted off, several were left dead near the fence he erected at his own expense to protect them, they were cut up and broken by visitations, some known to the landowner, some not. His ability to have a livelihood by farming was drastically curtailed, and his trust in scientists destroyed. The National Arboretum replaced a few of his seedling, but no other offer of assistance or sympathy was ever forthcoming. Distrust and ill will regarding these mistreatments persists to the present. (Ray and Jim Haulsee, personal communications)

During the mid-1980's, reproduced populations of phenotypic RLB and SB were out-planted on USFS property, in 20 plots within the Cressy Creek drainage, and have done very well. Survival rates have been high, many of the trees exceed 10 meters in height, and the plots have been maintained, thinned, and monitored by VDACS and USFS personnel. The USFS continued to maintain and monitor the out-plantings in the Cressy Creek drainage, most recently in July 2003. **Nine hundred fifty three phenotypic RLB in twenty separated out-plantings derived from the reproduced population are alive** (USFS,2003), and only 57 have died since 1997. Some phenotypic SB were thinned to eliminate competition. **No natural establishment has occurred, although RLB catkins have been regularly observed. Environmental conditions that favor RLB establishment were not observed at any of the twenty out-plant localities in 2003, or at the site of the natural population. The "weak link" in expected natural reproduction seems to be the almost total lack of appropriate environmental conditions for seedling establishment at all RLB localities.** (personal observation, 2003)

In 1988, Arthur Cronquist published RLB as probably a "striking Mendelian variant" although he specifically **did not propose a taxonomic change, nor did he cite supporting evidence for this opinion.**

Throughout the 1990's propagation research continued (Ong, 1990; Jamison, 1991; and Gibson, 1997). Ong (1990) stated that during his research, " genotypic differences with regard to both rooting and shooting abilities were observed"; that " It is such variability that warrants the identification and vegetative propagation of superior genotypes"; and that, " Behavior in culture is determined to a larger degree by the selection of genotypes rather than the selection of environmental regimes". **This data would indicate genetic variation in important phenotypic characters within RLB phenotypes.**

In 1994, federal status was changed from endangered to threatened as a result of success with out-planting large numbers of individuals, distribution of the plant to arboreta, collections, and conservation of germplasm (1400+ individuals). (USFWS, 1994) State status

remained unchanged primarily as a result of difficulty in de-listing or changing status. (Chase, personal communication)

After 1995, recovery and research efforts on the species dropped dramatically. Sharik (August 1995) provided a compilation of the "Existing Information on the Genetics of the Virginia Round-leaf Birch, Betula uber (Ashe) Fern. In this summary, **Sharik concluded that RLB should more appropriately be called B. lenta var. uber Ashe, and that round leaf shape is due to a typical Mendelian recessive gene in homozygous genotype,** and gave a summary of the crosses and results generated in cooperation with the late Peter Feret at Reynolds Homestead. He mentions that crosses between one phenotypic RLB from the seed produced outplantings x two different Cressy Creek phenotypic SB yielded 50 % RLB phenotype (2:1 ratio), and crosses between phenotypic RLB x RLB produced almost 100% RLB phenotype. Open pollinated RLB and SB both produced almost all SB. Over 7500 progeny were produced in controlled crosses, but less than 400 were considered "uncontaminated" enough to use for this summary. "In conclusion, the results of **our controlled-crossing experiments, while somewhat limited in scope, do not** refute our original **hypothesis that leaf shape** in the RLB-SB complex **is controlled by a single gene, with the ovate shape characteristic of SB exhibiting complete dominance** over the round shape typical of RLB." **The one and two year seedling that were produced were examined specifically and exclusively for leaf shape (round vs. ovate)**. A paper reporting these crossing results were submitted to a peer reviewed journal by Peter Feret, but never published. His submission review said that analysis was not "rigorous" (Peter Feret, Reynolds Homestead, personal communication), and his subsequent untimely death prevented continued work. I was unable to locate a copy of this manuscript, but Sharik (1995) very adequately summarizes the results.

Phenotypic SB can genetically "contain" and reproduce phenotypic RLB leaf shape, but no genetic work has been done to look at the other characters of RLB, including one (rhododendrin) evidently not found in SB (F. Santamour, cited in Sharik, 1990).

In 2003, I visited a representative set of out-plantings, with current survey data from USFS, both of the original private localities, and the original public site where the species occurs. **Three**

saplings on one private tract, 1 adult on the another tract, 1 adult and 1 sapling on a third tract and the two trees on public property are doing well.
In 2003, eight, out of the original 41 natural population plants are alive, along with 953 reproduced population plants of phenotypic RLB out-planted on public land (USFS, 2003) (TOTAL 961).

Recommendations:

I reviewed all known published information and interviewed most of the individuals involved in the history of the project to protect the plant.
Santamour found similar patterns of isozyme perioxidases show similar patterns in *B. lenta* and uber (USFWS, 1990). Hayden (1984)found that the wood patterns of *B. uber* and *B. lenta* were indistinguishable. The controlled genetic crosses looked only and exclusively at leave shape round (*uber*) vs. ovate (*lenta*). Leaf shape was examined in juvenile (1-2 yr.) plants. The crosses used both *B. uber* and *B. lenta* plants that had been growing in close proximity for some time and birches are notorious for hybridization. Sharik (1980) found 600 (300 were mature enough to produce fruit) *B.lenta* and 7 *B. alleghaniensis* growing in the area of the remaining 11 mature trees of *B. uber*. Pollen source distance was a problem during several of the crossing experiments. *Betula lenta* and *uber* evidently have a diploid, 2 (n) = 28 set of chromosomes (USFWS,1990) and the crossing experiments certainly indicate that phenotypic *B. lenta* crossed with phenotypic *B. uber* can produce ratios that resemble single recessive gene inheritance (Sharik, 1995).
This single phenotypic character may very well be a homozygous recessive trait and one that has been passed both to and from phenotypic *B. lenta* specimens in the area over time. However, there are factors to consider other than leaf shape in the delineation of a species, and although reproductive characters are similar to *B. lenta* (Sharik and Ford, 1984), phenotypic *B. uber* shows variation in other morphological traits. Whether or not these characters are sufficient to delineate a species is uncertain. Sprouting, which is often under genetic control, is variable (Ong, 1990). Sharik and Ford (1984) found differences in spacing and overall number of leaf veins, dentition, and petiole length even though they used only leaves from spur shoots of branches in the lower inside crown leaves, which tend to be more similar to those of *B. lenta* than terminal or sun

leaves. The size and growth rates of *B. uber* and *B. lenta* are different as shown by the out-plantings. *B. uber* was described originally as a small tree and it is consistently outgrown in the out-plantings by phenotypic *lenta*. The branching pattern of *uber* is noticeably different (more diffuse) than *B. lenta*, as are numbers of leaves produced per branch. Santamour and Vettel found rhododendrin in the bark of *B. uber*, but the compound was absent in *B. lenta*. Based on these unexamined phenotypic characters shown by *B. uber,* the number and complexity of genes involved in *B. uber* morphology should be examined by direct genetic tests and considered in the larger question of the identity of *B. uber*.

The first recommendation would address this using direct DNA testing. Many investigative tools are now available that were unknown and untested when RLB status was changed from endangered to threatened. With DNA investigative techniques, such as RFLP, or comparable tests, it may be relatively simple and inexpensive to confirm or reject the "striking Mendalian variant" (homozygous recessive genotype) hypothesis. DNA determinations could be done with the original RLB (#782U, #370U) and SW (#100L, #158L, or #198L) cited in Sharik (1995). I was unable to relocate #158L and 198L because I didn't have a map with these two trees listed, but the others are still alive and available for testing. Dr. Sharik undoubtedly has localities for the two putative heterozygous SW trees used in the original crosses, and they are probably still extant. Since trees used in the original crosses are still available for all genotype possibilities: (1) a homozygous condition for the dominant gene for ovate leaf shape (#100L), (2) heterozygous for the dominant gene for ovate leaf shape and the recessive allele for round leaf shape (#198L or #158L), and (3) a homozygous recessive for round leaf shape (#782), RFLP tests should be able to differentiate between these differing amounts and qualities of DNA with a minimum amount of time and expense. Direct DNA tests would be essential for confirming or disproving the "striking Mendalian variant" (homozygous recessive genotype) hypothesis.

The second recommendation would address the current lack of natural reproduction at sites on National Forest property, and the only vital criterion not met for de-listing. During the review of existing information, it became obvious that establishment was the only part of *B. uber* 's life cycle that current environmental conditions where were not met. A compilation by T.L. Sharik on 5-10-88, titled "Annual net changes in the Cressy Creek Betula uber population", shows that 81 new individuals were "birthed" in 1982. This occurred as a direct result of a 1981 clearing of

two areas adjacent to reproductive RLB trees when seed production on these trees was the highest recorded since monitoring started (Sharik, 1990). No other year produced any establishment. Birches do not consistently produce numerous seeds, and having areas adjacent to adults when heavy seed production does occur is essential. Areas available for seedling establishment should be cleared around all of the adult RLB populations and all SB in and near these populations should be removed to prevent genetic swamping during open out-crossing.

When complete, these actions should (1) provide the necessary information needed for taxonomic clarification and , (2) meet the last vitally important criterion needed for de-listing.

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APPENDIX I

Acknowledgements and Contacts

I would like to acknowledge the assistance of each person who provided help and information for this report. Jerry Chase, T. L. Sharik and Cecil Thomas were especially gracious with time and information.

Individuals contacted and/or cited in text, with annotation:

Jerry Chase, Regional Supervisor
Virginia Department of Agriculture and Consumer Services (VDACS)
Office of Plant and Pest Services
250 Cassell Road
Wytheville, VA 24382
(276) 228-5501

Maintains copies of all VDACS surveys and work on the populations, with the exception of the data base disks. George Anderson and Mary Simms, and Mary Knott monitored flowering, mortality, heights and diameters up until 1997. The records from 1990 until 1995 are relatively complete at this office.

Peter Ferret, deceased, Copies of his reprints are available at the Department of Forestry, Virginia Tech.

Thomas R. Fox, Associate Professor
Department of Forestry
Virginia Tech
228 Cheatham Hall
Blacksburg, VA 24061
(540) 231-8862

James Haulsee, son of Mr. and Mrs Ray Haulsee and heir to the original seedling bed discovered in 1976.
Route 1
Chilhowie, VA 24319
(276) 646-2514

Mr. Haulsee is still very much upset by the consistent bad treatment of his father during the whole affair. He indicated that he would consider visitors to the original seedling bed as trespassers and have them prosecuted as such. He did indicate that he would work with me to cut back the competition around the surviving saplings on the site and repair the protective fence.

Marshall Trammel, Virginia Department of Agriculture and Consumer Services (VDACS)
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Richmond, VA 23209

Worked on the committee in the early years.

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Information on the records at Reynolds Homestead, and Richard Krey, who worked with Peter Ferret on the out-plantings, public distribution, and crosses at Reynolds.

Statement of Objectivity:

This report, and any field-work upon which it is based, have been done with the utmost care and deliberation. Every effort has been made to use the most currently available and valid references, combined with careful observation in the field. When possible, statements involving assumption or hypothesis have been differentiated from those using established data. Field observations are always subject to errors of omission and commission due to seasonality, weather conditions, and fatigue. The observations have been made using experience and expertise of the investigator, following the Code of Ethics of the Society of Wetland Scientists (www.sws.org), but no warranty is expressed or implied.

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