

Title Page

Title of Project: Assessment of Distribution, Abundance, and Ecological and Economic Impacts of the Chinese mitten crab, *Eriocheir sinensis*, in the San Francisco Bay-San Joaquin Delta ecosystem, with special reference to South San Francisco Bay.

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Executive Summary:

The Chinese mitten crab (*Eriocheir sinensis* H. Milne Edwards) is a recent arrival to the Bay and Delta ecosystem, and its establishment has generated widespread attention. This catadromous crab has already spread over several hundred square miles throughout the freshwater and estuarine ecosystems of the Bay and Delta (Attachment 1). In countries in which it has established, including much of Europe, the mitten crab is known to have dramatic ecological and economic effects (Panning 1938, Clark 1998). These effects range from erosion and collapse of banks and levees due to the crab's burrowing activities, to interference with commercial fisheries due to net damage and possible predation on and competition with harvested species and other aquatic species. The Chinese mitten crab is known in its native range in Asia to carry a debilitating human parasite, the lung fluke *Paragonimus westermanii*. Much of the ecology and impacts of this crab are largely unknown for the crab in its new range here in the Bay and Delta. As a new arrival in its early stages of invasion, with potentially devastating ecological and economic impacts, the Chinese mitten crab merits immediate research attention.

This research proposal addresses the ecology and impacts of the Chinese mitten crab in the San Francisco Bay-Delta ecosystem. This proposal has four goals: 1) monitor the abundance and distribution of the mitten crab, 2) define habitat preferences and quantify impacts on levees and banks, 3) using field and laboratory methods, evaluate the impacts of the mitten crab on commercially valuable invertebrate species, 4) research the role of the mitten crab in the food web, emphasizing impacts to endangered and commercially valuable species. This project will take a multi-level ecological and economic approach in order to quantitatively assess the ecology and impacts of this species in the Bay-Delta ecosystem.

The primary field site for this proposal is the estuary of the South Bay and its major tributaries (Attachment 2). We will establish five core field sites and fifteen additional field sites along these major tributaries in order to monitor mitten crab seasonal patterns in abundance, distribution and migration, habitat preferences and areas where the threat to bank and levee integrity from crab burrowing activities will be the highest. We will analyze additional data from trawl data collected by the Marine Science Institute (MSI), a non-profit education and research organization that conducts continuous year-round trawls of the South Bay, in order to compare freshwater population dynamics of the mitten crab with dynamics in the Bay.

Field enclosures will be used to examine competitive interactions between mitten crabs and two species of crayfish, *Procambarus clarkii* and *Pacifastacus leniusculus*. *Procambarus* commonly occurs with mitten crabs in the South Bay, and *Pacifastacus* is a valuable commercial crayfish species in the Delta. Surveys of the crayfish and shrimp industries of northern California will be conducted in order to assess catch damage attributable to the mitten crab on these industries. Laboratory experiments conducted at the campus of the University of California at Berkeley will examine the competitive interactions of mitten crabs with crayfish species. We will conduct behavioral experiments at multiple life stages of each species to examine interspecific competition for dominance, food and shelter.

Feeding preference laboratory experiments will be conducted in order to assess the role of the mitten crab in Bay-Delta food webs. Crabs will be presented with food choices including detritus, shrimp, vegetation and aquatic insects. We will introduce the live shrimp *Palaemonetes paludosus* in feeding studies in order to assess whether populations of commercially valuable shrimp such as *Palaemon* and *Crangon*, as well as the endangered freshwater shrimp, *Syncaris*, are impacted by the mitten crab. We will also conduct gut content analysis of crabs collected

from south bay tributaries and Sonoma Creek to look for dietary preferences and determine changes in mitten crab diets with development.

The principal investigator for this project has over 25 years of experience in the field of aquatic ecology (Attachment 3). He will be assisted by a graduate student researcher with significant experience in the field of ecology and natural resource management. The applicants' proposal is supported by several agencies and organizations, including the Santa Clara Valley Water District and MSI. Research efforts will be coordinated with the efforts of MSI and with the research objectives and efforts of members of the Interagency Ecological Project's Chinese mitten crab workgroup, a workgroup in which our laboratory participates.

The proposed research is compatible with several CALFED goals and objectives. In line with CALFED's mission to create a plan to restore the ecological health of the Bay-Delta ecosystem, this research will provide high-quality, quantitative research vital to understanding of the role of the Chinese mitten crab in the health of the Bay-Delta ecosystem. This research will provide the comprehensive monitoring, indicator development and directed research that are called for in pages 6-11 of the Ecosystem Restoration plan (ERP). The ERP, Volume I, states the need for development of a comprehensive monitoring, assessment and research program (CMARP). This proposal creates a comprehensive program that addresses the response of the Bay-Delta ecosystem to disturbance at multiple spatial and temporal scales. The CMARP directive emphasizes the current fragmentary nature of existing monitoring and research and calls for a comprehensive and integrated approach to this research. We have close connections throughout government agencies, non-profit organizations and industries that will allow us to disseminate, communicate, and receive feedback on our project to make this work as integrated with and appropriate to research and management needs as possible.

This proposal meets several strategic objectives defined in the ERP. The proposal addresses the needs identified in the ERP to specifically research the interaction of the Chinese mitten crab with the commercially-valuable signal crayfish and grass shrimp, identified by the ERP as species targeted for maintenance and enhancement. Research will also establish impact of the mitten crab on the California freshwater shrimp, identified by the ERP as a priority species for population recovery and management. This proposal also answers the goals stated in the ERP and detailed in the draft Non-Indigenous Species Management Plan to identify, delineate and understand the mechanisms of impact of invasive species.

As mitten crab populations spread, more and more habitats and species will be affected. Accelerated bank erosion is already visually evident among sloughs in the South Bay (Halat 1996). Government fish facilities are already heavily affected by large numbers of mitten crabs clogging facility intakes (Scott Sigfreid, pers. comm.) The damage from mitten crabs is clearly beginning. The more knowledge we have about the mitten crab, the better prepared we will be to make informed decisions about its management. This proposal presents a unique opportunity to begin early in the process of establishment of this species to quantitatively assess the ecological and economic impacts of the Chinese mitten crab and contribute meaningfully to our knowledge about the health of the Bay-Delta ecosystem.

Project Description

Proposed Scope of Work:

The proposed program will use experimental field and laboratory studies, combined with continuous monitoring data, to examine the biology, population dynamics and impacts of a recently introduced species, the Chinese mitten crab (*Eriocheir sinensis* H. Milne Edwards) on freshwater and estuarine habitats of the San Francisco Bay-Delta ecosystem.

By investigating the mitten crab's ecology and impacts, we will quantitatively address the role of this new species in the San Francisco Bay-Delta ecosystem. This project has four goals: 1) monitor the abundance and distribution of the mitten crab throughout southern San Francisco Bay and its tributaries, 2) define habitat preferences and quantify impacts on levees and banks, 3) using field and laboratory methods, explore the impacts of the mitten crab on commercially valuable invertebrate species, 4) research the role of the mitten crab in the food web, emphasizing impacts to endangered and commercially valuable species. This research proposal will begin July 1999, and will be completed in the spring of 2002. Please see the attached quarterly task schedule (Attachment 4) for a specific breakdown of research and oversight tasks.

1) Monitor abundance and distribution of the Chinese mitten crab:

We will monitor abundance and distribution in order to gather information about the population dynamics, habitat preferences and migration cycles of the mitten crab. We will collect field data to assess the densities and distribution of mitten crabs in South San Francisco Bay. Sex ratios and mean size be monitored in order to examine population sex and age dynamics. A sample of crabs will be collected for gut content analysis (see discussion below). Monthly data of average burrow densities and burrow entrance diameters will be collected from three separate five meter transects of bank at five sites in South San Francisco Bay within gradients of similar salinity and tidal influence. Two sites will be along Alviso Slough, one on Stevens Creek, and two on Guadalupe Slough (Attachment 2). We will choose fifteen additional sites throughout the South Bay based on this survey and we will conduct quarterly data collection at these sites in order to document trends in abundance and distribution of mitten crabs throughout the Santa Clara Valley watershed.

In order to define the overall spread of the mitten crab throughout the South Bay, we will conduct a yearly census of the presence of mitten crabs along the length of four major tributaries: Stevens Creek, Guadalupe Slough and its tributary San Thomas Aquino Creek, Alviso Slough and its tributary the Guadalupe River, and Coyote Creek. We have gained permission for access to all sites from the Santa Clara Water Valley District. We will coordinate with and aid in the execution of already-established yearly South Bay mitten crab censuses conducted by Marine Science Institute (MSI) volunteers. We will use census and monitoring data in coordination with the physical and biological data described below to create population dynamics models using modeling programs including STELLA and MATLAB.

We will also analyze continuous trawl data from MSI in order to determine migration patterns from tributaries into the South Bay. We have quantified trawl data of mitten crab size, sex and fertility by 1000m² trawl grids from 1996 to the present. We will continue to quantify this data over the duration of this project. Data will be analyzed to examine sex ratios, fertility rates and timing of migration and reproduction.

2) Quantify habitat associations and impacts to banks and levees:

During monitoring activities, we will collect physical and biological habitat data in order to quantify habitat preferences of the mitten crab. We will collect substrate, bank angle, vegetation, salinity and dissolved oxygen data at the monitoring sites on a monthly basis using standard aquatic instrumentation. Major streamside vegetation types will be identified using keys for local and regional vegetation. We will quantify bank damage attributable to mitten crabs in order to assess the extent of bank erosion and damage due to burrowing activities. Bank slumping and erosion at these sites will be quantified by measuring bank recession and depression in burrowed areas relative to average bank height and slope in adjacent non-affected areas. We will quantify sediment removal from burrowing by calculating average burrow volume and density from five meter transects.

3) Impacts of the Chinese mitten crab on commercially-valuable species: freshwater crayfish and grass shrimp populations:

Our observations suggest a competitive dominance by mitten crabs over crayfish for shelter. Field observations have indicated negative interactions between mitten crabs and the signal crayfish, *Pacifastacus leniusculus* (K Halat, pers. comm., T Dudley, pers. comm.). Controlled behavioral experiments will take place at the University of California at Berkeley to examine competition for shelter, food and dominance between the Chinese mitten crab and *P. leniusculus*. A series of freshwater aquaria will be used in a controlled climate laboratory. Source populations will include commercially-harvested *P. leniusculus* and mitten crabs harvested from South Bay sloughs and from the USBR Tracy fish facility (Scott Sigfreid, pers. comm.). Mitten crabs and crayfish will be used to test vulnerability and aggression of each species to the other. Fifteen same-sex pair interactions of the two species in each combination of life stage: juvenile-adult, adult-adult, adult-juvenile, will be conducted. Methods established by Soderback (1990) and Bovbjerg (1970) will be used. Shelters will be introduced in 5 additional paired interactions to examine interspecific shelter competition. Control tanks with one individual of each species in their own aquaria will establish shelter use and preference in the absence of competitors (based on the methods of Blank and Figler 1996).

Field enclosure experiments will measure the effects of mitten crabs on growth rates of crayfish species. As *P. leniusculus* is not found in the tidal channels of the South Bay, only the crayfish *Procambarus clarkii* will be used for field enclosures in the South Bay. *P. leniusculus* will be used for tidal Delta channels. Exact sites for field enclosures will be determined based on consultation with the Santa Clara Water Valley District in the South and with the Department of Fish and Game in the Delta to determine sites with physical consistency and low visibility to reduce potential vandalism. At this time a county siting for Delta enclosures has not been determined, but county officials will be contacted prior to making this decision. Each treatment will be run for a period of three months. Three treatments will be used: crabs alone, crayfish alone, and crabs and crayfish together. Enclosures will be conducted of nylon mesh buried and weighted into the substrate and supported with rebar. Enclosures will be covered by mesh to prevent predation by mammals and birds.

Growth measurements of crabs and crayfish will be taken every two weeks. At each experimental site, crayfish outside of the enclosures will be captured, tagged, marked and measured for a mark-recapture study to look at growth of wild populations. Mitten crabs outside enclosures will not be marked because recapture of these migrating, quick-moving crabs is very

difficult. This experimental design is based on scale and sampling considerations analyzed in a study of crayfish interactions conducted by Feminella and Resh (1989).

We will work with commercial fisheries to determine impacts of the mitten crab on commercial harvests. We have sent out an initial survey to crayfish fishermen to assess numbers of crabs caught in crayfish traps, evidence of predation or negative interaction with crayfish, and perceptions of effects on harvest. We will continue to conduct these surveys over the next three years. In addition, we propose to begin a quantitative survey of the Bay shrimping industry. Using the protocol designed for our crayfish industry survey, we will develop a survey to distribute throughout the shrimping industry to assess catches of mitten crabs in shrimp nets and effects on damage to shrimp harvest.

4) Chinese mitten crab dietary preferences and food web impacts:

From initial lab work and literature, we know that mitten crabs are generally omnivorous with some shift towards carnivory with age. No work has been done so far, however, to quantify the role of the mitten crab in Bay and Delta food webs. We will use laboratory experiments in order to determine what impacts the mitten crabs are having on local food webs. Mitten crabs will be obtained from Sonoma Creek and from South Bay streams. A sample of crabs from both South Bay monitoring stations and Sonoma Creek will be preserved with 70% ethanol and transported back to the laboratory for gut analysis. Each crab will be weighed, measured and sexed prior to preservation. Upon dissection, a visual fullness estimate will be taken (Stehlik 1993) and gut contents will be preserved and dissected (following the methods described by Hyslop 1980 and Stevens et al. 1982). When discerning gut contents, the ingested food will be identified to the lowest taxonomic level possible. Data will be analyzed for both juvenile and adult crabs using multivariate statistics.

Crabs will be transported live to the laboratory and placed in individual tanks for feeding preference studies. Crabs will be starved for three days prior to the experiment and then offered a choice of two food types. Four types of food will be offered: live freshwater shrimp, detritus, freshwater vegetation, and aquatic insects. Detritus, vegetation and other aquatic protein sources used for the feeding study will be collected directly from crab collection sites. The shrimp used in the study are *Palaemonetes paludosus*, a freshwater shrimp similar in morphology and biology to the endangered California freshwater shrimp, *Syncaris pacifica*, and readily available by mail order. These experiments will additionally test for evidence of predation on the types of shrimp commercially harvested in the Bay (*Crangon* and *Palaemon*). Food will be weighed prior to placement in the tank and left in the tank for 24 hours. Remaining food will be removed and weighed. Tanks with the same amount of food, in the same combinations, but without crabs will be used to control for autogenic changes in the food (Roa 1992). Results from the feeding preference experiments will be analyzed using procedures suggested by Peterson and Renaud (1989) and Roa (1992). Three hundred crabs for each gut analysis study (600 total) and over 45 crabs for each feeding preference study (90 total) will be analyzed in this experiment.

Locations:

The majority of the field work for this project will be conducted in Santa Clara County, with additional data collection in Sonoma County and one or more counties within the San Joaquin-Sacramento Delta (see discussion above). Please see Attachment 2 for the locations of the primary field work for this proposal. All laboratory work will be conducted on the campus of the University of California at Berkeley.

Biological/Ecological Context:

The primary ecological and biological objectives for this project are:

- To elucidate the biology of the Chinese mitten crab in its new environment, with specific reference to:
life history, migration, population dynamics and habitat and food preferences.
- To quantitatively assess the impact of the Chinese mitten crab over spatial scales ranging from populations to ecosystems, with specific reference to:
bank stability as a factor in riparian and levee integrity, trophic dynamics of the Bay/Delta ecosystem, and commercially valuable species (signal crayfish *Pacifastacus leniusculus*, grass shrimp *Crangon*, *Palaemon*) and threatened and endangered species (California freshwater shrimp *Syncarus*).

The Chinese mitten crab is the primary stressor under investigation in this proposal, and the watershed of the Bay-Delta ecosystem, with particular reference to the tributaries and estuaries of the South Bay, is the primary habitat that is the focus of this study. The central hypothesis of our research is that, since its introduction into the Bay and Delta, the Chinese mitten crab is causing changes and stresses at multiple levels of the ecology and economy of the Bay-Delta ecosystem. The primary objectives defined above describe the specific measurements we propose to take in order to quantitatively test this hypothesis. This proposal emphasizes an ecosystem-based approach by choosing multiple, interrelated scales at which to measure ecological impacts.

Qualitative research about the distribution of the mitten crab is available through public reports (Veldhuizen and Heib 1998, Cohen and Carlton 1997). The Department of Fish and Game and other entities have begun tracking the distribution of the Chinese mitten crab throughout the Suisun Marsh/ San Joaquin Delta area (Holmes & Osmondsun 1998). Less attention has been paid, however, to the distribution of the crab throughout the South Bay, even though the potential for impacts from burrowing is probably highest in this area (K. Hieb, pers. comm.). Very little quantitative information is known or has been published regarding the ecology and impacts of the crab in its new environment in the Bay-Delta ecosystem. Our research will provide quantitative information about the process of invasion and establishment of the Chinese mitten crab. This research will provide crucial ecological and economic information to researchers, managers and policymakers that will help these professionals make informed decisions regarding the management and control of this species.

Linkages:

We have monitored the abundance and distribution of mitten crab populations in South San Francisco Bay from 1995 through 1997 under a grant from the Water Resources Center. The field work for this project, using the six sites described above and additional South Bay sites, has produced an initial assessment of population densities and some information regarding habitat preferences that will form the basis of further studies under this proposal (Halat 1989). The 1995 grant has concluded, but our need to continue to track the abundance and distribution of this population has not. Continuing abundance and distribution data is greatly needed to

understand the habitat preferences, growth and spread of this species as well as identify areas at higher risks of impact by the mitten crab. The opportunity to continue to add to the three years of data that we have already collected will help to build an excellent long-term data set for modeling and establishing the population dynamics of this species. Pilot laboratory studies of crab-crayfish interactions and crayfish industry surveys conducted under this initial grant have identified a need for further quantitative study of the impacts of mitten crabs on this commercially-valuable species.

CALFED's mission is to develop a long-term, comprehensive plan that will restore the ecological health of the Bay-Delta ecosystem (CALFED ERP page 1). This proposal meets that mission by quantifying the effects of the Chinese mitten crab on the Bay-Delta ecosystem and will provide the foundation for informed decisions regarding the management and control of this invasive species. This proposal closely aligns with the implementation strategy laid out in pages 6 - 11 of the Ecosystem Restoration Program Plan (ERP) Volume I. Specifically, this proposal follows the protocols defined by the ERP, including Indicators (e.g.: extent of erosion in banks due to mitten crab burrowing activities), Comprehensive Monitoring (e.g.: measuring the change in status of bank erosion over time throughout the South Bay) and Directed Research (e.g.: experiments to determine the interactions of mitten crabs with signal crayfish). The data collected by this research will be used as a basis for modeling the population dynamics of invasive species with specific reference to impacts on the Bay and Delta, a method described in step 3 of ERP implementation steps, page 7: creating conceptual models to describe the Bay-Delta ecosystem.

The ERP (Vol1) describes the challenges of a comprehensive monitoring, assessment and research program (CMARP). In particular, this document describes the difficulties of the fragmentary nature of existing research, and the need for a coherent, overall picture of monitoring, environmental responses over large spatial scales, and how monitoring data can be used by decision makers (page 8). This proposal aims to create a comprehensive monitoring and research program that addresses the response of the Bay-Delta ecosystem to disturbance at multiple spatial and temporal scales. Our laboratory interacts closely with commercial fisheries, government agencies at local, state and federal levels, and non-profit educational and research organizations. We also participate on the Interagency Ecological Program (IEP) Project Work Team on the Chinese mitten crab. We consider one of the highest priorities of this research to be its integration with current efforts to monitor the Chinese mitten crab and other invasive species in the Bay-Delta ecosystem. We will focus our efforts to ensure that the information generated by this research is expertly communicated to resource managers and decision makers. This proposal answers the concerns of the CMARP and meets the six goals of the applied research program to understand, provide monitoring protocols, test causal relationships in the environment, reduce uncertainty, provide academic research and revise conceptual models in light of new information (page 9).

This proposal also meets several strategic objectives outlined by the ERP. This project provides the research necessary for making informed decisions about maintaining and enhancing populations of selected species for sustainable and commercial and recreational harvest, specifically in reference to two second-priority species: the signal crayfish and grass shrimp (page 394). This proposal answers the specific request of the ERP to "determine the interaction and potential effects between mitten crabs and signal crayfish on both the commercial and recreational fisheries" (page 415) and to "determine the interactions and potential effects between mitten crabs and grass shrimp on the commercial fishery" (page 418). This research

will help quantify the impact of the Chinese mitten crab on the California freshwater shrimp, identified by the ERP as a priority species for population recovery and maintenance (Vol II page 39).

A major goal of the ERP is to address the role of invasive species in the Bay-Delta ecosystem. This proposal responds to the opportunity defined in the ERP section on invasive species to "develop a better understanding of how non-native species affect ecological processes and biological interactions" (Vol I page 462). This research will provide a basis for making informed decisions as described under Objective 7 of the aquatic invasive organisms section of the ERP to develop focused control efforts on those introduced species where control is most feasible and of greatest benefit (page 467). The Chinese mitten crab is specifically identified for further research and management in the Non-indigenous Invasive Species Strategic Management Plan (Dec 1998 Draft). This plan recognizes that "ecosystems infested with NIS are not consistently identified and delineated" (Page 17). The monitoring proposed here specifically addresses this need. This proposal answers the NIS plan's call to "understand the mechanisms by which the species disrupts the natural balance of the ecosystem... [and] assess the ecological [and] socio-economic... impacts of NIS in terms that are meaningful to decision makers and the general public" (page 30).

System-wide ecosystem benefits:

The products of this research will be beneficial to a system-wide understanding of the impacts of the Chinese mitten crab in the Bay and Delta. Modeling, analysis and dissemination of this research will provide the tools for understanding and managing this species over the entire ecosystem. The quantification of economic and ecological system impacts can be applied to other systems as well, in applications ranging from determining ecosystems at high risk of invasion and establishment by this species, to providing models for economic impacts by invasive species applicable to a wide variety of economies.

Compatibility with non-ecosystem objectives:

This proposal specifically addresses the CALFED objective of "providing long-term protection for multiple Delta resources by maintaining and improving the integrity of the Delta levee system" (Levee Protection Program Plan, February 1999 Draft, page 1-5). The burrowing habits of the Chinese mitten crab have been shown to cause severe damage to levees and earthen banks (Panning 1938). This threat has been recognized by California resource agencies (Veldhuizen and Heib 1998). The goal of this proposal to research the extent of burrowing and relate these activities to physical and biological site characteristics will provide important risk information for the South Bay as well as for channelized and natural riparian ecosystems throughout the Bay and Delta.

Technical Feasibility and Timing:

The components of this research program were chosen on the basis of what were viewed as high-priority areas of research regarding the ecology and impacts of the Chinese mitten crab, on the expertise of our lab, and on the existence of our recent mitten crab project providing baseline data for further investigation. The principal investigator is an expert in the field of invertebrate and aquatic ecology (Attachment 3). The principal investigator and his students have expertise in the field of behavioral ecology, biomonitoring, morphology and taxonomy, population and community ecology, resource economics and survey methods. These skills are appropriate for the projects outlined in this proposal. We investigated alternative areas of study for this project, including toxin bioaccumulation in mitten crabs, effects on agricultural crops, and damage to fish populations at fish collection facilities. While many of these effects are important and merit study, we are aware through involvement with the IEP Chinese mitten crab workgroup that other agencies and institutions are already addressing many of these areas of research. We thus chose the combination of research methods and questions that we felt were most in need of attention and that best fit the expertise we could bring to the research.

We have notified all counties and agencies directly affected by the proposed research (Attachment 5). The Santa Clara Valley Water District has agreed to provide site access, and the principle investigator is in the process of supplying the necessary insurance and permit documents to the District in order to formalize this agreement. The principle investigator, his students and the University of California hold the proper federal and state permits for collection and retention of Chinese mitten crabs (Attachment 6).

All field research has been chosen based on information in the scientific literature in addition to personal observation and research that has delineated the appropriate methods and timing for field work. The principal investigator has the appropriate laboratory space and equipment to provide the correct conditions for behavioral and trophic experiments. Our laboratory has the appropriate software (modeling programs including Excel and STELLA, GIS programs including ArcView) to properly collect and analyze data.

We do not expect that any regulations such as zoning or county planning ordinances will interfere or be incompatible with the objectives of this proposal.

Monitoring and Data Collection Methodology:

Because data collection and monitoring are primary emphases of this proposal, we have described these processes in detail in the body of the project description. We have also included detailed information in Table 2: Monitoring and Data Collection Methodology. This table follows each component of the proposal, defines the monitoring parameters and data collection approach as they are defined in the project description, and defines the tools used for data evaluation.

We intend to integrate CALFED reporting requirements and additional research updates into our project in a way that will ensure that all interested parties are kept informed about the progress of this research and that research outcomes are made widely available. Progress reports will be sent at the close of major stages of the research, such as the feeding preference study, behavioral experiments, etc (see attached quarterly task schedule). These reports will be sent to the Marine Science Institute, to the Santa Clara Water Valley District and affected counties, to

interested government agencies such as the Department of Fish and Game and the US Fish and Wildlife Service, to fisheries, and will also be made available to CALFED.

Feedback from all parties involved in and affected by this research will be incorporated into the evaluation and presentation of research. Our laboratory will take advantage of the expertise represented in the Chinese mitten crab project workgroup to solicit reviews and critiques of methods, analysis and presentation of the data.

Table 2. Monitoring and Data Collection Methodology:

1) Biological and Ecological Objectives			
Hypothesis/Question to be evaluated	Monitoring Parameter(s) and Data Collection Approach	Data Evaluation Approach	Comments/Data Priority
What is the distribution and abundance of the Chinese mitten crab in San Francisco's South Bay?	<ul style="list-style-type: none"> -Five core field stations, sampled monthly, fifteen additional field stations, sampled quarterly -Morphological measurements will be taken with calipers -Baseline distribution survey, all major South Bay tributaries -Mitten crab size, sex and maturity parameters collected at each site -Crabs collected for gut content analysis will be immediately preserved in 70%EtOH and transported individually in museum jars back to the lab 	<ul style="list-style-type: none"> -Spreadsheet Software for collection and analysis of distribution, abundance and morphology database (JMP, Excel) -Modeling software for population dynamics (STELLA, MATLAB) 	<ul style="list-style-type: none"> -Sex identification and reproductive maturity will be determined as described in Panning (1938)
What are the habitat preferences of the Chinese mitten crab in freshwater systems and how do these preferences determine impacts to banks and levees?	<ul style="list-style-type: none"> -Collection of physical/ecological parameters: -DO (DO meter) -Salinity (Salinity meter) -Streamside vegetation (identification keys) -Bank substrate(pebble count) -Bank angle (measuring tape, protractors) -Collection of burrow abundance and distribution, 5m sampling transects, burrow densities and sizes recorded 	<ul style="list-style-type: none"> -5m transects at each core sight will be chosen randomly -Same software as above for collection, analysis and modeling of data in relation to mitten crab population dynamics 	

<p>Is the Chinese mitten crab affecting populations of commercially-valuable invertebrate species?</p>	<p>-Growth rate experiments: measurements of carapace width, length, and weight of crayfish and crabs in enclosures; measurements and tagging of crayfish outside of growth rate cages (Equipment: Rebar, Nylon mesh and chicken wire, calipers, scales, equipment for crayfish pleopod marking) -Behavioral experiments: studies of interspecific aggression and dominance (Equipment: aquaria and aquaria supplies, substrate, shelters (PVC piping, terra cotta pots)) -Crayfish and Shrimp industry surveys to assess damage to harvest and numbers of mitten crabs harvested</p>	<p>-Multivariate statistical techniques, analysis conducted, methods following Feminella and Resh (1989) -Interspecific interactions scored and analyzed using methods defined by Bjovberg 1970 -Qualitative survey data will be compiled and assessed, qualitative survey data will be compiled and analyzed using Excel</p>	<p>Tagging methods will be compared for efficacy between pleopod notching and carapace cauterization (M Pinheiro pers comm)</p>
<p>Is the Chinese mitten crab substantially altering local food webs, and if so, what aspects of the food web are being affected?</p>	<p>-Gut content analysis: museum jars, 70%EtOH, dissecting microscopes, scales -Food preference studies: <i>Palaemonetes paludosus</i>, detritus, vegetation and aquatic insects collected from South Bay and Sonoma creeks; 24 aquaria; scales, calipers</p>	<p>-Data analyzed for percentages of taxonomic groups ingested using Excel -STELLA or equivalent program for multivariate statistics will be used -Multivariate analysis using methods of Peterson and Renaud(1989) and Roa(1992)</p>	

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Local Involvement:

The following counties have been notified of the project: Michael Lopez, planning office manager, Santa Clara County, and the Environmental Advisory Commission of the City of Sonoma, Sonoma County. Please see attached letters for details of these notifications.

We have a working relationship with the Marine Science Institute (MSI) and a letter of their support for this proposal is attached. The Santa Clara Water Valley District has been notified of and has approved access for this project. As our laboratory is in the process of finalizing this relationship for the duration of this project, confirmation of notification and access may be secured by contacting Miles Mahoney at the Santa Clara Valley Water District at (408)265-2600 or at milesmah@scwvd.dst.ca.us. At this time, we do not believe that our research will affect private landowners. If our laboratory determines that sights should be surveyed and need to be accessed that are held privately or by corporate landowners, we will contact these groups and secure permission prior to attempting access to these areas.

As discussed in the Monitoring and Data Collection section above, our proposal includes provisions for updating all affected and interested parties regarding our research. Both interim reports and the final report will be made widely available to nonprofit organizations, industries and government agencies.

Cost:

Budget:

Total budgeted costs requested from CALFED broken down by specific task and by quarter are included as Attachment 7 of this proposal.

Budget justifications for each component of budgeted tasks are as follows:

Salaries and Wages:

The principal investigator's wages and benefits are not included as part of this grant request. The principal investigator will donate his time for oversight and involvement in this proposal. The wages for the principal investigator are thus calculated as non-CALFED support in this budget.

Wages and benefits of the graduate student and undergraduate student researchers are calculated based on standard University of California position wages. Benefits for the graduate student researcher are calculated based on standard University of California graduate benefit payments.

Supplies:

Supplies have been allocated based on equipment needed per task and per quarter. Supplies have been calculated based on costs calculated in attachment 7b: Estimated Costs of Equipment.

Travel:

Travel has been calculated based on estimating the mean distances between the campus of the University of California and field sites described in this proposal. Travel reimbursement rate was calculated based on University of California reimbursement rate of \$.31/mile.

Schedule:

Please see attached quarterly task schedule (Attachment 4) for a breakdown of tasks by quarter. Salaries are paid by the University on a monthly basis. Equipment and mileage reimbursement are repaid on a quarterly basis by the University to the principal investigator and his students based on expenses claimed for that quarter. Given these funding mechanisms, an opportunity exists to fund this proposal incrementally, but University administrators will need to discuss these arrangements further should such a funding schedule be necessary.

Cost-Sharing:

The only cost-sharing that is a part of this proposal is the University funding of the principal investigator's commitment to this project. These wages are calculated accordingly as non-CALFED support in the attached budget (Attachment 7).

Applicant Qualifications:

This research will be conducted under the direct management and supervision of the principal investigator, professor Vincent Resh. Please see the attached curriculum vitae and selected publications (Attachment 3) to review the principal investigator's qualifications for this research proposal.

Deborah Rudnick will be the primary graduate student researcher for this proposed project. Ms. Rudnick is a first-year doctoral student in the Environmental Science, Policy and Management program at U.C. Berkeley. She received her BA in Biology from Brown University. Ms. Rudnick has over three years of professional experience in the fields of behavioral ecology and natural resource management. She has also held several professional and volunteer positions managing programs and volunteers and writing reports and publications. Her computer skills include extensive experience with word processing, spreadsheet and data analysis programs. Her responsibilities will include data collection and analysis, report preparation and oversight of undergraduate and volunteer staff involved with this proposal.

Leah Rogers will be the initial graduate student working with this proposal. Ms. Rogers will be a senior in the Environmental Science program at Berkeley. She has completed extensive coursework in ecology and natural resources, and has research experience working with data collection and report preparation. Ms. Rogers will be primarily involved in the gut content analysis and feeding preference studies under the supervision of the graduate student researcher and principal investigator.

Additional undergraduate students will be hired subsequent to Ms. Roger's completion of these projects. Applicants will be reviewed on the basis of relevant coursework, interest and experience and supervised by the graduate student researcher and principal investigator.

We do not believe there are any conditions such as alternative funding sources or other University commitments that indicate a conflict of interest regarding this research proposal.

Compliance with Standard Forms and Conditions

Forms disseminated by the CALFED proposal, Attachments D and E, are included behind proposal attachments 1-7.

Literature Cited:

- Blank, G.S. and Figler, M.H. 1996. Interspecific shelter competition between the sympatric crayfish species *Procambarus clarkii* (Gerard) and *Procambarus zonangulus* (Hobbs and Hobbs). *Journal of Crustacean Biology* Vol 16(2):300-309.
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U.S. Fish and Wildlife Service. 1997. Draft California Freshwater Shrimp (*Syncaris pacifica* Holmes) Recovery Plan. U.S. Fish and Wildlife Service, Portland, OR.

Veldhuizen, T.C. and S. Stanish. 1999. Overview of the life history, distribution, abundance, and impacts of the Chinese mitten crab, *Eriocheir sinensis*. California Department of Water Resources, Environmental Studies Office, Interagency Program, Sacramento, CA.

Personal Communications:

Tom Dudley, Associate Professor, University of California at Berkeley.

Kathy Heib, Aquatic Biologist, California Department of Fish and Game, Stockton, CA.

Kathleen Halat, Graduate Student, University of California, Berkeley.

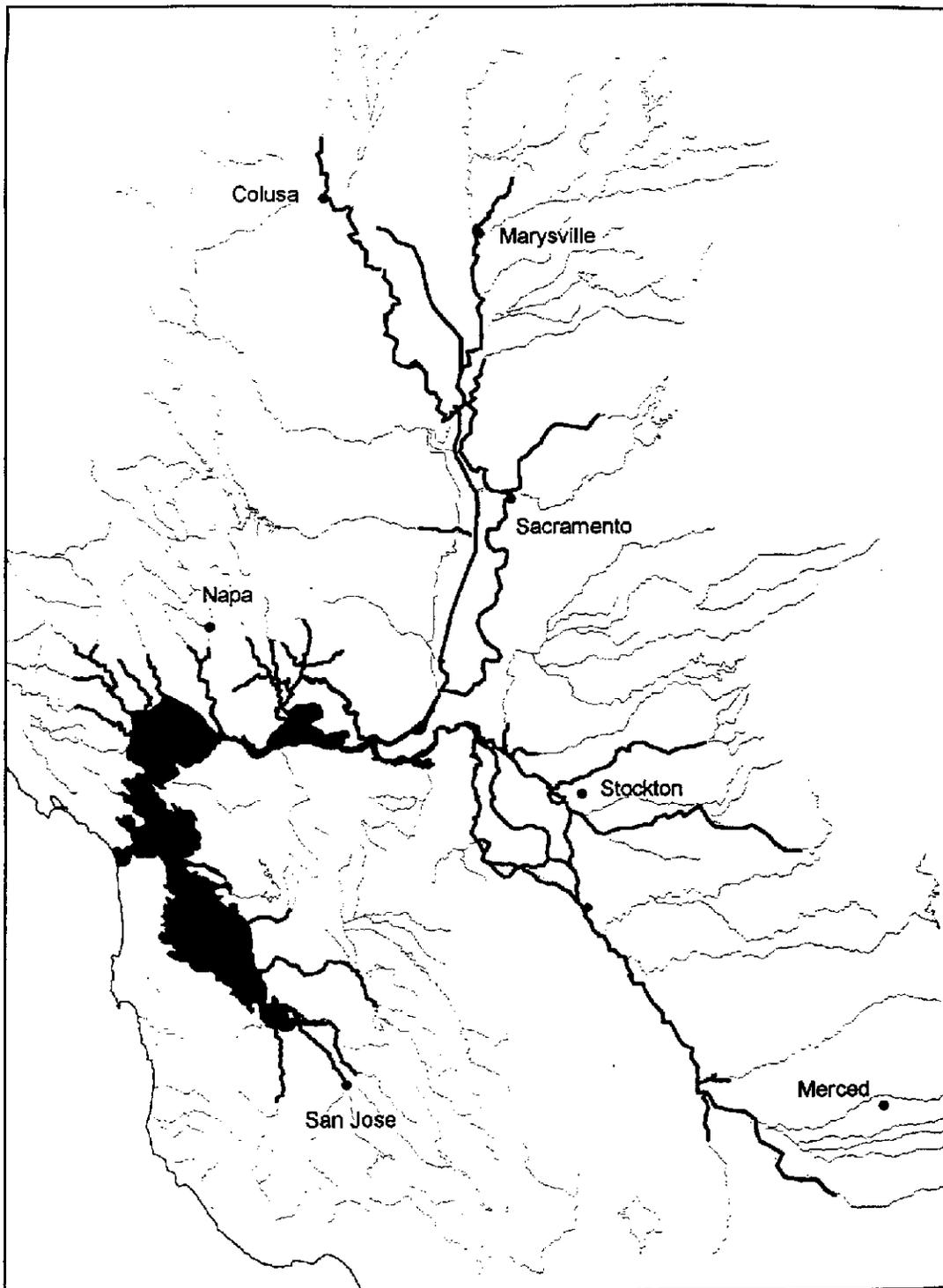
Professor Marcelo Antonio Amaro Pinheiro. FCAV - UNESP Campus de Jaboticabal
Department of Applied Biology, Brazil.

Scott Sigfreid, Facilities Technician, USBR Tracy Fish Facility, Tracy, CA.

Attachment 1

Overall Distribution of the Chinese mitten crab throughout the Bay-Delta Ecosystem (1997).

Reprinted with permission from the California Dept of Fish and Game.



Attachment 2

**Map of the location of primary field research
(USGS Map, 1:100,000 scale)**

**Tributaries where field research will occur are highlighted: Core
monitoring sites are starred***

***Monitoring site locations:**

Alviso Slough: Alviso Slough at Tasman Rd, Alviso Slough at 237

**Guadalupe Slough: Guadalupe Slough at Tasman Rd, Guadalupe Slough at
Baylands Park**

Stevens Creek: Stevens Creek at Crittenden Rd

Attachment 3

**Curriculum Vitae and Selected Publications of the Principal
Investigator**

SELECTED PUBLICATIONS

- Resh, V. H. and Rosenberg, D. M. (eds.). 1984. *The Ecology of Aquatic Insects*. Praeger Scientific, NY. 625 pp.
- Lamberti, G. A. and Feminella, J. W., and Resh, V. H. 1987. Herbivory and intraspecific competition in a stream caddisfly population. *Oecologia* 73:75-81.
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- Resh, V. H., Norris, R. H., and Barbour, M. T. 1995. Design and implementation of rapid assessment approaches for water resource monitoring using benthic macroinvertebrates. *Australian Journal of Ecology* 20: 108-121.
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- Merritt, R. W., Resh, V. H., and Cummins, K. W. 1996. Design of aquatic insect studies: collecting, sampling, and rearing procedures. Pp.12-28. In: R. W. Merritt and K. W. Cummins, *An Introduction to the Aquatic Insects of North America*, 3rd Ed., Kendall/Hunt Publishing Company, Dubuque, Iowa.
- Hauer, F. R. and Resh, V. H. 1996. Benthic macroinvertebrates. pp. 339-369, In: F. R. Hauer and G. A. Lamberti (eds.) *Methods in Stream Ecology*. Academic Press, San Diego.

Attachment 4

Proposal Quarterly Task Schedule

I - 0 1 9 7 3 3

	Summer 1999	Fall 1999	Winter 1999	Spring 2000	Summer 2000	Fall 2000	Winter 2000
	Monitor distribution	Monitor distribution	Monitor distribution	Monitor distribution	Monitor distribution	Monitor distribution	Monitor distribution
	Baseline distribution				Field enclosures - South Bay and Delta	Bank Impact Assessment	Bank Impact Assessment
	Food preference	Food preference	Food preference			Crayfish Lab interactions-Adult-Adult	Crayfish Lab interactions Adult-Adult
	Gut Content Analysis	Gut Content Analysis	Gut Content Analysis	Gut Content Analysis			
			Surveys to Crayfish industry	Analysis of Landing Receipt Data			Surveys to Crayfish industry
Spring 2001	Summer 2001	Fall 2001	Winter 2001	Spring 2002			
Monitor distribution	Monitor distribution	Monitor distribution	Monitor Distribution	Data Analysis			
	Field Enclosures-Bay and Delta	Bank impact assessment	Bank impact assessment	Prepare Report			
Crayfish Lab interactions Adult-Juvenile Juvenile-Juvenile				Publish and Disseminate Findings			
		Analysis of MSI Trawl Data	Surveys to Crayfish industry				

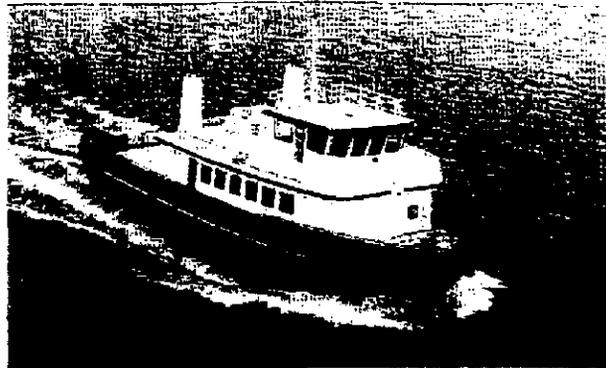
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Attachment 5

Letters of Support and Notification:

**Marine Science Institute
City of Sonoma
Santa Clara County
Santa Clara Valley Water District**

MARINE
SCIENCE
INSTITUTE



Students of all ages discover science and marine biology aboard our new 90-foot research vessel.

April 7, 1998

Dear CALFED Proposal Reviewer:

The Marine Science Institute is writing in strong support for Professor Vincent Resh's application for funding under the 1999 CALFED proposal solicitation. We believe that the efforts of this laboratory have and will continue to produce important information regarding the environmental health of our bay ecosystems and the risks to these ecosystems from invasive species.

Our organization has worked closely with Professor Resh and members of this laboratory on the introduction of the Chinese mitten crab into southern San Francisco Bay. Since 1996, we have shared our labor and equipment with Professor Resh to help gather trawl data on the distribution and abundance of the mitten crab in the south bay. It is our intention to continue to strengthen this relationship with Professor Resh and his laboratory in order to continue to generate research and awareness regarding this species and its impacts on the health of San Francisco Bay. We have agreed to serve as a resource for continuing research, and will provide such resources as a part of the efforts described by this proposal, so that the effects of this species on upstream ecosystems can be linked to their ecology in the bay.

The research conducted by Professor Resh's laboratory is consistent with our mission of K-12 environmental education and monitoring. Through our efforts and the efforts of Professor Resh's laboratory, we believe that this research will help raise public awareness and inform policy and management professionals regarding the ecology, impacts and control of invasive species in the San Francisco Bay and Delta ecosystems. We will continue to place our full support behind Professor Resh's research, and we hope that you will do the same.

All the best,

Jeffrey Rutherford
President
Marine Science Institute

PS. Our website is at www.sfbaymsi.org.



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SANTA BARBARA • SANTA CRUZ

COLLEGE OF NATURAL RESOURCES
ENVIRONMENTAL SCIENCE, POLICY AND MANAGEMENT
DIVISION OF INSECT BIOLOGY
201 WELLMAN HALL
BERKELEY, CALIFORNIA 94720-3112

TELEPHONE: (510) 642-3327
FAX: (510) 642-7428

April 8, 1999

City of Sonoma
Environmental Advisory Commission
No. 1 the Plaza
Sonoma, CA 95476

Dear Advisory Commission member:

I am contacting you about a proposal to conduct research that would take place in the city and county of Sonoma. I am a Berkeley student applying for a CALFED Bay-Delta grant for ecological research under the principle investigator Professor Vincent Resh of Berkeley. I will be examining the diet and feeding preferences of the Chinese mitten crab (*Eriocheir sinensis*) with emphasis on effects of this species on the endangered California freshwater shrimp (*Syncaris pacifica*). This research will help assess the impact of this recently-established invasive species on the ecosystem and management strategies designed to limit its population.

I will be collecting specimens of the Chinese mitten crab, and any data necessary for this project from Sonoma Creek at public access areas. I will not be collecting or using actual specimens of the California freshwater shrimp in my experiment. I have obtained all necessary permits for scientific collection of injurious wildlife from both the California Department of Fish and Game and the U.S. Department of Fish and Wildlife.

I do not intend to disturb Sonoma creek or its surroundings in any other manner. I hope that you will support this research project, as it has widespread implications for future decisions regarding the Chinese mitten crab. I thank you in advance for your cooperation. If you have any questions, please call or email me directly.

Sincerely,

A handwritten signature in cursive script that reads "Leah Rogers".

Leah Rogers
University of California, Berkeley
windnsea@uclink4.berkeley.edu
(510) 665-4240

Cc: City of Sonoma Planning Commission

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201 WELLMAN HALL
BERKELEY, CALIFORNIA 94720-3112

TELEPHONE: (510) 642-3327
FAX: (510) 642-7428

April 7, 1999

Michael Lopez, planning office manager
Santa Clara County Planning Office
70 West Hedding Street
San Jose, CA 95110-1705

Dear Mr. Lopez:

I am writing to contact you regarding our interest in conducting research in Santa Clara County to begin this summer. I am a graduate student in the laboratory of professor Vincent Resh at the University of California at Berkeley. Our laboratory has over the past three years been involved in a study to monitor the abundance and distribution of the Chinese mitten crab, a recently-established non-indigenous crab that inhabits the the rivers and estuary of the South Bay.

Research conducted over the past few years has been conducted with the approval of Santa Clara Water Valley District, and we are again in contact with SCWVD in order to ensure that our proposal is in line with their needs and management responsibilities.

We wanted to take this opportunity to inform the county of our proposal to do research, and to invite any questions or commentary on our plans. The research will take place within the major tributaries to the South Bay in Sunnyvale, San Jose and Milpitas. We will not alter the physical habitat of the streams. We do intend to collect Chinese mitten crabs from these streams under appropriate permits from the state and federal government.

If you have any questions or would like to review a copy of the proposal we will be submitting to CALFED for funding consideration, please do not hesitate to contact me. Thank you for your time, and I look forward to hearing from you.

Sincerely,

A handwritten signature in black ink, appearing to read "Debbie Rudnick".

Debbie Rudnick
510-642-6315
drudnick@nature.berkeley.edu

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DIVISION OF INSECT BIOLOGY
201 WELLMAN HALL
BERKELEY, CALIFORNIA 94720-3112

TELEPHONE: (510) 642-3327
FAX: (510) 642-7428

March 2, 1998

Dear Mr. Mahoney:

Per your request, I am writing with my proposal to conduct research in the Santa Clara Water Valley District on the abundance, distribution and impacts of the Chinese mitten crab on riparian systems. I am a graduate student at the University of California at Berkeley, and my lab holds a grant to study the ecology and impacts of this non-native species. The opportunity to access the river systems of your district will be invaluable to the success of our research. I hope that my work will be compatible with your agency's mission and expectations.

I. Type of Work:

Research will be conducted to monitor the abundance and distribution of the Chinese mitten crab, *Eriocheir sinensis*, throughout the South Bay. Observations and sampling of crabs will occur throughout several stream systems in the SCWVD. At this time, we are considering approximately 20 sampling stations for data collection. In addition, baseline sampling of benthic biota and physical data will be collected will be conducted in order to examine impacts of the mitten crab on river communities and bank stability. We also propose to install a series of cages for use in growth rate experiments with the mitten crab and freshwater crayfish. It is our hope that SCWVD will discuss with us concerns and options for siting this equipment.

II. Timeframe and length of study:

Based on agreement regarding this proposal, activities are planned to begin in April and continue throughout the remainder of this calendar year. Site sampling will occur once per month surrounding a daytime low tide, with occasional additional sampling of overall macroinvertebrate distribution and nocturnal observations of crabs to monitor diel behavioral changes. At this time, we are seeking funding to continue this research on a long-term basis, so there is potential to continue monitoring sites for an additional 2 to 4 years.

III. Number and Age of researchers:

At this time, myself, Professor Vincent Resh- our principal investigator and laboratory head- and one undergraduate research assistant are planning to conduct these studies. Occasionally, colleagues will accompany us to provide input. All individuals involved will be over 18.

IV. Access:

Most sites will be accessible by foot. However, there are some sites where the opportunity to park in or at SCWVD gates would make access easier, so this access is something I would like to be considered for/discuss further.

V. Location:

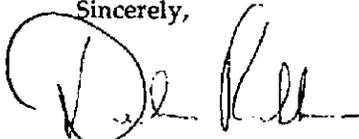
Please see attached map. At this time we would like to do further exploratory studies to get a sense of distribution of the population before confirming all sample sites. At this point, we have a few sample sites that are confirmed for continuous monitoring (see starred areas on map).

VI. Report Availability:

We will certainly make whatever information we get available and will happily discuss with you how to present this in a manner most compatible with SCWVD's needs.

Thank you for your consideration.

Sincerely,

A handwritten signature in black ink, appearing to read 'Debbie Rudnick', written in a cursive style.

Debbie Rudnick

Attachment 6

Permit for collection and retention of the Chinese mitten crab



State of California
DEPARTMENT OF FISH AND GAME

1998 SCIENTIFIC COLLECTING PERMIT APPLICATION

License and Revenue Branch
3211 "S" Street,
Sacramento, CA 95816
(916) 227-2225

The Resources Agency



NEW

RENEWAL

(copy of previous permit and report of specimens collected must be attached)

PERMIT MUST BE IN IMMEDIATE POSSESSION WHILE COLLECTING

RESIDENT NONRESIDENT STUDENT GOVERNMENT COMMERCIAL FISHING CLASS STUDENT COMMERCIAL FISHING CLASS FACULTY OTHER

Read the instructions on the top copy before completing application. Type or print clearly.

NAME <u>Deborah Anne Rudnick</u>		DATE OF BIRTH <u>06/13/77</u>	
ADDRESS <u>201 Wellman Hall ESPM University of California Berkeley CA 94720</u>		CITY/STATE/ZIP <u>Berkeley CA 94720</u>	
AGENCY/INSTITUTION/FIRM NAME <u>University of California</u>		DAY TELEPHONE <u>(510) 1642-6315</u>	
ADDRESS <u>201 Wellman Hall ESPM University of California Berkeley CA 94720</u>		DAY TELEPHONE <u>() SAME</u>	
College and commercial fishing class students must obtain the signature of one sponsor; private, scientific or educational collectors must have two signatures from professional staff of a college, museum or other scientific institution.			
SPONSOR'S NAME AND TITLE <u>Vincent Rosh, professor</u>		ORGANIZATION <u>University of California</u>	
ADDRESS <u>201 Wellman Hall ESPM Berkeley CA 94720</u>		DAY TELEPHONE <u>(510) 642-3763</u>	
SPONSOR'S NAME AND TITLE		SIGNATURE <u>Vincent H. Rosh</u>	
ADDRESS		DATE <u>29 Sept 1998</u>	
CITY/STATE/ZIP		DAY TELEPHONE	
SIGNATURE		DATE	

Do you have a current Federal permit to capture or band live birds or salvage dead birds in California? Yes No (if yes, attach a photocopy of permit)

Requested authorization(s) (see reverse side of form)

Describe the purpose, methods, number of specimens to be collected for your project and any other facts to justify the need to capture or possess any specimens. NOTE: Attach additional sheets if necessary. Attach a copy of your federal permit if you want to collect a federally listed threatened or endangered species.

Purpose: The purpose of this research is to study the behavioral ecology of the Chinese mitten crab, Eriocheir sinensis. Our laboratory is researching the impact of this introduced species on the ecology of the San Francisco Bay/delta ecosystem. We intend to capture approximately 50 crabs, 20 adult males and females. Methods will include crab traps in sloughs/tidal creeks, supplemented by some collection by the Marine Science Institute, who travels for adult breeding E. sinensis during the winter months. These crabs will be used in experiments examining the interaction of the Chinese mitten crab with freshwater crayfish species. Crabs will also be harvested to sample gut contents in order to analyze feeding habits. Due to their designation as injurious species, crabs will be killed after use and will not be re-released.

Methods of Take: crab traps and bay trawling

Where/How Specimens Kept: kept at 201 Wellman Hall, UC Berkeley

Attachment 7

**Proposal Budget
Breakdown by task and by fiscal quarter**

4/13/99

Grant Budgets.xls Ecosystem Fed

	7/1/99-6/30/00		7/1/00-6/30/01		7/1/01-6/30/02		TOTAL	
	CalFed Support	Non-CalFed Support	CalFed Support	Non-CalFed Support	CalFed Support	Non-CalFed Support	CalFed Support	Non-CalFed Support
Salaries & Wages								
Vincent H. Resh, P.I. @ 10% for 12 mos		12,947		13,594		14,274		40,815
Graduate Student Researcher (1) (\$2,344; 2,391; 2,439 x 10 months @ 50%) (\$2,344; 2,391; 2,439 x 2 mos x 100%)	11,720 4,688		11,955 4,782		12,195 4,878		35,870 14,348	
Lab Assistant I (1) (\$10.19; 10.39/hr x 12 mos x 50%) (\$10.60/hr x 12 months x 25%)	10,638		10,847		5,533		21,485 5,533	
Subtotal Salaries	27,046	12,947	27,584	13,594	22,606	14,274	77,236	40,815
Benefits								
P.I. @ 17%		2,201		2,311		2,427		6,939
GSR @ 1.3% (academic year)	152		155		159		466	
GSR @ 3% (summer)	141		143		146		430	
GSR-SHIP	460		483		507		1,450	
GSR-Fee Remission	3,960		4,158		4,366		12,484	
Subtotal GSR	4,713		4,939		5,178		14,830	
Lab Helpers 3%	319		325		166		810	
Subtotal Benefits	5,032	2,201	5,264	2,311	5,344	2,427	15,640	6,939
Supplies (field and lab supplies)	3,225		2,240		1,500		6,965	
Travel								
Trips to San Jose, Tracy, Sonoma (125 mi @ \$0.31/mi)	1,395		1,550		1,163		4,108	
Trips to MSI (80 mi @ \$0.31/mi)	25		25		25		75	
Subtotal Travel	1,420		1,575		1,188		4,183	
TOTAL DIRECT COSTS	36,723	15,148	36,663	15,905	30,638	16,701	104,024	47,754
INDIRECT COSTS @ 50.4% MTDC	16,281	7,635	16,139	8,016	12,986	8,417	45,405	24,068
TOTAL REQUEST	53,004	22,783	52,802	23,921	43,624	25,118	149,429	71,822
Note: Modified total direct costs = total costs - GSR-SHIP and GSR-Fee Remission								

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4/13/99

Grant Budgets.xls Ecosystem Store

	7/1/99-6/30/00		7/1/00-6/30/01		7/1/01-6/30/02		TOTAL	
	CalFed Support	Non-CalFed Support	CalFed Support	Non-CalFed Support	CalFed Support	Non-CalFed Support	CalFed Support	Non-CalFed Support
Salaries & Wages								
Vincent H. Resh, P.I. @ 10% for 12 mos		12,947		13,594		14,274		40,815
Graduate Student Researcher (1) (\$2,344; 2,391; 2,439 x 10 months @ 50%) (\$2,344; 2,391; 2,439 x 2 mos x 100%)	11,720 4,688		11,955 4,782		12,195 4,878		35,870 14,348	
Lab Assistant I (1) (\$10.19; 10.39/hr x 12 mos x 50%) (\$10.60/hr x 12 months x 25%)	10,638		10,847		5,533		21,485 5,533	
Subtotal Salaries	27,046	12,947	27,584	13,594	22,606	14,274	77,236	40,815
Benefits								
P.I. @ 17%		2,201		2,311		2,427		6,939
GSR @ 1.3% (academic year)	152		155		159		466	
GSR @ 3% (summer)	141		143		146		430	
GSR-SHIP	460		483		507		1,450	
GSR-Fee Remission	3,960		4,158		4,366		12,484	
Subtotal GSR	4,713		4,939		5,178		14,830	
Lab Helpers 3%	319		325		166		810	
Subtotal Benefits	5,032	2,201	5,264	2,311	5,344	2,427	15,640	6,939
Supplies (field and lab supplies)	3,225		2,240		1,500		6,965	
Travel								
Trips to San Jose, Tracy, Sonoma (125 mi @ \$0.31/mi)	1,395		1,550		1,163		4,108	
Trips to MSI (80 mi @ \$0.31/mi)	25		25		25		75	
Subtotal Travel	1,420		1,575		1,188		4,183	
TOTAL DIRECT COSTS	36,723	15,148	36,663	15,905	30,638	16,701	104,024	47,754
INDIRECT COSTS @ 10% MTDC	3,230	1,515	3,202	1,591	2,577	1,670	9,009	4,775
TOTAL REQUEST	39,953	16,663	39,865	17,496	33,215	18,371	113,033	52,529
Note: Modified total direct costs = total costs - GSR-SHIP and GSR-Fee Remission								

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I-019744

4/13/99

Grant Budgets.xls Quarters--year 1

7/1/99-6/30/00	July - Sept		Oct-Dec		Jan-Mar		Apr-June		TOTAL	
	CalFed Support	Non-CalFed	CalFed Support	Non-CalFed						
Salaries & Wages										
Vincent H. Resh, P.I. @ 10% for 12 mos		3,236		3,237		3,237		3,237		12,947
Graduate Student Researcher (1) (\$2,344 x 10 months @ 50%) (\$2,344 x 2 mos x 100%)	2,344 2,344		3,516		3,516		2,344 2,344		11,720 4,688	
Lab Assistant I (1) (\$10.19/hr x 12 mos x 50%)	2,659		2,659		2,660		2,660		10,638	
Subtotal Salaries	7,347	3,236	6,175	3,237	6,176	3,237	7,348	3,237	27,046	12,947
Benefits										
P.I. @ 17%		550		550		551		550		2,201
GSR @ 1.3% (academic year)	30		46		46		30		152	
GSR @ 3% (summer)	70		0		0		71		141	
GSR-SHIP			230		230				460	
GSR-Fee Remission			1,980		1,980				3,960	
Subtotal GSR	100		2,256		2,256		101		4,713	
Lab Helpers 3%	79		80		80		80		319	
Subtotal Benefits	179	550	2,336	550	2,336	551	181	550	5,032	2,201
Supplies (field and lab supplies)	1,230		810		810		375		3,225	
Travel										
Trips to San Jose, Tracy, Sonoma (125 mi @ \$0.31/mi)	465		465		232		233		1,395	
Trips to MSI (80 mi @ \$0.31/mi)			25						25	
Subtotal Travel	465		490		232		233		1,420	
TOTAL REQUEST	9,221	3,786	9,811	3,787	9,554	3,788	8,137	3,787	36,723	15,148

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Grant Budgets.xls Quarters--year 2

7/1/00-6/30/01	July - Sept		Oct-Dec		Jan-Mar		Apr-June		TOTAL	
	CalFed Support	Non-CalFed	CalFed Support	Non-CalFed						
Salaries & Wages										
Vincent H. Resh, P.I. @ 10% for 12 mos		3,398		3,398		3,399		3,399		13,594
Graduate Student Researcher (1) (\$2,391 x 10 months @ 50%) (\$2,391 x 2 mos x 100%)	2,391 2,391		3,586		3,587		2,391 2,391		11,955 4,782	
Lab Assistant I (1) (\$10.39/hr x 12 mos x 50%)	2,711		2,712		2,712		2,712		10,847	
Subtotal Salaries	7,493	3,398	6,298	3,398	6,299	3,399	7,494	3,399	27,584	13,594
Benefits										
P.I. @ 17%		577		578		578		578		2,311
GSR @ 1.3% (academic year)	30		47		47		31		155	
GSR @ 3% (summer)	72		0		0		71		143	
GSR-SHIP			241		242				483	
GSR-Fee Remission			2,079		2,079				4,158	
Subtotal GSR	102		2,367		2,368		102		4,939	
Lab Helpers 3%	81		81		81		82		325	
Subtotal Benefits	183	577	2,448	578	2,449	578	184	578	5,264	2,311
Supplies (field and lab supplies)	1,000		420		410		410		2,240	
Travel										
Trips to San Jose, Tracy, Sonoma (125 mi @ \$0.31/mi)	698		388		232		232		1,550	
Trips to MSI (80 mi @ \$0.31/mi)			25						25	
Subtotal Travel	698		413		232		232		1,575	
TOTAL REQUEST	9,374	3,975	9,579	3,976	9,390	3,977	8,320	3,977	36,663	15,905

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Grant Budgets.xls Quarters--year 3

7/1/01-6/30/02	July - Sept		Oct-Dec		Jan-Mar		Apr-June		TOTAL	
	CalFed Support	Non-CalFed	CalFed Support	Non-CalFed						
Salaries & Wages										
Vincent H. Resh. P.I. @ 10% for 12 mos		3,568		3,568		3,569		3,569		14,274
Graduate Student Researcher (1) (\$2,439 x 10 months @ 50%) (\$2,439 x 2 mos x 100%)	2,439 2,439		3,658		3,659		2,439 2,439		12,195 4,878	
Lab Assistant I (1) (\$10.60/hr x 6 mos x 50%)	2,766		2,767						5,533	
Subtotal Salaries	7,644	3,568	6,425	3,568	3,659	3,569	4,878	3,569	22,606	14,274
Benefits										
P.I. @ 17%		606		607		607		607		2,427
GSR @ 1.3% (academic year)	31		48		48		32		159	
GSR @ 3% (summer)	73						73		146	
GSR-SHIP			253		254				507	
GSR-Fee Remission			2,183		2,183				4,366	
Subtotal GSR	104		2,484		2,485		105		5,178	
Lab Helpers 3%	83		83		0		0		166	
Subtotal Benefits	187	606	2,567	607	2,485	607	105	607	5,344	2,427
Supplies (field and lab supplies)	1,000		250		250				1,500	
Travel										
Trips to San Jose, Tracy, Sonoma (125 mi @ \$0.31/mi)	698		233		232				1,163	
Trips to MSI (80 mi @ \$0.31/mi)			25						25	
Subtotal Travel	698		258		232		0		1,188	
TOTAL REQUEST	9,529	4,174	9,500	4,175	6,626	4,176	4,983	4,176	30,638	16,701

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Task Detail	Year 1				Year 2				Year 3			
	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4	Qtr. 1	Qtr. 2	Qtr. 3	Qtr. 4
Monitor Distribution (and bank assessment)												
Salaries & Benefits												
PI (cost share)	(1894)	(1894)	(947)	(189)	(944)	(1950)	(974)	(995)	(1043)			
GSR	2,394	2,880	2,880	1,107	1,221	853	1,488	1,221	1,245	1,845	1,836	
Lab Asst.		274	274	274	1,346	2,793	2,514	2,794	1,425	2,137		
SAE	470	250	250	250	250	250	250	250	250	250	250	250
Travel	231	231	231	231	231	231	231	231	231	231	231	231
Subtotal--Monitor Distribution (and bank assess)	3,297	3,643	3,643	1,964	3,100	4,159	4,464	4,497	3,153	4,463	2,018	2,477
Feeding Preference												
Salaries & Benefits												
PI (cost share)	(944)	(944)	(947)									
GSR	478	577	577									
Lab Asst.	1,369	2,172	2,172									
SAE	435	435	435									
Travel	232	232										
Subtotal--Feeding Preference	3,514	3,436	3,204	0	0	0	0	0	0	0	0	0
Cut Content Analysis												
Salaries & Benefits												
PI (cost share)	(944)	(947)										
GSR	1,916	1,752	577									
Lab Asst.	1,369	274	274	2,466								
SAE	125	125	125	125								
Travel												
Subtotal--Cut Content Analysis	3,410	2,141	976	2,591	0	0	0	0	0	0	0	0
MSI Travel Counts												
Salaries & Benefits												
PI (cost share)												
GSR		577				506				514		
Lab Asst.										713		
SAE												
Travel		25				25				25		
Subtotal--MSI Travel Counts	0	602	0	0	0	530	0	0	0	1,262	0	0
Surveys to Calfskin/Sheep Industry												
Salaries & Benefits												
PI (cost share)			(1894)				(995)				(917)	
GSR			1,732				1,468				4,608	
Lab Asst.							270					
SAE												
Travel												
Subtotal--Surveys to Calfskin/Sheep Industry	0	0	1,732	0	0	0	1,737	0	0	0	4,608	0
Oversight and Closure of GCA and Feeding												
Salaries & Benefits												
PI (cost share)				(1894)								
GSR				1,954								
Lab Asst.												
SAE												
Travel												
Subtotal--Oversight and Closure of GCA and Feeding	0	0	0	1,954	0	0	0	0	0	0	0	0
Analysis of Landing Receipt Data												
Salaries & Benefits												
PI (cost share)				(1704)								
GSR				2,130								
Lab Asst.												
SAE												
Travel												
Subtotal--Analysis of Landing Receipt Data	0	0	0	2,394	0	0	0	0	0	0	0	0
Field Enclosures												
Salaries & Benefits												
PI (cost share)					(2081)				(3131)	(2047)		
GSR					3,663				3,757	1,843		
Lab Asst.					1,356				1,424			
SAE					780				780			
Travel					465				465			
Subtotal--Field Enclosures	0	0	0	0	4,214	0	0	0	6,375	1,843	0	0
Behavioral Interaction												
Salaries & Benefits												
PI (cost share)						(1988)	(1988)	(2982)		(2068)		
GSR						4,466	2,979	3,663		1,842		
Lab Asst.						170	160	160				
SAE						156						
Travel												
Subtotal--Behavioral Interaction	0	0	0	0	0	4,790	3,139	3,823	0	1,842	0	0
Data Comp (cost share) and Analysis												
Salaries & Benefits												
PI (cost share)												(1044)
GSR												2,491
Lab Asst.												
SAE												
Travel												
Subtotal--Data Comp (cost share) and Analysis	0	0	0	0	0	0	0	0	0	0	0	2,491
Prepare Report												
Salaries & Benefits												
PI (cost share)												(1044)
GSR												1,246
Lab Asst.												
SAE												
Travel												
Subtotal--Prepare Report	0	0	0	0	0	0	0	0	0	0	0	1,246
Publish and Disseminate Findings												
Salaries & Benefits												
PI (cost share)												(2088)
GSR												1,246
Lab Asst.												
SAE												
Travel												
Subtotal--Publish and Disseminate Findings	0	0	0	0	0	0	0	0	0	0	0	1,246

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Grant Budgets.xls Task Sheet

Task Detail	Year 1				Year 2				Year 3			Total
	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Qtr 1	Qtr 2	Qtr 3	
Monitor Distribution (and bank assessment)												
Salaries & Benefits												
PI (cost share)	(1894)	(1894)	(947)	(189)	(994)	(1988)	(994)	(995)	(1043)			
GSR	2,394	2,886	2,886	1,197	1,221	893	1,488	1,221	1,245	1,843	1,536	
Lab Asst.		274	274	274	1,396	2,793	2,514	2,794	1,425	2,137		
S&E	670	250	250	250	250	250	250	250	250	250	250	
Travel	233	233	233	233	233	233	232	232	233	233	232	
Subtotal--Monitor Distribution (and bank assess)	3,297	3,643	3,643	1,954	3,100	4,169	4,484	4,497	3,153	4,463	2,018	0
Feeding Preference												
Salaries & Benefits												
PI (cost share)	(946)	(946)	(947)									
GSR	478	577	577									
Lab Asst.	1,369	2,192	2,192									
S&E	435	435	435									
Travel	232	232										
Subtotal--Feeding Preference	2,514	3,436	3,204	0	0							
Gut Content Analysis												
Salaries & Benefits												
PI (cost share)	(946)	(947)										
GSR	1,916	1,732	577									
Lab Asst.	1,369	274	274	2,466								
S&E	125	125	125	125								
Travel												
Subtotal--Gut Content Analysis	3,410	2,131	976	2,591	0	0						
MSI Trawl Counts												
Salaries & Benefits												
PI (cost share)												
GSR		577				595				614		
Lab Asst.										713		
S&E												
Travel		25				25				25		
Subtotal--MSI Trawl Counts	0	602	0	0	0	620	0	0	0	1,352	0	0
Surveys to Crayfish/Shrimp Industry												
Salaries & Benefits												
PI (cost share)			(1894)				(995)				(4176)	
GSR			1,732				1,488				4,608	
Lab Asst.							279					
S&E												
Travel												
Subtotal--Surveys to Crayfish/Shrimp Industry	0	0	1,732	0	0	0	1,767	0	0	0	4,608	0

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Grant Budget

Overight and Closure of GCA and Feeding													
Salaries & Benefits				(1894)									
PI (cost share)				1,196									
GSR													
Lab Asst.													
S&E													
Travel													
Subtotal--Overight and Closure of GCA and Feeding	0	0	0	1,196	0	0	0	0	0	0	0	0	0
Analysis of Landing Receipt Data													
Salaries & Benefits				(1704)									
PI (cost share)				2,396									
GSR													
Lab Asst.													
S&E													
Travel													
Subtotal--Analysis of Landing Receipt Data	0	0	0	2,396	0	0	0	0	0	0	0	0	0
Field Enclosures													
Salaries & Benefits					(2981)				(3131)	(2087)			
PI (cost share)					3,663				3,737	1,843			
GSR					1,396				1,424				
Lab Asst.					750				750				
S&E					465				465				
Travel													
Subtotal--Field Enclosures	0	0	0	0	6,274	0	0	0	6,376	1,843	0	0	0
Behavioral Interaction													
Salaries & Benefits													
PI (cost share)						(1988)	(1988)	(2982)		(2088)			
GSR						4,465	2,979	3,663		1,842			
Lab Asst.													
S&E						170	160	160					
Travel						155							
Subtotal--Behavioral Interaction	0	0	0	0	0	4,790	3,139	3,823	0	1,842	0	0	0
Data ComPI (cost share)ation and Analysis													
Salaries & Benefits													
PI (cost share)													(1044)
GSR													2,491
Lab Asst.													
S&E													
Travel													
Subtotal--Data ComPI (cost share)ation and Analysis	0	0	0	0	0	0	0	0	0	0	0	0	2,491

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Prepare Report													
Salaries & Benefits													
PI (cost share)													(1044)
GSR													1,246
Lab Asst.													
S&E													
Travel													
Subtotal--Prepare Report	0	0	0	0	0	0	0	0	0	0	0	0	1,246
Publish and Disseminate Findings													
Salaries & Benefits													
PI (cost share)													(2088)
GSR													1,246
Lab Asst.													
S&E													
Travel													
Subtotal--Publish and Disseminate Findings	0	0	0	0	0	0	0	0	0	0	0	0	1,246

1-019751

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Attachment 7b:

Estimated costs of equipment

Estimated Costs of Equipment

Item	Quantity	Price per Item \$	Total Price \$
Shrimp (<i>Palaemonetes</i> spp.)	300	0.75	225
Aquarium tank (10 gallon)	24	35	840
Aquarium tank (20 gallon)	4	60	240
Aquarium accessories (nets, filters, substrates)			\$500
Waist-high waders	2	60	120
aquatic nets	2	20	40
<u>Replacement costs for wear and tear:</u>			
Measuring equipment			\$3,000
Preservation and Dissection equipment			\$500
Enclosure and Tagging Equipment			\$1,500
TOTAL			6965

APPLICATION FOR FEDERAL ASSISTANCE		2. DATE SUBMITTED	Application Identifier
1. TYPE OF SUBMISSION: Application <input type="checkbox"/> Construction <input type="checkbox"/> Construction <input checked="" type="checkbox"/> Non-Construction <input type="checkbox"/> Non-Construction		3. DATE RECEIVED BY STATE	State Application Identifier
		4. DATE RECEIVED BY FEDERAL AGENCY	Federal Identifier
5. APPLICATION INFORMATION			
Legal Name The Regents of the University of California		Organizational Unit CNR: Environmental Science, Policy & Management	
Address (give city, county, state, and zip code) University of California, Berkeley Sponsored Projects Office 336 Sproul Hall, Alameda County Berkeley, CA 94720-5940		Name and telephone number of the person to be contacted on matters involving this application (give area code) <u>Administrative Contact</u> <u>Technical Contact</u> Lynn Deetz Vincent H. Resh (510) 643-6113 (510) 642-3763	
6. EMPLOYER IDENTIFICATION NUMBER (EIN): 9 4 — 6 0 0 2 1 2 3		7. TYPE OF APPLICANT: (enter appropriate letter in box) <input type="checkbox"/> I A. State H. Independent School Dist. B. County I. State Controlled Institution of Higher Learning C. Municipal J. Private University D. Township K. Indian Tribe E. Interstate L. Individual F. Intermunicipal M. Profit Organization G. Special District N. Other (Specify): I	
8. TYPE OF APPLICATION: <input checked="" type="checkbox"/> New <input checked="" type="checkbox"/> Continuation <input type="checkbox"/> Revision If Revision, enter appropriate letter(s) in boxes(es) <input type="checkbox"/> <input type="checkbox"/> A. Increase Award B. Decrease Award C. Increase Duration D. Decrease Duration Other (specify):		9. NAME OF FEDERAL AGENCY: Department of the Interior,	
10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: TITLE		11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: Assessing Ecological and Economic Impacts of the Chinese Milten Crab in the Bay-Delta Ecosystem	
12. AREAS AFFECTED BY PROJECT (cities, counties, states, etc.) California			
13. DATED PROJECT: Start Date Ending Date 07/01/99 06/30/02		14. CONGRESSIONAL DISTRICTS OF: a. Applicant b. Project 9th 9th	
15. ESTIMATED FUNDING: a. Federal \$ 149,429 b. Applicant \$ c. State \$ d. Local \$ e. Other \$ f. Program Income \$ g. TOTAL \$ 149,429		16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS? a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON: DATE _____ b. NO. <input checked="" type="checkbox"/> PROGRAM IS NOT COVERED BY E.O. 12372 X OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW	
		17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT? <input type="checkbox"/> Yes If "Yes," attach an explanation. <input checked="" type="checkbox"/> No	
18. TO THE BEST OF MY KNOWLEDGE AND BELIEF, ALL DATA IN THIS APPLICATION/PREAPPLICATION ARE TRUE AND CORRECT THE DOCUMENT HAS BEEN DULY AUTHORIZED BY THE GOVERNING BODY OF THE APPLICANT AND THE APPLICANT WILL COMPLY WITH THE ATTACHED ASSURANCES IF THE ASSISTANCE IS AWARDED			
a. Typed Name of Authorized Representative Lynn Deetz		b. Title Senior Research Administrator	c. Telephone number (510) 643-6113
d. Signature of Authorized Representative 		e. Date Signed 4/15/99	

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I-019754

BUDGET INFORMATION -- Non-Construction Programs

SECTION A - BUDGET SUMMARY									
Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		Total (g)			
		Federal (c)	Non-Federal (c)	Federal (e)	Non-Federal (f)				
1.		\$	\$	\$	\$	\$ 53,004.00			
2.									
3.									
4.									
5. TOTALS		\$	\$	\$ 53,004.00	\$	\$ 53,004.00			
SECTION B - BUDGET CATEGORIES									
Object Class Categories	(1)	(2)		GRANT PROGRAM, FUNCTION OR ACTIVITIES		TOTAL (5)			
		Federal	Non-Federal	Federal (e)	Non-Federal (f)				
a. Personnel		\$27,046	\$	\$	\$	\$27,046			
b. Fringe Benefits		\$5,032				\$5,023			
c. Travel		\$1,420				\$1,420			
d. Equipment									
e. Supplies		\$3,225				\$3,225			
f. Contractual									
g. Construction									
h. Other									
I. Total Direct Charges (Sum of 6a-6h)		\$36,723				\$36,723			
J. Indirect Charges		\$16,281				\$16,281			
k. TOTALS (Sum of 6l and 6j)		\$53,004	\$	\$	\$	\$53,004			
7. Program Income		\$	\$	\$	\$	\$			

SECTION C - NON-FEDERAL RESOURCES					
(a) Grant Program	(b) Applicant	(c) State	(d) Other Sources	(e) TOTALS	
8.	\$	\$	\$	\$	
9.					
10.					
11.					
12. TOTALS (sum of lines 8 and 11)	\$	\$	\$	\$	
SECTION D - FORCASTED CASH NEEDS					
	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
13. Federal	\$	\$	\$	\$	\$
14. NonFederal					
15. TOTAL (sum of lines 13 and 14)	\$	\$	\$	\$	\$
SECTION E- BUDGET ESTIMATES OF FEDERAL NEEDS FOR BALANCE OF THE PROJECT					
	(a) First	(c) Second	(a) Third	(e) Fourth	
16.					
17.	\$	\$	\$	\$	
18.					
19.					
20. TOTALS (sum of lines 16 - 19)	\$53,004	\$52,802	\$43,624	\$	
SECTION F - OTHER BUDGET INFORMATION (Attach additional Sheets if Necessary)					
21. Direct Charges: None is out of the ordinary		22. Indirect Charges: 50.4% MTDC			
23. Remarks MTDC = \$32,303					

1-019756

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ASSURANCES - NON-CONSTRUCTION PROGRAMS

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PLEASE DO NOT RETURN YOUR COMPLETED FORM TO THE OFFICE OF MANAGEMENT AND BUDGET. SEND IT TO THE ADDRESS PROVIDED BY THE SPONSORING AGENCY.

NOTE: Certain of these assurances may not be applicable to your project or program. If you have questions, please contact the awarding agency. Further, certain Federal awarding agencies may require applicants to certify to additional assurances. If such is the case, you will be notified.

As the duly authorized representative of the applicant, I certify that the applicant:

1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.
2. Will give the awarding agency, the Comptroller General of the United States and, if appropriate, the State, through any authorized representative, access to and the right to examine all records, books, papers, or documents related to the award; and will establish a proper accounting system in accordance with generally accepted accounting standards or agency directives.
3. Will establish safeguards to prohibit employees from using their positions for a purpose that constitutes or presents the appearance of personal or organizational conflict of interest, or personal gain.
4. Will initiate and complete the work within the applicable time frame after receipt of approval of the awarding agency.
5. Will comply with the Intergovernmental Personnel Act of 1970 (42 U.S.C. §§4728-4763) relating to prescribed standards for merit systems for programs funded under one of the 19 statutes or regulations specified in Appendix A of OPM's Standards for a Merit System of Personnel Administration (5 C.F.R. 900, Subpart F).
6. Will comply with all Federal statutes relating to nondiscrimination. These include but are not limited to: (a) Title VI of the Civil Rights Act of 1964 (P.L. 88-352) which prohibits discrimination on the basis of race, color or national origin; (b) Title IX of the Education Amendments of 1972, as amended (20 U.S.C. §§1681-1683, and 1685-1686), which prohibits discrimination on the basis of sex; (c) Section 504 of the Rehabilitation Act of 1973, as amended (29 U.S.C. §794), which prohibits discrimination on the basis of handicaps; (d) the Age Discrimination Act of 1975, as amended (42 U.S.C. §§6101-6107), which prohibits discrimination on the basis of age; (e) the Drug Abuse Office and Treatment Act of 1972 (P.L. 92-255), as amended, relating to nondiscrimination on the basis of drug abuse; (f) the Comprehensive Alcohol Abuse and Alcoholism Prevention, Treatment and Rehabilitation Act of 1970 (P.L. 91-616), as amended, relating to nondiscrimination on the basis of alcohol abuse or alcoholism; (g) §§523 and 527 of the Public Health Service Act of 1912 (42 U.S.C. §§290 dd-3 and 290 ee 3), as amended, relating to confidentiality of alcohol and drug abuse patient records; (h) Title VIII of the Civil Rights Act of 1968 (42 U.S.C. §§3601 et seq.), as amended, relating to nondiscrimination in the sale, rental or financing of housing; (i) any other nondiscrimination provisions in the specific statute(s) under which application for Federal assistance is being made; and, (j) the requirements of any other nondiscrimination statute(s) which may apply to the application.
7. Will comply, or has already complied, with the requirements of Titles II and III of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (P.L. 91-646) which provide for fair and equitable treatment of persons displaced or whose property is acquired as a result of Federal or federally-assisted programs. These requirements apply to all interests in real property acquired for project purposes regardless of Federal participation in purchases.
8. Will comply, as applicable, with provisions of the Hatch Act (5 U.S.C. §§1501-1508 and 7324-7328) which limit the political activities of employees whose principal employment activities are funded in whole or in part with Federal funds.

9. Will comply, as applicable, with the provisions of the Davis-Bacon Act (40 U.S.C. §§276a to 276a-7), the Copeland Act (40 U.S.C. §276c and 18 U.S.C. §874), and the Contract Work Hours and Safety Standards Act (40 U.S.C. §§327-333), regarding labor standards for federally-assisted construction subagreements.
10. Will comply, if applicable, with flood insurance purchase requirements of Section 102(a) of the Flood Disaster Protection Act of 1973 (P.L. 93-234) which requires recipients in a special flood hazard area to participate in the program and to purchase flood insurance if the total cost of insurable construction and acquisition is \$10,000 or more.
11. Will comply with environmental standards which may be prescribed pursuant to the following: (a) institution of environmental quality control measures under the National Environmental Policy Act of 1969 (P.L. 91-190) and Executive Order (EO) 11514; (b) notification of violating facilities pursuant to EO 11738; (c) protection of wetlands pursuant to EO 11990; (d) evaluation of flood hazards in floodplains in accordance with EO 11988; (e) assurance of project consistency with the approved State management program developed under the Coastal Zone Management Act of 1972 (16 U.S.C. §§1451 et seq.); (f) conformity of Federal actions to State (Clean Air) Implementation Plans under Section 176(c) of the Clean Air Act of 1955, as amended (42 U.S.C. §§7401 et seq.); (g) protection of underground sources of drinking water under the Safe Drinking Water Act of 1974, as amended (P.L. 93-523); and, (h) protection of endangered species under the Endangered Species Act of 1973, as amended (P.L. 93-205).
12. Will comply with the Wild and Scenic Rivers Act of 1968 (16 U.S.C. §§1271 et seq.) related to protecting components or potential components of the national wild and scenic rivers system.
13. Will assist the awarding agency in assuring compliance with Section 106 of the National Historic Preservation Act of 1966, as amended (16 U.S.C. §470), EO 11593 (identification and protection of historic properties), and the Archaeological and Historic Preservation Act of 1974 (16 U.S.C. §§469a-1 et seq.).
14. Will comply with P.L. 93-348 regarding the protection of human subjects involved in research, development, and related activities supported by this award of assistance.
15. Will comply with the Laboratory Animal Welfare Act of 1966 (P.L. 89-544, as amended, 7 U.S.C. §§2131 et seq.) pertaining to the care, handling, and treatment of warm blooded animals held for research, teaching, or other activities supported by this award of assistance.
16. Will comply with the Lead-Based Paint Poisoning Prevention Act (42 U.S.C. §§4801 et seq.) which prohibits the use of lead-based paint in construction or rehabilitation of residence structures.
17. Will cause to be performed the required financial and compliance audits in accordance with the Single Audit Act Amendments of 1996 and OMB Circular No. A-133, "Audits of States, Local Governments, and Non-Profit Organizations."
18. Will comply with all applicable requirements of all other Federal laws, executive orders, regulations, and policies governing this program.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL 	TITLE Senior Research Administrator
APPLICANT ORGANIZATION The Regents of the University of California	DATE SUBMITTED April 14, 1999

Standard Form 424B (Rev. 7-97) Back

Attachment D
Terms and Conditions for State (CALFED) Funds

This section provides contract terms and conditions applicable to contracts issued under State (CALFED) funds. The specific terms and conditions may vary, depending on the applicant category (State entities, Federal and other public entities, non-profit organizations, and private entities), and the type of project (Public Works/Construction or Services), as identified in Table D-1. Specific documents that should be submitted with the proposal are shown in Table D-1.

The general terms and conditions which will apply to Category III contracts funded with Proposition 204 funding are provided below.

In addition to these general terms and conditions, specific additional standard clauses will be applicable depending on the type of project and applicant category. Table D-1 provides a summary of those standard clauses for different types of projects and different applicant categories. Those standard clauses are provided at the end of this attachment.

1. **Term of Contract:** The term of the agreement will be dependent on the project and may range from 1 to 3 years. The agreement shall not become effective until fully executed by the parties and approved by the Department of General Services.
2. **Payment Schedule:** No funds will be disbursed by State or National Fish and Wildlife Foundation (NFWF) to Contractor without 1) an executed copy of the Contract, 2) receipt of an original invoice with supporting documentation, and 3) receipt and satisfactory completion of deliverables and/or phases of work as set forth in the agreement, including quarterly financial and programmatic reports. Payments shall be in arrears within 30 days of receipt of invoice by CALFED.
3. **Budget Variances:** Variances which exceed ten percent of a project task's approved budgeted amount should have approval in advance, with written explanations of programmatic changes to cover such variances but must remain within the maximum contract amount.
4. **Subcontracts:** Contractors are responsible for all subcontracted work. Subcontract terms and conditions must include all applicable contract terms and conditions as presented herein. Subcontractor agreements require approval by the State or NFWF, unless the subcontract was included and approved as part of the main proposal. Any amendments to subcontract must be approved by the State or NFWF. In obtaining subcontracts, contractor must obtain at least 3 competitive bids for all subcontracted work, or comply with the provisions of Government Code Section 4525 et seq., if applicable, or submit written justification for and obtain the State's or NFWF's approval of non-compliance with these requirements.
5. **Substitution:** Should the State or NFWF be dissatisfied with the work of subcontractors or employees of the contractor, the State or NFWF may require the contractor to substitute different qualified subcontractors or employees. The State or NFWF must approve such substitutions in advance of providing applicable services.
6. **Conflict of Interest:** Contractor shall comply with all applicable State laws and rules pertaining to conflict of interest, including but not limited to Government Code 1090 and Public Contract Code 10410 and 10411.
7. **Standard of Professionalism:** Contractor shall conduct all work consistent with the professional standards for the industry and type of work being performed under the contract.
8. **Rights in Data:** All data and information obtained and/or received under contract shall be in the public domain. Contractor shall have the right to disclose, disseminate and use, in whole or part, any

final form data and information received, collected and developed under this agreement, subject to inclusion of appropriate acknowledgment of credit to the State or NFWF, CALFED, and all cost sharing partners for their financial support. Use of draft data requires pre-approval by State or NFWF and CALFED. Contractor shall not sell or grant rights to a third party who intends to sell such product as a profit-making venture.

9. Indemnification: The Contractor agrees to indemnify, defend and hold harmless the CALFED agencies, the State of California, the Resources Agency, Department of Water Resources, and National Fish and Wildlife Foundation and their officers, agents and employees from any and all claims and losses accruing or resulting to any or all contractors, subcontractors, material persons, laborers, and any other person, firm or corporation furnishing or supplying work services, materials or supplies in connection with the performance of this contract, and from any and all claims and losses accruing or resulting to any person, firm or corporation who may be injured or damaged by the Contractor in the performance of this contract.

10. Independent Status: The Contractor, and the officers, agents and employees of Contractor, in the performance of the contract, shall act in an independent capacity and not as officers or employees or agents of the State of California, NFWF, CALFED Agencies, the Resources Agency, or Department of Water Resources.

11. Termination Clause: The State or NFWF may terminate this agreement and be relieved of the payment of any consideration to Contractor should Contractor fail to perform the covenants herein contained at the time and in the manner herein provided. In the event of such termination the State or NFWF may proceed with the work in any manner deemed proper by the State. The cost to the State shall be deducted from any sum due the Contractor under this agreement, and the balance, if any shall be paid the Contractor upon demand.

12. Assignment: Without the written consent of the State, this agreement is not assignable by Contractor either in whole or in part.

13. Integration Clause: No alteration or variation of the terms of this contract shall be valid unless made in writing and signed by the parties hereto, and no oral understanding or agreement not incorporated herein, shall be binding on any of the parties hereto. This contract may be amended upon mutual written agreement of the parties and approved by State or NFWF and CALFED.

14. Consideration: The consideration to be paid Contractor as provided herein, shall be in compensation for all of the Contractor's expenses incurred in the performance hereof, including travel and per diem, unless otherwise expressly so provided.

15. Dispute Resolution: Any claim that Contractor may have regarding the performance of this agreement including, but not limited to, claims for additional compensation or extension of time, shall be submitted to the Executive Director, CALFED, within thirty days of its accrual, CALFED and Contractor shall then attempt to negotiate a resolution of claim and process an amendment to this agreement to implement the terms of any such resolution.

16. Time is of the essence in this agreement.

**STANDARD CLAUSES -
INTERAGENCY AGREEMENTS**

Audit Clause. For contracts in excess of \$10,000, the contracting parties shall be subject to the examination and audit of the State Auditor for a period of three years after final payment under the contract. (Government Code Section 8546.7).

Availability of Funds. Work to be performed under this contract is subject to availability of funds through the State's normal budget process.

Interagency Payment Clause. For services provided under this agreement, charges will be computed in accordance with State Administrative Manual Section 8752 and 8752.1.

Termination Clause. Either State agency may terminate this contract upon 30 days advance written notice. The State agency providing the services shall be reimbursed for all reasonable expenses incurred up to the date of termination.

Severability. If any provision of this Agreement is held invalid or unenforceable by any court of final jurisdiction, it is the intent of the parties that all other provisions of this Agreement be construed to remain fully valid, enforceable, and binding on the parties.

Y2K Language. The Contractor warrants and represents that the goods or services sold, leased, or licensed to the State of California, its agencies, or its political subdivisions, pursuant to this Agreement are "Year 2000 compliant" For purposes of this Agreement, a good or service is year 2000 compliant if it will continue to fully function before, at, and after the Year 2000 without interruption and, if applicable, with full ability to accurately and unambiguously process, display, compare, calculate, manipulate, and otherwise utilize date information. This warranty and representation supersedes all warranty disclaimers and limitations and all limitations on liability provided by or through the Contractor.

**STANDARD CLAUSES -
SMALL BUSINESS PREFERENCE AND CONTRACTOR IDENTIFICATION NUMBER**

NOTICE TO ALL BIDDERS:

Section 14835, et. seq. of the California Government Code requires that a five percent preference be given to bidders who qualify as a small business. The rules and regulations of this law, including the definition of a small business for the delivery of service, are contained in Title 2, California Code of Regulations, Section 1896, et. seq. A copy of the regulations is available upon request. Questions regarding the preference approval process should be directed to the Office of Small and Minority Business at (916) 322-5060. To claim the small business preference, you must submit a copy of your certification approval letter with your bid.

Are you claiming preference as a small business?

_____ Yes* _____ No

*Attach a copy of your certification approval letter.

U.S. Department of the Interior

Certifications Regarding Debarment, Suspension and
Other Responsibility Matters, Drug-Free Workplace
Requirements and Lobbying

Persons signing this form should refer to the regulations referenced below for complete instructions:

Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions - The prospective primary participant further agrees by submitting this proposal that it will include the clause titled, "Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transaction," provided by the department or agency entering into this covered transaction, without modification, in all lower tier covered transactions and in all solicitations for lower tier covered transactions. See below for language to be used; use this form for certification and sign; or use Department of the Interior Form 1954 (DI-1954). (See Appendix A of Subpart D of 43 CFR Part 12.)

Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions - (See Appendix B of Subpart D of 43 CFR Part 12.)

Certification Regarding Drug-Free Workplace Requirements - Alternate I. (Grantees Other Than Individuals) and Alternate II. (Grantees Who are Individuals) - (See Appendix C of Subpart D of 43 CFR Part 12)

Signature on this form provides for compliance with certification requirements under 43 CFR Parts 12 and 18. The certifications shall be treated as a material representation of fact upon which reliance will be placed when the Department of the Interior determines to award the covered transaction, grant, cooperative agreement or loan.

PART A: Certification Regarding Debarment, Suspension, and Other Responsibility Matters - Primary Covered Transactions

CHECK ___ IF THIS CERTIFICATION IS FOR A PRIMARY COVERED TRANSACTION AND IS APPLICABLE.

- (1) The prospective primary participant certifies to the best of its knowledge and belief, that it and its principals:
 - (a) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Federal department or agency;
 - (b) Have not within a three-year period preceding this proposal been convicted of or had a civil judgment rendered against them for commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public (Federal, State or local) transaction or contract under a public transaction; violation of Federal or State antitrust statutes or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property;
 - (c) Are not presently indicted for or otherwise criminally or civilly charged by a governmental entity (Federal, State or local) with commission of any of the offenses enumerated in paragraph (1)(b) of this certification; and
 - (d) Have not within a three-year period preceding this application/proposal had one or more public transactions (Federal, State or local) terminated for cause or default.
- (2) Where the prospective primary participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

PART B: Certification Regarding Debarment, Suspension, Ineligibility and Voluntary Exclusion - Lower Tier Covered Transactions

CHECK ___ IF THIS CERTIFICATION IS FOR A LOWER TIER COVERED TRANSACTION AND IS APPLICABLE.

- (1) The prospective lower tier participant certifies, by submission of this proposal, that neither it nor its principals is presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in this transaction by any Federal department or agency.
- (2) Where the prospective lower tier participant is unable to certify to any of the statements in this certification, such prospective participant shall attach an explanation to this proposal.

01-2811
March 1995
This Form incorporates 01-1953, 01-1954,
01-1955, 01-1958 and 01-1963

PART C: Certification Regarding Drug-Free Workplace Requirements

CHECK ___ IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS NOT AN INDIVIDUAL.

Alternate I. (Grantees Other Than Individuals)

- A. The grantee certifies that it will or continue to provide a drug-free workplace by
- (a) Publishing a statement notifying employees that the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance is prohibited in the grantee's workplace and specifying the actions that will be taken against employees for violation of such prohibition;
 - (b) Establishing an ongoing drug-free awareness program to inform employees about—
 - (1) The dangers of drug abuse in the workplace;
 - (2) The grantee's policy of maintaining a drug-free workplace;
 - (3) Any available drug counseling, rehabilitation, and employee assistance programs; and
 - (4) The penalties that may be imposed upon employees for drug abuse violations occurring in the workplace;
 - (c) Making it a requirement that each employee to be engaged in the performance of the grant be given a copy of the statement required by paragraph (a);
 - (d) Notifying the employee in the statement required by paragraph (a) that, as a condition of employment under the grant, the employee will —
 - (1) Abide by the terms of the statement; and
 - (2) Notify the employer in writing of his or her conviction for a violation of a criminal drug statute occurring in the workplace no later than five calendar days after such conviction;
 - (e) Notifying the agency in writing, within ten calendar days after receiving notice under subparagraph (d)(2) from an employee or otherwise receiving actual notice of such conviction. Employers of convicted employees must provide notice, including position title, to every grant officer on whose grant activity the convicted employee was working, unless the Federal agency has designated a central point for the receipt of such notices. Notice shall include the identification numbers(s) of each affected grant;
 - (f) Taking one of the following actions, within 30 calendar days of receiving notice under subparagraph (d)(2), with respect to any employee who is so convicted —
 - (1) Taking appropriate personnel action against such an employee, up to and including termination, consistent with the requirements of the Rehabilitation Act of 1973, as amended; or
 - (2) Requiring such employee to participate satisfactorily in a drug abuse assistance or rehabilitation program approved for such purposes by a Federal, State, or local health, law enforcement, or other appropriate agency;
 - (g) Making a good faith effort to continue to maintain a drug-free workplace through implementation of paragraphs (a) (b), (c), (d), (e) and (f).
- B. The grantee may insert in the space provided below the site(s) for the performance of work done in connection with the specific grant:

Place of Performance (Street address, city, county, state, zip code)

Check ___ if there are workplaces on file that are not identified here.

PART D: Certification Regarding Drug-Free Workplace Requirements

CHECK ___ IF THIS CERTIFICATION IS FOR AN APPLICANT WHO IS AN INDIVIDUAL.

Alternate II. (Grantees Who Are Individuals)

- (a) The grantee certifies that, as a condition of the grant, he or she will not engage in the unlawful manufacture, distribution, dispensing, possession, or use of a controlled substance in conducting any activity with the grant;
- (b) If convicted of a criminal drug offense resulting from a violation occurring during the conduct of any grant activity, he or she will report the conviction, in writing, within 10 calendar days of the conviction, to the grant officer or other designee, unless the Federal agency designates a central point for the receipt of such notices. When notice is made to such a central point, it shall include the identification number(s) of each affected grant

PART E: Certification Regarding Lobbying
Certification for Contracts, Grants, Loans, and Cooperative Agreements

CHECK IF CERTIFICATION IS FOR THE AWARD OF ANY OF THE FOLLOWING AND THE AMOUNT EXCEEDS \$100,000: A FEDERAL GRANT OR COOPERATIVE AGREEMENT; SUBCONTRACT, OR SUBGRANT UNDER THE GRANT OR COOPERATIVE AGREEMENT.

CHECK IF CERTIFICATION IS FOR THE AWARD OF A FEDERAL LOAN EXCEEDING THE AMOUNT OF \$150,000, OR A SUBGRANT OR SUBCONTRACT EXCEEDING \$100,000, UNDER THE LOAN.

The undersigned certifies, to the best of his or her knowledge and belief, that:

- (1) No Federal appropriated funds have been paid or will be paid, by or on behalf of the undersigned, to any person for influencing or attempting to influence an officer or employee of an agency, a Member of Congress, and officer or employee of Congress, or an employee of a Member of Congress in connection with the awarding of any Federal contract, the making of any Federal grant, the making of any Federal loan, the entering into of any cooperative agreement, and the extension, continuation, renewal, amendment, or modification of any Federal contract, grant, loan, or cooperative agreement.
- (2) If any funds other than Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress, or an employee of a Member of Congress in connection with this Federal contract, grant, loan, or cooperative agreement, the undersigned shall complete and submit Standard Form-LLL, "Disclosure Form to Report Lobbying," in accordance with its instructions.
- (3) The undersigned shall require that the language of this certification be included in the award documents for all subawards at all tiers (including subcontracts, subgrants, and contracts under grants, loans, and cooperative agreements) and that all subrecipients shall certify accordingly.

This certification is a material representation of fact upon which reliance was placed when this transaction was made or entered into. Submission of this certification is a prerequisite for making or entering into this transaction imposed by Section 1352, title 31, U.S. Code. Any person who fails to file the required certification shall be subject to a civil penalty of not less than \$10,000 and not more than \$100,000 for each such failure.

As the authorized certifying official, I hereby certify that the above specified certifications are true.

SIGNATURE OF AUTHORIZED CERTIFYING OFFICIAL

TYPED NAME AND TITLE Lynn Deetz, Senior Research Administrator

DATE April 14, 1999