Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

Project Information

1. **Proposal Title:**

   Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

2. **Proposal applicants:**

   Michael Napolitano, San Francisco Bay Regional Water Quality Control Board
   Bruce Orr, Stillwater Sciences
   William Dietrich, UC-Berkeley

3. **Corresponding Contact Person:**

   Michael Napolitano
   San Francisco Bay Regional Water Quality Control Board
   1515 Clay Street, Suite 1400 Oakland, CA 94612
   510 622-2300
   MBN@rbs.swrcb.ca.gov

4. **Project Keywords:**

   At-risk species, fish
   Turbidity and sedimentation
   Watershed Management

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:**

   State Agency

9. **Location - GIS coordinates:**

Latitude: 38.402

Longitude: -122.360

Datum: NAD83

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

The Napa River is located approximately 50 miles north of San Francisco. The river drains into San Pablo Bay, near the mouth of the Sacramento-San Joaquin estuary.

10. **Location - Ecozone:**

    2.2 Napa River

11. **Location - County:**

    Napa

12. **Location - City:**

    Does your project fall within a city jurisdiction?

    Yes

    If yes, please list the city: Calistoga, Saint Helena, Napa

13. **Location - Tribal Lands:**

    Does your project fall on or adjacent to tribal lands?

    No

14. **Location - Congressional District:**

    1

15. **Location:**

    California State Senate District Number: 2

    California Assembly District Number: 7

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: 0

Total Requested Funds: $994,958

b) Do you have cost share partners already identified?

Yes

If yes, list partners and amount contributed by each:

San Francisco Bay RWQCB **in-kind contributions estimated at $96,000**

c) Do you have potential cost share partners?

Yes

If yes, list partners and amount contributed by each:

Napa County Resource Conservation District	**data and private property access agreements**
CA Department of Fish and Game	**habitat surveys, data, peer review**

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?

Yes

If yes, identify project number(s), title(s) and CALFED program.

Proposal #119	**Napa River Watershed Mapping Partnership**	**CALFED Watershed Program**

98E-09	**Merced River Corridor Restoration Plan-Phase II**	**ERP**

2000 E-05	**Merced River Corridor Restoration Project-Phase III**	**ERP**

99-B152	**A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin**	**ERP**

Service Agreement #010801	**Tuolumne River Coarse Sediment Management Plan**	**CALFED Service Agreement**

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?

    Yes

    If yes, identify project number(s), title(s) and CVPIA program.

99173	**Merced River Corridor Restoration Plan-Phase I**	**AFRP**

CVPIA 11332-9-MO79	**Merced River: Ratzlaff Project**	**AFRP**

CVPIA 11332-9-MO80	**Stanislaus River: 2 Mile Bar**	**AFRP**

CVPIA 11332-0-MO09	**Stanislaus River: Smolt Survival**	**AFRP**

CVPIA 11332-1-GO06	**Calaveras Salmonid Limiting Factors Study**	**AFRP**

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.

9-124-120-0	**Napa River Phase 1 TMDL Study**	**RWQCB**

2001-03	**Northern Napa River Tributaries Salmonid Habitat Study**	**Napa County RCD**
00-014	**Napa River Salmonid Habitat Protection**	**CA Coastal Conservancy**

Please list suggested reviewers for your proposal. (optional)

Russ Henley	**CA Department of Forestry**	**(916)227-2659**	**Russ_Henly@fire.ca.gov**
Joe Dillon	**US National Marine Fisheries Service**	**(707)578-3435**	**Joseph.J.Dillon@noaa.gov**
Ken Cummins	**California Cooperative Fish Research Unit**	**(707) 826-3268**	**kenwcummins@aol.com**
Darren Fong	**US National Park Service**	**(415)331-8716**	**darren_fong@nps.gov**

21. **Comments:**

Environmental Compliance Checklist

<u>Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration</u>

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.

      All work proposed in this project involves only benign field data collection. As such, it is not subject to CEQA or NEPA permit requirements.

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

   <u>CEQA Lead Agency:</u>
   <u>NEPA Lead Agency (or co-lead:)</u>
   <u>NEPA Co-Lead Agency (if applicable):</u>

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?

      None

   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 Required, Obtained

Rivers and Harbors Act

CWA 404

Other

PERMISSION TO ACCESS PROPERTY

Permission to access city, county or other local agency land. Agency Name: City of Napa, Napa County, Napa Sanitation District, Napa County RCD	Required, Obtained
Permission to access state land. Agency Name: CA Department of Parks and Recreation, CA Department of Fish and Game, CA Department of Forestry, Napa County Community College	Required, Obtained
Permission to access federal land. Agency Name:	
Permission to access private land. Landowner Name: Land Trust of Napa County, Ray/Mauvais Carreon, George Henke, Lamoreaux Family, Hsieh/Hansen Vineyards, Saintsbury Vineyards, Lee Hudson, Sterling Vineyards, Beringer Wine Estates, Red Wing Vineyards, Honig Vineyard and Winery, Emmolo Vineyards, Frogs Leap Vineyard, Beckstoffer Vineyards, Volker Eisele, Knoxville Associates, Diane Miller, Chardonnay Golf Club, Nancy Dollar Estate, Flying L Ranch, John Tutuer, Green Valley Ranch, Elizabeth Case Williamson, Bob and Cathy Burke, Susan Card, David Garden, Cain Cellars, John Kelly, Michael Marston, Peter Mennen, Spottswoode Vineyard and Winery, Allan Nichol, Jim and Sandra Perry, Diana Stockton, White Sulfur Springs Resort, Bahns and Judith Stanley, Eric Titus, and Karen Rippey	Required, Obtained

6. **Comments.**

Land Use Checklist

Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

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

   No

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

   Yes

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

   No

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

   research only

4. **Comments.**

Conflict of Interest Checklist

Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

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):

Michael Napolitano, San Francisco Bay Regional Water Quality Control Board
Bruce Orr, Stillwater Sciences
William Dietrich, UC-Berkeley

Subcontractor(s):

Are specific subcontractors identified in this proposal? Yes

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

Robin Grossinger SFEI

Helped with proposal development:

Are there persons who helped with proposal development?

No

Comments:

Budget Summary

Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

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**	
1a	Sediment source assessment						64017			64017.0		64017.00	
1b	LWD Assessment									0.0		0.00	
1c	Physical barriers to fish passage									0.0		0.00	
1d	Baseflow reduction and hydrograph change						96350			96350.0		96350.00	
1e	Temperature monitoring and modeling						55494			55494.0		55494.00	
1f	Analysis of historical channel conditions and channel changes						74907			74907.0		74907.00	
2a1	Fish Monitoring						6930			6930.0		6930.00	
2a2	Predation rate study						51060			51060.0		51060.00	
2a3	Changes in estuary rearing habitat						24900			24900.0		24900.00	
2a4	Historical salmonid distribution and abundance						20306			20306.0		20306.00	
2b	Steelhead growth study						115350			115350.0		115350.00	
2c	Chinook salmon redd scour						28033			28033.0		28033.00	

2d	California freshwater shrimp						46131			46131.0		46131.00
3	Population dynamics analysis						25825			25825.0		25825.00
4	Report production and outreach						40046			40046.0		40046.00
5	Project management						29824			29824.0		29824.00
		0	0.00	0.00	0.00	0.00	679173.00	0.00	0.00	679173.00	0.00	679173.00

Year 2													
Task No.	**Task Description**	**Direct Labor Hours**	**Salary *(per year)***	**Benefits *(per year)***	**Travel**	**Supplies & Expendables**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
1a	Sediment source assessment						34470			34470.0		34470.00
1b	LWD Assessment									0.0		0.00
1c	Physical barriers to fish passage									0.0		0.00
1d	Baseflow reduction and hydrograph change						51881			51881.0		51881.00
1e	Temperature monitoring and modeling						29881			29881.0		29881.00
1f	Analysis of historical channel conditions and channel changes									0.0		0.00
2a1	Fish Monitoring									0.0		0.00
2a2	Predation rate study						17020			17020.0		17020.00
2a3										0.0		0.00
2a4										0.0		0.00
2b							44365			44365.0		44365.00
2c							13082			13082.0		13082.00
2d							21528			21528.0		21528.00
3							25825			25825.0		25825.00
4							40046			40046.0		40046.00
5							29824			29824.0		29824.00
		0	0.00	0.00	0.00	0.00	307922.00	0.00	0.00	307922.00	0.00	307922.00

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=987095.00

Comments.

All costs are included under "Services or Consultants" as Regional Board will not be billing CALFED for direct labor and costs.

Budget Justification

Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

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

No direct Regional Board staff labor hours are included in the requested funds from CALFED. Regional Board labor hours will be internally funded. Subcontractor labor hours are included in the subcontractor budget summary attachment to the proposal package

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

No Regional Board staff salaries are included in the requested funds from CALFED. Regional Board staff salaries will be internally funded. Subcontractor salaries are included in the subcontractor budget summary attachment to the proposal package.

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

No Regional Board staff benefits are included in the requested funds from CALFED. Regional Board staff benefits will be internally funded. Subcontractor benefits are included in the subcontractor budget summary attachment to the proposal package

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

No Regional Board travel costs are included in the requested funds from CALFED. Regional Board travel costs will be internally funded. Subcontractor travel is from the Bay Area to the Napa River, and includes the cost of mileage, lodging and meals. Subcontract travel costs are included in the subcontractor budget summary attachment to the proposal package.

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

Supplies are included in the subcontractor budget summary attachment to the proposal package

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.

Stillwater Sciences and San Francisco Estuary Institute are the primary subcontractors. No year estimates were provided, as this was a bid based on tasks. The subconsultant budget summary attachment describes the services to be provided by subconsultants.

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.

New equipment will be not be purchased for the project

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

Regional Board project management will be internally funded. Subconsultant project management is specified in Task 5 and is included in the subconsultant budget summary attachment to the proposal package. Coordination with subconsultants, data management, supply procurement, and project administration are the principal project management activities in the proposed project and are estimated to require $59,648.

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

Other Regional Board direct costs are not included in the requested funds from CALFED. Other Regional Board direct costs will be internally funded. Other subcontractor direct costs are included in the subcontractor budget summary attachment to the proposal package and include costs associated with computer systems and networks.

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.

Regional Board indirect costs are not included in the requested funds from CALFED. Regional Board indirect costs will be internally funded. Subcontractor indirect costs are included in the subcontractor budget summary attachment to the proposal package. Subcontractor indirect costs include office expenses (rent, utilities, telephones, computer supplies, data connectivity, etc.), office staff, insurance, legal and accounting costs, proposal expenses and depreciation for capital items such as furniture and office equipment.

Executive Summary

Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

Napa River watershed is an area of special biological significance, supporting a community of seventeen native fishes. Historically, the Napa River was estimated to support a run of 2,000-4,000 coho salmon and 6,000-8,000 steelhead trout. By late the 1960s, however, coho salmon had been extirpated, and the present-day run of steelhead is believed to be less than a few hundred adults. Chinook salmon have also suffered severe declines. California freshwater shrimp are federally listed as endangered and are currently restricted to the Napa River watershed and a few others in the North Bay and coastal Marin and Sonoma counties. Current and historical land and water use practices in Napa River watershed have altered physical processes that shape quality, abundance, and connection of suitable habitat for salmonids and other native aquatic species. The proposed project is Phase II of an ongoing study in the Napa River basin. In Phase I of this study, to be completed in December 2001, the Regional Board contracted with the University of California at Berkeley, in collaboration with Stillwater Sciences, to develop a holistic and quantitative assessment of the current biotic and physical condition of stream and riparian habitat. Phase II of the study, proposed for funding herein, is intended to: · refine our understanding of limiting factors for key native fish and wildlife species, · assess process-specific and linkages between hillslope and channel processes at the watershed scale, and · establish management recommendations to facilitate aquatic ecosystem restoration and the conservation of threatened native aquatic species. The overarching goal of this project is to determine the geomorphic and ecological factors that are most important to ecosystem-based watershed restoration, including restoration actions designed to promote recovery of key at-risk species within the Napa River system. The anticipated outcomes of the proposed project support several Draft Stage 1 Implementation Plan priorities, ERP Goals, and Science Program Goals.

Proposal

San Francisco Bay Regional Water Quality Control Board

Physical Processes and Population Dynamics Assessment in the Napa River Basin - A Foundation for Restoration

Michael Napolitano, San Francisco Bay Regional Water Quality Control Board
Bruce Orr, Stillwater Sciences
William Dietrich, UC-Berkeley

Physical Processes and Population Dynamics Assessment in the Napa River Basin Watershed – a Foundation for Restoration

Prepared for
CALFED Ecosystem Restoration Program

Prepared by
San Francisco Bay Regional Water Quality Control Board
1515 Clay Street, Suite 1400
Oakland, California 94612
with
Stillwater Sciences
2532 Durant Avenue, Suite 201
Berkeley, California 94704
and
University of California at Berkeley

October 5, 2001

A. PROJECT DESCRIPTION: PROJECT GOALS AND SCOPE OF WORK

A.1 Problem

Current and historical land use practices in the Napa River basin have altered physical processes that impact the quality and abundance of suitable habitat for salmonids and affect aquatic ecosystem health. The proposed project is the second phase of an ongoing study to (1) identify factors potentially limiting populations of key aquatic species in decline in the Napa River system, including steelhead (*Oncorhynchus mykiss*), chinook salmon (*O. tshawytscha*), and California freshwater shrimp (*Syncaris pacifica*), and (2) provide the foundation for identifying, prioritizing, and implementing ecosystem-based watershed restoration actions.

The Napa River drains a 426-mi^2 watershed that discharges into San Pablo Bay, located near the mouth of the Sacramento-San Joaquin estuary (Figure 1). The watershed supports a community of seventeen native fish species including several threatened and/or rare species such as steelhead/rainbow trout, fall-run chinook salmon, Pacific and river lamprey (*Lampetra tridentate, L. ayresi*), hardhead (*Mylopharodon conocephalus*), hitch (*Lavinia exilicauda*), tule perch (*Hysterocarpus traski*), and Sacramento splittail (*Pogonichthys macrolepidotus*) (Leidy 1997). Historically, the Napa River was estimated to support a run of 6,000–8,000 steelhead trout, and as many 2,000–4,000 coho salmon. By late the 1960s, coho salmon had been extirpated, and steelhead trout had declined to 1,000–2,000 adults (USFWS 1968). The present-day run of steelhead is believed to be less than a few hundred adults (Emig and Rugg, personal communication, 2000). Much less information is available to determine the historical status of chinook salmon, although examination of Napa River habitat and hydrology and oral history interviews conducted in the Sonoma Creek watershed (an adjacent basin with similar physical form and hydrology) suggest that it may have supported a large run of chinook salmon as recently as the 1940s (Sonoma Ecology Center, unpublished report). California freshwater shrimp, which are known to occur in the Napa River and a few of its tributaries, are federally listed as endangered and currently restricted to only a few watersheds in the North Bay and coastal Marin and Sonoma counties.

By the 1840s, the primary land uses in the Napa River watershed were agricultural activities including timber production, grazing, and field crops. Vineyards were first developed in the 1860s, and up until 1960 the valley floor was used primarily for a combination of orchards, field crops, and vineyards, with localized urban development in the cities of Napa, Yountville, Saint Helena, and Calistoga. Since 1970, the area under grape production in the Napa River basin has rapidly increased from approximately 15 mi^2 in 1970 to 49 mi^2 in 1996 (about 25 percent of which occur on hillsides and the remainder on the valley floor and alluvial fans), and is estimated to reach 82 mi^2 by 2010 (RCD 1997). Timber was intensively harvested in certain parts of the watershed until the 1950s. Groundwater pumping rates peaked between 1910 and 1950 and gradually decreased until recent frost pumping has once again increased groundwater extraction. Approximately 30 mi^2 of the basin are currently used for urban uses, including areas that are managed for water supply, resorts (spas and golf courses), rural residential housing, and rangeland (Figure 2). Three large dams built between 1945 and 1960 regulate runoff from approximately 72 mi^2 (17 percent) of the watershed. Direct in-channel alterations include river bottom dredging on the mainstem Napa River from river mile (RM)–15 to improve navigation, removal of large woody debris and channel clearing from the 1960s to 1970s, and levee building in the 1960s and 1990s for flood control. These land cover changes, in-channel impacts, and water use practices have altered the physical processes that shape the quality, abundance, and connection of habitat for salmonids and other native fish and wildlife species.

Considering the decline of several native aquatic species in the late 1980s, and evidence of widespread tributary bank erosion problems and severe surface erosion at sites being cleared for hillside vineyards, the San Francisco Bay Regional Water Quality Control Board (Regional Board) listed the Napa River and its tributaries (in 1990) as impaired by sediment under section 303(d) of the Clean Water Act. In Phase I of this study, which will be completed in December 2001, the Regional Board contracted with the University of California at Berkeley, in collaboration with Stillwater Sciences, to develop a holistic and quantitative assessment of the current biotic and physical condition of stream and riparian habitat. Other recent and ongoing studies in the Napa River basin (such as the Army Corps flood control project and fisheries monitoring program) have focused primarily on the tidal wetlands and estuary downstream of the city of Napa. The UC Berkeley/Stillwater Sciences assessment conducted for the Regional Board was designed to provide critical information on current conditions and restoration potential in the Napa River basin upstream of the city of Napa. Phase I studies have used a rapid assessment approach, including regional GIS analyses and reconnaissance-level surveys, to (1) describe the current biotic and geomorphic state of the Napa River watershed; (2) begin development of a sediment TMDL for the watershed in order to confirm or reject the validity of the sediment listing; and (3) begin evaluating potential limiting factors for key native fish and wildlife species.

The overarching goal of this project is to determine the geomorphic and ecological factors that are most important to ecosystem-based watershed restoration, including restoration actions designed to promote recovery of key at-risk species within the Napa River system.

Phase II of the study, proposed for funding herein, is intended to:

- refine our understanding of limiting factors for key native fish and wildlife species,
- assess process-specific causalities (natural and anthropogenic) and linkages between hillslope and channel processes at the watershed scale, and
- establish management recommendations to facilitate aquatic ecosystem restoration and the conservation of threatened native aquatic species.

Specific hypotheses to be tested during Phase II are identified at the end of Section A.2.

A.2 JUSTIFICATION

While priority restoration actions have been identified for other well-studied Bay-Delta watersheds, we lack even general knowledge of how and to what extent beneficial uses have been degraded in the Napa River watershed. With a seemingly intact native fishery and high stakeholder involvement, the Napa River presents a valuable model for how needs for ecosystem restoration and the potential for economic impact can be used to determine the most reasonable management actions.

Well-established and effective watershed planning and stewardship groups are active within the Napa River basin and present an excellent opportunity for the proposed project, and therefore CALFED, to collaborate on activities being planned and conducted by local groups and organizations. The Napa River basin also provides an opportunity to perform a clear test of process-based restoration to increase the production of salmonids. Because the watershed is west of the Delta, salmon smolts are not subject to the intense predation and density-independent mortality that accompanies migration through the Delta, which makes evaluation of restoration projects on the Central Valley rivers difficult.

Restoration planning in the basin will be based on an iterative process of hypothesis development and testing, followed by a refinement of the hypotheses. Because of the uncertainties of population dynamics of key species within the Napa River basin, during Phase I we conducted pilot-level investigations to provide us with more information in order to refine our initial hypotheses. Phase II studies will build on the information gained in Phase I, targeting the most important issues and ultimately providing recommendations for restoration action to local stakeholders and interest groups. In addition, our iterative process of hypothesis development and testing will provide the foundation for a longer-term adaptive management approach that stakeholders can use to prioritize, monitor, and refine watershed and river restoration actions within the Napa River basin.

CONCEPTUAL MODELS

General Process-based Conceptual Models

A very simplified diagram of the conceptual model underlying our approach is shown in Figure 3. In this model, the magnitude, timing, and spatial distribution of watershed inputs (e.g., water, sediment, and nutrients) is influenced by natural and anthropogenic disturbance. Alterations in watershed inputs alter important geomorphic processes (e.g., sediment transport and channel migration). These processes construct geomorphic attributes that determine habitat structure, complexity, and connectivity. Species abundance and population dynamics, community composition, and trophic structure may be directly affected by these habitat attributes. A more detailed, process-based conceptual model of the physical factors that might be limiting salmonids in the Napa River basin is provided in Figure 4.

General Life-history-based Conceptual Models

Mortality at every life history stage affects population dynamics. It is only by taking a holistic approach that the relative effects of different sources of mortality can be understood. It is within this context that the effects of changes in the watershed will be examined. Table 1 shows some of the life-stage specific sources of mortality that may be important in the Napa River basin. Aside from mortality factors, we also must understand key factors affecting recruitment, growth, and migration rates if we hope to understand the dynamics of populations of interest. Figure 5 (a, b, and c) provides simple life-history-based conceptual models indicating the factors affecting population dynamics of chinook salmon, steelhead, and California freshwater shrimp.

Use of Analysis Species

Through pilot studies conducted in Phase I of the study, we have determined three at-risk species within the Napa River system as target species. These species have exhibited marked decline within the Napa River system from historical conditions. These are: steelhead, chinook salmon, and California freshwater shrimp.

Steelhead use both the mainstem and tributary. Little is known about their mi gration patters and population dynamics. Chinook salmon may have been present in large numbers historically in the Napa River basin. In recent years, however, biologists from the CDFG and U.S. Environmental Protection Agency have documented the presence of only a small spawning run of chinook salmon (L. Week, pers. comm., 2000). Chinook salmon are expected to immigrate into the Napa River during October through December. Suitable spawning habitat occurs in isolated patches along the upper mainstem near Calistoga. Chinook salmon smolts are expected to outmigrate in March through June.

California freshwater shrimp is listed as federally endangered and has a very restricted distribution in Napa, Sonoma, and Marin counties. It is currently known to occur in only a few spots along the Napa River and two of its tributaries (Huichica and Garnett creeks). Freshwater shrimp are typically found near undercut banks with submerged root mats and well-developed overhanging riparian cover. Changes in mainstem channel morphology, as well as reduction of riparian vegetation cover, may be particularly important impacts on this species. Based on the extensive surveys of the mainstem Napa River conducted during Phase I, potential habitat appears to be relatively abundant. However, a more quantitative assessment is needed to (1) link population abundance with habitat quality, (2) determine the distribution of habitat in the Napa River basin as a whole, and (3) understand the geomorphic processes responsible for forming and maintaining freshwater shrimp habitat. In particular, the importance of overhanging vegetation is a concern that should be addressed in Phase

II in view of the ongoing defoliation of channel banks to eliminate habitat for the sharpshooter that causes Pearce's disease.

Models and Hypotheses About Current and Historical Conditions

The reference model approach is an effective tool for determining factors limiting salmonid populations and assessing the impacts of watershed activities (e.g., forestry, agriculture, vineyards, highway construction, urban development) on habitat conditions from their reference or pristine state. From there, we assess how changes in habitat quality and quantity affect density-dependent and density-independent survival at each life history stage and then use population response models to determine the population-level effects for each key species (in this case, steelhead, chinook salmon, and freshwater shrimp). This reference model approach generates quantitative hypotheses for specific hydrological, ecological and geomorphic attributes for an individual watershed, sub-watershed, or reach. In turn, these hypotheses provide a framework for collecting and evaluating field data. The use of the reference model will allow us to differentiate anthropogenic effects (e.g., accelerated sediment loading due to erosion, reduced sediment transport due to dams, and changes in hydrologic regime caused by land use activities) from those caused by natural processes. By using this approach, we can then evaluate the combined effects of different management actions to determine the most cost-effective methods for achieving the desired goals.

Historically, the mainstem Napa River was a low gradient, gravel-bedded stream exhibiting bar-pool morphology and high sinuosity. In confined reaches, floodplain extent was constrained by coarse-textured, erosion-resistant alluvial fans. In less confined portions of the valley floor, the river was often locally anastomosing, with relatively broad, frequently inundated, fine-grained floodplains with well established riparian vegetation. Tributary streams had relatively high gradients and ample supplies of large woody debris, with a step-pool morphology. These tributaries supplied much of the coarse sediment delivered to the mainstem river.

Current and historical land use practices in the Napa River basin have altered geomorphic and hydrologic processes of the mainstem and its tributaries. These alterations have affected the quality and abundance of suitable aquatic and riparian habitat for native species. In the sand and gravel-bedded reaches of the mainstem Napa River, levee construction has resulted in channel simplification and incision and has restricted the historically anastomosing reaches to a single channel. In addition, increased fine sediment loading from bank erosion and coarse sediment capture by east side tributary dams have converted the natural bar-pool morphology to a plane-bed morphology in many reaches. Increased fine sediment supply has also caused fining of bed material suitable for chinook salmon spawning habitat. Channel simplification and incision has scoured coarse material from the channel bed and isolated the channel from its floodplain. Increased channel bed mobilization has resulted in frequent scouring of salmon redds. This scour has also resulted in the formation of long, deep pools which now dominate many reaches of the river. The pools create lentic habitat for non-native predatory fish, increasing the exposure of native salmonids to predation during rearing and outmigration. Floodplain isolation has resulted in the loss of side channel, backwater, and slough habitats. Throughout most of its length, the mainstem Napa River now has only a narrow band of riparian vegetation. Reduced summer (low) flows from irrigation water withdrawals may result in higher water temperatures and create fish passage barriers over riffles, exacerbating the risks to outmigrating smolts.

Clearing of woody debris has altered the morphology and hydrology of many tributary streams. Under historical conditions, many tributaries exhibited a step-pool morphology which was maintained by woody debris continually entering the stream system. Removal of woody debris has resulted in a simplified channel morphology, higher flow velocities, channel incision, reduced nutrient supply, and the coarsening of the channel bed. Larger tributaries, such as Dry, Conn, and Soda creeks, show signs of recent incision and have graded to the current level of the mainstem Napa River. In some cases, smaller tributaries cutting across the valley floor have not adjusted to the lowered level of the mainstem and are elevated at their confluence with the mainstem, forming potential barriers to upstream fish migration.

A summary of our current conceptual models, developed during the Phase I study, of historical and current conditions in the mainstem Napa River and implications for effects on various chinook salmon life stages is provided in Figure 5. Figure 6 provides an illustration of the changes documented in the mainstem Napa River since the 1940s.

Summary of Phase I Reconnaissance Studies
Phase I (to be completed in December 2001) was initiated in response to the Napa River being listed as "sediment-impaired" by the Regional Board. Phase I studies began the development of a sediment TMDL for the Napa River basin. Reconnaissance pilot studies found that while somewhat high, fine sediment deposition was not a striking problem in tributaries of the Napa River basin. However, significant downcutting and aggradation (particularly in alluvial fans at the base of tributary confluences with the mainstem) was observed. Large woody debris loading seemed uncommonly low for a forested stream. It was also observed that dessicated riffles and isolated pools tended to force juvenile salmonids into dense aggregations where food stress appeared likely. Thus, we hypothesized that various other factors besides sediment may also be contributing to impaired conditions for salmonids and other species within the system. Our conceptual understanding of the physical habitat characteristics considered to be potentially limiting salmonid production in the Napa River include flow, sediment, large woody debris loading, temperature, and potential barriers to migration (Figure 4). The results of these pilot studies and reconnaissance site visits are presented below, and provide the basis for the Phase II studies proposed in Section A.3.

Flow
Long-time observers believe there has been a substantial reduction in dry season low flow over the past 40 years, possibly due to groundwater pumping, in tributaries important to steelhead/rainbow trout, freshwater shrimp, and other native aquatic species (USFWS, 1968; Emig and Rugg, pers. comm. 2001). Juvenile steelhead and other coldwater species may experience low growth, weight loss, or mortality during summer in response to: (1) reduction or cessation of flow over riffles, which may cause a dramatic reduction in food supply (macroinvertebrates in riffles drift into pools with flowing water); or (2) direct mortality via complete desiccation of reaches where successful spawning and incubation occurred (Figures 7 and 8). We conducted a pilot study in summer of 2001 in eight pools located in two Napa River tributaries (including sites believed to have relatively favorable flow conditions). Fish growth was measured, habitat quality was assessed, and water level and temperature were continuously monitored. Limited or negative growth rates for young-of-the-year steelhead were documented at all sites (Figure 9), implying that food resources were insufficient in summer 2001 (in the reaches monitored) to satisfy metabolic demands. Should low (or lack of) dry-season flow prove to be a significant influence on smolt size (and hence ocean survival), little information is currently available to evaluate impacts of humans on flow persistence, or to evaluate cost-effective means to jointly improve instream flow and water supply reliability.

Widespread use of high intensity, short duration spray irrigation to protect vines from frost damage (mid-March through mid-May) is also a concern because: (1) timing is similar or coincident with ocean migration of juvenile salmonids; (2) a large acreage is planted in grapes in the Napa River watershed (approx. 32,000 acres or about 50 mi^2); (3) few tributary diversions have flow monitoring or bypass requirements; and (4) desiccation was observed in lower reaches of several tributaries during a severe frost event this past spring that likely resulted in stranding and mortality of juvenile steelhead trout. An analysis is needed to separate the effects of localized drying due to spray irrigation from the cumulative effects of land use in the basin.

The magnitude and timing of other types of diversions or groundwater pumping is poorly known, but could result in ecologically significant flow alterations. For example, barriers associated with flow may not allow juveniles or smolts to emigrate from tributary streams to the mainstem or estuary during critical periods. Widespread and early drying of tributaries was observed during the summer season (Stillwater Sciences, unpublished data, 2001). A lowered water table, perhaps caused by groundwater withdrawals throughout the year and frost protection pumping in the early spring, have resulted in tributaries becoming dry earlier in the season than under historical conditions, potentially trapping emigrating smolts in upstream reaches.

Phase II studies will be conducted to determine if the lack of flow in the spring and/or summer is ecologically significant, how historical and present-day human activities influence spring and dry season flow persistence, and what can be done to enhance instream flow and water supply reliability.

Sediment

Extensive surveys have been conducted the past two summers in the mainstem Napa River and its tributaries to document channel conditions. We have found that riffles are composed of fine gravel and sand throughout mainstem Napa River upstream of its estuary. Although fine and coarse sediment deposition is pervasive in the mainstem channel, habitat degradation (deep channel incision and simplification of plan form) appears to be a much more important factor limiting salmon run size in mainstem Napa River. Fine sediment deposition (in response to recent land use) does not appear to be a significant factor limiting steelhead trout in tributaries, although a reduction in fine sediment deposition in potential spawning areas would likely enhance survival to emergence. Spatially extensive turbidity monitoring in wet season of 2000–01, a below-average runoff year with maximum flow approaching bankfull, does not indicate that turbidity reached levels that would impair growth of juvenile trout (Figure 10). Further turbidity monitoring may be justified, however, under wetter conditions and/or larger runoff events, as rates of sediment delivery from episodic processes, such as hillslope and valley floor gullies, bank erosion, road failure, and landslides, could greatly increase suspended sediment supply, and increased supply may persist for several years following a large disturbance. A basis for predicting future sediment production and channel response to more intensive or rapid land cover changes (and/or erosion control and prevention activities) may be needed, however, to guide local, state, and federal regulatory decisions. A sediment source analysis would answer the key information gaps regarding sediment issues.

Studies of sediment routing through channels may also be useful to guide restoration and management decisions. For example, it appears that large wood loading in tributary channels is much lower than expected under mixed evergreen forest, which covers large portions of many tributary watersheds (Figure 2). Restoration of complex channel habitat in tributaries may require enhanced recruitment and loading of large wood in channels, which will influence tributary channel form and sediment routing through channels. Sediment routing studies are needed to predict channel changes in order to optimize ecological benefits, manage flooding, and protect streamside property.

Large woody debris

Field reconnaissance of Napa River tributaries indicate that large woody debris (LWD) loading is much lower than typical of mixed evergreen forests. Although the history of wood removal from the Napa River and its tributaries is poorly known (there are some records of stream cleaning projects in the 1960s and 1970s), LWD was likely reduced by direct removal from many or most streams for a variety of reasons.

LWD removal is important because LWD can have a profound effect on channel morphology in forested streams (Harmon et al. 1986, Nakamura and Swanson 1993, Montgomery et al. 1996). Individual logs and log jams create steps in the longitudinal profile that can account for a significant portion of the head loss in streams

(Harmon et al. 1986). Because the head loss in concentrated near the obstruction, LWD reduces the local slope, creating stable alluvial features upstream of the wood jam. LWD also helps create diverse and complex channel morphology, sorting bed materials into distinct textural patches and creating diverse habitat conditions (Harmon 1986). The reduced LWD loading in Napa River tributaries has likely increased the mobility of coarse sediment (by direct removal of roughness and increases in local slope upstream of former jam locations) and reduced the diversity of in-channel habitats. Additionally, loss of LWD (in combination with channel incision) has likely reduced sediment storage, pool frequency, and cover for juvenile steelhead rearing in tributaries. A channel lacking deep-water refugia would result in exposure of fish to higher temperatures and elevated predation by terrestrial predators such as birds, snakes, and mammals

Barriers
Physical barriers along the Napa River's tributaries may prevent adult steelhead from reaching suitable spawning habitat in upstream reaches. Historically, approximately 300 miles of the 1,300 miles of stream channel within the Napa River watershed were likely accessible for spawning and rearing steelhead in most years (USFWS, 1968; Stillwater Sciences, unpublished data, 2000). Three large dams at Conn, Bell Canyon, and Rector reservoirs along tributaries by the same name, reduce historically available habitat by 17 percent. Prior to construction of Conn Reservoir in 1946 (drainage area = 54 mi^2), Conn Creek may have been an important tributary for steelhead trout in the watershed. Other large dams (Milliken, Bear Canyon, and Kimball Canyon), numerous small dams, road crossings, water diversions, and dewatered reaches may also present substantial impediments or barriers to anadromous fish migration in many tributaries. Preliminary review of data collected by CDFG (1950s), Napa RCD (unpublished data, 2001) and Stillwater Sciences (unpublished data, 2001) found that over 90 (current estimates suggest many more) barriers have been generated on Napa River tributaries since the 1950s.

Temperatures
Elevated summer water temperatures do not generally reach levels that are lethal to juvenile fish in the Napa River system, according to thermograph data deployed in the mainstem and tributary streams last fall (Figure 11). However, juvenile fish may experience increased metabolic dema nds and/or substantially reduced prey availability during summer baseflows resulting in decreased growth. Qualitative surveys of the Napa River showed disconnected and dewatered riffles, with juvenile fish congregated in isolated pools. A pilot food growth study conducted summer 2001 found that juvenile salmonids are often food-stressed in these habitats, and grow little, or may even lose weight during the summer months (see Figures 7-9 and discussion above under *Flow*).

Predation
During surveys conducted in the mainstem Napa during Phase I a large number of black bass and pike minnow were observed in al of the pools. Because these pools comprise 80-90% of channel length predation is likely and important source of mortality for chinook and steelhead. There have been a number of efforts to document presence of fish at a range of spot locations in the tributaries and the mainstem of the Napa River (DFG records and Leidy 1984, 1998) and during the summer of 2001, an extensive effort was undertaken by Friends of the Napa River to snorkel all fish-bearing streams to document abundance and species composition of fish occupying the system. However, little is known about the temporal patterns of movement and feeding of juveniles and smolts in the system.

Estuary
The possibility exists that juvenile rearing and/or smolt production was never important in the mainstem Napa River and its tributaries. Juveniles may have moved downstream to the estuary for all or much of their rearing and smolt stages. Changes in the estuary from historical conditions, such as wetland draining and introduction

of exotic predators, may have eliminated or reduced this source of alternative rearing habitat, resulting in reduced production of salmonids in the basin.

Review of existing information, historical analysis, and focused field efforts, including fish sampling, are proposed in Phase II to test the hypothesis that altered estuary conditions have substantially reduced the availability of rearing habitat for chinook and steelhead juveniles.

SUMMARY OF HYPOTHESES TO BE TESTED IN PHASE II

The following are the hypotheses about the cause of decline of key species for which there is the most support from our initial studies:

Chinook salmon:

H1: Changes in channel morphology resulting from levees and channel incision on the mainstem Napa River is the primary cause of decline in chinook salmon populations. Changes in channel morphology have resulted in greatly reduced spawning habitat, scouring of redds, large increases in predator habitat, and disconnection of off-channel rearing habitat.

Steelhead:

H1: Inadequate production and delivery of invertebrate food as a result of partial riffle dewatering from water abstraction reduces juvenile growth, resulting in juvenile steelhead that are too small to smolt, or if they smolt, suffer high mortality.

H2: Historically, the most important life history strategy for steelhead was to migrate and rear in the estuary for one or more years. Tributary rearing may have never contributed to a large number of successful smolts. Large-scale changes in estuarine rearing conditions as a result of dredging, channelization, and other factors eliminated or greatly reduced the life-history strategy of estuarine rearing.

California freshwater shrimp:

H1: Restoring or protecting the geomorphic and riparian vegetation processes that lead to deep undercut banks with hanging roots for cover is essential for maintaining freshwater shrimp populations.

A.3 Approach

The purpose of the second phase of this project is to complete the process of documenting and refining the understanding of the potential limiting factors on analysis species populations that was begun in Phase I. More rigorous analysis, including more intensive field studies, plot-based studies, and modeling, will be used to develop a more quantitative understanding of the relationship between land and water management practices and their impacts on the river ecosystem. Phase II will provide a clearer story of what has happened in the watershed since arrival of European-Americans and provide much stronger evidence for cause-and-effect linkages among land use practices, sediment delivery and temperature loading, flow and physical habitat conditions, salmonid and freshwater shrimp population dynamics, and aquatic ecosystem health.

As in Phase I, the approach to Phase II will be to conduct hypothesis-driven studies that focus on life history stages and processes that are likely to limit overall production of our three analysis species: steelhead, chinook salmon, and California freshwater shrimp.

In addition to building upon the work conducted during Phase I, during Phase II we will make use of high-resolution digital elevation data (4–5 m horizontal resolution DEMs with 15 cm vertical accuracy) and digital terrain models (DTMs) of the channel network and mass wasting (shallow and deep-seated landslide) hazards that will be developed under the Napa River Basin Mapping Partnership project (NRBMP).

The results of the Phase I study and the NRBMP will provide a strong foundation for Phase II studies to refine and test key hypotheses, and develop recommended actions for ecosystem-based watershed restoration.

Task 1: Process-Based Assessment Of Potential Physical Factors Limiting Abundance Of Analysis Species

This task includes studies designed to test hypotheses regarding the ecological importance of various physical factors. These studies also provide the foundation for much of the work on analysis species proposed under Task 2 and the population dynamics analysis and synthesis conducted under Task 3.

Task 1A. Sediment dynamics. Traditional approaches to sediment source analysis (determining rates of sediment delivery to channels) typically involve inventory and quantification of dominant sediment sources over various temporal and spatial scales, utilizing extensive field surveys and aerial photograph analysis. This approach is not feasible in the Napa River basin (NRB), however, in consideration of its large area, diverse conditions, limited public access, time and budget constraints. In order to gather the information needed to rapidly develop a sediment source assessment for the NRB, we will draw traditional sediment budget techniques (e.g., Reid and Dunne 1996, Dietrich et al. 1982) complemented by state-of-the art GIS and digital terrain model (DTM) techniques designed to specifically address the challenges presented by the NRB. Extensive review of literature will be performed to fill in data gaps on the types and magnitudes of erosion rates typical for dominant processes in the NRB.

Our approach involves the following steps: (1) stratification of the watershed into geomorphic terrains or land types (i.e., areas expected to have similar sediment production characteristics under reference and disturbed conditions) that have been classified and delineated in Phase I of the study; (2) development of site-specific hypotheses about how land use, topography, and lithology affect upslope erosion and sediment delivery, and rates, to channels; (3) use of land type-specific or tributary-specific intensive analysis, exploring mechanistic relationships between sediment production dynamics in order to estimate process-specific sediment production and delivery rates (aerial photo interpretation, field surveys, and GIS/DTM modeling techniques); and (4) use of an extensive analysis (aerial photograph interpretation and, possibly, helicopter surveys and LIDAR) to allow for landtype-based extrapolation of land type-specific sediment delivery from each sediment source to describe expected sediment sources and their magnitudes in the entire NRB. At a minimum, the 1990-2000 time period will be assessed.

Task 1B. Large woody debris (LWD) assessment. This task includes two components: assessment of current LWD loadings and determination of whether LWD removal has reduced winter refugia for juvenile steelhead. We believe this task is important, but can be deferred until alternative funding sources are secured, so *at this time we are not requesting funding from CALFED for this task* (also see comments under Task 1C regarding working with stewardship groups).

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Task 1C. Physical barriers to fish passage. Current information on known or potential barriers is extremely limited. Some field surveys of road crossings and assessment of their likelihood to act as barriers is being conducted this fall as part of Phase I. More information will be needed, however, to test the hypothesis that physical barriers are limiting access to significant amounts of potential habitat. We believe this task is important, but can be deferred until alternative funding sources are secured, so *at this time we are not requesting funding from CALFED for this task* We will work with local tributary stewardship groups to see if alternative funding can be secured for them to perform comprehensive surveys of channels (including LWD) and identify, evaluate, and rank all impediments and/or barriers to fish migration.

Task 1D. Baseflow reduction and hydrograph change. This task involves qualitative assessment of: (1) effects land management activities on quick flow volume; (2) effects of surface and ground water pumping on dry season flow persistence and magnitude; and (3) whether reach-scale aggradation in tributaries has occurred submerging former perennial flow. Investigations will be conducted in five tributary watersheds that are or were historically important streams for steelhead trout and/or freshwater shrimp, and where stewardship groups are actively engaged in management and restoration planning: Carneros, Dry, Ritchie, Soda, and Sulfur. Selected tributaries are quite variable with respect to geology, topography, rainfall, and land cover characteristics providing the opportunity to distinguish relative influences of these attributes on baseflow persistence.

Land use activities that reduce rainfall interception (e.g., conversion of forest to vineyard), infiltration capacity, and/or surface roughness, or which rely upon the installation of subsurface drainage pipes (to rapidly drain fields) may cause significant increase in peak runoff rate during storms to the detriment of groundwater recharge and consequent dry season baseflow. Potential significance of land use related increases to quick flow will involve: a) field surveys to identify dominant modes of storm runoff (Horton overland flow, natural soil pipes, engineered drainage, etc.), measure rainfall intensity and duration, measure infiltration rates, and describe soil profiles; b) review existing rainfall-runoff monitoring data collected by Napa County RCD; c) interpret time sequential aerial photographs (1940’s, 1960’s, 1980’s, 1998) to map changes in land cover types through time.

Surface-ground water pumping may have direct effect on spring and dry season baseflow persistence. Long-term measurements of ground water level have been made at approximately fifty wells in Napa Valley and adjacent alluvial fans. We will use these data, and collect additional seasonal data (fall, winter, spring, and summer) throughout the study period to evaluate inter-annual and long-term trends in groundwater elevation as compared to local streambed elevation (surface discharge). We will install twenty-five continuous water-level gages over five tributary watersheds (Carneros, Dry, Redwood, Ritchie, and Soda) to monitor baseflow persistence in the spring through fall of 2002 and 2003. Existing hydrologic data for tributaries will be reviewed together with extensive channel walks in winter, spring, and fall to delineate ephemeral, intermittent, discontinuously wetted, and perennial reaches. Available historical data will also be assessed (CDFG stream surveys, etc.) to determine whether extent of perennial and/or discontinuously wetted channels has been reduced since 1960’s. Channel and helicopter surveys will be conducted in tributary reaches expected to be vulnerable to aggradation (streambed slope ≤ 3 percent). Field evidence, bridge surveys, historical ground photographs, landowner interviews, and aerial photo interpretation will be used to evaluate channel aggradation and potential effect on flow persistence.

Task 1E. Temperature monitoring and modeling. Phase I studies indicate that warm temperatures may be impairing aquatic ecosystem function. This task is designed to generate additional information on the spatial and temporal patterns of stream temperature under current conditions, model expected conditions under more natural reference conditions, explore the role that changes in riparian vegetation and stream shading might play in any modeled differences between reference and current conditions, and use model “gaming” to explore the effects of various riparian vegetation management scenarios on stream temperature. The three main subcomponents of this task are described below:

- *Monitor temperatures in key tributary and mainstem sites.* Continue monitoring temperature at the 28 thermograph sites established during Phase I studies, or at new sites as needed to better document spatial and temporal patterns of stream temperature and to provide data to calibrate a temperature model for selected reaches.

- *Assess riparian vegetation cover and the potential impact of vegetation clearing on temperature.* Use reconnaissance field visits, biological observations, aerial photograph interpretation, existing GIS vegetation coverages (USGS and USDA Forest Service), and historical analysis (Task 1F) to compare the likely historical condition with the current extent and condition (particularly average height) of riparian vegetation.
- *Model effects of riparian vegetation on stream temperature in selected perennial reaches.* We will model stream temperature under various scenarios (current, historical, potential future riparian management options) for selected portions of the perennial channel network in the basin. The proposed temperature modeling approach uses temperature monitoring data to provide a comprehensive assessment of current temperature conditions throughout the stream channel network and provides a powerful tool for comparing existing temp erature conditions with estimated reference conditions, and for comparing different scenarios for future riparian management practices. The model has been applied in a number of basins in California and Oregon, and was used to develop the first temperature TMDL in California (South Fork Eel TMDL, EPA 1999).

Task 1F. Analysis of changes in channel conditions. Physical changes to the Napa River and its tributaries during the 175 years since European settlement have been massive and rapid, and, in all likelihood, have significantly altered the way that water and sediment are transported through the system. However, a functional understanding of how these impacts have affected key physical factors has been hindered by the lack of sufficiently detailed information about reference condition. In this task, a focused research effort will investigate the historical character of natural streams and significant associated features such as discontinuous channels, distributary systems, braided channel systems, and riparian overstory. A wide range of historical documents, including early Spanish and American maps, surveys, written accounts, landscape paintings, and ground and aerial photography will be analyzed to document the historical channel network plan form, early channel depths (at known points for resurvey), and the width and linear extent of riparian vegetation. The information will contribute to analyses of sediment storage, channel aggregation/degradation, and specific changes in fish habitat conducted by Stillwater Sciences and UC Berkeley in Tasks 1 and 2 and the synthesis covered under Task 3. Selected features will be synthesized into maps and graphics. All historical features will be documented in terms of accuracy and uncertainty, following established methodologies (Grossinger 2001). This task will be carried out by the San Francisco Estuary Institute's historical ecology research team, which has developed a suite of successful methodologies for synthesizing historical data into technical products, and will benefit from resources already developed by SFEI's collaborative Napa Watershed Historical Ecology Project. This broad-based effort involves many local citizens helping to gather information about the history of the Napa watershed and will provide an information base allowing this substantial task to be completed cost-effectively. Geomorphologists an ecologists at Stillwater Sciences will compare current versus historical conditions to assess changes in channel and riparian habitats.

Task 2: Mechanistic Studies and Life History Assessments of Analysis Species

Task 2A. General salmonid research.

- *Task 2A1. Salmonid monitoring.* Monitoring to assess timing of adult immigration for spawning and juvenile outmigraton (for both chinook salmon and steelhead) is greatly needed. However, we plan to coordinate with CDFG, NMFS, Army Corps of Engineers, and other stakeholders to seek other funding for this important monitoring effort. Thus, *we are not seeking CALFED funding for this task at this time.*
- *Task 2A2. Assess impacts of predators in the mainstem on outmigrating smolts.* Sampling will be conducted to determine predator abundance and distribution in the mainstem using seine nets, visual

observations, and electrofishing. Diet composition of predators during peak smolt outmigration will be determined by stomach pumping.

- *Task 2A3. Assess importance of estuary rearing.* We will review existing information to evaluate historical and current fish distribution and estuary conditions to develop a conceptual understanding of the significance of estuary rearing for steelhead and chinook salmon in the Napa Basin. We will then develop and refine our hypotheses about the importance of the estuary for rearing habitat.
- *Task 2A4. Assess historical evidence for salmonid distribution and abundance.* Essential to understanding the causes of salmonid decline is an understanding of the prior extent of their distribution, and the timing of significant periods of decline. Significant sources of such valuable information are available, in the form early explorers' and settlers' accounts, town histories, and articles in local newspapers and fishing magazines. These documentary sources will be collected and combined with "old-timer" interview data and a limited analysis of ichthyoarcheological data from available reports of the contents of middens and other archeological sites. These independent sources of evidence will be integrated to provide a qualitative understanding to help answer key questions such as the historical presence of Chinook salmon in Napa River, the relative distribution of salmonids in local tributaries, and the correlation of periods of major decline with changes in land management.

Task 2B. Steelhead. This task involves conducing an expanded version of the 2001 pilot study on juvenile steelhead growth to test the bioenergetics hypothesis that food limitation and temperature interact to limit growth rates of juvenile steelhead in the tributaries. This task will involve two primary components:

- *Assess growth of juvenile steelhead in tributaries of the Napa River.* To assess the effects of flow reductions on juvenile steelhead growth, we will use methods similar to those used in our Phase I pilot study. Our goal is to determine growth rates for different periods of the year for age 0+, 1+ and 2+ steelhead. We wish to determine when fish are able to grow and what size they would attain prior to smolt outmigration. Fish will be captured in the spring, and measured and weighed. Prior to release, each fish will be given a unique subcutaneous mark using a benign marking method tested extensively by Ricker (see Attachment). Marked fish will be recaptured at the end of the summer, weighed, measured, and re-released. Unmarked fish captured at this time will also be given unique marks to increase the sample size. This process will be repeated at the end of the fall, winter, and spring. The final recapture will be conducted at the end of the second summer. Recapture efforts will extend several hundred meters upstream and downstream of the initial sites both to increase the number of recaptures and to document whether fish that move have greater or lesser growth rates than those that remain in a given habitat unit. Study sites will be selected to represent the range of hydrologic conditions in the Napa River (i.e., streams that have greatly reduced flow to those that have relatively impaired discharge). We will monitor temperature continuously at all sites. Scales will be taken from a sub-sample of juvenile fish to help assess their age composition. Scales will also be collected from adult carcasses to determine the age at smolting of successfully returning fish.
- *Assess potential food availability throughout the year in tributaries of the Napa River.* The goal of this task is to determine the effect of flow in the riffles on invertebrate production and delivery to downstream pools where juvenile steelhead are rearing. As channel width and/or substrate size increase, greater flows will be needed to provide optimal conditions for food production and delivery. We will develop a relationship between discharge, riffle width, riffle substrate size distribution, and invertebrate food availability. We will choose riffles that represent a variety of channel widths, substrates, and flow conditions. We will choose most of our riffles directly upstream of pools where the juvenile steelhead have been marked, so that we can relate food availability to growth rates. At each riffle we will measure drift for 5–10 days during the twilight period when drift is typically highest. We will also take benthic samples using a Hess sampler. We will take the invertebrate samples at the beginning, middle, and end of each fish capture-recapture period. We will examine how the effects of flow on invertebrate

availability and fish growth vary seasonally, and develop a tool for assessing the flow requirements necessary to allow juvenile steelhead to grow to a size that will produce smolts large enough to have a high likelihood for survival.

Task 2C. Chinook salmon. This task focuses on testing a key hypothesis regarding redd scour as a potential limiting factor (redd scour) for chinook salmon in the Napa River. The goal of this study is to determine the recurrence interval of high flows necessary for scouring redds and killing deposited eggs. If low recurrence interval flows (e.g. flows that may occur several times a winter) scour redds, as our initial analysis indicates, we can calculate how this affects the probability of successful Chinook salmon egg survival-to-emergence. We propose to build artificial redds with scour cores. After each high-flow event we will document the depth of scour and relate it to typical egg pocket depths from the literature.

Task 2D. California freshwater shrimp. Very little is known about the current distribution and abundance of California freshwater shrimp in the basin and there is a lack of rigorous data on preferences or utilization rates for different types of potential habitat. In addition, the processes responsible for creating and maintaining critical habitat are unknown. There are two components to this task:

- *Task 2D1. Assess population abundance of freshwater shrimp in the Napa River.* This task will involve conducting dip net surveys along the mainstem and tributaries of the Napa River. Initial sampling will focus on comparing shrimp abundance in various habitats to address habitat preference or utilization. Sampling will occur at locations where shrimp are known to occur, as well as other slow-water habitats, throughout the year, to determine life history characteristics and test the hypotheses that (1) the freshwater shrimp only occur in pools with well-developed undercut banks with alder or willow root mats and overhanging riparian vegetation, and (2) suitable habitat is relatively abundant in the mainstem and certain low-gradient reaches of some tributaries (such as Huichica Creek). We also propose to conduct sampling upstream and downstream of potential barriers, if any barriers are found near sites containing shrimp, to test whether physical barriers might be limiting the current distribution of this species.
- *Task 2D2. Determine the geomorphic processes responsible for forming undercut banks and maintaining overhanging riparian vegetation.* No integrated study has yet been undertaken to develop an understanding of the key processes and conditions involved in creating and maintaining appropriate habitat for this species. We propose to (1) conduct reconnaissance-level channel surveys to develop hypotheses about the processes necessary to form undercut banks, and what is required to maintain them; and (2) assess the extent of potentially suitable undercut bank habitat within the Napa River basin.

Task 3. Population Dynamics Analysis

This task will synthesize the information obtained from Tasks 1 and 2 and previous Phase I studies through the construction of a *reference model of natural processes and conditions* (based on reconstruction of historical conditions prior to pre-European-American disturbances and on our empirical and theoretical understanding of natural river and watershed processes in the Napa River basin) and a *model of current processes and conditions*. These models will incorporate a mechanistic or process-based understanding of cause-and-effect relationships, and will therefore be able to help predict future conditions likely to occur under various management scenarios. In particular, the models will be designed to lead to quantitative modeling of population dynamics of the analysis species under different scenarios. The results of this data synthesis and modeling process will be used to generate recommendations for watershed and river-riparian management (e.g., best or better management practices) and restoration (e.g., a prioritized list of restoration strategies and actions most likely to improve river ecosystem health and/or maintain or restore species of concern).

The watershed analysis functions like a forensic investigation: a means of reconstructing the processes that led to the impairment of beneficial uses. The reference model, which is developed through an iterative interdisciplinary process throughout the project, serves as a forensic tool throughout the watershed analysis from generation of initial hypotheses through evaluating BMPs and restoration priorities. For example, the reference model may indicate that pools are significantly shallower now as a results of (1) removal of LWD from channels (LWD causes deep pools to scour), (2) channel straightening, which would eliminate deep pools caused by bends in the channel, (3) decreases in peak flows below reservoirs would allow pools to fill in, or (4) channel aggradation and bank erosion due to increases in mass wasting or surface erosion from roads could lead to filling of pools irrespective of peak flows.

This task has two primary components:

- *Analyze data from Tasks 1–2 for each analysis species to construct a population dynamics model.* Combine our understanding from Phase II studies on sediment dynamics, large woody debris, physical barriers to fish passage, hydrologic factors, and temperature with knowledge of specific life history requirements in the Napa River basin to determine the most important factors controlling population dynamics for each of the analysis species (steelhead, chinook salmon, and California freshwater shrimp). The relative importance of specific limiting factors will be objectively evaluated through the use of quantitative population dynamics modeling.
- *Synthesize the various restoration requirements of the analysis species into restoration recommendations.* In many cases, spatial and temporal scales of restoration actions will determine the success for each analysis species. This task will synthesize our understanding of the needs of various species to determine the best course of action to restore beneficial uses to the Napa River basin.

Task 4: Report Production and Public Outreach

Report Production. This task includes production of a draft report (or progress report) at the end of year 1, and a revised draft and final project report at the end of year 2. These reports will provide technical information useful to various stakeholders: the Regional Board (to develop a TMDL for the Napa River basin), Napa County (to help meet CEQA needs for permitting and planning processes), and the RCD and landowners (for management plans and restoration actions).

The year 1 draft report and the year 2 final report will specifically include (1) background information on current and historical conditions in the basin, (2) review of all hypotheses developed during Phase I and II studies, (3) a summary of the conclusions regarding each hypothesis (i.e., rejected, accepted, or uncertain) and the level of uncertainty associated with these conclusions, (4) conclusions regarding the most important factors currently limiting the populations of analysis species and general aquatic ecosystem integrity, (5) recommendations regarding specific ecosystem-based restoration strategies for the watershed, and (6) guidance on long-term monitoring and adaptive management needs in the basin that should be developed as part of a coordinated stakeholder process for watershed restoration.

Public Outreach. There will be a public workshop near the beginning of Phase II to inform stakeholders about the proposed work plan, a workshop at the end of Year 1 to provide and interim status report, and a third workshop at the end of the second year to present data, conclusions, and recommendations for management and restoration actions. Workshops will be developed and presented by staff from the Regional Board, Stillwater Sciences, and UC Berkeley. In addition, Regional Board staff will conduct numerous ongoing coordination meetings and outreach efforts with local, state and federal agencies, citizen's groups (such as local watershed groups), and other interested parties.

Task 5: Project Management

Project management will include efforts related to permitting (scientific collecting permits will be needed), accessibility issues (coordination with landowners), task management, and general project administration. Regional Board staff will provide overall project coordination. Stillwater Sciences will provide day-to-day project management for all technical tasks.

A.4 Feasibility

Although there is a public right of access to nearly the full length of mainstem Napa River (approximately 55 miles) because it meets the legal definition of navigability, access to most tributary stream reaches requires permission from private landowners. We have identified approximately 200 miles of tributary streams as high-priority reaches for survey and analysis. About 80 percent of the length of these streams is owned by approximately 150 to 200 landowners. To date, the Regional Board has received permission to access approximately 50 miles, or about 25 percent, of the priority tributary reaches, and anticipates receiving permission to access about 50 more miles this winter.

Stakeholder participation and coordination efforts are underway under the guidance of the Regional Board. The Regional Board is working with the Napa County Farm Bureau, Land Trust of Napa County, Napa County Resource Conservation District, and individual landowners to facilitate permission to access privately-owned parcels. The Regional Board has also received permission from Napa County to use its GIS-based Assessors Parcel Maps and Landowner Contact Lists to aid in identifying ownership throughout the watershed.

Permission gained to date is expected to be sufficient for analyzing human influences on sediment delivery and routing through channels, baseflow persistence, and stream temperature. Analysis of large wood (loading, distribution, and function) and fish migration barriers will require significant additional permissions (perhaps an additional 50 miles or more). Remote sensing tools, including high-resolution topographic mapping of channels using laser altimetry and helicopter surveys, may also be useful for extrapolating large wood loading and function, and fish migration barriers in reaches where permission for access is not obtained.

A.5 Performance Measures

As a scientific assessment, this project will primarily use project outputs to measure project performance and goal achievement. Project outputs that will serve as performance measures include data reports, presentations, and publications produced as a result of conducting the tasks listed in Section A.3. By increasing our understanding of the physical, hydrologic, and ecological factors limiting salmonid and shrimp production, we will be able to make scientifically-based management recommendations by the end of this phase.

A.6 Data Handling and Storage

This project will result in the collection and development of data and information over a 3-year period, and will build on previously obtained data. All data collected will undergo standard Stillwater Sciences QA/QC procedures before the originals are archived. This process includes review of field notes and data by field crew personnel, a check of data entry to ensure accuracy, and creation of working and back-up copies of original data sheets to eliminate possible loss of or tampering with original data.

Draft and final reports will be posted on Regional Board and Napa County websites. GIS data layers will be maintained on Regional Board and Napa County (Information Technology Services) websites, and available for use at the Napa County Assessors Office. GIS data layers will also be provided to project supporters (see Section E) and other interested groups or agencies upon request. Upon completion of the technical report for the TMDL (projected for December 2003), all field survey forms, maps, and data files developed for the study will be available to the public upon request. For management and archival purposes, electronic and paper copies of these data will be provided to CDFG, NMFS, Napa County Planning, Napa County RCD, U.S. Army Corps of Engineers, and the Water Resources Archive at UC Berkeley.

A.7 Expected Products/Outcomes

The expected products and outcomes of the proposed project will be reports and public workshops and are outlined in detail in Task 4 of Section A.3.

A.8 Work Schedule

A detailed work schedule is presented in Figure 13.

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

B.1 ERP, Science Program and CVPIA Priorities

The anticipated outcomes of the proposed project support several Draft Stage 1 Implementation Plan priorities, including: BR-5 (restore shallow water, stream, and riparian habitats for benefit of at-risk species); BR-6 (protect at-risk species in Bay using water management and regulatory approaches); BR-8 (use existing/proposed monitoring to improve strategies for restoring Bay fish populations and at-risk species); MR-5 (ensure restoration is not threatened by degraded water quality); and MR-6 (ensure recovery of at-risk species by developing conceptual models). ERP Goals addressed by the proposed project include: ERP 1 (recover at-risk species including steelhead trout and chinook salmon); ERP 2 (maintain and restore ecosystem processes to support self-sustaining native species assemblages); ERP 4 (protect habitat via holistic watershed assessment to guide management priorities); and ERP 6 (maintain or improve sediment and water quality). All Science Program Goals are integrated into our technical study, except for analysis of environmental justice and social issues associated with restoration, which will be addressed in the adoption of County Regulations (revised Conservation Regulations) and state regulatory actions (TMDL implementation). The proposed Napa River watershed analysis and restoration plan will contribute to the accomplishment of CVPIA Priorities to protect San Francisco Bay and enhance native fish and wildlife species associated with riverine and riparian habitats.

B.2 Relationship to Other Ecosystem Restoration Projects

Several restoration projects, plans, and studies are currently being implemented or planned in the Napa River basin that share this project's overarching goal of understanding and ultimately restoring ecosystem processes in the basin. Projects in the basin that relate directly to the efforts of this assessment project include:

- Napa River Sediment TMDL Phase I Study is a fish and wildlife limiting factors study being funded by Regional Board and California Coastal Conservancy. The goals of the study are to identify and rank the primary factors (with a focus on sediment) limiting native fish and wildlife (specifically steelhead, chinook salmon, and freshwater shrimp) in the Napa River Basin and to establish preliminary priorities for management and restoration.
- The Napa River Watershed Mapping Partnership is being lead by the Regional Board and funded through the CALFED Watershed Program to develop high-resolution digital topographic maps to accurately delineate the complete channel network in the Napa River watershed, map landslide hazard areas, predict channel response to disturbance, and evaluate distributions of native fish, amphibians, and other riparian species.
- The Napa River Flood Management Plan, designed by the Community Coalition for Napa Flood Management Plan and sponsored by the Napa County Flood Control and Water Conservation District, is a cooperative project to bring flood protection, watershed management, and environmental restoration to the Napa River Valley. The Plan is a multi-objective and restorative approach to flood protection that will restore

over 650 acres of high-value tidal wetlands of the San Francisco Bay Estuary while protecting homes, businesses, and public properties from 100-year flood levels.

- U.S. Army Corp of Engineers Napa River Project will reconnect nearly seven miles of the lower Napa River to its floodplain to provide flood protection while creating wetlands, maintaining fish and wildlife habitats, and retaining the natural characteristics of the river. Project features include creating marsh plain and floodplain terraces, removing dikes, relocating bridges, creating maintenance roads and recreation trails, and modifying the channel, levees, floodwalls, and pump stations. The Napa River Fisheries Monitoring Plan, an integral part of the Napa River Project, will evaluate how successful the restoration features of the project are in providing habitat for native fish.
- Department of Water Resources Fish Passage Improvement Program includes feasibility/removal studies for the City of Saint Helena to support the removal of York Creek Dam to improve passage for migrating fish.

B.3 Requests for Next-phase Funding
Not applicable; the applicant has not previously applied for or received funding from ERP. The proposed project is the second phase of a project currently being funded by the Regional Board, with additional funding provided by the Coastal Conservancy.

B.4 Previous Recipients of CALFED Program or CVPIA Funding
Previous funding awarded to the applicants from the CALFED or CVPIA programs are described in detail in Table 2.

B.5 System-wide Ecosystem Benefits
The data and analyses provided by the proposed project will produce synergistic, watershed-wide benefits when combined with the other conservation, restoration, and research projects currently being conducted in the Napa River watershed that are described in Section B.2. The proposed project will combine with the other efforts currently underway in the watershed to provide the biological and geomorphic information necessary to make informed land management decisions and prioritize restoration actions that will improve ecological conditions and geomorphic processes throughout the Napa River Basin.

In addition, a portion of the data and analyses that are produced during the proposed project may be applicable to the Sonoma Creek watershed. Sonoma Creek is the adjacent watershed west of the Napa River basin and the two watersheds share similar climate, hydrology, and land use issues.

B.6 Additional Information for Proposals Containing Land Acquisition
N/A

C. QUALIFICATIONS
The Project Team consists of the San Francisco Bay Regional Water Quality Control Board (Regional Board), Stillwater Sciences, the University of California at Berkeley, and the San Francisco Estuary Institute. The Regional Board will act as the local lead, conduct public outreach, hold public workshops, and review and contribute to project planning and implementation. Stillwater Sciences, as a subconsultant, will be the technical lead, organizing, planning, and conducting all studies. Stillwater Sciences with their subconsultant SFEI will evaluate the potential for an historical ecological approach to the question of limiting factors. The Regional Board will be the CALFED contractee and project manager and will be responsible for payments, reporting, and accounting.

The lead management team will consist of Michael Napolitano (Regional Water Quality Control Board), Bruce Orr (Stillwater Sciences), and Robin Grossinger (SFEI). The team leaders will be supported by experienced staff members, all of whom have extensive experience in the Napa River basin.

San Francisco Bay Regional Water Quality Control Board: The San Francisco Bay Regional Water Quality Control Board (Regional Board) regulates surface water and groundwater quality in the San Francisco Bay Area. The area under the Regional Board's jurisdiction includes San Francisco, San Pablo, and Suisun bays. It also includes Tomales Bay, streams and rivers flowing into the bays beginning at a point just west of Antioch, ocean waters, and groundwaters.
Michael Napolitano will be the Project Manager, with responsibility for oversight of contractors and review and approval of all work. Mr. Napolitano is currently responsible for coordination and oversight of the Napa River sediment total maximum daily load (TMDL) study. Mr. Napolitano has substantial professional experience in conducting technical studies, project management, public presentations, grant administration, stakeholder coordination, and preparation of technical reports.

Stillwater Sciences: Stillwater Sciences is a firm of biological, ecological, and geological scientists. The company specializes in developing new scientific approaches and technologies for problem-solving in aquatic and terrestrial systems and has extensive experience and in-house ability in GIS applications to environmental analyses. Stillwater Sciences is currently working with the Regional Board to complete Phase I Napa studies.
Dr. Bruce Orr has over 20 years of experience in population and community ecology of aquatic, terrestrial, and freshwater and tidal wetland environments in California and the western United States. Dr. Orr has managed a variety of complex, multi-year projects that have focused on the use of watershed analysis and ecosystem management approaches to meet a variety of regulatory needs, including TMDLs and jurisdictional delineation of wetlands, state and federal Endangered Species Acts (including HCPs), and California Forest Practice Rules.
Mr. Frank Ligon is an aquatic ecologist and geomorphologist with over 20 years of experience in examining the role of fluvial processes and morphology in the ecology of stream fish, invertebrates, and plant communities. He has successfully managed several complex, long-term projects involving watershed analysis, salmon ecology and restoration, geomorphology, and riverine ecosystem restoration.
Mr. Greg Fanslow is an ecologist and project manager with expertise in terrestrial and aquatic ecology, public speaking and presentation, and TMDL-related issues. He is experienced in environmental data collection and analysis, biological resource and population modeling, and statistical analyses. He is trained in aquatic habitat evaluation, sediment sampling and sorting methods, and stream channel surveying techniques.
Mr. Martin Trso is a California Registered Geologist with over 11 years of geologic mapping and interpretation experience, and over 8 years of experience in quantitative process geomorphology. His current work on the Napa River includes channel assessment, sediment transport and deposition, hydrologic processes and conducting field surveys.
Mr. Ethan Bell is a Fisheries Biologist with a Master's degree and extensive experience working with salmonids in California coast range rivers. He has expertise in fish sampling techniques, including use of passive integrated transponders (PIT tags), and operation of fyke, pipe, and rotary screw traps and has helped with the fisheries component of the Phase I Napa River studies.
Mr. Douglas Allen is a Geomorphologist and Geographic Information Systems (GIS) Specialist with over 10 years of experience in physical geography and geology, with an emphasis on hillslope and fluvial geomorphology, digital terrain modeling, remote sensing, and GIS. Mr. Allen specializes in watershed analysis; he co-developed a basin-scale stream temperature model (BasinTemp®) and has conducted digital terrain modeling and GIS/shallow landslide hazard potential analysis on the Napa River.

San Francisco Estuary Institute: The Historical Ecology Project of the San Francisco Estuary Institute (SFEI) endeavors to recover and synthesize the diverse, underutilized, and gradually diminishing historical

resources for understanding the earlier structure and function of Bay Area creeks, wetlands, and terrestrial habitats, integrating historical data with maps and timelines to provide effective planning and management for habitat and fisheries restoration.
Mr. Robin Grossinger works on wetlands and is the Technical Director of the Historical Ecology Project. In his Master's research, he used historical data to characterize the natural plan form of tidal marshlands in the San Francisco Estuary, and the effects of local freshwater inputs on subregional marsh form.

Senior Project Scientist
Senior project scientists are active participants in Stillwater Sciences' technical studies, from the proposal stage through field reconnaissance and discussions of field methods, to data interpretation and report review. Unlike peer-reviewers who provide input at the end of the project, senior project scientists provide ongoing support to ensure that the best possible science is used in the project.
Dr. William Dietrich is a fluvial geomorphologist and chairman of the Earth and Planetary Science Department, UC Berkeley. Dr. Dietrich's research has been instrumental in the development of the watershed analysis methodologies that are now being used to guide much of the planning effort for the restoration of Pacific salmon. Much of his recent work has focused on the downstream effects of dams and land use on fluvial systems, including the linkages between physical processes and aquatic biota, and the development of methods for restoring degraded rivers.

D. COST

D.1 Budget
Please see web forms and Attachment A for budget information.

D.2 Cost-sharing
Cost-sharing will be achieved primarily through in-kind contributions of data, staff time, and equipment use. The Napa County RCD will contribute data from their turbidity, flow, and hillslope runoff monitoring programs and staff time to obtain permission to access privately-owned parcels. The CDFG will contribute data from their habitat surveys and fish growth studies and staff-time to provide scientific peer review of analyses and reports produced during the proposed project. In addition, the Regional Board will contribute staff time for project administration, public outreach and education, obtaining permission for access to private property, interagency coordination, technical analysis of opportunities for holistic water resources management, data management, and distribution of project reports and data. Estimated value of Regional Board in-kind services is $96,000.

E. LOCAL INVOLVEMENT
As a second-phase project, the proposed assessment will continue to coordinate with local government, landowners, and other project stakeholders. Phase II will provide public outreach by publicly presenting and distributing the data collected and reports produced by the project (see Section A.6).

Many groups and agencies have expressed support for the proposed project, including the Napa County Administrator, Napa County Flood Control and Water Conservation District, Assemblymember Patricia Wiggins, Napa County Farm Bureau, Napa County Resource Conservation District, The Land Trust of Napa County, San Francisco Estuary Institute, Friends of the Napa River, California Department of Fish and Game, California Coastal Conservancy, National Marine Fisheries Service, U.S. Environmental Protection Agency, and U.S. Army Corps of Engineers. In addition, many landowners along the proposed study reaches are supportive of the proposed project and have given permission to access their land for data collection. Letters of support from groups, agencies, and landowners are available upon request.

F. COMPLIANCE WITH STANDARD TERMS AND CONDITIONS

The applicants have reviewed and are able to comply with the terms and conditions set forth in Attachments D and E of the Proposal Solicitation Package.

G. LITERATURE CITED

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Tables, Figures, and Attachments

Table 1. Summary of conceptual models and hypotheses developed during Phase I regarding historical and current conditions in the main stem Napa River and their potential effects on various life stages of chinook salmon.

Life History Stage	Historical Condition	Current Condition
Upstream migration	Upstream migration might have been delayed until first substantial rains (typically in November or December) provided sufficient flow for fish to negotiate bars that created barriers at low flows. The population was probably late fall-run.	Probably similar to historical condition, with fewer bars to negotiate but possibly increased groundwater withdrawals resulting in lower flows (and possibly dry reaches) creating temporary barriers
Spawning and incubation	Spawning habitat was relatively abundant, and probably of good quality (but actual quality unknown).	Spawning area has been greatly diminished, with higher amounts of fine sediments resulting in presumed decrease in gravel quality (will collect winter permeability data this year under Phase I to assess gravel quality). Bed mobility has likely increased, leading to a high scour rate of gravels and increased mortality during the egg incubation stage.
Rearing	Abundant, good quality fry rearing habitat (riffle margins, side channels, sloughs) with abundant food supply likely to have been present in the Napa River. The estuary may have provided important rearing habitat for juvenile chinook. Some juveniles might have migrated to the estuary for rearing soon after emergence (within 1-2 weeks), while others might have reared in the river until warmer temperatures in late spring or summer triggered migration to the estuary.	Very limited rearing habitat is present in the Napa River (slough, side channel, and riffle margin habitats have decreased substantially). High mortality is likely from exotic predators now found in the dominant long, deep pool habitat. Estuarine habitat loss and degradation may substantially limit the potential for rearing in the estuary. In addition, downstream migration may be limited or prevented at times by lack of flow (some reaches of the main stem go dry).
Outmigration	Unlike many Central Valley rivers draining the Sierra Nevada, the natural hydrograph did not include a snowmelt spring runoff peak that would have facilitated outmigration, but outmigrants had only a relatively short distance to travel to reach the bay (and did not require a long journey through the Delta region. Exotic predators were limited or absent. It is possible that warm temperatures occurred during outmigration in some years (such effects would be exacerbated in years when late spawning occurred due to late onset of winter baseflows)	It is likely that outmigrants experience high mortality as they have to run through a gauntlet of exotic predators in the long, deep pools now present in the main stem. There is a possible decrease in spring flows, which were probably already low under historical conditions, which might reduce outmigrant success. Water temperature may have increased, which might reduce growth and/or survival.
Summary of chinook production potential	Overall, the Napa River likely had reasonably high chinook salmon production, with low fall flows and spring temperatures as the most likely key limiting factors. Likely supported a sustainable population of chinook.	Currently is extremely limited for chinook salmon production. Spawning gravel quantity and quality, redd scour, reduced riverine and estuarine rearing habitat, and introduced predators are likely key limiting factors. Delayed upstream adult migration caused by low fall flows may also be a key factor limiting production in some years. There is evidence that some, but very limited, successful spawning has occurred in recent years.

Table 2. Previous receipt of CALFED or CVPIA funding.

Project title	Program/Project Number	Current status	Project milestones
Regional Board previous CALFED Program funding			
Napa River Watershed Mapping Partnership	CALFED Watershed Program/Proposal #119	preparing contract	Award letter was received August 7, 2001; currently awaiting instructions to begin contract preparation.
Stillwater Sciences previous CALFED Program funding			
Merced River Corridor Restoration Plan-Phase II	ERP/ Project #98E-09	complete	(1) social, institutional, and infra-structural opportunities and constraints to restoration analysis; (2) baseline evaluations of geo-morphic and riparian vegetation conditions
Merced River Corridor Restoration Project-Phase III	ERP/Project #2000 E-05	in progress	development of (1) geomorphic-ally functional channel and flood-plain design guidelines; (2) the Merced River Corridor Restoration Plan; (3) conceptual designs for 5 top-priority restoration projects
A Mechanistic Approach to Riparian Restoration in the San Joaquin Basin	ERP/#99-B152	starting-up/in progress	(1) literature and existing data review; (2) development of conceptual model and study plan
Tuolumne River Coarse Sediment Management Plan	Service Agreement #010801	in progress	(1) fine sediment report; EACH and stock recruitment modeling underway
M&T Ranch Pump Intake Assessment	Contract 01A120210D	complete	developed mitigating techniques for sediment burial of pump intake
Saeltzer Dam Removal Analysis	Contract B-81491	complete	(1) application of sediment transport model to a dam removal project; (2) pre- and post-dam removal channel monitoring
Stillwater Sciences previous CVPIA funding			
Merced River Corridor Restoration Plan-Phase I	AFRP/	complete	formation of the Merced River Stakeholder Group and Technical Advisory Committee
Merced River: Ratzlaff Project	AFRP/CVPIA 11332-9-MO79	complete	provide comments on existing and proposed restoration efforts; coordinate with Merced River Restoration Project
Stanislaus River: 2 Mile Bar	AFRP/CVPIA 11332-9-MO80	complete	prepare summary of restoration potential and strategies, focusing on geomorphic opportunities and constraints
Stanislaus River: Smolt Survival	AFRP/CVPIA 11332-0-MO09	complete	prepare assessment of coded wire tag and multiple mark-recovery smolt survival assessment programs
Calaveras River Spawning Habitat Evaluation	AFRP/	complete	conduct reconnaissance-level evaluation of steelhead and salmon habitat conditions and population dynamics

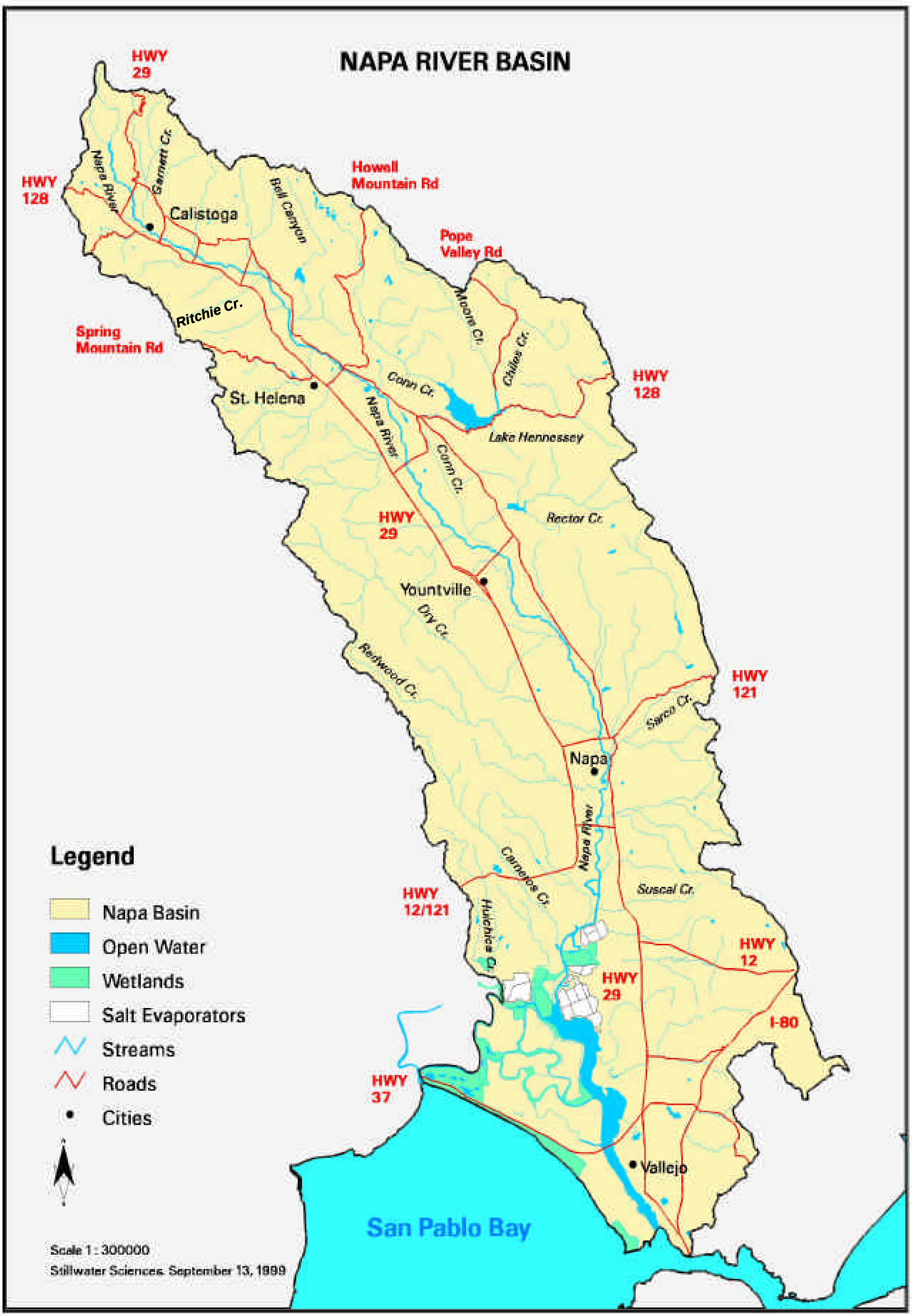


Figure 1. Napa River location map.

Stillwater Sciences

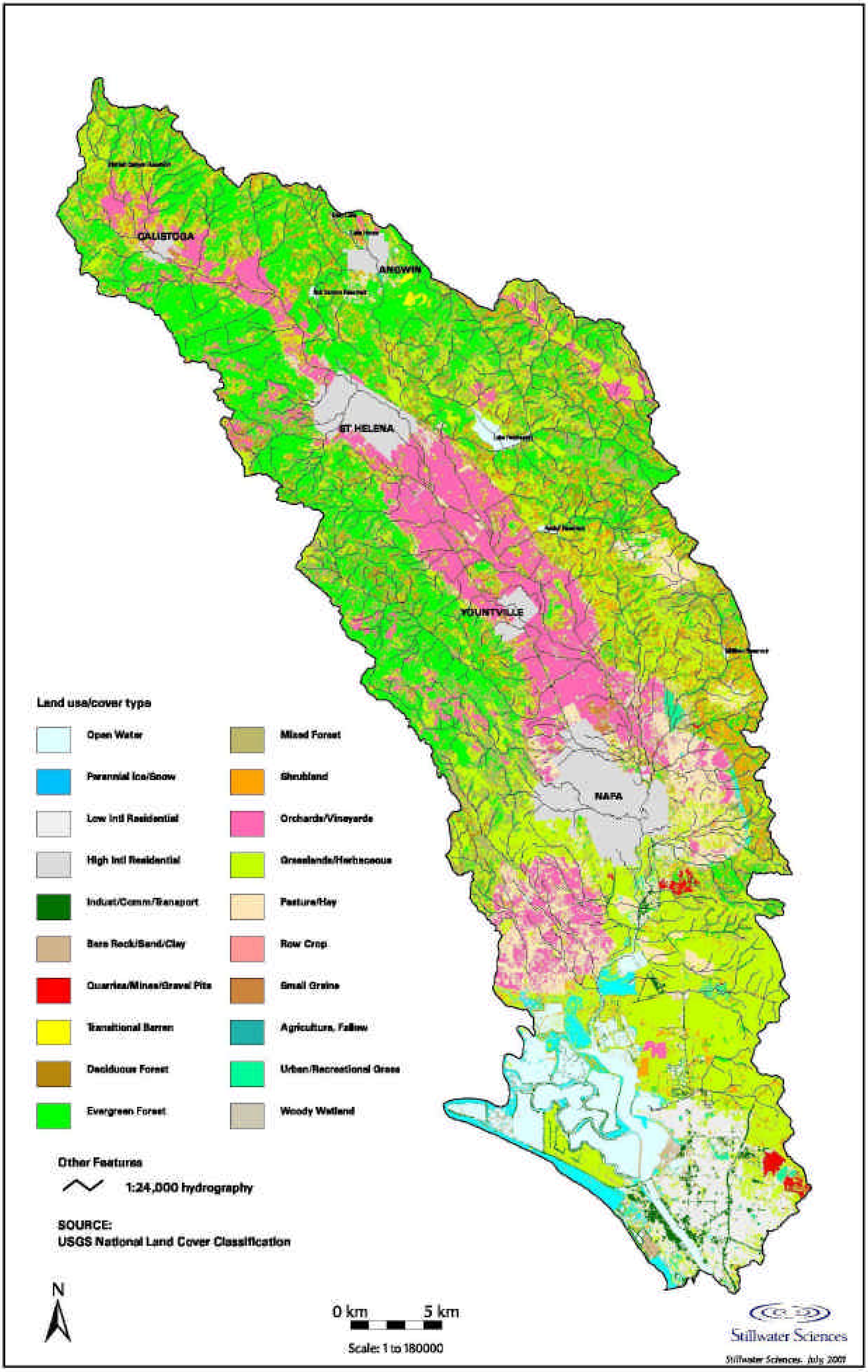


Figure 2. Land use and land cover types in the Napa River basin.

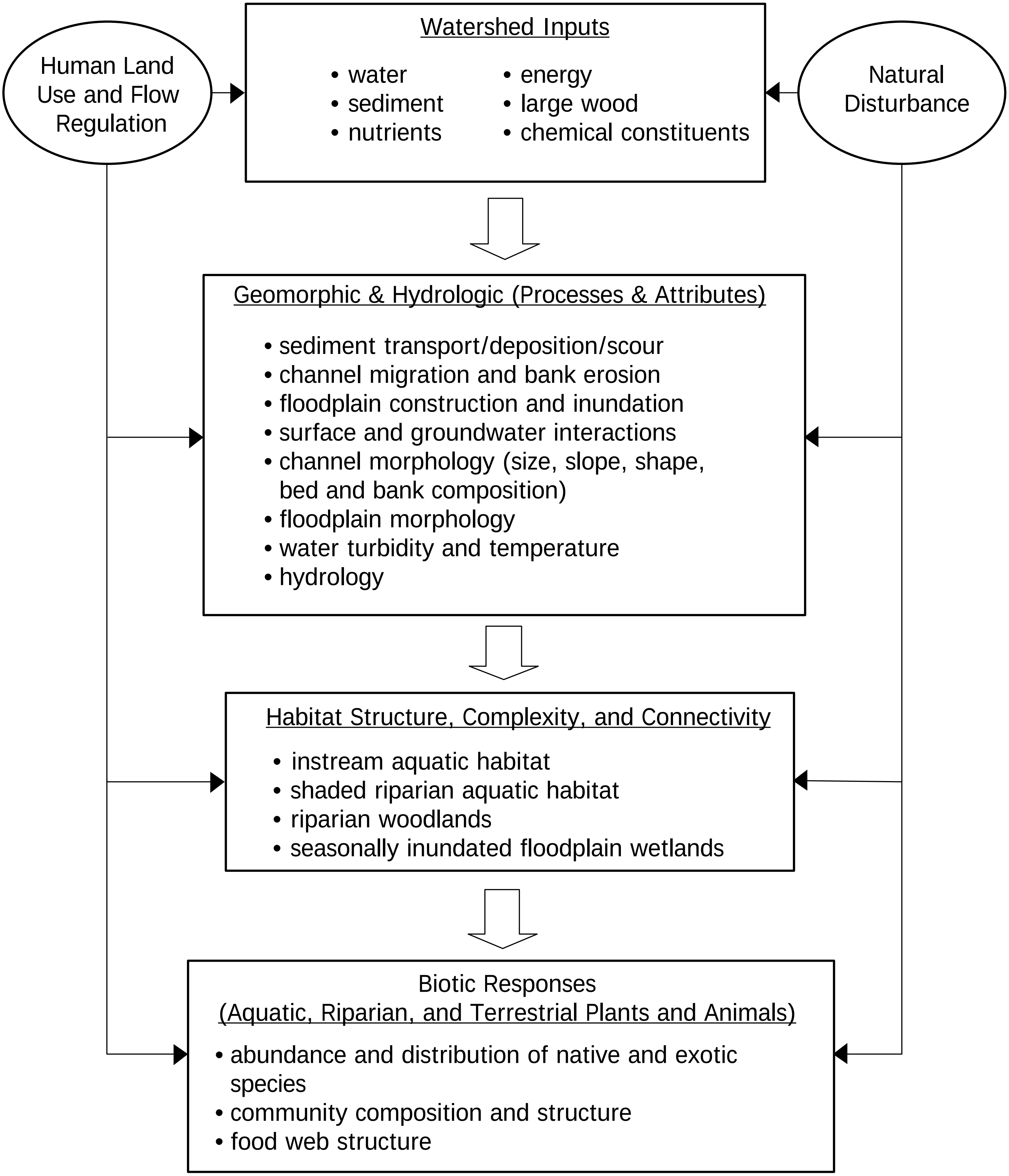


Figure 3. A simplified conceptual model of the physical and ecological linkages used in developing biotic response indices of river ecosystem health.

Stillwater Sciences

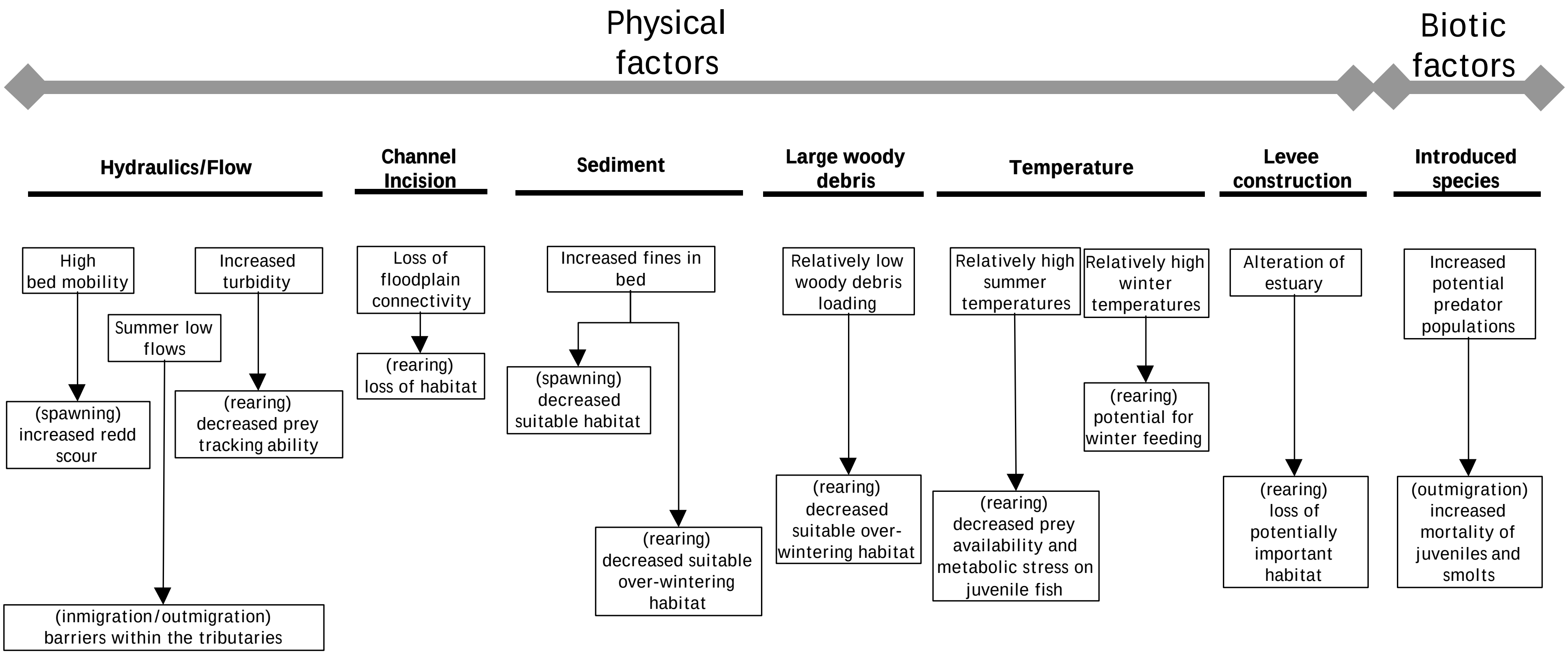
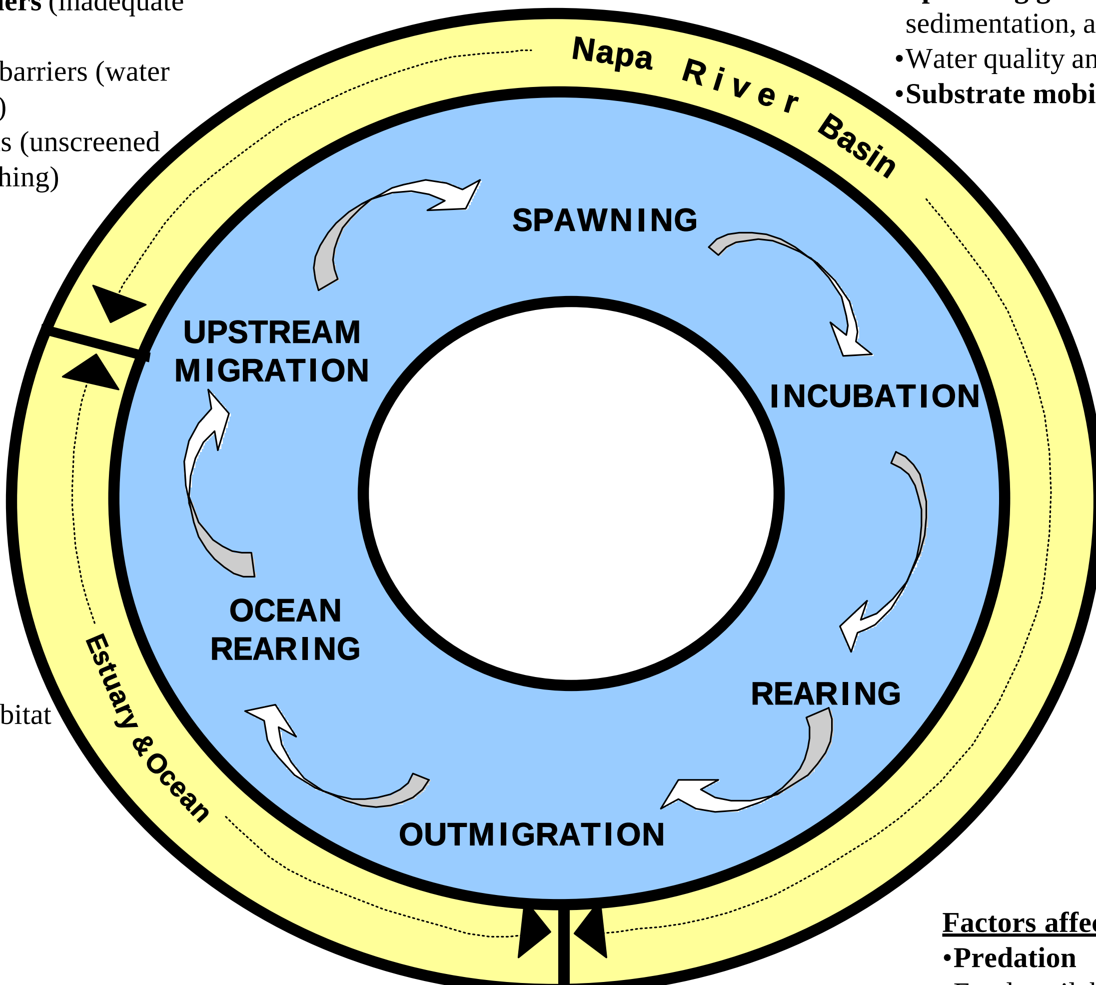


Figure 4. Simplified conceptual model of factors potentially limiting steelhead and chinook salmon production in the Napa River basin.

Stillwater Sciences

Factors Affecting Upstream Migration
- Attraction flows
- **Physical migration barriers** (inadequate flows)
- Environmental migration barriers (water quality, water temperature)
- Migration corridor hazards (unscreened diversions, bypasses, poaching)

Factors Affecting Spawning and Incubation
- **Spawning gravel quantity** and redd superimposition
- **Spawning gravel quality** (intergravel flow, sedimentation, armoring)
- Water quality and temperature
- **Substrate mobility/scouring (redd scour**



Factors Affecting Fry Rearing
- **Availability of suitable stream margin and off-channel habitat for fry rearing**
- Water quality (temperature, toxics)
- **Predation**
- Displacement by high flows

Factors Affecting Estuary and Ocean Rearing
- Loss of estuarine rearing habitat
- Temperature
- Water quality
- Dissolved oxygen
- Harvest
- Ocean conditions

Factors affecting Juvenile Rearing
- **Predation**
- Food availability
- Water quality and **temperature**

Factors Affecting Outmigration
- **Adequate flows for outmigration**
- **Water quality and temperature**
- **Predation**
- Diversion hazards

Figure 5a. Chinook salmon life cycle and potential limiting factors in the Napa River basin. Key limiting factors are shown in bold.

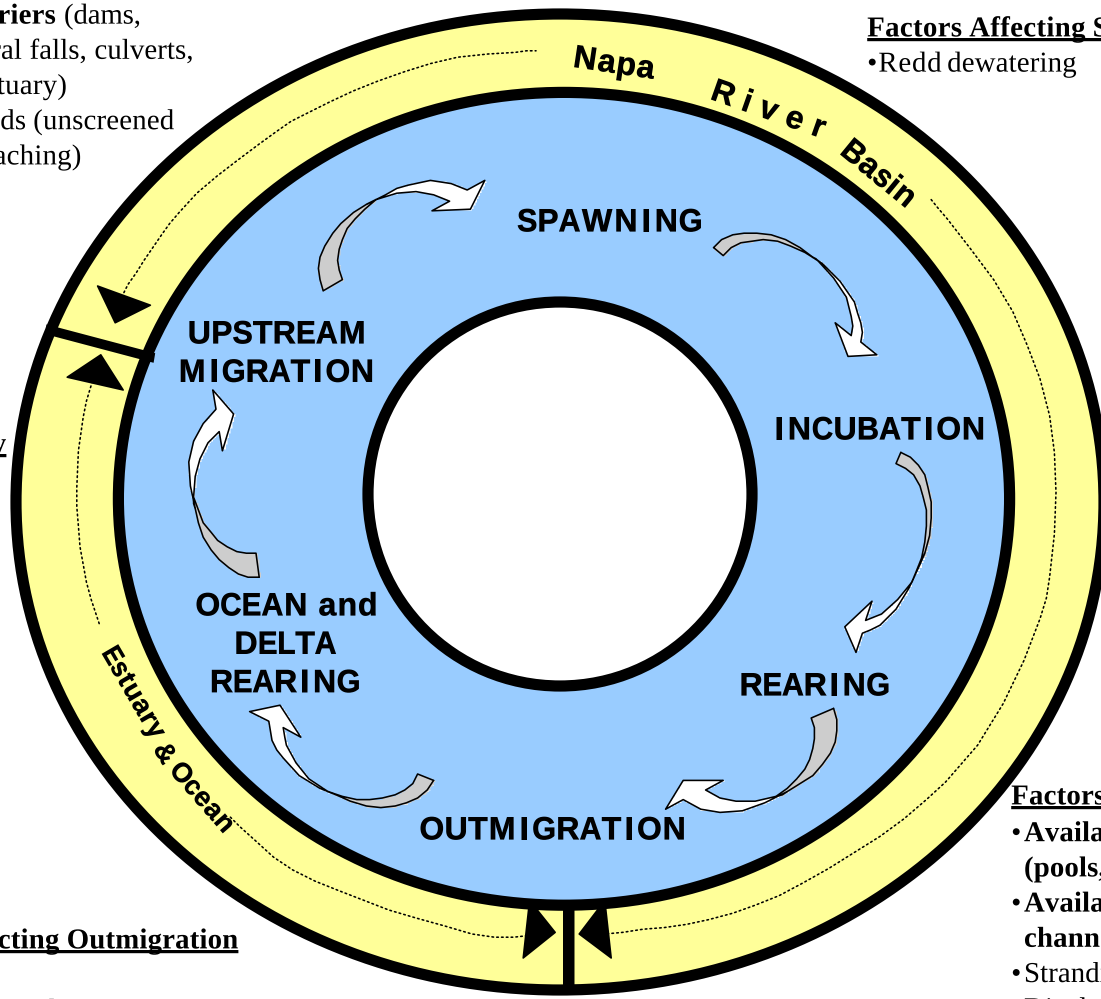
Stillwater Sciences

Factors Affecting Upstream Migration

- **Physical migration barriers** (dams, dewatered reaches, natural falls, culverts, sand bars at mouth of estuary)
- Migration corridor hazards (unscreened diversions, bypasses, poaching)

Factors Affecting Spawning and Incubation

- Redd dewatering



Factors Affecting Fry Rearing

- Proximity of fry rearing habitat to spawning areas
- Water quality (temperature, toxics)
- Food availability
- Stranding by low flows
- Displacement by high flows

Factors Affecting Estuary and Ocean Rearing

- Loss of estuarine rearing habitat
- Temperature
- Water quality
- Dissolved oxygen
- Harvest
- Ocean conditions

Factors affecting Juvenile Rearing

- **Availability of oversummering habitat (pools, temperature refugia)**
- **Availability of overwintering habitat (in-channel LWD, interstitial habitat)**
- Stranding by low flows
- Displacement by high flows
- **Food availability**
- Water quality and **temperature**

Factors Affecting Outmigration

- **Predation**
- Diversion hazards

Figure 5b. Steelhead life cycle and potential limiting factors in the Napa River basin. Key limiting factors are shown in bold.

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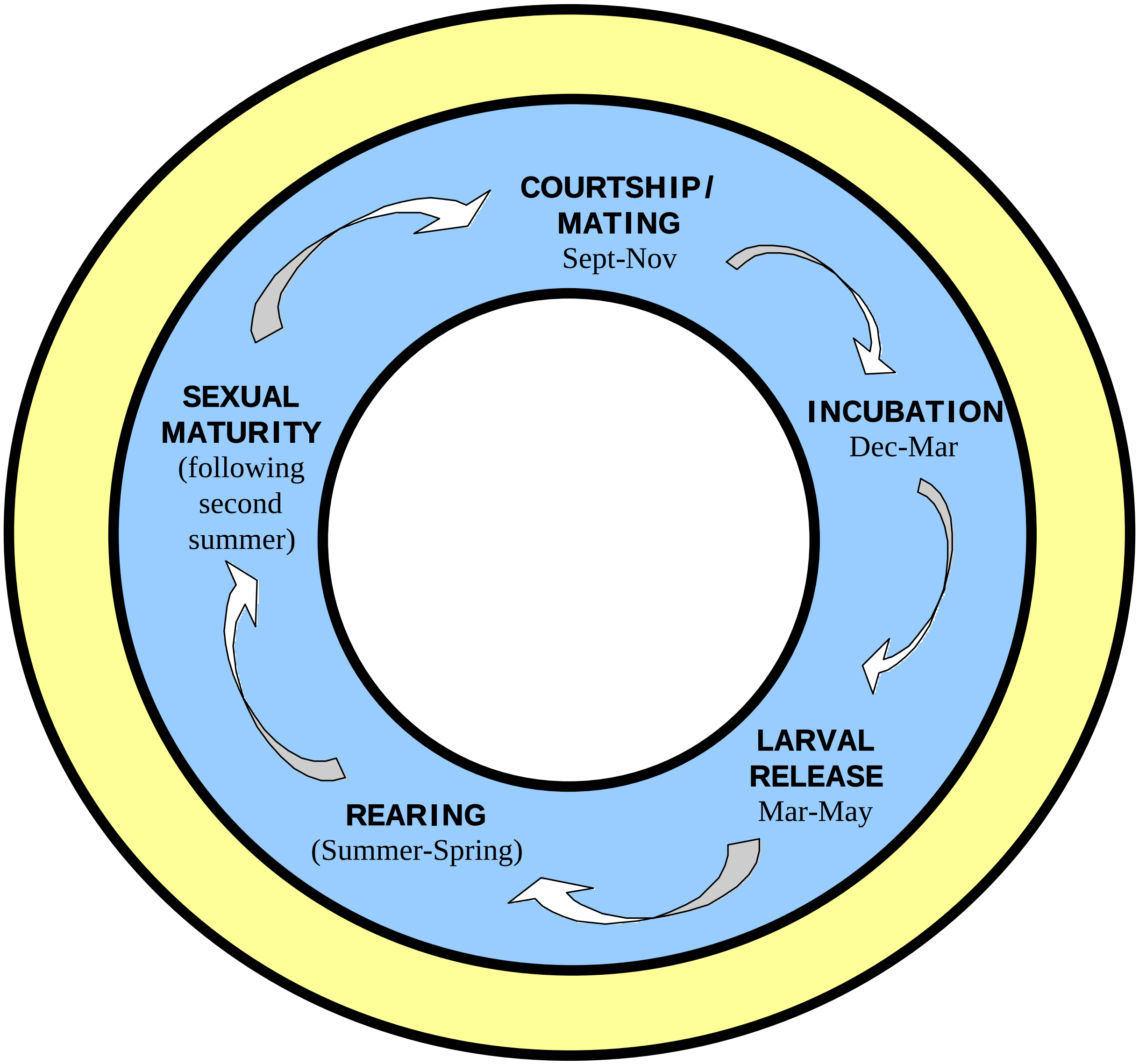

Potential Limiting Factors

- Water quality--temperature, dissolved oxygen, toxins
- **Cover habitat--overhanging banks for overwintering and submerged leafy branches during summer**
- Flow--flushing flows during the winter and flows for dispersal in the spring
- Barriers (both physical and flow-related)
- Predation (by both native and introduced species)
- Disease/parasites

Figure 5c. Simplified California freshwater shrimp life cycle and potential limiting factors in the Napa River basin (based on USFWS 1998). Because there is so much uncertainty regarding details of California freshwater shrimp life history, factors are not identified specific to life history stage. **Key limiting factors are shown in bold.**

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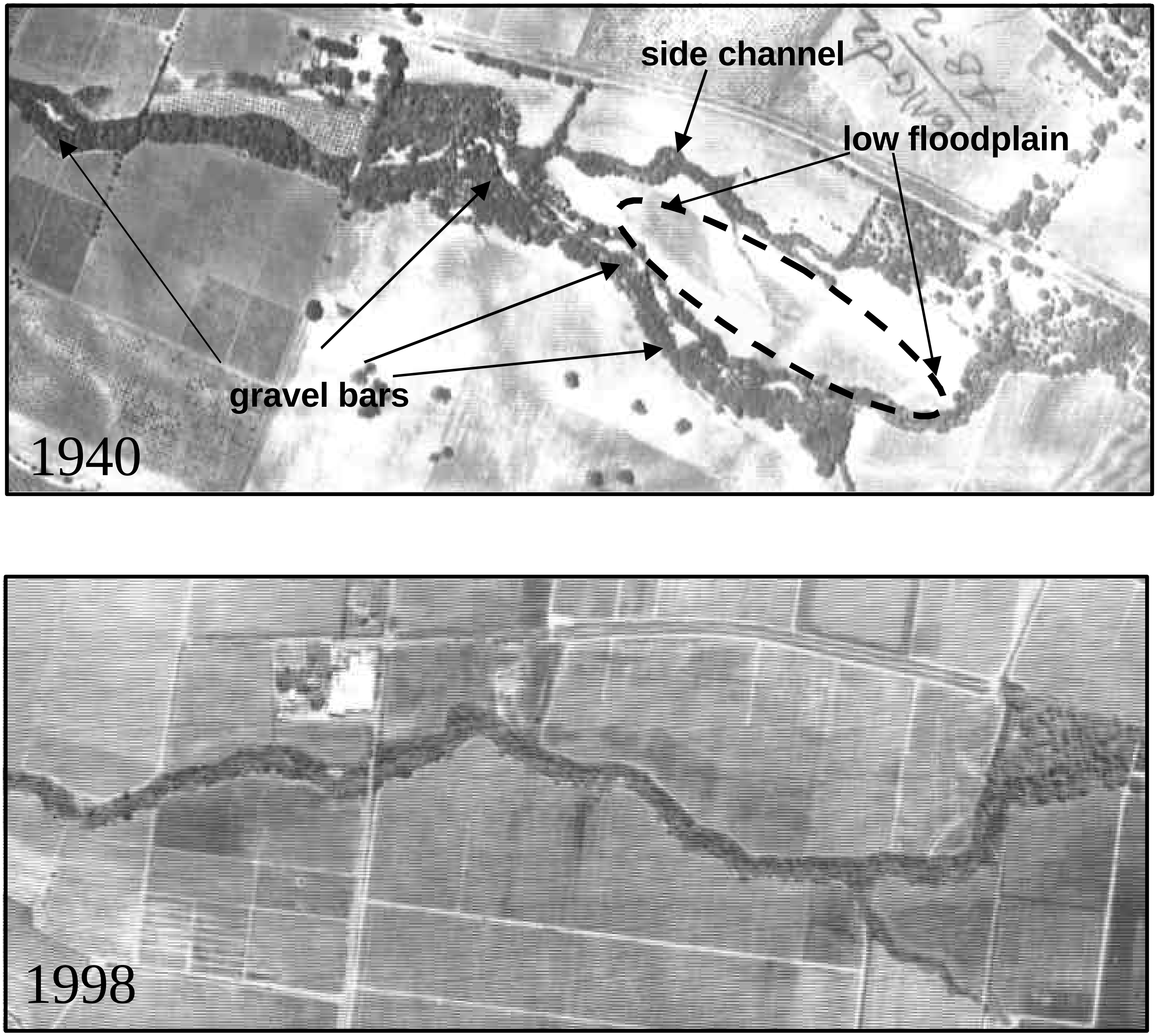

Figure 6. Comparison of 1940 and 1998 aerial photographs of the mainstem Napa River, north of Ritchie Creek.

In 1940, the channel was mainly characteristic of a wandering stream with local areas containing braided gravel bars within the low-flow channel. The channel was connected to its floodplain with a well defined side channel, which served as backwater rearing habitat for salmonids.

The 1998 aerial photograph depicts a simplified channel where the channel is narrowed and is no longer connected with the floodplain (position of previous overflow channels can only be faintly distinguished by dark traces on photo). These changes are most likely due to channel incision, levee construction, and LWD removal.

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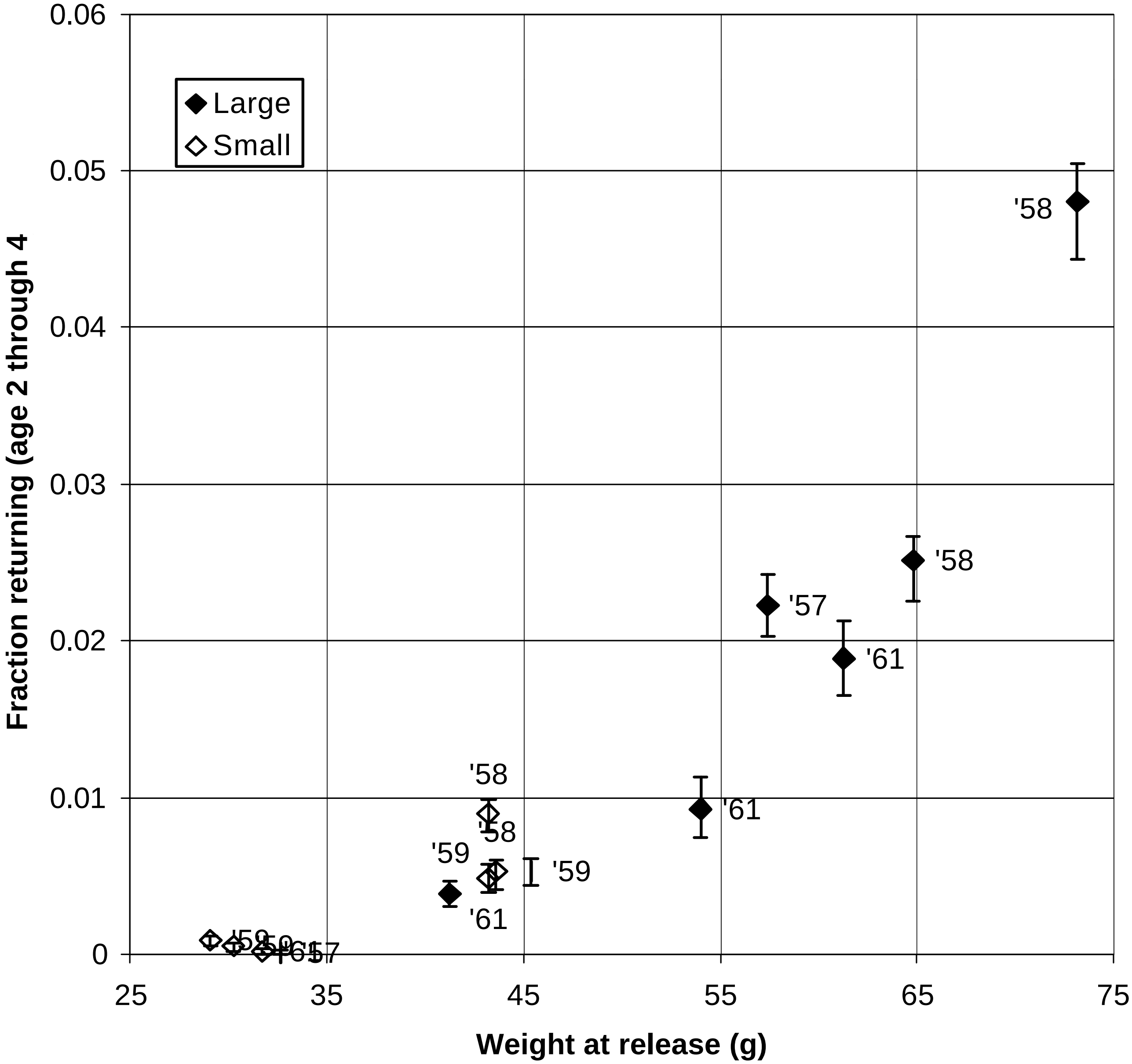

Figure 7. Probability of return of small versus large steelhead hatchery smolts released between 1957 and 1961, from a mark-recapture study on Casper Creek, a small coastal stream in Mendocino County. Source: Kabel and German 1967

Results indicate a striking exponential relationship between smolt size at the time of outmigration the chances of successful return as an adult, indicating that increased size at time of smolting strongly increases the probably of successful return to the system as an adult. In view of the importance of smolt size for successful adult returns shown by these data, the potentially limited feeding opportunities in the Napa system that result from drying of riffles and elevated temperatures led to the hypothesis that insufficient juvenile growth could dramatically reduce the number of returning adults.
Source: Kabel and German 1967

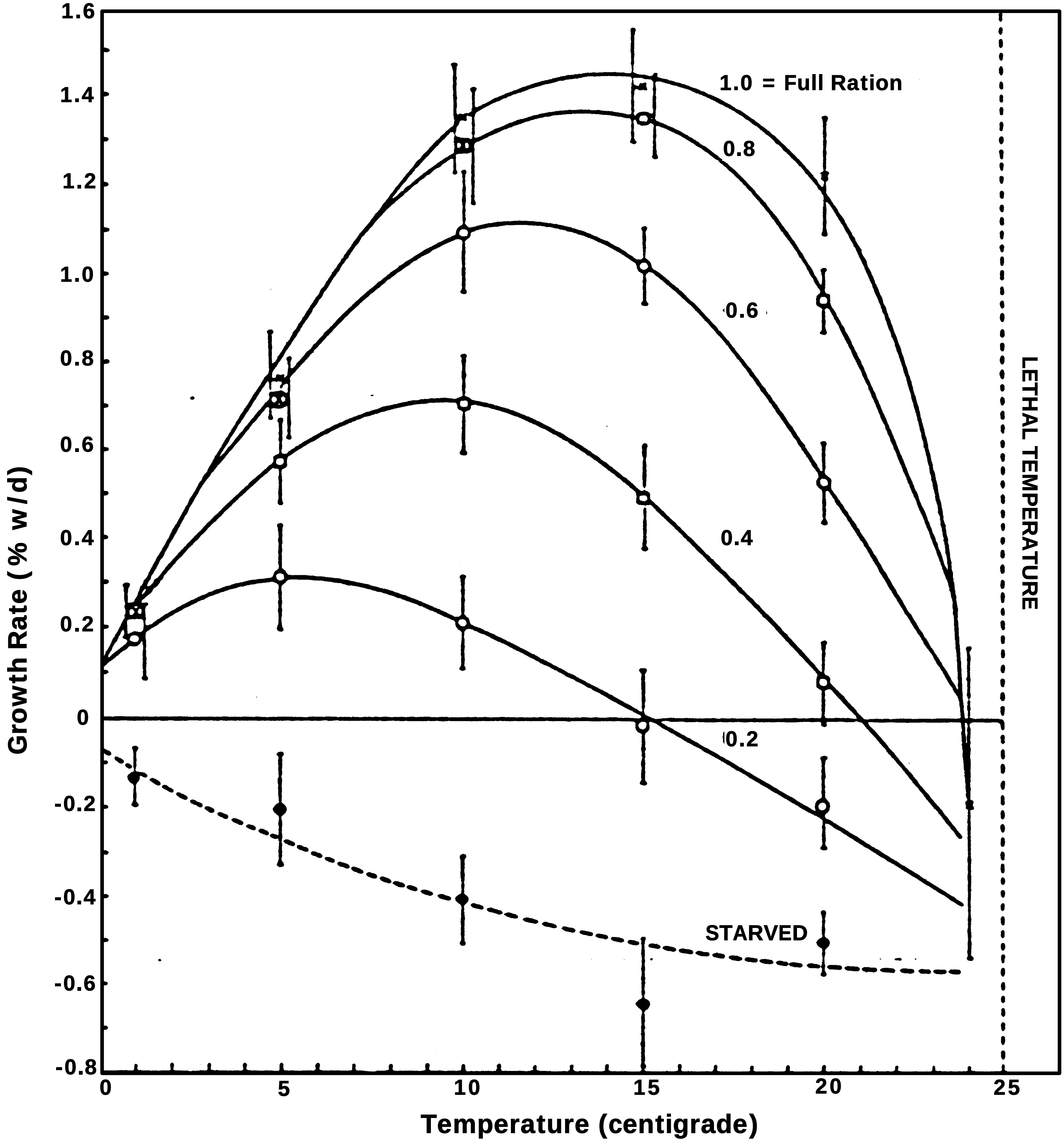

Figure 8. Stream temperature versus steelhead growth rate. **Source: Brett et al (1969).**

This figure illustrates the relationship between food availability, temperature, and growth rates of steelhead in a laboratory experiment in which steelhead juveniles were held at a variety of temperatures and groups at each temperature were fed different levels of ration. The results indicate that at a given ration level, increasing temperatures result in increased growth rate up to some optimal point, beyond which growth rates decline.

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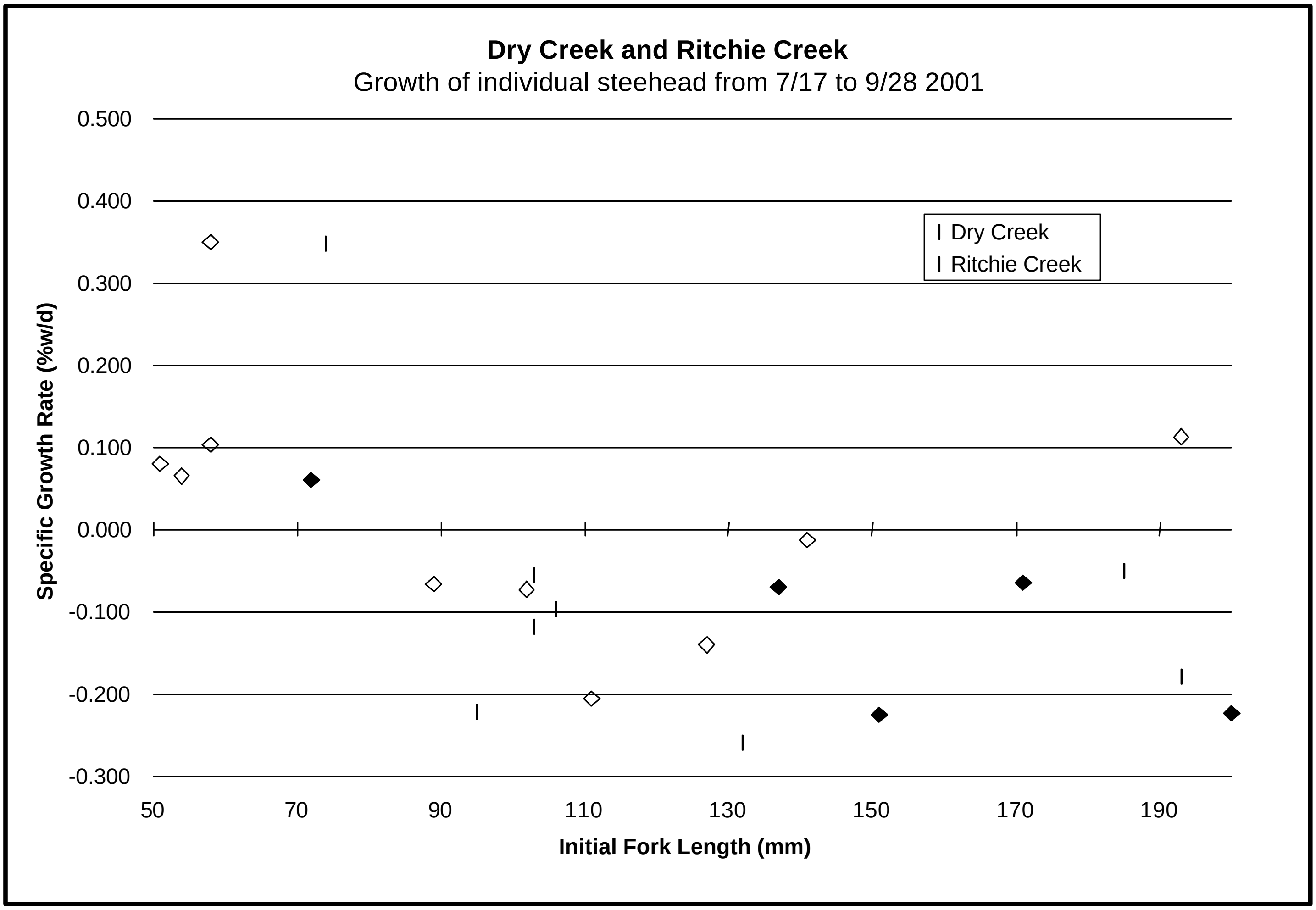
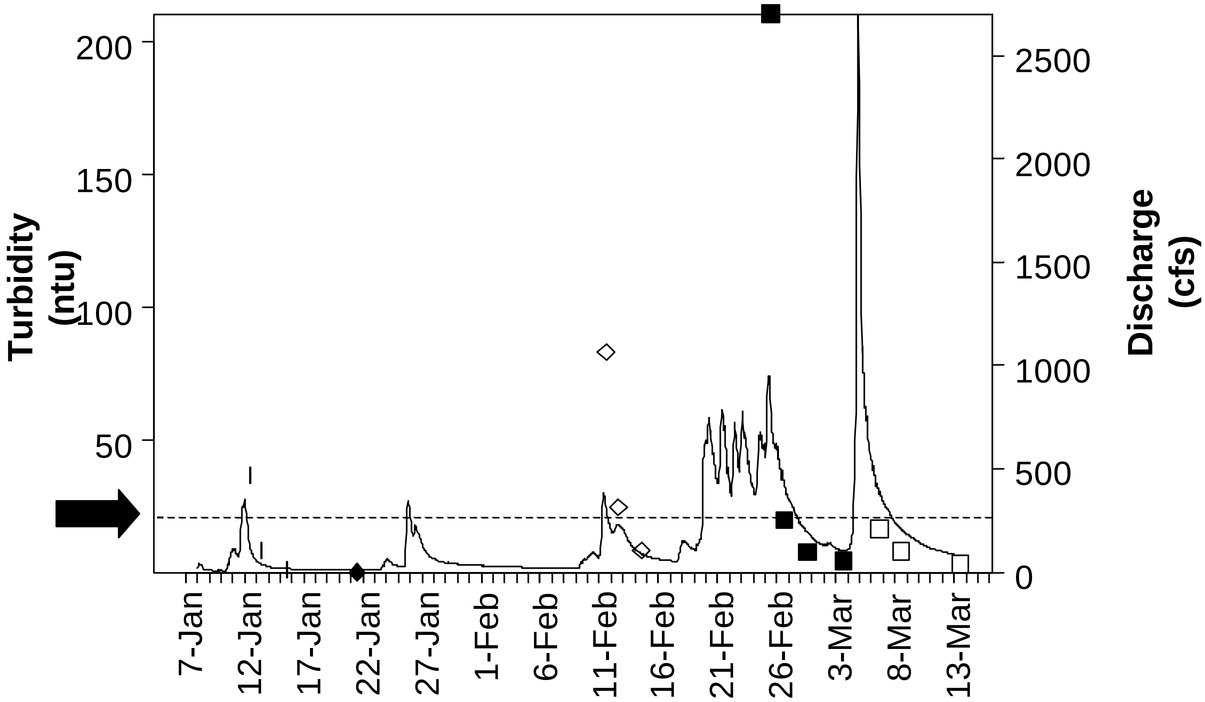


Figure 9. Little or negative summer growth of juvenile steelhead.
To determine whether riffle/pool connectivity (a function of flow) and elevated temperatures have an impact on summer growth of steelhead, a growth pilot study was conducted between July and late September 2001. Study streams were Ritchie Creek and Dry Creek, tributaries on the western side of the Napa River Basin. These tributaries were selected to represent different levels of riffle/pool connectivity, with Ritchie Creek having somewhat better connectivity between riffles and pools. Steelhead were captured, measured, and weighed and given individual marks, using subcutaneous elasto-polymer injections, early in the summer. At the end of summer, fish were recaptured so that change in length and weight could be determined.

Provisional data analysis for this pilot study indicates that most steelhead lost a significant amount of weight over the course of the study, with only the smallest fish making extremely small positive gains. The tendency of the smallest fish to consistently show positive growth rates while larger fish consistently showed negative growth rates may be an indication of a bioenergetic issue, in which the energetic cost of pursuing a given prey item is higher for a large fish than for a small fish. If this were true, this would also imply that large fish do not enjoy a competitive advantage over smaller fish. The issue of fish growth and invertebrate food sources will be explored in more tributaries at more times of year to gain a full understanding of factors controlling fish growth.

Dry Creek at Solano Avenue



Redwood Creek at Redwood Drive

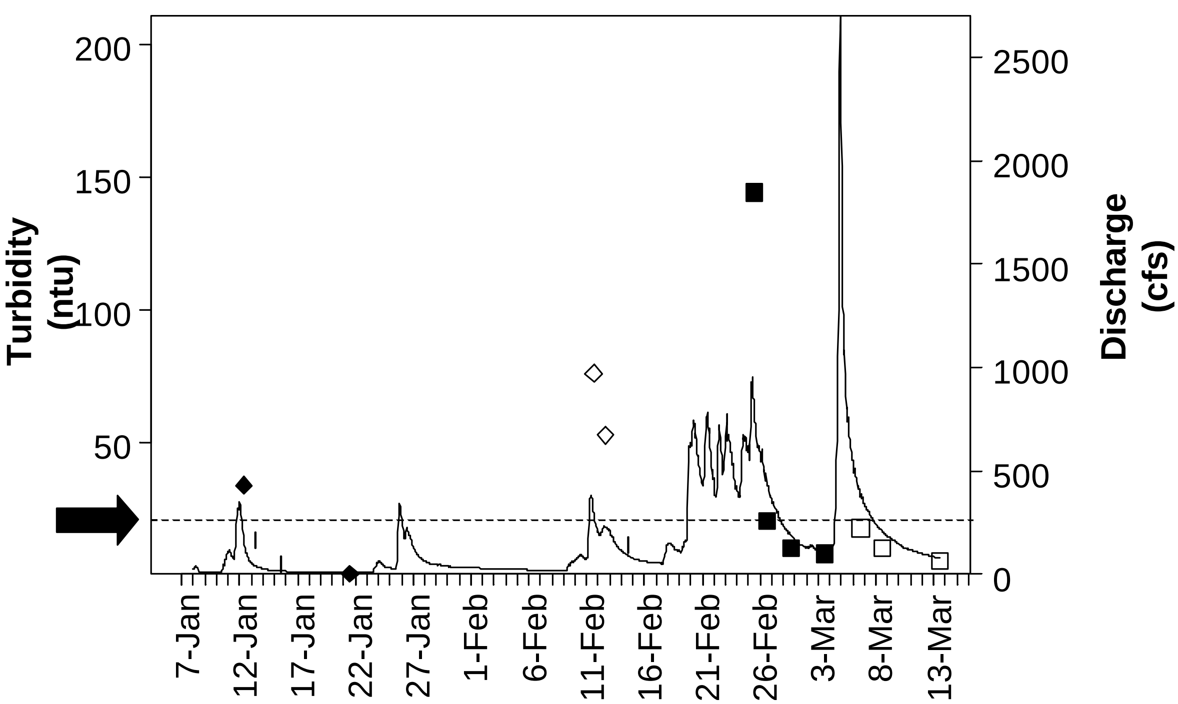


Figure 10. Turbidity does not appear to impair wintertime growth of juvenile steelhead. As a result of concerns about hillslope development resulting in increased turbidity in the Napa system, a turbidity study was conducted between January and March 2001 to determine if winter baseflow turbidity levels are high enough to interfere with visual prey tracking by juvenile steelhead. Turbidity was sampled at eighteen tributaries following significant storm events. The results of this effort, illustrated for two representative tributaries above, indicate that while turbidity increases markedly during peak storm runoff, it quickly falls to low levels within one to two days. The conservative threshold for an impact to successful feeding of 20 NTU (see arrow at Y axes) indicated that no feeding opportunities would have been lost during base flows and that turbidity can be assumed not to be a limitation on steelhead growth during the winter months.

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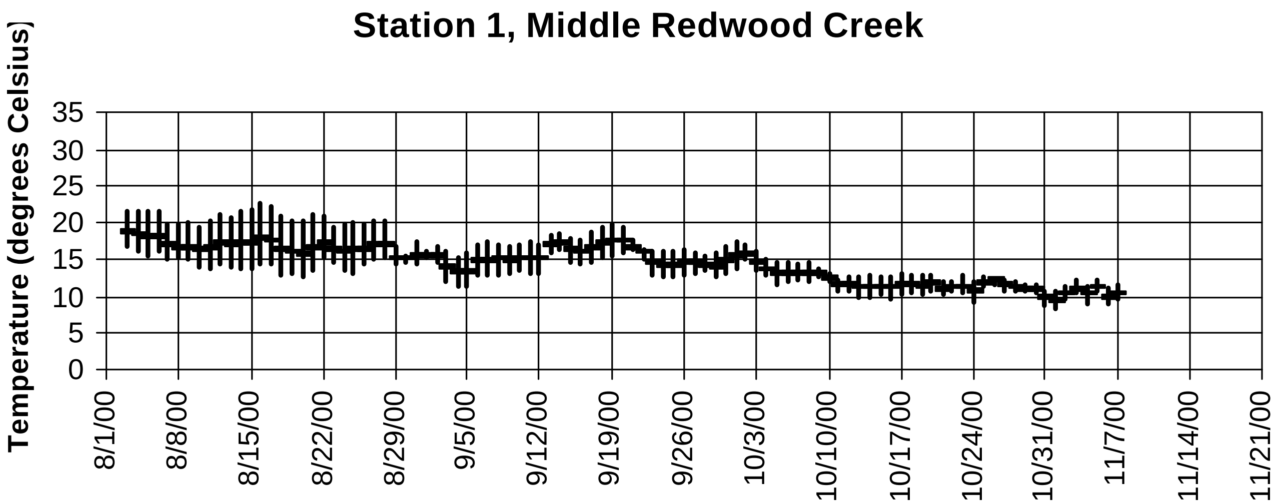

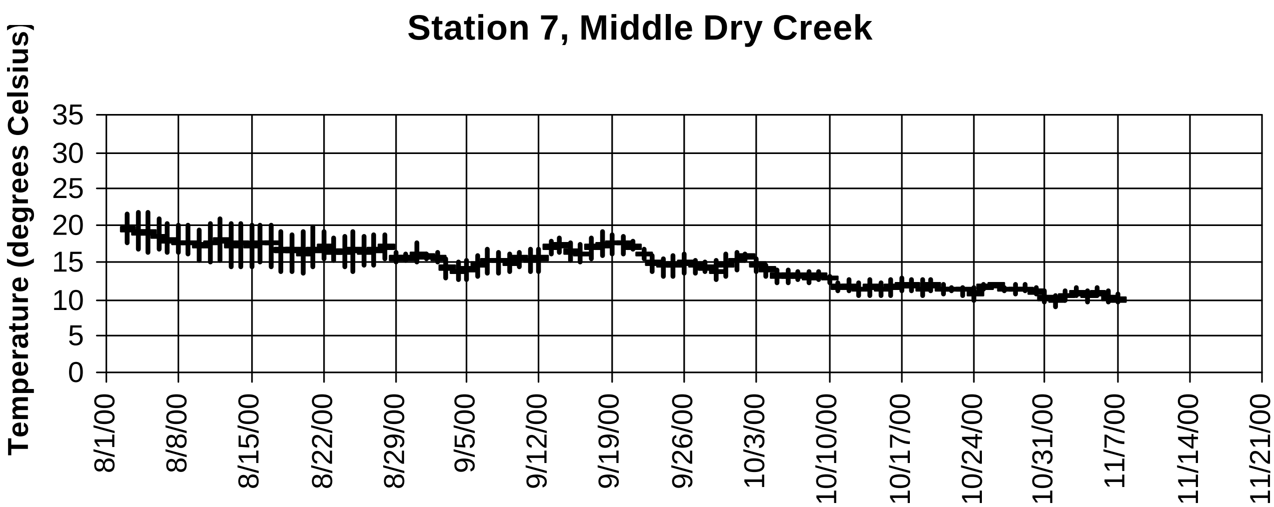

Figure 11. Temperatures are not lethal but sometimes stressful for steelhead in Napa River tributaries.

Twenty eight thermographs were deployed at tributary and mainstem sites throughout the Napa River basin from mid-summer to late fall 2000 and again in mid-summer to late fall 2001. Thermographs were deployed in well-mixed, shaded pools, generally upstream of public crossings. Example data of the results of this monitoring effort are shown for the canyon reaches of Redwood Creek and Dry Creek, where steelhead rearing would be expected to occur. In general, temperatures throughout the Napa River Basin do not reach acute lethal levels. Temperatures approaching and exceeding 20 degrees centigrade, however, are common. Temperatures at this level are sufficient to cause elevated metabolism and potentially affect growth efficiency of juvenile salmonids during the summer months.

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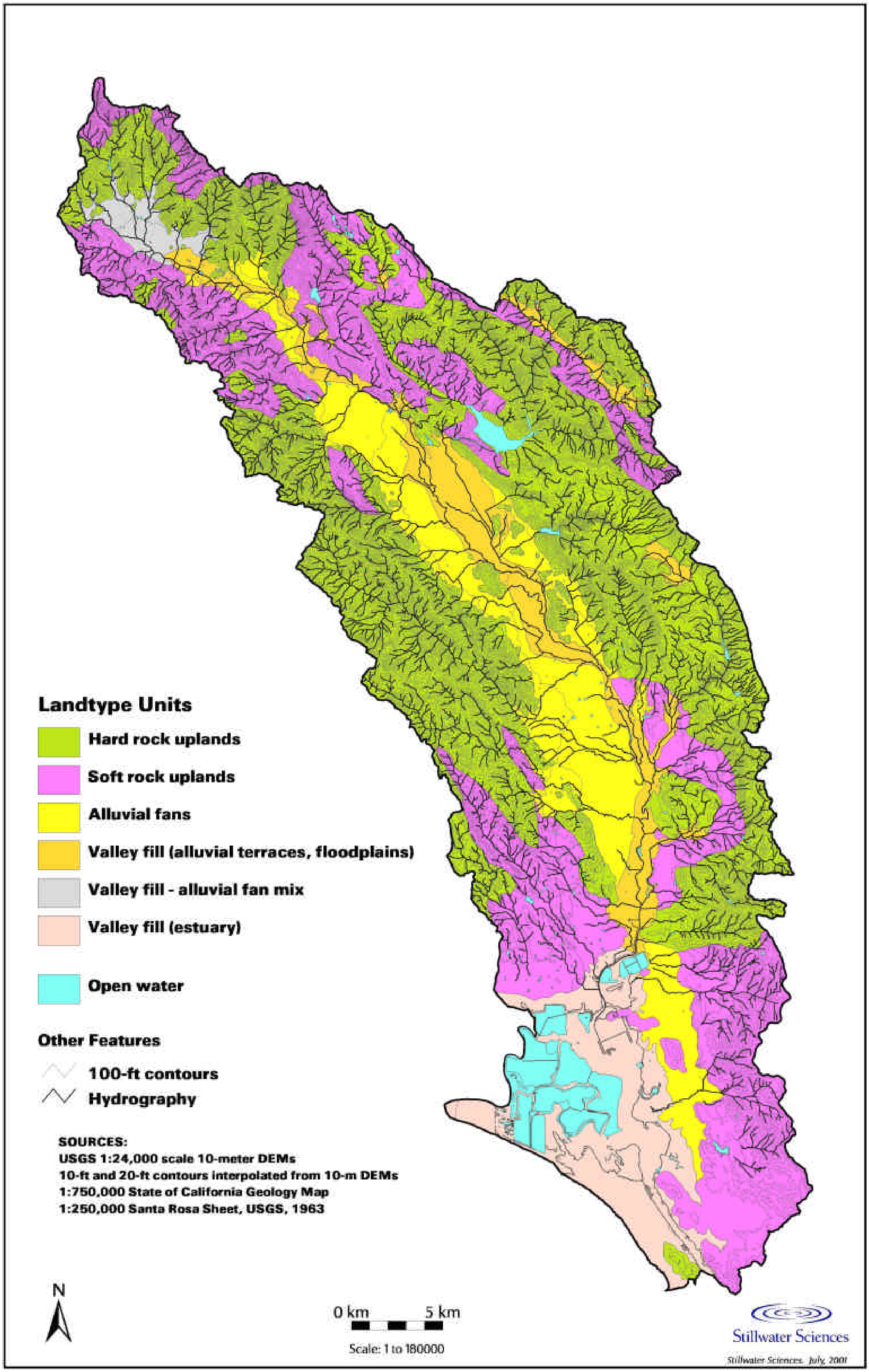

Figure 12. Land type units in the Napa River basin.

	2002			2003												2004											
	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Task 1: Process-based assessment of potential physical factors limiting abundance of analysis species																											
Task 1A. Sediment dynamics															X												
Task 1B. LWD reduction																											
Task 1C. Physical barriers to fish passage																											
Task 1D. Baseflow reduction and hydrograph change															X												X
Task 1E. Temperature															X												X
Task 1F. Analysis of Historical Channel Conditions															X												
Task 2: Mechanistic studies and life history assessments of analysis species																											
Task 2A. General Salmonids																											
2A1. Salmon monitoring																											
2A2. Assess impacts of predators in the mainstem on outmigrating smolts.										X												X					
2A3. Assess importance of estuary rearing.															X												
2A4. Assess historical evidence for salmonid presence															X												
Task 2B. Steelhead															X												X
Task 2C. Chinook salmon							X																				
Task 2D. California Freshwater Shrimp															X												
Task 3. Population dynamics analysis															X												X
Task 4. Report Production and Outreach		X													X												X
Task 5: Project Management																											

X = Deliverable

Figure 13. Work Schedule