

99 D116

4.5 PSP Cover Sheet (Attach to the front of each proposal)

Proposal Title: Assessment of Pesticide Effects on Fish and Their Food Resources in the Sacramento-San Joaquin Delta
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Amount of funding requested: \$ 1,586,894 (State) for 3 years
 \$ 1,875,561 (Fed.)

Indicate the Topic for which you are applying (check only one box).

- | | |
|--|---|
| <input type="checkbox"/> Fish Passage/Fish Screens | <input type="checkbox"/> Introduced Species |
| <input type="checkbox"/> Habitat Restoration | <input type="checkbox"/> Fish Management/Hatchery |
| <input type="checkbox"/> Local Watershed Stewardship | <input type="checkbox"/> Environmental Education |
| <input checked="" type="checkbox"/> Water Quality | |

Does the proposal address a specified Focused Action? yes no

What county or counties is the project located in? Contra Costa, Solano, Sacramento, San Joaquin
Merced, Yolo

Indicate the geographic area of your proposal (check only one box):

- | | |
|---|---|
| <input type="checkbox"/> Sacramento River Mainstem | <input type="checkbox"/> East Side Trib: _____ |
| <input type="checkbox"/> Sacramento Trib: _____ | <input type="checkbox"/> Suisun Marsh and Bay |
| <input type="checkbox"/> San Joaquin River Mainstem | <input type="checkbox"/> North Bay/South Bay: _____ |
| <input type="checkbox"/> San Joaquin Trib: _____ | <input type="checkbox"/> Landscape (entire Bay-Delta watershed) |
| <input checked="" type="checkbox"/> Delta: _____ | <input type="checkbox"/> Other: _____ |

Indicate the primary species which the proposal addresses (check all that apply):

- | | |
|--|---|
| <input type="checkbox"/> San Joaquin and East-side Delta tributaries fall-run chinook salmon | <input type="checkbox"/> Spring-run chinook salmon |
| <input type="checkbox"/> Winter-run chinook salmon | <input type="checkbox"/> Fall-run chinook salmon |
| <input type="checkbox"/> Late-fall run chinook salmon | <input type="checkbox"/> Longfin smelt |
| <input checked="" type="checkbox"/> Delta smelt | <input type="checkbox"/> Steelhead trout |
| <input checked="" type="checkbox"/> Splittail | <input type="checkbox"/> Striped bass |
| <input type="checkbox"/> Green sturgeon | <input checked="" type="checkbox"/> All chinook species |
| <input type="checkbox"/> Migratory birds | <input type="checkbox"/> All anadromous salmonids |
| <input type="checkbox"/> Other: _____ | |

Specify the ERP strategic objective and target (s) that the project addresses. Include page numbers from January 1999 version of ERP Volume I and II:

Delta smelt (p. 194); Winter-run chinook salmon (p. 220)
Spring-run chinook salmon (p. 220); Fall-run chinook salmon (p. 222)
Splittail (p. 209); Contaminants (p. 506)

Indicate the type of applicant (check only one box):

- | | |
|--|---|
| <input type="checkbox"/> State agency | <input type="checkbox"/> Federal agency |
| <input type="checkbox"/> Public/Non-profit joint venture | <input type="checkbox"/> Non-profit |
| <input type="checkbox"/> Local government/district | <input type="checkbox"/> Private party |
| <input checked="" type="checkbox"/> University | <input type="checkbox"/> Other: _____ |

Indicate the type of project (check only one box):

- | | |
|--|---|
| <input type="checkbox"/> Planning | <input type="checkbox"/> Implementation |
| <input type="checkbox"/> Monitoring | <input type="checkbox"/> Education |
| <input checked="" type="checkbox"/> Research | |

By signing below, the applicant declares the following:

- 1.) The truthfulness of all representations in their proposal;
- 2.) The individual signing the form is entitled to submit the application on behalf of the applicant (if the applicant is an entity or organization); and
- 3.) The person submitting the application has read and understood the conflict of interest and confidentiality discussion in the PSP (Section 2.4) and waives any and all rights to privacy and confidentiality of the proposal on behalf of the applicant, to the extent as provided in the Section.

Lynn Deetz, Sr. Research Administrator

Printed name of applicant:

Lynn Deetz

Signature of applicant

**ASSESSMENT OF PESTICIDE EFFECTS ON FISH AND THEIR FOOD
RESOURCES IN THE SACRAMENTO-SAN JOAQUIN DELTA**

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Type of Organization: State-controlled university

Tax Status: Tax-exempt

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EXECUTIVE SUMMARY

Abundant evidence exists for the presence of significant amounts of pesticide residues in the Sacramento River, San Joaquin River, and Delta and concurrent toxicity to invertebrate species used in standard toxicity tests. While this result is cause for concern, there is disturbingly little data by which to assess effects on local populations of fish and invertebrates in the rivers and associated sloughs. Nearly all work to date has focused on toxicity testing using nationally standardized tests, most commonly with the cladoceran *Ceriodaphnia dubia*, rather than resident species. Moreover, attempting to compare pesticide concentrations to published toxicity data does not take into account local conditions like interactive effects of multiple pesticides, acclimation or sensitization due to prior pesticide exposure, or bioavailability limitations, all of which can dramatically alter an expected level of toxicity. Finally, past work has regarded the invertebrate toxicity test organism as merely a monitoring tool, rather than putting results in an ecological context by considering how impacts to one species may affect others in the environment that depend upon it, such as fish predators. We are proposing an integrated laboratory and field study with the objectives of providing information on pesticide toxicity to resident species, developing the data needed to apply laboratory-derived toxicity measures to realistic field conditions, and putting results in an ecological context focusing on juvenile chinook salmon and their prey.

Work will be conducted over a three year period. Initial tasks will be laboratory studies meant to improve interpretation of toxicity testing results by putting classical toxicity testing in a more environmentally realistic context, then the lessons learned will be tested in two field seasons.

Task 1 - As an initial step we will review the Department of Pesticide Regulation data base on pesticide use, monitoring data from the Delta and lower Sacramento/San Joaquin, and general toxicity literature. We will identify and document the use of pesticides (including herbicides) that are used in the Central Valley, Delta, and Sacramento Delta waters, and present at potentially toxic levels either solely or in an interactive fashion with other substances. These priority pesticides will be the focus of all later lab and field work.

Task 2 - We will screen resident species as to their suitability for toxicity testing, and fully develop testing protocols for the preferred organisms with emphasis on sublethal endpoints. One of the principal invertebrate groups we will focus on are arthropods because of their presumed greater sensitivity to pesticides. We will also develop toxicity testing protocols for chinook salmon embryo and juveniles using both lethal and sublethal endpoints. Biomarker development will be incorporated in this task, emphasizing endpoints such as immune system effects and acetyl-cholinesterase activity, which are either clearly pesticide linked and/or have obvious adverse consequences for the organism.

Task 3 - As a prelude to later field application, we will refine Toxicity Identification Evaluation (TIE) procedures for several resident invertebrate species identified in Task 2, and establish TIE profiles as needed for the priority pesticides identified in Task 1.

Task 4 - Pesticide toxicity has invariably been evaluated based on exposure to a single substance, when in fact an aquatic organism is likely to be exposed to many pesticides simultaneously. In this task we will screen binary combinations of the priority pesticides for interactions, and when established, develop dose-response data for concurrent exposure to the two pesticides. The results will aid in the interpretation of field data when unexpected toxicity (or lack thereof) is attributable to pesticide synergism or antagonism.

Task 5 - An animal's sensitivity to a given pesticide exposure may be a function of historical exposure that makes the individual more sensitive to or tolerant of repeated exposure. We will define realistic pulse profiles (duration, magnitude and frequency) to which Delta organisms are likely to be exposed, and determine the effect of this exposure on pesticide tolerance.

Task 6 - Association with dissolved organic matter (DOM) or suspended particles may lessen the bioavailability of the more hydrophobic pesticides such as chlorpyrifos. By manipulating DOM concentrations we will examine its effect on pesticide toxicity, and determine if concurrent measures of DOM quantity/quality would substantially enhance interpretability of field pesticide data. We will

also establish if pesticides adsorbed to particulate matter can be viewed as non-bioavailable, or if desorption into the dissolved phase occurs at a rate fast enough to contribute to water column toxicity.

Task 7 - Throughout at least Jan-March (and potentially beyond) in two years we will conduct field work at about 4 sites within the Delta. The selection of these locations will be made after a comprehensive literature review and preliminary sampling earlier in the project period, but it is our current intention to locate 1-2 sites in the mainstem rivers (Sacramento/San Joaquin) and locate the remainder of the sites in creeks or sloughs representative of specific source types (e.g. orchards, urban runoff). At all sites we will characterize pesticide concentrations on a daily basis during high flow events and weekly otherwise. We will perform laboratory toxicity tests using the resident species protocols we have developed, and conduct TIEs to establish the causative agent. We will also conduct in situ toxicity tests during high flow events using hatchery-supplied juvenile salmon, measuring survival, growth, and suitable biomarkers such as immune system effects and acetylcholinesterase inhibition. Our intent is to use this data set to field validate the results of the prior laboratory studies on pesticide interactions, multiple pulses, and bioavailability. The field work will include stomach content analyses of juvenile fall-run chinook salmon collected by USFWS in order to: 1) select appropriate resident invertebrate species for toxicity test development in light of their food value to salmon; 2) evaluate the plasticity of salmon prey selection as pesticides and/or other high flow-related factors change food availability; and 3) establish how quickly a population eliminated during a high flow event recovers in density and reappears in the diet. In addition, we will characterize the diet of other CALFED-priority species such as Delta smelt, winter-run chinook, and splittail to the extent they are available (e.g., incidental collection mortalities), but their availability is limited due to their protected status and USFWS take restrictions.

Task 8 - Finally, we will present the results in a format intended for use by environmental managers. We will prepare recommendations based on the laboratory and field results on how to monitor pesticides and toxicity in the Delta including such things as a list of pesticides of concern within specific watersheds, resident species that have proven successful for routine monitoring, frequency of sampling during and between storm events, and ancillary variables needed to predict bioavailability.

Our proposed studies seek to take toxicity testing beyond its use as a monitoring tool, and into an ecological context by focusing on fish and their invertebrate prey. Direct pesticide toxicity to fish in the Delta is a possibility, and our laboratory exposures of salmon and in situ salmon toxicity tests are specifically designed to address that issue at both a lethal and sublethal level. Indirect effects through changes in food abundance, however, are also of concern, and our invertebrate toxicity testing will be done with that perspective. Extensive stomach content analysis is planned specifically to guide and justify our choices of resident invertebrates.

Our project team brings to the study unique and broad qualifications, and most importantly, unparalleled research experience on pesticides and pesticide toxicity in the Delta. The UC Davis Aquatic Toxicology Laboratory has done the majority of toxicity testing and TIE work in the Delta, and Dr. Werner's research has focused on the development of chronic or sublethal indicators of toxic effects as is intended in these studies. DeltaKeeper is already conducting pesticide monitoring in the Delta and their results will benefit this project. Members of their organization have an intimate knowledge of the Delta system that is unmatched. Dr. Kuivila at USGS is well-recognized for her analytical work on pesticides in the watershed. Dr. Weston has worked extensively on environmental and organismal factors affecting bioavailability, and the development of chronic toxicity tests. Dr. Lydy's research has specialized on pesticide interactions, and especially those involving organophosphates. Our combined experience allows us to build upon our on-going work, much of it in the Delta, of immediate and direct relevance to the proposed studies

PROJECT DESCRIPTION

Proposed scope of work

There is abundant evidence that pesticides in Delta waters are periodically present at concentrations high enough to cause toxicity in standard bioassay organisms. Efforts to assess the significance of these results, however, are hampered by lack of information on resident species, the inability to apply laboratory-derived toxicity measures to realistic field conditions, and the difficulty of interpreting the existing monitoring data in an ecological context. Nevertheless, magnitude, timing and geographic extent of toxicity suggests that pesticide effects on resident species populations, either through direct toxicity or indirectly through loss of prey organisms, is a high priority area for investigation if restoration of the Bay-Delta is to be successful. We propose an integrated laboratory and field study with the following objectives:

- Conduct an initial data review to identify pesticides of concern and field sites;
- Develop toxicity tests with resident species, focusing on chinook salmon and their prey, and chronic endpoints such as abnormal development, growth, cellular effects, immune system effects, and target enzyme inhibition;
- Evaluate the influence of local conditions (e.g., pesticide mixtures, organic matter) on pesticide bioavailability and/or toxicity in order to enhance interpretation of existing monitoring data;
- Assess toxicity under realistic exposure conditions in which multiple pesticide pulses vary in magnitude, frequency and duration;
- Conduct a comprehensive field study in which we will: 1) determine magnitude and duration of toxic pulses at selected sites; 2) demonstrate the effect of pesticide on resident aquatic species in both lab and in situ exposures; 3) determine the pesticides(s) causing toxicity to these resident species through Toxicity Identification Evaluations; and 4) examine salmonid diet composition throughout these pesticide events to link invertebrates impacts to habitat trophic value for fish.
- Integrate existing information and data developed through these studies to formulate recommendations for a pesticide monitoring and management strategy in the Delta.

Task 1: Identification of Pesticides of Interest - We will first determine on which pesticides to focus our lab and field studies. Some, such as diazinon and chlorpyrifos, would certainly be included, but we wish to incorporate others that have received less attention to date. We will include in this task a review of the pesticide use data base maintained by the Dept. of Pesticide Regulation (DPR). One member of our project team (USGS) has this data base in-house, and thus will be able to efficiently establish the amount of pesticides applied to what crops and the timing and method of application by watershed. We will also conduct an extensive review of existing information from the Central Valley Regional Water Quality Control Board (CVRWQCB), USGS NAWQA and Toxics Programs, DPR and other agencies and watershed projects such as the Sacramento River Watershed Project to compile a data base on pesticide concentrations in the Sacramento/San Joaquin Rivers and Delta.

To supplement the above concentration data we will compile literature data on what levels of each pesticide observed or likely to be present in surface waters are linked to toxicity. We will also review the results of past Toxicity Identification Evaluations (TIE) in the Rivers and Delta to establish probable agents of toxicity. Results from ongoing studies (e.g. DeltaKeeper, Sacramento River Watershed Project) will be incorporated in the review, and in fact one of our project participants (UC Davis) has performed the vast majority of the TIEs that have been done in the Delta. The outcome of Task 1 would be a list and supportive documentation of pesticides, including herbicides, that are used in the Central Valley, demonstrated or likely to be in Delta waters, and present at potentially toxic levels either solely or in an interactive fashion with other substances.

Task 2: Develop toxicity tests for resident species - Nearly all toxicity data available in the Delta is based on standard national test species, such as *Ceriodaphnia dubia*. Considerable controversy exists regarding the reliability of indicator species under controlled laboratory conditions to predict ecosystem impacts in the Delta, and it is therefore necessary to develop toxicity tests using suitable resident species. Efforts to achieve this goal are already underway by one project participant (UC

will help explain toxicity data in field samples. Results of these studies will provide managers with important information on acceptable levels of pesticide contaminants when in combinations typically found in the Delta, and facilitate interpretation of toxicity data.

Task 5: Pulse experiments - Past monitoring data has shown pesticide concentrations in the Sacramento and San Joaquin Rivers rise and fall in "pulses" concurrent with rainfall events. These pulses may last only a day or two in creeks, but up to 10 days or more in major rivers. Virtually all pesticide toxicity data in the literature is based on a single exposure over a standardized time period (e.g., 96 hr LC₅₀). Recognizing that resident communities are exposed to multiple pulses of pesticides rather than a single exposure, we want to mimic these pulses in lab exposures. We will use existing data plus data developed early in Task 7 (below) to define some realistic pulse profiles for 2-3 Task 1-priority contaminants (time between pulses, magnitude of each pulse, duration of each pulse). Once we have defined these realistic profiles, we will recreate them in lab exposures with resident species and then challenge the organisms in dose-response tests. The primary objective will be to establish if responses are dependent upon the animal's past exposure history. It could be argued that multiple small pulses could either stress the organisms making later exposures more toxic, or conversely may result in acclimation allowing survival at what would otherwise be toxic levels.

Task 6: Bioavailability: The influence of DOM and sorption to sediments on the bioavailability of select pesticides may need to be considered in interpreting field pesticide and toxicity monitoring data. DOM will be isolated from several different sites using ultrafiltration and spiked back at varying concentrations in combination with selected Task 1 pesticides, and toxicity measured with several resident species identified in Task 2. The DOM will be characterized as to quantity and quality to allow prediction of bioavailability in field samples. Other laboratory experiments will be used to study the fate of pesticides transported into surface water sorbed to sediments. For example, our data has shown chlorpyrifos occurs in the San Joaquin River adsorbed to sediment. This particulate fraction is generally considered non-bioavailable to invertebrates and fish within the water column, but it is not known if the pesticide may desorb and thus become available. The kinetics of desorption of sediment-bound pesticides will be measured under various salinities and types of sediments.

Task 7: Field investigations - All the above tasks are intended to help interpret field monitoring data given environmentally realistic conditions (resident species, DOM, multiple pesticides, etc.), and we wish to evaluate the predictive value of our laboratory work in field testing. We anticipate primary field efforts in the winter months, both because juvenile salmon are in the Delta at that time and because historical data indicates the highest concentrations of pesticides and the greatest toxicity during that period, but we may extend sampling into spring and summer if dictated by Task 1.

Field studies will be done at about 4 sites within the Delta and lower San Joaquin River, the exact location of which will be determined early in the project period after reviewing available data and attempting to link our studies with existing work. We specifically want to locate some sites in back sloughs because of the important nursery habitat they provide for juvenile fishes, and we will also strive to select sites that are representative of specific pesticide sources (e.g. orchards, urban runoff). At each field site we will:

- 7a) Gather concentration data for the Task 1 priority pesticides in water samples collected daily during high flow events and weekly at other times.
- 7b) Bring water samples to the lab for testing with the resident species tests developed in Task 2.
- 7c) Perform TIEs on samples showing significant toxicity in order to identify the toxic agent.
- 7d) Quantify dissolved organic matter and measures of quality (e.g., UV spectra) in field samples to predict bioavailability and help interpret toxicity data.
- 7e) Perform in situ toxicity testing using juvenile chinook salmon and resident invertebrate species for which we have developed testing protocols. Organisms will be placed at sites just prior to a storm event, and recovered after flows decline. Data collected under 7a will allow quantification of the exposure. We will measure: mortality (invertebrates, salmon), growth (salmon), immune system

responses (salmon) and appropriate cellular responses such as lysosomal membrane stability, stress proteins and/or acetyl-cholinesterase inhibition (invertebrates, salmon).

7f) Describe salmon diets by stomach content analyses. USFWS conducts regular sampling throughout our study area, and will provide fall-run chinook from their trawls and beach seines, collected both before and after storm events, for analysis of stomach contents. These analyses will guide and justify the choices of resident species for which we develop toxicity tests, for we specifically want to emphasize salmon prey species in this study. Stomach content data will also be of interest to see how prey choices change from before to after a storm event, since the high flows may provide a prey that was not previously available, or the accompanying pesticide concentrations may eliminate certain previous diet items. This task will help define the plasticity of salmon prey choices and the extent to which they can adjust to changes in food type and availability, as well as the rate at which species that have been eliminated from the diet may recover and reappear at a later time. To the extent they are available, we will also characterize the diet of other CALFED-priority species such as Delta smelt, winter-run chinook, and splittail. Their availability is limited due to their protected status and USFWS take restrictions, but we will take advantage of any collection mortalities to identify stomach contents and consider the potential effect of pesticides on these species. Literature data will be relied upon for those species which we are unable to collect adequate numbers.

Task 8: Recommendations for pesticide management and monitoring- The results of the field and laboratory studies will be synthesized to provide recommendations on management of pesticides so as to minimize aquatic toxicity and monitoring approaches that could be adopted by CMARP or other state/federal programs. Management recommendations may focus on identification of pesticides which are considered to present the greatest threat to Delta fish and/or their invertebrate prey. Recommendations for monitoring may include such items as a list of pesticides of concern, resident species that have proven successful for routine monitoring, frequency of sampling during and between storm events, and ancillary variables to measure to predict bioavailability. Other important information may include how to interpret toxicity based on interactive effects among pesticides. Our goal is to place the science in a context accessible to environmental managers and pesticide users.

Location of Project

Field work would be done in the Delta beginning at Chipps Island and extending up the Sacramento River to Freeport and the San Joaquin River to the lower Merced River (we have used the term "Delta" throughout the proposal for brevity). Affected counties include Contra Costa, Merced, Solano, Sacramento, San Joaquin and Yolo.

ECOLOGICAL/BIOLOGICAL BENEFITS

Ecological/Biological Objectives

Populations of many aquatic species in the delta are in decline (Herbold et al., 1992, Jassby et al. 1995). This decline has been attributed to a number of factors (dams, water diversions, loss of habitat, exotic organisms), but toxic contaminants have often been among the suggested causes (Bailey et al. 1994; Bennett and Moyle 1996). Laboratory bioassays have identified pesticides, in particular organophosphate insecticides, as the major causes of toxicity detected in Delta water samples (Deanovic et al. 1996; 1997; Werner et al. 1998). Toxicity of water samples to bioassay organisms has been linked to pesticides and metals in the Sacramento River basin (Connor et al. 1993; Connor et al. 1994; Kuivila and Foe 1995; Foe and Connor 1991), and to pesticides in storm and irrigation runoff from row and orchard crops in the San Joaquin River Basin (Foe and Connor 1991; USGS 1997; 1998a; 1998b; Kuivila and Foe 1995; Foe 1995; Foe and Shepline 1993).

There is, however, a fundamental difficulty in trying to use existing data to predict pesticide effects either on fish or their invertebrate prey in the Delta. Nearly all work to date has involved: 1) monitoring of dissolved pesticide concentrations and comparison to published toxicity data; 2) toxicity testing using nationally standardized tests, most commonly with *Daphnia magna* or *Daphnia dubia*. The fundamental problem with such an approach is that literature toxicity data does not take into account

local conditions like interactive effects of multiple pesticides, acclimation or sensitization due to prior pesticide exposure, or bioavailability limitations attributable to factors such as dissolved organic matter. Thus the literature values may be dramatically different than the concentrations that are actually toxic in Delta waters. Moreover, there is no information on how pesticide sensitivity of *C. dubia* compares to that of resident species. We are proposing an integrated laboratory and field study with the objectives of providing information on pesticide toxicity to resident species, developing the data needed to apply laboratory toxicity measures to realistic field conditions, and putting results in an ecological context focusing on juvenile chinook salmon and their invertebrate prey.

The field sites that we select will not be adequate for a broad survey of toxicity throughout the Delta, but instead we have opted for intensive study at about 4 representative sites so that we may focus more on temporal patterns, causality, and factors which may modify predicted toxicity. The expectation from prior work is that the major toxicity will be due to dormant spray pesticides applied to orchards with some toxicity possibly due to other types of applications (row crops, rights-of-way, urban use). We may locate 1-2 of our sites so as to characterize mainstem rivers (e.g. Freeport and/or Vernalis), but we also wish to emphasize back slough habitats because of their fish habitat value, higher pesticide concentrations, and proximity to potential sources which should allow clearer source identification.

The emphasis on chinook salmon is, we believe, an important part of the overall project. There is reason to believe that pesticides in the Delta may be having direct toxic effects on the juveniles that are in the system during winter periods of high pesticide concentrations. It has been found, for example, that diazinon concentrations as low as 0.3-1.0 $\mu\text{g/l}$ impair olfactory function in Atlantic salmon (Moore and Waring, 1996). Diazinon concentrations averaging 1-7 $\mu\text{g/l}$ may persist for several days in the Sacramento and San Joaquin Rivers (Foe et al., 1998), and are likely to be considerably higher in tributary sloughs and creeks, suggesting a very real possibility of sublethal effects on salmon fry and smolts in the area. Pesticide effects on salmon may be indirect as well. It is known that juvenile chinook in the Delta feed upon dipterans, cladocerans, copepods, and amphipods (Kjelson et al., 1982), and as arthropods, these groups may be particularly sensitive to pesticide toxicity. It has been shown that measured concentrations of diazinon in the Delta would be expected to exceed the LC_{50} for over half the arthropods species whose tolerance has been tested (Foe et al., 1998), thus there is great potential that pesticides may substantially reduce the density of those species upon which the juvenile salmon depend. We have integrated both direct and indirect toxicity into our study. Direct toxicity will be tested by developmental toxicity tests with chinook salmon embryos, a larval/juvenile growth bioassay, and appropriate cellular and biochemical biomarkers. These toxicity tests will be done in the lab with field-collected samples, as well as in situ during high flow events. Indirect effects on important prey will be addressed by extensive gut content analysis to identify those prey organisms, and then develop pesticide toxicity testing protocols with these same species.

We believe that in situ toxicity testing is a powerful, yet underutilized tool. In situ toxicity tests with juvenile salmon will provide the best evidence of impacts under field conditions, with causality established by pesticide-specific biomarkers, TIEs, and a comparison of measured field pesticide concentrations to those levels demonstrated to be toxic in the laboratory bioassays. UC Davis and DeltaKeeper are currently developing in situ tests for use in the Delta, and we believe expansion of this technique to the present study will prove extremely valuable.

Finally, we intend to devote substantial effort to biomarkers of pesticide exposure, with emphasis on those endpoints that would generally be recognized as having adverse consequences for the individual. Acetyl-cholinesterase inhibition is an example of a compound-specific endpoint we will pursue, for it is generally recognized as a clear indication of exposure to organophosphate or carbamate pesticides. In investigations of avian mortality from unknown causes, for example, a 50% reduction in brain acetyl-cholinesterase activity is considered clear evidence that mortality was due to pesticide application (Hill and Fleming, 1982), and the enzyme activity is also a well established biomarker of organochlorine exposure in freshwater and marine fish (Sturm et al., 1999). A compound-specific biomarker response such as inhibition of acetyl-cholinesterase activity has the potential to be used as a measure of pesticide exposure and effect in field populations. Other cellular

and biochemical indicators of deleterious effect that will be investigated for their suitability as sublethal endpoints are measurement of lysosomal membrane stability, stress protein expression, and immune system function as serum cortisol concentration. These endpoints are sensitive and more general in nature, allowing an assessment of the overall condition of the organism.

Linkages

The proposed work builds upon or is of direct benefit to many other projects within the Delta including several which are funded by CALFED. DeltaKeeper is currently working on a CALFED-funded study of toxicity at two Delta sites. We have included DeltaKeeper as a project participant in part because they will be able to contribute extensive sampling experience and other data to this project.

A very close link exists between the proposed project and CVRWQCB's Sacramento River watershed monitoring program. The UC Davis Aquatic Toxicology Laboratory is performing all toxicity testing and TIE work for the Sacramento River program. Results and experience gained from that study will be readily available to our proposed work.

CALFED is currently funding work by Zalom et al. on alternative practices to reduce pesticide impacts on water quality. This study involves, in part, development of bioassays with a number of resident freshwater invertebrates. The UC Davis Aquatic Toxicology Lab is involved in these studies, and will use them as a basis for expansion into more candidate species under the current study.

Many pesticide testing and monitoring programs in the Sacramento or San Joaquin Rivers and tributaries rely upon toxicity testing with *C. dubia*. Among these programs are two funded by CALFED ("Sacramento County Urban Runoff OP Pesticide Toxicity Control" and "Toxicity testing with diazinon and chlorpyrifos"). These two programs and the many others that utilize *C. dubia* will directly benefit from the proposed work in that we will be developing alternative tests based upon resident species in the Bay-Delta system.

The USGS Toxics Project is studying transport and fate of pesticides in San Francisco Bay Estuary with emphasis on degradation rates of dissolved pesticides and input of pesticides bound to suspended sediments. Other on-going USGS studies are focused on the variation in quality of DOM in the Delta and input of suspended sediments.

Finally, many programs such as those of DPR and the USGS have done pesticide and/or toxicity monitoring in the Delta, and we will utilize their results in the early stages of our study as we select the pesticides and study sites on which we will focus.

The proposed work is relevant to the Ecosystem Restoration Program (ERP) Strategic Objectives for contaminants (p. 506, 2/99 ERP) as well as to those pertaining to many priority fish species that would be in the Delta at the time of our sampling and potentially be at risk for direct or indirect mortality related to pesticides (fall-run chinook, p. 222; winter-run chinook, p. 220; spring-run chinook, p. 220, splittail, p. 209, and Delta smelt, p. 194).

System-wide Ecosystem Benefits

We have focused our efforts on salmon and the invertebrate prey upon which they feed, but our results are likely to be relevant to other fish species as well which are in the Delta at the times of elevated pesticide concentrations and feed upon arthropod organisms that may be susceptible to pesticide toxicity. Delta smelt, for example, feed on copepods and mysids (Moyle et al., 1992); splittail also feed heavily on mysids (Meng and Moyle, 1995). While we can not analyze stomach contents of these fishes to the extent we will with salmon because of their limited availability, we will utilize literature sources to determine food preferences, and we may have resident species toxicity testing results pertinent to these prey items.

The resident species toxicity tests we will be developing are in the context of fish prey organisms and their potential reduction in abundance due to pesticide exposure. However, we should note that the tests we develop will have applications in general surface water monitoring programs in lieu of or in addition to standard EPA test species. There has been considerable interest expressed in

finding one or more resident species that could be used for toxicity testing purpose, irregardless of any trophic linkage to fish, and the products of our studies should have immediate benefit in this area.

Compatibility with Non-Ecosystem Objectives

Our studies support both the Ecosystem Quality and Water Quality objectives of the Bay-Delta Program. The Ecosystem Quality objective seeks to improve aquatic habitat. We have focused on fishes, and particularly chinook salmon, and the effects pesticides may have on them through direct toxicity or indirect effects on prey organisms. It is essential that pesticide effects, if any, be identified and corrected if CALFED's objective of improving habitat for this important species is to be met. With respect to the Water Quality objective, toxicity testing is a pivotal part of many water quality monitoring programs in the Delta and its tributaries. Our results will help interpret toxicity data by demonstrating how factors such as pesticide mixtures, DOM and suspended solids, and previous exposure to pesticides may modify expected correlations between pesticide concentrations and their toxic effects.

TECHNICAL FEASIBILITY AND TIMING

There are several unique attributes of our project team and the proposed work that we believe are unmatched by any other investigators in the region. It is, in fact, these unique characteristics that make the proposed work technically feasible.

Analytical capabilities - As a group we have unparalleled breadth in pesticide analytical capability. We are able to analyze pesticides both by gas chromatography (both USGS and Wichita State Univ.) and by immunoassay (both UC Davis and Wichita State Univ.). Dr. Bruce Hammock of UC Davis has offered to provide technical support and his laboratory has developed antibodies for a broad array of pesticides (Table 1). Immunoassays offer significant advantages in their low cost and thus high number of samples that can be accommodated. In those cases where gas chromatography is preferable, such as to discriminate among certain structurally similar compounds, both Dr. Kuivila (USGS) and Dr. Lydy (Wichita State Univ.) have extensive experience, and our broad capability in both techniques allows us to use which ever is technically preferable for the specific task.

Toxicity testing experience - Much of the toxicity testing and development work will be done at the UC Davis Aquatic Toxicology Laboratory. More details are provided under Qualifications, so we only note here that the lab has been working extensively in the Delta for over a decade, and has directly relevant Delta experience unmatched by any other investigators.

Salmon diet analysis - Linking our sampling to the regular trawl and seine sampling of USFWS, will allow us to obtain stomach contents throughout the field season from fall-run chinook fry in large number and other races/species in limited number (dependent upon incidental sampling mortality) including winter-run chinook and Delta smelt. The ability to determine their prey preferences throughout the study period, and changes in prey selection with respect to simultaneous pesticide monitoring, is one of the key elements of our study. This component links the invertebrate toxicity data to its ecological ramifications in terms of forage value of the habitat to priority fish species. The prey data will serve to guide our choices of invertebrate toxicity test organisms, and will show if and how diet composition changes after a period of high pesticide concentrations. While we recognize that it will be difficult to causally link a change in diet to pesticides, if we should see no change in diet quality or quantity after these pesticide pulses it would suggest the absence of an effect on prey species abundance. Finally, these data will answer a question that is often raised on how rapidly a prey species population can recover if reduced in density by pesticide toxicity. Rather than sampling the invertebrate community directly, we can utilize the salmon as an integrator of prey species availability, and examine if the species switches to alternative prey after a pesticide event, and how quickly the original prey species returns to the diet in their original density.

In situ toxicity testing - In situ testing is being increasingly recognized by EPA as a favored tool because of its high ecological relevance. The UC Davis and DeltaKeeper team members are the only investigators to have used this technique in the Delta. For fish and invertebrate species in the water column that may be displaced downstream during the high flow events that often accompany

TABLE 1
IMMUNOASSAYS* AVAILABLE FROM THE
PESTICIDE BIOTECHNOLOGY LABORATORY
University of California, Davis, CA 95616
January 1999

Herbicides

Triazine and metabolites
Atrazine
Simazine
Propazine
Ametryn
Cyanazine
Atrazine mercapturate
Hydroxyatrazine
Hydroxysimazine
N-dealkylated triazines

Phenylureas
Monuron
Diuron
Linuron
Thiocarbamates
Molinate
Thiobencarb
Bentazon
Paraquat
Bromacil
Triclopyr

Insecticides

Carbaryl and it's metabolite 1-Naphthol
Pyrethroids
Esfenvalerate and metabolites
Permethrin and metabolites
Fenpropathrin and metabolites

Benzoylphenylureas
Diflubenzuron
BAY SIR 8514
Bacillus thuringiensis δ -endotoxin
Bacillus thuringiensis β -exotoxin

Others

4-Nitrophenol, leaving group of methyl and ethyl parathion
4-Nitrophenyl glucuronide
Thiophenyl glucuronide
Triton series X & N detergents (ethoxylates of nonyl/octyl phenol)

Naphthalene mercapturates
TCDD
Alternaria toxins

Antibodies Available**

Amitrole
Glyphosate

Fenoxycarb
2,4,5-Trichlorophenoxyacetic acid

*All antibodies are polyclonal. With many of these antibodies, there is cross reactivity with structurally related compounds. We may, thus have assays for compounds that are not listed here. If you are interested in a particular class, please inquire.

**For these compounds there are antibodies available, however assays have not been completely worked out. Further development toward viable assays is possible with some of these antibodies.

Contact:

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(530) 752 8465 Laboratory / (530) 752 7519 Office / (530) 752 1537 FAX
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periods of high pesticide concentrations, it is difficult to track a given population, and the exposure history of any individuals collected is unknown. However, by raising these resident organisms in fixed enclosures, exposure is unambiguous. Coupling these tests with sublethal measures of toxicity, including pesticide specific biomarkers like acetyl-cholinesterase inhibition, provides a powerful technique to examine pesticide impacts under realistic field conditions.

It may be noted that we have not planned any direct sampling of water column or benthic invertebrate populations before/after periods of elevated pesticide levels, generally accompanied by high flows. Defensible quantification of pelagic organism abundance would be extremely difficult because of the potential for downstream displacement. Benthic organism abundance is not directly linked to salmon which feed in the water column, and in any event attributing abundance changes to pesticide effects would be equivocal given the dramatic changes in the hydrological regime concurrent with the pesticide exposure. We believe our approach of gut content analysis over time is as good or better than direct invertebrate sampling, and more clearly linked to the food value of the habitat, a critical consideration in our study. In addition, the in situ testing can address potential toxicity to resident species without directly sampling them. Finally, we note that the Dept. of Wildlife Resources samples benthic invertebrates at many sites throughout the Delta on a monthly basis. These data will be evaluated if needed, for example, if one of our selected test species regularly appears in the data base.

MONITORING AND DATA COLLECTION METHODOLOGY

Monitoring and data collection information is summarized in Table 2 and has been described in detail previously in the "Project Description" section.

It is our intent to integrate our data collection to the greatest degree possible with a wide range of data collection efforts by a number of state and federal agencies. This includes, but is not limited to:

- Department of Pesticide Regulation - We will utilize their Pesticide Use Report database and review their regular monitoring results in design of our program.
- Department of Water Resources - We will analyze their monthly benthic community monitoring data and rely upon the expertise of their staff on salmonid feeding habits.
- Central Valley Regional Water Quality Control Board - We will assess the pesticide data collected through their Sacramento River watershed monitoring program.
- US Geological Survey - We will incorporate the results of their pesticide monitoring through NAWQA and other programs in design of our studies.
- US Fish and Wildlife Service - Their regular salmon collections will be an integral part of our field efforts and a source of the fish used for stomach content analysis.

We believe that integration of our study with past and on-going efforts by other investigators can both dramatically enhance the value of the data we produce, and result in substantial cost savings to CALFED by providing information that would be prohibitively expensive if we were to collect it independently.

Our field work will be "event-based" in that acceleration of activities will occur immediately before and during rainfall events. In situ toxicity tests will be deployed just prior to anticipated heavy rainfall. Water samples for toxicity testing and pesticide analysis will be collected weekly between storms and daily during periods of highest flow. We recognize the need for rapid response when sampling in smaller creeks and sloughs where the pesticide pulse is anticipated to appear quickly and briefly. Four project participants (UCB,UCD, USGS and DeltaKeeper) are all participating in the field efforts in order to meet the logistical needs of sampling multiple sites in a temporally intensive manner in periods of inclement weather.

Field work of limited scale will be done in the year 2000 to evaluate potential field sites and obtain some stomach content data, but our primary field efforts will occur in 2001 and 2002. We anticipate sampling will be most intense during the January to March period when existing data suggests the greatest potential for toxicity, but we may extend sampling to other times after a thorough review of all available pesticide monitoring and toxicity data.

Table 3. Monitoring and Data Collection Information

<u>Hypothesis/Question Evaluated</u>	<u>Monitoring Parameters and Data Collec. Approach</u>	<u>Data Evaluation Approach</u>	<u>Comments/Data priority</u>
<u>Biological/Ecological Objective:</u> Identification of pesticides of interest			
Which pesticides are used in the Central Valley, present in surface waters, and likely to be associated with toxicity?	Review DPR data base, existing monitoring data, and literature toxicity data.	Develop a list of priority pesticides to direct project efforts.	High
<u>Biological/Ecological Objective:</u> Development of toxicity testing protocols			
Which resident species are suitable for pesticide toxicity monitoring?	Screen multiple species, with particular emphasis on salmon and their arthropod prey.	Select species that are pesticide sensitive, suitable for lab testing, and important to fish.	High
Can TIEs be developed for the species/compounds of interest?	Perform standard TIE procedures with selected species and spikes of compounds of interest.	Establish TIE profiles for pesticides.	High
<u>Biological/Ecological Objective:</u> Environmental factors affecting pesticide toxicity			
How is toxicity influenced by simultaneous exposure to multiple pesticides?	Screen binary combinations of pesticides followed by intensive dose-response quantification of selected combinations.	Identify and quantify additive, antagonistic and synergistic interactions.	High
How is toxicity influenced by exposure history to previous pesticide pulses?	Expose test species to realistic pesticide scenarios and follow with test for pesticide tolerance.	Analyze LC ₅₀ data in light of exposure history.	High
How is toxicity influenced by the quantity/quality of dissolved organic matter?	Add DOM in varying concentrations and measure response in toxicity.	Establish if and to what degree DOM reduces toxicity of hydrophobic pesticides.	High
How is toxicity influenced by suspended particles?	Examine pesticide desorption under varying conditions and sediments	Determine if adsorbed pesticides need to be considered bioavailable.	High

Table 3. Monitoring and Data Collection Information (continued)

Hypothesis/Question Evaluated	Monitoring Parameters and Data Collec. Approach	Data Evaluation Approach	Comments/ Data priority
Biological/Ecological Objective: Field investigations			
What pesticides are found in surface waters and at what concentrations?	Daily to weekly monitoring at about 4 sites.	Compare results to historical data.	High
Are surface waters toxic to resident species?	Test for toxicity both in the lab and by in situ testing.	Establish if lethal or sublethal effects are evident.	High
What agents are responsible for the toxicity?	Conduct TIEs on toxic samples.	Evaluate results by standard EPA protocols.	High
Is toxicity of field samples modified by the factors examined under prior objective?	Measure toxicity in field samples and in lab water with single pesticide additions.	Interpret discrepancies in view of pesticide interactions, DOM, field exposure history, etc.	High
Does fish prey availability change following high pesticide concentration events, can fish switch to alternate prey, and how quickly does the initial prey species recover?	Obtain fish from regular USFWS trawls and beach seines. Emphasis on fall-run chinook because of abundance, with other races/species as available. Analyze gut contents.	Analyze data for temporal changes and interpret with respect to pesticide concentration data and known toxic levels derived from lab exposures.	High
Biological/Ecological Objective: Recommendations for pesticide management and monitoring			
What recommendations on pesticide use and monitoring might be made in view of this work?	Interpret all data collected in the project to identify recommendations to protect aquatic biota, especially salmon and their prey.	Provide scientific results in a format most useful to state and federal environmental managers and pesticide users.	High

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Our analytical methods will include both immunoassays for selected pesticides and gas chromatography analyses. Both methods have their advantages and we have the capability to utilize either one depending on the needs of the task.

Development of toxicity tests for resident species and the field toxicity testing and TIEs will be done by the Aquatic Toxicology Laboratory of UC Davis. The laboratory is fully equipped to conduct various toxicant exposure and surface water monitoring studies using both standard EPA bioassay organisms and the resident species to be evaluated in these studies. The lab already has had experience with some resident species and with the in situ toxicity tests as proposed for these studies. The Aquatic Toxicology Laboratory has performed work for numerous state and federal agencies, and is well acquainted with standardized protocols and QA/QC methodology.

LOCAL INVOLVEMENT

We are pleased that DeltaKeeper has chosen to join our project team and play a substantial role in design of the program, field sampling, and data interpretation. Their knowledge of and experience in the Delta will be invaluable in design of the field program, and their boats and network of volunteers should be a significant asset in the daily sampling at numerous field sites throughout high flow events. As a local environmental advocacy group, we believe their participation will help the study be responsive to the needs of the local community and that they will serve as a vehicle to get project results to that community.

We have developed our study in consultation with state and federal resource managers, and members of academia, and we look forward to this relationship continuing throughout the study. Letters of support are attached to indicate awareness of and support for our work from the following:

- Deborah Denton, US Environmental Protection Agency
- Alan Jassby, Univ. California Davis
- Bruce Hammock, Univ. California Davis (including offer of collaboration)
- Jeffrey McLain, US Fish and Wildlife Service (including offer of collaboration)
- Peter Moyle, Univ. California Davis
- Matthew Nobriga, Department of Water Resources

We anticipate that our results will be of considerable interest to a broad audience including the scientific community, resource management agencies, and pesticide manufacturers and users. We would be happy to present one or more seminars on project results in the Sacramento area, and will work with CALFED in developing the format and public announcements for these seminars. We anticipate agency staff and the scientific community will be reached by oral presentations at local environmental conferences (e.g., State of the Estuary Conference, NorCal chapter of the Society for Environmental Toxicology and Chemistry, Interagency Program meeting). In addition we will publish the results in both the peer-reviewed literature and local forums such as the IEP Newsletter.

The field work will be conducted in Contra Costa, Merced, Solano, Sacramento, San Joaquin, and Yolo counties. As requested by CALFED, the County Board of Supervisors and Planning Department of these counties have been notified, and a copy of the letter is attached. A copy of letters to the Delta Protection Commission and Bay Conservation and Development Commission is also attached.

COST

Budget

The budget for the proposed work is shown in the attached tables with each page representing the budget for a single institution. University of California Davis (UCD), US Geological Survey (USGS), Wichita State University (WSU), and DeltaKeeper are participating in this project as subcontractors to the University of California Berkeley (UCB), and the total dollar value of their subcontracts are included in the Univ. California budget under the "other direct cost" category.

Salary costs include those for the principal investigators and other employees as appropriate to each institution: UCB - Graduate and undergraduate students, technician; UCD - post-doctoral researcher, technician, and undergraduate student; WSU - post-doctoral and graduate student; USGS and DeltaKeeper - staff. Fringe benefit rates vary depending on the type of position.

Materials and acquisitions largely consist of expendable supplies associated with the laboratory pesticide exposures and field work. The only equipment items included in the budget are incubators at UCB (\$14,000) for temperature control during pesticide exposure and Hydrolabs at UCD (\$12,000) for measurement of general water quality conditions during field sampling.

Indirect costs vary among the institutions. UCB indirect costs will depend upon whether the source of funds is state or federal, and thus two alternative budgets are provided. If state funds, a indirect rate of 10% is applied against direct costs excluding equipment, graduate student fee remission and graduate student health insurance. A 10% indirect rate is also applied to subcontracts up to \$25,000, beyond which no indirect costs are applied on funds passed through to subcontractors. In preparing the budget, indirect costs on the first \$25,000 of each subcontract were placed in the first quarters and in the first tasks each subcontractor participates in until the \$25,000 limit was reached (i.e., UCB indirect costs on the USGS subcontract in Task 1, quarters 1 and 2; WSU subcontract in Task 4, quarters 3 and Task 5, quarter 3; DeltaKeeper subcontract in Task 1, quarter 1 and Task 7, quarter 2). No UCB indirect charges are applied to any funds passed through to UCD because it and UCB are both in the University of California system. If federal funds are used for this project, the indirect cost rate at UCB is 50.4% applied to the same modified total direct cost basis and applied to subcontracts in the same manner as described for state funds.

Among the subcontractors, UCD indirect costs are 10% of total direct costs if state funds and 44.5% of total direct costs if federal funds. Therefore two budgets are also supplied for UCD. USGS indirect costs are 96% of total direct costs. WSU indirect costs are 46% of total direct costs. DeltaKeeper's overhead is 15% of total direct costs.

The Project Management Task, budgeted only for the prime contractor (UCB), includes time required to prepare quarterly reports, respond to requests for information from CALFED or member agencies, give oral presentations to CALFED, track progress by the subcontractors, and includes local travel costs to CALFED offices or the locations of collaborators.

Table 3. Project schedule

	1999	2000	2001	2002
][][][][
	ONDJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJAS
Task 1 - Identify priority pesticides	xxxxxxx			
Task 2 - Resident species		xxxxxxxxxxxxxxxxxxxx		
Task 3 - TIE development			xxxxxxxxxxxxxxxxxxxx	
Task 4 - Pesticide interactions		xxxxxxxxxxxxxxxxxxxx		
Task 5 - Pulse experiments		xxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxxxxxxxxxxx	
Task 6 - Bioavailability		xxxxxxxxxxxxxxx	xxxxxxx	
Task 7 - Field studies		xxxxx	xxxxxxxxxxxxxxxxxxxx	xxxxxxxxxxx
Task 8 - Recommendations				xxxxxxx

Schedule

Three field sampling periods are planned. The first in 2000 will be limited in scope and is intended for the purpose of screening potential field sites, and for preliminary stomach content analyses of salmon to define prey items that should be investigated in development of resident species toxicity tests. Thereafter we envision an iterative lab/field study. Laboratory work on pesticide mixtures, DOM effects, etc. will be done in 2000, then field evaluated in the intensive field program of early 2001, then further refinement and development lab work done in late 2001, followed by another intensive field effort in early 2002. The schedule of Table 3 shows field studies extending throughout each year in order to allow periods for sample analyses/data interpretation.

COST SHARING

Dr. Michael Lydy has received funding from EPA to study the biochemical mechanisms underlying synergistic interaction between the organophosphate pesticides and triazine herbicides. This research will be of direct benefit to our CALFED-funded studies. If state funds are provided to support the proposed work, one-half of the value of Dr. Lydy's EPA grant is offered as in-kind cost sharing to this project, a contribution valued at \$134,710. (If the source of funds are federal monies, federal funds can not be used as a match).

DeltaKeeper has offered a match of \$20,300 consisting of \$2000 in cash and \$18,300 as the value of time provided by volunteers who will assist in field sampling efforts.

The total cost share for this project from the two sources identified above (assuming state funds are provided) totals \$175,010.

APPLICANT QUALIFICATIONS

There are five principal investigators on the project team and biosketches are provided for each of them below.

Dr. Donald Weston will act as Project Manager for the proposed work, and will be responsible for primary contact with CALFED and the coordination of tasks among the other project participants. He also will have primary technical responsibilities in Tasks 5 (pulse experiments) and Task 7 (salmon diet analysis portion of field work), and partial responsibility in Tasks 1 (pesticides of concern), 6 (bioavailability), and 8 (recommendations). Dr. Weston is an ecotoxicologist at the University of California, Berkeley, with nearly 20 years experience. His research has focused on issues pertaining to bioaccumulation of contaminants, and has included work on bioavailability, trophic transfer of contaminants, sediment toxicity testing, and toxicant effects on benthic community structure. He has done a great deal of work in recent years on bioavailability including the effect of dissolved organic matter on PCB bioaccumulation, and the effects of digestive chemistry on the bioavailability of particle-sorbed contaminants. He has also worked on the development of chronic bioassays, specifically the use of growth rate in the amphipod *Ampelisca abdita* as a measure of sediment toxicity.

Much of the toxicity testing work will be coordinated by Dr. Inge Werner (biosketch below) and Ms. Linda Deanovic at the UC Davis Aquatic Toxicology Laboratory (laboratory director: Prof. D.E.Hinton, laboratory manager: L.A. Deanovic). This lab has a 12 year history of toxicity testing in California with emphasis on the Sacramento/San Joaquin watershed and Delta. The lab played a decisive role in identifying and tracing pesticides draining from rice fields in the Colusa Basin, and has been involved in numerous toxicity studies on the Sacramento River and the Delta (Sacramento Point Source Discharge Survey, Sacramento Reservoir Survey, Sacramento River Watershed Project, Sacramento-San Joaquin Delta Monitoring Project, DeltaKeeper Sacramento-San Joaquin Delta Project). Toxicity identification studies done by the Aquatic Toxicology Lab helped identify organophosphate pesticides as the principal toxic agents being transported through the river system and Delta. Additional work led to the recognition of dormant sprays and urban runoff as some of the principal sources of toxic pesticides in the San Joaquin river and Delta (Urban Storm Runoff Toxicity Study, Pesticide Transport in Air Project, Central Valley Orchard and Alfalfa Study, Dormant Spray Insecticides Study, In Season Orchard Spray Study).

Mr. Bill Jennings will coordinate the activities of DeltaKeeper, including their assistance in study design and the field sampling effort. As Chairman of the California Sportfishing Protection Alliance, and subsequently DeltaKeeper, Bill Jennings has labored in the trenches of environmental protection for the last two decades. Since establishing DeltaKeeper, he has assembled and trained a highly skilled group of volunteers engaged in an ambitious monitoring program that includes a CALFED-funded Delta Toxicity Study and an EPA funded Urban Waterways Monitoring Project. DeltaKeeper has four boats patrolling the maze of Delta waterways. Mr. Jennings' efforts have been recognized by the California Legislature and the Department of Fish and Game and he has received

the Conservation Achievement Award from the American Fisheries Society, the International Conservation Award from the Federation of Flyfishers and was honored as Outdoor Californian of the Year by the California Outdoor Writers Association.

Dr. Kathryn Kuivila will be responsible for analysis of pesticide concentrations in the field samples (Task 7) and for carrying out laboratory studies on the effect of DOM and sorption to sediments on toxicity (Task 6) and will participate in the identification of pesticides of concern (Task 1) and recommendations for monitoring and management (Task 8). Dr. Kuivila received her Ph.D. in Chemical Oceanography from the University of Washington in 1986. She is currently employed as a research hydrologist by the Water Resources Division of the U.S. Geological Survey in the California District Office in Sacramento, California. Her primary focus of research is on the transport, degradation, and fate of organic contaminants, particularly pesticides, in the San Francisco Bay Estuary and has an international reputation in the scientific community. She has been studying pesticides in San Francisco Bay since 1990 and is well respected by the state and local resource managers in the area. Her research efforts have contributed greatly to understanding riverine pesticide inputs, transport of pesticides during high flow events, and degradation of pesticides within the estuary. Dr. Kuivila has a strong record of collaborating with state and local agencies, including the Central Valley Regional Water Quality Control Board, California State Water Quality Control Board, Interagency Ecological Program, U.S. EPA, and California Department of Fish and Game.

Dr. Michael Lydy is an environmental toxicologist at Wichita State University and Director of the Environmental Toxicology Core Facility. He has been involved in research on toxicity and bioavailability of pesticides for over 13 years. Because of his extensive experience in toxicity of pesticide mixtures, and especially the synergistic toxicity of atrazine and organophosphate insecticides, he has been included in this project as lead investigator for Task 4 (pesticide interactions). Two of his recent publications provide evidence of his expertise in areas critical to the success of this study: 1) Pape-Lindstrom, P.A. and M.J. Lydy. 1997. Synergistic toxicity of atrazine and organophosphate insecticides contravenes the response-addition mixture model. *Environmental Toxicology and Chemistry*, v.16 (11): 1-6, and 2) Lydy, M.J., D.S. Carter and C.G. Crawford. 1996. Comparison of gas chromatography mass spectrometry and immunoassay techniques on concentrations of atrazine in storm runoff. *Archives of Environmental Contamination and Toxicology*, v.31: 378-385.

Dr. Ingeborg Werner of UC Davis will have primary responsibility in Tasks 2 (resident species and TIE development), the toxicity testing components of the field work, and will have shared duties in Tasks 1 and 8. Dr. Werner holds a Master's degree in limnology, and a doctoral degree in ecotoxicology (*magna cum laude*). Her research work on stress proteins in amphipods as biomarkers of sediment pollution was performed at the Romberg Tiburon Center for Environmental Studies, San Francisco State University (Dr. James T. Hollibaugh), and partially funded by the Interagency Ecological Program for the San Francisco Bay/Delta Estuary. Her research interests focus on the development and application of toxicity tests using chronic endpoints and indicators of sublethal pollutant impacts (biomarkers) in aquatic organisms. These cellular indicators are examined and compared to other sublethal indicators of deleterious effect at various levels of organization, e.g. DNA, tissue, organism, and population in the laboratory and field. Developmental aspects of stress protein expression were studied in fish. Future work will expand the biomarker approach to the assessment of sediment toxicity in collaboration with researchers from UC Davis, Department of Civil and Environmental Engineering, SFEI, USGS and Point Reyes Bird Observatory. Her recent work with the UC Davis Aquatic Toxicology Lab includes aquatic monitoring studies to assess pesticide toxicity in the Delta, impact and efficacy of alternative pest control methods in the Sacramento/San Joaquin watershed, toxicity of MTBE to freshwater organisms, and toxicity of stormwater runoff in California urban areas.

There are also two unfunded collaborators for whom we have not provided biosketches, but letters offering support services can be found later in this proposal. Dr. Jeffrey McLain with the US Fish and Wildlife Service will assist in providing us fall-run chinook salmon and other races/species as available from their regular collection activities throughout the Delta, and will provide technical

expertise on salmon ecology. Dr. Bruce Hammock of UC Davis will provide training and reagents for immunoassays of pesticide concentrations.

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Principal Investigator: DONALD F. WESTON, Ph.D.
University of California, Berkeley

TOTAL BUDGET
University of California, Berkeley

If funded with Federal funds:

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs (@ 50.4% MTDC)	Total Costs
Task 1	200	8,140	-	1,500	81,183	90,823	21,878	112,701
Task 2	0	-	-	-	220,120	220,120	-	220,120
Task 3	0	-	-	-	92,280	92,280	-	92,280
Task 4	0	-	-	-	174,780	174,780	12,322	187,102
Task 5	2,487	59,319	-	23,000	100,424	182,743	37,339	220,082
Task 6	1,720	43,410	-	10,000	159,000	212,410	29,439	241,849
Task 7	4,039	103,370	-	9,500	432,014	544,884	64,851	609,735
Task 8	870	24,161	-	2,000	119,809	145,970	13,038	159,008
Project Mgt. Task	480	19,932	-	-	1,800	21,732	10,952	32,684
Grand Totals	9,796	\$ 258,332	\$ -	\$ 46,000	\$ 1,381,410	\$ 1,685,742	\$ 189,819	\$ 1,875,561

If funded with State funds:

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs (@ 10% MTDC)	Total Costs
Task 1	200	8,140	-	1,500	74,877	84,517	4,341	88,858
Task 2	0	-	-	-	172,937	172,937	-	172,937
Task 3	0	-	-	-	70,248	70,248	-	70,248
Task 4	0	-	-	-	174,780	174,780	2,445	177,225
Task 5	2,487	59,319	-	23,000	84,600	166,919	7,408	174,327
Task 6	1,720	43,410	-	10,000	159,000	212,410	5,842	218,252
Task 7	4,039	103,370	-	9,500	390,205	503,075	12,866	515,941
Task 8	870	24,161	-	2,000	116,455	142,616	2,586	145,202
Project Mgt. Task	480	19,932	-	-	1,800	21,732	2,172	23,904
Grand Totals	9,796	\$ 258,332	\$ -	\$ 46,000	\$ 1,244,902	\$ 1,549,234	\$ 37,660	\$ 1,586,894

QUARTERLY BUDGET
University of California, Berkeley

If funded with Federal funds:

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	67,259	46,442	-	-	112,701
Task 2	-	46,543	57,159	57,159	160,861
Task 3	-	-	-	20,315	20,315
Task 4	-	-	36,770	34,259	71,029
Task 5	-	10,963	39,840	32,759	83,562
Task 6	-	33,434	52,319	50,815	136,568
Task 7	-	80,989	-	-	80,989
Task 8	-	-	-	-	-
Project Mgt. Task	2,674	2,674	2,674	2,674	10,696
Grand Totals	69,933	\$ 220,045	\$ 188,762	\$ 197,981	\$ 676,721

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	55,659	3,600	-	-	59,259
Task 3	20,315	36,750	14,900	-	71,965
Task 4	24,448	24,448	17,956	29,711	96,564
Task 5	29,417	11,285	11,285	32,448	84,435
Task 6	44,489	-	-	43,737	88,226
Task 7	-	142,657	113,656	13,424	269,737
Task 8	-	-	-	-	-
Project Mgt. Task	2,724	2,724	2,724	2,724	10,896
Grand Totals	177,053	\$ 221,464	\$ 160,521	\$ 122,044	\$ 681,082

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	112,701
Task 2	-	-	-	-	-	220,120
Task 3	-	-	-	-	-	92,280
Task 4	19,509	-	-	-	19,509	187,102
Task 5	28,841	11,622	11,622	-	52,085	220,082
Task 6	17,055	-	-	-	17,055	241,849
Task 7	13,424	130,367	101,366	13,852	259,009	609,735
Task 8	-	-	81,010	77,998	159,008	159,008
Project Mgt. Task	2,773	2,773	2,773	2,773	11,092	32,684
Grand Totals	81,602	\$ 144,762	\$ 196,771	\$ 94,623	\$ 517,758	\$ 1,875,561

QUARTERLY BUDGET
University of California, Berkeley

If funded with State funds:

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	49,587	39,271	-	-	88,858
Task 2	-	36,648	44,730	44,730	126,108
Task 3	-	-	-	15,465	15,465
Task 4	-	-	26,893	34,259	61,152
Task 5	-	8,345	33,643	26,785	68,773
Task 6	-	33,434	47,246	46,146	126,826
Task 7	-	68,286	-	-	68,286
Task 8	-	-	-	-	-
Project Mgt. Task	1,956	1,956	1,956	1,956	7,824
Grand Totals	\$ 51,543	\$ 187,940	\$ 154,468	\$ 169,341	\$ 563,292

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	43,229	3,600	-	-	46,829
Task 3	15,465	27,976	11,342	-	54,783
Task 4	24,449	24,448	17,956	29,711	96,564
Task 5	22,407	8,591	8,591	26,448	66,037
Task 6	39,751	-	-	39,201	78,952
Task 7	-	123,906	94,988	10,219	229,115
Task 8	-	-	-	-	-
Project Mgt. Task	1,992	1,992	1,992	1,992	7,968
Grand Totals	\$ 147,293	\$ 190,515	\$ 134,869	\$ 107,571	\$ 580,248

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	88,858
Task 2	-	-	-	-	-	172,937
Task 3	-	-	-	-	-	70,248
Task 4	19,509	-	-	-	19,509	177,225
Task 5	21,823	8,847	8,847	-	39,517	174,327
Task 6	12,474	-	-	-	12,474	218,252
Task 7	10,219	113,348	84,428	10,545	218,540	515,941
Task 8	-	-	74,107	71,095	145,202	145,202
Project Mgt. Task	2,028	2,028	2,028	2,028	8,112	23,904
Grand Totals	\$ 66,053	\$ 124,223	\$ 169,410	\$ 83,668	\$ 443,354	\$ 1,586,884

Principal Investigator: Donald P. Weston, Ph.D.
University of California, Berkeley

TOTAL BUDGET
University of California, Davis

If funded with Federal funds:

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1	720	16,300	-	1,500	480	18,280	8,134	26,414
Task 2	6,080	105,801	-	24,000	6,960	136,761	60,859	197,620
Task 3	3,000	54,642	-	5,500	3,720	63,862	28,418	92,280
Task 4	0	-	-	-	-	-	-	-
Task 5	1,440	35,863	-	-	10,000	45,863	20,410	66,273
Task 6	0	-	-	-	-	-	-	-
Task 7	5,520	93,275	-	20,500	7,410	121,185	53,927	175,112
Task 8	240	7,947	-	480	1,300	9,727	4,327	14,054
Grand Totals	17,000	\$ 313,828	\$ -	\$ 51,980	\$ 29,870	\$ 395,678	\$ 176,075	\$ 571,753

If funded with State funds:

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1	720	16,300	-	1,500	480	18,280	1,828	20,108
Task 2	6,080	105,801	-	24,000	6,960	136,761	13,676	150,437
Task 3	3,000	54,642	-	5,500	3,720	63,862	6,386	70,248
Task 4	0	-	-	-	-	-	-	-
Task 5	1,440	35,863	-	-	10,000	45,863	4,586	50,449
Task 6	0	-	-	-	-	-	-	-
Task 7	5,520	93,275	-	20,500	7,410	121,185	12,118	133,303
Task 8	240	7,947	-	480	1,300	9,727	973	10,700
Grand Totals	17,000	\$ 313,828	\$ -	\$ 51,980	\$ 29,870	\$ 395,678	\$ 39,567	\$ 435,245

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QUARTERLY BUDGET
University of California, Davis

funded with Federal funds:

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	13,207	13,207	-	-	26,414
Task 2	-	41,443	52,059	52,059	145,561
Task 3	-	-	-	20,315	20,315
Task 4	-	-	-	-	-
Task 5	-	10,963	-	-	10,963
Task 6	-	-	-	-	-
Task 7	-	-	-	-	-
Task 8	-	-	-	-	-
Grand Totals	13,207	\$ 65,613	\$ 52,059	\$ 72,374	\$ 203,253

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	52,059	-	-	-	52,059
Task 3	20,315	36,760	14,900	-	71,965
Task 4	-	-	-	-	-
Task 5	-	11,285	11,285	4,748	27,318
Task 6	-	-	-	-	-
Task 7	-	37,435	37,435	13,424	88,294
Task 8	-	-	-	-	-
Grand Totals	72,374	\$ 85,470	\$ 63,620	\$ 18,172	\$ 239,636

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	26,414
Task 2	-	-	-	-	-	197,620
Task 3	-	-	-	-	-	92,280
Task 4	-	-	-	-	-	-
Task 5	4,748	11,622	11,622	-	27,992	66,273
Task 6	-	-	-	-	-	-
Task 7	13,424	29,771	29,771	13,852	86,818	175,112
Task 8	-	-	7,027	7,027	14,054	14,054
Grand Totals	18,172	\$ 41,393	\$ 48,420	\$ 20,879	\$ 128,864	\$ 671,753

QUARTERLY BUDGET
University of California, Davis

* funded with State funds:

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	10,054	10,054	-	-	20,108
Task 2	-	31,548	39,630	39,630	110,808
Task 3	-	-	-	15,465	15,465
Task 4	-	-	-	-	-
Task 5	-	8,345	-	-	8,345
Task 6	-	-	-	-	-
Task 7	-	-	-	-	-
Task 8	-	-	-	-	-
Project Mgt. Task	-	-	-	-	-
Grand Totals	10,054	\$ 49,947	\$ 39,630	\$ 55,095	\$ 154,726

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	39,629	-	-	-	39,629
Task 3	15,465	27,976	11,342	-	54,783
Task 4	-	-	-	-	-
Task 5	-	8,591	8,591	3,614	20,796
Task 6	-	-	-	-	-
Task 7	-	28,497	28,497	10,219	67,213
Task 8	-	-	-	-	-
Project Mgt. Task	-	-	-	-	-
Grand Totals	55,094	\$ 65,064	\$ 48,430	\$ 13,833	\$ 182,421

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	20,108
Task 2	-	-	-	-	-	150,437
Task 3	-	-	-	-	-	70,248
Task 4	-	-	-	-	-	-
Task 5	3,614	8,847	8,847	-	21,308	60,449
Task 6	-	-	-	-	-	-
Task 7	10,219	22,663	22,663	10,545	66,090	133,303
Task 8	-	-	5,350	5,350	10,700	10,700
Project Mgt. Task	-	-	-	-	-	-
Grand Totals	13,833	\$ 31,510	\$ 36,860	\$ 15,895	\$ 98,098	\$ 435,245

TOTAL BUDGET

U.S. Geological Survey

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1	720	24,000	-	-	-	24,000	22,000	46,000
Task 2	400	11,700	-	-	-	11,700	10,800	22,500
Task 3	0	-	-	-	-	-	-	-
Task 4	0	-	-	-	-	-	-	-
Task 5	0	-	-	-	-	-	-	-
Task 6	1,920	70,000	-	10,000	-	80,000	74,000	154,000
Task 7	2,060	80,800	-	11,700	-	92,500	87,500	180,000
Task 8	660	36,000	-	-	-	36,000	34,500	70,500
Grand Totals	5,760	\$ 222,500	\$ -	\$ 21,700	\$ -	\$ 244,200	\$ 228,800	\$ 473,000

Wichita State University

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1	0	-	-	-	-	-	-	-
Task 2	0	-	-	-	-	-	-	-
Task 3	0	-	-	-	-	-	-	-
Task 4	5,027	91,046	-	19,000	9,666	119,712	55,068	174,780
Task 5	303	8,678	-	6,000	2,000	16,678	7,673	24,351
Task 6	0	-	-	-	-	-	-	-
Task 7	0	-	-	-	-	-	-	-
Task 8	260	10,902	-	-	1,500	12,402	5,705	18,107
Grand Totals	5,590	\$ 110,626	\$ -	\$ 25,000	\$ 13,166	\$ 148,792	\$ 68,446	\$ 217,238

DELTAKEEPER

Tasks	Direct Labor Hours	Direct Salary & Benefits	Service Contracts	Material & Acq. Costs	Misc. & Other Direct Costs	Total Direct Costs	Indirect Costs	Total Costs
Task 1	748	16,013	-	500	432	16,945	5,463	22,408
Task 2	0	-	-	-	-	-	-	-
Task 3	0	-	-	-	-	-	-	-
Task 4	0	-	-	-	-	-	-	-
Task 5	0	-	-	-	-	-	-	-
Task 6	0	-	-	-	-	-	-	-
Task 7	2,134	38,369	-	5,000	6,000	49,369	7,446	56,815
Task 8	547	11,491	-	400	1,382	13,273	1,873	15,146
Grand Totals	3,429	\$ 65,873	\$ -	\$ 5,900	\$ 7,814	\$ 79,587	\$ 14,782	\$ 94,369

QUARTERLY BUDGET
U.S. Geological Survey

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	23,000	23,000	-	-	46,000
Task 2	-	5,100	5,100	5,100	15,300
Task 3	-	-	-	-	-
Task 4	-	-	-	-	-
Task 5	-	-	-	-	-
Task 6	-	33,434	33,433	33,433	100,300
Task 7	-	30,000	-	-	30,000
Task 8	-	-	-	-	-
Grand Totals	\$ 23,000	\$ 91,534	\$ 38,533	\$ 38,533	\$ 191,600

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	3,600	3,600	-	-	7,200
Task 3	-	-	-	-	-
Task 4	-	-	-	-	-
Task 5	-	-	-	-	-
Task 6	26,850	-	-	26,850	53,700
Task 7	-	40,000	40,000	-	80,000
Task 8	-	-	-	-	-
Grand Totals	\$ 30,450	\$ 43,600	\$ 40,000	\$ 26,850	\$ 140,900

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	46,000
Task 2	-	-	-	-	-	22,500
Task 3	-	-	-	-	-	-
Task 4	-	-	-	-	-	-
Task 5	-	-	-	-	-	-
Task 6	-	-	-	-	-	154,000
Task 7	-	35,000	35,000	-	70,000	180,000
Task 8	-	-	35,250	35,250	70,500	70,500
Grand Totals	\$ -	\$ 35,000	\$ 70,250	\$ 35,250	\$ 140,500	\$ 473,000

QUARTERLY BUDGET
Wichita State University

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	-	-	-	-	-
Task 2	-	-	-	-	-
Task 3	-	-	-	-	-
Task 4	-	-	24,448	34,269	58,707
Task 5	-	-	3,322	8,226	11,548
Task 6	-	-	-	-	-
Task 7	-	-	-	-	-
Task 8	-	-	-	-	-
Grand Totals	\$ -	\$ -	\$ 27,770	\$ 42,485	\$ 70,255

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	-	-	-	-	-
Task 3	-	-	-	-	-
Task 4	24,449	24,448	17,956	29,711	96,564
Task 5	3,320	-	-	7,293	10,813
Task 6	-	-	-	-	-
Task 7	-	-	-	-	-
Task 8	-	-	-	-	-
Grand Totals	\$ 27,769	\$ 24,448	\$ 17,956	\$ 37,004	\$ 107,177

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	-
Task 2	-	-	-	-	-	-
Task 3	-	-	-	-	-	-
Task 4	19,509	-	-	-	19,509	174,760
Task 5	2,190	-	-	-	2,190	24,351
Task 6	-	-	-	-	-	-
Task 7	-	-	-	-	-	-
Task 8	-	-	11,706	6,401	18,107	18,107
Grand Totals	\$ 21,699	\$ -	\$ 11,706	\$ 6,401	\$ 39,806	\$ 217,238

QUARTERLY BUDGET
Delta Keeper

Tasks	Quarter 1 Oct-Dec 1999	Quarter 2 Jan-Mar 2000	Quarter 3 Apr-Jun 2000	Quarter 4 Jul-Sept 2000	Year 1 Total
Task 1	7,469	-	-	-	7,469
Task 2	-	-	-	-	-
Task 3	-	-	-	-	-
Task 4	-	-	-	-	-
Task 5	-	-	-	-	-
Task 6	-	-	-	-	-
Task 7	-	18,938	-	-	18,938
Task 8	-	-	-	-	-
Grand Totals	\$ 7,469	\$ 18,938	\$ -	\$ -	\$ 26,407

Tasks	Quarter 5 Oct-Dec 2000	Quarter 6 Jan-Mar 2001	Quarter 7 Apr-Jun 2001	Quarter 8 Jul-Sept 2001	Year 2 Total
Task 1	-	-	-	-	-
Task 2	-	-	-	-	-
Task 3	-	-	-	-	-
Task 4	-	-	-	-	-
Task 5	-	-	-	-	-
Task 6	-	-	-	-	-
Task 7	-	26,407	-	-	26,407
Task 8	-	-	-	-	-
Grand Totals	\$ -	\$ 26,407	\$ -	\$ -	\$ 26,407

Tasks	Quarter 9 Oct-Dec 2001	Quarter 10 Jan-Mar 2002	Quarter 11 Apr-Jun 2002	Quarter 12 Jul-Sept 2002	Year 3 Total	Grand Totals
Task 1	-	-	-	-	-	7,469
Task 2	-	-	-	-	-	-
Task 3	-	-	-	-	-	-
Task 4	-	-	-	-	-	-
Task 5	-	-	-	-	-	-
Task 6	-	-	-	-	-	-
Task 7	-	26,407	-	-	26,407	71,752
Task 8	-	-	7,574	7,574	15,148	15,148
Grand Totals	\$ -	\$ 26,407	\$ 7,574	\$ 7,574	\$ 41,555	\$ 94,369

UNIVERSITY OF CALIFORNIA, DAVIS

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APR 08 1999

Ms. Lynn Deetz
Sponsored Projects Office
336 Sproul Hall, Mail Code 5940
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Berkeley, CA 94720-5940

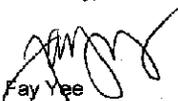
Dear Ms. Deetz:

Research Proposal Entitled
"Assessment of Pesticide Effects on Fish and Their Food Resources in the Sacramento-San Joaquin Delta"
Principal Investigator - **Don Weston**, UCB
Collaborating Principal Investigator - **Inge Werner**, UCD

We are pleased to forward concurrence of the planned involvement of UCD personnel and facilities in the reference proposal. The research efforts here will conduct under the supervision of Inge Werner.

If the referenced proposal results in funding, we shall expect to receive support from UCB in accordance with the policy on multiple campus projects pursuant to Contract and Grant Memo No. 84-34 Supplement 1, dated May 3, 1985.

Sincerely,


Fay Yee
Contracts & Grants Analyst

Enclosures

c: I. Werner
B.I. Osburn



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Water Resources Division
California District
Office of the District Chief
Placer Hall, 6000 J Street, Suite 2012
Sacramento, California 95819-6129
(916) 278-3000 Fax (916) 278-3070
<http://water.wr.usgs.gov>

April 8, 1999

Ms. Lynn Deetz
Sponsored Projects Office
University of California
336 Sproul Hall
Berkeley, California 94720-5940

Dear Ms. Deetz:

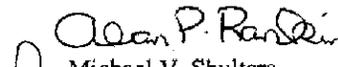
This letter confirms discussions between our respective staffs, concerning a new cooperative study involving the University of California (UC) and the U.S. Geological Survey (USGS) beginning in Federal Fiscal Year (FFY) 2000 (October 1, 1999 to September 30, 2000).

The USGS is pleased to collaborate with the UC on the project "Assessment of Pesticide Effects on Fish and their Food Resources in the Sacramento-San Joaquin Delta". The estimated cost of USGS work proposed during FFY's 2000-2002 is \$473,000. A detailed budget is enclosed identifying costs associated with the various elements of work.

If this collaborative work is agreed upon, the USGS will require a signed agreement before work can proceed by the USGS.

If you have any questions concerning this program, please contact Kathy Kuivila, in our Sacramento Project Office, at (916) 278-3054.

Sincerely,


for Michael V. Shulters
District Chief

Enclosures

cc: Dr. Donald Weston, Department of Integrative Biology, University of California,
3060 Valley Life Sciences Building, Berkeley, California 94720-3140



WICHITA STATE UNIVERSITY

Office of Research Administration

April 7, 1999

Ms. Lynn Deetz
Sponsored Projects Office
University of California
336 Sproul Hall
Berkeley, CA 94720-5940

Dear Ms. Deetz:

Wichita State University agrees to participate with the University of California-Berkeley in the proposal being submitted to CALFED Bay-Delta Program Office entitled *Assessment of Pesticide Effects on Fish and Their Food Resources in the Sacramento-San Joaquin Delta*. If a grant is awarded, Wichita State University will accept a subcontract to perform the work outlined in the proposal subject to all established regulations and procedures.

Wichita State University pledges the value of the second year of Dr. Lydy's EPA EPSCoR grant, *Evaluating the Effects of Pesticide Mixtures to Aquatic Organisms: Mechanisms of Synergistic Toxicity*, in the amount of \$134,710, as in-kind support of the proposed work.

Sincerely,

Gerald D. Loper
Associate Vice President for Research

GDL:erm
attachment

San Francisco



DeltaKeeper™

April 9, 1999

Ms. Lynn Deetz
Sponsored Projects Office
University of California
336 Sproul Hall
Berkeley CA 94720-5940

Dear Ms. Deetz

DeltaKeeper is pleased to be a collaborator taking part in the project sponsored by University of California as the Assessment of Pesticide Effects on Fish and their Food Resources in the Sacramento-San Joaquin Delta. DeltaKeeper has worked extensively during the last year with the U.C. Davis Aquatic Toxicology Laboratory on a Calfed-funded project to establish baseline data for toxicity in the Delta. We are delighted to support continuation of this important work by providing monitoring and data analysis support to the University of California and other collaborators. We look forward to working on a highly successful project.

Sincerely,



Michael Lozeau
Executive Director

cc: Marsha Mather-Thrift Development Director
Bill Jennings, DeltaKeeper

Presidio Building 1004
PO Box 29921
San Francisco, CA 94129-0921

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I - 0 1 9 0 1 6

415 561 2299
fax 415 561 2290
1-800-KEEP-BAY
www.sfbaykeeper.org

I-019016



United States Department of the Interior

FISH AND WILDLIFE SERVICE

Sacramento-San Joaquin Fisheries Resource Office
4001 North Wilson Way, Stockton, CA 95205-2486
209-946-6400 voice, 209-946-6002 fax



April 2, 1999

Dr. Donald Weston
University of California Berkeley
1301 South 46th Street, Building 112
Richmond, CA 94804

Dr. Weston:

Thank you for contacting the U.S. Fish and Wildlife Service concerning your study on the assessment of pesticide effects on fish and their food resources in the Sacramento-San Joaquin Delta. The importance of juvenile salmon prey availability and toxicity is of interest to the U.S. Fish and Wildlife Service.

Because this information may be of value in the protection and rehabilitation of chinook salmon, the Service is willing to accommodate your field collection and technical expertise needs during the course of your study. Several of the sampling locations indicated in your draft proposal are part of the U.S. Fish and Wildlife Service's ongoing juvenile chinook monitoring program. If your project is selected, we are willing to assist you with the collection of fall run juvenile salmon for the purposes of stomach analysis at these ongoing monitoring sites. Depending on current take restrictions and permitting requirements, listed species such as delta smelt, winter run chinook, and steelhead may be more difficult to obtain. The Service also is willing to provide some technical expertise on a limited basis.

If you should have any more questions, please don't hesitate to contact the Stockton Fishery Resource Office at (209) 946-6400.

Sincerely,

Jeffrey McLain
Supervisory Fishery Biologist

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

COLLEGE OF AGRICULTURAL AND
ENVIRONMENTAL SCIENCES
AGRICULTURAL EXPERIMENT STATION
(530) 752-0475
FAX: (530) 752-1537

DEPARTMENT OF ENTOMOLOGY
ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8584

April 7, 1999

Dr. Don Weston
University of California
1301 S. 46th St., Bldg. 112,
Richmond, CA 94804

Dear Dr. Weston:

This letter is written in support of the project entitled "Assessment of Pesticide Effects on Fish and their Food Resources in the Sacramento-San Joaquin Delta" by Drs. Don Weston, UC Berkeley and Inge Werner of the UC Davis Aquatic Toxicology Laboratory to CalFed. We are enthusiastic about providing immunoassays for the analysis of pesticides or their metabolites to their laboratory. My laboratory has been involved in the development of immunoassays for pesticides and pesticide metabolites for a number of years. The technology has been shown to be quantitative, adaptable to the field and is especially suited to the analysis of a large number of samples, such as may be generated in the proposed ecotoxicology study. To transfer this technology to users, such as the Aquatic Toxicology laboratory, is a major goal of our work. Thus we will provide both reagents and training in their use.

Our past collaborations, in which we have transferred assays for molinate and thiobencarb to the Aquatic Toxicology Laboratory, have been rewarding and we are pleased to continue these collaborations with Dr. Werner on the proposed project.

Sincerely,

A handwritten signature in cursive script that reads "Bruce D. Hammock" with a small flourish at the end.

Bruce D. Hammock
Professor of Entomology



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, CA 94105-3901

April 14, 1999

Dr. Donald Weston
University of California, Berkeley
1301 S. 46th St., Bldg. 112
Richmond, CA 94804

Dear Dr. Weston,

I am writing in support of the research proposal entitled "Assessment of pesticide effects on fish and their food resources in the Sacramento-San Joaquin Delta". This three year project to evaluate the presence of significant amounts of pesticide residues in the Sacramento and San Joaquin Rivers and Delta using both standard and indigenous test species would be a highly valued research benefit to protecting aquatic resources in California. A paramount strength of this research proposal is it addresses the link between pesticides exposures based on previous monitoring and toxicological response data with additional studies with standard and indigenous species to further assess biomarker endpoints such as suppressed immune system responses with real world exposures based on in-situ testing. In addition, I can provide collaborative data examining the interactive toxicological responses of survival and behavioral responses of insecticides exposures to both the standard fish species and an indigenous fish species to enhance this research project.

The research has several advantages: (1) the research project has a demonstrated need and benefit to assist in achieving the CALFED goals, (2) the research will be conducted by a well balanced team of academic, government and private sector nationally known scientists with lots of previous experience and knowledge in directly in this field and (3) the project utilizes a sound scientific approach and standard test methods. I urge its full funding.

Sincerely,

A handwritten signature in black ink, appearing to read "Debra L. Denton".

Debra L. Denton
Environmental Scientist
USEPA Region 9 Toxicity Coordinator

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UNIVERSITY OF CALIFORNIA, DAVIS

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COLLEGE OF AGRICULTURAL AND
ENVIRONMENTAL SCIENCES
AGRICULTURAL EXPERIMENT STATION
COOPERATIVE EXTENSION

DEPARTMENT OF WILDLIFE, FISH AND CONSERVATION BIOLOGY
ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-8751
FAX (530) 752-4154

13 April 1999

CALFED Bay-Delta Program
1416 Ninth St
Sacramento CA 95814

Dear Colleagues:

This letter is written in support of the project entitled "Assessment of pesticide effects on fish and their food resources in the Sacramento-San Joaquin Delta" by Dr. Don Weston and his interdisciplinary team of university scientists, the USGS and Deltakeeper, a non-profit organization. I am enthusiastic about their approach to answering the important question of how pesticides and mixtures of pesticides influence populations of native fish species such as chinook salmon, and their food resources. The combination of ecological tools with standard toxicity testing and modern molecular techniques will enable them to detect acute as well as chronic effects, which will yield important information for both the scientific community and regulatory agencies.

This is the kind of research that needs to be done in order to develop a proper ecosystem recovery plan for the estuary. The information should be useful in formulating adaptive management strategies.

Sincerely,

A handwritten signature in black ink, appearing to read "Peter B. Moyle".

Peter B. Moyle
Professor

UNIVERSITY OF CALIFORNIA, DAVIS

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO



SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF ENVIRONMENTAL SCIENCE AND POLICY

ONE SHIELDS AVENUE
DAVIS, CALIFORNIA 95616-5576

Dr. Don Weston
University of California
Richmond Field Station
1301 S. 46th St., Bldg. 112
Richmond, CA 94804

Fax: (510) 643-6264

15 April 1999

Dear Dr. Weston,

This letter is written in support of the proposed project entitled "Assessment of Pesticide Effects on Fish and Their Food Resources in the Sacramento-San Joaquin Delta" on which you, as Principal Investigator, will work with an interdisciplinary team of university scientists, the USGS and Deltakeeper, a non-profit organization.

Our own team recently embarked on a study of the food resources for secondary production in the Sacramento-San Joaquin Delta. This research is supported by a CALFED Category III grant, as well as by the USGS and Center for Ecological Health Research at UC Davis. The goals of this project are to identify the sources, quantity and quality of organic matter and its availability to secondary producers in different Delta habitats. While our study evaluates the nutritional quality of Delta habitats for primary consumers, it is not specifically designed to assess the effects of toxins on habitat quality for secondary production, nor will it answer the question of how dissolved organic matter influences toxicity of these compounds. Understanding the effects of pesticides on resident consumers in the Delta such as native fish, zooplankton and benthic invertebrates is an essential part of a complete evaluation of Delta habitats for these organisms and the implementation of effective management strategies.

We believe that the proposed study on pesticide effects in the Delta will yield highly useful information. The combination of ecological tools with standard toxicity testing and modern molecular techniques will allow detection of acute as well as chronic effects, yielding important information for both the scientific community and regulatory agencies. Further, the proposed study complements our own study in various aspects.

We therefore strongly support your proposal and look forward to collaboration on these issues.

Sincerely,

Alan Jassby
Research Ecologist

DEPARTMENT OF WATER RESOURCES
ENVIRONMENTAL SERVICES OFFICE
3251 S STREET
SACRAMENTO, CA 95816-7017



To Whom It May Concern:

This is a letter of support for a proposal to conduct an assessment of pesticide effects on fish and their food resources in the Sacramento-San Joaquin Delta. The impacts to fisheries in the San Francisco Bay-Delta system are generally considered to be the result of the cumulative impacts of multiple stressors. Some stressors, such as water diversion impacts, have been extensively studied. Other stressors, such as effects of toxic compounds, have been less extensively studied. As you know, it is impossible to assess the importance of any potential stressor without appropriate data on its environmental effects. The relative impact of contaminants on local invertebrates commonly utilized as prey by fishes in the delta is unknown. If funded, this study would help fill this information gap.

The proposed study will provide:

- Baseline data on the susceptibility of locally important prey invertebrates to commonly used toxic substances
- Field data on the actual toxicity of delta water samples to chinook salmon and invertebrates commonly eaten by salmon and other fishes
- Important information on "real-world" interactions of toxic substances with each other as well as with carbon sources present in delta water. This will allow for greater confidence in the interpretation of toxicity data.

CALFED would benefit from the comprehensive toxicity dataset this study will provide. A broad information base is essential for making informed and appropriate decisions regarding restoration of natural resources in the San Francisco Bay-Delta ecosystem.

Matthew L. Nobriga

A handwritten signature in black ink that reads "Matthew L. Nobriga".

Environmental Specialist II

LOCAL NOTIFICATION

The following letter has been sent to the County Board of Supervisors and the County Planning Department in Contra Costa, Merced, San Joaquin, Solano, Stanislaus and Yolo counties.

Dear Sirs:

The University of California, Berkeley is submitting a proposal to CALFED entitled "Assessment of Pesticide Effects on Fish and Their Food Resources in the Sacramento-San Joaquin Delta". CALFED has requested that all investigators submitting proposals to CALFED notify the Board of Supervisors and Planning Departments in counties in which work will be conducted. This letter serves to provide that notification.

The proposed project is a collaborative effort among investigators at the University of California, US Geological Survey, Deltkeeper, Wichita State University, and with sampling assistance provided by the US Fish and Wildlife Service. We are studying the toxicity of pesticides in surface waters to resident invertebrate species and the fish which feed upon them, particularly chinook salmon. Part of the proposed work involves collection of samples throughout the Delta, Sacramento and San Joaquin Rivers and their tributaries, and it is possible that we may be collecting from water bodies within the boundaries of your county. Work to be done on site includes collection of water samples, placement of cages containing salmon or invertebrates in a creek or river for short periods, and fish seining done in conjunction with US Fish and Wildlife Service as part of their regular monitoring program.

CALFED will make the funding decisions later this summer, and if our study is funded, work will be performed from fall 1999 through fall 2002. If you have any questions please call me at 510-231-5626.

Donald P. Weston

The following letter has been sent to the Delta Protection Commission and Bay Conservation and Development Commission

Dear Sirs:

The University of California, Berkeley is submitting a proposal to CALFED entitled "Assessment of Pesticide Effects on Fish and Their Food Resources in the Sacramento-San Joaquin Delta". CALFED has requested that all investigators submitting proposals to CALFED notify the Commission of the proposed work. This letter serves to provide that notification.

The proposed project is a collaborative effort among investigators at the University of California, US Geological Survey, Deltkeeper, Wichita State University, and with sampling assistance provided by the US Fish and Wildlife Service. We are studying the toxicity of pesticides in surface waters to resident invertebrate species and the fish which feed upon them, particularly chinook salmon. Part of the proposed work involves collection of samples throughout the Delta, Sacramento and San Joaquin Rivers and their tributaries. Work to be done on site includes collection of water samples, placement of cages containing salmon or invertebrates in a creek or river for short periods, and fish seining done in conjunction with US Fish and Wildlife Service as part of their regular monitoring program.

CALFED will make the funding decisions later this summer, and if our study is funded, work will be performed from fall 1999 through fall 2002. If you have any questions please call me at 510-231-5626.

Donald P. Weston

State of California

DEPARTMENT OF WATER RESOURCES

The Resources Agency

Agreement No. _____

Exhibit _____

**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.

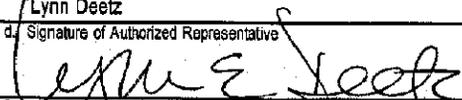
Termination Clause. Either State agency may terminate this contract upon 30 days advance written notice. The State agency providing the services shall be reimbursed for all reasonable expenses incurred up to the date of termination.

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.

YZK 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.

DWR 4187 (REV. 1/99)

**APPLICATION FOR
FEDERAL ASSISTANCE**

1. TYPE OF SUBMISSION: <i>Application</i> <input type="checkbox"/> Construction <input checked="" type="checkbox"/> Non-Construction		2. DATE SUBMITTED		Application Identifier										
		3. DATE RECEIVED BY STATE		State Application Identifier										
<i>Preapplication</i> <input type="checkbox"/> Construction <input type="checkbox"/> Non-Construction		4. DATE RECEIVED BY FEDERAL AGENCY		Federal Identifier										
5. APPLICATION INFORMATION														
Legal Name The Regents of the University of California			Organizational Unit University of California, Berkeley; Dept. of Integrative Biology											
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) Administrative Contact Technical Contact Lynn Deetz Donald P. Weston, Ph.D. (510) 643-6113 510-231-5626											
6. EMPLOYER IDENTIFICATION NUMBER (EIN): <table border="1" style="width:100%; text-align:center; border-collapse: collapse;"> <tr><td>9</td><td>4</td><td>-</td><td>6</td><td>0</td><td>0</td><td>2</td><td>1</td><td>2</td><td>3</td></tr> </table>			9	4	-	6	0	0	2	1	2	3	7. TYPE OF APPLICANT: (enter appropriate letter in box) 1	
9	4	-	6	0	0	2	1	2	3					
8. TYPE OF APPLICATION: <input checked="" type="checkbox"/> New <input 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): _____			A. State B. County C. Municipal D. Township E. Interstate F. Intermunicipal G. Special District H. Independent School Dist. I. State Controlled Institution of Higher Learning J. Private University K. Indian Tribe L. Individual M. Profit Organization N. Other (Specify): _____											
10. CATALOG OF FEDERAL DOMESTIC ASSISTANCE NUMBER: <table border="1" style="width:100%; text-align:center; border-collapse: collapse;"> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </table> TITLE: _____													9. NAME OF FEDERAL AGENCY: CALFED	
12. AREAS AFFECTED BY PROJECT (cities, counties, states, etc.) Contra Costa, Solano, Sacramento, & San Joaquin Counties, CA			11. DESCRIPTIVE TITLE OF APPLICANT'S PROJECT: Assessment of Pesticide Impacts on Fish and Their Food Resources in the Sacramento-San Joaquin Delta FDP-II											
13. PROPOSED PROJECT: Start Date 10/01/99		Ending Date 9/30/02		14. CONGRESSIONAL DISTRICTS OF: a. Applicant 9th										
15. ESTIMATED FUNDING:		16. IS APPLICATION SUBJECT TO REVIEW BY STATE EXECUTIVE ORDER 12372 PROCESS?												
a. Federal	\$1,875,561	a. YES. THIS PREAPPLICATION/APPLICATION WAS MADE AVAILABLE TO THE STATE EXECUTIVE ORDER 12372 PROCESS FOR REVIEW ON: DATE _____												
b. Applicant	\$ 155,010	b. NO. <input checked="" type="checkbox"/> PROGRAM IS NOT COVERED BY E.O. 12372												
c. State	\$	<input type="checkbox"/> OR PROGRAM HAS NOT BEEN SELECTED BY STATE FOR REVIEW												
d. Local	\$	17. IS THE APPLICANT DELINQUENT ON ANY FEDERAL DEBT?												
e. Other	\$	<input type="checkbox"/> Yes if "Yes," attach an explanation. <input checked="" type="checkbox"/> No												
f. Program Income	\$	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												
g. TOTAL	\$2,030,571	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												

Previous Editions Not Usable

Standard Form 424
Prescribed by OMB Circular A-102

Authorized for Local Reproduction

BUDGET INFORMATION – Non-Construction Programs

SECTION 7. BUDGET SUMMARY						
Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Ecosystem Restoration Program		\$	\$	\$ 1,875,561	\$ 20,300	\$ 1,895,861
2.						
3.						
4.						
5. TOTALS		\$	\$	\$ 1,875,561	\$ 20,300	\$ 1,895,861
6. Object Class Categories	GRANT PROGRAM FUNCTION OR ACTIVITY					TOTAL
	(1) Total Project	(2)	(3)	(4)	(5)	(6)
a. Personnel	217,390	0	0	0	0	217,390
b. Fringe Benefits	40,942	0	0	0	0	40,942
c. Travel	4,950	0	0	0	0	4,950
d. Equipment	14,000	0	0	0	0	14,000
e. Supplies	32,000	0	0	0	0	32,000
f. Contractual	1,356,360	0	0	0	0	1,356,360
g. Construction	0	0	0	0	0	0
h. Other	20,100	0	0	0	0	20,100
i. Total Direct Charges (Sum of 6a - 6h)	1,685,742	0	0	0	0	1,685,742
j. Indirect Charges	189,819	0	0	0	0	189,819
k. TOTALS (Sum of 6i and 6j)	\$ 1,875,561	\$ -	\$ -	\$ -	\$ -	\$ 1,875,561
7. Program Income	\$	\$	\$	\$	\$	\$

1-019026

1-019026

SECTION C - NON-FEDERAL REVENUES						
(g) Grant Program	(h) Applicant	(c) State	(d) Other Sources	(e) TOTALS		
8. Ecosystem Restoration Program	\$ 20,300 \$	\$	\$	\$	\$	20,300
9.						
10.						
11.						
12. TOTALS (sum of lines 8 and 11)	\$ 20,300 \$	\$	\$	\$	\$	20,300
SECTION D - FORECASTED CASH NEEDS						
	Total for 1st Year	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter	
13. Federal	\$ 676,721 \$	69,933 \$	220,045 \$	188,762 \$	197,981	
14. Non-Federal						
15. TOTALS (sum of lines 13 and 14)	\$ 676,721 \$	69,933 \$	220,045 \$	188,762 \$	197,981	
SECTION E - BUDGET ESTIMATES OF FEDERAL NEEDS FOR BALANCE OF THE FISCAL YEAR						
FUTURE FUNDING PERIODS (Years)						
(g) Grant Program	(b) First	(c) Second	(d) Third	(e) Fourth	(f) Fifth	
16. Ecosystem Restoration Program	\$ 676,721 \$	681,082 \$	517,758			
17.						
18.						
19.						
20. TOTALS (sum of lines 16 - 19)	\$ 676,721 \$	681,082 \$	517,758			
SECTION F - OTHER BUDGET INFORMATION						
21. Direct Charges	\$1,685,742	22. Indirect Charges:		\$189,819		
23. Remarks:						

Indirect Costs are calculated at a rate of 50.4% of Modified Total Direct Costs (i.e., less equipment & less subcontract amounts over initial \$25,000).

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.

DI-2011
March 1995
This form consolidates DI-1953, DI-1954,
DI-1955, DI-1956 and DI-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 E. Dostz
Senior Research Administrator
Sponsored Projects Office
University of California
Berkeley Campus

DATE

4/15/99

ASSURANCES - NON-CONSTRUCTION PROGRAMS

OMB Approval No. 0348-004

Public reporting burden for this collection of information is estimated to average 15 minutes per response, including time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to the Office of Management and Budget, Paperwork Reduction Project (0348-0040), Washington, DC 20503.

**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:

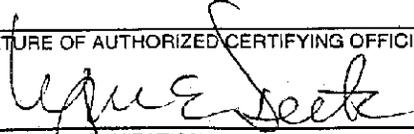
1. Has the legal authority to apply for Federal assistance and the institutional, managerial and financial capability (including funds sufficient to pay the non-Federal share of project cost) to ensure proper planning, management and completion of the project described in this application.
2. Will give 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.

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Prescribed by OMB Circular A-102

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 Lynn E. Deetz Senior Research Administrator
APPLICANT ORGANIZATION UNIVERSITY OF CALIFORNIA	DATE SUBMITTED 4/15/99

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