F-0160

I. ***Executive Summary***

Title: Efficacy of Bats in Codling Moth Control in Walnuts in a Reduced-Input Production System. **Applicants**: *Patricia A Delwiche & Gregory Treber*

Project Description and Primary Biological / Ecological Objectives

This project will be a field study of the relationship between bats and codling moth (CM) in established walnut orchards along the Sacramento River, within the Sacramento River National Wildlife Refuge. Pesticide use in these orchards has been minimal for several years; no organophosphate or carbamate insecticides have been used since 1994. CM levels in these orchards have been high; the parasitic wasp *Trichogramma platneri* (TP) was employed for CM control in 1996 and 1997. Bats (species unknown) have been observed in the orchards, but location of roosts is unknown.

The objectives of this project are: 1) to determine the relationship between bat numbers and CM damage in a walnut orchard; 2) to explore the feasibility of biological control of CM in walnuts using bats and parasitic wasps; and 3) to identify the preferred design and location of bat houses for bat populations in the Sacramento River Valley. By quantifying the relationship between bats and moths, we hope to offer a model for alternative CM control which results in reduced pesticide usage and consequently, reduced pesticide aerial loss and runoff, and improved ecological function of aquatic and terrestrial habitats.

Approach / Tasks / Schedule Bat houses will be erected on poles in the orchards in winter 1998. Six walnut orchards at the research site will be farmed following reduced-chemical-input practices, using only TP for CM control. Sampling sites (trees) within the orchards will be locations at which both bats and CM infestation will be monitored throughout the growing seasons. Variables to be considered will be proximity of sampling sites to water (river) and proximity of sampling sites to roosts (if some houses become occupied). Associated tasks are as follows (listed chronologically by initiation date):

Year 1 (1998):
1. Experiment design and layout (Jan 1998)
2. Construct Bat Houses (Jan 1998)
3. Erect Poles and Bat Houses (Mar 1998)
4. Monitor for Codling Moth (Mar 1998)
5. Release *Trichogramma* for CM Control (June 1998)
6. Monitor for presence and numbers of bats (June 1998)
7. Submit annual report (Dec 1998)

Year 2 (1999):
8. Monitor for Codling Moth (Mar 1999)
9. Release *Trichogramma* for CM Control (June 1999)
10. Monitor for presence and numbers of bats (June 1999)
11. Submit final report (Dec 1999)

Justification for Project and Funding by CALFED CM is the major insect pest of walnuts grown in California. Typically it is controlled through the application of chemical insecticides. Some of those in wide use are highly toxic to a variety of organisms, and have been detected in waterways, including the Sacramento and San Joaquin Rivers, adjacent to or downstream from farmland.

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Figures from TNC indicate that 76% of the acreage in the 100-year floodplain of the Sacramento River from Keswick (Shasta Co.) to Verona (Sutter Co.) is designated agricultural in use, suggesting a significant potential for compromised water quality due to pesticide contamination in this watershed.

Biological control of CM is a feasible alternative, through parasitic wasps and mating disruption. Bats are voracious eaters, and have also been suggested as a means of CM control. Anecdotal reports suggest that CM control by bats in various crops can be effective, but quantitative studies are lacking, especially for specific cropping situations.

Budget Costs and Third Party Impacts

Year 1 (1998):	$ 28,429.64
Year 2 (1999):	$ 21,679.91
Total Amount requested:	**$ 50,109.55**

Walnut growers in the Sacramento Valley would be those most immediately impacted by implementation of this project. It is anticipated that this project will generate information of immediate practical value to growers regarding the value of bats for CM control, and regarding specific details on attracting wildlife. This project may offer a low-cost, ecologically-based means of insect control that will be applicable to other cropping systems as well. Adjacent farmlands will benefit from improved ecosystem functioning and enhanced biodiversity of aquatic and terrestrial habitats.

Applicant Qualifications Project applicants Delwiche and Treber have previously worked together on several proposals and funded restoration projects. The education and experience of both applicants have prepared them for the various responsibilities within this effort, including experiment design, execution of field operations, supervision of data collection, data analysis, and report preparation.

Monitoring and Data Evaluation The major portion of this project, as indicated by both time and budget allocations, will be in the area of monitoring for the presence and relative numbers of the two organisms, bats and CM. CM infestations will be estimated at designated sampling sites at four periods throughout the growing season by destructive sampling of fruits; at the same time, bat numbers will be estimated at the same sampling sites by means of ultrasonic counting devices calibrated to reflect actual observed bat numbers. Data evaluated will be correlations between bat numbers and moth numbers, between bat numbers and proximity values, and between moth numbers and proximity values.

Local Support / Coordination with other Programs / Compatibility with CALFED Objectives Collaborators include TNC, USFWS, CSU, Chico University Farm, and potentially, Pacific Gas and Electric. TNC routinely conducts public education field days at Phelan Island, demonstrating the integration of agricultural and conservation activities. Multiple benefits will accrue from this project, namely, control of other pest species, potential for reduction of other pesticides, and applicability of results to other cropping systems. Investigation of strategies which reduce contaminant loads is clearly and directly related to CALFED's mission to improve aquatic and terrestrial habitats.

II. Title Page

a. Title of Project: Efficacy of Bats in Codling Moth Control in Walnuts in a Reduced Input Production System

b. Principal Investigators:

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c. Type of Organization: Auxiliary Organization of CSU, Chico as provided for in *California Education Code Title 5*
Tax status: Non Profit

d. Tax Identification Number: 68-0386518

e. Technical Financial Contact:

Jeff Wright, Director
Office of Sponsored Projects
California State University, Chico
Chico, CA 95929
(916)898-5700 / FAX (916) 898-6804
e-mail: jwright@oavax.csuchico.edu

f. Participants / Collaborators:

1) *Pacific Gas & Electric*
2) University Farm, California State University, Chico
3) The Nature Conservancy
4) US Fish & Wildlife Service

g. RFP Project Group Type: Other Services

III. ***Project Description***

a. Project Description and Approach

This project will be a field study of the relationship between bats and CM in established walnut orchards along the Sacramento River, within the Sacramento River National Wildlife Refuge (SRNWR). In accordance with a Cooperative Land Management Agreement (CLMA) between The Nature Conservancy (TNC) and US Fish & Wildlife Service (USFWS), pesticide use in these orchards has been minimal for several years; no chemical insecticides have been used in 1996 or 1997. CM levels in these orchards have been high; the parasitic wasp *Trichogramma platneri* (TP) was employed for CM control in 1996 and 1997. Bats (species unknown) have been observed in the orchards, but location of roosts in unknown.

The objectives of this project are: 1) to determine the relationship between bat numbers and CM damage in a walnut orchard; 2) to explore the feasibility of biological control of CM in walnuts using bats and parasitic wasps; and 3) to identify the preferred design / color / orientation / location of bat houses for bat populations in the Sacramento River Valley. By quantifying the relationship between bats and moths, we hope to offer a model for alternative CM control which results in reduced pesticide usage and consequently, reduced pesticide aerial loss and runoff, and improved ecological function of aquatic and terrestrial habitat.

Bat houses will be erected on poles in the orchards in winter 1998. Since other researchers have found it difficult to establish bats in designated areas, we are not assuming that residency will be taken up in any of the houses over the course of the study. The experiment was deliberately designed to generate meaningful data regarding the relationship between bat and moth numbers even if the houses are not ever occupied. Six walnut orchards at the research site will be farmed according to standard practices, using only TP for CM control. Sampling sites (trees) within the orchards will be locations at which both bats and CM infestation will be monitored throughout the growing seasons. Variables to be considered will be distance of sampling sites from water (river) and distance of sampling sites from roosts (if some houses become occupied). Associated tasks are as follows (listed chronologically by initiation date):

Year 1 (1998):
1. Experiment design and layout (Jan 1998)
2. Construct Bat Houses (Jan 1998)
3. Erect Poles and Bat Houses (Mar 1998)
4. Monitoring for Codling Moth (Mar 1998)
5. Release *Trichogramma* for CM Control (June 1998)
6. Monitor for presence and numbers of bats (June 1998)
7. Submit annual report (Dec 1998)

Year 2 (1999):
8. Monitor for Codling Moth (Mar 1999)
9. Release *Trichogramma* for CM Control (June 1999)
10. Monitor for presence and numbers of bats (June 1999)
11. Submit final report (Dec 1999)

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b. Location and/or geographic boundaries of project

The Phelan Island Unit of the SRNWR is within the Farwell and Capay Rancho. The unit contains 308.51 acres, of which approximately 237 are the Island itself. Located in the Sacramento River Watershed, 4.5 miles south-southeast of Hamilton City on the west side of the Sacramento River in Glenn County, Phelan Island lies immediately east-northeast of the Stony Creek and Sacramento River confluence at river mile 191 (Figure 1). Sixty-five acres of the unit are planted to walnuts and 70 to prunes; the remaining acreage is either existing riparian habitat or has recently been planted to riparian species (Figure 2). The project described in this document will be carried out in the 65 acres of walnuts.

c. Expected benefits

Water quality is the primary stressor addressed in this project. The enhancement of water quality by contaminant reduction, which this project undertakes, will have most immediate effects on instream aquatic and shaded riverine aquatic habitats. The presence of the mixed riparian and cottonwood riparian forest vegetation types on Phelan Island, and the proximity of the Sacramento River, present foraging opportunities for many wildlife species. It is expected that the conversion from chemical pest control to biological methods will be beneficial to most wildlife species, will allow for increased diversity in both agricultural and wild lands, and will result in improved downstream water quality through reduction of pesticide runoff and aerial loss. Third-party beneficiaries are growers, who may experience reduced pest control costs and concurrent enhancement of biodiversity in farmed and non-farmed properties.

d. Background and Biological/Technical Justification

Codling moth is the major insect pest of walnuts grown in California. Typically it is controlled through the application of chemical insecticides. Over the last few years insecticide use, in walnuts as well as other crops, has moved away from organochlorine compounds toward organophosphate and carbamate compounds. These latter insecticide classes are generally less persistent, have a lower potential for development of insect resistance, and are often more selective than organochlorines. Some of those in wide use are, however, highly toxic to a variety of organisms (Edge, et al.; Graham & Desgranges; Hanazato; Greg Treber, pers. comm.), and have been detected in waterways, including the Sacramento and San Joaquin Rivers, adjacent to or downstream from farmland (Domagalski; MacCoy, et al.; Smith, et al.). Figures from TNC (Draft Handbook, 1997) indicate that 76% of the acreage in the 100-year floodplain of the Sacramento River from Keswick (Shasta Co.) to Verona (Sutter Co.) is designated agricultural in use, suggesting that the potential for compromised water quality due to pesticide contamination in this watershed is significant.

Biological control of CM is a feasible alternative: Mills and his co-workers (1995) have shown that careful releases of TP can control moderate levels of CM. In apples, the same pest can be effectively managed by use of pheromone-mediated mating disruption. Bats are voracious eaters, and have also been

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suggested as a means of CM control. Anecdotal reports suggest that CM control by bats in various crops can be effective, but quantitative studies are lacking, especially for specific cropping situations. The proposed approach differs from other biological strategies for CM control in that it involves bats as well as TP, and it may be able to manage CM when the moth is present in large numbers.

This is a new project; the walnut orchards on Phelan Island have been in existence since the 1960's, but until recent years have been farmed using conventional, pesticide-based measures. The orchards are surrounded by fields in various stages of restoration to riparian habitat, the result of several federally- and locally-funded projects.

e. Proposed Scope of Work

The project has been broken down into 11 tasks, which address the various phases of design, construction and execution. They are detailed below in chronological order, according to initiation date, along with technical details, timing and deliverables.

Year 1 = 1998

TASK 1: Experiment design and layout

The purpose of this task is to design and lay out experiment to test the hypothesis: CM numbers can be reduced by using bats and parasitic wasps in reduced-input walnut production systems. The product of this task will be a plan detailing the experimental layout / design. Month of initiation: 1/98; month of completion: 3/98.

Subtask 1.1: Map physical layout of orchards, identifying sites for bat houses, size and orientation of transects, and location of sampling units (Figure 3).

Subtask 1.2: Prepare data files, maps and sampling site descriptions. (Develop formulae to quantify proximity of sampling sites to bat houses ("roosting proximity") and to water source ("water proximity"); after some bat houses become occupied, roosting proximity values will be used to describe sampling sites relative to occupied bat house(s).) Hire student assistants, assemble required materials.

Subtask 1.3: Prepare site for experiment: Select and tag trees along each transect to serve as sampling sites throughout the season.

Subtask 1.4: Submit interim report and invoice by 3/98.

TASK 2: Construct Bat Houses

The purpose of this task is to construct bat houses according to several different designs, so that at least two different styles of house can be erected on each pole in the walnut orchards at the research site. We hope to recruit the help of Chico Junior High School's Industrial Technology classes with the construction of these houses, but cannot be assured of their help at the time of proposal submission. If CJHS does not construct houses, student assistants will be hired to make them. Month of initiation: 1/98; month of completion: 3/98.

Subtask 2.1: Contact CJHS I-Tech staff regarding cooperative project; deliver building plans to them.

Subtask 2.2: Assemble materials for house construction.

Subtask 2.3: Assemble, paint houses.

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Subtask 2.4: Submit interim report and invoice by 3/98.

TASK 3: Erect Poles and Bat Houses

The purpose of this task is to erect mounting poles and bat houses in walnut orchards as early as possible in the spring, before bats migrate from hibernacula. Month of initiation: 3/98; month of completion: 5/98.

Subtask 3.1: Erect poles to supplement those left by PG&E. Location of poles will have previously been determined (Subtask 1.1).

Subtask 3.2: Mount two bat houses of each of two designs on each pole.

Subtask 3.3: Submit interim report and invoice by 5/98.

TASK 4: Monitoring for Codling Moth

The purpose of this task is to assess the incidence of CM at locations throughout the orchard (sampling sites), throughout the growing season. Month of initiation: 3/98; month of completion: 10/98.

Subtask 4.1: Early in season, use pheromone-baited CM traps to detect first appearance of CM and to determine biofix. Begin accumulating degree-days.

Subtask 4.2: Quantify CM severity at sampling sites at periods of peak moth populations, as determined by trap counts (approximately mid-April, early May, early June, late July) and phenology model.

Subtask 4.3: Calculate correlations between CM numbers and bat numbers (Task 6), and between CM numbers and proximity of sampling site to occupied bat houses.

Subtask 4.4: Submit interim report and invoice by 8/98.

TASK 5: Release *Trichogramma* for CM Control

The purpose of this task is to provide a base level of CM control through release of the parasitic wasp *Trichogramma*. Depending on CM emergence rates and numbers (Task 4), wasp release will begin sometime in April or May. Wasps will be released at every tree, at intervals of approximately ten days, throughout the growing season. Month of initiation: 4 or 5/98; month of completion: 10/98.

Subtask 5.1: Order wasps from insectary 1 week - ten days in advance.

Subtask 5.2: Release wasps as needed for CM control. Continue releases through third moth flight.

Subtask 5.3: Submit interim report and invoice by 10/98.

TASK 6: Monitor sampling sites for presence and numbers of bats

The purpose of this task is to determine initial and subsequent bat numbers, and their relationship to roosting sites and to codling moth numbers (Task 4). Month of initiation: 5/98; month of completion: 10/98.

Subtask 6.1: Prepare monitoring and recording equipment for bat observations: calibrate recording devices.

Subtask 6.2: Determine initial bat numbers at standardized locations throughout orchard (sampling sites), before bat houses are occupied.

Subtask 6.3: Monitor bat houses periodically to determine occupancy, and house style preferred by bats.

Subtask 6.4: Monitor, using bat-detecting devices and/or visual counts, bat numbers at standardized locations throughout orchard (sampling sites) at

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periods of peak moth populations, as determined by trap counts (approximately mid-April, early May, early June, late July).

Subtask 6.5: Calculate correlation between bat numbers and bat roosting-site proximity values (Task 1).

Subtask 6.6: Submit interim report and invoice by 10/98.

TASK 7: Annual report

The purpose of this task is to summarize the results obtained from year 1 of the study. The product of this task will be a report which integrates the various analyses into a meaningful synopsis of the year's work, in the context of previous knowledge.

Subtask 7.1: Submit annual report and invoice by 12/98.

Year 2 = 1999

TASK 8: Monitoring for Codling Moth (Same as Task 4 for 1998)

TASK 9: Release *Trichogramma* for CM Control (Same as Task 5 for 1998)

TASK 10: Monitor for presence and numbers of bats (as for Task 6, 1998)

TASK 11: Final report

The purpose of this task is to summarize the results obtained from both years of the project. The product of this task will be a report which integrates the results from both years.

Subtask 11.1: Submit final report and invoice by 12/99.

f. Monitoring and Data Evaluation

The major portion of this project, as indicated by both time and budget allocations, will be in the area of monitoring for the presence and relative numbers of the two organisms, bats and CM. CM infestations will be estimated at designated sampling sites at four periods throughout the growing season by destructive sampling of fruits; at those same four periods of CM monitoring, bat numbers will be estimated at the same sampling sites by means of ultrasonic counting devices calibrated to reflect actual observed bat numbers. Destructive sampling of fruits (using pruning tower to collect 25 fruits from throughout the canopy of each sampling site) will be used for CM monitoring, rather than visual counts, as have been used by some researchers, because it is felt that destructive sampling yields a less biased estimate of true CM infestation. Numerous methods are available for detecting and monitoring bats (Kunz); visual counts and electronic detection were selected in preference to trapping or photographic methods in the interests of efficiency. The limitations and biases of each of these methods have been pointed out by Kunz, and must be recognized in interpretation of data. Data evaluated will be correlations between bat numbers and moth numbers, between bat numbers and proximity values, and between moth numbers and proximity values.

g. Implementability

The proposed program is in compliance with the Cooperative Land Management Agreement between TNC and USFWS for management of this property. TNC has expressed full support of research efforts such as these, aimed at reduction of chemical inputs on agricultural properties in the SRNWR. Contribution of materials (unused power poles) from Pacific Gas & Electric may occur, pending clarification of liability status. Outreach programs (field days) routinely conducted

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by both TNC and CSU, Chico's College of Agriculture at the research site, are directed toward education of the general public, the farming community and conservation groups.

h. Bibliography

Domagalski, J.L. 1995. Nonpoint sources of pesticides in the San Joaquin River, California: Input from winter storms, 1992-93. US Geol. Surv. OF 95-0165:1-14.

Edge, W.D., R.L. Carey, J.O. Wolff, L.M. Ganio and T. Manning. 1996. Effect of Guthion 2S® on *Microtus canicaudus*: a risk assessment validation. *J. Appl. Ecol.* 33:269-278.

Foe, Christopher. 1997. Calif. Water Resources control Board, Pers. comm.

Graham & DesGranges. 1993. Effect of azinphosmethyl on birds of potato fields and apple orchards. *Agriculture, Ecosystems & Environment*. v. 43: 183-199.

Hanazato, Takayuki. 1991. Effects of long- and short-term exposure to carbaryl on survival, growth and reproduction of *Daphnia ambigua*. *Environ. Pollution* 74:139-148.

Kuivila, K. 1993. Diazinon concentrations in the Sacramento and San Joaquin Rivers and San Francisco Bay, California, February 1993. *USGS Water Fact Sheet*, OF 93-0440: 1-2.

Kunz, Thomas H. 1988. *Ecological and Behavioral Methods for the Study of Bats. Smithsonian Institution*, Washington D.C.

MacCoy, Dorene, Kathryn L. Crepeau, and Kathryn M Kuivila. 1995. Dissolved pesticide data for the San Joaquin River at Vernalis and the Sacramento River at Sacramento, California, 1991-94. US Geol. Surv. OF 95-0110:1-29.

Mills, N., et al. 1995. *Trichogramma* augmentation as a component of the management of codling moth in walnuts. Walnut Marketing Board, pp. 137-149.

Sanger, S.L. 1996. Researcher tests batty idea against codling moth. Good Fruit Grower.

Smith, S., T.E. Reagan, J.L. Flynn, and G.H. Willis. 1983. Azinphosmethyl and fenvalerate runoff loss from a sugarcane-insect system. *J. Environ. Qual.*, 12:534-537.

The Nature Conservancy. 1997. Draft Handbook Appendix D. (unpubl.)

Treber, Greg. 1997. Pers. comm.

Willis, G.H. and L.L. McDowell. 1982. Pesticides in agricultural runoff and their effects on downstream water quality – a review. *Environ. Chem. Toxicol.*1:267:279 (*cited in*: Smith, et al., 1983).

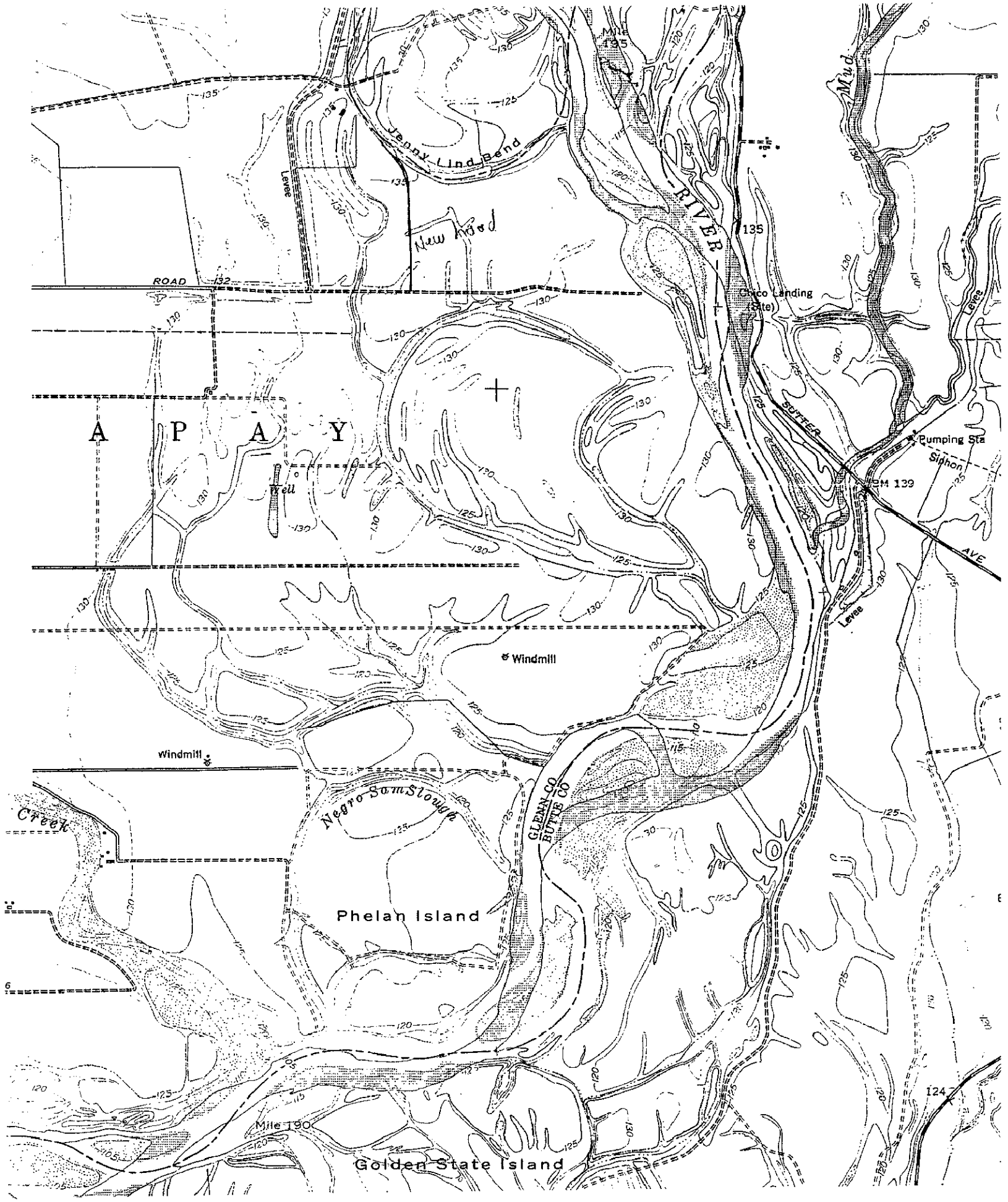

Figure 1. Location of Phelan Island

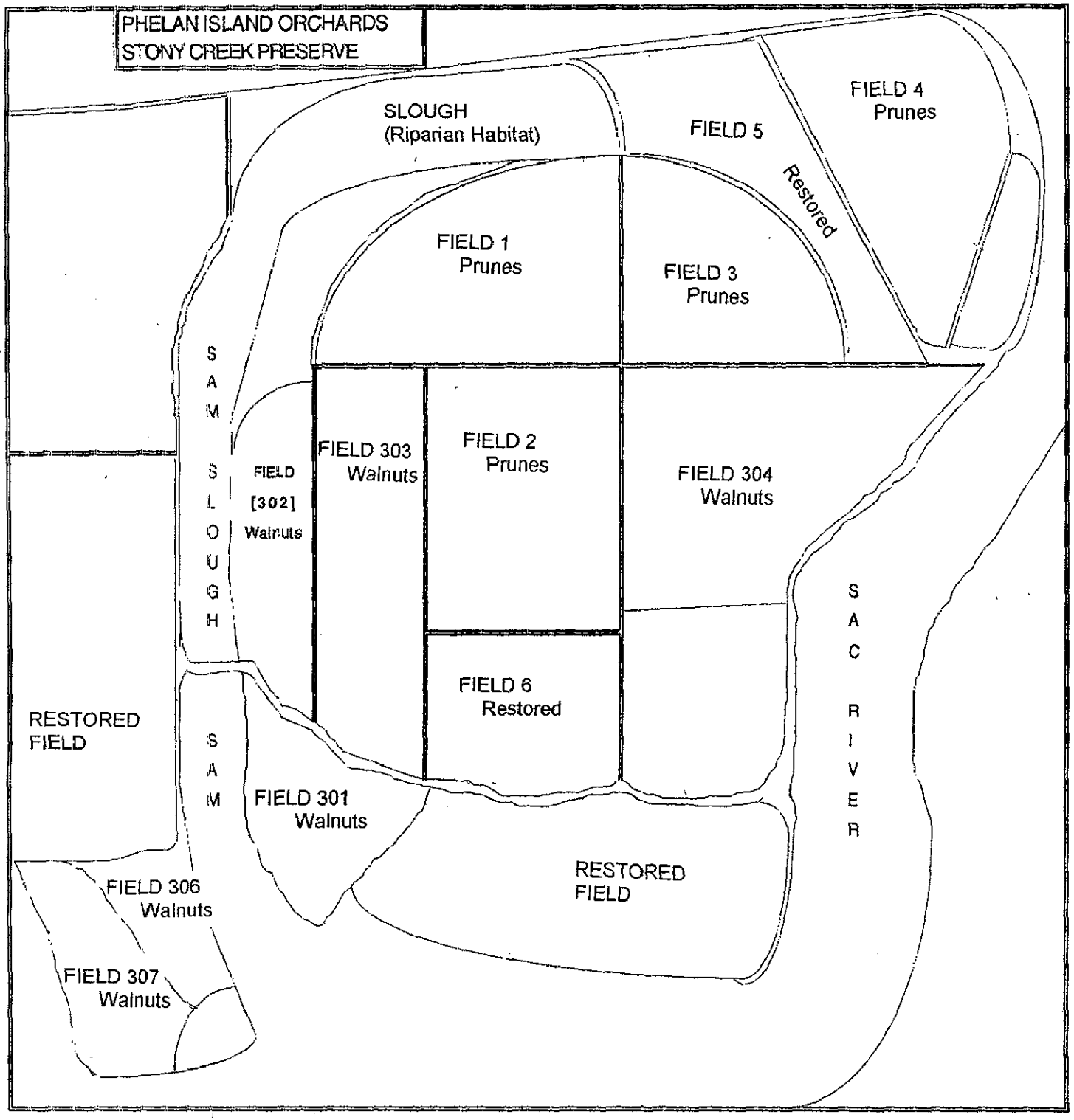

Figure 2. Location of Phelan Island orchards

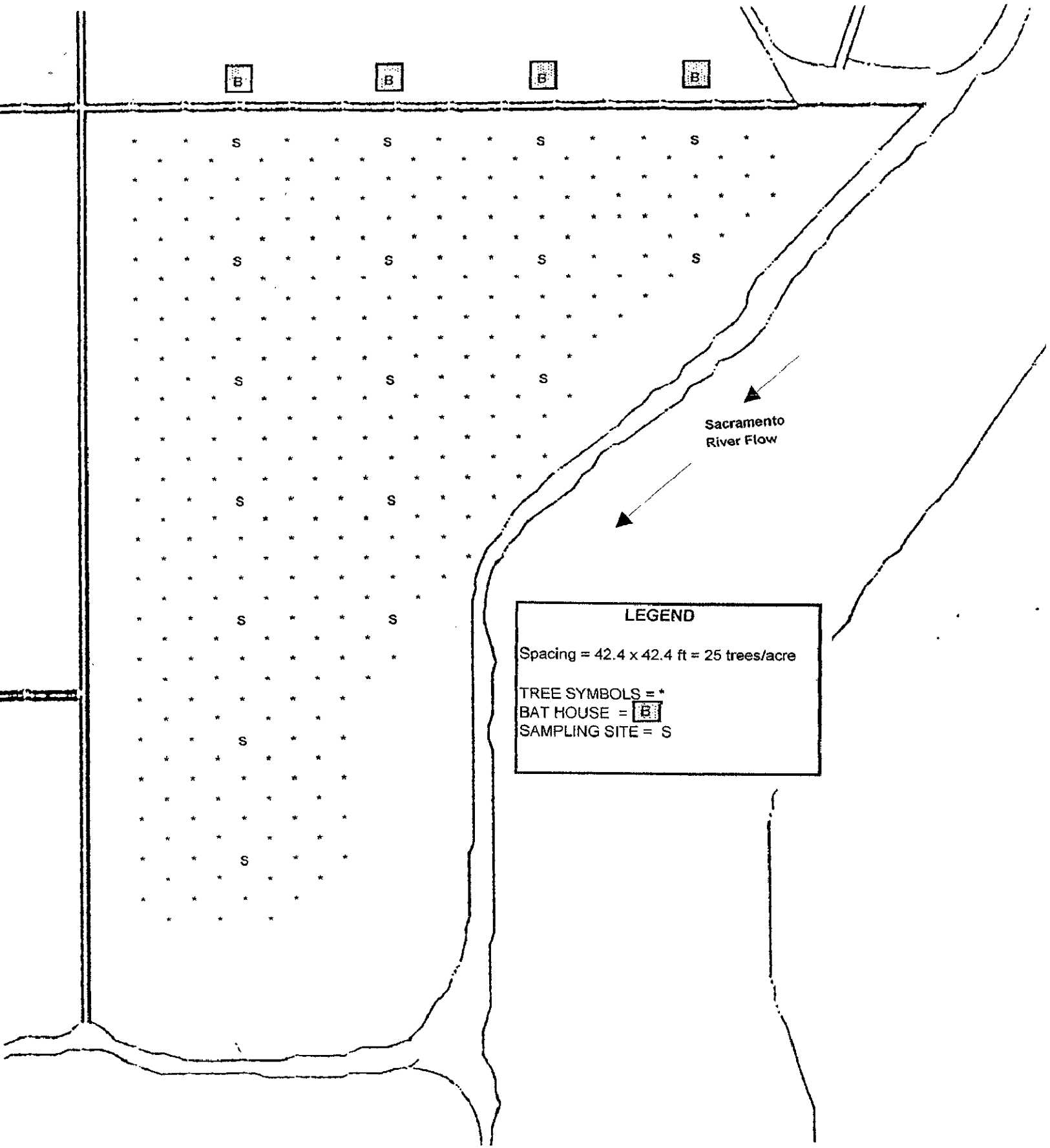

Figure 3. Proposed location of bat houses and sampling sites in walnut Field 304.

IV. ***Costs and Schedule to Implement Proposed Project***

a. Budget Costs

Table 1 breaks down project costs by budget category and task. Associated comments are as follows:

1) We have interpreted the category "Overhead Labor" to mean Indirect Costs, and we calculated it as 20% of Total Direct Costs.
2) "Direct Salary and Benefits" is calculated differently for the two project applicants, and differently for student labor.
3) Consultant Fred Thomas is the Pest Control Advisor who will advise us regarding CM development and population levels.
4) In the category "Material and Acquisition Contracts", the annual cost to this project of *Trichogramma* ($3800) is actually half of the total annual cost. The remainder is being picked up by the regular farming enterprise (CSU, Chico match). Cost of poles on which to mount bat houses ($450) may, in fact be less, if PG&E is able to donate their power poles already present at the site.
5) In the category "Miscellaneous", "Communication" includes telephone, FAX and copying costs. "Travel" includes both travel to the research site, and transport of equipment to the site.

b. Schedule Milestones

As indicated in section IIIe (above), the completion of the 11 specific tasks coincides with interim reports, which will detail the work accomplished, and associated invoices. Annual reports will summarize project results to date.

c. Third Party Impacts

Walnut growers in the Sacramento Valley would be those most immediately impacted by implementation of this project. It is anticipated that this project will generate information of immediate practical value to growers regarding the value of bats for CM control, and regarding specific details (number of bat houses needed, optimal design and location, distance from water source). This project may offer a low-cost, ecologically-based means of insect control that will be applicable to other cropping systems as well. Adjacent farmlands will benefit from improved ecosystem functioning and enhanced biodiversity of aquatic and terrestrial habitats.

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Table 1: CALFED cost Breakdown Table

Project Phase and Task	Direct Labor Hours	Direct Salary and Benefits	[a] Overhead Labor	Service Contracts	Material and Acquisition contracts	Miscellaneous and other Direct Costs	**Totals, by task**
Task 1: Design	63	1306.79	271.36			Communication, $50	**$1,628.15**
Task 2: Houses	64	931.49	316.30		Bat houses: $600	Communication, $50	**$1,897.78**
Task 3: Erect	57	986.49	457.30		Poles: $450, Pile driver + tractor rental: $200, Pruning tower rental, 1 week: $450	Communication, $50; Travel, $150	**$2,743.79**
Task 4: CM	219	3062.51	1226.50	Consultant Fee, Fred Thomas, $1000	Codling moth traps: $120, Pruning tower rental, 4 weeks: $1800	Communication, $100;Travel, $50	**$7,359.01**
Task 5: TP	324	3391.04	1458.21		*Trichogramma:* $3800	Communication, $50; Travel, $50	**$8,749.25**
Task 6: Bats	271	3990.84	908.17		Electronic bat detector: $400	*Communication*, $50; Travel, $100	**$5,449.01**
Task 7: Annual Report	25	402.21	100.44			Communication, $100	**$602.65**
Task 8: CM (Yr 2)	219	3062.51	1226.50	Consultant Fee, Fred Thomas, $1000	Codling moth traps: $120, Pruning tower rental, 4 weeks: $1800	Communication, $50;Travel, $100	**$7,359.01**
Task 9: TP (Yr 2)	324	3391.04	1458.21		*Trichogramma:* $3800	Communication, $50; Travel, $50	**$8,749.25**
Task 10: Bats (Yr 2)	251	3198.55	669.71			Communication, $50;Travel, $100	**$4,018.26**
Task 11: Final report	45	1194.50	258.90			Communication, $100	**$1,553.40**
Totals, by category	**1862**	**$24,917.96**	**$8,351.59**	**$2,000.00**	**$13,540.00**	**$1,300.00**	**$50,109.55**

[a] We are calculating this category at 20% of Total Direct Costs (TDC).

V. *Applicant Qualifications*

Project applicants Delwiche and Treber have previously worked together on several proposals and funded restoration projects (Phelan Island Riparian Restoration Plan Sub-Unit 4, 1997; Beale AFB Riparian Restoration Plan, 1997). The education and experience of both applicants have prepared them for the designated responsibilities within this effort. (See attached resumes.) Project applicant Delwiche will be responsible for design of experiment, analysis of data, and preparation of interim and final reports. Project applicant Treber will be responsible for execution of field operations and supervision of data collection. CSU, Chico students will be hired for materials acquisition and preparation, and for data collection and entry.

Patricia Ann Delwiche

Education

University		Major Field
University of Wisconsin-Madison:	Ph.D. 1980	Plant Pathology & Plant Breeding
University of Wisconsin-Madison:	M.S. 1976	Plant Pathology
University of Wisconsin-Madison:	B.S. 1973	Molecular Biology

Employment

California State University, Chico
School of Agriculture
Chico, CA 95929

1993-present
Lecturer, Plant Science
Director: Dr. Thomas Dickinson

Butte College
Agriculture & Natural Resources
3536 Butte Campus Drive
Oroville, CA 95965

1993-1995
Associate Faculty, Plant Science
Chairman: Mr. Owen Peterson

Awards, Grants and Achievements

CELT Awards for Faculty Development, Oct. 1995, May 1996
CSU, Chico University Foundation Summer Scholars Award, Nov. 1995
Research Award: Soil-borne Pathogens of Strawberry, 1995, Ekland Marketing

Publications

Bonman, J.M., P.A. Delwiche, R.L. Gabrielson and P.H. Williams. 1980. *Leptosphaeria maculans* on cabbage in Wisconsin. Plant Disease 64: 326.

Bonman, J.M., R.L. Gabrielson, P.H. Williams and P.A. Delwiche. 1981. Virulence of *Phoma lingam* to cabbage. Plant Disease 65: 865-867.

Delwiche, Patricia A. 1976. Genetic Studies in *Brassica nigra* L. Koch. M.S. thesis, University of Wisconsin - Madison. 90 pp.

I-000647

Delwiche, Patricia A. 1980. Genetic Aspects of Blackleg (*Leptosphaeria maculans*) Resistance in Rapeseed (*Brassica napus*). Ph.D. thesis. University of Wisconsin - Madison. 144 pp.

Delwiche, P.A., C.R. Grau and D.C. Arny. 1981. Host range of the alfalfa strain of *Verticillium albo-atrum*. Proc. 17th Central Alfalfa Imp. Conf. 4 pp.

Delwiche, P.A., C.R. Grau, D.C. Arny and W.C. Warfield. 1982. Evaluation of Verticillium wilt resistance in field trials and growth chamber tests. (Abstr.) National Alfalfa Improvement Conf., Davis, CA.

Delwiche, P.A., C.R. Grau and R.G. Harvey. 1981. Factors affecting alfalfa stand establishment. Phytopathology 71: 870.

Delwiche, P.A., C.R. Grau and R.G. Harvey. 1981. Investigations of factors responsible for alfalfa establishment failures. Proc. 17th Central Alfalfa Imp. Conf. p.8.

Delwiche, P.A., C.R. Grau, E.B. Holub and J.B. Perry. 1987. Characterization of *Aphanomyces euteiches* isolates recovered from alfalfa in Wisconsin. Plant Disease 71:155-161.

Delwiche, P.A., C.R. Grau and D.P. Maxwell. 1981. Reaction of alfalfa cultivars and other crops to Wisconsin isolates of *Verticillium albo-atrum* (alfalfa strain). Phytopathology 71: 870.

Grau, C.R., Delwiche, P.A., R.L. Norgren, T.E. O'Connell and D.P. Maxwell. 1981. Verticillium wilt of alfalfa in Wisconsin. Plant Disease 65:843-844.

Grau, C.R., P.A. Delwiche, D.C. Arny and D.A. Rohweder. 1982. Verticillium wilt of alfalfa. Univ. of Wisconsin Ext. Publ. No. A3165.

Grau, C.R., S.L. Nygaard, D.C. Arny and P.A. Delwiche. 1991. Comparison of methods to evaluate alfalfa cultivars for reaction to *Verticillium albo-atrum*. Plant Dis. 75:82-85.

Kinglsey, P., J.M. Scriber, C.R. Grau and P.A. Delwiche. 1983. Feeding and growth performance of *Spodoptera eridania* (Noctuidae: Lepidoptera: on Vernal alfalfa as influenced by Verticillium wilt. Prot. Ecol. 5: 127-134.

Pfender, W.F., P.A. Delwiche, C.R. Grau and D.J. Hagedorn. 1984. A medium to enhance recovery of *Aphanomyces* from infected plant tissue. Plant Dis. 68:845-847.

Curriculum Vitae
GREGORY A. TREBER

Education: A.A., Columbia Community College, 1978 (with distinction)
B.S., Agriculture - Biology (minor), CSU, Chico, 1981
Graduate Student in Agriculture, 1992 - present

Thesis Title: The Effect of Two Livestock Grazing Systems on the Growth and Survival of Blue Oak Saplings

Work Experience:

California State University, Chico, Farm Staff. Manager of 400 acres within and adjacent to the Sacramento River National Wildlife Refuge. Director of restoration on The Nature Conservancy's Stony Creek Preserve (Phelan Island). 1993 - present.

Biology Technician, U.S. Bureau of Land Management (Cedarville). Team leader of ecological site inventory. Measured botanical composition, production, % cover/species. Identify and correlate soils with vegetation type. Aerial photo interpretation. 1993 (Summer).

Biology Technician, U.C. Cooperative Extension (Glenn-Tehama). Vernal pool plant identification and transect reading for grazing impact research project. 1993 (Summer).

Manager, MNC&K Farming Ltd. Manage all farming and ranching activities associated with a 1200-acre walnut and grazing operation. Designed and maintained computerized business and cultural operations documentation. Budget center of $250,000. 1988-1991.

Ranch Supervisor, Newhall Land & Farming Co. Managed 500-acre commercial walnut and prune operation. Responsible for a work force of 4-18 employees, all cultural operations, and budget center of $550,000. Required coordination of harvesting and shipping over 120 tons of fruit per day. 1981-1988.

Publications:
Schlising, R., Treber, G.A. & Warren, C. First-year Response to Fire by the California Grassland Perennial, *Dodecatheon clevelandii ssp. patulum*. (Primulaceae). *Madrono* 43 (1).

Awards-Honors: Fred Shanks Memorial Scholarship. 1981, 1993.
Mark Burleigh Memorial Scholarship, 1993.
Outstanding Achievement Award, CSU,Chico School of Agriculture. 1993.

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STATE OF CALIFORNIA

NONDISCRIMINATION COMPLIANCE STATEMENT

STD. 19 (REV. 3-95) FMC

COMPANY NAME

CSU, Chico Research Foundation

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unless specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code of Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and the development, implementation and maintenance of a Nondiscrimination Program. Prospective contractor agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant for employment because of sex, race, color, ancestry, religious creed, national origin, disability (including HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leave and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospective contractor to the above described certification. I am fully aware that this certification, executed on the date and in the county below, is made under penalty of perjury under the laws of the State of California.

OFFICIAL'S NAME

Jeff Wright

DATE EXECUTED

7/24/97

EXECUTED IN THE COUNTY OF

Butte

PROSPECTIVE CONTRACTOR'S SIGNATURE

PROSPECTIVE CONTRACTOR'S TITLE

Director, Office of Sponsored Programs

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

CSU, Chico Research Foundation