

Rare Plants of the Suisun Marsh Ecosystem

Project Information

1. Proposal Title:

Rare Plants of the Suisun Marsh Ecosystem

2. Proposal applicants:

Peggy Fiedler, L.C. Lee & Associates, Inc.
Shane Staten, L.C. Lee & Associates, Inc.
Lyndon Lee, L.C. Lee & Associates, Inc.
Doug Partridge, L.C. Lee & Associates, Inc.

3. Corresponding Contact Person:

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4. Project Keywords:

At-risk species, plants
Endangered Species
Native Plants

5. Type of project:

Research

6. Does the project involve land acquisition, either in fee or through a conservation easement?

No

7. Topic Area:

At-Risk Species Assessments

8. Type of applicant:

Private for profit

9. Location - GIS coordinates:

Latitude: 38.017

Longitude: -121.783

Datum: NAD27

Describe project location using information such as water bodies, river miles, road intersections, landmarks, and size in acres.

The latitude and longitude boxes above would not allow for the input of multiple sites. The following is a complete listing that includes all lat/long information. Rush Ranch, Suisun Marsh (38.208, -122.017) Fagan Slough Ecological Preserve (38.217, -122.292) Antioch Dunes National Wildlife Refuge (38.017, -121.783) Hill Slough (38.233, -122.042) Smithhampton Marsh (Benicia State Recreation Area)(38.075, -122.192)

10. Location - Ecozone:

2.1 Suisun Bay & Marsh, 2.2 Napa River

11. Location - County:

Contra Costa, Napa, Solano

12. Location - City:

Does your project fall within a city jurisdiction?

Yes

If yes, please list the city: Antioch, Benicia, Napa

13. Location - Tribal Lands:

Does your project fall on or adjacent to tribal lands?

No

14. Location - Congressional District:

1, 7, 10

15. Location:

California State Senate District Number: 2, 4, 7

California Assembly District Number: 7, 8, 11

16. How many years of funding are you requesting?

2 years

17. Requested Funds:

a) Are your overhead rates different depending on whether funds are state or federal?

No

If no, list single overhead rate and total requested funds:

Single Overhead Rate: 0

Total Requested Funds: \$181,850

b) Do you have cost share partners already identified?

No

c) Do you have potential cost share partners?

No

d) Are you specifically seeking non-federal cost share funds through this solicitation?

No

If the total non-federal cost share funds requested above does not match the total state funds requested in 17a, please explain the difference:

18. Is this proposal for next-phase funding of an ongoing project funded by CALFED?

No

Have you previously received funding from CALFED for other projects not listed above?

No

19. Is this proposal for next-phase funding of an ongoing project funded by CVPIA?

No

Have you previously received funding from CVPIA for other projects not listed above?

No

20. Is this proposal for next-phase funding of an ongoing project funded by an entity other than CALFED or CVPIA?

No

Please list suggested reviewers for your proposal. (optional)

Professor Bruce Pavlik Mills College 510.430.2158 bruce@mills.edu

Ms. Brenda Grewell UC Davis 530.795.2432 bjgrewell@ucdavis.edu

Professor Michael Barbour UC Davis 530.752.2956

Dr. Ed Guerrant Berry Botanic Garden 503.636.4112.x29

21. Comments:

Our overhead is subsumed in our billing rates. Our profit margin is expected to be approximately 10%.

Environmental Compliance Checklist

Rare Plants of the Suisun Marsh Ecosystem

1. CEQA or NEPA Compliance

a) Will this project require compliance with CEQA?

No

b) Will this project require compliance with NEPA?

No

c) If neither CEQA or NEPA compliance is required, please explain why compliance is not required for the actions in this proposal.

This is a scientific study only. No landuse change that would require CEQA/NEPA compliance is involved.

2. **If the project will require CEQA and/or NEPA compliance, identify the lead agency(ies). If not applicable, put "None".**

CEQA Lead Agency:

NEPA Lead Agency (or co-lead:)

NEPA Co-Lead Agency (if applicable):

3. **Please check which type of CEQA/NEPA documentation is anticipated.**

CEQA

- Categorical Exemption
- Negative Declaration or Mitigated Negative Declaration
- EIR
- X none

NEPA

- Categorical Exclusion
- Environmental Assessment/FONSI
- EIS
- X none

If you anticipate relying on either the Categorical Exemption or Categorical Exclusion for this project, please specifically identify the exemption and/or exclusion that you believe covers this project.

4. **CEQA/NEPA Process**

a) Is the CEQA/NEPA process complete?

Not Applicable

b) If the CEQA/NEPA document has been completed, please list document name(s):

5. **Environmental Permitting and Approvals** (*If a permit is not required, leave both Required? and Obtained? check boxes blank.*)

LOCAL PERMITS AND APPROVALS

Conditional use permit

Variance

Subdivision Map Act

Grading Permit

General Plan Amendment

Specific Plan Approval

Rezone

Williamson Act Contract Cancellation

Other

STATE PERMITS AND APPROVALS

Scientific Collecting Permit Required

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land.

Agency Name:

Permission to access state land.

Agency Name: California Department of Fish and Game

Required

Permission to access federal land.

Agency Name: United States Fish and Wildlife Service

Required

Permission to access private land.

Landowner Name:

6. Comments.

Land Use Checklist

Rare Plants of the Suisun Marsh Ecosystem

1. **Does the project involve land acquisition, either in fee or through a conservation easement?**

No

2. **Will the applicant require access across public or private property that the applicant does not own to accomplish the activities in the proposal?**

Yes

3. **Do the actions in the proposal involve physical changes in the land use?**

No

If you answered no to #3, explain what type of actions are involved in the proposal (i.e., research only, planning only).

This is a "research only" proposal.

4. **Comments.**

Conflict of Interest Checklist

Rare Plants of the Suisun Marsh Ecosystem

Please list below the full names and organizations of all individuals in the following categories:

- Applicants listed in the proposal who wrote the proposal, will be performing the tasks listed in the proposal or who will benefit financially if the proposal is funded.
- Subcontractors listed in the proposal who will perform some tasks listed in the proposal and will benefit financially if the proposal is funded.
- Individuals not listed in the proposal who helped with proposal development, for example by reviewing drafts, or by providing critical suggestions or ideas contained within the proposal.

The information provided on this form will be used to select appropriate and unbiased reviewers for your proposal.

Applicant(s):

Peggy Fiedler, L.C. Lee & Associates, Inc.
Shane Staten, L.C. Lee & Associates, Inc.
Lyndon Lee, L.C. Lee & Associates, Inc.
Doug Partridge, L.C. Lee & Associates, Inc.

Subcontractor(s):

Are specific subcontractors identified in this proposal? No

Helped with proposal development:

Are there persons who helped with proposal development?

No

Comments:

Budget Summary

Rare Plants of the Suisun Marsh Ecosystem

Please provide a detailed budget for each year of requested funds, indicating on the form whether the indirect costs are based on the Federal overhead rate, State overhead rate, or are independent of fund source.

Independent of Fund Source

Year 1												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1	Literature review and consultation with experts	90	8250	\$0**	0	0	0	0	0	8250.0	0	8250.00
2	Initiate field surveys for Astragalus and Cirsium to determine species status and distribution	220	18250	\$0**	3000	0	0	0	0	21250.0	0	21250.00
3	Collect/clean seed of all four rare plant species	100	6850	\$0**	1200	0	0	0	0	8050.0	0	8050.00
4	Initiate field studies on causes of rarity for Cordylanthus	65	4800	\$0**	0	0	0	500	0	5300.0	0	5300.00
5	Initiate field studies on causes of rarity for Cirsium	113	9025	\$0**	12100	0	0	1500	0	22625.0	0	22625.00
6	Establish greenhouse experiments for three rare species	80	4250	\$0**	450	0	0	1500	0	6200.0	0	6200.00
7	Initiate propagation experiments for Astragalus	40	3483	\$0**	900	0	0	0	0	4383.0	0	4383.00
8	Initiate propagation experiments for Oenothera	40	3633	\$0**	450	0	0	0	0	4083.0	0	4083.00

9	Prepare interim (and yearly) reports	60	4800	\$0**	0	0	0	0	0	4800.0	0	4800.00
		808	63341.00	0.00	18100.00	0.00	0.00	3500.00	0.00	84941.00	0.00	84941.00

Year 2												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
4	Initiate field studies on causes of rarity for Cordylanthus	195	14400	\$0**	0	0	0	0	0	14400.0	0	14400.00
5	Initiate field studies on causes of rarity for Cirsium	337	27075	\$0**	0	0	0	0	0	27075.0	0	27075.00
6	Establish greenhouse experiments for three rare species	80	8500	\$0**	0	0	0	0	0	8500.0	0	8500.00
7	Initiate propagation experiments for Astragalus	80	6967	\$0**	0	0	0	0	0	6967.0	0	6967.00
8	Initiate propagation experiments for Oenothera	80	7267	\$0**	0	0	0	0	0	7267.0	0	7267.00
9	Prepare interim (and yearly) reports	60	4800	\$0**	0	0	0	0	0	4800.0	0	4800.00
10	Prepare final report	300	27900	\$0**	0	0	0	0	0	27900.0	0	27900.00
		1132	96909.00	0.00	0.00	0.00	0.00	0.00	0.00	96909.00	0.00	96909.00

Year 3												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
		0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Grand Total=181850.00

Comments.

*See budget justification **See budget justification for explanation Our overhead is subsumed in our billing rates. Our expected profit margin is expected to be approximately 10%. Numbers in the Salary column represent the total salary estimated for each task. Because the billing rate for NWSTC is variable, our billing method does not entirely fit the budget summary forms. As a result, we have multiplied each NWSTC member's salary by their expected labor hours for each task to determine their total salary per task. NWSTC members' total salaries per task are summed to provide the total amount of salary estimated per task. We apologize for the confusion, but this is the only way we can input the budget data into this form. Feel free to contact us for a more detailed budget (510-748-0362).

Budget Justification

Rare Plants of the Suisun Marsh Ecosystem

Direct Labor Hours. Provide estimated hours proposed for each individual.

Fiedler 540 Lee 75 Stewart 65 Partridge 335 Staten 625 Burke 160 Romero 80 Pitts 60 Total hours = 1,740

Salary. Provide estimated rate of compensation proposed for each individual.

Fiedler \$100/hour Lee \$150/hour Stewart \$90/hour Partridge \$65/hour Staten \$65/hour Burke \$65/hour Romero \$75/hour Pitts \$40/hour These figures represent company billing rates, not salaries.

Benefits. Provide the overall benefit rate applicable to each category of employee proposed in the project.

Benefits are included in the billing rates. Based on company history, benefits represent approximately 15% of project costs.

Travel. Provide purpose and estimate costs for all non-local travel.

All non-local travel involves round-trip airfare for NWSTC/LCLA Seattle staff to travel to field sites to assist local NWSTC/LCLA staff. Airfare is calculated at \$450/round trip Seattle-Oakland; a total of 26 individual tickets. Hotel and food are calculated at \$150/day; total of 64 days predicted.

Supplies & Expendables. Indicate separately the amounts proposed for office, laboratory, computing, and field supplies.

No supplies and expendables costs are estimated in this proposal.

Services or Consultants. Identify the specific tasks for which these services would be used. Estimate amount of time required and the hourly or daily rate.

None are required.

Equipment. Identify non-expendable personal property having a useful life of more than one (1) year and an acquisition cost of more than \$5,000 per unit. If fabrication of equipment is proposed, list parts and materials required for each, and show costs separately from the other items.

A total of \$3,000, allocated as \$1,500 for tasks #5 and #6, are for the purchase and construction of a small "hoop" (greenhouse) house, approximately 10' x 20', and constructed of plastic sheeting.

Project Management. Describe the specific costs associated with insuring accomplishment of a specific project, such as inspection of work in progress, validation of costs, report preparation, giving presentatons, reponse to project specific questions and necessary costs directly associated with specific project oversight.

Project management is included as 10% of Fiedler's total hours. This amounts to 54 hours or \$5,400.

Other Direct Costs. Provide any other direct costs not already covered.

The only additional direct cost is document production, which has been calculated at \$5,000.

Indirect Costs. Explain what is encompassed in the overhead rate (indirect costs). Overhead should include costs associated with general office requirements such as rent, phones, furniture, general office staff, etc., generally distributed by a predetermined percentage (or surcharge) of specific costs.

No indirect costs are included in this cost estimate.

Executive Summary

Rare Plants of the Suisun Marsh Ecosystem

The National Wetland Science Training Cooperative, a division of L.C. Lee & Associates, Inc. (NWSTC/LCLA) proposed to study four rare plant species of the Greater Suisun Marsh Ecosystem that have been identified as at risk species in CALFEDs Multi-species Conservation Strategy. These rare plants include the Antioch Dunes evening primrose (*Oenothera deltoides* ssp. *howellii*), Alkali milkvetch (*Astragalus tener* var. *tener*), Soft birds beak (*Cordylanthus mollis* ssp. *mollis*), and the Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*). Essential studies and surveys identified in CALFEDs Ecosystem Restoration Program that will provide critical information for the recovery of these four species are the focus of this proposal. Tasks identified include (a) field surveys to document the current distribution; (b) complementary field and greenhouse experiments to determine basic life history features that are potential causes of rarity; and (c) field and greenhouse propagation trials to determine the best means of species reintroduction. NWSTC/LCLA proposes to address these three suites of tasks over a two-year grant period.

Proposal

L.C. Lee & Associates, Inc.

Rare Plants of the Suisun Marsh Ecosystem

Peggy Fiedler, L.C. Lee & Associates, Inc.

Shane Staten, L.C. Lee & Associates, Inc.

Lyndon Lee, L.C. Lee & Associates, Inc.

Doug Partridge, L.C. Lee & Associates, Inc.

Rare Plants of the Greater Suisun Marsh Ecosystem

OCTOBER, 2001



L.C. LEE & ASSOCIATES, INC.
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CALFED
BAY-DELTA
PROGRAM



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I. EXECUTIVE SUMMARY

The National Wetland Science Training Cooperative, a division of L.C. Lee & Associates, Inc. (NWSTC/LCLA) proposes to study four rare plant species of the Greater Suisun Marsh Ecosystem that have been identified as “at risk species” in CALFED’s Multi-species Conservation Strategy. These rare plants include the Antioch Dunes evening primrose (*Oenothera deltooides* ssp. *howellii*), Alkali milkvetch (*Astragalus tener* var. *tener*), Soft bird’s beak (*Cordylanthus mollis* ssp. *mollis*), and the Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*). Essential studies and surveys identified in CALFED’s Ecosystem Restoration Program that will provide critical information for the recovery of these four species are the focus of this proposal. Tasks identified include (a) field surveys to document the current distribution; (b) complementary field and greenhouse experiments to determine basic life history features that are potential causes of rarity; and (c) field and greenhouse propagation trials to determine the best means of species reintroduction. NWSTC/LCLA proposes to address these three suites of tasks over a two-year grant period.

A. Project Description

Planning efforts for ecosystem recovery in the San Francisco Estuary (Estuary) have targeted the high marsh ecosystem as a restoration priority (CALFED 2001). This is because much of the high marsh ecosystem is fragmented, degraded, or converted to agriculture and other human uses. As a consequence, the high marsh is a rare ecosystem within the Estuary, and indeed, in many other estuary ecosystems throughout the world. Naturally rare wetland species endemic to the Estuary are at particular risk, as the species’ already restricted distributions are interrupted, fragmented, and contracted through urbanization and agriculture.

A few naturally rare animal species within the San Francisco Estuary, such as the Salt marsh harvest mouse (*Reithrodontomys raviventris*), have received considerable attention, protection, and study (see reviews in Goals Project 2000). However, all but the most unusual rare plant species are poorly known in any ecosystem, and the wetlands of the Estuary are no exception. This observation may seem surprising to some, given the many research institutions and large urban population of the San Francisco Bay region.

Rarity in biological world takes many forms, and the is product of a variety of causes and consequences (Fiedler 1986, Kunin & Gaston 1993, Gaston 1994). Rare plant species tend to exhibit a different suite of causes that are the consequence of congruence of at least three intrinsic traits – geographic distribution, population size, and evolutionary history (Fiedler & Ahouse 1992). Rabinowitz (1981) suggested that habitat specificity is an important influence in defining botanical rarity, although this feature is not always distinct from geographic distribution.

One of the peculiar aspects of rarity for plants in the United States (regardless of their state and/or federal protection status) is the high proportion of rare species that are restricted to wetland or aquatic habitats (Niering 1988). This is in part because of the

enormous losses of wetland and aquatic habitats throughout the country, and in part, because of rare species' restriction to specific wetland environments. Rarity in wetland plants therefore, is a consequence of evolutionary history, specific habitat requirements, and habitat fragmentation and loss. Distinguishing among causes of rarity, as well as the consequences of rarity, is critical to successful recovery and management of rare plant species (Fiedler & Ahouse 1992).

Rare Plants in the San Francisco Estuary. Baye and his colleagues (2000) point out that the plant communities of tidal marshes of the San Francisco Estuary are not known as species-rich wetland communities. They argue that this impression is due in part to modern documents (*e.g.*, Josselyn 1983) that both underreport the flora of tidal marshes, and neglect historical records. Baye *et al.* (2000:17) also argue that: “. . . the modern lack of attention to rare plants in the Estuary is probably due to unfamiliarity with plant species which [sic] were known only to early botanists, but are either now entirely extinct (or even extirpated) in the Estuary. Most of these [rare] species were known from tidal marsh edges, transitional habitats of high ecological diversity. This is significant, because original remnants of this ecotone are almost complete eliminated from the estuary, and their modern counterparts are mostly weedy, disturbed habitats like dikes.”

I. Project Goals

The primary goal of the proposed project is to provide reliable, scientifically defensible information on the rare plants of the Greater Suisun Marsh Ecosystem that will be immediately useful for the restoration and recovery of four highly endangered rare plant species. Ten additional secondary or supporting goals of the proposed project are identified below, and include:

- (1) Establish the current geographic distribution, population size, and general population vigor for *Astragalus tener* var. *tener*.
- (2) Establish most suitable restoration techniques for *Astragalus tener* var. *tener* for possible reintroduction to enhanced and restored habitat.
- (3) Establish most appropriate restoration techniques, focusing on seed fate, for *Oenothera deltoides* ssp. *howellii* for possible reintroduction to enhanced and restored habitat.
- (4) Establish the most likely causes of rarity for *Cirsium hydrophilum* var. *hydrophilum*
- (5) Establish basic habitat requirements for *Cirsium hydrophyllum* var. *hydrophilum*.
- (6) Establish management needs to recovery populations of *Cirsium hydrophilum* var. *hydrophilum*.
- (7) Establish the most likely causes of rarity for *Cordylanthus mollis* ssp. *mollis*.

B. Scope of Work

The proposed work will focus on four rare plants of the Greater Suisun Marsh Ecosystem. These four have been identified by CALFED as plants for which specific

information is necessary for their restoration and recovery in the San Francisco Estuary. This is important, because as cogently pointed out by Baye and his colleagues (2000), ecosystem restoration efforts in the Estuary have been designed, nearly exclusively, for the restoration of specific wildlife species. Plants are viewed as habitat, with little regard to historically abundant, infrequent or rare plant taxa that add diversity and disparity to the salt and brackish marsh ecosystems. They argue that conservation of plant species diversity in the Estuary will require both active protection of remnant plant refugia, active management of conserved areas, systematic inventory of the Estuary's botanical resources, and large-scale, scientifically sound tidal marsh restoration and reintroduction projects" (Baye *et al.* 2000). This work proposed within is intended to address most of the needs in light of the current knowledge of rare plants of the Greater Suisun Marsh Ecosystem.

1. Study Region

The Great Suisun Marsh Ecosystem for this study is bounded on the west, by the Carquinez Bridge at the western limit of the Carquinez Strait; on the north, by the incorporated limits of Suisun City and Travis Air Force Base; on the east by Collinsville along the Sacramento River, and McAvoy Harbor along the San Joaquin River; and, on the south, the Atcheson-Topeka-Santa Fe and Southern Pacific Railroad rights-of-way (Figure 1). These boundaries are both somewhat artificial and constrained, but they represent geographic limits imposed primarily by the current distributions of the rare plants as a consequence of habitat destruction, politics, and accidents of history.

2. Rare Plant Species of the Greater Suisun Marsh Ecosystem

(a) Alkali Milkvetch (*Astragalus tener* var. *tener*)

Very little is known about the Alkali milkvetch (Figure 1a), which is an annual member of the very large locoweed genus, *Astragalus*. Its habitat is been described as "alkali vernal pools" (Skinner & Pavlik 1994), although Baye *et al.* (2000) report that *A. tener* var. *tener* was recently rediscovered near the historic Bay shoreline in the city of Fremont. Prior to this very recent rediscovery, the last Bay Area collection was in 1959. Collections of this rare taxon come from 13 counties, from Yolo County in the north, to Monterey/San Joaquin counties in the south. It is believed to be extinct in nine of these 13 counties. Currently, the Alkali milkvetch is threatened with habitat destruction, primarily agricultural conversion (Skinner & Pavlik 1994). A single population of this rare milkvetch is protected at the Jepson Prairie Preserve.

(b) Antioch Dunes Evening Primrose (*Oenothera deltoides* ssp. *howellii*)

Oenothera deltoides ssp. *howellii* (Figure 1b) is one of two endemic plant species restricted of the Antioch Dunes, a sand dune ecosystem along the Sacramento-San Joaquin River Delta. The formerly extensive dune system once stretched along approximately nine miles of the south bank (river left) of the San Joaquin River in and

near the town of Antioch (Roof 1969). Today, only a fraction of the inland dune ecosystem remains, and what does is seriously degraded by sand mining, agricultural development, and related urbanization. The Antioch Dunes National Wildlife Refuge was created in 1978 to preserve this unique remnant landscape, which now can be described as a mosaic of natural and anthropogenic substrates (Skinner & Manning 1993). Today this rare evening primrose is known from seven populations with the Refuge.

Of all the rare plants of the Greater Suisun Marsh Ecosystem, the Antioch dunes evening primrose is perhaps the best known. Early research was initiated by the California Department of Fish and Game (Johnson 1979) to determine the status of this, as well as other endemic taxa. This research was followed a short time later by the comprehensive research Dr. Bruce Pavlik and his students (Pavlik and Manning 1993, Pavlik *et al.* 1993). Recovery work, based largely on Pavlik's work, is in progress. NWSTC/LCLA has been in contact with Dr. Pavlik, and will coordinate closely with him regarding the proposed work.

(c) Suisun Thistle (*Cirsium hydrophilum* var. *hydrophilum*)

As for the Alkali milkvetch, very little is known about the Suisun thistle (Figure 1c). It is endemic to the Suisun Marsh ecosystem, but remained little noticed since its description by Gray in 1888, and subsequent taxonomic work by J.T. Howell in 1959 did not generate additional interest. By 1975, the plant had not been reported for approximately 15 years, and it was considered possibly extinct (Federal Register 62(224); November 20, 1997). Dr. N. Havlik rediscovered this species on Grizzly Island within Suisun Marsh in 1989. Because of its extremely distribution, low population numbers, and extensive threats such as hydrology, competition from native and non-native plants, and seed predation by larvae of the weevil *Phyciodes mylitta*, this thistle was listed as endangered by the U.S. Fish and Wildlife Service in 1997. Seed predation by this (and other) weevils has been documented as a direct cause of local extirpation in other rare species, including thistles (Hegazy & Eesa 1991, Louda & Potvin 1995). Suisun thistle populations are now protected in part at Grizzly Island Wildlife Area and Peytonia Slough Ecological Reserve (Skinner & Pavlik 1994), although a large fire during the last year may have negatively impacted the Peytonia Slough population (Grewell personal communication).

(d) Soft Bird's beak (*Cordylanthus mollis* ssp. *mollis*)

Cordylanthus mollis ssp. *mollis* is an annual member of the hemiparasitic genus *Cordylanthus*. It is found primarily in the upper marsh zone of the salt and brackish tidal marshes the fringe San Pablo and Suisun Bays in the San Francisco Estuary ecosystem. Some controversy exists regarding the number of extant populations and the size of these populations (Federal Register 62(224); November 20, 1997). However, annual plant populations are extraordinarily variable in time and space, an inherent characteristics that can confound active management approaches.

Soft bird's beak (Figure 1d) is the subject of extensive research by Dr. Eliska Rejmankova and her doctoral student, Ms. Brenda Grewell, University of California,

Davis and funded by CALFED. Their research involves the comparative experimental reintroduction of *Cordylanthus mollis* ssp. *mollis* at the Spring Branch tidal marsh at Rush Ranch. NWSTC/LCLA has been in communication with the University of California, Davis, research team, and will work in close coordination with Rejmankova and Grewell.

Ms. Grewell has been instrumental in the protection of several rare *Cordylanthus* taxa (and other marsh plant species, including *C. hydrophilum* var. *hydrophilum*) through agency efforts and private research. However, additional information has been requested by CALFED, specifically the reasons for the species' rarity, as well as its habitat requirements, including salinity limits, parasite hosts, and so forth.

FIGURE 1A. ALKALI MILKEVETCH (*ASTRAGALUS TENER* VAR. *TENER*) (SOURCE: HICKMAN (1993))

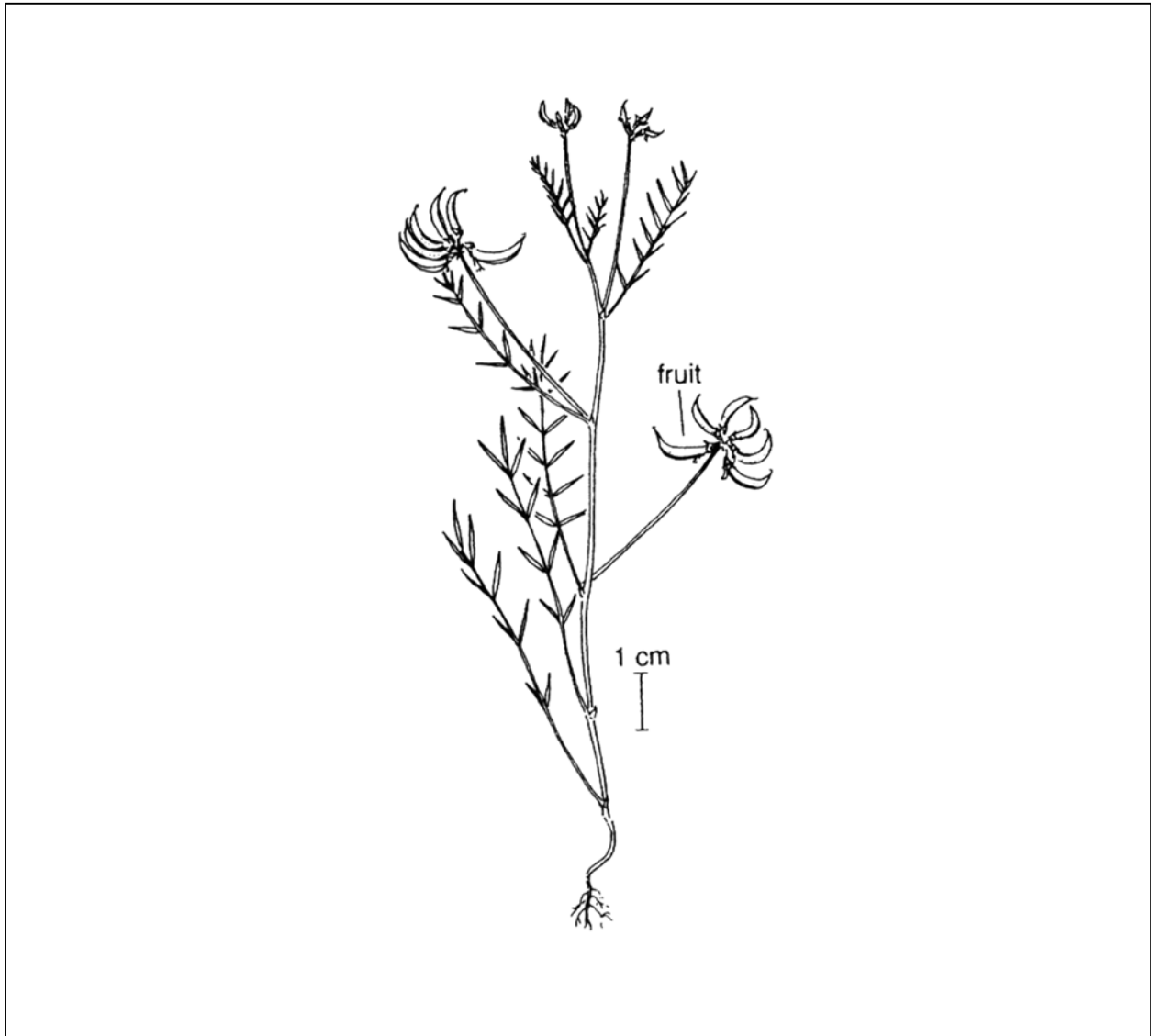


FIGURE 1B. ANTIOCH DUNES EVENING PRIMROSE (*OENOTHERA DELTOIDES* SSP. *HOWELLII*)



FIGURE 1C. SUISUN THISTLE (*CIRSIUM HYDROPHILUM* VAR. *HYDROPHILUM*)



FIGURE 1D. SOFT BIRD'S BEAK (*CORDYLANTHUS MOLLIS* SSP. *MOLLIS*)



3. Tasks

The follow ten tasks have been identified, as outlined below.

- Task #1. Literature review and consultation with experts
- Task #2. Initiate field surveys for *Astragalus* and *Cirsium* to determine species status and distribution
- Task #3. Collect/clean seed of all four rare plant species
- Task #4. Initiate field studies on causes of rarity for *Cordylanthus*
 - A. Establish seed germination/establishment plots
 - B. Conduct competition experiments
- Task #5. Initiate field studies on causes of rarity for *Cirsium*
 - A. Conduct field pollination studies
 - B. Establish seed germination/establishment plots
 - C. Conduct competition experiments
- Task #6. Establish greenhouse experiments for three rare species (*Cirsium*, *Astragalus*, *Cordylanthus*)
 - A. Conduct seed germination experiments in greenhouse
 - B. Conduct competition experiments
- Task #7. Initiate propagation experiments for *Astragalus*
 - A. Conduct propagation experiments with seed
 - B. Conduct propagation experiments with vegetative material
- Task #8. Conduct seed fate experiments for *Oenothera* in the field
- Task #9. Prepare interim (and one-year) reports
- Task #10. Prepare final report

B. Project Justification

Baye and his colleagues (2000) point out that the plant communities of tidal marshes of the San Francisco Estuary are not known as species-rich wetland communities. They argue that this impression is due in part to modern documents (*e.g.*, Josselyn 1983) that both under report the flora of tidal marshes, and neglect historical records. Baye *et al.* (2000:17) also argue that: “. . . the modern lack of attention to rare plants in the Estuary is probably due to unfamiliarity with plant species which [sic] were known only to early botanists, but are either now entirely extinct (or even extirpated) in the Estuary. Most of these [rare] species were known from tidal marsh edges, transitional habitats of high ecological diversity. This is significant, because original remnants of this ecotone are almost complete eliminated from the estuary, and their modern counterparts are mostly weedy, disturbed habitats like dikes.”

We are focusing on these four rare species of the Greater Suisun Marsh Ecosystem for the following reasons.

Administrative:

1. All four species have been determined by CALFED to be “at risk” species as described in the “Multi-species Conservation Strategy.” All four have been identified in Attachment 3 of the *Draft Stage 1 Implementation Plan* (CALFED 2001: 143) to require “essential studies and surveys to achieve recovery goals.”
2. A single field team surveying and conducting an inventory on a suite of rare plant species within the same geographic region and habitat should lead to an increase in efficiency (in both time and funding) for the field component of this proposed work.

Scientific Reasons:

1. All four rare species historically are, or currently are restricted to this region (*i.e.*, Suisun Marsh and North Bay) of the San Francisco Estuary; -- that is, none currently are more widely distributed within the Sacramento-San Joaquin Estuary (*e.g.*, Delta mudwort [*Limosella subulata*]). As such, they represent a discrete subset of rare species (*i.e.*, local, anthropogenic endemics) within the Estuary, and within the Greater Suisun Marsh Ecosystem.
2. All four species are extremely rare, based upon number of population and in most cases, in population size. For example, each taxon in this study has less than ten extant populations (known), and a number of the populations of these rarities (*e.g.*, *C. mollis* ssp. *mollis*, *C. hydrophilum* var. *hydrophilum*) can support less than 10 individuals in any given year.
3. Required inventory and survey work to complete this project requires the survey of a range of habitats, from high marsh (*e.g.*, *Corylanthus*, *Cirsium*), to alkali flats (*e.g.*, *Astragalus*), to sand dunes (*e.g.*, *Oenothera*). As such, this survey should lead to a higher probability of finding a rare plant population where it might not be expected, in addition to where it is likely to occur.

C. Approach / Study Design

Research on these species as well as other rare congenics will serve as the basis for the study designs. For example, during the late 1980’s Karron (1987a, 1987b, 1989; Karron *et al.* 1988) examined the genetics and life history traits of a rare and common species of *Astragalus*. Their work is directly applicable to the issues of pollination ecology and habitat specificity that are two of the important issues facing the Alkali milkvetch. Similarly, Dr. Bruce Pavlik and his students (Pavlik & Manning 1993, Pavlik *et al.* 1993) examined the limits to population growth of the Antioch Dunes evening primrose, which provides an excellent starting point for the design of field experiments to determine the fate of seeds after they have been shed, and prior to germination. Lastly, the current research on the Soft bird’s beak by Rejmankova and her students will guide the development of the causes of rarity in *Cordylanthus*. More specific details will follow,

but NWSTC/LCLA will finalize the extent of the proposed research based several issues, including funding. Most critical however, is that the size and extent of the proposed research that involves collection of seed will dependent greatly on the conditions of the collection permit to be issued by the U.S. Fish and Wildlife Service. Therefore, NWSTC/LCLA emphasizes that the it recognizes that limits to the research will be set by the terms of conditions of the scientific permits required by the governing regulatory agencies.

1. Field Surveys

Field surveys will be conducted during the flowering period for *Astragalus* and *Cirsium*. Survey teams will focus on both historical and current plant occurrences as keep on record by the California Natural Diversity Data Base. All populations of each of these species will be recorded with a GPS (global positioning system) point, and the completion of a CNDDDB field survey form. A complete species list for each rare plant occurrence also will be developed. A map for each rare species documenting the current location of each population will be produced in the final report.

2. Greenhouse Studies

Seed Germination: NWSTC/LCLA proposes to conduct germination trials to determine the germination requirements, as well as the proportion of seed that germinates. All seed will be collected during the first year of research, and seed from every plant from every population understudy of *Astragalus*, *Cirsium*, and *Cordylanthus* will be held separately under refrigeration. Seeds will be grown under sterile conditions and in the field, as possible. As currently envisioned, five replicates of 50 seeds each for each experimental condition will be conducted.

Propagation: NWSTC/LCLA proposed to grow some material of all four species to use in experimental field reintroduction experiments. Details of each experiment are in flux, and dependent upon permit conditions. However, the proposed research shall be based on current work being conducted by Rejmankova for *Cordylanthus*, and by Pavlik on *Amsinckia* (Pavlik 1991, 1992, 1993, Pavlik *et al.* 1993), *Oenothera* and *Erysimum capitatum* var. *angustatum* (Pavlik and Manning 1993, Pavlik *et al.* 1993).

3. Field Studies

Field studies on the germination behavior of *Cirsium* will be conducted at Peytonia Slough Ecological Reserve, and *Cordylanthus* will be conducted at Fagan Slough Ecological Reserve, Southhampton Marsh at Benicia State Recreation Area, and Rush Ranch in Suisun Marsh. Field experimental studies on the fate of *Oenothera* seeds after shedding and before seedling establishment will be conducted at the Antioch Dunes National Wildlife Refuge. Approximately five replicate plots will be established at all field locations. However, the details of this and other experiments will rest on the

conditions of the endangered species permits that NWSTC/LCLA will apply for prior to the commencement of the project.

D. Project Feasibility

This project will commence in mid-May of 2002 and will continue until end of the spring of 2004. Based on the extensive experience of NWSTC/LCLA team's field work in the Estuary (primarily on the rare plant *Lilaeopsis masonii*), this timeline should be appropriate for the creation of a draft HGM guidebook for Suisun Marsh.

Further, the project is eminently feasible because of the project manager's (Dr. P. Fiedler) decades of experience in rare plant biology, as well as LCLA's experience in the preparation of mitigation and/or monitoring plans for rare plants in the Bay Area. For example, under contract to the National Park Service in 2000, LCLA prepared a monitoring plan for the Francisco thistle, a rare *Cirsium* species restricted to serpentinite seeps in the Presidio and the Marin Headlands. Under a separate private contract in 2000, LCLA worked with the Department of the Army to develop monitoring protocols for a suite of rare species at Fort Hunter-Liggett in Monterey County. More fundamental, however, is that LCLA specializes in the field of wetland ecosystem restoration, and has extensive field experience in this region of the Bay Delta Ecosystem.

E. Project Performance Measures

The following is a list of performance measures that can be used to determine the progress of this proposed project:

- Submittal of monthly reports detailing the progress of the proposed research
- Submittal of final report, with results directly applicable to the recovery of the four rare species that are the subject of the proposed research
- Specific proposals for the recovery of the four rare species that are the subject of the proposed research
- Dissemination and assistance to public and private agencies interested in the results of the work

F. Data Handling and Storage

Data will be handled by NWSTC/LCLA staff and stored in Alameda, California. Ten hard copies of the final report will be produced. Two electronic copies will be made available. Additional copies of the report can be made available upon request.

G. Expected Outcomes & Products

The final product will be a report with specific recommendations for the recovery of the four targeted rare plant species in the Greater Suisun Marsh Ecosystem. The immediate outcome of the proposed work will be natural history information that will be directly

applicable to the recovery of the Alkali milkvetch, Soft bird’s beak, Suisun thistle, and Antioch Dunes evening primrose. The long term outcome is the recovery of four rare species in the Estuary.

H. Work Schedule

Table 1. Proposed work schedule.

TASKS	Spr 02	Su 02	Fa 02	W 02	Spr 03	Su 03	F 03	W 03	Spr 04
Task #1: Literature review and consultation with experts									
Task #2. Initiate field surveys for <i>Astragalus</i> and <i>Cirsium</i> to determine species status and distribution									
Task #3. Collect/clean seed of all four rare plant species									
Task #4. Initiate field studies on causes of rarity for <i>Cordylanthus</i>									
A. Establish seed germination/establishment plots									
B. Conduct competition experiments									
Task #5. Initiate field studies on causes of rarity for <i>Cirsium</i>									
A. Conduct field pollination studies									
C. Establish seed germination/establishment plots									
D. Conduct competition experiments									
Task #6. Establish greenhouse experiments for three rare species									
A. Conduct seed germination experiments in greenhouse									
B. Conduct competition experiments									
Task #7. Initiate propagation experiments for <i>Astragalus</i>									
A. Conduct propagation experiments with seed and vegetative material in the field									
Task #8. Initiate propagation experiments for <i>Oenothera</i>									
A. Conduct propagation experiments with seed in the field									
Task #9. Prepare interim (and yearly) reports									
Task #10. Prepare final report									

II. APPLICABILITY TO CALFED ERP AND SCIENCE PROGRAM GOALS, AND IMPLEMENTATION PLAN AND CSPIA PRIORITIES

A. ERP, Science Program, and CVPIA Priorities

The proposed research on four rare plants of the Greater Suisun Marsh Ecosystem directly addresses the Bay Region draft Stage 1 PSP priority of understanding the performance of wetlands restoration efforts on a local and regional scale. This is because these at least three of the four rare species represent the remnants of formerly much more widespread species that likely ringed the high marsh margins and alkaline (flats) that ringed the Bay-Delta ecosystem. Thus the rare plants are very localized in current abundance, but represent rarities in a now sparse, highly degraded and fragmented wetland ecosystem. In addition, the results of the proposed study will aid in the re-establishment and recovery of “at-risk” species. This then meets the Bay Region restoration priority of Goal #1 for endangered and at risk species. Specifically, the proposed research addresses objective numbers 1 and 2 as articulated in the Draft State 1 Implementation Plan (August 6, 2001):

Objective No. 1 states: “Achieve, first, recover and then large self-sustaining populations of the following at-risk native species dependent on the Delta, Suisun Bay and Suisun Marsh. . . soft bird’s-beak, Suisun thistle, Antioch dunes evening primrose” (CALFED 2001:140).

Objective No. 2 states: “Contribution to the recovery of . . . at-risk native species in the Bay-Delta estuary and its watershed. . . . alkali milkvetch” (CALFED 2001:140).

B. Relationship to Other Ecosystem Restoration Projects

A portion of the proposed work directly dovetails the CALFED-funded research on Soft bird’s beak that is in its second and final year of funding. This project is CALFED Bay-Delta Program Ecosystem Restoration Project 99-N05, entitled “Reintroduction of Endangered Soft Bird’s Beak to Restored Habitat in Suisun Marsh; Restoration Strategies for Rare Plant and Tidal Marsh Community Recovery,” with Dr. Eliska Rejmankova of the University of California, Davis, as the principal investigator. LCLA’s proposed work will directly complement, and perhaps carry on, the research of the UC Davis wetland group on this rare species.

C. Requests for Next-Phase Funding

Next-phase funding will not be required for this project.

D. Previous Recipients

LCLA/ NWSTC has not been the recipients of previous CALFED funding.

E. System-Wide Ecosystem Benefits

As a tool for current and future rare plant restoration (reintroduction) projects in the Greater Suisun Marsh, the basic life history data collected in this study may be applicable to the restoration and recovery of other rare species, including the Jepson tulle pea (*Lathyrus jepsonii* ssp. *jepsonii*) and the Contra Costa wallflower (*Erysimum capitatum* ssp. *angustatum*, among others. Thus considerable opportunity for technology transfers exist with this broad research on rare wetland plants in the Greater Suisun Marsh Ecosystem.

F. Additional Information

No additional information is required.

III. QUALIFICATIONS

A. National Wetland Science Training Cooperative, L.C. Lee & Associates, Inc.

The National Wetland Science Training Cooperative is a division of L.C. Lee & Associates, Inc. (LCLA), an environmental consulting firm specializing in wetland and riparian ecosystem science, ecosystem restoration, wetland and endangered species regulatory assistance, and training. LCLA takes a multi-disciplinary approach to resource assessment, restoration, and management. LCLA's work is based upon current federal, state, and local regulations and substantiated by thorough scientific analysis. The firm's strict adherence to scientific accuracy and objectivity allows it to resolve complex permitting or design problems in a non-confrontational and timely fashion. LCLA has been based in Seattle since 1990, qualifying as a Minority/Women Owned business under Washington state guidelines. LCLA opened a San Francisco Bay Area office in the city of Alameda in Spring 2001.

LCLA staff scientists have extensive experience over the last twelve years in endangered species issues, as well as wetland ecosystem restoration, and the management of waters of the U.S., including wetlands (waters/wetlands), throughout North America. While the majority of LCLA's work is wetland ecosystem restoration and functional assessment, LCLA has completed several rare plant contracts in the greater Bay Area. One contract involved the peer review of monitoring protocols for several rare plants on Ft. Hunter Liggett in Monterey County. A more extensive contract involved LCLA staff in the survey and inventory, and development of monitoring protocol for extant populations of the Francisco thistle (*Cirsium andrewsii*) in the Presidio and the Marin Headlands of the Golden Gate National Recreation Area. This project

B. Staff Scientists

The project team will be composed of the following LCLA staff scientists: Peggy L. Fiedler, Ph.D.; Lyndon C. Lee, Ph.D.; Scott R. Stewart, Ph.D.; Douglas Partridge, and Shane Staten. Dr. Fiedler will be the project manager and lead scientist for this project. The background and expertise of each is described in the following text.

Peggy L. Fiedler, Ph.D.

Dr. Peggy Fiedler is recognized internationally as an expert on rare plant biology. She has more than 20 years of field research and teaching in ecology and evolutionary biology, with an emphasis on the causes and consequences of rarity in Mediterranean floras. Since 1985, Dr. Fiedler served on the faculty of the Biology Department of San Francisco State University, initially as a visiting lecturer. In 1989, she assumed a tenure track appointment as a conservation ecologist. Dr. Fiedler also directed the graduate program in conservation biology. She resigned as full professor in 2000, and joined the staff of L.C. Lee and Associates, Inc. Currently she serves as senior associate and directs the Bay Area (Alameda) office of the company.

With respect to this proposal, Dr. Fiedler also has studied rare wetland plants of the San Francisco Estuary. With her students from San Francisco State University, Dr. Fiedler spent over 5 years researching Mason's lilaepsis (*Lilaeopsis masonii* [Apiaceae]), a rare plant endemic to the Sacramento-San Joaquin Delta. With her LCLA colleagues, Dr. Fiedler completed recently a survey and mitigation plan for Mason's lilaepsis within the lower Napa River ecosystem (LCLA 2001).

Dr. Fiedler also is recognized internationally as an expert on the California flora, specializing on the genus *Calochortus* (Calochortaceae). Her primary research focused on the demography, evolution, and systematics of *Calochortus*, in particular, the biology of its rare species. Her dissertation work on the comparative demography of rare and common *Calochortus* species of is a landmark study that established transition matrix analysis as the primary tool for assessing population viability for species of conservation concern. She has coauthored treatments of this genus for the *Jepson Manual: Higher Plants of California* (Hickman 1993), the *Flora of North America* (expected 2001), and the *Oregon Flora Checklist* (S. Sundberg, convening editor).

Under the auspices of the U.S. Environmental Protection Agency (EPA), Dr. Fiedler, along with two collaborators, developed a methodology for the classification and description of wetlands in the coastal watersheds of central and southern California. This work also represents the first comprehensive inventory of wetlands in the state, and serves as a model for wetland ecologists interested in documenting the rich wetland heritage of California. Dr. Fiedler currently is completing another EPA contract to extend this methodology to vernal ecosystems in the state. She also developed a plant identification book on common wetland plants for the Great Valley, published by the U.S. Army Corps of Engineers, Sacramento District.

In 1998, Dr. Fiedler received a Fulbright Senior Scholar Fellowship for collaborative research at Kings Park and Botanic Garden in Perth, Western Australia. She spent six months in Western Australia working on the genus *Anigozanthos* (Haemodoraceae) as a model for understanding the demographic behavior of interspecific hybridization. This experience is important for the proposed work on the interspecific hybridization of *Cirsium hydrophyllum* var. *hydrophyllum*.

Dr. Fiedler is an active member of the conservation scientific community. She has published more than 30 journal articles, book chapters, and taxonomic treatments, as well as 12 technical reports. She has also edited two volumes on conservation biology published by Chapman & Hall, NY (1992. *Conservation Biology. The Theory and Practice of Nature Conservation, Preservation, and Management*. [with S.K. Jain] and 1998. *Conservation Biology. For the Coming Decade*. [with P.M. Kareiva]). Dr. Fiedler also wrote a lay book entitled *Rare Lilies of California*, illustrated by C. Watters and published by the California Native Plant Society (1996). She served as President of the California Botanical Society from 1993-94, and as a board member from 1987-88 and 1995-97. Dr. Fiedler also served on the editorial board for the international journal *Biological Conservation* from 1992 - 1998 (Associate Editor 1992-95). Currently she is Associate Editor for book reviews for the Society of Conservation Biology's journal, *Conservation Biology*, and a member of the Reintroduction Specialist Group of the International Union for the Conservation of Nature / Species Survival Commission. Dr. Fiedler also holds an appointment as a Research Associate at the University Herbaria, University of California, Berkeley. In 1992, Dr. Fiedler was inducted as a Fellow of the California Academy of Sciences. In 1995, she received the Larry Heckard Fellowship at the Jepson Herbarium at the University of California Berkeley and was a nominee for the Pew Fellowship in Conservation and the Environment in 1995.

Lyndon C. Lee, Ph.D.

Dr. Lyndon C. Lee founded L.C. Lee & Associates, Inc. in 1989 after researching and working in wetlands, forestry, soils and wildlife for more than fifteen years. Dr. Lee served as senior wetland ecologist for the U.S. Environmental Protection Agency Headquarters, Washington, D.C. from 1986 to 1989. During this time, he was directly involved with the formulation of national wetlands policy and regulatory procedures. He directed a team of technical experts that dealt with top priority wetland problems throughout the country, and served as the Superfund and RCRA liaison from the Office of Wetlands Protection. During his tenure at EPA, Dr. Lee directed a landmark study of cumulative impacts to bottom-land hardwood forests of the southeast. Dr. Lee also founded the National Wetland Science Training Cooperative while at EPA, which he has continued to direct since leaving the agency.

Dr. Lee came to EPA from the University of Georgia Savannah River Ecology Laboratory in Aiken, South Carolina, where he was manager of the Wetlands Division for two years. He supervised the wetland research program at the U.S. Department of Energy's Savannah River Nuclear Facility and National Environmental Research Park with an annual budget of more than four million dollars. The program involved assess-

ing and monitoring the effects of nuclear energy production on riparian and riverine wetland ecosystems, management of radionuclide, heavy metal and organic contaminants in wetlands, and restoration of wetland ecosystems degraded by chronic thermal and contaminant inputs.

While pursuing his graduate degrees, Dr. Lee spent six years researching and working in wetland, riparian, and forested ecosystems throughout the Pacific Northwest and Northern Rocky Mountains. He worked for several years as the Senior habitat ecologist for the Interagency Grizzly Team's Border Grizzly Project, Montana Forest and Range Conservation Experiment Station, Missoula, Montana. There he developed, conducted and supervised research dealing with the definition, description, classification, protection and restoration of Grizzly Bear and Grey Wolf habitat throughout the northern Rocky Mountains, southeastern British Columbia and northern Mexico.

The scope of Dr. Lee's consulting experience over the last 10 years has taken him to all areas of this country and to a number of other nations. He has completed more than 125 contracts with private industry, research and conservation organizations, and private landowners. These projects have involved applied wetland and riparian ecosystems ecology, development and implementation of silvicultural and land-use management prescriptions for wetlands and riparian ecosystems, jurisdictional delineation of wetlands and riparian zones, assessment of impacts to wetland and riparian ecosystems, wetland assessments for compensatory mitigation, wetland creation and restoration, recommendations for management of contaminants and/or hazardous materials in wetland ecosystems, expert testimony, and training in all of the above. He has extensive knowledge of wetland and wildlife ecology, forestry, and soil science and a national reputation on issues relating to wetlands science, regulations and assessment of wetland functions and impacts to wetlands.

Dr. Lee has been active in teaching and training throughout his career. He has served as Adjunct Assistant Professor at both the University of South Carolina and George Mason University. He held the position of Assistant Research Professor at the University of Georgia's Institute of Ecology while working at the Savannah River Ecology Laboratory and at EPA Headquarters. While at the Universities of Washington and Montana, he assisted in teaching a variety of courses and served as a principal instructor for the Montana Forest Habitat Type Short Courses. Since 1987, Dr. Lee has led over 60 training sessions through the National Wetland Science Training Cooperative.

Dr. Lee is an active member of the wetland scientific community. He has published more than 30 professional papers and 50 technical reports, and has presented more than 40 oral papers and seminars. In 1992, he was awarded Life Membership in the Society of Wetland Scientists and has received their designation as a Professional Wetlands Scientist. In addition, he is an active member of the Ecological Society of America, AAAS, the Society of American Foresters and the Association of State Wetland Managers. He continues to play a very prominent role in shaping national policies concerning wetlands protection and is regarded as one of the top national experts on wetland issues.

Dr. Lee's duties for this project will include the assistance in project management, research design, and field data collection.

Scott R. Stewart, Ph.D.

Dr. Scott Stewart has worked with L.C. Lee & Associates, Inc. as a senior scientist since 1998, serving in the capacity of soil scientist/geomorphologist and biogeochemist. Prior to coming to LCLA, Dr. Stewart spent three years working as a soil scientist with the U.S. Department of Agriculture-Natural Resources Conservation Service in Alaska. He has three years experience as a laboratory technician at the University of Oregon in the field of genetics and microbiology, four years experience as a research assistant at the University of Oregon and three years experience as a research and teaching assistant at Oregon State University in the field of soil and water sciences.

Dr. Stewart's doctoral research focused on surface and subsurface hydrology, redox chemistry, and the age and provenance of the strata and redoximorphic concretions and nodules underlying the Jackson-Frazier Wetland near Corvallis Oregon. The Jackson-Frazier wetland formed on Vertisols in Holocene alluvium incised into Pleistocene/Holocene valley fill materials. The biogeochemical and hydrologic processes within the Pleistocene/Holocene alluvium are driven as a function of current climatic conditions and Willamette Valley stratigraphy.

Dr. Stewart's duties for this project will include the assistance in *in situ* and laboratory soils analyses, microhabitat data collection, and research design.

Douglas Partridge, M.S.

Doug Partridge completed a Masters degree in Biology from the University of Michigan, with an emphasis in plant ecology in Spring 2000. His thesis project at the University of Michigan examined life history traits that help to explain abundance and distribution patterns of invasive herbaceous plants.

Prior to graduate school, Mr. Partridge worked on several ecological research projects focused on plant ecology. He was the project coordinator for research to determine the effects of seed weight and intraspecific competition on germination and seedling behavior. Mr. Partridge was also a research assistant for the University of Michigan Biological Station researching the effects of elevated concentrations of atmospheric carbon dioxide and soil nitrogen on the growth and survival rates of Trembling aspen (*Populus tremuloides*).

Since joining LCLA, Mr. Partridge has assisted on several jurisdictional wetland delineations, as well as numerous reconnaissance-level identification and mapping of sensitive areas including steep slopes, erosion hazards, and waters of the U.S. including wetlands. Subsequently, Mr. Partridge assisted in the development of reports for both delineations and reconnaissance-level investigations, the development of mitigation plans, and acquiring permits for private landowners, as well as city and county

governments. Mr. Partridge has also been involved in rare plant surveys, as well as a Hydrogeomorphic Method (HGM) project in Santa Barbara, California. These projects included the development of field methodology, fieldwork, data analysis, mapping, and assisting in the writing of a report and/or HGM Guidebook.

Mr. Partridge's duties for this project will include field survey, research design, data collection and analysis, and document production.

Shane Staten, M.E.M.

Mr. Staten received a Masters of Environmental Management from Duke University's Nicholas School of the Environment and Earth Sciences, specializing in wetland ecology, restoration and management, as well as forest management. In 1999, he was named a Doris Duke Charitable Foundation Conservation Fellow for outstanding promise in the field of conservation. Mr. Staten was a maintenance assistant in Duke Forest, helping with daily forest management, prescribed burns, and GPS data collection.

During the summer of 2000, as part of a wetland restoration project north of Klamath Falls, Oregon, Mr. Staten performed a seed bank germination study for The Nature Conservancy's Williamson River Delta Preserve. This study determined the locations of wetland seed banks on the property as well as the hydrologic levels most conducive for reviving wetland flora.

Prior to receiving his master's degree, Mr. Staten graduated with honors from the University of California, Berkeley, from the department of Integrative Biology (major) and the department of Conservation and Resource Studies (minor). Mr. Staten's honor thesis examined female mate choice of colonial Tuco-tucos (*Ctenomys sociabilis*), a species of Argentinean subterranean rodent. During the summer of 1999, Mr. Staten worked as a laboratory assistant for Prof. Whendee Silver in the College of Natural Resources at U.C. Berkeley on a project dealing with the carbon cycle and its relation to global climate change.

Mr. Staten's duties for this project will include logistics, field survey, research design, data collection and analysis, and document production.

IV. COST

A. Budget

Total cost for the project is estimated to be \$181, 850, as detailed in the budget section in the body of the proposal.

B. Cost-Sharing

NWSTC/LCLA will share equipment and local travel costs. No other cost-share partners have been identified.

V. LOCAL INVOLVEMENT

No involvement by local private or public groups has been identified for this project.

VI. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

NWSTC/LCLA will comply with all standard State and Federal contract terms.

VII. LITERATURE CITED

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