

Recovery Plan
For The
Lyrate Bladderpod
(Lesquerella lyrata) Rollins



U.S. Fish and Wildlife Service
Southeast Region
Atlanta, Georgia

LYRATE BLADDERPOD
(*Lesquerella lyrata* Rollins)

RECOVERY PLAN

Prepared by

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through the

Alabama Natural Heritage Program
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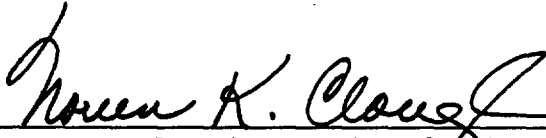
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Jackson, Mississippi

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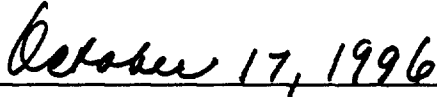
U.S. Fish and Wildlife Service
Southeast Regional Office
Atlanta, Georgia

Approved:



Noreen K. Clough, Regional Director,
Southeast Region, U.S. Fish and Wildlife Service

Date:



October 17, 1996

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By approving this document, the Regional Director certifies that the data used in its development represent the best scientific and commercial data available at the time it was written. Copies of all documents reviewed in development of the plan are available in the administrative record, located at the Jackson, Mississippi, Field Office.

Literature citations should read as follows:

U.S. Fish and Wildlife Service. 1996. Recovery Plan for the Lyrate Bladderpod (*Lesquerella lyrata* Rollins). Atlanta, Georgia. 27 pp.

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The cover illustration was done by Anna Asquith of the Institute

EXECUTIVE SUMMARY

Current Status: *Lesquerella lyrata* is listed as threatened without critical habitat. It is known from one extant population each in Colbert, Franklin, and Lawrence Counties, Alabama. Populations occur on private land with plants extending on to county and State-maintained road rights-of-way at several sites.

Habitat Requirements and Limiting Factors: Populations occur in shallow soils adjacent to outcrops supporting cedar glades. Currently, no portion of any of the populations occurs on a relatively pristine cedar glade, as plants are found in disturbed gladey lawns, fallow/cultivated fields, grassy and rocky pastures, and roadsides. *Lesquerella lyrata* is believed to be an early successional species which is eliminated by the shade and competition of invading perennials. This species is vulnerable due to its limited distribution and threats from herbicide usage, road improvement, a proposed rock quarry, and increasing development in the area.

Recovery Objective: Delisting.

Recovery Criteria: This species will be considered for delisting when nine demonstrably secure and self-sustaining populations exist. A demonstrably secure population is defined as one for which legal protection and active, successful management have been established. A self-sustaining population is defined as a population that is shown by monitoring data to be reproducing and relatively stable for at least a 10-year period.

Actions Needed: (1) Protect populations and manage habitat; (2) survey for additional populations; (3) establish additional populations, if needed; (4) conduct autecological research; (5) conduct long-term population monitoring; (6) maintain plants and seeds *ex situ*; and, (7) provide information to the public.

Total Estimated Cost of Recovery: It is not possible to determine costs beyond the first few years. The cost of implementation of tasks over the next 3 years, for which cost estimates have been made, totals \$59,000.

Date of Recovery: It is not possible to determine a date of recovery at this time since the achievement of recovery depends upon the outcome of several of the recovery tasks.

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PART I: INTRODUCTION

A. Background

Lyrate bladderpod (*Lesquerella lyrata* Rollins) is a small, annual species that belongs to the Brassicaceae (Cruciferae) family. It was discovered and described by Dr. Reed C. Rollins in Franklin County, Alabama in 1955 during an intensive study of the easternmost species of the genus in North America (Rollins 1955). *Lesquerella* is a large genus in North America, with approximately 70, mostly herbaceous species known from Texas, the American Southwest, and Mexico. In the eastern United States, there are six species of *Lesquerella* confined to the Interior Low Plateau physiographic provinces (Fenneman 1938) of central Kentucky and Tennessee, and of northern Alabama (Rollins and Shaw 1973).

Presently, *L. lyrata* is known from one extant population each in Franklin, Colbert, and Lawrence Counties, Alabama. (A population is defined as an aggregation of discrete occurrences, no single one of which is in excess of 1 mile from the next most proximal occurrence.) Of the three sites discovered in Franklin County by Rollins (1955), apparently only the type locality remains extant. Intensive surveying by numerous workers for a number of years, particularly by Dr. David H. Webb of Florence, Alabama, yielded the discovery of the additional populations in Colbert and Lawrence Counties. Because of the very restricted distribution of the species and the demonstrable threats to the species and its habitat, *L. lyrata* was officially listed as threatened under the Endangered Species Act of 1973, as amended, on October 29, 1990 (U.S. Fish and Wildlife Service 1990).

B. Description and Taxonomic Status

Rollins (1955) provided a detailed description of *L. lyrata* in his type description of the species. A close-up photograph of a portion of the infrutescence of the species also accompanied his description. A general abbreviated description, modified from Rollins' (1955) account follows:

Lesquerella lyrata is an annual made up of one to several, usually simple and erect stems of 1 to 3 decimeters (dm) (4 to 12 inches) (in.) in length. Leaves and stems are shortly pubescent. The outer stems are usually decumbent at the base. Basal leaves are stalked and lyrate-shaped, 2 to 7 centimeters (cm) (0.8 to 2.8 in.) long and 6 to 15 millimeters (mm) (0.2 to 0.6 in.) wide. The terminal lobes are large and orbicular to elliptic in shape. The stem leaves are ovate to broadly oblong and obtuse, 5 to 20 mm (0.2 to 0.8 in.) long and 4 to 10 mm (0.2 to 0.4 in.) wide, and sessile with prominent ear-like projections (auricles) at the bases. The margins of the stems are nearly smooth to coarsely toothed.

Inflorescences are dense. The flowers are ascending on densely pubescent stalks 1 to 1.5 cm (0.4 to 0.6 in.) long. Sepals are pubescent, yellowish, oblong, 3 to 4 mm (0.1 to 0.2 in.) long and 1.2 to 1.5 mm (0.1 in.) wide. Petals are yellow, broadly ovate, 5 to 7 mm (0.2 to 0.3 in.) long and 3.5 to 4 mm (0.1 to 0.2 in.) wide, and slightly rounded. The fruits are siliques, which are glabrous, globose in shape, 2.5 to 3.5 mm (0.1 in.) high and 3 to 4 mm (0.1 to 0.2 in.) broad. Seeds are flattened, brown, oval to nearly orbicular in outline, and margined, and range from 1.5 to 2.5 mm (0.1 in.) on the longest dimension.

Taxonomically, *L. lyrata* resembles both *L. auriculata* and *L. densipila* (Rollins 1955). The former species is widely distributed in central Oklahoma and is found at a few stations in eastern Texas, while the latter has a distribution in the Central Basin of Tennessee and the middle portion of the greater Tennessee River Valley in northern Alabama (Marshall, Morgan, Lawrence, and Franklin Counties) (Rollins and Shaw 1973, Kral 1983). *Lesquerella lyrata* and *L. densipila* have not been observed occurring together, nor has *L. lyrata* been observed occurring with the other *Lesquerella* species (*L. lescurii*) that is reported for Alabama (Kral 1983).

Rollins (1955) considered *L. lyrata* to be an evolutionary link between *L. densipila* and *L. auriculata*, the somewhat closer relationship being with the former. Kral (1983)

noted the close resemblance of *L. lyrata* and *L. densipila*, that the fruits of *L. lyrata* were slightly smaller and that both the fruit and the persistent styles are perfectly glabrous. McDaniel (1987) suggested that this difference, while consistent, was insufficient to justify recognition at the species level, and stated that assignment to varietal rank would be more appropriate. However, no worker has formally provided data to support such a change in taxonomic status.

C. Distribution

The current and historical distribution of *L. lyrata* is confined to parts of Franklin, Colbert, and Lawrence counties in Alabama (Figure 1). Rollins (1955), in describing the species, reported three separate stations for Franklin County. Only one of these occurrences, the type locality, at what is known as Richardson's or Cherry Hill Crossing is known to be extant. Attempts to locate plants at his other two localities have been unsuccessful (Webb and Kral 1986, McDaniel 1987; personal observation 1989, 1991, 1992, 1995). However, the exact location of one of these collections, as described by Rollins (1955), was unclear and difficult to precisely identify.

Other Franklin County locations for *L. lyrata* include a site (near Waco) that appears to be documented by a voucher made by J. Baskin and C. Caudle in 1966 or 1967 (apparently deposited at the Vanderbilt University Herbarium). More recently, the author discovered a small colony of 500 to 1,000 plants in a muddy pasture east of Waco. This recently documented occurrence may represent the colony discovered by Baskin and Caudle, or it may be a new locality. Additional occurrences in Franklin County are located on the right-of-way adjacent to a county road. Most of these occurrences were seen by the author to be extant in April, 1992 and 1995.

Lesquerella lyrata was not known from Colbert County until reported by Webb and Kral (1986). This location is the only one known for *L. lyrata* in Colbert County. The population extends onto roadsides, adjacent pastures, and scrub woodlands. A smaller concentration of the plants lies just

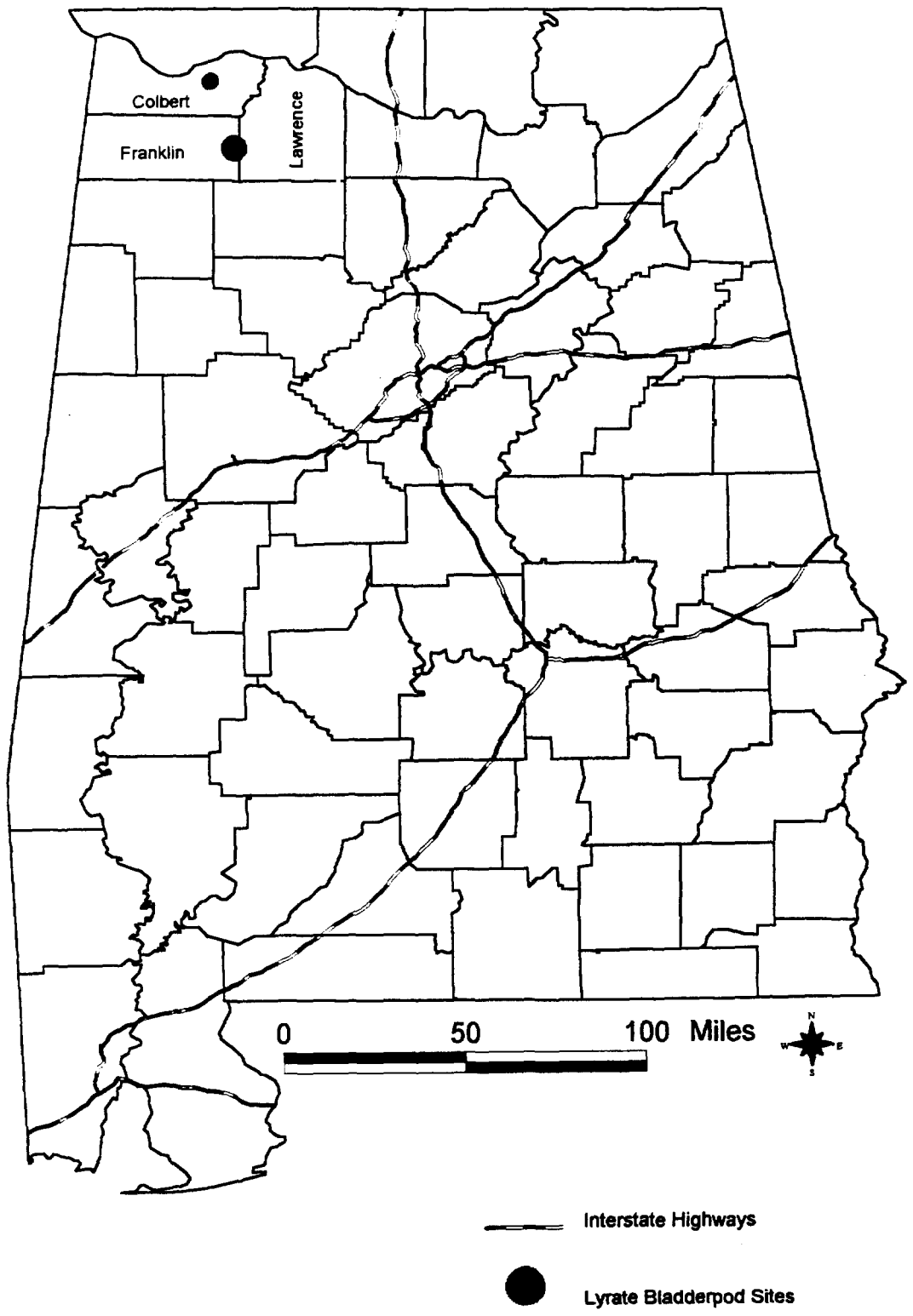


Figure 1: Distribution of Lyrate Bladderpod

to the west in a glade pasture site. The Lawrence County occurrence is the most recently discovered population, found by David H. Webb in April, 1992 (Webb pers. comm. 1994). Plants are located in glade pastures at two sites, approximately 1 mile apart. The author found only one of these occurrences extant and thriving in 1995.

Regarding the physiographic distribution of *L. lyrata*, Webb and Kral (1986) noted that the Colbert County and Franklin County populations were part of two separate and distinct cedar glade systems, the former located in the Tennessee Valley proper and the latter located in the Moulton Valley portion (which also contains the Lawrence County occurrences). The Tennessee Valley glades are underlain by Tusculumbia limestone, and the Moulton Valley sites are on Bangor limestone, both of Mississippian age (Szabo et al. 1988). Webb and Kral (1986) also pointed out that the two areas are separated by the Little Mountain Formation, the geology of which is dominated by Hartselle sandstone, and Pride Mountain Formation shales on the north escarpment (Szabo et al. 1988). Harper (1942) noted that the area is characterized by sandstone outcrops, not limestone outcrops like those found in the Tennessee and Moulton valleys which support a flora very different from that found on sandstone outcrops.

The Colbert County population is located in the Spring Creek watershed, which drains in a southwesterly direction and empties into the Tennessee River just below Sheffield, but the Franklin and Lawrence County populations are in the Town Creek watershed. Town Creek forms the entire eastern boundary of Colbert County and empties into the Tennessee River roughly 20 miles upstream of the mouth of Spring Creek (USDA Soil Conservation Service 1984).

D. Habitat

Members of the genus *Lesquerella* tend to occupy open, and often xeric habitats (Rollins and Shaw 1973), a general description that fits the cedar glade and adjacent area habitats that support *L. lyrata* (Rollins 1955, Kral 1983, Webb and Kral 1986, McDaniel 1987). All known extant sites, and all historical sites that have been relocated, are

adjacent to limestone outcrops supporting cedar glades. There still appear to be a number of cedar glade systems across the Tennessee Valley of northern Alabama (Webb et al. 1992), including some within the range of *L. lyrata*; however, the species has been identified from only a few of them.

Lesquerella lyrata likely evolved on northern Alabama's glade systems, which are "now highly disturbed and occur as isolated pockets surrounded by agricultural lands" (Webb and Kral 1986). Other glades have been destroyed by development for homes and dumping of garbage (Kral 1983). It appears that some disturbance is necessary to maintain the species (Rollins and Shaw 1973, Kral 1983, Webb and Lyons 1984, Webb and Kral 1986, McDaniel 1987). Thus, it is inferred that the species is less common now than in presettlement times, partly due to the apparent lack of natural disturbances on undisturbed glades within the range of *L. lyrata*, as evidenced by the absence of *L. lyrata* on most of those glades (McDaniel 1987).

Cedar glades generally comprise outcroppings of limestone and associated shallow soils that are conspicuously dominated by eastern red cedar (*Juniperus virginiana*). Hackberry (*Celtis occidentalis*) and aromatic sumac (*Rhus aromatica*) also appear to be fairly common on, or adjacent to, most of the sites where *L. lyrata* has been found. While *L. lyrata* is a component of the cedar glade flora (Rollins 1955, Rollins and Shaw 1973, Webb and Kral 1986), it often appears to occur without associates (U.S. Fish and Wildlife Service 1990), usually in the fallow cultivated fields in which it is most often found (McDaniel 1987). However, some associates are reported. Weedy associates reported in the fallow field habitat, are *Cerastium glomeratum* (chickweed) and *Krigia oppositifolia* (false dandelion) (McDaniel 1987). From the adjacent cedar glades, *L. lyrata* is reported to occur in association with *Sedum pulchellum* (rock moss), *Delphinium alabamicum* (Alabama larkspur), *Isoetes butleri* (quillwort), *Leavenworthia alabamica* (Alabama glade-cress) and *Arenaria patula* (sandwort) (Webb and Lyons 1984, McDaniel 1987).

Presently, none of the extant populations of *L. lyrata* occur on a relatively pristine cedar glade. The population centered at Richardson's Crossing in Franklin County is found in gladey lawns, fallow and cultivated garden plots, managed road shoulders, grassy and rocky pastures, and limestone gravelly woods edges. The Colbert County population primarily occupies cultivated cotton fields, but also is found on gravelly road shoulders, shallow, wet roadside ditches, the margins of pushed up stump heaps, and a grassy pasture with several large outcroppings of limestone. The Lawrence County population is found in both grassy and bare pastures, the latter of which is centered on highly disturbed cedar glades and barrens, and on cultivated ground.

E. Life History

Lesquerella lyrata is an annual species of mustard restricted to cedar glades and adjacent suitable habitats. The species is adapted to surviving the harsh, and usually very xeric conditions of these habitats by remaining dormant during the summer months as seeds, which do not germinate until fall. After germination and initial growth, young plants overwinter as rosettes (U.S. Fish and Wildlife Service 1990). Flowering takes place usually from mid-March to early or mid-April, and seed dispersal generally occurs from the end of flowering until mid-May (U.S. Fish and Wildlife Service 1990).

Lesquerella lyrata is believed to be an early successional species that colonizes the shallow soils on, and adjacent to cedar glades. It appears to slowly disappear as the soil layer develops (U.S. Fish and Wildlife Service 1990), which fosters greater competition from other plant species. While *L. lyrata* is eliminated by the shade and competition introduced by invading perennials (Kral 1983, McDaniel 1987), it appears that soil disturbance is necessary to both effectively remove competing vegetation and to bring seeds to the soil surface to facilitate germination (Webb and Lyons 1984, U.S. Fish and Wildlife Service 1990).

As indicated, *L. lyrata* responds positively to certain disturbances. Portions of the Franklin and Colbert County populations, particularly around the area of the type locality, appear to have declined during the past several years due to natural succession and a lack of adequate disturbance to the sites (McDaniel 1987, U.S. Fish and Wildlife Service 1990). This trend appears to have continued based on observations of the Colbert and Franklin County populations by the author in 1989, 1991, 1992, and 1995. However, when appropriate disturbance is present, local populations appear to respond positively, accounting for the explosive nature of the species noted by McDaniel (1987), although other factors also may be at play, such as late freezes during flowering, fall droughts, or timing in the plowing of fields that contain the species. Observations of *L. lyrata* over just a few seasons confirm that populations can fluctuate quite dramatically. Some fluctuations appear to be so dramatic that populations actually may seem to appear and disappear over a number of seasons, a possible example being the discovery of an occurrence of *L. lyrata* near Waco in Franklin County, the site perhaps representing a portion of the population originally documented by J. Baskin and C. Caudle in 1966 (Webb pers. comm. 1992). In 1995, less than 50 plants were observed for all known sites in the Franklin County population, and no plants were observed at the Waco locality.

F. Reasons for Listing

Lesquerella lyrata was once thought to be extinct (U.S. Fish and Wildlife Service 1980), as it had not been seen by botanists since its original discovery by Rollins in 1955. Its rediscovery in 1984 at its type locality (Webb and Kral 1986) helped lead to its eventual listing under the Endangered Species Act. Only one additional population has been discovered since listing. Preliminary considerations for listing as well as the documentation and proposal in support of listing enumerated three general categories of potential threat to the species (McDaniel 1987, U.S. Fish and Wildlife Service 1990). The three factors given were as follows: (1) the inability of existing regulatory mechanisms to adequately protect the species; (2) the

present or threatened destruction, modification, or curtailment of the habitat or range of *L. lyrata*; and, (3) the presence of other natural or manmade factors affecting the continued existence of *L. lyrata*. Prior to this species' Federal listing, there were no regulatory mechanisms in place; however, protection for this species under the Act is limited since most of the populations occur on private land. The main contributing factors leading to the threatened status of *L. lyrata* are impacts to the species' habitat and the species' own extremely limited historical and present distribution.

Most northern Alabama cedar glade systems have been unable to escape human disturbances, including those glade areas that probably naturally supported populations of *L. lyrata*. More recently, most impacts to these glades appear to be from agriculture (Webb and Kral 1986), partly from both livestock management and row crop cultivation. While certain agricultural practices are evidently compatible with the survival of *L. lyrata*, legitimate concerns about importune plowing times, and especially the use of preemergent herbicides have been raised (Webb and Lyons 1984, Webb and Kral 1986, McDaniel 1987). Home construction, trash dumping, and road building also have been observed as negative influences on cedar glade systems, including species of *Lesquerella* (Kral 1983).

The small number of populations make the species especially vulnerable to road widening, housing, and commercial or industrial development. The Colbert and Franklin County populations are located within 10 miles of growing urban areas which increases their vulnerability. A portion of one of these populations is on land recently subdivided for development and another is near a proposed rock quarry.

Of more immediate concern is the lack of proper management. Since *L. lyrata* is essentially no longer known to exist as a part of a functioning glade system, with its own naturally supplied disturbances, its long-term survival probably can only be ensured by active management. To date, beneficial disturbances generally have been supplied by agricultural activities, primarily row cropping, which under certain conditions is not incompatible with the existence of *L.*

lyrata (Webb and Kral 1986, McDaniel 1987). However, any changes from current beneficial agricultural practices to such practices as the implementation of ill-timed plowing, the conversion of row crops to improved pasture (or abandonment of a field), or the use of preemergent herbicides, would likely pose a serious threat to *L. lyrata* (Webb and Lyons 1984, Kral 1983, Webb and Kral 1986, McDaniel 1987). The fact that most of these actions already had been observed in regard to *L. lyrata* heightened the need for concern and prompted the listing of the species.

G. Conservation Measures

Federal listing of *L. lyrata* is the only mechanism currently in place that affords and promotes protection for the species. However, this extends protection to the plant only in regard to Federal actions (actions funded, permitted, or carried out by a Federal agency). The State and county highway departments have been made aware of the locations for this species and been advised on protective measures needed to ensure the plant's survival on the roadside rights-of-way which they manage. Surveys of the north Alabama glade systems and associated rare plants were initiated in 1994 and are continuing (Hilton 1996). Other studies, which will focus on this species, will be undertaken shortly and include species biology studies (e.g., germination studies, basic life cycle information, seed bank investigations) and monitoring populations' responses associated with experimental exclosures.

H. Strategy for Recovery

In order to guarantee the long-term survival of *L. lyrata*, it will be necessary to sufficiently protect and properly manage viable populations of the species. Development of a strategy that can achieve this end will require first the development of a working definition of a viable population; second, the protection and management (possibly including enhancement) of extant populations, and third, the location of new, or possibly the reestablishment of extirpated, or establishment of new populations.

Protection and management should first entail renewing contact with the State/county highway departments and landowners and soliciting their cooperation through participation in cooperative agreements that will outline an acceptable management regimen for each portion of the populations. After this, other options, such as the purchase of conservation easements or fee acquisition, can be explored.

While a great deal of effort already has been made in searching for new populations, such efforts should continue. It is reasonable to believe that there are other populations of *L. lyrata* that await discovery (McDaniel 1987) as the Lawrence County population was just discovered in 1992 (Webb pers. comm. 1994). Since the three known extant populations of *L. lyrata* are inadequate to ensure a secure future for the species, and barring the discovery of sufficient additional populations, searches for and evaluations of suitable sites for both the reestablishment, and establishment of populations of *L. lyrata* should be conducted concurrently with the searches for new populations. The areas of known historical occurrence logically are the first places that should be examined.

Investigations into the biology of *L. lyrata* should be initiated as soon as possible. Of particular importance is the initiation of monitoring activities to determine the source, or sources of population fluctuations and to assess the association to alterations in land use or variations in environmental conditions, such as rainfall and temperature. Landowner cooperation and consent, while required in order to obtain the best information, is not necessary to initiate acquisition of some of the most basic data, which can be gathered from such sources as roadside observations. Best management of *L. lyrata* ultimately will rest upon solid information that can be gained about the species' biology, particularly in regard to the way *L. lyrata* responds to weather, disturbances and other changes to its habitat.

PART II: RECOVERY

A. Recovery Objective

Lesquerella lyrata may be considered for delisting when nine demonstrably secure and self-sustaining populations exist. A demonstrably secure population is defined as one for which legal protection and active, successful management have been established. A self-sustaining population is defined as a population that is shown by monitoring data to be reproducing and relatively stable for at least a 10-year period. The existence of nine such populations (three populations for each extant genetic group) should provide a sufficient buffer against unforeseeable losses of populations.

B. Narrative Outline

1. Protect and manage known populations. The first priority is to obtain protection of all known populations. Protection entails both legal protection and proper management of the populations. The first step suggested here is to develop a working definition of a viable population. Next, using this definition, all populations should be examined to determine the boundaries of the optimum minimum habitat required to maintain each population (preserve design). Anticipating that not all of the land confined within the first choice configuration may be available for protection, alternatives to this configuration should be devised. Once an acceptable strategy for minimum protection is put in place through cooperative agreements with landowners and land managers, then efforts to protect additional portions of the population can be pursued, ideally covering all parts of the populations. Due to the limited number of populations, efforts towards the protection and management of all sites is essential to preventing this species' irreversible decline in the near future.
 - 1.1 Negotiate with State and local highway departments. Populations of *L. lyrata* in both Franklin and Colbert counties partly occupy rights-of-way

belonging to county and State roadways. These road rights-of-way may serve as refugia of inestimable value in the event that inadequate amounts of privately owned lands supporting *L. lyrata* can be protected. Immediate action should be taken to formalize cooperative management agreements with the local and/or State highway departments responsible for the maintenance of these roadways. Elements of any cooperative agreement should include fixed mowing and maintenance schedules that do not injure rosettes in the fall or mature plants prior to seed set in the spring. Proscriptions on the use of herbicides and guidance on notification prior to the implementation of any new construction activities, such as road-widening, paving, or grading of the road shoulder, should also be addressed in these agreements.

- 1.2 Negotiate with landowners. Landowner cooperation is critical to the long-term survival of this species, particularly since populations are located primarily on private lands. All landowners should be contacted and their consent sought to provide for the protection and management of populations. There are a variety of options, affording varying levels of protection for *L. lyrata*, that may be pursued. Acquisition in fee, acquisition of an interest (i.e., a conservation easement), and formal and informal conservation agreements with landowners are the alternatives that are recommended. However, before any of these options are pursued in regard to specific sites, a strategy for the best application of each of these tools for all *L. lyrata* populations should first be devised.

- 1.2.1 Conservation easements. *Lesquerella lyrata* appears to be dependent on frequent disturbance. Disturbance usually comes from such activities as plowing, timbering, mowing or grazing (Kral 1983, Webb and Lyons 1984, Webb and Kral 1986, McDaniel 1987). Since the glade systems on which *L. lyrata* occur no longer are intact, but exist as "isolated

pockets surrounded by agricultural lands" (Webb and Kral 1986), the species' long-term survival is tied to the fate of the agricultural lands on which most of the species occurs. The single most important source of disturbance appears to be that provided by the cultivation of annual row crops. In order to protect *L. lyrata*, a landowner must be prepared to provide the necessary disturbance, or essentially, management. It is apparent that those currently cultivating the land already are in the best position to provide the necessary management or disturbance. It is for this reason that conservation easements with existing landowners are encouraged (Webb and Kral 1986) and may be the preferred option in most cases. Easements provide the added benefit of being less costly than outright acquisition.

Easements should stipulate that habitats not be plowed after a certain date in the fall or prior to a certain date in the spring, in order to avoid destruction of rosettes or of plants with immature fruits, respectively. If possible, it may be wise to stipulate that cultivation, or some significant disturbance occur with a certain minimum frequency (e.g., at least once every 3 years). Easement terms also should preclude the use of preemergent herbicides, or of any herbicides during the time in which *L. lyrata* may be growing. While easements cannot guarantee that the habitats continue to be cultivated or favorably disturbed, they can ensure that the lands are not developed or converted to some detrimental land use.

- 1.2.2 Fee acquisition. Outright ownership of the glade systems containing *L. lyrata* has been strongly recommended (Webb and Kral 1986). This appears to be the best strategy for any

populations found centered around glades judged not to be too irreparably damaged. Glades typically require little management, unlike the cultivated fields and other disturbed areas adjacent to the glades where the bulk of *L. lyrata* is found.

1.2.3 Conservation management agreements.

Agreements, similar to those negotiated with the highway departments, can be negotiated with landowners. Conservation agreements allow a greater degree of flexibility to conservation planners. They can serve as an interim measure of protection or be a recourse when acquisition or an easement are not feasible.

Conservation agreements can be undertaken both formally and informally. Formal agreements, with signatures of both parties, are preferred. However, some landowners may be reluctant to participate in agreements which may alter their land use plans or restrict their freedom in the use of their land. In these cases, an informal, non-binding commitment from a landowner is preferable to no agreement at all. These kinds of agreements can still afford access to property for the purposes of monitoring or other study. Landowner rights and feelings must always be considered and respected.

In all cases, an attempt should be made to gain commitment from landowners to notify the Fish and Wildlife Service before any major actions are implemented which may have an adverse effect on *Lesquerella lyrata* (i.e., home construction, property sale). These commitments can be included as part of a formal management agreement or as a condition within an easement. In the case of lands sensitive enough to merit consideration for fee or interest acquisition, purchases of

rights of first refusal also should be weighed as important options.

- 1.3 Develop management plans for each population and site. Preliminary management plans should be developed concomitantly with the preserve designs for each population. These plans help to direct protection strategies with landowners and land managers and ensure that management activities can be readily implemented once acquisitions, agreements, etc., are in place. Management plans also can help provide a basis, or working platform for long-term monitoring of *L. lyrata* populations, even in those places where management rights or conservation agreements cannot be obtained.

Some baseline data are available to assist in the development of management plans for each of the populations. Sources for this information are the natural heritage databases of the Tennessee Valley Authority (TVA) and Alabama. Another valuable source of information is Dr. David H. Webb, a botanist for TVA who resides in Florence, Alabama. Dr. Webb has spent a number of years searching for and observing this species in its habitat and is familiar with the glade habitats in the Colbert, Franklin, and Lawrence County area.

2. Search for new populations. The 1992 discovery of occurrences of *L. lyrata* in Lawrence County, the new discovery (or rediscovery) of this species near Waco, the species' apparent propensity for dramatic fluctuations in the size of its populations (McDaniel 1987), plus the strong possibility that there remain unexplored (in terms of *L. lyrata*) cedar glades reasonably proximal to the known current and historic range of the species, suggest that searches for new populations should continue. While these searches may yield no additional localities for *L. lyrata*, they are certain to reveal habitat to which *L. lyrata* could be introduced, or re-introduced, if this action is found to be necessary.

- 2.1 Conduct searches for additional populations. Searches for new occurrences of *L. lyrata* should focus on suitable areas reasonably close to the extant sites. Of particular importance would be an attempt to conclusively relocate the site reported by Rollins (1955) to be on "bottomland 4 miles north of Richardson's Crossing, about 9 miles east of Russellville." Some searching should also be conducted on the large glade areas at the northern edge of Bankhead National Forest (Lyons *in litt.* 1995).
- 2.2 Continue to re-examine historic occurrence localities. Historic localities for *L. lyrata* should be included under search efforts carried out within the species' known range. The knowledge that these sites once supported *L. lyrata*, coupled with the knowledge that *L. lyrata* seems to disappear and reappear in places, indicates that the sites of historic occurrence should be observed more frequently. Visits to all sites of historic occurrence could be conducted annually as a routine part of the monitoring of extant populations.
- 2.3 Search for potential relocation/establishment sites for possible use in future. Establishment of additional populations may be necessary if other natural populations are not located. For purposes of establishing (or reestablishing) new populations of *L. lyrata*, sites of historic occurrence are logical first choices for attempting to carry out such activities. However, there may be certain circumstances that would preclude the use of these sites (e.g., inability to gain the cooperation of the landowner(s) or habitat modification that has rendered the habitat unsuitable for such activities). Because of this, alternative sites for the introduction of *L. lyrata* also should be identified, both within and reasonably adjacent to the known historic range of the species. A range of criteria can be devised to help identify what may qualify as an acceptable site.

3. Conduct autecological research. Relatively little is known about the basic biology of *L. lyrata*. Questions exist about the species and its relationship with its environment and such information is important in determining proper management needs. Several areas of study are addressed in tasks 3.1 to 3.3, however, research should not be limited to these items.
 - 3.1 Conduct hybridization studies. Hybridization studies between *L. lyrata* and *L. densipila* have been suggested as a means of determining whether the former would be more appropriately treated as a variety of the latter (McDaniel 1987). While the taxonomic question is important, answering it may have only limited relevance in regard to recovery actions. However, hybridization studies may be of value concerning the potential establishment of new populations of *L. lyrata*. If the two species are shown to not hybridize, then sites with or near to extant *L. densipila* populations, which are known to occur in both Franklin and Lawrence Counties (Kral 1983), could be utilized for establishment of *L. lyrata*. However, if the species hybridize, then precautions would need to be taken to keep new populations of *L. lyrata* safely distant from those of *L. densipila*.
 - 3.2 Conduct studies on seedbank size and seed viability. Seed banks of *L. lyrata* in cultivated fields have been suggested to be very important to the survival of the species (Lyons in litt. 1995, Webb and Kral 1986). Presently, the extent of this value is not known. Research into the reproductive capacity of *L. lyrata* (i.e., how many seeds can be produced per plant) under varying environmental conditions would be useful, as would research into the long-term viability of the seeds in the soil.
 - 3.3 Study germination relative to natural conditions and agricultural practices. Little is known about optimum conditions for germination of *L. lyrata*. Research toward determining those conditions and the requirements of *L. lyrata* are needed. This

information may assist in explaining some of the wide fluctuations in the sizes of populations that have been observed (Webb and Kral 1986, McDaniel 1987). In conjunction with such investigations, the effect of herbicide use, particularly of preemergent herbicides, on the germination of *L. lyrata* seeds is especially needed (Webb and Kral 1986). Use of such herbicides pose a real threat to the species (Webb and Lyons 1984), but their application may also be coincidentally influencing changes in population levels.

4. Conduct long-term site and population monitoring.

Simple, low cost plans for annual or biennial monitoring of known *L. lyrata* populations should be developed and put in place as soon as possible. In addition, sites of historic occurrences should be regularly visited. Any monitoring plan should routinely gather information that will provide basic information on *L. lyrata*, such as area occupied by the species or reproductive success, as well as information on prevailing local environmental conditions, changes in land use at the population sites, and potential threats.

4.1 Implement population monitoring. Dramatic fluctuations in size and apparent health of the populations of *L. lyrata* have been noted (Webb and Lyons 1984, Webb and Kral 1986, McDaniel 1987). The degree to which these fluctuations are natural, and hence of no concern, or the degree to which they are a result of external factors which can be ameliorated or eliminated by better management, is not known. A simple monitoring plan, designed to gather basic, but easily observable information on the year-to-year behavior of the species, as well as the year-to-year changes in its environment would be essential in providing answers to these questions. The information gathered also would serve as a basis upon which to build further work.

Data to be collected for monitoring should include such items as the following: beginning and ending general flowering dates; the area exploited every

year by the population; the varying land usages where plants are observed and the observed level of success of the species as a result of each; observed changes in any land use during the course of a year; and any observed new potential threats. In addition, collecting such local environmental data as daily precipitation amounts and temperature extremes would be of value. Over only a few seasons, such information may suggest which management and protection strategies are optimal and give insight into what constitutes an area sufficient to permit normal fluctuations in a local population and what constitutes a normal fluctuation in a population.

- 4.2 Monitor management techniques and results. As monitoring data accumulate, monitoring techniques should be reviewed and refined, eliminating exercises that are not producing useful results, while adding others, either to answer new questions or to find more effective ways to answer old ones. Such reviews and changes in plans and techniques should be conducted as often as necessary.
5. Maintain seeds and plants ex situ. The greatest threat to this species is its extreme vulnerability due to its limited range and small number of populations. To buffer against the potential catastrophic loss of the known populations, seeds from the populations should be maintained in long-term storage and living collections should be maintained at botanical gardens. Guidance in setting up and maintaining such collections can be obtained from the Center for Plant Conservation.
 - 5.1 Maintain seeds. Arrangements should be made for long-term storage of seed collections from each known population at the USDA Agricultural Research Service National Seed Storage Laboratory in Fort Collins, Colorado. The viability of the seed in these collections should be checked periodically by the Laboratory personnel, and seed should be replaced as often as necessary by fresh collections

from in-State biologists. Information gained here could contribute significantly to the accomplishing of other recovery goals.

- 5.2 Maintain plants. Living collections of each known population of *L. lyrata* should be maintained in caretaker programs at botanical gardens, such as those participating in the Center for Plant Conservation's program for threatened and endangered plant species. Collections should be maintained at physically separate sites to avoid crossing. Plants from these collections also could be used in conjunction with research on the biology of the species.
6. Provide information to the public. Conservation efforts with the greatest successes are those with the greatest amount of public support. Plans should be developed to disperse information on *L. lyrata* to the local public, particularly to agricultural landowners. Providing information to landowners about the conservation needs of the species should help cultivate support and consequently cooperation for the recovery of the plant. It also will increase the chances that previously unknown populations, if they exist, will be discovered and reported. Finally, proper education will increase the likelihood of recruiting cooperative landowners for participation in the creation of reestablishment sites, at both historic and previously unoccupied localities, if needed.

Local Alabama Agricultural Extension Service offices, Alabama Forestry Commission offices, USDA Soil Conservation Service or Agricultural Stabilization and Conservation Service offices, and farmers' cooperatives are logical avenues that can and should be used for the distribution of this information. However, the greatest amount of time should be spent with the owners of the populations of *L. lyrata*.

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PART III: IMPLEMENTATION SCHEDULE

The following Implementation Schedule outlines recovery actions and their estimated costs for the first 3 years of the recovery program. It is a guide for meeting the objective discussed in Part II of this plan. This schedule indicates task priorities, task numbers, task descriptions, duration of tasks, the responsible agencies, and lastly, estimated costs.

Priorities in column one of the following Implementation Schedule are assigned as follows:

- 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.
- 2 - An action that must be taken to prevent a significant decline in species population/habitat quality or some other significant negative impact short of extinction.
- 3 - All other actions necessary to provide for full recovery of the species.

Key to acronyms used in Implementation Schedule

- USFWS** - U.S. Fish and Wildlife Service
ES - Ecological Services Division, U.S. Fish and Wildlife Service
HC - Habitat Conservation, U.S. Fish and Wildlife Service
ADOT - Alabama Department of Transportation
ALNEP - Alabama Natural Heritage Program
TNC - The Nature Conservancy
CPC - Center for Plant Conservation
USDA - U.S. Department of Agriculture

IMPLEMENTATION SCHEDULE										
PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION	RESPONSIBLE PARTY			COST ESTIMATES (\$K)			COMMENTS/NOTES
				USFWS			FY 1	FY 2	FY 3	
				Region	Division	Other				
1	1.1-1.2.3	Protect populations.	Continuous	4	ES	ALNHP, TNC, ADOT				
1	1.3	Develop management plans.	2 years	4	ES	ALNHP, Contractor	2.0	2.0		
2	2.1-2.3	Search for new populations.	4-5 years	4	ES	ALNHP, Contractor	4.0	4.0	4.0	
2	3.1	Conduct hybridization studies.	2 years	4	ES	Contractor	5.0	3.0		
2	3.2	Study seedbank size and seed viability.	3 years	4	ES	Contractor	5.0	3.0	3.0	Study initiated in 1996
2	3.3	Germination studies	3 years	4	ES	CPC, Contractor	5.0	2.5	2.5	Studies initiated in 1996
2	4.1, 4.2	Conduct long-term monitoring.	Continuous	4	ES	ALNHP, Contractor	5.0	2.5	2.5	
2	5.1	Maintain seeds.	Continuous	4	ES	USDA, ALNHP	1.0			1 year for initial collecting
2	5.2	Maintain plants.	Continuous	4	ES	CPC				Cost to be determined
3	6	Provide public with information.	Continuous	4	ES	ALNHP, CPC	1.0	1.0	1.0	

IV. APPENDIX

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