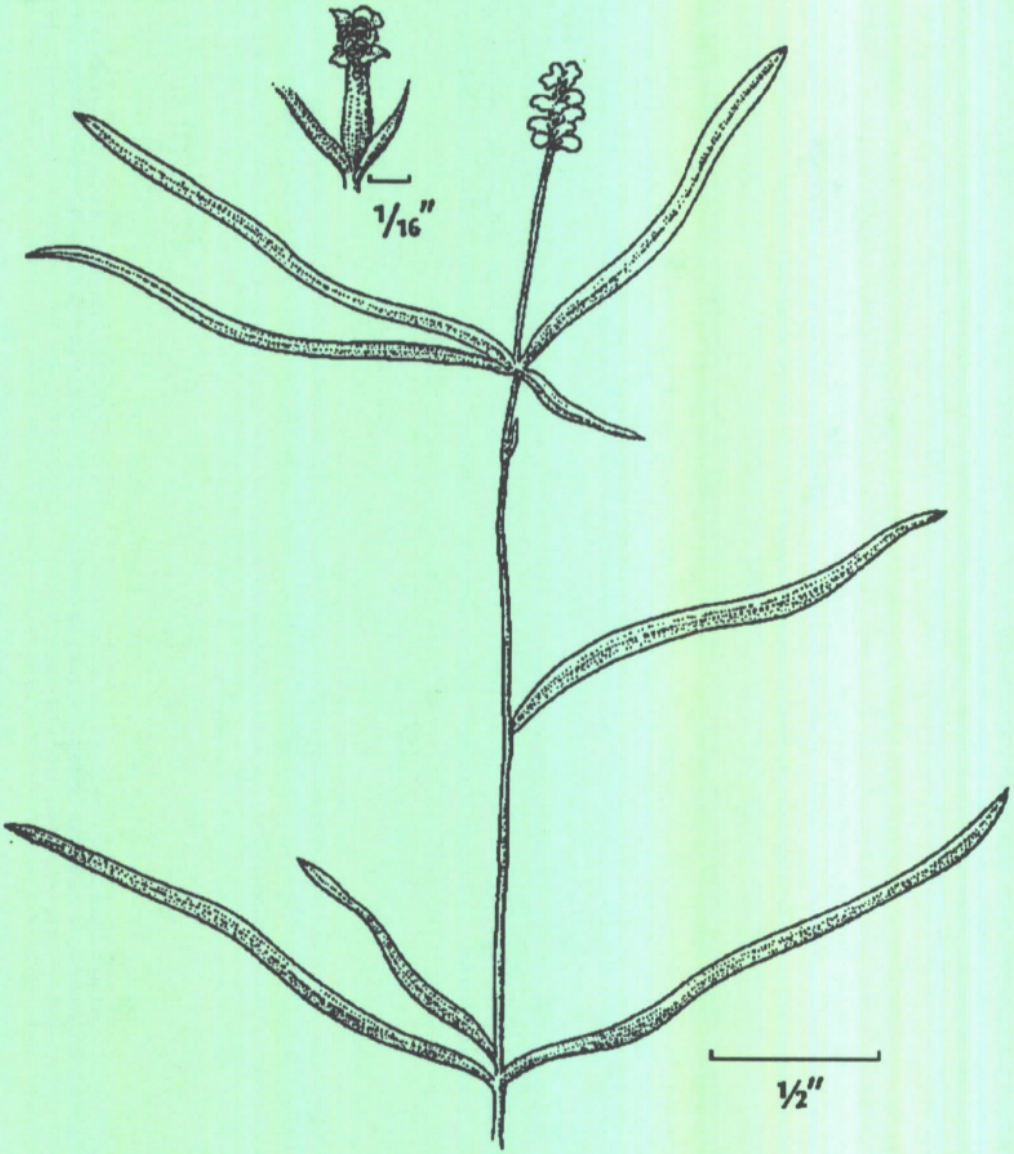
Little Aguja Pondweed Recovery Plan
(*Potamogeton clystocarpus*)



U.S. FISH AND WILDLIFE SERVICE
REGION 2, ALBUQUERQUE, NEW MEXICO
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LITTLE AGUJA PONDWEED

(*Potamogeton clystocarpus*)

RECOVERY PLAN

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for
Region 2
U.S. Fish and Wildlife Service
Albuquerque, New Mexico

Approved: _____
Regional Director, U.S. Fish and Wildlife Service

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LITERATURE CITATIONS

Literature Citations should read as follows:

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EXECUTIVE SUMMARY OF LITTLE AGUJA PONDWEED RECOVERY PLAN

Current Species Status: Little Aguja pondweed is listed as endangered. It is known from only a few miles of a single stream in the Davis Mountains, Jeff Davis County, Texas. No populations have been observed since flooding occurred in 1991 and 1992.

Habitat Requirements and Limiting Factors: Little Aguja pondweed is an aquatic species growing in alluvial substrates in shallow, relatively protected areas of Little Aguja Creek. Little Aguja Creek has a dynamic, deep, and rocky streambed and flows above ground only intermittently along its course. The species occurs in small isolated colonies and is threatened by periodic droughts and scouring floods. Habitat alteration from new modifications of the drainage could reduce or destroy available habitat. Changes in land use in streamside areas might decrease water flow rates or reduce water quality (through nutrient enrichment or pollution).

Recovery Objective: To maintain any populations that may be located, initiate conservation activities, determine if recovery is feasible, and develop recovery criteria.

Recovery Criteria: None developed at this time. An assessment of the potential for recovery is a task in the Recovery Plan.

Actions Needed:

1. Search for the species.
2. Protect any sites discovered.
3. Establish a reserve germ bank/cultivated population.
4. Conduct biological studies necessary for successful management and restoration.
5. Assess restoration feasibility and develop recovery criteria.
6. Develop a public outreach program for the species.

Costs (Dollars X 1000):

	Priority 1 tasks	Priority 1• tasks	Priority 2 tasks	Priority 3 tasks	Total
Year					
1994	34.5	8.5	4.0	0.0	47.0
1995	24.5	54.0	4.0	0.0	82.5
1996	21.5	82.0	26.0	0.0	129.5
1997-2004	131.0	120.0	107.0	5.0	363.0
TOTAL	211.5	264.5	141.0	5.0	622.0

Date of Recovery: If continuous progress is made the objectives of this plan should be met by 2016.

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I. INTRODUCTION AND BACKGROUND

A. Listing History and Recovery Priority

Little Aguja pondweed (Potamogeton clystocarpus) was federally listed as endangered on November 14, 1991 (U.S. Fish and Wildlife Service, 1991). No critical habitat was designated. Potamogeton clystocarpus has a recovery priority of 5. Recovery priorities for listed species range from 1 to 18, with species ranking 1 having the greatest recovery priority. A recovery priority of 5 indicates that this is a full species with a high degree of threat and a relatively low recovery potential (U.S. Fish and Wildlife Service 1983a, 1983b).

The listing of the Little Aguja Pondweed was locally controversial, and many residents and landowners opposed the listing of the species through letters and testimony at a public hearing. They expressed concerns about a number of issues, primarily the perception that listing the species would seriously impede landowner's traditional uses of their property, and a suspicion that the listing would result in the Federal Government using condemnation to acquire properties of landowners who had no desire to sell their property. The Service has stated that current uses of the property do not appear incompatible with the needs of Potamogeton clystocarpus, based on what we know about the species at the present time. Land acquisition has not been recommended as necessary to protect, stabilize, and work toward the recovery of this species.

B. Taxonomy

Little Aguja pondweed (Potamogeton clystocarpus) specimens were first collected by Moore and Steyermark in 1931. It was from this collection that Fernald (1932) selected the type specimen, held at the Gray Herbarium (with isotypes in nine other herbaria). The species was described by Fernald (1932) based on distinctive features of the fruit and stipules, as well as other morphological and anatomical characteristics. Haynes (1974) revised subsection Pusilli of the genus (the narrow leaved pondweeds), and he agreed that Potamogeton clystocarpus was a unique species.

C. Morphological Description

The species of subsection Pusilli of the genus Potamogeton are all linear leaved aquatic plants that grow totally submersed, except for a short time when the flowers extend above the water on thread-like stalks (peduncles). Developing fruits recurve beneath the water. All the species resemble each other in growth form, and general leaf size and shape, and can be impossible to distinguish from one another without flowers or fruits. Mature fruits are important for the identification of Potamogeton clystocarpus. Stipule characters may also be helpful, as Potamogeton clystocarpus generally has stipules clasping the stem but with the margins free. Stipule characters are less reliable, however, and are not considered diagnostic as changes due to age or wear in the environment could cause characters to be misinterpreted (Rowell 1983, Haynes 1974).

The stems of Potamogeton clystocarpus are light green to brown, rounded to slightly compressed, and about 0.5-0.7 mm (1/32 in.) in diameter. The leaves are green and linear, 3- to 5-nerved, with an acute apex, and are up to 7.8 cm (3 1/16 in.) long and 1.7 mm (1/16 in.) wide, usually with white to gold glands present. Stipules are brown, thin and delicate but not shredding at the tip, are usually convolute (one longitudinal edge overlapping the other) but with the margins free, up to 6.2 mm (1/4 in.) long and 0.5 to 0.8 mm (1/64 to 1/32 in.) in diameter. Peduncles are cylindrical, axillary or terminal, erect, relatively long (3.2 to 4.8 cm (1 1/4 to 1 15/16 in.)), and up to 0.5 mm (1/64 in.) in diameter. The spike can be rounded or cylindrical, up to 7.5 mm (5/16 in.) long, and 3.0-5.7 mm (1/8 to 7/32 in.) in diameter, with the blooms arranged in 1-3 verticels up to 1.7 mm (1/16 in.) apart. Petals and sepals are 1.7-2.0 mm (1/16 to 13/16 in.) long and 1.5-1.8 mm (about 1/16 in.) wide. Fruits are egg-shaped to nearly round and are brown to yellow green, 2.0 to 2.2 mm (about 3/32 in.) long and 1.7-1.8

mm (about 1/16 in.) wide, with a dorsal and 2 lateral keels. The dorsal keel is smooth margined (without undulations), may extend up to 0.2 mm (1/128 in.) high and may have a bulbous protrusion at the base. The two lateral keels may be rounded or very obscure, and the sides of the fruit depressed except near the base. The tip of the fruit tapers to a beak that is slightly off-centered and recurved. The base of the fruit may have two or more protuberances, and the fruit wall is rough. Turions (corm-like underground structures) and winter buds are not known from this species.

D. Distribution and Abundance

Potamogeton clystocarpus has a very restricted distribution in the Davis Mountains, Jeff Davis County, Texas (Figure 1). The species has never been reported to occur anywhere but in the drainage of Little Aguja Canyon, in pools in Little Aguja Creek. The species was first collected by Moore and Steyermark (collection #3088) in 1931. It was collected again at least three times prior to 1962 (Warnock and Turner #8076, Palmer #34526, and Correll and Ogden #25070). These collections have notations that the plants occur in "Little Aguja Canyon", "Frequent in still water in Little Aguja Canyon", and "Buffalo Trail Scout Camp area" and do not imply that the species was rare or restricted to a particular locality. Elevations noted in collections and observation records range from 1,524 to 1,615 meters (5,000 to 5,300 feet). It may be significant that one collection observes that the plant is frequent in the Canyon. Rowell (1990 in litt) noted that he had found the species in several different parts of the creek in different years. The status report on the species (Rowell 1983) notes that the species has a scattered distribution in the creek, and where present is generally abundant in a small isolated population. Given the dynamics of the creek system, it is likely that the species has persisted because it had several to many populations scattered throughout the creek, with populations appearing and disappearing or shifting as the creekbed changed.

In summary it appears that the species has been documented to be present in Little Aguja Creek since 1931, has been found in several localities, that it may have been frequent at one time, and that populations observed had "abundant" numbers of individuals (Rowell 1983). Records exist of qualified botanists verifying the existence of plants in 1982 (Texas Natural Heritage Program, pers. comm. and Rowell 1983) and again in 1988

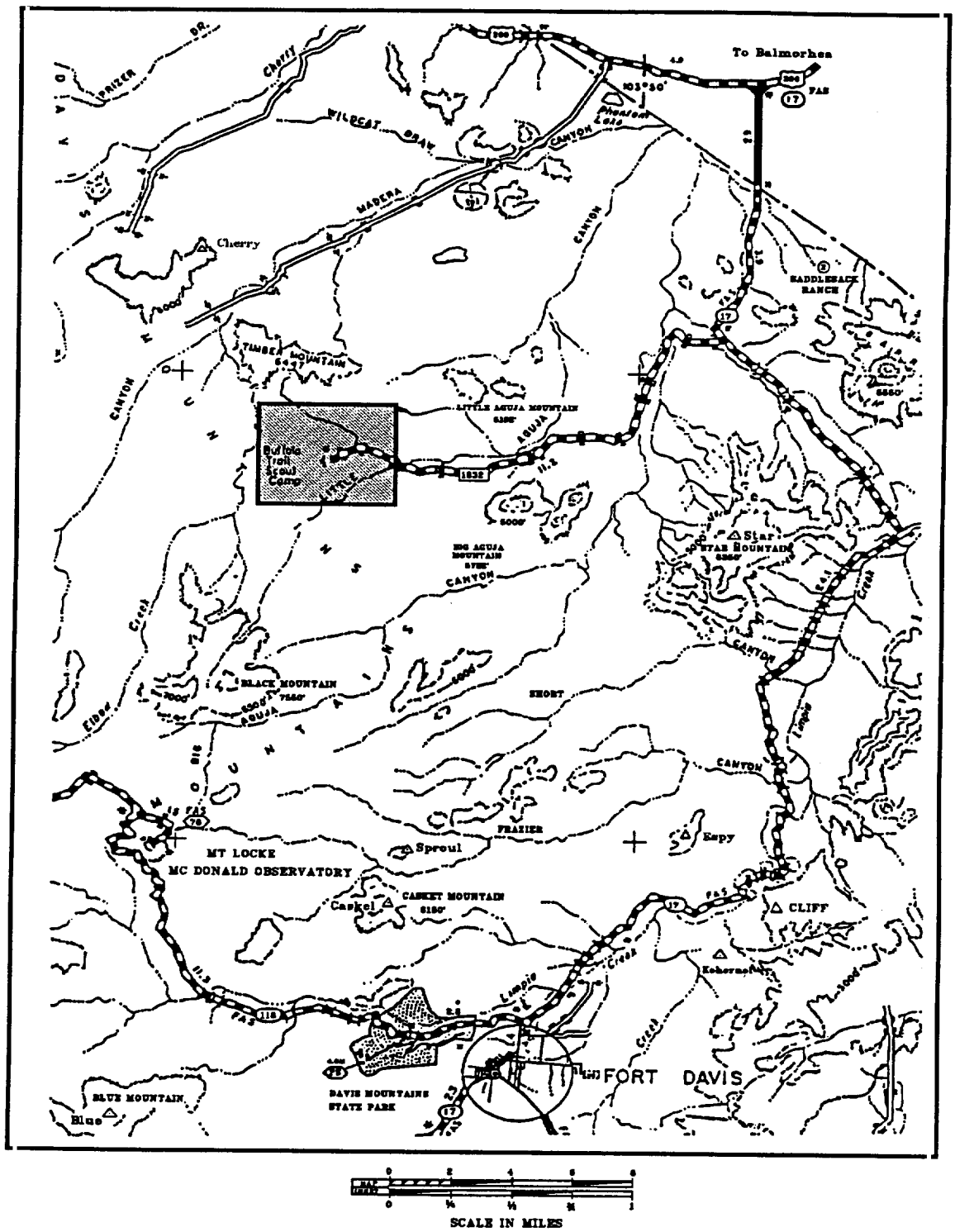

FIGURE 1. Approximate location of known distribution of Potamogeton clystocarpus

(telephone record from Chester Rowell) on the Boy Scout Ranch property.

At the time of the publication of the proposed rule to list Potamogeton clystocarpus it was believed that there were three collection localities known on two different properties. Before the publication of the final rule, however, it was determined that specimens from two collection localities on one of the properties were misidentified, and were in fact a different species of Potamogeton that also occurs in the watershed. This left only one known documented population in Little Aguja Creek on property owned by the Buffalo Trail Council, Boy Scouts of America and operated as a Boy Scout Ranch. In 1990 and 1991 several scouring floods occurred in the canyon. In September 1992 several miles of the creek drainage were searched, including the portion of the Creek where the documented population had been known to occur, but the species was not located. The species is probably adapted to survive periodic flooding and drought (Rowell 1983). While the previously known population of Potamogeton clystocarpus has apparently been damaged or destroyed by recent floods, it is hoped that the species will reappear at or near the previously known site or elsewhere in the watershed. The Service has not been able to conduct a comprehensive search of the entire creek area.

E. Habitat

Little Aguja Creek, where Potamogeton clystocarpus occurs, drains a small watershed in the Davis Mountains, which are mainly Tertiary igneous rocks (rhyolite, tuffs, and basalts). Stream areas are in the Rockhouse Association of the Soil Conservation Service soil survey of Jeff Davis County (U.S. Soil Conservation Service 1977).

Average annual precipitation in nearby Alpine is 37.18 cm (14.6 in.), with the highest rainfall occurring from June to September. Highest rainfall months are July and August when an average of 13 cm (5.1 in.) is recorded.

Potamogeton clystocarpus is an aquatic species growing in igneous derived alluvium substrate in shallow, relatively protected areas of Little Aguja Creek. The species occurs in small isolated colonies in pools within the streambed.

Little Aguja Creek has a very dynamic, deep, and rocky streambed. The stream drains part of the Central Highlands of the Davis Mountains and flows toward the Pecos River. Several small springs are located along and within the stream. The source of water contributing to spring flow is unclear. The McCutcheon Aquifer underlies the Davis Mountains, but its relationship to the creek, its springs, and flow regimes is unclear. Hart's (1992) work on the hydrogeology of the Davis Mountains area notes that the area is riddled with faults and formations that block water flow in some areas and facilitate it in others, that local ground water basins occur in the area, and that alluvial aprons along drainages also serve as local ground water reservoirs in the area. The creek flows above ground year-round only intermittently along its course. Water levels fluctuate greatly during the year, and most of the streambed

dries completely during periodic droughts. The role of springs in maintaining longer-lasting pools is unclear. Flash floods occur almost annually and occasionally severely alter the stream channel. Boulders of several tons are frequently moved considerable distances (Dan Damon, ranch manager, pers. comm.).

Quantitative measurements on habitat characteristics such as depth, substrate type, water temperature, chemical profiles, flow profiles, etc. have never been made for the species. Field work conducted in September 1992 on a portion of the stream revealed 24 populations of other species of Potamogeton. These other species tended to occur in relatively shallow (1 to 5 feet deep) pools with freshwater inflow from nearby seeps or springs. Pools believed to be those from which Potamogeton clystocarpus had previously been found were similar. The substrate in pools believed to be those where Potamogeton clystocarpus had previously been recorded was slightly coarser, but it is unknown if this was the condition when the plants were found there, as the channel characteristics may have changed considerably due to recent flooding.

The water quality needs of this species are also unknown. Within the genus, some species are tolerant of eutrophic conditions (water that is naturally or through pollution becomes nutrient-rich with minerals and organic material, stimulating algal blooms and seasonal oxygen deficiencies), while other species are not (Dr. Robert Haynes, University of Alabama, in litt., 1990). Water in the area is considered to be normally clear and clean with relatively low nutrient loads. However, Rowell (1983) in his status report describes the habitat as quiet pools and herbarium specimen labels note "still water" (B. Warnock # 8076 and B. Turner, SMU). Rowell notes that pools may dry completely during drought, raising the possibility that local pool conditions may become more nutrient-rich at certain seasons or in some years (with algal blooms and low oxygen levels), and

that the species has some tolerance for such conditions.

While the water quality needs of Potamogeton clystocarpus are unknown, and requirements of other species are known to vary widely, Kantrud (1990) has reviewed a number of articles that give insight into the types of variables that may be important. Temperature, turbidity, siltation, coarseness of substrate and nutrient levels have been demonstrated to be important in the growth and reproduction of a variety of other Potamogeton species (Kantrud 1990).

F. Associated Species

While photographs of the creek taken at the time of the status survey (in 1983) appear to show a more diverse and mature community, when examined by the Service in 1992 aquatic vegetation in Little Aguja Creek was relatively sparse. Aquatic species observed were relatively isolated and did not tend to occur with several associated species. Most of the shallow pools along the streambed were vegetated with only a species or two, in patchy, widely dispersed colonies. There are several other species of pondweeds present in the creek, including Potamogeton foliosus (leafy pondweed), Potamogeton pectinatus (Sago pondweed), Potamogeton pusillus (baby pondweed), and Potamogeton nodosus (long-leaf pondweed). Najas guadalupensis (southern naiad) is also found in the creek (Rowell 1983).

G. Life History

Very little is known about the life history of Potamogeton clystocarpus. Blooming and fruiting occur from May to October and possibly later (Correll and Johnston 1979). Winter buds and turions (vegetative reproductive structures commonly produced by some other species of Potamogeton) are not known to occur in this species. It is assumed that the species is dispersed through seed and vegetative stem fragments, which root at the nodes.

H. Impacts and Threats

Because only one documented population of Potamogeton clystocarpus is currently known and the species has not been relocated recently, it is considered extremely vulnerable to extinction through catastrophic events. While the species may never have been common, current numbers of populations and individuals appear to be at critically low levels, and it occurs in a very small portion of the creek. The reasons for the present low number of plants and extremely limited distribution are unclear, but are likely related to changes in water quality, quantity, or seasonal flow regime in the watershed. Such changes might have been caused by a number of human-related, natural, or combined impacts in the watershed in the past. Examples might include reduced flows from local water use or aquifer pumpage, or vegetation changes that change runoff levels or intensity, or nutrient enrichment from high numbers of livestock or wildlife drinking or grazing near the water. Today, periodic droughts and scouring floods in the watershed may reduce numbers of individuals to low enough levels that the species is unable to persist, or its genetic viability may be seriously impaired, triggering an irreversible decline.

Present activities on the property where the documented population existed appear to be compatible with species needs. The property is presently used as a Boy Scout Ranch, with only a few horses, a few goats, and native wildlife. Current conditions at the Boy Scout Ranch do not appear damaging. Changes in the activities at the site or upstream as a result of new ownership or management activities could be damaging if the needs of the species are not known and provided for. Changes that might impact the amount of water in Little Aguja Creek or the quality of water need to be carefully considered for potential adverse impacts to the species.

Changes in water quality could be caused by increases in stocking levels or accidental chemical contamination of the stream. If the species is found to be unable to tolerate eutrophic conditions, increases in numbers of animals (livestock or wildlife) in the near stream area could be harmful. Manure in nearstream areas from livestock and wildlife may increase nutrient loads in runoff into the Creek, and secondarily in the pools. There is some evidence of locally increased nitrate levels in the Davis Mountains area. Hart's (1992) study of the hydrogeology of the Davis Mountains analyzed nitrate contents in 174 wells in the Davis Mountains area, and 80% showed low levels of nitrates. Fourteen wells, however, showed high nitrate levels. Nine of these were in the central highlands area of the Davis Mountains (whose surface drainages include Little Aguja Creek and flow toward the Pecos River) or southwest of Fort Davis. Three of the wells were on ranches where it was noted that livestock could be the source of elevated nitrates. Five of the wells were near towns where human waste was suspected as the contamination source.

Pollution of Little Aguja Creek with petrochemicals or pesticides would also be potentially harmful. Such chemicals are not known to be commonly used in the area, but care should be taken to avoid applications or spills near Little Aguja Creek.

Water use at the Boy Scout Ranch does not currently appear detrimental to water flows in the upstream pools where Potamogeton clystocarpus occurs. The adjacent ranch, also along Little Aguja Creek, has been commended for the fact that it uses no pumps or wells to supply the ranch with water (Brune 1981). Changes in water levels and spring flow rates in the immediate area in a longer historical context are unknown. Brune (1981) notes that water tables in some areas of the county have declined 50 meters (164 feet) since settlement. Care should be taken in future planning, as activities that divert water or change water

flows, depth, substrate or temperature could destroy needed habitat. Flood control measures that affect stream configurations need to be carefully planned to avoid destruction of habitat or siltation of pools.

The amount of water supplying the pools that are habitat for the species could be impacted by changes in stream and spring management (such as dams, flood control structures, spring boxes, changes in water use upstream, etc.). There are springboxes along the canyon bottom, and some water diversion and manipulation (e.g. construction of stock tanks along drainages and manipulations to increase the flow of water from local waterbearing features) has occurred in the canyon. Impacts from past construction and associated activities are unknown.

While the extent of predation on Potamogeton clystocarpus is unknown, it is possible that this may present a threat to the species, especially as plants undoubtedly are at critically low numbers in the wild. Members of the genus Potamogeton are known to be important food sources for waterfowl and other wildlife. Gaevskaya (1966 as cited in Kantrud 1990) compiled a list of over 124 species of animals including vertebrates and invertebrates known to feed on Potamogeton, and many other authors have noted detrimental effects from rooting fish, coatings from microorganisms that block light or cause disease, grazing by snails, attacks on rhizomes by nematodes, feeding waterfowl, etc. (Kantrud 1990).

I. Conservation and Research Efforts

The Buffalo Trail Scout Ranch is voluntarily protecting pools that probably supported Potamogeton clystocarpus in the past and has assisted in surveys to try to locate the species and develop a habitat profile.

In 1992 the Buffalo Trail Scout Ranch planned some streambed work for flood control and roadway stabilization. These plans were reviewed by the Service at the invitation of the landowner, who was concerned and wanted to avoid any adverse impacts to the pondweed or its potential habitat. Due to the location, small area of activity, and timing of the proposed work, no adverse impacts were anticipated.

In September 1992 the Service conducted a survey of the property known to have Potamogeton clystocarpus in the past. Over 20 sites in the Creek were located that had species of the linear-leaved group of pondweeds, but none were Potamogeton clystocarpus.

Mr. Doug Williams of Mercer Arboretum assisted the Service in the search for Potamogeton clystocarpus in 1992 and has taken cuttings of the related species of Potamogeton that were found. Mercer arboretum is a member garden of the Center for Plant Conservation, a non-profit group consisting of affiliated botanical gardens around the nation working to preserve rare and endangered plants. Should the species be relocated, Mercer Arboretum has committed to establishing a conservation collection of the species to assist in the preservation of the genome. Preliminary work propagating and cultivating the related species found at the site has been done to help develop techniques that may be useful in cultivation of the species when it is relocated.

J. Recovery Strategy

With only one known population documented since 1983 and the recent disappearance of the species from that known locality, Potamogeton clystocarpus is extremely vulnerable to extinction, if it is not already lost. Prevention of the extinction of the species in the wild is of first priority.

A concentrated search for the species needs to be made throughout Little Aguja Creek. The initial status survey examined crossings of other streams in the area without finding the species, and botanists collecting in the area have never found Potamogeton clystocarpus along other streams. Nevertheless, there is a small chance that the species might be found along similar adjacent streams, and these should also be rigorously searched.

A cooperative effort between landowners, the Service, and other conservation agencies will be needed to stabilize and conserve Potamogeton clystocarpus. Many local landowners opposed the listing of the species, apparently out of concern that the Service intended to acquire land to preserve Potamogeton clystocarpus even from landowners unwilling to sell, or that the Service would forcibly limit landowners' ability to manage their lands. These concerns need to be addressed before conservation efforts can proceed. The Service has never recommended land acquisition as a preservation or recovery strategy for Potamogeton clystocarpus, and does not believe it is necessary in order to conserve the species. The Service believes that voluntary cooperative efforts to preserve and manage the species are the most desirable approach and should be effective. The Service needs to inform landowners of the need to locate and conserve the species, and the sorts of activities that would be involved in surveys, research, and conservation activities. The

cooperation of interested landowners is essential for completing surveys for the species and working for its preservation and recovery. Landowners should be informed that survey and conservation activities will only be conducted with their permission, advance notification of visits, and careful coordination of logistics and concerns.

When (if) the species is relocated, every effort should be made to stabilize and protect the population(s) in the wild from destruction or accidental harm. The dynamics of the streambed and flood and drought cycles present real challenges to efforts to preserve the species in any one location. A strategy of protection in the wild, off-site cultivation of a reserve population, and eventual dispersal of the species to several sites (throughout the potential habitat) to reduce the chances of loss should be pursued.

Short-term management guidelines and cooperative plans should be developed to protect and preserve any known sites and alleviate obvious threats as much as possible. Sites should be carefully monitored, tracking population size and condition.

So little information is known about the species, its requirements, and its responses to stress and management techniques that long-term management plans cannot reasonably be formulated without additional research. Baseline information is needed about critical needs and responses.

Because the species is vulnerable at present and the stream system is so dynamic, site management alone does not provide sufficient security. A seed bank and cultivated collection is recommended to preserve a genetically representative population off-site at a secure botanical facility and to generate plant material that may be needed in conservation efforts in the wild. Establishing this cultivated collection will require studies of

seed viability, longevity, germination requirements, vegetative propagation, and other aspects of biology in the field and in cultivation that are pertinent to securing and maintaining a quality conservation collection.

The demographic and genetic viability of wild populations needs to be evaluated and maintained. If populations are not viable and reproducing, augmentation of wild populations through breeding programs or adding individuals may be necessary.

Designing a monitoring or management plan that is fine-tuned to meet species needs will require more detailed information about the species, its habitat requirements, any factors limiting its growth and reproduction, and its responses to disturbance and management treatments.

Protection and stabilization of any populations located in the wild will probably be insufficient to guarantee survival of the species and allow delisting. Full recovery will probably require the establishment of additional populations in the creek, and it is unclear if this is feasible. Evaluating the feasibility of full recovery is one of the objectives of this plan. Before the feasibility of recovery (including possible reintroduction) can be evaluated, additional studies will also be needed.

To meet this need for information for monitoring, management, and an assessment of the feasibility of full recovery, studies are recommended to examine habitat and critical system variables (like water chemistry and flow rates), demographic structure, genetic variability and viability, phenology (the relationship of climate and seasonality to the life history stages of a plant) and development, reproductive biology (including seeds and vegetative systems), dispersal, and the mechanisms for establishment of new plants. These studies

are included as tasks in this plan.

The Service's experiences with misunderstandings about its conservation mission and methods of operation, the importance of preserving Potamogeton clystocarpus, and the kind of management techniques and action that are involved in conserving our endangered resources has illuminated a need for better communication and education at many levels including landowners, neighbors, local residents, organizations, leaders and government representatives. The cooperation of an informed and concerned local population is critical to the conservation of Potamogeton clystocarpus. This need for information, communication, and cooperation should be addressed through a comprehensive program that includes personal contacts, offers to assist landowners, presentations, meetings, and publications.

II. RECOVERY

A. Objectives and Recovery Criteria

The objectives of this recovery plan are to prevent the extinction of Potamogeton clystocarpus, to determine if full recovery of the species is feasible, and to develop recovery criteria if appropriate.

The potential for recovery for Potamogeton clystocarpus is unknown because there is little information about the current status of the species and the availability of extant populations or potential habitat to conduct recovery activities. No recovery criteria for the species have been developed as there is no recorded information about numbers of individuals in sustainable populations, the distribution of populations in the habitat, or the dynamics of the plants in these changeable habitats. This information is needed to serve as a basis for delimiting the number of individuals that would constitute a viable population and the number of populations that would constitute full recovery. These parameters will need to be determined and are included as tasks in the plan. Ideally this information would be developed from studies conducted on Potamogeton clystocarpus. If populations are located and are initially too fragile to allow the collection of needed data, initial estimates may need to be developed using data from closely related species to minimize impacts to wild populations.

B. Recovery Outline

The following is an outline of the recovery tasks needed to attain the objectives of this plan. The following section (Narrative Outline of Recovery Actions) includes more detailed information on the tasks.

1. Establish a cooperative relationship with area landowners that will allow surveys and conservation activities to proceed

2. Continue to search for Potamogeton clystocarpus in the Little Aguja Creek watershed and adjoining watersheds

    2.1 Search Little Aguja Creek annually for at least 7-10 years, then every other year for at least 6 additional years depending on regional weather conditions, and finally, conduct 2 additional surveys at 3 year intervals

    2.2 Conduct a rigorous survey of adjacent watersheds every other year for at least 7 years, depending on regional weather conditions

3. Stabilize any populations of Potamogeton clystocarpus located, monitor conditions, evaluate management needs, and develop management plans that preserve natural habitat, provide protection from existing and potential threats, and promote their survival

    3.1 Immediately protect populations from any obvious, manageable threats

    3.2 For each site evaluate the condition of the population and likely site activities, then develop and implement

a short-term management plan that provides effective protective practices and management

3.3 Develop and implement a long-term management plan for each site and for associated areas of the watershed

3.4 Monitor populations for general condition, reproductive success, and to identify any needed management action or revisions to management plans

3.5 Ensure knowledge of and compliance with any applicable Federal and State laws and regulations

4. Establish an off-site conservation collection of plants and propagules to guard against catastrophic loss

4.1 Include maximum genetic diversity

4.2 Establish a monitoring and management plan for the collection

4.3 Coordinate the conservation collection program with research efforts

5. Conduct studies needed to provide a basis for identifying other possible factors limiting growth and reproduction, developing and evaluating protective management plans, managing the conservation collection, determining recovery feasibility, and developing recovery criteria

5.1 Determine hydrologic requirements in the wild

5.11 Study flow levels and rates

5.12 Study hydrochemical profiles and water quality

requirements

5.2 Determine other factors limiting growth or reproduction in the natural environment

5.3 Study community structure

5.4 Study ecosystem and community dynamics

5.41 Study seasonal and cyclic phenomena

5.42 Study positive and negative interactions with other species

5.43 Investigate the role of the seed bank

5.44 Study response to disturbance and management activities

5.5 Characterize the phenology and identify most vulnerable phases of the life cycle

5.6 Study cultivation requirements

5.61 Study seed biology

5.62 Study the biology of seedlings, vegetative fragments, or other propagules

5.63 Investigate propagation techniques

5.7 Study population biology

5.71 Evaluate demographic conditions, determine apparent requirements for long-term survival, and

present options and recommendations for achieving and/or maintaining stable conditions

5.72 Evaluate present genetic variability and viability, determine apparent requirements for viability, and present options and recommendations for achieving and/or maintaining viable conditions

5.73 Determine reproductive biology and dispersal mechanisms

5.731 Determine types of reproduction and contribution to populations

5.732 Study dispersal and establishment mechanisms

6. Evaluate the potential for full recovery and develop recovery criteria if appropriate

7. Develop public awareness about the concern for Potamogeton clystocarpus and the need for continued efforts to preserve and study it

C. Narrative Outline of Recovery Actions

1. Establish a cooperative relationship with area landowners that will allow surveys and conservation activities to proceed. Area landowners are concerned about good stewardship and conservation of unique resources, but are concerned about the Service's role and its intentions with regard to the Jeff Davis Mountains and the stream habitat of Potamogeton clystocarpus. The Service needs to inform area landowners that its concern for the species is genuine, that based on what we know at this time land uses in the area do not appear incompatible with protection and conservation of the species, and that land acquisition is not believed to be necessary and has never been proposed in efforts to prevent the extinction of this species. Landowners need be aware that their cooperation is critical to the survival of the species, and that the Service is seeking genuine cooperative partnerships to achieve its conservation goals. The Service should continue personal contacts and one-on-one meetings with area landowners to inform them of the need for additional surveys, review the sorts of studies and activities that might be expected in efforts to conserve the species, and outline the technical and other assistance available to achieve these needed actions. Only by overcoming previous misunderstandings and developing a spirit of cooperation and commitment can the necessary activities for conservation of Potamogeton clystocarpus proceed.

2. Continue to search for Potamogeton clystocarpus in the Little Aguja Creek watershed and adjoining watersheds. The Little Aguja Creek watershed, where documented populations of Potamogeton clystocarpus exist, should be thoroughly

searched each year to locate any surviving populations. While the chances appear small that the species might occur in any other adjacent watersheds, these also should be rigorously searched.

2.1 Search Little Aguja Creek annually for at least 7-10 years, then every other year for at least 6 additional years, depending on regional weather condition, and finally conduct 2 additional surveys at 3 year intervals. The search for Potamogeton clystocarpus in Little Aguja Creek should be conducted at least annually for a minimum of 7-10 years, and possibly longer if conditions have been unfavorable for its growth and establishment (such as years with very low flows or years with extreme, destructive flooding). In the first few years it would be beneficial to visit the watershed more than once during the growing season, monitoring the relative growth and reproductive periods of all the Potamogeton species present. This would ensure that Potamogeton clystocarpus is not being missed in annual surveys because of some unrecognized, relatively short period of growth that is not presently documented, or because it is obscured by other species at other times of the year. If it is not located in a reasonably rigorous period of annual surveys, then the search could be scaled back to every other year, but searches should cover at least a 13 year period (in total) to assure that every effort has been made to locate any surviving populations. Finally an additional two searches should be made at 3 year intervals (6 years total) to ensure that the species has not reappeared due to new plants germinating following overturning of sediments, etc. At the end of the search period the likelihood of extinction should be reviewed in light of weather patterns, creek

conditions, and effectiveness at searching all potential habitat.

2.2 Conduct a rigorous survey of adjacent watersheds every other year for at least 7 years, depending on regional weather conditions. As noted previously, surveys of stream crossings of adjacent waterways and historical botanical collections from other watersheds in the area have not documented any occurrences of Potamogeton clystocarpus. However, as the species is known to be rare, and the habitat is dynamic, it is possible that these investigations simply missed the species. There is a small chance that the species may be found in some of these adjacent waterways, and they should also be rigorously searched periodically. If Potamogeton clystocarpus exists in any other waterways it would be of critical importance to preservation of the species because such populations would be very significant genetically.

3. Stabilize any populations of Potamogeton clystocarpus located, monitor conditions, evaluate management needs, and develop management plans that preserve natural habitat, provide protection from existing and potential threats, and promote their survival. If any populations of Potamogeton clystocarpus can be found, they should receive the highest possible level of attention. Following consultation with landowners, cooperatively provide immediate protection from any obvious threats at the site. Because population numbers and sizes are expected to be very small, significant loss or damage could occur from even very small scale, localized events or harmful activities in the area. Thorough evaluations of site conditions and present or potential threats are needed, coupled with good planning for protection and management, both in the short and long-term.

Local, federal, and state agencies need to be informed of the needs of the species and any opportunities or obligations they may have to contribute to its preservation and conservation.

3.1 Immediately protect populations from any obvious, manageable threats. If any known serious threats occur at sites where populations of the plant occur, action should be taken immediately to eliminate or reduce them through appropriate planning and management. An example of such activity might be the hand removal of invertebrate predators if they were found in high numbers and observed to be damaging the plants.

3.2 For each site evaluate the condition of the population and likely site activities, then develop and implement a short-term management plan that provides effective protective practices and management. A simple site evaluation should be made for each population found, detailing and evaluating its present condition (location, size, substrate, erodability, hydrological chemical profile, general plant condition, evidence of predation or disease, associated species, etc.) and any obvious actions that should be taken to prevent decline (protection from predation, reducing any obviously limiting competitive growth, etc.). Ongoing or likely activities in the creekbed, immediately upstream, or in near-stream areas should also be evaluated for potential immediate or secondary effects. Following this evaluation, an interim or short-term management plan should be developed in cooperation with the landowner, with practices designed to protect against threats and maintain the population until comprehensive long-term management strategies can be developed. These interim management actions should

be conservative and minimal to avoid inadvertent harm resulting from a lack of information about the species, its responses to management techniques, and its needs. Implementation goals, fiscal needs and resources, and responsibilities should be clear.

3.3 Develop and implement a long-term management plan for each site and for associated areas of the watershed. As information becomes available about critical needs for Potamogeton clystocarpus and its responses to stresses and management actions, long-term management plans should be developed. These plans, in addition to providing for protection and maintenance, should incorporate any tasks needed for habitat conservation or improvement in the watershed, the preservation of population integrity including genetic variability and viability, and possible restoration following disturbances.

3.4 Monitor populations for general condition, reproductive success, and to identify any needed management action or revisions to management plans. Any populations located should be closely monitored. Monitoring will provide the basis for evaluations of relative stability, reproductive success, and effectiveness of management activities. Monitoring should be designed to collect data based on suitable measures of vigor and reproduction and provide quantitative data that are useful in an analytical context for needed research. If several populations can be located, comparisons should be made between populations on a regular basis to help differentiate normal population fluctuations from conditions that reveal stress or decline.

3.5 Ensure knowledge of and compliance with any applicable Federal and State laws and regulations. There are some Federal and State requirements regarding permits and landowner permission for collection, research or cultivation, and transport of plant materials. State law requires that any collection of listed plants for commercial purposes be done only with written permission of the landowner, and plant materials must be permitted and tagged. Federal permits are also needed for commercial sale and cultivation of endangered plant species, or to transport plant materials across state lines in interstate commerce. Any collection activity (including collection for research or for a person's personal use) that occurs without landowner permission in violation of state trespass laws is also prosecutable under the Endangered Species Act. Federal agencies operating locally in funding or carrying out activities in the habitat of Potamogeton clystocarpus have an obligation, under section 7 of the Endangered Species Act, to be sure their activities do not jeopardize the existence of the species. Landowners and local government and agency personnel need to be aware of the presence and needs of the species as well as requirements and opportunities. This should prevent inadvertent violations of the Act (and damage to the species) and help ensure that the species is afforded all the protection and conservation assistance available.

4. Establish an off-site conservation collection of plants and propagules to guard against catastrophic loss. Preservation of Potamogeton clystocarpus in its natural habitat is of first priority. However, there are apparently few populations in the wild and the species occurs in a very restricted geographic area that is highly dynamic (Rowell

1983, U.S. Fish and Wildlife Service 1991). These factors make the species vulnerable to extinction through local catastrophic events. To prevent total loss of the species and preserve any genotypes found for future restoration activities and research, a germ bank and cultivated conservation collection off-site at a secure botanical facility should be established. The conservation collection should be established using responsible techniques that do not threaten the reproductive capacity of existing populations. It is unclear at present if the seed of Potamogeton clystocarpus can be successfully stored long-term. If so, this would be most efficient, combined with a commitment for support in storage, periodic testing, and any necessary propagation or renewal activities from an allied conservation facility. If seed storage is not a viable option, a genetically representative collection of cultivated plant materials may be necessary.

4.1 Include maximum genetic diversity. Materials for the conservation collection should be collected and maintained in a manner that will represent and maintain the maximum possible genetic diversity. This will ensure that the genetic viability of the species can be maintained and is necessary for the species to retain its ability to respond to environmental changes through natural evolutionary processes.

4.2 Establish a monitoring and management plan for the collection. Establishing and maintaining a conservation collection requires expenditure of considerable amounts of time and funding. Cooperation among all parties involved in cultivation and conservation to create an efficient coordinated program is essential. Such programs should be guided by formal management plans that provide for any necessary

cultivation, periodic monitoring, testing, and assessment of the collection. This plan must be compatible with Service policy regarding captive propagation of listed species. The plan should establish appropriate guidelines for collection (such as using similar documentation for collections, maximizing genetic representation, and limiting impacts to wild populations), seed storage, propagation responsibilities and targets, data collection, and distribution and disposal protocol. The guidelines given in Falk and Holsinger's Genetics and Conservation of Rare Plants (1991) would serve as an excellent starting point for a species-specific plan. The plan should provide for periodic coordination among all parties to set reasonable limits for annual collections and to promote the sharing of material, experience, and data. Formal planning and periodic coordination should minimize collection pressures on small populations and make the best possible use of available material and data collected.

4.3 Coordinate the conservation collection program with research efforts. Cultivation for conservation purposes will require additional investigation and careful documentation. Research (using cultivated materials that minimize impacts to wild populations) should be encouraged at many levels, from gardens with conservation collections to agency and independent academic researchers. All aspects of cultivation including growing plants from seed, vegetative structures, or using tissue culture and other techniques should be examined. Managers of conservation collections should work closely with researchers studying reproductive biology, genetics, and restoration needs. Conservation collections can

contribute needed knowledge of cultivation requirements, provide plant materials for research, and strive to collect data using comparable methods so that data can be compared and shared. Researchers should share findings that can be incorporated into the management of the conservation collection to improve efficiency and success, and horticultural research can yield important insight into habitat and management needs.

5. Conduct studies needed to provide a basis for identifying other possible factors limiting growth and reproduction, developing and evaluating protective management plans, managing the conservation collection, determining recovery feasibility, and developing recovery criteria. Lack of knowledge about the basic biology and habitat characteristics of Potamogeton clystocarpus make it impossible to evaluate the possible factors involved in its scarcity and vulnerability. Local residents may provide a valuable historical perspective. Only as more is learned about the species can long-term management plans be formulated, the potential for recovery be realistically evaluated, and effective recovery activities and target criteria be developed. More information is also needed to assist in efforts to establish off-site conservation collections of plants and seed. While the need for information is great and rapid progress is important, research activities could cause damage to any populations located if not carefully coordinated. Landowners, agencies, and investigators, will need to carefully plan and coordinate field activities and lab investigations, working in teams and sharing data whenever possible. Careful coordination and good communication is necessary to minimize research impacts on the wild population(s), maximize use of limited research funding and cultivated materials, and avoid

having activity from one study interfering with monitoring efforts or other research studies.

5.1 Determine hydrologic requirements in the wild. Because Potamogeton clystocarpus is a submersed aquatic plant the nature of the hydrological system it inhabits must be thoroughly understood. Critical variables and tolerances must be identified to guide habitat evaluation and restoration work as well as to succeed with off-site cultivation.

5.11 Study flow levels and rates. The depth and flow rate of water in aquatic systems has been shown to be important to species distribution and abundance in other species of Potamogeton (Kantrud 1990). Upper and lower tolerances for both of these variables should be investigated for Potamogeton clystocarpus in the laboratory and in the wild, if possible. These studies should include an evaluation of any long-term changes in watershed depths and flows in light of these tolerances, and whether or not they may have influenced Potamogeton clystocarpus.

It appears that groundwater tables have declined in the area; since settlement in the Jeff Davis County area, tables have declined more than 50 meters (164 feet) in places (Brune 1981). Brune also noted that in 1976 "about a dozen springs" in the vicinity of Fishing Springs flowed 7.5 lps or liters per second (.26 cfs or cubic feet per second), while in 1932 flow in the area was 96 lps (3.4 cfs). However, Brune notes the 1932 measure included "several other springs", and it appears the two numbers are not directly comparable. This

should be investigated further to determine if long-term changes in flows can be determined. From Brune's text this is unclear as he includes no detail on timing of measurement, whether 1932 and 1976 would be considered typical or abnormal flow years, or other information that would help evaluate any-long term changes.

The work of White, Gale, and Nye (1940) may be helpful as it appears to establish some historical baseline for flows in Little Aguja and adjacent creeks and also well levels in the area. They report discharges from Little Aguja Canyon and its south fork in 1932 and 1933. Interviews with local landowners may also be helpful. Hart (1992) notes that the underlying McCutcheon Aquifer does not appear to be one in which water tables have dropped significantly from 1968 to 1980, but that pumpage in excess of recharge occurred in some areas before that. She does not note the cause or extent of this prior pumpage, but it is assumed to be from intensive irrigated agricultural activity in the lowlands prior to the 1960's, which later ceased to be profitable (Dan Damon, pers. comm.) The relationship between the aquifer and flows in Little Aguja Creek is unclear.

Sources and significance of groundwater in the flow regime of Little Aguja Creek and the maintenance of seasonal pools needs clarification. Hart (1992) notes that the area is riddled with underlying faults and fault zones, which block water flow in some areas and facilitate it in others, while local ground water basins are known to occur. In addition, Hart (1992) and White,

Gale, and Nye (1940) note that alluvial aprons along drainages also serve as ground water reservoirs in the area. Long-term changes impacting such local systems need to be examined for past and potential impact on the habitat of Potamogeton clystocarpus.

5.12 Study hydrochemical profiles and water quality requirements. Identifying the hydrochemical profile of aquatic habitats within Little Aguja Creek, and any specific requirements for Potamogeton clystocarpus, will be important in identifying appropriate habitat for the species and for evaluating threats and management needs. At a minimum, studies should be conducted to evaluate salinity, pH, mineral composition, and dominant cations and anions. Salinity (estimated as total dissolved solids (TDS) in mg/L) and pH (relative acidity or alkalinity of the water) have been shown to be significant factors in differentiation of habitats for different species of Potamogeton. Genetically fixed local populations or areas (ecotypes) that can be differentiated based on salinity tolerances have been identified within some Potamogeton species (Kantrud 1990), as well as differences between species. Pip (1987) conducted an ecological study of 17 species of Potamogeton in central North America and found that the linear-leaved species Potamogeton pectinatus, Potamogeton foliosus, and Potamogeton vaginatus occurred in waters with significantly higher mean salinities and that Potamogeton pectinatus occurred in more alkaline waters relative to other species of Potamogeton. Kantrud (1990) suggests mineral composition of

waters may also favor some species over others. Specific cation and anion composition can also be important. For example, it is known that Potamogeton pectinatus is tolerant of higher chloride (Cl) levels in the water column than other Potamogeton species. Hart (1992) notes that the waters in the Toyahvale area have elevated Cl levels relative to wells in other areas of the Davis Mountains. This Cl profile may be important to Potamogeton clystocarpus.

5.2 Determine other factors limiting growth or reproduction in the natural environment. Identifying those environmental variables critical for successful growth and reproduction in Potamogeton clystocarpus is essential for evaluating any previously unrecognized threats, for developing management guidelines for the species, and for identifying potential habitat for restoration and recovery activities. Substrate type, particularly particle size, appears to be a significant factor in species habitat preferences. Kantrud (1990) reports work by Ravanko along rocky shorelines and by Rich in marshland that showed that species of Potamogeton change within wetland areas as substrates change from coarse to finer textures. Kantrud (1990) has reviewed a number of articles noting that temperature, turbidity (as it impacts siltation rates and light penetrance), siltation, and nutrient levels have significant impacts on growth and reproduction in some Potamogeton species. This research on Potamogeton clystocarpus would be expected to involve some experiments under controlled conditions as well as some data gathering and observation work in the field.

5.3 Study community structure. The most recent survey for

the species occurred relatively soon after scouring floods in the watershed, and the composition of the aquatic communities in Little Aguja Creek appeared relatively simple. However, site photographs from previous years show a more diverse and mature aquatic community. Information about the associated species that may occur with Potamogeton clystocarpus under natural conditions is important to establish a baseline for monitoring the condition of any populations that may be located. This baseline information is also needed to develop and evaluate management guidelines for the species that will adequately address factors such as optimum shade, total plant density, potential competitors throughout the life cycle, and identifying potential habitat for restoration work. Data collected should include species present, relative dominance, density, frequency, and constancy. Careful documentation and measurement of all plants present in the habitat through the year may reveal diagnostic features of the habitat or important dynamic relationships in the life cycle.

5.4 Study ecosystem and community dynamics. Knowledge about the habitat of Potamogeton clystocarpus is so limited that we are unable to definitively characterize its exact habitat, define those critical factors and processes necessary to sustain it, advise what habitat restoration activities might benefit the species, or to predict how it might respond to various disturbances. Characterization of seasonal events and pressures such as rainfall and temperature regimes and their impact on the species is needed. The influence of cyclic dynamic processes such as drought cycles and flooding events should be evaluated. Study of positive and negative interactions with other species (herbivory, disease,

seed or propagule dispersal, and influences on germination and seed bank conditions) is necessary. A knowledge of these processes is important for the formulation of monitoring and management plans to maintain or restore populations and to determine the potential for full recovery of this species.

5.41 Study seasonal and cyclic phenomena. An understanding of any necessary or limiting natural phenomena will be needed to formulate effective management or restoration plans. Periods of establishment, growth and mortality in the life cycle of Potamogeton clystocarpus should be examined for correspondence with seasonal weather cycles (such as rainfall, or warming and cooling periods) or seasonal habitat events (such as downdrawing of pools or ice scouring). In addition, the impact of more sporadic or cyclical events, such as prolonged drought or severe flooding, should be evaluated for past or potential influences on mortality, reproductive success, dispersal of seed or propagules, and germination or establishment of new individuals.

5.42 Study positive and negative interactions with other species. Both positive and negative impacts of other species in the community need study. Shade and competition from other plants during the growing season may be significant. Herbivory may present a threat to seed maturation or dispersal, or to optimum plant growth during certain critical periods. The coating of seeds by fungi or ingestion by animals is an important factor in the germination of many aquatic plants (Leck 1989). Provisions may need to be made in management plans

to accommodate certain critical interactions or mediate the impact of identified threats.

5.43 Investigate the role of the seed bank. The presence and relative importance of seed banks in maintaining populations of Potamogeton is not well understood and could be of critical importance in sustaining populations both within more stable sites in the watershed and in the dynamic watershed system as a whole. Leck (1989) notes that most aquatic plants with persistent seed banks have small seeds, and that most submersed species germinate while inundated. Dormancy of seed varies, with some species germinating soon after dispersal and others having dormant seeds whose germination is triggered by scouring or drying of seed. Potamogeton has small seeds and may have a seed or vegetative propagule bank (or both). If a seed bank is present it would be important to characterize its longevity, regeneration time, and factors influencing germination conditions.

5.44 Study response to disturbance and management activities. While an analysis of some seasonal or cyclic disturbances (such as drought or flooding) would be conducted under task 5.41 above, other large and small-scale disturbances should also be examined. For example, rooting in the root zone by fish can have dramatic effects on stands of other species of Potamogeton (Kantrud 1990). Studies should also be conducted (in an experimental context) on typical disturbances caused by man either accidentally or intentionally. These would include such

disturbances as substrate turnover and siltation (associated with channel modifications, the removal of competing vegetation, development of fishing resources, water features, or control structures) or the short and long-term effects of any chemicals that might be used near shore or in streams. These studies should reveal the tolerances of the species for various factors, show which are of management concern, and give some basis for developing management guidance.

5.5 Characterize the phenology and identify most vulnerable phases of the life cycle. Sporadic observations by botanists are the only indication of seasonal phenology known for Potamogeton clystocarpus. A program of taking periodic quantitative phenological observations several times during the growing season should be initiated. Observations should include such periods as shoot elongation, bud and flower formation, flower opening, fruit development, fruit dispersal, formation of any vegetative reproductive structures, etc. These studies should include quantitative data collection conducted for several seasons, covering the spectrum of climatic variation. An evaluation should be made of any stages in the life cycle that are critical and consistently impaired, any known causes of impairment, and advisable management. This data would also be used in examining seasonal phenomena in task 5.41.

5.6 Study cultivation requirements. An off-site cultivated collection and seed bank is advised, and additional studies are needed for the establishment of a successful management program for both natural and cultivated populations. While the cultivation of other species of Potamogeton widely used in aquatic habitat

restoration and waterfowl management have had considerable study, there appears to be significant differences in habitat requirements for different species, and no quantitative data exists for Potamogeton clystocarpus.

5.61 Study seed biology. Attributes in addition to simple seed production, such as viability, longevity, degree of dormancy, and factors inducing and breaking dormancy need to be determined.

5.62 Study the biology of seedlings, vegetative fragments, or other propagules. Light, temperature, moisture, and nutrient requirements for establishment of seedlings, rooting of vegetative fragments or establishment of seedlings from other types of propagules need to be understood (establishment means attaining independence from seed or propagule reserves and making the transition to independent nutrition and growth). These requirements and tolerance ranges need to be investigated for both field and cultivated conditions, as they are likely to vary. This task would concentrate on cultivated conditions; field conditions are to be investigated under task 5.732. Threats to seedling establishment (such as disease and predation) need to be identified, monitored, and evaluated.

5.63 Investigate propagation techniques. Cultivation using seed, cuttings, or other propagation techniques (such as tissue culture) should be investigated for use in the conservation

collection or in restoration management. Clonal techniques present challenges in maintaining needed levels of genetic variability for natural populations. If properly handled however, these techniques may be invaluable in producing needed materials for research and restoration activities with minimal impact on wild populations (D. Spencer, Aquatic Weed Laboratory, pers. comm., 1992).

5.7 Study population biology. The current status of populations in terms of stability, viability, and reproductive biology (seed fertility, pollen viability, pollination effectiveness) are unknown. Studies are needed to evaluate the condition and stability of existing populations and to assist in formulating effective management plans.

5.71 Evaluate demographic conditions, determine apparent requirements for long-term survival, and present options and recommendations for achieving and/or maintaining stable conditions. Analysis of the distribution of different age-classes in existing populations and the relative contribution of each to regeneration is important in evaluating population persistence and stability (Harper 1977). For Potamogeton clystocarpus this is unknown and needs to be established. The survivorship curve (average number of individuals of a given age class surviving over time) of the species is not known. This study should provide information needed to assess the demographic stability of populations, and should develop recommendations and targets for numbers of individuals of various ages needed to maintain the

population.

5.72 Evaluate present genetic variability and viability, determine apparent requirements for viability, and present options and recommendations for achieving and/or maintaining viable conditions. The genetic viability of Potamogeton clystocarpus is unknown. Low variability may develop in areas where populations have few individuals and are geographically isolated from each other (Futuyma 1986). In some species low genetic variability results in lowered fertility and viability and an impaired ability to respond to environmental change. Other species appear to retain viability even under conditions of low variability. The genetic variability and viability of existing populations of Potamogeton clystocarpus needs to be evaluated and recommendations for management developed.

5.73 Determine reproductive biology and dispersal mechanisms. No studies of the reproductive biology of Potamogeton clystocarpus have been done. This information is needed before long-term management of wild populations, a cultivation program, or restoration and recovery work can be successful. The reproduction of Potamogeton clystocarpus from flowering to the germination and establishment of new plants (including mechanisms, processes, and necessary agents), needs to be understood. This investigation would build on the phenological information collected in task 5.5, but examine in greater detail in an experimental context the processes involved. Any stages that appear to be impaired should be evaluated, and

recommendations to address these deficiencies should be developed.

5.731 Determine types of reproduction and contribution to populations. Seed production through outcrossing and the production of clones through the rooting of vegetative fragments are assumed to occur. Additional studies are needed to document the actual incidence of selfing, outcrossing, and cloning and the potential for other types of propagules such as winter buds or turions. The relative importance of each of these reproductive methods to establishing and maintaining populations should be established. The potential for hybridization with other species in the area should be evaluated.

5.732 Study dispersal and establishment mechanisms. Seed production and viability of Potamogeton clystocarpus in the field need to be determined, as well as the dispersal mechanism(s) and dispersal distances of seed, fragments, and propagules. Losses of seed crops due to disease and predation should be monitored.. Factors influencing establishment under field conditions and tolerance ranges for the species need to be determined. This information is needed for restoration and management planning.

6. Evaluate the potential for full recovery and develop recovery criteria if appropriate. Based on the results of

studies conducted in task 5, the potential for full recovery of Potamogeton clystocarpus should be evaluated. If recovery appears feasible, then appropriate down and/or de-listing criteria should be developed.

7. Develop public awareness about the concern for Potamogeton clystocarpus and the need for continued efforts to preserve and study it. Provisions for working with local landowners is discussed in task 1. An understanding of the need to protect and preserve Potamogeton clystocarpus and support for efforts to conserve it is desirable in the local community as well. Presentations and the distribution of brochures and other materials to local government officials and leaders would be helpful, as would contacts at local community events. Informing the local media about plans and progress should be beneficial. While the greatest need for public understanding and support is in the local area, other Texans and Americans should be informed about endangered species, their needs, and their value as a part of our natural heritage. These larger audiences are probably best reached through the educational system, youth groups, television and radio programming and similar products where information can be presented as part of an overall program to explain the importance and benefits of preserving biodiversity.

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PART III. IMPLEMENTATION SCHEDULE

The following implementation schedule outlines actions and estimated costs for the Potamogeton clystocarpus recovery program. It is a guide for meeting the objectives discussed in Part II of this Plan. The schedule indicates task priorities, task numbers, task descriptions, duration of tasks, responsible agencies, and estimated costs. These actions, when accomplished, should help conserve Potamogeton clystocarpus, protect its habitat, and determine if it can be recovered. It should be noted that the estimated monetary needs for all parties involved in recovery are identified in the implementation schedule for the first three years only, and therefore are not reflective of total recovery costs. An estimate of the total cost of the tasks identified in this plan is provided in the Executive Summary, page ii. The costs estimated are intended to assist in planning. This recovery plan does not obligate any involved agency to expend the estimated funds. Though work with private landowners is called for in the recovery plan, private landowner actions are voluntary and they are not obligated to expend any funds.

Task Priorities

Priority 1 - An action that must be taken to prevent extinction or to prevent the species from declining irreversibly in the foreseeable future.

Priority 1• - An action that by itself will not prevent extinction or an irreversible decline, but which is necessary to carry out a task that is a priority 1 as defined above.

Priority 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.

Priority 3 - All other actions necessary to meet the recovery objective.

Abbreviations Used

CPC - Center for Plant Conservation
FWS - Fish and Wildlife Service
  ES - Ecological Services
  LE - Law Enforcement
TPWD - Texas Parks and Wildlife Department

LITTLE AGUJA PONDWEED RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
1	1.0	Establish a cooperative relationship with area landowners that will allow surveys and conservation activities to proceed	Continuous	2	ES	TPWD	1.0 0.5	1.0 0.5	1.0 0.5	necessary for all other tasks
1	2.1	Search Little Aguja Creek annually for at least 7-10 years, then every other year for at least 6 additional years, depending on regional weather condition, and finally, conduct 2 additional surveys at 3 year intervals	19-22	2	ES	TPWD	2.5 1.0	2.5 1.0	2.5 1.0	one year completed necessary to tasks 3.1, 3.2, 3.4, 3.5, 4.1, all site based research studies, task 3.3, and task 6
1	2.2	Conduct a rigorous survey of adjacent watersheds every other year for at least 7 years	7	2	ES	TPWD	4.0 1.0		4.0 1.0	necessary to tasks 3.1, 3.2, 3.4, 3.5, 4.1, all site based research studies, task 3.3, and task 6
1	3.1	Immediately protect populations located from any obvious, manageable threats	one year or continuous	2	ES	TPWD	5.0 1.0	1.0 1.0		depends on threats identified
1	3.2	Conduct site evaluations and develop and implement short-term management plans	2	2	ES	TPWD	3.0 0.5	2.0 0.5		
1	3.4	Monitor populations	continuous	2	ES	TPWD	4.0 1.0	4.0 1.0	4.0 1.0	necessary to tasks 3.1, 3.2, 5.71, 5.731, 3.3, 5.41, and 6.0 helpful to task 5.2
1	3.5	Ensure knowledge of and compliance with applicable Federal and State laws and regulations	ongoing	2	ES LE	TPWD	1.0 1.0 1.0	1.0 1.0 1.0	1.0 1.0 1.0	

LITTLE AGUJA PONDWEED RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
1	4.1	Establish an off-site cultivated collection/seed bank with maximum genetic diversity	5	2	ES	CPC TPWD	2.0 4.0 1.0	2.0 4.0 1.0	2.0 1.0 0.5	necessary to tasks 3.1, 3.3, 5.61, 5.62, 5.63, 5.72, 5.731, and 6.0 helpful to tasks 5.11, 5.12, 5.2, 5.5, 5.42, 5.43, 5.5, 7.0
1•	5.11	Study flow level and flow rate requirements	3	2	ES	TPWD		8.0 2.0	8.0 2.0	initiate after initial surveys necessary to tasks 3.1, 3.3, 3.4, 3.5, 4.1, 6.0 helpful to tasks 5.41, 5.44, 5.62, and 5.732
1•	5.12	Study hydrochemical profiles and water quality requirements	3	2	ES	TPWD		7.0 1.5	7.0 1.5	established government agency aquatic plant research labs are potential cooperators necessary to tasks 3.1, 3.3, 3.4, 3.5, 4.1 helpful to tasks 5.44, 5.62, 5.63
1•	5.3	Study community structure	2	2	ES	TPWD		5.0 1.0	5.0 1.0	necessary to tasks 2.1, 2.2, 3.3, 3.4, 3.5, 5.41, 5.44, and 6
1•	5.44	Study response to disturbance and management activities	5	2	ES	TPWD			6.0 2.0	initiate after initial surveys and habitat work are done necessary to tasks 3.1, 3.3, 3.4, 3.5, and 6 helpful to task 5.2
1•	5.5	Characterize the phenology and identify most vulnerable phases of the life cycle	5	2	ES	TPWD	6.5 2.0	6.5 2.0	6.5 2.0	necessary to tasks 3.1, 3.3, 3.4, 3.5, 4.1, and 6 helpful to tasks 5.2, 5.42, and 5.44

LITTLE AGUJA RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
1•	5.61	Study seed biology	5	2	ES	TPWD		2.0 0.5	2.0 0.5	initiate after initial surveys necessary to tasks 3.3, 3.4, 3.5, 4.1, and 5.43 helpful to tasks 5.2, 5.44, and 5.732
1•	5.62	Study the biology of seedlings, vegetative fragments, or other propagules	3	2	ES	CPC TPWD		1.0 4.0 1.0	1.0 4.0 1.0	initiate after initial surveys necessary to tasks 3.1, 3.3, 3.4, 3.5, 5.2, and 6 helpful to task 5.42, 5.43, 5.44, 5.63, 5.71, 5.731, and 5.732
1•	5.63	Investigate propagative techniques	2	2	ES	CPC TPWD		0.5 3.5 0.5	0.5 3.5 0.5	would initiate as soon as plants are located necessary to tasks 4.1, 5.12, 5.2, 5.44, 5.62, 5.731, and 5.732
1•	5.71	Evaluate demographic conditions, determine requirements for long-term survival, and present options and recommendations	4	2	ES	TPWD			5.0 1.0	initiate after initial surveys necessary to tasks 3.1, 3.3, 3.4, 3.5, 5.44, and 6 helpful to tasks 5.2, 5.43, and 5.62

LITTLE AGUJA PONDWEED RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
1•	5.72	Evaluate present genetic variability and viability, determine requirements for viability, and present options and recommendations	2	2	ES	TPWD			5.0 1.0	inititate after preliminary population evaluations necessary to 3.3, 3.4, 3.5, 4.1, and 5.2
1•	5.731	Determine types of reproduction and contribution to populations	3	2	ES	TPWD		6.0 2.0	6.0 2.0	coordinate with task 5.732 necessary to tasks 3.1, 3.3, 3.4, 3.5, 4.2, 5.12, 5.2, and 5.42
1•	5.732	Study dispersal and establishment mechanisms	3	2	ES	TPWD			6.0 2.0	coordinate with tasks 5.731 and 5.62 necessary to tasks 3.1, 3.3, 3.4, 3.5, and 5.2 helpful to tasks 4.1, 5.41, 5.42, 5.43, 5.44, 5.5, and 5.62
2	3.3	Develop and implement a long-term management plan for each site located	continuous	2	ES	TPWD				dependent on research results helpful to tasks 3.1, 3.4, and 3.5
2	4.2	Establish a monitoring and management plan for the cultivated collection	1	2	ES	CPC TPWD			0.5 0.5 0.5	necessary to task 4.1
2	4.3	Coordinate the conservation collection program with research efforts	continuous	2	ES	CPC TPWD			0.5 0.5 0.5	necessary to task 4.1 helpful to tasks 5.61, 5.62, 5.63, 5.72, 5.731, and 5.732

LITTLE AGUJA PONDWEED RECOVERY PLAN IMPLEMENTATION SCHEDULE

PRIORITY #	TASK #	TASK DESCRIPTION	TASK DURATION (YRS)	RESPONSIBLE PARTY			COST ESTIMATES ($000)			COMMENTS
				FWS		OTHER	YEAR 1	YEAR 2	YEAR 3	
				REGION	PROGRAM					
2	5.2	Determine other factors limiting growth or reproduction in the natural environment	5	2	ES	TPWD			6.0 2.0	necessary to tasks 3.1, and 3.3 helpful to tasks 3.4, 3.5, 5.44, 5.62, and 6
2	5.41	Study seasonal and cyclic phenomena	3	2	ES	TPWD			5.0 1.0	necessary for tasks 3.1, 3.3, 3.4, 3.5, and 5.2 helpful to tasks 5.43, 5.44, and 5.71
2	5.42	Study positive and negative interactions with other species	3	2	ES	TPWD			6.0 2.0	necessary to tasks 3.1, 3.3, 3.4, 3.5, 5.5, and 5.732 helpful to tasks 5.2, 5.44, 5.62, and 6
2	5.43	Investigate the role of the seed bank	3	2	ES	TPWD				should wait until seed biology work is done necessary to tasks 3.1, 3.3, 3.5, and 5.732 helpful to tasks 5.2 and 5.44
2	7.0	Develop public awareness about the concern for Potamogeton clystocarpus and the need for continued efforts to preserve and study it	ongoing and continuous	2	ES	CPC TPWD	3.0 1.0	3.0 1.0	0.5 0.5	
3	6.0	Evaluate the potential for full recovery and develop recovery criteria if appropriate	2	2	ES	TPWD				cannot initiate prior to completion of survey work

Appendix

Summary of Comments Received on the Draft Little Aguja Pondweed Recovery Plan

In December of 1993, the Service distributed over 80 copies of the draft recovery plan to landowners, recovery team members, agencies, academic researchers, botanical gardens, conservation organizations, agricultural producer organizations, and interested individuals. In addition, 74 letters were distributed notifying addressees that the plan was available for public review and comment. To reach concerned landowners and residents, the Service contacted the local landowners association, made announcements in the local media, and conducted an informal briefing, with copies of the plan available. This informal briefing was held on December 16, 1993, at Indian Lodge in Davis Mountains State Park and included an overview of the plan, procedures for commenting, and a period for answering questions. Nineteen people attended the briefing and there was active participation from the audience and a discussion of concerns. At the end of the public comment period written comments had been received from the six respondents listed below.

Mr. Topper Frank, President, Davis Mountains Trans-Pecos Heritage Association

Mr. Gary Graham, Carrollton, Texas

Dr. Kent E. Holsinger, Center for Conservation and Biodiversity, Department of Ecology and Evolutionary Biology, The University of Connecticut

Ms. Jackie Poole and Ms. Gena Janssen, Endangered Resources Branch, Texas Parks and Wildlife Department

Dr. Chester Rowell, Marfa, Texas (submitted by Mr. Ben Love)

Mr. Greg Wieland, Mercer Arboretum and Botanic Gardens, Humble, Texas

All comments were considered when revising the draft plan. The Service appreciates the time that each of the commenters took to review the draft and to submit their comments. One letter combined brief comments about the plan with a petition to delist the species, and the issues related to listing the species were reviewed and evaluated as a part of the consideration of the petition. The 90-day finding on whether or not the petition presented information indicating that delisting may be warranted is made as a separate action and will be published in the Federal Register.

The comments discussed below represent a composite of those received. Comments of a similar nature are grouped together. Substantive comments that question approach, methodology, or financial needs called for in the draft plan, or suggest changes to the plan, are discussed here. Comments received that related to the original listing decision, perceived value of this species, or general comments about the Endangered Species Act that did not relate to the Little Aguja pondweed are not discussed here. Comments regarding simple editorial suggestions such as better wording or spelling and punctuation changes, errors in addition, etc., were incorporated as appropriate without discussion here.

All comments received are retained as a part of the Administrative Record of recovery plan development in the Austin, Texas, Ecological Services office.

Comments on Recovery Plan Tasks

Comment: In light of the number of species known to have been rediscovered after time sequences of as long as 50-100 years from their last sighting, the number of years allowed for the search seems too brief. You should thoroughly search suitable habitat annually for a long enough period to allow several drought/flood cycles, probably at least 20 years.

and

Comment: It might be advisable to continue the surveys in the creek for an even longer time, say at four year intervals for an additional 20 years beyond the nine you have described. Locating rare populations takes both luck and skill, and recovery efforts should not be terminated before we are very certain the species is no longer extant. Additional periodic surveys represent minimal commitment, but provide a great deal of extra insurance against giving up too soon and losing the species as a result.

Response: The Service has reexamined the recommended search periods in light of the above comments and revised them to include annual searches for 7-10 years depending on local growing conditions, followed by searches every other year for a 6 year period, and adding a period of 6 years when searches would be done every 3 years. This gives a total search period of 19-22 years and a total of 12-15 complete searches of the creek. It is true that a longer period of searches that would cover several drought cycles provides extra insurance. We did not lengthen the period for annual searches to 20 years as some recommended

however, because it seems that 7-10 years should encompass several seasons with favorable growing conditions, and represents an intense effort to find the species. We did clarify existing language to make it clear that at the end of this 7-10 year period of intense effort, evaluators should examine their records. If they feel that conditions have not been sufficient to support good growth or reestablishment, or the entire creek area has not been thoroughly searched, annual surveys should be extended. If the species has not been located in what evaluators feel has been a reasonable period of intense annual effort, it is reasonable to scale back future efforts. Periodic searches at longer intervals should allow the detection of the species if it should reappear due to reestablishment with some change in conditions. The longer the period that goes by without the relocation of the species during thorough searches, the less likely it is that the species will reestablish itself, hence the decrease in the frequency of the searches.

Comment: What happens at the end of your recommended search period? Would the species be declared extinct and delisted? Does the Service have a policy on when a species' status is determined to be historic, extirpated, or extinct?

and

Comment: It seems there is considerable doubt that the species continues to exist. When a species was known to exist in an area and then cannot be found would it not mean that the species is no longer "endangered" but rather extinct?

Response: With rare species, locating individuals and populations can require patience and the expenditure of a great amount of search time. Failure to locate the species in a few tries does not necessarily mean that the species does not exist. It may have been overlooked, or have been indiscernible because

of conditions in the wild at the time. Plant species particularly require searches over a fairly long period of time, because in some species a few new plants may germinate from soil seed banks even when it has been years since the species has been seen in an area.

The Service has no rigid guidelines regarding a specific period of time that is required before a species is considered to be extinct and delisted. However, our regulations (50 CFR 424.11) state that "...a sufficient period of time must be allowed before delisting to indicate clearly that the species is extinct." Such a determination will consider the life cycle of the species involved, the dynamics of its habitat, the range covered, and the level of effort that has been expended to relocate the species. Cases must be evaluated on a species-by-species basis.

In the case of the Little Aguja Pondweed, the situation regarding the likelihood of extinction must be reviewed, at the end of the designated search period, in light of weather patterns, creek conditions, and effectiveness at searching all potential habitat. If the Service is confident that conditions should have allowed the growth or reestablishment of the species and a rigorous effort has been made to find it without success, it would begin the process of delisting due to extinction. If listing still appears warranted, additional searches would be recommended.

Comment: The reasons for the apparent disappearance of the species should be explored in case the problems are easily remedied, and thus the species would reappear. All landowners should be interviewed for what impacts and changes they remember, and activities such as tanks, wells, pumps, etc. that they remember that may have impacted the area. If such changes are reversible and landowners cooperative, the watershed could be returned to its previous condition to see if the pondweed would

reappear.

Response: It is not clear that it would be necessary or realistic to "return" the entire watershed to some previous condition, with a hope that the species would reappear. Without more knowledge of species requirements it would be difficult to establish any targets for habitat restoration or improvement, because we do not know the critical variables involved (such as possibly water depth, flow rate, substrate texture, or water chemistry) or what acceptable levels may be. We know that as recently as 1988 the species was still present in the creek. It is possible that it may still be found so that its habitat needs can be evaluated, examined in a historical context, and provided for. The plan does recommend that an evaluation be made to look at what may be limiting the species, including historic changes (particularly task 5.11). Task 5 recommends studies to identify possible factors limiting growth and reproduction. Certainly interviews with landowners would be an important part of such studies, and wording has been added to clarify this. Habitat improvement or restoration activities may be important to recovering the species, and as needs become more clear, specific projects can be designed to meet target habitat needs. Tasks 3.2 and 3.3 call for short and long-term management plans to be developed, in cooperation with landowners, that provide for species needs including habitat conservation or improvement.

Comment: Are other species of Potamogeton in the creek closely related to Potamogeton clystocarpus? Does hybridization pose a risk to small populations?

Response: Some of the other species are relatively closely related, but no hybrid specimens are known nor have potential hybrids been observed. The potential for hybridization in the wild should be evaluated, and language has been added to the plan under task 5.731 to address this.

Comment: Is it known if Potamogeton clystocarpus or any of its close relatives, are self-incompatible? If seed production can occur through selfing, it will also be important to determine the relative importance of selfed and outcrossed reproduction in the production of seed.

Response: The breeding system is unknown. Other species are reported to be mostly outcrossing. Language has been added to task 5.731 to evaluate the potential importance of reproduction through selfing.

Comment: It is especially important that searches be conducted at a variety of times of the year, to be sure the species is not overlooked just because it is less noticeable, or not actively growing at certain phases of the life cycle.

Response: Task 2.1 includes a caution that at least initially searches should be conducted more than once during the growing season to ensure the species is not overlooked due to unrecognized differences in its life cycle. The wording has been changed to make this more clear.

Comment: Why is the Draft Recovery Plan recommending "rigorous searching" of other adjacent streams for the plant, when Dr. Rowell was told not to "bother to look outside Little Aguja Canyon" when he conducted the status survey?

Response: Botanists interested in aquatic species have explored and collected in the adjacent areas in the past without finding the species. The chances that such populations exist outside areas previously collected are slim. The status survey was conducted to help evaluate the species' condition. Therefore the status survey focused primarily on the canyon system the species was known from as the best indicator of species condition. Known populations are very vulnerable to extinction due to their low

numbers and the threats they face.

The Recovery Plan identifies a strategy to ensure the survival of the species and the ecosystem it depends on. Studies have shown that within a species, adaptations for different sites may occur within or between different populations, even when they are fairly close to each other. That is, some populations are genetically adapted to conditions of a particular site. Preserving all of these different genetic types can be very important to preserving a species' ability to colonize new sites and adjust to changes in its environment, enhancing its chances for survival. Preserving genetic representation of all possible populations is important for the conservation collection. This is important both for the general conservation of the species and for any restoration work that may be needed.

Comments About Threats

Comment: The Recovery Plan is full of speculation about threats and important factors. It is filled with words like "might, may, possible, may be, suspected, etc." This represents a terrible lack of any scientific basis for the actions proposed.

and

Comment: The Recovery Plan fails to mention even one immediate and controllable threat.

Response: The plan does include qualifying language about threats and important factors, because there is a lack of data for this species that definitively demonstrates direct or indirect impacts. This does not mean that these identified areas of concern have no scientific basis. They are possibilities or

hypotheses raised as a result of a careful appraisal of the current situation and available background information. Investigating these hypotheses will result in the identification of the critical factors and management activities needed to conserve the species.

The Recovery Plan discusses threats, both immediate and potential, in section H. "Impacts and Threats". The most immediate threat is the vulnerability to extinction from catastrophic events such as flood or drought, due to the low numbers of populations and individuals known. Some of the threats discussed in the plan may have a low incidence of occurrence. However, due to the low numbers of populations and individuals, the species is particularly vulnerable to extinction from even an occasional occurrence or small, localized effects. Some threats are identified that are potential rather than immediate.

The species may be impacted by changes in water quantity or quality or activities that would impact stream configuration or flows. Wells, spring capture, water diversion, construction of impoundments, flood control activities, or changes in numbers of livestock or wildlife could all impact these critical factors. Many of these changes have occurred in the past in Little Aguja Canyon or areas immediately adjacent, with unknown impacts to the species. This section has been reworded to clarify this background information.

Identification of both existing and potential threats is an essential step in the protection of listed species. This process allows agencies, landowners and managers to be alerted about concerns so advance planning can be done. Cooperative development and implementation of management practices and protection mechanisms that will conserve the species can prevent serious damage and preserve overall habitat quality.

Comment: The Recovery Plan notes that the plant is mainly threatened by drought and flooding, neither of which can be controlled by man. It seems any attempt to "recover" the species is doomed to failure and the Recovery Plan is unneeded and will be a waste.

Response: While flood and drought cannot be stopped, extinction as a result of these extreme events may be avoided. A recovery strategy including some increase in the number and distribution of populations would improve the chances for survival. Improving survivorship in the wild, combined with cultivation in an off-site refugium for possible reintroduction if the species is inadvertently lost in the wild, could make it possible to prevent extinction and maintain the species in its natural environment.

Comment: If so little is known about the plant, how can you conclude that at some point in history a more extensive population has existed, and therefore there is a "need" to recover the plant? There is no doubt that the plant is rare, but it probably has always been rare. That doesn't mean it needs any assistance.

Response: The apparent rarity of Little Aguja pondweed is not the sole basis for the Service's concern and belief that a recovery effort is appropriate. Listing and recovery decisions are based on an evaluation of the threats facing a species and its vulnerability to extinction. Historical evidence of prior distribution and abundance can be an important factor in evaluating this vulnerability and in planning a recovery strategy. However, it is not the only consideration in a decision to list, and lack of exact information about past distribution and abundance does not prevent recovery. The determining factor in listing is whether or not under present circumstances the species is vulnerable to extinction. The purpose of recovery planning is to outline a strategy for

minimizing that chance of extinction. Potamogeton clystocarpus has a small number of populations and individuals, a restricted range, and current and potential threats to the habitat that are of sufficient magnitude to cause extinction. It is considered extremely vulnerable, and this is the basis for its endangered status. Recovery would involve providing for the maintenance or establishment of enough populations that the species is able to continue to survive in the wild, and does not necessarily require knowledge of (or a return to) exact historical conditions.

Comment: It is entirely possible that Potamogeton clystocarpus has always been relatively rare and restricted to Little Aguja Creek. While human-caused changes in waterflow and water quality may have contributed to its decline and possible extinction, the first paragraph on page 12 makes it sound as if human-caused changes were responsible for its initial rarity.

Response: Potamogeton clystocarpus has never been collected except in Little Aguja Creek, and in this broad geographical sense it would always have been considered relatively rare in comparison to other Potamogeton species or other aquatic species.

The current situation, where only one population has been recently documented, is believed to be an extreme and vulnerable situation for the species. It is these "present low numbers" that are referred to in the Impacts and Threats section and not historical levels, which are unknown except for information gleaned from previous collections. The wording in this section has been changed to clarify this.

The historical distribution and abundance of the species is not well documented. However, information from previous collections and recorded observations, observations of habitat dynamics, and the inability to locate the species recently have provided a basis for believing that the species was probably more widespread

in the past, though not necessarily common. Given the dynamics of the system it is unlikely that the species has persisted as a single population in a single location over time. It is far more likely to have had a scattered distribution with several to many populations that appeared and disappeared in response to changes in the creek. We have included more detail about previous collections and observations in section D., "Distribution and Abundance".

Comment: It seems that the Service, with this recovery plan, is reneging on an earlier commitment. In its November 13, 1991 news release announcing the listing of the pondweed as endangered the Service quoted Regional Director Michael Spear saying "the role of the Fish and Wildlife Service to secure its future will only be to arrange for propagation of a reserve population offsite, or provide technical assistance or other form of cooperation at the request of the landowner". This 1991 statement was a commitment indicating by inference that no recovery plan would be written. Section 4(f) of the Endangered Species Act requires the preparation of a recovery plan unless the Service finds that such a plan will not promote recovery of the species. The Service should withdraw the Draft Recovery Plan.

and

Comment: Because of its commitment in its press release at the time of listing, the recovery plan should delete any references to further study, land access, searches, surveys, protection from immediate threats, management plans, development of state and national awareness, or any other activity not described in the agency's official press release, because there is no evidence of any request of the landowner.

Response: The final rule, published in the Federal Register November 14, and referred to in the Press Release, notes that

recovery actions for the species might include monitoring, a cultivated collection to provide material for research and reintroduction, and education. It noted that recovery activities would be addressed in detail in the recovery plan for the species. Mr. Spear's quote in the Press Release was a part of remarks intended to reassure concerned parties that recovery actions for the species would be conducted cooperatively with landowners.

The Service feels that a recovery plan will promote recovery of the species by providing guidance for priorities and coordination of the efforts of all involved parties. The plan is the primary planning document for the Service in implementing the intended cultivated reserve population offsite. Tasks 1,2,4, and many parts of task 5 are necessary to the success of the cultivation effort. Cultivated collections serve as a back up and are a high priority in recovery for very vulnerable species. However, they are only a part of recovery efforts that also typically include technical assistance or other cooperative efforts (also noted in the press release) to maintain the species as a part of its natural ecosystem. Other plan tasks outline the technical research assistance or cooperative efforts that may be needed.

Comments About Herbarium Specimens, Cultivated Specimens, and Their Role in the Conservation of the Species

Comment: What is the current status of the population of specimens in the herbaria that was mentioned? Can't the cultivation of these specimens prevent extinction?

Response: A herbarium is a museum collection of pressed and dried plant specimens, not a live collection. Seed from old pressed herbarium sheets are often not viable, especially for aquatic species, and because they are isolated single plants or portions of plants, they do not represent a good sample of the

genetic variation in the population they came from, or of the species as a whole. They do not provide a reliable buffer against extinction. If at all possible, cuttings or seed should be taken that are representative of the variation found in an entire population at a site and stored in a seed bank or cultivated, if necessary. Currently, there are no live specimens of Potamogeton clystocarpus in cultivation, nor any seed in conservation seed banks.

Comment: It is my impression that most aquatics do poorly in conservation seed banks. This makes the genetic problems associated with an off-site collection more difficult to deal with, but such a collection is still advisable.

Response: While Potamogeton clystocarpus may not be a good candidate for preservation in a seed bank, it has some characteristics that make it worth attempting. Leck, Parker, and Simpson (1989) edited a recent volume, Ecology of Soil Seed Banks, which includes a chapter on wetland seed banks in the wild. Wetlands do have seed banks in the wild, though their longevity and role in providing for the continuation of a species on a site varies with different species. They did note that wetland species that have persistent seed banks tend to have small seeds, and that seeds of wetland species can have prolonged dormancy while retaining viability. They also note that drying reduces the viability of some species. If seed cannot be stored in an artificial seed bank, cultivated specimens would become the only alternative for an off-site collection of genetically representative material, hence both are provided for in the plan (task 4).

Comments on Recovery Criteria Needs

Comment: With the streamflow dynamics described it is probably unrealistic to hope any single population can remain viable for

an indefinite period. If rediscovered, persistence in the wild is very likely to require many populations. This habitat situation appears to have many similarities with the case of the endangered Furbish's lousewort along the St. John's River in Maine.

Response: It is likely that the species has survived in the past by having several to many scattered populations in the creek, with populations appearing and disappearing as the creekbed changed, and a discussion of this probability has been added to the Distribution and Abundance section. A recovery strategy of increasing the number of populations may very well be needed, as noted in the Recovery Strategy section. An estimate of the exact number of populations needed will require further study of the species and the creek.

Comment: If recovery is deemed necessary, at what point will it be determined to have occurred? The recovery plan begs the question. The draft plan gives an objective of determining if recovery is feasible and developing appropriate criteria, a task estimated to take considerable time and money. This seems like an idealist's way of maintaining a continuing government job.

Response: Most recovery plans include quantified recovery criteria. In the case of Little Aguja pondweed, as noted in Part II under Objectives and Recovery Criteria, recovery criteria are not yet quantifiable because there is not yet enough information about the habitat dynamics and population size requirements of a healthy population to support an estimate. Attempting to devise criteria without some basic data would result in unreliable and possibly harmfully misleading criteria. Some initial research is needed to give a basis for specific population numbers, sizes and distribution. Such research is seldom conducted by the Service, though it may be partially or completely Service funded. Most of these studies are conducted by local academic institutions or

wildlife agencies.

Comment: Do you distinguish between extinction in the wild and extinction in cultivation?

and

Comment: The plan does not say whether the primary goal is to preserve the species or to preserve the habitat that the species may or may not be found in.

Response: The mission of the Service in conserving listed species is to ensure the continuance of both the species and the habitat on which it depends in the wild. It is the stated purpose of the Endangered Species Act (Act) to "provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species...". Preservation in a seed bank or cultivated garden setting alone is not sufficient for a species to be considered conserved under the Act. In addition, Service Recovery Policy states that "Captive propagation/cultivation may be a useful tool to facilitate recovery of a species in the wild, but it is not a substitute for reestablishment of viable wild populations." Language has been added to the Recovery Strategy section to make it clear that the primary recovery objective is preservation of the species in the wild.

Comments on Taxonomy and Identification

Comment: Who did Haynes (1974) agree with that this was a "unique species"?

Response: The species was first named and described by Fernald

in 1932. Ogden also recognized the species in his treatment for the Flora of Texas (1966). This information is included in the Taxonomy Section.

Comment: Can the Service even properly identify the species?

Response: Yes. The Service's staff botanist is familiar with the species, as well as other closely related species in the area. Other botanists of cooperating agencies and institutions are also familiar with the species characteristics and are competent to identify it.

Comments on the Service's Intent to Acquire Land

Comment: While the author assures us that the Service has never recommended land acquisition as a recovery strategy and does not believe it is necessary, this does not alleviate the fears of the landowners.

and

Comment: "The author says 'every effort should be made to stabilize and protect the population(s) in the wild from destruction or accidental harm.' This every effort I am sure would include land acquisition."

and

Comment: Your comment that land acquisition is not believed to be necessary as a recovery strategy "at this time" is just a threat. You may do so at any time, now or in the future.

Response: The Service has never identified land acquisition as necessary or desirable for the conservation or recovery of Little

Aguja pondweed. The Service has tried to make this clear in the Recovery Plan, which is the guidance document for Service recovery activities for this species. Service policy restricts the use of funds to purchase land to benefit listed species unless it is identified as essential habitat in the recovery plan. Recovery planning guidelines state that requests for acquisition will not be submitted to congress unless land acquisition is identified as a need in the recovery plan.

The Service does have the authority to acquire land for conservation purposes, but it does not do so for most listed species, and does not believe it is necessary for Little Aguja pondweed. When the Service does acquire property, it has a policy of doing so only from willing sellers.

Based on what we know about the species and its ecosystem, conservation of this species should be achievable through cooperation with landowners (Task 1). While many things about the biology and specific needs of the species are unknown, the Service does not expect additional information to drastically change the factors of concern or approach to recovery. It is expected that additional study will fine-tune our understanding of what is needed. The kinds of activities that are anticipated are outlined in some detail in the Recovery Plan, and are believed to require minimal inconvenience or modification to current landowner activities and land use.

Concern for Impacts on Local Activities

Comment: Any "plan" must include the possible impact on the landowners and other human population as well as the economic impact on the community. The author has glossed over this requirement by saying that the Service hasn't done anything yet.

and

Comment: What impact will it have on the economy of Jeff Davis County if the Service decides it is no longer feasible for the area to be used as a living and working community for fear of destroying the habitat of a "pondweed"?

Response: Recovery plans do not require an impact or economic analysis because they are broad planning documents that list tasks the Service thinks may contribute to the recovery of a species, and set out the general strategy for management and treatment of the species. Many cooperators are usually involved in implementation, including local landowners and often the local community.

Recovery plans make general recommendations that do not impose any obligations on the numerous potential cooperators. Participating in recovery efforts for this species is not expected to result in adverse impacts to the local economy or the community's general activities. The Little Aguja Pondweed Recovery Plan gives an overview of the types of activities that are anticipated. Participation by landowners is voluntary and would consist mainly of allowing access for study and of exercising sensitivity to Little Aguja pondweed populations while planning and carrying out activities on their properties. As more is learned about the species, some landowners may be able to assist in recovery by participation in small-scale habitat improvement projects.

Comment: This plan proposes to spend $6 million dollars to the detriment of the taxpayer. Why doesn't the Service give this money to the landowners as an incentive not to expand their use of the land? This would guarantee the continued existence of the pondweed and the community.

Response: The $6 million dollar figure is in error. The executive summary of the plan notes that all beneficial activities identified, if implemented, could cost up to $608,000.

The recovery plan identifies a variety of tasks including protection of the genetic material of the species and implementation of management practices that will provide for species needs in the wild. To do this, some further study must be done, and some off-site activities are needed. Payments to landowners not to "expand" land use would not be sufficient to meet all the needs of conserving the species.

However, landowner assistance can be a useful tool in promoting the survival of listed species, and the plan provides for this in advocating cooperative activities under tasks 1 and 3.

Funds identified reflect an estimate of funds that would be needed to achieve all identified tasks, including funds of all involved parties, public and private.

Other Comments

Comment: Why weren't two of the local experts in the botany of the area, who have firsthand knowledge of the plant and are familiar with the Creek, not contacted during the preparation of the draft Recovery Plan? Why has the Service relied on the expertise of a scientist in California?

Response: The Service provided many opportunities for local experts to provide information in its evaluation of the species and its needs. One of the local experts was awarded the contract to do the status survey prior to listing. The Service sent letters to the scientific community, including local botanists, informing them that the species was under consideration for

listing and asking if there was any additional data or information available that should be considered. A request for any additional pertinent information was included in the publication of the proposed rule. Notifications were sent that a public hearing would be held. Both of these botanists have relayed their comments and information to the Service, as did other botanists familiar with the species and the habitat.

All of this material has been carefully reviewed, and some is cited in the plan. Many botanists across the country, including both of the botanists concerned, were sent copies of the draft recovery plan for their comments. All information and comments received were considered in drafting and revising the draft plan.

The expertise of the botanists of the local area is generally in taxonomy and floristics (the study of which plant species are in a particular area and their distribution). To address recovery strategies the Service also sought expertise in physiological ecology (study of how characteristics of the environment influence a species) to help determine factors that were likely to be critical to the survival of this particular species. The scientist in California that provided much of this information is an aquatic plant scientist who has expertise with Potamogetons and has studied the kinds of environmental factors that affect the growth and vigor of other species in this particular genus. Information from both areas of expertise are important to consider in drafting a recovery plan.

Comment: Is there any evidence that the government, through this or any similar plan, can preserve or restore the species?

Response: The condition of many listed species has improved due to recovery efforts, many of which have been identified through recovery plans. Four species have recovered to the point that they no longer need the Act's protection, while 17 have been

upgraded from endangered to the less serious threatened category. These numbers are expected to increase significantly over the next several years as more and more listed species begin to reach recovery goals. Species such as the bald eagle, peregrine falcon, whooping crane and American alligator have all seen dramatic benefits from recovery efforts.

In 1990, the Service did an analysis of the impacts of recovery planning on endangered species and found that species with approved recovery plans had a higher percentage of species improving in status than those without plans (14% versus 3%). There were also more stable populations and fewer declining populations for species with recovery plans as opposed to those without recovery plans. Implementation of recovery plan tasks provide significant gains towards positive species recovery efforts.