

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

Project Information

1. Proposal Title:

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

2. Proposal applicants:

William Grader, The Institute for Fisheries Resources
Natasha Benjamin, The Institute for Fisheries Resources
Allison Vogt, The Institute for Fisheries Resources
Nicole Brown, The Institute for Fisheries Resources

3. Corresponding Contact Person:

William Grader
The Institute for Fisheries Resources
PO Box 29196 San Francisco, CA 94129-0196
415 561-3474
fish4ifr@aol.com

4. Project Keywords:

**At-risk species, fish
Habitat Evaluation
Restoration Ecology**

5. Type of project:

Research

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

No

7. Topic Area:

At-Risk Species Assessments

8. Type of applicant:

Private non-profit

9. Location - GIS coordinates:

Latitude: 37.822

Longitude: -122.304

Datum:

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

All research sites are within the confines of the San Francisco Bay

10. Location - Ecozone:

2.5 San Pablo Bay, Code 16: Inside ERP Geographic Scope, but outside ERP Ecozones

11. Location - County:

Alameda, Contra Costa, Marin, San Francisco, Solano, Sonoma

12. Location - City:

Does your project fall within a city jurisdiction?

No

13. Location - Tribal Lands:

Does your project fall on or adjacent to tribal lands?

No

14. Location - Congressional District:

8

15. Location:

California State Senate District Number: 7, 3, 9, 8

California Assembly District Number: 11, 13

16. How many years of funding are you requesting?

2

17. Requested Funds:

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

No

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

Single Overhead Rate: 15

Total Requested Funds: \$926,078.54

b) Do you have cost share partners already identified?

No

c) Do you have potential cost share partners?

No

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

No

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

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

No

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

No

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

No

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

No

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

Yes

If yes, identify project number(s), title(s) and funding source.

BIO-IBN-306-1417	Novel Mechanisms of Motility Induction in the Sperm of a Teleost Fish	National Science Foundation
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Please list suggested reviewers for your proposal. (optional)

21. Comments:

Environmental Compliance Checklist

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

1. CEQA or NEPA Compliance

a) Will this project require compliance with CEQA?

No

b) Will this project require compliance with NEPA?

No

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

CEQA or NEPA compliance is not needed because our proposal does not call for any procedures which would have an environmental impact. It is purely a research project that requires an existing literature research component and low impact field research such as water sampling and observational recordings.

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

CEQA Lead Agency:

NEPA Lead Agency (or co-lead):

NEPA Co-Lead Agency (if applicable):

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

CEQA

-Categorical Exemption

-Negative Declaration or Mitigated Negative Declaration

-EIR

Xnone

NEPA

-Categorical Exclusion

-Environmental Assessment/FONSI

-EIS

Xnone

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

4. **CEQA/NEPA Process**

a) Is the CEQA/NEPA process complete?

Not Applicable

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

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

LOCAL PERMITS AND APPROVALS

Conditional use permit

Variance

Subdivision Map Act

Grading Permit

General Plan Amendment

Specific Plan Approval

Rezone

Williamson Act Contract Cancellation

Other

STATE PERMITS AND APPROVALS

Scientific Collecting Permit Required, Obtained

CESA Compliance: 2081

CESA Compliance: NCCP

1601/03

CWA 401 certification

Coastal Development Permit

Reclamation Board Approval

Notification of DPC or BCDC

Other

FEDERAL PERMITS AND APPROVALS

ESA Compliance Section 7 Consultation

ESA Compliance Section 10 Permit

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

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

Agency Name:

Permission to access state land.

Agency Name:

Permission to access federal land.

Agency Name:

Permission to access private land.

Landowner Name:

6. Comments.

Land Use Checklist

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

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

No

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

No

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

No

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

Research only

4. **Comments.**

Conflict of Interest Checklist

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

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

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

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

Applicant(s):

William Grader, The Institute for Fisheries Resources
Natasha Benjamin, The Institute for Fisheries Resources
Allison Vogt, The Institute for Fisheries Resources
Nicole Brown, The Institute for Fisheries Resources

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

If yes, please list the name(s) and organization(s):

Willaim Kier	Kier Associates
Fred Griffin, PhD	UC Davis Bodega Marine Laboratory
Gary Cherr, PhD	UC Davis Bodega Marine Laboratory
Marilyn Latta	Save the Bay
Pat Higgins	Kier Associates
Jan Derksen, PhD	Kier Associates
Michael F. McGowan, PhD	San Francisco State University

Helped with proposal development:

Are there persons who helped with proposal development?

Yes

If yes, please list the name(s) and organization(s):

Steve Edmundsen NOAA

Comments:

Budget Summary

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

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

Independent of Fund Source

Year 1												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1	Project Management	720	25200	7560	2000	2000		2000		38760.0	5814	44574.00
2	Literature search	80	1280	384						1664.0	249.6	1913.60
3	Herring survey									0.0		0.00
3.1	Physical measurements	1920	31872	7968	1500	2000		12000	24000	79340.0	20670	100010.00
3.2	Biological surveys	2880	46080	11520	4000	12000		6000	42000	121600.0	31265	152865.00
4	Oyster survey									0.0		0.00
4.1	Survey	352	7255.24	4948.8	1000	15000		3700		31904.04	4785.61	36689.65
4.2	Water quality	352	255.24	4948.8	1000	12000		11500		29704.04	5505.61	35209.65
4.3	Analyze data	624	20401.9	13910.4	200	300				34812.3	5221.85	40034.15
4.4	Synthesize data	904	43120.	29400	250	500				73270.0	10990.5	84260.50
5	Dungeness crab survey									0.0		0.00
5.1	Stock identification	160	8000	2400	500	2000		5000		17900.0	2685.	20585.00
5.2	Larvae distribution	640	25600	7680	500	1000		1000		35780.0	5367	41147.00
5.3	Juvenile distribution	640	25600	7680	500	1000		1000		35780.0	5367	41147.00
5.4	Predation	320	12800	3840	500	500		3000		20640.0	3096	23736.00
6										0.0		0.00
		9592	247464.38	102240.00	11950.00	48300.00	0.00	45200.00	66000.00	521154.38	101017.17	622171.55

Year 2												
Task No.	Task Description	Direct Labor Hours	Salary (per year)	Benefits (per year)	Travel	Supplies & Expendables	Services or Consultants	Equipment	Other Direct Costs	Total Direct Costs	Indirect Costs	Total Cost
1	Project Management	720	25200	7560	2000	2000		2000		38760.0	5814	44574.00
6	Data Analysis									0.0		0.00
6.1	Development of databases	320	30400	9120		1000		2500		43020.0	6453	49473.00
6.2	Develop coverages	960	91200	27360		1000		2500		122060.0	18309	140369.00
7	Community Outreach	600	15000	4500						19500.0	2925	22425.00
8	Leagal Regulatory Analysis	80	7600	2280						9880.0	1482	11362.00
9	Develop recommendations	320	19200	5760						24960.0	3744	28704.00
		3000	188600.00	56580.00	2000.00	4000.00	0.00	7000.00	0.00	258180.00	38727.00	296907.00

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

Grand Total=919078.55

Comments.

Budget Justification

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

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

Zeke Grader - 80 hours Natasha Benjamin - 480 hours Allison Vogt - 80 hours William Kier - 460 hours Fred Griffin - 800 hours Gary Cherr - 800 hours Graduate Student - 800 hours

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

Zeke Grader - \$95/hr Natasha Benjamin - \$23/hr Allison Vogt - \$15/hr William Kier - \$95/hr Fred Griffin - \$40/hr Gary Cherr - \$40/hr Graduate Student - \$16/hr

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

Institute for Fisheries Resources - 30% Bodega Marine Lab - 25%

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

All local travel

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

Office Supplies - \$1000 Laboratory supplies Field supplies Computer supplies

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

No Services or consultants

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

No equipment over \$5000 per unit

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

Program Initiation/Coordination - The Program Manager will initiate the Program, supervise progress and prepare reports at an average of ten hours a week at \$20 per hour, equaling \$9600 for 1 year.

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

Herring Survey - Equipment: 4 YSI remote environmental sensors at \$3000 each = \$12,000 and Boat & diver time = \$42,000

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

Indirect costs include rent, phone, fax, email, internet service, support staff, bookkeeper, accountant

Executive Summary

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

The purpose of the two-year project is to identify as well as develop, through field research, the information necessary for creation of plans for the protection and restoration of three important aquatic resources of San Francisco Bay Pacific herring (*Clupea pallasii*), native oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*). The project will develop recommendations for the necessary elements of plans for each of the three species, including protocols for on-going monitoring, testing, and adaptive management. It does not, however, create such plans. The project is comprised of four elements. The first will include the identification of current, historic and potential habitats within San Francisco Bay for the three species. It will also promote the continuance of existing research on larval transport, or initiate such research where necessary, to determine parameters for healthy habitat, including salinity requirements and currents. Additionally, development of sampling methods for improving information on presence and movement of various life history stages of the three species, including sampling of non-native aquatic invasive species that may pose a potential threat. The second element of the project will include the identification and analysis of current fishery regulatory measures impacting the Bay habitats of the three species as well as investigation into the permitting requirements necessary for restoration of habitat and species within the Bay, including those that may impede protection or restoration. The third element of the project will be to compile data, including maps, current and previous scientific papers (published and unpublished), graphs, photograph, charts, into a user-friendly resource information system that comports with the IEP and is capable of incorporating other data compilation systems. The final element of the project will be the culmination of the above research into recommendations submitted to CALFED for the creation of protection and restoration plans for each of the three species and their habitats in San Francisco Bay, along with recommendations for on-going monitoring (CVPIA priority BR-8) that will be necessary for inclusion into such plans, including that needed for adaptive management. Once this data is known, an effective and efficient restoration program can be put in place that reverses downward population trends of these three species (ERP Goal 1) in the San Francisco Bay. These species, particularly the native oyster population can have a disproportionate influence on important ecosystem processes (ERP Goal 2) such as primary productivity (by filter feeding on phytoplankton), invasive species control (by competition for space and filtering larvae) (ERP Goal 5), water quality (filtering and sequestering sediment in faeces and pseudofaeces) (ERP Goal 6), and trophic dynamics (prey to fish, birds, crabs, and snails). We will be monitoring the X2 relationships for these species at various life stages to begin to determine and analyze the relationships with fresh water inflow in keeping with the CVPIA priority BR-7.

Proposal

The Institute for Fisheries Resources

The Development of Information Necessary for Establishment of Protection and Restoration Plans for Three Economically Important Aquatic Species of San Francisco Bay Pacific Herring (*Clupea pallasii*), Native Oyster (*Ostrea lurida*), and Dungeness Crab (*Cancer magister*)

William Grader, The Institute for Fisheries Resources
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PROJECT DESCRIPTION

The goal of this two-year project is to carry out the literature review, data collection, research, and mapping necessary for the creation of comprehensive plans for the restoration of three key aquatic species native to San Francisco Bay, that are, or were, of significant economic importance: Pacific herring (*Clupea pallasii*), native oyster (*Ostrea lurida*) and Dungeness crab (*Cancer magister*). The project itself does not establish restoration plans for any of the above three species, but undertakes the preliminary work required, in the two-year proposed period, to develop information needed for the creation of plans for protection and restoration of these three significant native species within San Francisco Bay under CALFED's Ecosystem Restoration Program.

The four objectives to be met in achieving the goal of this project are:

1. Research the biological and physical information necessary for establishing restoration plans. This will entail: a) identification of existing biological and physical studies and data relating to these three species within San Francisco Bay; b) continuance of existing research to improve the level of understanding of the biological and physical requirements for these species, including studies of larval life history, salinity and temperature thresholds, etc.; c) assessment of limiting factors within the Bay; d) mapping of existing habitats and known ranges of the three species within the Bay; and e) identification of both historic and potential habitats.
2. Identify and analyze the policy and regulatory measures bearing on the protection, restoration or expansion of the habitats of the three species within San Francisco Bay, as well as the protection and restoration of the species themselves, including those policies or regulations that may promote protection and restoration and those that may impede protection and restoration. The policy and regulatory analysis is a minor component, although it provides important information in the construction of comprehensive restoration plans for each of the three species in San Francisco Bay.
3. Gather and store data from the first two objectives into a user-friendly resource information system, that can incorporate GIS information, published and unpublished reports, graphs, photographs and charts to aid in the construction of restoration plans. The model for the information system here is the "KRIS" (Klamath Resource Information System) program currently being used as the data system for California's coastal watersheds from San Francisco Bay to the Oregon border. It is capable of incorporating existing data sets and data information systems; thus any problems of incompatibility would be avoided.
4. Make recommendations for the creation of protection and restoration plans for each of the three species. This will include the necessary elements for such plans, and recommendations for on-going monitoring for such factors as salinity and temperature, sampling methodologies to be used, and adaptive management.

The project is intended to be of two-years duration. Its geographic coverage will be San Francisco Bay, including San Pablo Bay, and will include physical sampling and data collection. This sampling and collection will be the focus of the first year. The focus of the second year will be the completion of any remaining field work, the policy and permitting analysis, the data gathering, assimilation, and storage, and the development of recommendations to CALFED for protection and restoration plans for each of the three species.

1. Problem

The impetus that led to this project proposal is essentially three-fold:

To date the focus of CALFED's Ecosystem Restoration Program has been on the Delta and upstream habitats. The primary fishery focus has been on salmon, smelt and other ESA-listed or at-risk species utilizing the Delta or riverine habitats. Despite the significant ecological importance of the San Francisco Bay to this overall ecosystem, it has been largely ignored. As the single most important estuary on the west coasts of North and South America, the Bay supports numerous important fish and wildlife species that cannot be overlooked in CALFED's planning for ecosystem restoration and development of a secure water source for California's urban and agricultural uses. The Bay simply cannot be overlooked in the ecosystem restoration effort, nor can it be separated into its various geographic parts, with some targeted for restoration efforts and other parts ignored. It is a highly altered environment following 150 years of population growth and development, including early depositions of soils on the Bay floor from hydraulic mining, filling, diking, dredging, the accumulation of pollutants in sediments, the introduction of large numbers of non-native aquatic invasive species, and the reduction and change in fresh water inflow resulting from Delta and upstream water projects.

The species of the Bay, such as herring, native oysters, and Dungeness crab, which are either of historic or current economic importance have been largely overlooked by restoration efforts. These species depend on a healthy Bay environment and the demise of at least two – oysters and Dungeness crab are tied to the ecological health of San Francisco Bay.

For example, Dungeness crab populations, which utilize San Francisco Bay as a nursery area, are at population levels approximately ten percent of pre-1950's numbers in the Gulf of the Farallones area. There has been little recent research done on Dungeness crab in the Bay, excepting trawl surveys conducted by the California Department of Fish & Game monitoring populations of all fish species. While the ocean fishery for Dungeness crab is extensively regulated, there are no projects targeting the protection of the crab's habitats, much less any plans for restoration.

Only remnant populations of native oysters remain in San Francisco Bay, and only recently have oysters discovered in the Bay been identified as native stocks. This species most certainly would qualify as a species at risk, if not a candidate for listing under either

the federal or California Endangered Species Act (ESA). Some oyster research has been spearheaded recently by researchers from San Francisco State University, working with Save the Bay, under a RAE/NOAA Partnership Project where preliminary results indicate restoration may be feasible.

Herring have been extensively researched by the California Department of Fish & Game in the agency's spawning and biomass surveys conducted for the purpose of setting fishing quotas and developing fishery management measures. Additional research has been conducted on herring larval fate and transport by the University of California's Bodega Marine Laboratory as part of the environmental impacts studies regarding the proposed expansion of San Francisco International Airport. Funding for that research has ceased, however, following the events of September 11th. A potential limiting factor to herring production is the amount of spawning area. The existing areas commonly occur on creosote pilings or vessel bottoms, as opposed to natural materials like Eel Grass beds. As in the case with Dungeness crab and native oyster, there is to date no plan for the protection, other than fishing regulations, for herring or the protection and restoration of the Eel Grass habitats utilized by these fish.

Not only does the ecological health of San Francisco Bay affect native species utilizing its habitat, but the health of San Francisco Bay may, in fact, affect restoration efforts within the Delta and upstream. For example, juvenile salmon spend essential maturation time in estuaries prior to going to sea. The success of salmon recovery measures in the Delta and upstream may be limited, therefore, if attention is not also paid to the Bay conditions these fish will encounter prior to going to sea. The Bay could prove to be a significant limiting factor. Attention to the health of the Bay and the restoration focused on a representative group of species native to the Bay, such as what this project proposes, could effect the success of other CALFED restoration projects in the Delta and upstream.

Second, prior to the creation of plans for the protection and restoration of herring, native oyster, and Dungeness crab within San Francisco Bay, information will need to be developed. This will entail more than just a literature search. Some data is only now forthcoming from current research, such as herring larval transport and fate, and other data will need to be developed or further expanded upon. Obviously not every question regarding the three species can be answered prior to embarking on a protection and restoration plan, but additional data will be useful, if not absolutely essential to the design of plans for each of the three species.

Lastly is the problem of urgency. CALFED is considering new water storage and conveyance facilities that will further reduce the fresh water inflow to San Francisco Bay. Indeed, legislation is now before the Congress that would reduce freshwater inflows to the Bay. This is occurring at the same time that little is known regarding the effects of freshwater inflows on herring, oysters or Dungeness crabs within San Francisco Bay, or the desired salinity levels of these species during their various life stages. Without having this information, these species and other species native to the Bay may be put at further risk, and could threaten the success of any ecosystem restoration program for San Francisco Bay.

Moreover, imminent plans for extensive Bay filling for an expanded airport, significant new dredging as part of plans to accommodate new container ships, coupled with the lack of programs for the control or containment of invasive aquatic species, may each affect the Bay's herring, native oyster or Dungeness crab populations, as well as the health itself of the Bay's ecosystem. Development of plans for the protection and restoration of these species or to restore the Bay ecosystem cannot wait. Delay could well doom the Bay and its fish and shellfish stocks.

2. Justification

There currently exists no comprehensive plan for identifying the habitat needs, including freshwater inflow requirements, of herring, native oysters or Dungeness crab in San Francisco Bay. Nor is there any plan for the protection of these species, their habitats, or for their restoration. However, if the CALFED plan for ecosystem restoration is to be successful, it, of necessity, must address some of the more important native fish and shellfish species of San Francisco Bay, such as herring, oysters and Dungeness crab – examining the habitat needs, required protection and potential for restoration of these three species. Moreover, the success of some of the existing CALFED efforts at restoring salmon populations may be threatened if the estuarine life cycle of salmon (i.e., the time juveniles spend in the Bay prior to migrating to the ocean) is not considered.

The three species were selected because of: 1) their economic importance, either currently or historically; 2) they're representative of three different phyla – a vertebrate (herring), a mollusk (oyster) and an arthropod (crab); and 3) they share many of the same habitats and, are believed, to be affected by similar environmental factors, such as salinity, water quality, disturbance of bottom substrate, and predation/competition for habitat from non-native aquatic invasive species.

The information that will be needed for the creation of plans for protection and restoration herring, native oysters, and Dungeness crab is also clearly justified from a review of CALFED's Program Goals, including:

At Risk Species. With only remnant remaining populations, native oysters in San Francisco Bay are clearly at risk. Arguably, herring and Dungeness crab populations within the Bay will also be at risk from further water diversions absent a clear understanding of these species salinity tolerances during their various life stages and the influence of fresh water inflows on survival and population abundance.

Ecosystem Processes and Biotic Communities. Measures taken to protect and restore these three species native to San Francisco Bay will likely mean the restoration of ecosystem processes and the Bay's biotic communities. Moreover, the restoration on native oyster populations may help to enhance Bay water quality. Further, development of the information necessary for creating protection and restoration plans for herring, native oysters and Dungeness crab in San Francisco Bay is consistent with CALFED's Strategic Goal 2.

Harvestable Species. Herring and Dungeness crab are currently extensively harvested (see background information below). A large oyster fishery also existed in San Francisco Bay until the early years of the 20th century. Although it is uncertain whether an oyster fishery can be reestablished again in San Francisco Bay, due to concerns regarding contamination and parasites, there is little doubt the success of restoring the Bay ecosystem could be measured by the restoration of an oyster fishery in San Francisco Bay, marketing for human consumption these bivalves taken directly from the Bay's waters.

The background information on the three species indicates their importance and the basis for their selection for this project:

Pacific Herring and Herring Habitats. Pacific herring (*Clupea pallasii*) are marine fish that are environmentally and economically important to San Francisco Bay. Fertilization, embryonic development, larval stages and early juvenile life all take place within the confines of the Bay for the San Francisco Bay population. All life stages considered, Pacific herring are major contributors to the food webs of San Francisco Bay marine and estuarine environments. Adults and juveniles consume plankton and are preyed upon by predators including salmon, rockfish, lingcod, birds, and marine mammals. Larvae are planktivorous feeders and in turn are preyed upon by other planktivores. Spawn (developing embryos) is a food source for birds, crustaceans and sturgeon. In turn, herring are dependent upon the estuary (specifically low salinity water) for reproduction and recruitment to the population.

The commercial fishery for Pacific herring in San Francisco Bay is the last viable urban fishery on the West Coast of the United States and has recently ranked in the top three in California. A roe fishery, it targets the ovaries of adult females, but males and females are exported since the fishery is a take all fishery. The fishery is tightly regulated by the California Department of Fish & Game with annual catch quotas established through a formula that takes into consideration estimates of the previous years spawning population size and the size of the spawn itself.

Reproductive stocks and the fishery fluctuate greatly, but this is thought to be the result of natural tendencies in fluctuation and not due to urban or fishing pressure. The fact that the herring population is not considered to be in immediate danger (e.g. as are winter run Chinook salmon) does not mean that they are not ecologically threatened and that their existence into the future is guaranteed. There are several reasons to suggest that the stocks of herring will need help in the future. First, they constitute the southernmost eastern Pacific breeding population(s) and because of the climatic variability of the California coast, they are subjected to more environmental stresses than more northerly stocks. Second, herring have not received much attention by those groups empowered to reduce and reverse the decline of the San Francisco Bay Estuary, yet it is evident that there has been loss of spawning habitat due to urban based destruction of natural substrates. The loss of marine algae and plants coupled with siltation of rock or gravel areas is significant. Because of this reproductive displacement

herring routinely spawn on artificial structures, such as creosote pilings along the San Francisco waterfront, substrates on which herring embryos do not survive.

Native Oysters and Oyster Habitats. San Francisco Bay's native oyster (*Ostreola conchaphalia*), *Ostreola*, is a small but ecologically and potentially economically important oyster. Commercially, the species is the subject of a growing industry in the Pacific Northwest and Tomales Bay for smaller, more "tasty" oysters. Ecologically, larvae and adults are components of water column and bay substrate communities. Larvae spend up to two months in the plankton, thus providing a food source for plankton consuming organisms. Adults are plankton consumers themselves, living on rock, pebble or hard mud substrates of intertidal and near-shore subtidal regions of the bays and estuaries. *Ostreola* is important ecologically, in part because of the complex and diverse communities or other animals and plants that inhabit oyster beds. They are also excellent indicators of both water column and substrate toxicant loads in both substrates and in the water column because of their habitat preferences and feeding strategies.

Historically a plentiful species, native oysters were all but eliminated from San Francisco Bay during the late 1800s and early 1900s. Large oyster beds historically existed at the current airport site. Interestingly, the demise of the native oyster first coincided with the influx of humans into California during the gold rush period, but was not the result of over fishing. The demise of populations of native *Ostreola* throughout San Francisco Bay is thought to be the result of urbanization. This includes pollution from sewage and chemicals in the Bay, air pollution, freshwater diversion, channeling and siltation of bay tidal lands, and encroachment of near shore and intertidal zones by development. Native populations of *Ostreola* are now purported to exist in isolated pockets at a number of sites within the Bay (see *SF Chronicle* Jan, 1999). The recent discovery of remnant populations of native oysters indicates that water quality improvements may have been successful. Restoration of naturally sustaining populations in San Francisco Bay would signify that important components of the Bay environment, intertidal and shallow subtidal habitats, are ecologically healthy. Furthermore, re-establishment of oysters in the Bay would provide an important element to maintaining overall estuarine diversity and health.

Dungeness Crab and Dungeness Crab Habitats. California's commercial fishing industry began around 1848 in San Francisco Bay and by the early 1860's Dungeness crab landings were being made at Fisherman's (then- Meigg's) Wharf. Until 1945, most of California's crab production occurred off the central California coast, mostly in San Francisco and the two ports to the north and south, each bordering what is considered the Gulf of the Farallones, Bodega Bay and Half Moon Bay.

Commercial landings of Dungeness crab along the Pacific Coast have fluctuated in a cyclic manner since the 1940's. A 9-10 year cycle has been observed. Landings in northern California have continued this cyclic pattern, but those in central California did not rebound in the early 1960's and have continued since then at unprecedented low levels. Following peak landings in central California of nearly 10 million pounds in

1956-57, landings for this area, roughly Half Moon Bay to Bodega Bay (the area within the Gulf of the Farallones) have ranged from one-half to one and a half million pounds annually.

Larval and juvenile Dungeness crabs are known to utilize San Francisco and San Pablo Bays. Long-time commercial fishermen reported large numbers of undersized Dungeness crab in many areas of San Francisco Bay (e.g., near the western footings of the Bay Bridge) that have disappeared since the early 1960's. San Francisco Bay has been an important nursery area for Dungeness crab and its recruits are necessary for a sustained central California fishery, however, changes in the Bay's ecology, including the reduction in freshwater inflows, and the presence of exotic invasives, such as green crab (*Carcinides maenas*) affect Dungeness Bay populations. Based on surveys done by the California Department of Fish & Game, it is also believed that the San Pablo Bay wetlands are extremely important crab habitats.

Although the proponents of this project feel there is justification (economy, overlapping habitats, etc.) for combining the three species for the purposes of developing the information necessary for creating plans for protection and restoration, it should be made clear they do not believe, nor are they proposing here that these species be combined in such plans. Rather, each species should have its own plan for protection and restoration as part of a larger program for the protection and restoration of San Francisco Bay's ecosystem.

3. Approach

This project has been divided up into two years, with the first focused on field research and the second focused on data analysis. The second year will also be used to complete any outstanding field research from the first year.

1.0 Project Management

2.0 Literature Search

3.0 Herring

There is a current research project for which there will be monitoring Richardson Bay during and after herring spawning events (funded by the City of San Francisco) Data was collected last year and will continue this upcoming season (Jan-Mar, 2002). The objectives are to determine larval fate beginning with pre-hatch embryonic development through the first two weeks of post-hatch larval life. Lab studies will be conducted to determine the salinity and temperature (important environmental variables to herring early life stages) tolerances of larvae as well as document those and other physical parameters of Richardson Bay important in both time and space to herring larvae.

Tasks

- 3.1 **Physical Measurements:** Define conditions (including salinity profiles) in Richardson Bay that support herring embryonic and larval development

Physical parameters

1. Salinity – **YSI ENVIRONMENTAL MONITORING SYSTEM**
2. Temperature - **YSI ENVIRONMENTAL MONITORING SYSTEM**
3. Tidal changes
4. Water-current patterns **ACOUSTIC DOPPLER CURRENT PROFILERS (ADCP)**

Water current patterns should be determined for

- a. Incoming and outgoing tidal cycles
- b. Spring and neap tidal cycles
- c. Seasonal patterns, e.g. During high and low freshwater input from Delta.

- 3.2 **Biological Surveys:** Document the salinity tolerances of embryos and larvae, and the sub-lethal effects of salinity stress on these life stages

Monitor the movement of larvae in and around Richardson Bay. Emphasis will be on physical parameters (e.g. temperature, salinity, water currents, classes of toxicants present) deemed to be important to the habitats and the biological communities that support Pacific herring embryos, larvae and juveniles. Previous research have shown that both salinity and temperature affect embryos and larvae; even though they are considered euryhaline, embryos and larvae of fish from San Francisco Bay do not survive well outside of the salinity range of 12-24 parts per thousand and temperatures above about 16°C.

Biological parameters

1. Overall chlorophyll - **YSI ENVIRONMENTAL MONITORING SYSTEM**
2. Eelgrass bed mapping – **LOW TIDE AERIAL PHOTOGRAPHY AND SCUBA DIVER SURVEYS**
3. Plankton species and abundances, both invertebrate (e.g. crab & oyster larvae as well as planktonic predators and prey of these larvae) and vertebrate (e.g. fish larvae, like herring). - **PLANKTON TOWS BOTH BOAT AND SHORE BASED**
4. Macro-invertebrate assemblages – **TRAWLS, GRAB SAMPLERS, AND SCUBA DIVER SURVEYS**
5. Vertebrate assemblages (fish, birds, marine mammals) – **TRAWLS, BOAT AND LAND BASED OBSERVATIONS**

Chlorophyll – Continuous with chlorophyll detector on YSI unit

Plankton and invertebrate samplings – once per month, once a week during times of hydrographic changes (seasonal changes in salinity & temp)

4.0 Oysters

The purpose of this work is to restore a key ecological component, native oysters, to the Bay Region of the San Francisco Bay-Delta Ecosystem. This species can have a

disproportionate influence on important ecosystem processes such as primary productivity (by filter feeding on phytoplankton), invasive species control (by competition for space and filtering larvae), water quality (filtering and sequestering sediment in faeces and pseudofaeces), and trophic dynamics (prey to fish, birds, crabs, and snails).

Preliminary pilot studies have been done (literature review by Griffin and Cherr 2001) and are underway (Save the Bay's pilot oyster recruitment monitoring and SFSU's experimental oyster culture facility). The objectives of this study are to further assess and quantify factors limiting the recovery of native oyster populations and to prepare a restoration plan to address these factors as part of CalFed's overall Ecosystem Restoration Plan.

Tasks and Rationale:

4.1 Survey: Survey current intertidal and subtidal distribution of native oysters south of Carquinez Straits. Anecdotal evidence from incidental observations and limited personal searches has found several sparse populations extant in widely separated areas from at least China Camp to Coyote Point on both the east and west shorelines of the bay. Knowledge of the current distribution and abundance is essential to characterize the habitat where they now occur in terms of potentially limiting factors such as water quality, sediment/substrate type, and presence of predators.

4.2 Measure Water Quality: Measure water quality, sediment properties, and quantify potential predators such as green crabs and oyster drills, and potential competitors such as fouling organisms at sites where native oysters are found to perform regression analyses as a first-cut approach to ranking the relative importance of these factors.

4.3 Analyze Data: Analyze existing IEP databases to characterize the distribution of oysters found in Task 1 with known factors such as salinity tolerance ranges and presence and abundance of known predators such as bat rays.

4.4 Synthesize Data: Synthesize the observational data with the results of database analysis to prepare a restoration plan consistent with CalFed objectives, ongoing restoration activities, and feasible actions.

5.0 Dungeness Crab:

The last comprehensive study on Dungeness crab was done from 1975 to 1980 (Tasto 1983) and this project hopes to repeat some the aspects of those studies.

5.1: Stock Identification: This includes sampling and determining possible genetic variation of stocks.

5.2: Distribution Larvae: Distribution and relative abundance of Dungeness crab larvae and associated zooplankters. This will include temperature and salinity measurements.

5.3 Distribution of Juveniles: Distribution, relative abundance, growth rates, and food habits of juvenile crabs, and the importance of San Francisco Bay as a nursery ground.

5.4 Predation: Study predators and their effects on the crabs.

6.0 Data Analysis

System coverages: System coverage is defined as the steps required to acquire, evaluate, incorporate, and maintain data elements (data tables, charts, photographic, GIS data layers and bibliographic materials) in the KRIS custom database and provide the training to maintain the system.

Kier associates will develop coverages for the three species. The process will require the acquisition, evaluation, standardization and tacking of data elements. Data acquisition will be based on information gathered in the proceeding tasks, including the literature search and the surveys of the three species. Data evaluation will involve the assessment of the data and the suitability and readiness of the data acquired. The next step is to standardize and incorporate the data elements into the Project database in the form of KRIS topics, maps, reports, manuals, relevant regulation, key correspondence and other bibliographic material. Following these steps there will be a review process where peer reviewers will review and approve the Program.

7.0 Community Outreach

Save The Bay will employ several strategies to promote the extension of their overall Community Based Restoration program through this project by training and educating volunteers, students, and teachers to restore shoreline, wetland, and creek habitats.

Volunteer and teacher training workshops on Saturdays: Save The Bay will host teacher and volunteer training workshops to train and educate program leaders in the goals of this project and to train in aiding the collection of data. The workshops will encompass a full Saturday, and will include both educational and hands-on restoration components. The workshops will focus on the background and goals of the CBR Program to help increase investment and commitment in the program. Teachers and volunteers can then become leaders and outreach agents in this restoration project. Each workshop will include speakers, resource materials, and field components that focus on native habitats, species, and the need for habitat restoration around the Bay.

8.0 Legal and Regulatory Review

1. Review biological and physical information developed and prepare draft list of recommendations for: a) the elements of a protection and restoration plan for each species, including the habitats; and b) the elements of on-going monitoring systems necessary for adaptive management and measuring effectiveness of plans.
2. Review policy and regulatory information and analysis developed and prepare draft of recommendations: a) identifying those policies that will favor protection

and restoration and those that may impede or conflict with species or habitat protection and restoration; b) identifying those permits required for the undertaking of species and habitat restoration; and c) identify any legislative or regulatory action that may be necessary to change policies or permitting requirements to facilitate protection and restoration measures.

3. Following review of drafts, prepare final set of recommendations, incorporating both physical and biological, and policy and regulatory aspects, necessary for protection and restoration plans

4. Feasibility

The tasks to achieve the objectives of this project are highly feasible within the allotted time. Our collection procedures can be followed throughout the year allowing for variability of mild weather conditions in the San Francisco Bay. The procedures are not untried, all procedures have been used previous to this project. Researchers are continuing data collection already begun or replicating proven procedures of earlier scientists. We are scheduled to complete field research with the first year and data analyses through the second year. This is a generous time frame for data analyses and recommendation formulation. If need be, surveying can be continued through the second year with the project completed on time and within budget.

Our proposal does not include any physical actions nor does it require permission to access property.

Permits needed for data collection (herring embryos and larvae, eelgrass, native oysters) from the California Department of Fish & Game are in hand. Additional permits may be required of for any additional people doing the collecting, divers, boat handlers, field people, etc.

5. Performance Measures

Because this project is intended principally to develop the information that will be needed for the creation of future plans for the protection and restoration of these three species, the specific measure of performance will simply be whether or not the information was produced. If it was not, then an explanation will be required with an outline of what additional research would be required to develop that information. This situation would be expected to occur only perhaps in the event some of the fieldwork could not be conducted or the results were inconclusive. The products from this project, in addition to the resource information system, will include a report with recommendations. Within the recommendations, will be those for the creation of a monitoring/evaluation system for the protection and restoration plans. This will be an integral part of the recommendation package and essential for, among other things, adaptive management measures and a means of measuring a plan's performance. For the purpose of this project, however, performance will be measured in terms of delivering the products promised, following their review.

6.Data Handling and Storage:

Kier Associates will serve as the repository for all information gathered from the various collection teams. Kier Associates shall provide an organized and easily accessible computer based collection of available technical information using the Klamath Resource Information System (KRIS) software program. Elements of this Program shall be developed in coordination with CALFED, the National Marine Fisheries Service (NMFS), the California Department of Fish & Game (CDFG).

The Program shall assemble relevant data including reports, studies, datasets, and GIS layers and will develop KRIS software coverage for the San Francisco Bay area. Training on and the submittal of a maintenance plan to update the resultant Program will be included in this project.

IFR and our collaborators will conduct studies to develop the most efficient and economical long-term solutions to the restoration and protection of herring, native oysters and Dungeness crabs in the San Francisco Bay. The studies, data analyses and recommendations will be completed in two years. The results of the studies will be used to implement reasonably foreseeable future restoration programs as funds are made available to establish a long-term restoration plan for the San Francisco Bay. Reports and data will be submitted to CALFED in hard copy and in an electronic format compatible with CALFED systems.

7.Expected Products/Outcomes:

Deliverables:

At the end or before the two-year project schedule, our team will deliver:

- (1) A thorough compilation of all pertinent data in the form of an organized and easily accessible computer based collection of all available technical information using the Klamath Resource Information System (KRIS) software program. With training on and the submittal of a maintenance plan to update the resultant Program to be included in this project
- (2) Recommendations for the creation of:
 - (a) A protection and restoration plan for each of the three species
 - (b) A monitoring plan required to continue data collection as necessary for a successful plan for protection and restoration (eg salinity and temperature) to help fulfill management objectives.

B.APPLICABILITY TO CALFED ERP AND SCIENCE PROGRAM GOALS AND IMPLEMENTATION PLAN AND CVPIA PRIORITIES:

This project can be defined as a targeted research project that is seeking to provide and compile critical base-line information to aid in the formation of a long-term restoration program for Pacific herring, native oyster, and Dungeness crab. This project constitutes the targeted research that is necessary for coordinated pilot projects such as the Native Oyster Restoration and Community Based Restoration Projects of Save the Bay. It is in keeping with all of the CALFED Science Program Goals.

Goal 1 – At Risk Species and the CVPIA priority BR-8 to use monitoring, evaluations of existing monitoring data and new investigations to develop improved strategies for restoring Bay fish populations and at-risk species. The uncertainty surrounding the reasons why species such as Pacific herring, native oysters and Dungeness crab are in decline in the San Francisco Bay need to be addressed. This project is a big step towards improving our understanding of these species and their habitats – which is needed in order to lay down the framework for a comprehensive restoration program and to set forth recommendations for policy changes to improve population health. Non-native predators and competitors, diseases, lack of appropriate substrate, water quality, changes in larval-retention circulation patterns, and critically low population size are among the likely limiting factors. These factors can be addressed to different degrees in a restoration program but restoration will be most efficiently accomplished if the different factors can be quantified or at least ranked so actions can be rationally prioritized.

Goal 2 – Ecosystem Processes and Biotic Communities - all the species in this project are native to the San Francisco Bay area. We are looking to improve the overall health of the Bay by learning more of the native species to tailor a restoration program to improve the health and increase the presence of these native populations. These species, particularly the native oyster population can have a disproportionate influence on important ecosystem processes such as primary productivity (by filter feeding on phytoplankton), invasive species control (by competition for space and filtering larvae), water quality (filtering and sequestering sediment in faeces and pseudofaeces), and trophic dynamics (prey to fish, birds, crabs, and snails). We will be monitoring the X2 relationships for these species at various life stages to begin to determine and analyze the relationships with fresh water inflow in keeping with the CVPIA priority BR-7.

Goal 3 – Harvestable Species - all three species hold economic value. Presently herring are commercially harvested in the Bay but a recent precipitous decline in the local Pacific herring population has been apparent. Dungeness crab are also commercially harvested at present though no longer in the Bay as they were historically. However, it is of particular importance that large Dungeness crab nursery areas fall within the Bay. Native oysters are presently too low in abundance for harvest. Historic numbers show that present day populations of all three species have declined. The maintenance, improvement and/or restoration of these animals would greatly benefit the future commercial fishing industry.

Goal 4 – Habitats - in this project we seek to identify and map herring, oyster and crab habitat as thoroughly as is possible. This mapping will prove to be very valuable in evaluating areas of the Bay that are essential fish habitat (EFH) for these species in future restoration plans and policies. This includes recording GPS coordinates for use in GIS databases. Oyster beds **are in and of themselves** reef habitats for self-sustaining biotic communities. Of particular note is the fact that it has been shown that several juvenile fish species have benefitted from the restoration of this habitat in the Chesapeake Bay.

Goal 5 – Non-native Invasive Species - Globally nonindigenous species have caused significant negative impacts to various commercial interests and native populations. This is especially true in the San Francisco Bay. The introduction of nonindigenous aquatic species into the San Francisco Bay has resulted in the large scale disruption of established food webs and subsequent loss or decline of native aquatic species at all trophic levels. This is apparent in the native oyster population and also the Dungeness crab population in the Bay may be bowing under the competitive pressures and predation of animals such as the exotic green crab and the oyster drill. Successful colonization and expansion of introduced (intentional and unintentional) organisms usually result from the availability of unoccupied niches (habitat) and the introduced organisms opportunistic life history patterns. In general, these species are described as “weedy” because of their ability to exploit disturbed habitats where the presence of a stable native community would otherwise preclude colonization. So steps towards the restoration and enhancement of these species may very well reverse the current proliferation in non-indigenous species and inhibit or prevent additional colonizations. This project is therefore in keeping with CVPIA priority BR-6 as well.

Goal 6 – Sediment and water quality – At least one of the species we target in this proposal plays a role in the improvement of water quality in the Bay, the native oyster. Our project recognizes the need to restore the ecological role that oysters play as filter feeders, transferring phytoplankton and other suspended solids from the water column into the sediments, enabling nutrient transfer and increased water clarity.

5. System-Wide Ecosystem Benefits

The information generated from this project provides resource managers with empirically based knowledge for decision making.

C. QUALIFICATIONS

The Institute for Fisheries Resources (IFR) will be taking the lead in this collaborative effort with Kier Associates (KA) UC Davis Bodega Bay Marine Laboratory (UCD-BML) and Save the San Francisco Bay - working together in a joint venture partnership under the guidance of IFR. IFR was established as a non-profit 501(c)(3) organization in 1992 by the Pacific Coast Federation of Fishermen’s Associations (PCFFA). IFR works as a fisheries conservation organization to help protect marine and anadromous biological resources. The mission of IFR is to support working fishing men and women in their united goal to sustain fisheries and their associated fishing communities and economies. Our efforts include protection, restoration, and enhancement of the public’s marine and

anadromous species and their habitats. We seek to accomplish this mission through research, advocacy, education, and hands-on restoration. What makes us different from other environmental organizations is that the impetus behind our work is the fishing communities themselves, specifically the fishing men and women who sit on our board of directors and represent fishermen throughout the U.S. Pacific Coast. They realize that unless habitat is restored and protected and fish stocks are rebuilt and harvested in a sustainable manner that the way of life they treasure cannot continue. The operations of IFR are headquartered in San Francisco with an additional office housed in Eugene, Oregon focusing its resources on the Northwest Pacific region. Our offices are manned by 3.5 full-time staff and additionally supplemented by two full-time Americorps members.

Bill Kier (Kier Associates)

Bill Kier will serve as the project manager for this project. Bill is the founder of Kier Associates, fisheries and watershed professionals. The firm is headquartered in the San Francisco Bay Area and has offices throughout the Pacific Northwest. Mr. Kier began his career as a fisheries scientist with the California Department of Fish and Game conducting life history studies of San Francisco Bay and Delta fishes. He has served as chief of Fish and Game's environmental services division, as assistant Secretary of the Resources Agency of California, as principal consultant to the California State Senate on natural resources management and environmental protection, and as director of the Senate's office of research and policy development.

Bill is a certified fisheries scientist, a member of the American Institute of Fishery Research Biologists, and of the American Society for Photogrammetry and Remote Sensing.

William 'Zeke' Grader (Institute for Fisheries Resources)

Zeke Grader will serve as a coinvestigator on this project. Zeke joined Pacific Coast Federation of Fishermen's Associations (PCFFA) as the Executive Director in 1976, creating the west coast's largest commercial fishing trade organization that, through its member organizations, represents fishing men and women who are owner/operators of their vessels or crew – commonly referred to as the “family fishermen.” Since 1992, Grader has also served as Executive Director of the Institute for Fisheries Resources, a non-profit, non-governmental organization begun by PCFFA dedicated to the promotion of sustainable fisheries. At PCFFA, Grader has been responsible for drafting legislation and working on regulations aimed at assuring sustainable fisheries, including measures to protect against overfishing, decreasing bycatch, rebuilding depleted fish stocks and protecting and restoring fish habitats. He has served as the president of the western region of the old National Federation of Fishermen and the West Coast Fisheries Development Foundation, and he currently serves on the board of directors of the Marine Fish Conservation Network. As a result of his work promoting sustainable fisheries and the protection of habitat, Grader has been the recipient of numerous commendations and awards, including the 1998 U.S. Department of Commerce's “Environmental Hero Award.”

Natasha Benjamin (Institute for Fisheries Resources)

Natasha Benjamin will assist in project coordination. Natasha is the Fisheries Program Officer for the Institute for Fisheries Resources. Her main focus is developing projects promoting sustainable fisheries, watershed resource information systems, San Francisco Bay restoration, and seafood consumer issues. Natasha is also the Editor of a weekly electronic newsletter, *Sublegals*, which features current local and international fishery issues, and has over 4000 subscribers. She is also the Executive Coordinator of the Golden Gate Biosphere Reserve Association organizing projects in protecting and maintaining the ecological and cultural integrity of the central California coastal bioregion. Natasha has an undergraduate degree in Marine Biology from Boston University and conducted research at the Woods Hole Marine Biological Laboratory. In 2000, she completed her Masters work in Marine Affairs and Policy focusing on fisheries policy from the University of Miami's Rosentiel School of Marine and Atmospheric Sciences.

Allison Vogt (Institute for Fisheries Resources)

Allison Vogt of the Institute for Fisheries Resources (IFR) will conduct the literature review of existing research on the herring, oyster, and crab populations and habitats within San Francisco Bay. She holds a B.S from the University of Notre Dame in Biology and Environmental Sciences and has recently joined the IFR staff after completing two years of service with the AmeriCorps Watershed Stewards Project.

Dr. Jan Derksen (Kier Associates)

Dr. Jan Derksen is the programmer who originally developed the KRIS software and is also a capable GIS analyst. Dr. Derksen has assembled and supervised electronic mapping projects for Kier Associates on several past projects. He has strong skills in ArcInfo, ArcView, Spatial Analyst and Image Analyst. He formerly taught database management in Humboldt State University for 15 years and has conducted KRIS trainings. Jan will integrate and handle final production of the Program and design the training and maintenance plans.

Patrick Higgins (Kier Associates)

Patrick Higgins is a fisheries biologist with extensive experience in salmon and steelhead conservation and restoration. He has written fisheries elements for a number of restoration places for a number of California rivers. Pat was the lead author of a report characterizing the risk of extinction of Pacific salmon stocks in northwestern California published by the Humboldt Chapter of the American Fisheries Society. He has helped implement monitoring programs by restoration groups in the Klamath and Eel River basins. Pat is a principal investigator in all KRIS projects and helps focus analyses to answer questions on resource conditions. Pat has been trained in the use of ArcView. He has conducted dozens of presentations and trainings for KRIS projects. Kris will aid in the overseeing of information acquisition, organization of peer review, helping to build the Kris system and in the organization and carrying out trainings.

Gary Cherr, Ph.D. (UC Davis Bodega Bay Marine Laboratory)

Dr. Gary N. Cherr of the University of California Davis Bodega Marine Lab (BML) will direct the further studies of the abiotic and biotic requirements of native oysters and herring in the Bay. He received his Ph.D. in Zoology from the University of California, Davis in 1984 and is currently on the faculties of both the BML and Sonoma State University. His areas of specialization include the biochemistry and cell biology of environmental stress as well as environmental toxicology. Current projects include an investigation into the identification and evaluation of environmental stressors and methods to reduce mortalities of the Pacific Oyster, *Crassostrea gigas*. Cherr is also the principal investigator for a project funded by the US Environmental Protection Agency as part of the Biological Responses to Contaminants Component of the Western Center for Estuarine Ecosystem Indicator Research.

Fred Griffin, Ph.D. (UC Davis Bodega Bay Marine Laboratory)

Dr. Fred Griffin of the University of California Davis Bodega Marine Lab (BML) will coordinate the biological and habitat studies of native oysters and herring. He received his Ph.D. in Zoology from the University of California, Davis in 1987 in Zoology and is currently an Assistant Research Biologist IV at the BML and on the faculty of Sonoma State University. His research interests include the developmental biology of aquatic organisms as well as the effects of environmental stressors and toxicants on developmental stages of aquatic organisms. Recent studies include investigations on the effects of environmental toxins, such as creosote, on herring development.

Michael F. McGowan, Ph.D (San Francisco State University)

Dr. Michael F. McGowan, of the Romberg Tiburon Center for Environmental Studies (RTC) will lead the oyster research as the Senior Fisheries Ecologist. He received his Ph.D. in Biological Oceanography from the University of Miami where he also conducted his Postdoctoral research in Fisheries Oceanography. Currently McGowan is a Senior Research Scientist at the RTCES as well as an Adjunct Professor of Biology at San Francisco State University. His research interests include basic and applied research emphasizing fishes and their environment in addition to quantitative assessments and objective criteria for ecological restoration. Recent projects in San Francisco Bay include an investigation of habitat restoration through native oyster enhancement funded by the Save San Francisco Bay Association as well as fish surveys of the main body and South San Francisco Bay.

Marilyn Latta (Save the Bay)

Marilyn Latta is the Community Restoration Specialist at Save the Bay. She will guide the extension of Save the Bay's Community Based Restoration (CBR) Program through this project. The CBR will aid in the collection of data needed to determine the status and distribution of herring, native oyster and Dungeness crabs in the San Francisco Bay. Save The Bay's Community-Based Restoration Program forms partnerships between Save The Bay, local middle and high schools, community groups, corporate sponsors, and resource agencies to increase support for and participation in the protection and restoration of creeks and wetlands throughout the San Francisco Bay Area.

F. Compliance with Standard Terms and Conditions

The Institute for Fisheries Resources agrees to comply with the State and Federal terms and conditions of the provisions necessary to conduct its program under the CALFED process.

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