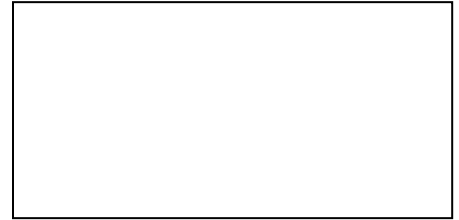


# ERP Proposal Application Form



## Section 1: Summary Information

1. Project title:	Battle Creek Stream Condition Monitoring for Adaptive Management
2. Applicant name:	Battle Creek Watershed Conservancy
3. Contact person:	Sharon Paquin-Gilmore
4. Address:	PO Box 606
5. City, State, Zip:	Manton, CA 96059
6. Telephone #:	530-474-3368
7. Fax #:	530-474-3368
8. Email address:	<a href="mailto:spaquingilmore@frontier.com">spaquingilmore@frontier.com</a>
9. Agency Type:	Federal Agency <input type="checkbox"/> State Agency <input type="checkbox"/> Local Agency <input type="checkbox"/> Nonprofit Organization <input checked="" type="checkbox"/> University (CSU/UC) <input type="checkbox"/> Native American Indian Tribe <input type="checkbox"/>
10. Certified nonprofit organization:	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> However, the Battle Creek Watershed Conservancy is an IRS §501(c)(3) status nonprofit organization. Federal Tax ID # 68-0411734 and has been awarded CALFED grants in the past.
11. New grantee:	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>
12. Amount requested:	\$ 445,225
13. Total project cost:	\$ 474,625
14. Topic Area(s):	<b>Primary:</b> Local Watershed Stewardship <b>Secondary:</b> At-Risk Species Assessment Ecosystem Water and Sediment Quality Riparian Habitat Hydrodynamics, Sediment Transport and Flow Regimes River Channel Restoration
15. ERP Project type:	<b>Primary:</b> Monitoring <b>Secondary:</b> Research Planning
16. Ecosystem Element:	<b>Primary:</b> Essential Fish Habitat <b>Secondary:</b> Central Valley Streamflows Freshwater Fish Habitats
17. Water Quality Constituent:	<b>Primary:</b> Turbidity and Sedimentation <b>Secondary:</b> Other – Watershed Stewardship
18. At-Risk species benefited:	Species and their Critical Habitats Benefited Include: Sacramento River Winter-Run Chinook Salmon ESU Central Valley Spring-Run Chinook Salmon ESU Central Valley Steelhead ESU

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<b>19. Project objectives:</b>	This monitoring and assessment project will determine the current status and trend in physical and biological stream habitat conditions within and upstream of the Battle Creek Salmon and Steelhead Restoration Project area enabling adaptive management.
<b>20. Time frame:</b>	Project will begin in fall 2011 and be completed fall 2014, within a 3 year period.

### Section 2: Location Information

<b>1. Township, Range, Section: and the 7.5 USGS Quad map name.</b>	This project will be implemented at 50 sites throughout the Battle Creek watershed. The center of the watershed and project area is the town of Manton for which this location information relates. Township 30 N; Range 1 E; Section 21 Manton Quadrangle, USGS 7.5 Minute Series <i>Locations for all 50 monitoring sites is located at the end of this proposal.</i>
<b>2. Latitude, Longitude (in decimal degrees, Geographic, NAD83):</b>	Latitude: 40.4352261 N Longitude: 121.8700738 W <i>Locations for all 50 monitoring sites is located at the end of this proposal.</i>
<b>3. Location description:</b>	This proposed project will be implemented at 50 sites throughout the Battle Creek watershed. The center of the watershed, and project area, is the town of Manton for which the location information provided relates. <i>Locations for all 50 monitoring sites is located at the end of this proposal.</i>
<b>4. County(ies):</b>	Shasta and Tehama Counties
<b>5. Directions:</b>	Directions to Manton: From the town of Red Bluff (On Interstate 5, between Corning and Cottonwood) head east on Antelope Blvd. Turn left onto Hwy 36 East, Turn left onto Manton Road (CR-A6). The town of Manton is 30 miles from Red Bluff.
<b>6. Ecological Management Region:</b>	Sacramento Region
<b>7. Ecological Management Zone(s):</b>	North Sacramento Valley
<b>8. Ecological Management Unit(s):</b>	Unit 4.4
<b>9. Watershed Plan(s):</b>	Battle Creek Watershed Community Strategy <a href="http://www.battle-creek.net/docs/bcwc_strategies/BCWC_StrategyComplete_2007_final.pdf">http://www.battle-creek.net/docs/bcwc_strategies/BCWC_StrategyComplete_2007_final.pdf</a> Battle Creek Watershed Assessment <a href="http://www.battle-creek.net/docs/BCWA_Report_Final1.pdf">http://www.battle-creek.net/docs/BCWA_Report_Final1.pdf</a> Battle Creek Salmon And Steelhead Restoration Project - Adaptive Management Plan. <a href="http://www.battle-creek.net/docs/restoration/adpt_mgt/AMP_April_2004.pdf">http://www.battle-creek.net/docs/restoration/adpt_mgt/AMP_April_2004.pdf</a> Battle Creek Stream Condition Monitoring Plan <a href="http://www.battle-creek.net/docs/monitoring/StreamConditionMonitoringPlan.pdf">http://www.battle-creek.net/docs/monitoring/StreamConditionMonitoringPlan.pdf</a>
<b>10. Project area:</b>	Battle Creek drains a watershed area of approximately 370 square miles in central Northern California within Shasta and Tehama Counties. Nearly 350 miles of streams in the Battle Creek watershed drain land at elevations as high as 10,400 feet and cascade steeply down through basalt canyons and foothills to the confluence with the Sacramento River at an elevation of 335 feet. Approximately 250 miles of stream are fish bearing and constitute the Project Area for this monitoring proposal. Approximately 87 miles of stream were historically accessible to anadromous fishes such as Chinook salmon and steelhead.
<b>11. Land use statement:</b>	Land use in Battle Creek is predominately industrial timber harvest, livestock ranch lands, and agricultural development, with areas of dense residential development and undeveloped wilderness areas within Lassen National Park. Within the next 5 years, the anticipated future land uses within the watershed

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	are not anticipated to change significantly.
<b>12. Project area ownership:</b>	% Private: 65%    % State: <1%    % Federal: 35%
<b>13. Project area with landowners support of proposal:</b>	The proposed work is performed at 50 monitoring sites, primarily private lands due to the high proportion of private ownership and randomly selected sampling sites. Willing landowners were identified during initial sampling in 2001-02. During repeat sampling in 2006, all landowners at all 50 sites provided access. As the BCWC has an ongoing active presence within the watershed, good relations with landowner and their support, it is highly likely that sites will be accessible for ongoing monitoring.

### **Section 3: Landowners, Access and Permits**

<b>1. Landowners Granting Access for Project:</b> (Please attach provisional access agreement[s])	While many of the monitoring sites related to this proposed project are on private lands, access agreements are primarily verbal and willing landowners were identified during the initial watershed assessment monitoring in 2001-2002. Landowners again granted access in 2006 for repeat monitoring at these same 50 sites. Landowner access is therefore not anticipated to be a limiting factor or require formal access agreements. A map of monitoring site locations (50) is included in this proposal under Approach and Scope of Work.
<b>2. Owner Interest:</b>	
<b>3. Permits:</b>	Permitting requirements for this project is limited to a single biological collection permit, issued by the DFG, for the collection of benthic macroinvertebrates. Securing this minor permit will not inhibit the start of the project in fall 2011.
<b>4. Lead CEQA agency:</b>	CEQA process not required.
<b>5. Required mitigation:</b>	Yes <input type="checkbox"/> No <input checked="" type="checkbox"/>

### **Section 4: Project Objectives Outline**

#### **1. List task information:**

The primary task from ERP Strategic Goals and Objectives that this proposal addresses is Goal #1. Endangered and Other At-risk Species and Native Biotic Communities. The primary ERP Objective for Goal #1 that this proposal addresses is Objective #1 Achieve recovery and self-sustaining populations of at-risk native species, specifically, Central Valley winter-, spring-, and fall/late fall-run Chinook salmon ESU's and Central Valley steelhead ESU. The significance of Battle Creek in achieving this ERP goal and objective cannot be overstated as all 5 of these salmon and steelhead ESU's have good re-introduction and restoration potential in Battle Creek though are currently either not present (e.g. winter-run Chinook), at very low population numbers (spring-run Chinook, steelhead), or prohibited from entering the upper water watershed at the hatchery barrier weir (fall and late fall-run Chinook salmon). Currently, the Battle Creek Salmon and Steelhead Restoration Project is being implemented to restore these salmon and steelhead populations.

Streams within the Battle Creek watershed are the conduits for the flow of water, sediment, nutrients, and energy that influence the productive capacity of local fish populations. The physical and biological condition of these streams can both influence and indicate how these ecosystem processes may affect Battle Creek salmon and steelhead populations. This project proposes to implement the Stream Condition Monitoring Plan (finalized in 2008) to establish trends in physical and biological stream attributes that could potentially be limiting factors for salmon and steelhead recovery within the watershed. Results of this monitoring will enable adaptive management to address limiting factors related to physical and biological stream conditions and aid in the interpretation of the effectiveness of the Battle Creek Salmon and Steelhead Restoration Project.

Goals and objectives for this proposed project are as follows:

1. Identify the current status of physical and biological stream conditions at the watershed and site scales.
2. Establish the trends since 2001-2002 in physical and biological stream conditions at the watershed and site scales.

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3. Determine the degree to which stream conditions are fluctuating independent of restoration actions (inter-annual variability).
4. Identify areas in the watershed that are consistently in poorer condition to enable the development of restoration prescriptions (stream/ riparian/ sediment source reductions) that can improve those conditions.
5. Identify stream conditions during the stock re-introduction / recovery window to aid in the interpretation of project effectiveness.

Implementing this proposed monitoring plan, tracking status and trends, and identifying and rectifying limiting factors is a sound and scientifically defensible approach to realizing ERP salmon and steelhead population restoration goals and to safeguard the substantial public restoration investments made in the Battle Creek watershed.

### 2. Additional objectives:

The goals/objectives of this proposed project may also enable the achievement of other ERP goals such as the harvest of species or enabling the identification of degraded stream conditions that can then be restored:

For example:

- Goal 3, Objective 1: Enhance fisheries for salmonids.
- Goal 1, Objective 3: Enhance and/or conserve native biotic communities.
- Goal 4, Objective 2: Restoration of aquatic habitats.
- Goal 6, Objective 3: Reduce fine sediment loading.

### 3. Source(s) of above information:

Ward, M.B., S.P. Tussing, J. Moberg, and P. Nelle. 2008. Battle Creek stream condition monitoring plan. Performed for the Battle Creek Watershed Conservancy and California State Water Resources Control Board. Terraqua, Inc., Wauconda, WA. 37 pp. <http://www.battle-creek.net/docs/monitoring/StreamConditionMonitoringPlan.pdf>

## **Section 5: Conflict of Interest**

Primary Contact for Proposal: Sharon Paquin-Gilmore  
Primary Investigator: Mike Ward (Terraqua Inc.)  
Co-Primary Investigator:  
Supporting Staff:  
Subcontractor: Terraqua Inc.: Mike Ward, Steve Tussing

All organizations and individuals who helped with proposal development are listed in this proposal.

## **Section 6: Project Tasks and Results Outline**

### 1. Detailed Project Description

#### ***Project Description:***

Battle Creek is widely recognized as a watershed critical to the survival and restoration of populations of Chinook salmon and steelhead, which are listed under state and federal endangered species acts. Restoration efforts in the Battle Creek watershed were initiated in 1997 by the Battle Creek Working Group (BCWG), and have resulted in the ongoing implementation of the Battle Creek Salmon and Steelhead Restoration Project (Restoration Project) which began in 2010. The Restoration Project is a multi-agency effort to improve fish passage conditions and habitat within the portion of the watershed encompassed by Pacific Gas and Electric (PG&E) Company's Battle Creek Hydroelectric Project. Since its inception in 1997, the Battle Creek Watershed Conservancy (BCWC) has facilitated local participation in the development of the Restoration Project. The BCWC continues to support the goals of the Restoration Project by working to improve reach-scale and watershed-scale factors that might jeopardize the goal of restoring local runs of Chinook salmon and steelhead to Battle Creek.

The Restoration Project will restore access to over 40 miles of historic anadromous stream habitats and will influence the population response of re-introduced Chinook salmon and steelhead. However, stream habitat conditions throughout the watershed will also influence the population response of the species targeted by the Restoration Project. The successful restoration of fish populations depend on a number of biological and physical (including chemical)

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processes within the Battle Creek watershed. Streams within the Battle Creek watershed are the conduits for the flow of water, sediment, nutrients, and energy that influence the productive capacity of local fish populations. The physical and biological condition of these streams can both influence and indicate how these ecosystem processes may affect Battle Creek fish populations. The effectiveness of the Restoration Project will be determined largely by tracking trends in fish population levels. Understanding fish population trends and restoration effectiveness will only be fully explainable through consideration of possible changes in the watershed's productive capacity as indicated by a time series of stream condition indicators. Separating the fish response caused by the Restoration Project and background trends in fish habitat has been an effort that Battle Creek Watershed Conservancy has developed over the last 10 years through an initial watershed assessment and subsequent stream condition monitoring program that effectively tracks the status and trends of fish bearing streams throughout the watershed.

The Battle Creek Watershed Conservancy (BCWC) recognized the likelihood that in-channel stream conditions may also influence the productive capacity of salmon and steelhead in Battle Creek. While the Restoration Project and other agency efforts have been mainly focused on hydropower-related limiting factors, the BCWC believed that it was critical to pay attention to stream conditions and their potential effects on the goals of the Restoration Project. Restoration Project managers also recognized the important link between successful adaptive management of the Restoration Project and watershed conditions. The Adaptive Management Plan (AMP; Terraqua 2004) for the Restoration Project highlighted the role of BCWC in monitoring watershed conditions, sediment processes, water temperature and climate. It also called for very close coordination of the BCWC's stream condition monitoring and the Restoration Project's adaptive management (Terraqua 2004).

The Battle Creek Watershed Conservancy (BCWC) successfully completed an assessment of stream conditions and sediment sources in the Battle Creek watershed in 2001-2002 (Ward and Moberg 2004; Terraqua and Kvam 2003) with funds provided by the Anadromous Fisheries Restoration Program. The watershed assessment documented existing stream conditions and developed a baseline against which future conditions may be compared in order to understand trends in watershed-scale stream conditions; and identified, and prioritized for treatment, sediment sources within Battle Creek. Of note was the finding that fine sediment levels within stream channels were high. In most cases, fine sediment levels were higher than levels which are favorable for salmonid production, higher than unmanaged California streams, and higher than U.S. Forest Service (USFS) standards but were similar to other managed watersheds on USFS lands in California.

Building upon the efforts of the watershed assessment, the BCWC successfully completed the design of a stream condition monitoring plan funded from Proposition 50 monies (CALFED Watershed Program Implementation) and managed by the California State Water Resources Control Board (SWRCB). The Stream Condition Monitoring Plan (SCMP) was completed in 2008 (Ward et al. 2008) and was implemented for a single year in 2006 (Tussing and Ward 2008). Terraqua Inc. was assisted by a Technical Advisory Committee (TAC) in the development of this plan, comprised of private and public sector experts in fisheries and watershed processes who closely overlap with the management of the Restoration Project. The Stream Condition Monitoring Plan was designed for intensive monitoring of stream conditions during the period of stock re-introduction through the attainment of recovery goals.

The Stream Condition Monitoring Plan was designed to address the several important uncertainties related to fish habitat conditions within and upstream of the Salmon and Steelhead Restoration Project area. The first was to identify the current biological and physical condition of fish habitats and establish a pre-project baseline for the Restoration Project. Current and ongoing Restoration Project related monitoring is focused on water temperatures and fish population metrics (e.g. numbers of adults, juveniles, redds etc.) within the project area and not on fish habitat conditions.

Secondly, it is uncertain whether fish habitat and stream conditions in the watershed are improving or degrading and where in the watershed poor conditions persist. Substantial investments in sediment source reductions were implemented by Lassen National Forest in collaboration with the BCWC after the watershed assessment identified that fine sediment levels at the watershed scale were elevated. Are additional sediment source reduction treatments necessary? The lack of current status and trend information limits the BCWC's ability to identify and prioritize sites for stream restoration or sediment source reduction treatments. A related uncertainty is the degree to which stream conditions are fluctuating independent of restoration actions. For example, stream condition monitoring results from 2006 revealed stream condition improvements but it is uncertain whether these were due to stream recovery from the 1997-1998 flooding event or may reflect more natural interannual variability associated with a given water year. Successive multi-year monitoring is necessary to establish the levels of inter-annual variability in monitoring metrics to enable the accurate interpretation of stream condition.

Third, uncertainties regarding the condition of fish habitats limit the ability to determine the effectiveness of the Restoration Project. There is an assumed link between habitat quality and the fish production capacity of that habitat. The collection of habitat quality information during the stock re-introduction / recovery window of the Restoration Project

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enables a more accurate interpretation of project effectiveness by allow the filtering out of the habitat signal to discern the degree to which restoration actions are driving changes in fish numbers.

### ***Project Goals and Objectives***

This project proposes to implement stream condition monitoring following the established monitoring plan (Ward et al. 2008) in order to identify the current status of stream conditions and establish trends since 2001-2002. Initiating stream condition monitoring in the fall of 2011, prior to the full implementation of the Restoration Project, would address the significant uncertainties described above.

Specifically, the goals and objectives for this proposed project are as follows:

6. Identify the current status of physical and biological stream conditions at the watershed and site scales.
7. Establish the trends since 2001-2002 in physical and biological stream conditions at the watershed and site scales.
8. Determine the degree to which stream conditions are fluctuating independent of restoration actions (inter-annual variability).
9. Identify areas in the watershed that are consistently in poorer condition to enable the development of restoration prescriptions (stream/ riparian/ sediment source reductions) that can improve those conditions.
10. Identify stream conditions during the stock re-introduction / recovery window to aid in the interpretation of project effectiveness.

### ***Project Location***

Battle Creek drains a watershed area of approximately 370 square miles in central Northern California within Shasta and Tehama Counties. The watershed includes the southern slopes of the Latour Buttes, the western slope of Lassen Peak, and the mountains south of Mineral, California. Nearly 350 miles of streams in the Battle Creek watershed drain land at elevations as high as 10,400 feet and cascade steeply down through basalt canyons and foothills to the confluence with the Sacramento River near Cottonwood, California, at an elevation of 335 feet. Approximately 250 miles of stream are fish bearing and 87 miles of stream were historically accessible to anadromous fishes such as Chinook salmon and steelhead. Land use in Battle Creek is predominately industrial timber harvest, livestock ranch lands, and agricultural development, with areas of dense residential development and undeveloped wilderness areas within Lassen National Park.

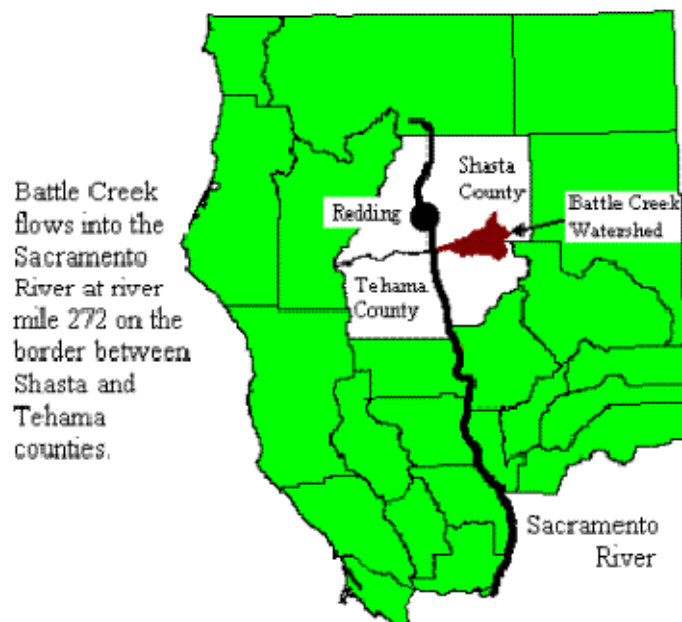


Figure 1. The location of the Battle Creek watershed in relation to the counties of Northern California.

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## ***Proposed Work***

The proposed stream condition monitoring project has both watershed coordination/ outreach and technical monitoring/ assessment components. Watershed coordination and outreach is key to providing watershed residents with information on what activities are occurring, securing ongoing landowners permission for access to monitoring sites, scheduling field visits to these sites and providing the public with materials on the results of investigations. The Stream Condition Monitoring Plan (Ward et al. 2008) is by design a multi-year framework where a rotating panel of 50 monitoring sites is completely sampled over a 4 year period (see Approach and Scope of Work). This proposed project of implementing the Stream Condition Monitoring Plan in years 2011 through 2014 would include three technical components:

1. Physical habitat monitoring at 20 sites per year following the proposed rotating panel design.
2. Biological monitoring of benthic macroinvertebrates at 50 sites per year.
3. Analysis and reporting of the results: Identifying the current status and trends in condition since 2001-2002 at the watershed and stream reach scales; identifying inter-annual variability in condition at watershed and stream reach scales; and identifying those sites that are chronically in poor condition and priority candidates for restoration actions.

Watershed coordination and outreach will necessarily occur throughout the duration of the project as the majority of monitoring sites are on privately held lands. Both the physical habitat and biologic field sampling would occur in the fall of the years 2011, 2012 and 2013. Data analysis would occur in spring/summer of 2014 and the Final Project Report written by contract end, anticipated being fall 2014.

## ***Hypothesis Testing to Achieve Project Goals and Objectives***

Some of the goals and objectives of this monitoring project will rely on formal hypothesis testing while others will not. This project will test hypotheses related to the potential change (positive or negative) in physical and biological stream condition metrics over multiple time periods. Formal hypothesis testing will therefore largely be focused on detecting the trends in stream conditions over multiple time periods. Specifically, the goal for this proposed project that will include formal hypothesis testing is the establishing of trends since 2001-2002 in physical and biological stream conditions at the watershed and site scales. The null hypothesis in these cases would be no change in watershed or site condition over time (2002 through 2013). These formal hypothesis tests will also attain the related goal of identify areas in the watershed that are consistently in poorer condition to enable the development of restoration prescriptions (stream/ riparian/ sediment source reductions) that can improve those conditions.

Some goals and objectives that relate to the annual status of stream conditions at the watershed and site scales will not include a formal test of hypotheses. For example, the goal of establishing the stream condition baseline prior to Restoration Project implementation (pre-project status) may only occur in year 2011 if substantial implementation occurs in subsequent years. The goal of providing an annual measure of the stream habitat condition signal for a given year to aid in the interpretation of Restoration Project effectiveness will be information used in separate analyses beyond the scope of this project. Additionally, while the measure of inter-annual variability in stream conditions over the three year period of this proposed project will be a significant aid in interpreting prior and current perceived changes in conditions, it is not a formal test of hypotheses. The degree of interannual variability will show up in formal hypothesis testing within trend analyses and if high, may make trend detections more difficult. Understanding the degree of interannual variability will provide important information to refine expectations relative to the duration of monitoring necessary to detect trends and possible refinements to the monitoring program to enable the achievement of goals.

## **2. Background and Conceptual Models**

The Battle Creek Salmon and Steelhead Restoration Project is a joint effort between PG&E, the National Marine Fisheries Service (NOAA Fisheries), California Department of Fish and Game (CDFG), U.S. Fish and Wildlife Service (USFWS), and U.S. Bureau of Reclamation (USBR) to restore salmon and steelhead runs in the Battle Creek watershed. A MOU was adopted in June 1999 stating the intent of the MOU Parties to engage in a restoration effort that would modify the facilities and operations of FERC Project No. 1121. The objectives of the Restoration Project are (1) the restoration of self-sustaining populations of Chinook salmon and steelhead and their habitat in the Battle Creek watershed, (2) up-front certainty regarding specific restoration components, (3) timely implementation and completion of restoration activities, and (4) joint development and implementation of a long-term AMP with dedicated funding sources to ensure the continued success of restoration efforts under this partnership (Restoration Project AMP 2004).

The MOU identifies Adaptive Management as an important component of the Restoration Project. Adaptive Management uses extensive monitoring to identify problems, examine possible solutions for meeting the biological



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objectives, and if needed, allow changes to Contemporary strategies and actions within established limits to try to achieve the objectives and desired results (Restoration Project AMP 2004). The Adaptive Management concept was formalized with the completion of the Battle Creek Salmon and Steelhead Restoration Project Adaptive Management Plan in 2004 (Restoration Project AMP 2004).

The Restoration Project AMP is just one aspect of the Restoration Project and is also linked to non-project restoration programs affecting salmon and steelhead populations both within and outside the Battle Creek watershed. The Restoration Project AMP focuses on improvements designed to reduce factors limiting freshwater life stages of anadromous salmonids affected by the Battle Creek Hydroelectric Project (Restoration Project AMP 2004). Other limiting factors (e.g. habitat issues) were identified in the AMP but were more appropriately addressed by “linkages” to other programs (Restoration Project AMP 2004). The restoration/management activities of the Battle Creek Watershed Conservancy (BCWC) are identified in the Restoration Project AMP (2004) as an important linkage and requiring very close coordination with the Restoration Project including the BCWC Watershed management strategy and watershed assessment (Restoration Project AMP 2004). Important BCWC activities linked to the Restoration Project AMP include watershed assessment activities, sediment quality monitoring, water temperature and climate monitoring, and data management and dissemination as these components are not addresses specifically by the AMP yet could be potential limiting factors for the Restoration Project.

The assessment of limiting factors for populations of anadromous salmonids in Battle Creek follows a life-cycle and watershed-based approach (Ward and Kier 1999; Restoration Project AMP 2004). This approach considered all the usual impacts to salmonid populations including changes to freshwater habitat, harvest influences, hydropower facilities and hatchery effects. The Battle Creek salmonid life cycle and limiting factors model with key uncertainties and key linkages to other programs is shown below as illustrated in the Restoration Project AMP (Conceptual Model 1; Restoration Project AMP 2004). The limiting factors identified in this model as more appropriately addressed by linkage to BCWC activities and programs include Water Quality, Habitat Quality, and Food and Nutrient Availability. Water quality can affect upstream migration, spawning and incubation, rearing and outmigration (Conceptual Model 1). Habitat quality and food and nutrient availability can affect rearing (Conceptual Model 1). This proposed project focuses on the monitoring and assessment of water and habitat quality, including sediment quality (% fines) in potential spawning habitats (pool tailouts).

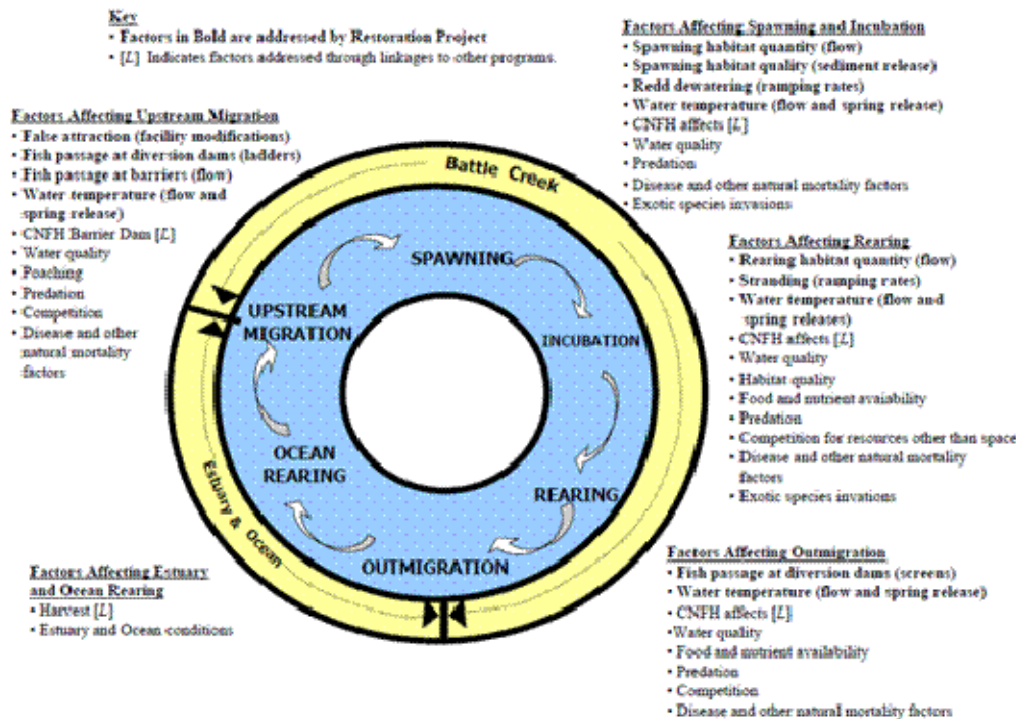


Figure 2. Battle Creek limiting factors model with key uncertainties and key linkages (From: Restoration Project AMP 2004).

### 3. Approach and Scope of Work

The proposed monitoring project will follow the approaches identified in the Battle Creek Stream Condition Monitoring Plan (SCMP; Ward et al. 2008). The SCMP is designed to be useful for status, trend, and restoration project effectiveness monitoring. This program is sensitive enough to promptly alert watershed managers to short-term, acute changes and to measure longer-term, chronic changes. This program will enable the aggregation of conditions at the watershed-scale but also be able to identify within-watershed variation. This program is designed to work with other



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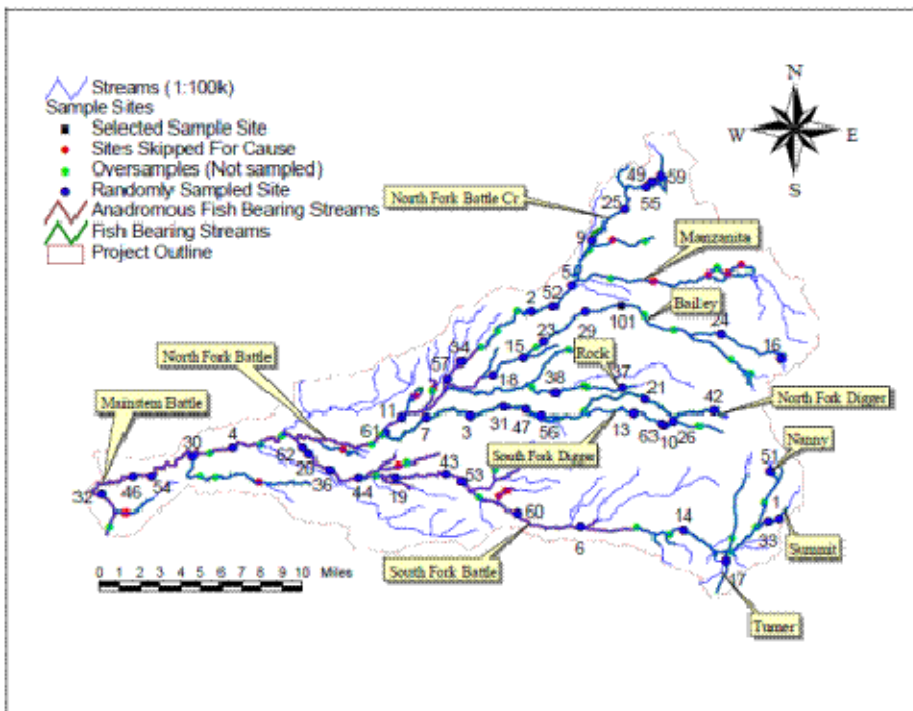
existing programs by filling data gaps necessary for understanding stream conditions and trends in Battle Creek. Sampling design, cost considerations, and knowledge of existing programs and their deficiencies were taken into consideration when designing this program. Greater detail regarding the methods for selecting the recommended indicators, protocols, sampling designs can be found in Appendix B of the SCMP.

The proposed implementation of the SCMP includes monitoring in two subject areas: biological monitoring through macroinvertebrate surveys and riparian condition surveys, and physical stream condition surveys.

### Elements of the SCMP

- 1) **Macroinvertebrate sampling:** Conduct annual surveys of macroinvertebrates during the low-flow season at the 50 probabilistically-selected monitoring sites established during the 2001-2002 watershed assessment. Analyze macroinvertebrate community composition for acute (annual) changes and chronic (long-term, multiple year) trends. Protocols to be used for aquatic macroinvertebrates collections are the AREMP RIVPACS sampling protocol advocated by Gallo et al. (2001) and developed by Hawkins et al. (2001). Within each monitoring reach, benthic macroinvertebrates will be collected with two fixed area kick net samples at each of four riffle habitats for a total of eight samples. These eight samples are combined to generate a single macroinvertebrate sample for the monitoring site.
- 2) **Physical stream condition and riparian condition monitoring:** Conduct annual surveys of physical stream conditions and riparian conditions at 20 of 50 probabilistically-selected monitoring sites established during the 2001-2002 watershed assessment to achieve monitoring of all 50 sites once every four years. This rotating panel design would include an annual panel of 10 "fixed-sites" and four rotating panels of 10 additional sites which would be sampled once every four years. In this manner, all 50 sites would be surveyed at least once every 4 years. Physical stream habitat and riparian condition data will be analyzed for long-term, multiple year trends. The AREMP RIVPACS monitoring protocols (Gallo et al. 2001, Gallo 2002) are to be implemented for the long-term monitoring of trends in Battle Creek stream channel condition and have been shown to perform as-well-as or better-than several other protocols commonly used for monitoring physical stream conditions (Lanigan et al. 2006). These protocols were previously implemented in 2001-2002 for the Battle Creek watershed assessment (Terraqua and Kvam 2003, Ward and Moberg 2004) and 2006 stream condition monitoring. These protocols include the following components: physical habitat mapping (width-to-depth ratios, pool frequencies, channel longitudinal and cross-sectional profiles), measuring stream bed particle size (e.g.,  $D_{50}$ ), embeddedness, estimating the percentage of fine sediment, the frequency of large woody debris, and riparian canopy cover. Ongoing repeat sampling of initial randomized sites sampled in 2001-2002 enable the assessment of status and trends in physical stream conditions of fish bearing streams of the entire watershed.

### Permanent Monitoring Sites (50 sites)



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Figure 3. A map of the Battle Creek watershed depicting sample sites locations (blue and black), site numbers, and the names of streams with sites that were sampled. Oversamples (green) and sites skipped for cause (red) are also depicted. The depicted stream network is based on a 1:100,000 scale hydrography layer.

### 4. Deliverables

Project deliverables will include:

- Detailed Assessment Monitoring Report
- Final Project Report
- Annual / Quarterly Reporting (as required)
- Posting of project data/database on BCWC website
- Presentation to the Greater Battle Creek Watershed Working Group
- Presentation to the Restoration Project Adaptive Management Technical Team
- Presentation to the Battle Creek Community at the BCWC Annual Meeting

### 5. Feasibility

Based upon experience with field conditions similar monitoring efforts within the Battle Creek watershed in the past, the scope of work and schedule proposed is feasible. No permitting is necessary other than a straightforward collecting permit for benthic macroinvertebrate sampling. This proposed project is also not contingent upon other funding or the timing of other projects.

### 6. Relevance to the CALFED ERP

**Relevance to this PSP** — This proposed monitoring project does not directly address priorities within the Sacramento-San Joaquin Delta, and Suisun Marsh and Bay. It does however have the characteristics of the types of projects that the ERP PSP views as being in great need and adding high value. First, the proposed project is Interdisciplinary in the scope of stream ecosystems component that will be monitored to determine stream condition. These include the structure of the physical channel and fish habitat provided (e.g. pool depth), sediment composition of the channel and in spawning habitats, the riparian zone and shading (stream temperature related) and the biological through the monitoring of macroinvertebrates (water quality inferences). Second, the project Analyzes, Integrates and Synthesizes Existing Information. The proposed monitoring and assessment will make use of previously collected data to establish trends in stream condition and will enable the interpretation of results from previous time periods especially related to the degree of background interannual variability which is currently a significant uncertainty. This project is also Collaborative in light of its explicit linkage to the Restoration Project Adaptive Management Framework and will help inform analyses performed by other watershed partners to determine the effectiveness of Restoration Project implementation activities.

**Relevance to CALFED Issues Outside this PSP** — This project supports several CALFED program objectives. Most directly, this project supports high priority anadromous salmonid monitoring, assessment, and restoration objectives within the Ecosystem Restoration Program (ERP). This project supports the successful implementation of CALFED's high priority Battle Creek Anadromous Salmonid Restoration Project by establishing a watershed approach to monitoring stream conditions within and upstream of the Restoration Project area. CALFED has made substantial investments in the implementation Battle Creek Salmon and Steelhead Restoration Project and in establishing a sound scientific framework to identify existing and emerging limiting factors within the Battle Creek watershed. This proposed project is the direct result of prior CALFED actions and investments as CALFED funded both the Battle Creek Watershed Assessment (2004) and the development of the Battle Creek Stream Condition Monitoring Plan (2008). This project establishes baseline and trend information on stream channel conditions that will be used to adaptively manage the Anadromous Salmonid Restoration Project and implement future watershed restoration actions.

This proposed project also supports other regional salmon and steelhead recovery planning efforts which overlap with CALFED goals. The ecological significance of Battle Creek has only increased with the development of the Draft Central Valley Recovery Plan for Salmon and Steelhead Salmon. The Recovery Plan states that Battle Creek represents the only Basalt and Porous Lava Diversity Group populations of spring-run Chinook salmon and steelhead (core 1 populations) and remains a high priority area for winter run re-introductions (core 1).

### 7. Expected quantitative results (project summary):

While this monitoring project is significant for CALFED issues outside this PSP, such as the restoration of threatened and endangered anadromous salmonid populations within the Central Valley, the results of this project do not align well with the descriptive criteria provided in Appendix E of this PSP. The Project Goals and Objectives, and Approach and Scope of Work sections provide descriptions of the expected quantitative results.

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### 8. Other products and results:

Project related results will include the following:

1. Identification of the current status of physical and biological stream conditions at the watershed and site scales.
2. Establish the trends since 2001-2002 in physical and biological stream conditions at the watershed and site scales.
3. Determine the degree to which stream conditions are fluctuating independent of restoration actions (inter-annual variability).
4. Identification of areas in the watershed that are consistently in poorer condition to enable the development of restoration prescriptions (stream/ riparian/ sediment source reductions) that can improve those conditions.
5. Identification of stream conditions during the stock re-introduction / recovery window to aid in the interpretation of project effectiveness.

### 9. Qualifications

#### Sharon Paquin-Gilmore

Sharon has been the Watershed Coordinator for the Battle Creek Watershed Conservancy (BCWC) since 1999, has extensive project management experience within the watershed. Sharon has served as the Project Manager for all of the BCWC's grants and all have been completed satisfactorily. The grants that Sharon has managed are identified in Table 1.

Table 1. Battle Creek Watershed Conservancy Grant Funded Projects Completed.

Grant Funded Projects	Funding Entity	Amount	Dates Active
Battle Creek Education Project	U.S. Fish & Wildlife Service	\$10,000.00	1998-2000
Battle Creek Curriculum Development, <i>Your Watershed At Work</i>	U.S. Fish & Wildlife Service	\$27,011.00	11/19/99 to 6/30/02
Battle Creek Watershed Stewardship Phase 1	CALFED	\$145,000.00	August 1999 to August 2002
Battle Creek Watershed Manton Defensible Fuel Profile Construction/Maintenance Project, Phase 1	Tehama Resources Advisory Committee	\$37,435.00	2000-2003
Battle Creek Watershed Stewardship Phase II	CALFED/CVPIA	\$268,817.00	2001-2004
Battle Creek Watershed Manton Defensible Fuel Profile Construction/Maintenance Project, Phase 2	Tehama Resources Advisory Committee	\$19,490.00	2004-2006
Battle Creek Watershed Conservancy Watershed Coordinator Grant	California Department of Conservation, Division of Land Resource Protection	\$87,918.00	June 1, 2004 to June 1, 2007
Battle Creek Watershed Stewardship Phase III	CALFED / California State Water Resources Control Board	\$635,980.00	April 5, 2005 to September 30, 2008

#### Subcontractor Selection

Terraqua Inc. is the subcontractor selected for this project due to their extensive experience within the watershed and ongoing relationship with the BCWC in providing technical watershed assessment, monitoring, and restoration services. Mike Ward (President, Terraqua Inc.) was lead author for the Battle Creek Salmon and Steelhead Restoration Project Adaptive Management Plan, Battle Creek Watershed Assessment and the Battle Creek Stream Condition Monitoring Plan. Steve Tussing (Senior Fisheries Biologist, Terraqua Inc.) has served as technical advisor to the BCWC Science Program for the last 4 years and participated in the development of the Stream Condition Monitoring Plan and its implementation in 2006. A brief company profile for Terraqua Inc. and resumes for Mike Ward and Steve Tussing are included below:

#### Terraqua Inc.

##### Introduction

Terraqua Inc. is a privately held company specializing in fisheries and terrestrial ecology which has been in business since January 1995. Terraqua staff, of approximately 25, has extensive experience in the fisheries field with primary emphasis on resident and anadromous salmonids and their relationship to natural and altered

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habitats in California and the Pacific Northwest. Our client base spans a range from corporations to agencies to non-profit groups that foster habitat restoration by local landowners. Our recent clients include Bonneville Power Administration, for whom we are coordinating the development and implementation of a Columbia basin-wide habitat monitoring program and coordinating the design and implementation of monitoring studies in the Wenatchee, Entiat and Methow Rivers; the Battle Creek Watershed Conservancy who we are representing in policy arenas pertaining to the management of Coleman National Fish Hatchery and the land and waters of Battle Creek, California. Other Terraqua projects have included work for the U.S. Bureau of Reclamation, PacifiCorp, California Department of Fish and Game, Parametrix/Grant County P.U.D., Metropolitan Water District of Southern California, the R2 Resources and Seattle City Light, Hydroacoustic Technology Inc., Pacific Coast Federation of Fishermen's Association, Diamond Belle Ranch/Walker Lake Fishing Lodge, Hoopa Valley Tribe, Fisheries Research Institute, Colville Confederated Tribes, and Pacific Gas and Electric.

### Staff

Terraqua maintains a low overhead in part by employing a small permanent staff augmented by seasonal technicians and by subcontracting within a network of other small consulting firms. Thus, we are able to furnish technical experts who are finely matched for individual clients' needs at reasonable rates. As the scope of work for this project is developed more fully, we can readily adjust our staffing to meet your needs. Project design and management, data analysis, and report preparation would be performed by Steve Tussing and/or Mike Ward as required by the technical complexity of the project.

**Steve Tussing, Senior Fisheries Biologist** – Based in Red Bluff, California with an M.S. in fisheries, Steve has 12 years of fisheries experience, serving 6 years as a consultant.

**Michael Ward, President Terraqua Inc./ Senior Fisheries Ecologist** – With 26 years of fisheries experience, , and 22 years experience as a consultant, Mike will ensure that any work meets the highest scientific standards and falls within budgetary constraints.

### Recent Project Examples:

#### **Bonneville Power Administration's, Integrated Status and Effectiveness Monitoring Program (ISEMP):**

Terraqua Inc. has been involved for several years in the implementation of the ISEMP Program within the Wenatchee and Entiat River pilot subbasins. These ongoing efforts strive to identify the status and trends of salmonid species and their habitats, and the effectiveness of restoration activities. Activities that Terraqua Inc. has been contracted for include: Implementation of monitoring and analysis activities related to fish and fish habitat; Analysis and reporting of results related to the implementation of monitoring activities; Coordinate contract development and implementation with partners; Coordinate the design and testing of a data management system to support the program including the development of standardized field protocols for monitoring activities.

#### **Battle Creek Salmon and Steelhead Restoration Project:**

Terraqua Inc. has been involved for several years in the ongoing development of the Battle Creek Salmon and Steelhead Restoration Project. Terraqua is currently representing Battle Creek Watershed Conservancy in technical and policy arenas pertaining to the Restoration Project; the management of Coleman National Fish Hatchery; and the land and waters of Battle Creek, California. Terraqua has also contracted with the U.S. Bureau of Reclamation, for whom we have prepared an adaptive management plan for watershed restoration and NEPA documentation for the \$90 million watershed restoration project. Terraqua has also implemented a watershed assessment and a Stream Condition Monitoring Plan for the Battle Creek watershed

### Project Related References:

David Byrnes, Bonneville Power Administration (503) 230-3171

Dr. Chris Jordan, NOAA Fisheries (ISEMP) (541) 754-4629

Sharon Paquinn-Gilmore, Battle Creek Watershed Conservancy (530) 474-3368

Mary Marshall, Bureau of Reclamation (Battle Creek) (530) 978-5248

**Resume: Mike Ward**

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**MICHAEL B. WARD**  
**Senior Fisheries Ecologist**

## EDUCATION

Univ. of Washington, M.Sc. Fisheries, 1993.  
Humboldt State Univ., B.Sc. Fisheries, 1989.  
Wa. State DNR Watershed Analysis, 1996.  
Wa. State DNR Stream Survey Protocol, 1997.

## PROFESSIONAL AFFILIATIONS

American Fisheries Society  
American Inst. of Fisheries Research Biologists  
Gilbert Ichthyological Society  
Pacific Fisheries Biologists

## PROFESSIONAL SUMMARY

Mr. Ward has been active in the field of fisheries ecology since 1986 and has been consulting on water-use/fisheries interactions since 1989. Mr. Ward has been vice-president/senior fisheries ecologist of Terraqua Inc. since January 1995. Mr. Ward is an expert in fisheries populations and habitat assessments, monitoring and study designs, and resource management planning. His research has focused on the relationships between fisheries, water quantity, and fish habitat in watersheds impacted by water diversions and land-use.

Mr. Ward has conducted extensive field research in during his career; including:

Spawning ground surveys: One season for fall chinook redd surveys in the Klamath River; two seasons developing spawning habitat criteria curves for fall chinook and steelhead in the Klamath River; two seasons of spawning ground surveys of sockeye in Bristol Bay rivers; and one season of coho redd surveys in Puget Sound streams.

Fish Sampling: Sampled fish using many kinds of nets, traps, electrofishing, long lining, and angling.

Biological Sampling: Have processed approx. 25,000 individual fish for a variety of morphometrics, scale/otolith collections, genetic and tissue sampling, egg collection, and organ analysis.

Tagging: Have used a variety of fish tags including CWT, PIT, floy, disk, and fin clips.

Fish Observation: Two seasons of sockeye spawning behavior by snorkeling; two seasons of centrarchid spawning behavior by SCUBA/snorkeling; two seasons of juvenile and adult steelhead use of thermally stratified river pools; one season of use of SCUBA/snorkeling for fish habitat use in the North Umpqua River; use of SCUBA and snorkeling for many other short-duration lake, river, and reservoir surveys.

Fish Habitat Surveying: Surveyed fish habitat in many lakes, rivers, reservoirs, and the North Pacific Ocean and Bering Sea; collected water quality information at many locations.

Boats/Planes: Proficient in the use of boats ranging in size from personal catarafts up to skiffs of 25'; used for research canoes, whitewater rafts, row boats, skiffs, 15 to 50-meter commercial fishing vessels, and high-seas oceanographic research vessels; used for research helicopters and single-engine fixed-wing aircraft.

## RELEVANT EXPERIENCE

### ***Okanogan/Similkameen Habitat and Snorkeling, Upper Columbia RFEF.***

Surveyed fish habitat, including fall chinook spawning grounds, and observed fish habitat use using snorkeling in the reaches of the Similkameen River from Enloe Dam downstream to the lower-most confluence with the Okanogan River and in the Okanogan downstream of Zosel Dam to the confluence. Have rafted/boated the Okanogan River between Oroville and Riverside.

### ***Stream Channel Monitoring, Bonneville Power Administration.***

Monitoring stream channels and fish habitat at sites within the Entiat and Wenatchee Rivers to support status/trend and effectiveness monitoring programs. Lead a field crew in the comparison of regional protocols in the John Day watershed, Or. Data collected included about several dozen parameters including longitudinal and cross-sectional stream surveys, gravel assessments, and riparian and human use factors.

### ***Restoration Project Effectiveness Monitoring,***

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### ***Bonneville Power Administration.***

Monitoring the effectiveness of the Bridge-to-Bridge restoration project in the Entiat River. Leading field crews in the monitoring of stream channels and fish habitat at treatment and control sites. Supporting snorkel surveys through seasonal habitat measurements.

### ***Watershed Assessment, Battle Creek, Battle Creek Watershed Conservancy, Ca.***

Conducted field research of instream and upland conditions in the Battle Creek Watershed at 50 sample sites covering about 100 miles of stream to characterize ecosystem processes that affect populations of trout, salmon, and other aquatic organisms. Fish habitat data being collected includes about two dozen parameters including longitudinal and cross-sectional stream surveys, gravel assessments, and identification of sediment sources.

### ***Salmonid Habitat Suitability, California Department. of Fish and Game***

Conducted field investigations to support the creation of habitat suitability criteria for instream flow modeling for Klamath River salmon and steelhead populations. Surveyed and identified habitat required by all life stages of chinook salmon and steelhead in 52 miles of river. Performed direct observations of fish habitat utilization using snorkeling and SCUBA.

### ***Steelhead Trout Habitat Utilization and Behavior Research, Eel River, Ca.***

Managed and implemented a two year study of the utilization of riverine pool habitat by steelhead trout in the Middle Fork Eel River, Ca. Repeatedly surveyed and identified adult steelhead habitat in 25 miles of river and assessed changes over time. Observed and quantified the distribution of juvenile steelhead within riverine pool habitat. Conducted a literature review of habitat and utilization of habitat by anadromous and resident salmonids with emphasis on steelhead. Analyzed habitat data and prepared reports.

### ***Twin Falls Hydroelectric Project, Wa.***

Studied trout behavior and habitat utilization in river reaches affected by a hydroelectric project on the South Fork Snoqualmie River, Wa. using snorkeling techniques. Evaluated the placement of large woody debris as enhancement structures for trout habitat.

### ***North Umpqua Hydroelectric Project, Or.***

Mapped and inventoried habitat, conducted in-stream snorkel surveys of microhabitat, SCUBA surveys of reservoirs; and conducted Hankin and Reeves-type electrofishing/snorkeling population estimates for trout and salmon populations in the mainstem North Umpqua River and several tributaries following US Forest Service guidelines.

## **GENERAL FISHERIES EXPERIENCE**

Vice-President/Fisheries Ecologist, Terraqua Environmental Consulting, Wauconda, Wa. 1/95 - present.

Managing a growing environmental consulting business with a staff of approximately 25. Currently coordinating the design and implementation of monitoring studies for Bonneville Power Administration including field studies for trend and effectiveness monitoring; representing the Battle Creek Watershed Conservancy in policy arenas pertaining to the management of Coleman National Fish Hatchery and the land and waters of Battle Creek, California; Other clients have included: Providing planning services to the U.S. Bureau of Reclamation for the Battle Creek Restoration Project; Metropolitan Water District of Southern California, PacifiCorp, California Fish and Game, Grant County P.U.D., Seattle City Light, Hoopa Valley Tribe, Pacific Gas and Electric, and Colville Confederated Tribes.

Aquatic Ecologist, Harza, Inc., Bellevue, Wa. 7/93 - 2/95.

Conducted habitat assessments and identified the impacts of the North Umpqua River Hydroelectric Project, Or. on trout and salmon fisheries. Studied the effects of heavy metal pollution and water quality problems on urbanized fish populations.

Research Assistant, Fisheries Research Institute, Univ. of Washington, Seattle, Wa. 9/90 - 7/93.

Sampled sockeye salmon in a month-long test gill-net fishery in the Bering Sea, Port Moller, Ak. Participated on the Salmonid Migration, Abundance, and Origin in North Pacific Offshore Waters project. Acted as fisheries scientist for the U. S. A. in joint fisheries research cruises on a Soviet vessel in the Bering Sea (spring 1991) and on a Canadian vessel (summer 1992).

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Fisheries Biologist, Steiner Environmental Consulting, Potter Valley, Ca. 8/89-12/90.

Conducted habitat assessments and identified the impacts of the Potter Valley Hydroelectric Project on anadromous salmonid populations in the Eel River, Ca. Interpreted an accumulated data base of habitat characteristics and population parameters of chinook salmon, steelhead trout, and Sacramento squawfish. Conducted literature research on project related topics. Formulated strategies for further research.

Project Manager, California Department of Fish and Game, U. S. Forest Service, Arcata, Ca. 5/88-5/90.

Proposed, planned and implemented a multi-year study of steelhead trout utilization of thermally stratified pool on the Middle Fork Eel River, Ca. Investigated the relationship between flow, temperature and other habitat parameters on steelhead habitat uses. Supervised a crew in the direct observation of fish migration and behavior. Mapped river habitat. Identified physical and thermal barriers to summer steelhead migration. Prepared final reports and presented data at scientific meetings.

Fishery Technician/Intern, U. S. Fish and Wildlife Service, Ashland, Wi. 5/85-5/86.

Learned coldwater, coolwater, and warmwater fishery management in systems in northern Wisconsin, Michigan, and Minnesota. Conducted habitat assessments, field surveys and implemented management practices. Supervised crews. Compiled and analyzed collected data. Serviced and repaired all equipment and instruments.

### SELECTED PUBLICATIONS AND PRESENTATIONS

- Ward, M.B. et al. 2006. A plan for adaptively managing the Battle Creek Hydroelectric Project and Battle Creek watershed for salmon and steelhead restoration. Prepared for the U.S. Fish and Wildlife Service.
- Ward, M.B., P. Higgins, J. Derksen, and W. Kier. 2000. Klamath Hydroelectric Project annotated bibliography of aquatics and wildlife. Prepared for PacifiCorp by Kier Associates.
- Ward, M.B. and W.M. Kier. 1999. Maximizing compatibility between Coleman National Fish Hatchery operations and salmon and steelhead restoration in Battle Creek. Prepared for the Battle Creek Working Group by Kier Associates.
- Ward, M.B. and W.M. Kier. 1998. Battle Creek Salmon and Steelhead Restoration Plan. Prepared for the Battle Creek Working Group by Kier Associates.
- Quinn, T.P., M.A. Adkison, and M.B. Ward. 1996. Behavioral tactics of male sockeye salmon (*Oncorhynchus nerka*) under varying operational sex ratios. *Ethology*, 102:304-322.
- Terraqua Environmental Consulting. 1996. A comparative study of factors affecting the production of Trinity River Hatchery fall chinook salmon. Prepared for the Hoopa Valley Tribal Council, Hoopa, Ca. 88 pp.
- Terraqua Environmental Consulting. 1996. A review of salmon production at the Trinity River Hatchery. Prepared for the Hoopa Valley Tribal Council, Hoopa, Ca. 28 pp. + appendices.
- Steiner Environmental Consulting. 1996. Potter Valley Diversion fish screen testing. Prepared for Pacific Gas and Electric Co., San Ramon, Ca. 49 pp. + appendices.
- Ward, M.B. 1995. The influences of ocean conditions on the production of Northern California salmon. Presentation at the Thirteenth Annual Salmonid Restoration Conference, Santa Rosa, Ca.
- Harza Northwest. 1994. Final technical report for aquatic resources study, North Umpqua Hydroelectric Project, FERC No. 1927. Prepared for PacifiCorp, March 1994.
- Ward, M.B. 1993. The physical dynamics of the Subarctic Front of the North Pacific Ocean and its relation to salmon (*Oncorhynchus* spp.) production. M.S. Thesis. University of Washington. 112 pp.
- Steiner Environmental Consulting. 1990. Potter Valley Project monitoring program (FERC No. 77, Article 39): Effects of operations of upper Eel River anadromous salmonids, 1988-89. Progress report. Prepared for Pacific Gas and Electric Co., San Ramon, Ca. 208 pp. + appendices.
- Ward, M. B. 1988. Adult steelhead trout utilization of summer holding pools, Middle Fork Eel River, Ca. *In: Proc. 1988 Conf. West. Div. Am. Fish. Soc.*, July 10-13, 1988.
- Ward, M. B. and W. B. Zeigler. 1986. U. S. Fish and Wildlife Service fishery management plan for Indian Lake, Lac Courte Oreilles Indian Reservation, Hayward, Wisconsin.



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Resume: Steve Tussing

**Steve P. Tussing**  
**Terraqua Inc.**  
19040 Hansen Drive  
Red Bluff, CA 96080  
530-528-2560  
sptussing@earthlink.net

## **EDUCATION:**

Master of Science (2006), Humboldt State University, Arcata, CA. Major: Natural Resources: Fisheries

Bachelor of Science (1997), Humboldt State University, Arcata, CA. Major: Interdisciplinary Studies: Ecologically Sustainable Systems.

## **PROFESSIONAL/ WORK EXPERIENCE:**

**Senior Fisheries Biologist**, Terraqua Inc, Red Bluff, CA. 2006 - Present

Conducted the monitoring and assessment of aquatic ecosystems, habitats and species. Developed fish and fish habitat monitoring protocols and long-term stream monitoring and QA/QC plans. Conducted analyses of downstream migrant trapping methods, fish habitat monitoring data (BACI design), and climate change impacts to streams. Represented landowner interests in technical and policy discussions pertaining to large scale restoration projects, wildfire management, fisheries recovery and management, and fish hatchery adaptive management. Presented technical information at community forums, working groups and technical meetings. Developed project proposals, budgets, and quarterly and annual project reports.

**Senior Fisheries Ecologist / Principal**, Steve Tussing Ecological Sciences, Red Bluff, CA. 2004 - Present

Conducted the monitoring and assessment of aquatic ecosystems, habitats and species including: macroinvertebrate bioassessments, fisheries assessments, freshwater mollusk surveys, and repeat photography. Performed watershed assessments of fisheries and aquatic resources. Assessed the impacts of hydropower projects and the climate change refugia needs of anadromous salmonids. Developed research and monitoring proposals, budgets, and contracts.

**Field Scientist**, The Nature Conservancy, Mt. Shasta, CA. 2002 – 2005.

Conducted ecological monitoring and assessment of aquatic ecosystems and species including water quality parameters, macroinvertebrate bioassessment, fishery assessment, photo-monitoring and freshwater mollusk surveys. Assessed the effects of river regulation (dams) on aquatic ecosystems and species including suspended sediment pulses, artificial peak flows, barriers to anadromous salmonid populations and consequences for long-term population and ESU viability including climate change considerations. Co-developed the North Coast Anadromous Salmonid Conservation Assessment to identify priority basins, threats and conservation strategies for eight salmonid ESU's. Worked as an aquatic ecologist within multi-disciplinary planning teams to develop conservation plans and recovery strategies at multiple spatial scales. Provided aquatic science expertise to support site-specific conservation activities in three California ecoregions (North Coast, Klamath, Central Valley)

**Research Assistant**, Humboldt State University & CA Cooperative Fisheries Research Unit, Arcata, CA. 1999-2002.

Quantified fish habitat attributes, and fish abundance/biomass/growth rates through the use of electrofishing, seine nets, minnow traps, fyke nets and rotary screw traps. Performed non-lethal tissue and scale sampling and fish tagging with passive integrative transponders (PIT tags). Determined fish age and growth rates thorough scale analyses. Tested multiple hypotheses with logistic regression and AIC model selection methodologies.

**Biological Technician**, CA Cooperative Fisheries Research Unit, Arcata, CA. 1998-1999.

Supported numerous concurrent studies of salmonid, lamprey and stream ecology in northern California. Quantified salmonid habitat and performed spawning surveys for coho and Chinook salmon, and steelhead. Performed sampling for population estimates of salmonids using electrofishing and direct observation (diving). Operated fyke nets and rotary screw traps for juvenile downstream migrant trapping. Estimated trap efficiencies and took non-lethal scale and tissue samples from salmonids and lamprey. Assisted in the placement and maintenance of salmonid redd traps to estimate numbers of emerging fry from redds, and to monitor permeability, temperature and conductivity within redds.

## **RECENT TECHNICAL PRESENTATIONS:**

## ERP Proposal Application Form

Effectiveness of Habitat Restoration Actions in the Entiat River Subbasin, WA. Prepared for the Columbia River Integrated Status and Effectiveness Monitoring Program (ISEMP). Presented at the Upper Columbia River Technical Team Analysis Workshop, Jan. 13<sup>th</sup>, 2010, Wenatchee, WA.

Potential Influence of Climate Change on Battle Creek Summer Streamflow. Prepared for the Battle Creek Watershed Conservancy. Presented at the Greater Battle Creek Watershed Working Group Meeting, July, 21<sup>st</sup> 2009, Mineral, CA.

### **PUBLICATIONS / TECHNICAL REPORTS:**

Tussing, S.P. (*In Prep*). Potential impacts of climatic change on Battle Creek and the Salmon and Steelhead Restoration Project. Technical memorandum prepared for the Battle Creek Watershed Conservancy.

Tussing, S.P. 2008. A Field Manual of Scientific Protocols for Downstream Migrant Trapping within the Upper Columbia Monitoring Strategy. Prepared for the Columbia River Integrated Status and Effectiveness Monitoring Program. 40 p.

Tussing, S.P. 2008. A Field Manual of Scientific Protocols for Fine Sediment Sampling within the Upper Columbia Monitoring Strategy. Prepared for the Columbia River Integrated Status and Effectiveness Monitoring Program. 26 p.

Ward, M.W., S.P. Tussing, J. Moberg, and P. Nelle. 2008. Battle Creek Stream Condition Monitoring Plan. Prepared for the Battle Creek Watershed Conservancy. 44 p.

Tussing, S.P., and M.W. Ward. 2008. Battle Creek Stream Condition Monitoring: 2006 data analysis report and correction to the 2001 and 2002 watershed assessment. Prepared for the Battle Creek Watershed Conservancy. 29 p.

Terraqua Inc./LNF 2008. Battle Creek Stewardship Phase III, Final Project Report. Prepared for the Battle Creek Watershed Conservancy. 29 p.

BCWC 2007. Quality Assurance Project Plan for Battle Creek Stream Condition Monitoring. Prepared for the Battle Creek Watershed Conservancy. 60 p.

Tussing, S.P. 2007. Anadromous salmonid downstream migrant abundance estimates: A review of downstream migrant trap efficiency methods. Technical memorandum prepared for the Columbia River Integrated Status and Effectiveness Monitoring Program. 20 p.

Tussing, S.P. 2006. McCloud River salmonid re-introduction and climate change refugia assessment. Prepared for California Trout and the California Hydropower Reform Coalition. 36p.

Tussing, S.P. 2006. Influence of growth, habitat, and density on emigration of coastal cutthroat trout (*oncorhynchus clarki clarki*) from small streams. Masters Thesis. 74 p.

Hesseldenz, T., S.P. Tussing, and D. LaPlant. 2006. McCloud-Pit Hydroelectric Project: Impacts and Potential Mitigation. Tom Hesseldenz and Associates. Prepared for: California Hydropower Reform Coalition.

Tussing, S.P. 2006. Repeat Photography of Spring and Fall 2005 Flows of the Lower McCloud River: historic summer baseflow, 400 cfs, 300 cfs, 250 cfs and historic bankful flood. Prepared for: McCloud River Club, California Dept. of Fish and Game, California Hydropower Reform Coalition. 72 p.

Tussing, S.P. 2005. McCloud River Club Research and Monitoring Report 2004. Prepared for The McCloud River Club. 28 p.

Tussing, S.P. and S.M. Wingo-Tussing. 2005. North Coast Anadromous Salmonid Conservation Assessment. The Nature Conservancy. 160 p.

Millet, W. et al. 2005. Working Toward a Humboldt-Del Norte Conservation Vision: identifying regional conservation priorities. The Nature Conservancy. 66 p.

Tussing, S.P. 2005. Shasta River Measures of Success Framework: anadromous salmonid viability indicators, existing monitoring efforts, and outstanding monitoring and science needs. The Nature Conservancy. 20 p.

Tussing, S.P. and S.M. Wingo-Tussing. 2005. McCloud River Preserve Research and Monitoring Report 2002 – 2004. The Nature Conservancy. 39 p.

Tussing, S.P. 2004. Klamath River Anadromous Salmonid Restoration: historical distribution and abundance, restoration of sustainability and harvestability, and potential habitat quality above Iron Gate Dam. The Nature Conservancy. 22 p.

Aldous, A., et al. 2003. The Klamath Basin Project Conservation Area Plan. The Nature Conservancy. 52 p.

## **10. Literature Cited**

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- Hawkins, C.P. 2003. Development, evaluation, and application of a RIVPACS-type predictive model for assessing the biological condition of streams in Region 5 (California) national forests. Completion Report. Western Center for Monitoring and Assessment of Fresh Water Ecosystems. Utah State University. Logan, Utah. 23 pp.
- Lanigan, S., B. Roper, J.M. Buffington, E. Archer, S. Downie, J. Faustini, S. Hubler, K. Jones, G. Merritt, D. Konhoff, A. Pleus, M. Ward and K. Wolf. 2006. Pacific Northwest side-by-side protocol comparison test. 5th National Water Quality Monitoring Conference, Monitoring Networks: Connecting for Clean Water. San Jose, CA.
- Terraqua Inc. and Kvam Aquatic Sciences. 2003. Characterization of aquatic macroinvertebrate communities in Battle Creek in 2001 and 2002 to support watershed assessment and future monitoring. Wauconda, WA. Prepared for Battle Creek Watershed Conservancy. 29 pp.
- Terraqua, Inc. 2004. Battle Creek Salmon And Steelhead Restoration Project - Adaptive Management Plan. Wauconda, WA. Prepared for U.S. Bureau of Reclamation, Sacramento, California. 219 pp. [http://www.battle-creek.net/docs/restoration/adpt\\_mgt/AMP\\_April\\_2004.pdf](http://www.battle-creek.net/docs/restoration/adpt_mgt/AMP_April_2004.pdf)
- Tussing, S.P. and M.B. Ward. 2008. 2006 Data Analysis Report and Correction to the 2001 and 2002 Watershed Assessment. Performed for the Battle Creek Watershed Conservancy and California State Water Resources Control Board. Terraqua, Inc., Wauconda, WA. 29 pp. <http://www.battle-creek.net/docs/monitoring/StreamConditionMonitoring2006.pdf>
- Ward, M.B. and J. Moberg. 2004. Battle Creek Watershed Assessment :Characterization of stream conditions and an investigation of sediment source factors in 2001 and 2002. Terraqua, Inc., Wauconda, WA. 72 pp. [http://www.battle-creek.net/docs/BCWA\\_Report\\_Final1.pdf](http://www.battle-creek.net/docs/BCWA_Report_Final1.pdf)
- Ward, M.B., S.P. Tussing, J. Moberg, and P. Nelle. 2008. Battle Creek stream condition monitoring plan. Performed for the Battle Creek Watershed Conservancy and California State Water Resources Control Board. Terraqua, Inc., Wauconda, WA. 37 pp. <http://www.battle-creek.net/docs/monitoring/StreamConditionMonitoringPlan.pdf>

## ERP Proposal Application Form

### Section 7: Project Budget

1. Detailed Project Budget (Excel spreadsheets can be used)

<b>Budget</b>			
<b>Battle Creek Stream Condition Monitoring for Adaptive Management</b>			
			<b>Totals</b>
<b>PERSONAL SERVICES</b>			
<b>Staff Level</b>	<b>Number of Hours</b>	<b>Hourly Rate</b>	
Administrator	220	\$45	\$9,900
Note: The Battle Creek Watershed Conservancy (BCWC) is largely staffed through subcontract (e.g. watershed coordinator, outreach specialist) and related expenses are captured under the Subcontractor Section below.			
Subtotal			\$9,900
Staff Benefits @ %			
<b>TOTAL PERSONAL SERVICES</b>			<b>\$9,900</b>
<b>OPERATING EXPENSES</b>			
<b>Description</b>			
<b>Subcontractor Costs:</b>			
BCWC Watershed Coordinator/ Project Manager: (190 hours @ \$45/hour)			\$8,550
BCWC Outreach Specialist: (180 hours @ \$45/hour)			\$8,100
Monitoring, Assessment and Final Project Report (Terraqua Inc.):			
Physical Habitat Monitoring			\$225,000
Biological (BMI) Monitoring			\$82,500
Analysis and Final Project Report			\$59,250
Data Management and Dissemination (BCWC website accessible)			\$4,250
Annual Performance Reporting (Watershed Coordinator, 70 hours @ \$45/hour)			\$3,150
Photographic Supplies			
Printing and Duplicating (Publications/Communications/Public Outreach)			\$1,050
Office Supplies			\$1,500
General Expense			
Travel (Mileage for Watershed Coordinator/Outreach, 3000 miles at \$0.50/ mile)			\$1,500
Training			
<i>Add/delete line items above for work to be performed by the contractor</i>			
<b>Total Operating Expenses</b>			<b>\$404,750</b>
<b>EQUIPMENT</b>			
SUBTOTAL			\$404,750
OVERHEAD @ 10% (Less Equipment)			\$40,475
<b>GRAND TOTAL</b>			<b>\$445,225</b>
<b>Other funding or in-kind contributors to project</b>			
BCWC Technical Advisor (In-Kind; Steve Tussing)- Technical Participation and Outreach to Working Groups and Restoration Project Adaptive Management Technical Team			<b>\$29,400</b>

2. Budget justification:

Projects costs are based upon the extensive professional experience of Terraqua Inc. personnel in implementing similar methodologies and scopes of work in the Battle Creek watershed (Watershed Assessment 2001-02 and Stream Condition Monitoring 2006) and the Columbia River Basin.

## ERP Proposal Application Form

**Table 2. Locations of Battle Creek Stream Condition Monitoring Sites (50 Sites)**

SITE	2006 tasks	Landowner Class	UTM_X_COOR	UTM_Y_COOR	Actual UTM-X	Actual UTM-Y	Dist. btw Actual and Original UTM (m)	Site Location Description
#001	H&B	USFS	623406	4468653	na	na	na	Summit Creek, upper site
#002	H&B	SPI	603758	4485106	na	na	na	Battle, North Fork d.s. L-Line
#003	H&B	Ind	598843	4476809	na	na	na	Digger d.s. Ponderosa Way
#004	H&B	Ind	580077	4474226	580072	4474254	28	Battle, Mainstem d.s. Baldwin
#005	H&B	SPI	606910	4487206	na	na	na	Battle, North Fork d.s. McCumber Reservoir
#006	H&B	BLM	607616	4467957	606816	4468044	804	Battle, South Fork, Panther Reach d.s. Panther Creek
#007	H&B	Ind	595357	4476673	595358	4476671	3	Digger d.s. Manton
#009	H&B	Ind	608591	4490775	608559	4490804	43	Battle, North Fork u.s. McCumber Reservoir
#010	H&B	SPI	614271	4476141	na	na	na	Digger, South Fork d.s. F-Line
#011	H&B	Ind	593465	4476686	593464	4476726	40	Battle, North Fork, NBCFeeder Reach u.s. Digger
#013	Bugs	SPI	611890	4477009	na	na	na	Digger, South Fork d.s. A-Line
#014	Bugs	USFS	615834	4467732	na	na	na	Battle, South Fork d.s. Mineral
#015	Bugs	SPI	603073	4481397	603087	4481435	41	Bailey d.s. L-Line
#016	Bugs	LNP	623585	4481278	623530	4481270	55	Bailey near Soda Lake
#017	Bugs	Ind	619215	4465327	na	na	na	Turner Mt. Creek, Trib to South Fork at Mineral
#018	Bugs	SPI	600703	4480060	600682	4480095	41	Bailey u.s. Ponderosa Way
#019	Bugs	Ind	593039	4471925	593039	4471925	0	Battle, South Fork, Inskip Reach d.s. Inskip Dam
#020	Bugs	Ind	586141	4473741	586126	4473707	37	Battle, South Fork, Coleman Reach d.s. Manton Road
#021	Bugs	SPI	612790	4478141	612793	4478128	14	Digger, North Fork u.s. A-Line
#023	Bugs	SPI	604751	4482675	604730	4482698	30	Bailey u.s. L-Line
#024	Bugs	USFS	618786	4483287	618786	4483237	0	Bailey in Blue Canyon
#025	Bugs	SPI	611149	4493235	611135	4493254	22	Battle, North Fork d.s. USFS Boundary
#026	Bugs	USFS	615036	4476370	615031	4476369	5	Digger, South Fork lowest reach of USFS
#029	Bugs	SPI	608061	4485075	608502	4485025	444	Bailey d.s. Scharsch Meadows
#030	Bugs	Ind	576867	4473494	576860	4473503	11	Battle, Mainstem u.s. Spring Branch
#031	Bugs	SPI	601661	4477520	601643	4477473	50	Digger u.s. Ponderosa Way
#032	Bugs	Ind	569668	4470573	569667	4470573	0	Battle, Mainstem on Bloody Island
#033	Bugs	USFS	622520	4468417	622616	4468418	97	Summit Creek, lower site
#034	Bugs	PG&E	598163	4481081	unable to c	unable to d	na	Battle, North Fork, Keswick Reach d.s. Ponderosa Way
#036	Bugs	PG&E	587784	4472555	587896	4472564	113	Battle, South Fork, Inskip Reach u.s. Inskip PH
#037	Bugs	SPI	610922	4479100	611032	4478933	201	Rock d.s. A-Line
#038	Bugs	SPI	605624	4478643	NA	NA	NA	Rock near R-Line
#042	Bugs	USFS	618184	4477160	618141	4477105	69	Digger, North Fork d.s. Heart Lake
#043	Bugs	Ind	597001	4472213	597000	4472213	0	Battle, South Fork, South Reach u.s. Inskip Dam
#044	Bugs	Ind	590137	4471909	590032	4471871	111	Battle, South Fork, Inskip Reach d.s. Ripley Creek
#046	Bugs	CA	572099	4472025	571913	4471965	194	Battle, Mainstem d.s. Gover diversion
#047	Bugs	SPI	603259	4477289	603278	4477238	54	Digger North of Digger Butte
#049	Bugs	PG&E	613327	4495512	613358	4495549	48	Battle, North Fork d.s. NBCReservoir (1)
#051	Bugs	USFS	622681	4472397	622726	4472447	67	Nanny u.s. McGowan Lake
#052	Bugs	SPI	605515	4485523	na	na	na	Battle, North Fork d.s. Hwy 44
#053	Bugs	BLM	598246	4471590	598243	4471547	43	Battle, South Fork, South Reach d.s. Soap Creek
#054	Bugs	BLM	573635	4472058	573635	4472058	0	Battle, Mainstem downstream CNFH Intake #3
#055	Bugs	USFS	612965	4495008	612942	4495018	24	Battle, North Fork d.s. NBCReservoir (2)
#056	Bugs	Ind	604590	4476828	604564	4476830	25	Digger d.s. Forward Meadow
#057	Bugs	BLM	597154	4479716	597142	4479749	35	Battle, North Fork, Keswick Reach u.s. Volta PH
#059	Bugs	PG&E	613960	4495816	613886	4495825	74	Battle, North Fork u.s. NBCReservoir
#060	Bugs	Ind	602618	4468997	602618	4468997	0	Battle, South Fork, Panther Reach u.s. South Dam
#061	Bugs	Ind	592164	4475416	592163	4475416	0	Digger near mouth
#062	Bugs	Ind	585651	4474286	585650	4474286	0	Battle, S.F, Coleman Reach u.s. Confluence with N.F.
#063	Bugs	SPI	614040	4476216	614049	4476235	21	Digger, South Fork u.s. A-Line