

Quantification and Characterization of Trout Creek Restoration Effectiveness

SNPLMA Research Proposal: Round 9

Theme 4. Watershed Restoration: Subtheme A. Stream Channel and Meadow Restoration

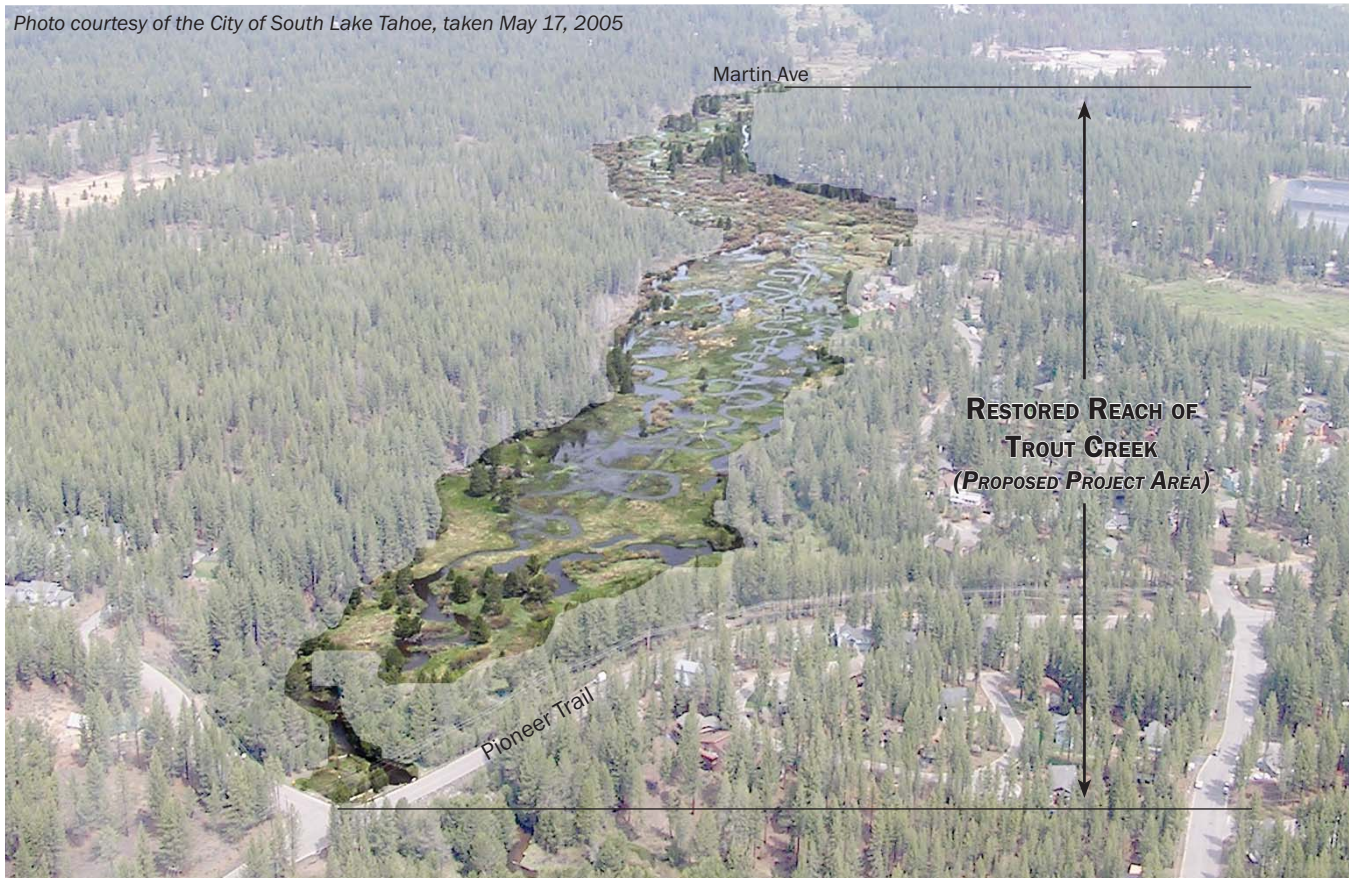
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Principal Investigator: Nicole Beck, PhD, 2NDNATURE LLC, nbeck@2ndnaturellc.com

Grant Contact: Krista McDonald, 2NDNATURE LLC, krista@2ndnaturellc.com

2NDNATURE LLC, 321 Frederick Street, Santa Cruz, CA 95062, 831.426.9119, fax 831.421.9023

Photo courtesy of the City of South Lake Tahoe, taken May 17, 2005



2NDNATURE

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321 Frederick Street
Santa Cruz, California 95062
p 831.426.9119 f 831.421.9023
w 2ndnaturellc.com

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Project Abstract

Many stream and meadow restoration projects have been implemented throughout the Lake Tahoe Basin over the past two decades. However a consistent definition of restoration effectiveness has not been defined nor have standardized methods been established to monitor and evaluate pre- and post-restoration conditions. This impedes the ability to define success for designers, funders and reviewers, and to communicate the benefits of stream restoration efforts to regulators and policy makers. In addition, the Lake Tahoe TMDL and associated Lake Clarity Crediting Program heighten the need to define and standardize a simple yet representative approach to estimate the water quality benefit of stream restoration efforts in the future. This research will:

- 1) apply the standardized approach of both simple and complex observations of Trout Creek to characterize pre and post-restoration stream reach condition by implementing the methodology and protocols of previously funded SNPLMA research (Round 7 and Round 8),
- 2) develop a simple methodology for the Stream Load Reduction Tool for local resource managers to predict the relative water quality benefits (total and fine sediment load reductions) as a result of stream morphologic modifications and floodplain restoration efforts using Trout Creek and Upper Truckee River as the tangible examples, and
- 3) enable load reductions from stream restoration to be accounted for in the Lake Tahoe total maximum daily load (TMDL) and Lake Clarity Crediting Programs.

Justification Statement

Numerous stream and meadow restoration efforts have been conducted in Lake Tahoe Basin over the past two decades. The intended benefits of such restoration efforts generally are to meet a number of multifaceted objectives. The Upper Truckee River Watershed Advisory Group (UTRWAG) has made considerable strides recently to define guidelines for general monitoring plans to evaluate stream restoration projects on the Upper Truckee River (UTRWAG 2007). Below are the UTRWAG (2007) goals of stream restoration projects:

- Goal #1: Restore properly functioning geomorphic channel configuration.
- Goal #2: Improve aquatic and wildlife habitat/populations.
- Goal #3: Improve functionality of floodplain for improving water quality.
- Goal #4: Improve riparian, meadow, and upland vegetation.
- Goal #5: Construct projects effectively and efficiently.

Despite this recent effort by UTRWAG, to date there is a significant lack of consistency on how to measure, document and track the effectiveness of implemented stream restoration projects in Lake Tahoe Basin with respect to meeting the intended project goals. Currently, a clear, defensible measurement of what defines 'effectiveness' is not available nor agreed upon by the Tahoe community of researchers and resource managers. Two recently funded SNPLMA research efforts (Round 7 and Round 8 2NDNATURE studies) are addressing this lack of consistency by developing both rapid evaluation methods and low-cost event-based sampling protocols. This proposed Round 9 research will use Trout Creek to solidify how these new methods and protocols can be used to characterize condition, evaluate effectiveness and establish a benchmark for successful restoration, which can be used as a reference point for subsequent evaluations throughout the Tahoe Basin.

The restoration of Trout Creek is touted throughout the Basin as a very successful restoration and is an ideal analog of an existing desired condition of Lake Tahoe restored meadow and stream complex. This research will use Trout Creek as a desired condition analog to integrate, focus and apply both simple and more complex observations and protocols being developed by the 2NDNATURE team (e.g. existing SNPLMA research). The data and information generated from the three 2NDNATURE SNPLMA studies (*if Round 9 is funded*) will be integrated into a simple mass balance predictive tool, termed the Stream Load Reduction Tool, to estimate the relative water quality benefits of stream restoration efforts. This simple yet representative predictive tool will provide a basis for including load reductions achieved by stream

restoration projects in the tracking of load reductions for the Lake Tahoe TMDL and assignment of urban Lake Clarity Credits through the Lake Clarity Crediting Program.

Background and Problem Statement

There are two main problems the proposed research will address:

1. Stream and meadow restoration projects in the Lake Tahoe Basin continue to be implemented without standardized protocols for effectiveness monitoring and results dissemination to other implementing agencies or members of the research community to appropriately facilitate adaptive management.

The research proposed by this study will build upon knowledge and momentum initiated by the current SNPLMA-funded 2NDNATURE efforts. Round 7 2NDNATURE research has refined detailed event-based fine sediment transport and floodplain deposition data collection using cost-effective techniques. These protocols and techniques are currently ready for application in other systems and would be implemented in Trout Creek using Round 9 funds. Current Round 8 2NDNATURE research is synthesizing previous approaches to restoration effectiveness evaluations and will produce both a working draft rapid assessment methodology to characterize stream reach conditions, as well as a recommended strategy of future detailed indicators and reporting metrics of pre- and post-project stream conditions in the fall of 2009. The research proposed herein for Round 9 would integrate, implement and refine the 2NDNATURE SNPLMA efforts using Trout Creek as the tangible example. This research will continue to work toward providing a practical tool and strategy for resource managers to measure, document and track a selection of specific physical, chemical and biological parameters of stream and meadow systems. Independently, the data parameters, indicators and metrics will provide very specific data on the condition of the restored Trout Creek stream and meadow reach. Collectively, the parameters will provide a quantitative characterization of the existing functional components of this desired stream and meadow condition.

2. The Lake Tahoe agencies, implementers and urban jurisdictions have a need to estimate the water quality benefit of stream restoration projects with respect to Lake Tahoe TMDL allocations and future lake clarity credits for urban jurisdictions.

The 2NDNATURE team will integrate, analyze and apply existing and future USGS, 2NDNATURE and other relevant data to meet current resource agencies, implementers and urban jurisdictions needs and develop the Stream Load Reduction Tool. 2NDNATURE will provide a relatively reliable yet simple methodology for resource managers to integrate geomorphic, hydrologic and water quality data to estimate the annual total and fine sediment reductions on a similar accounting scheme as the urban water quality estimates conducted by the Pollutant Load Reduction Model (PLRM). 2NDNATURE is a key member of the PLRM development team, which also includes Northwest Hydraulic Consultants (nhc) and Geosyntec and is funded by the US Army Corps of Engineers (USACE). The Stream Load Reduction Tool will provide a consistent methodology to apply data from existing streams to estimate the relative total and fine sediment load reduction¹ expected over any specified time frame, thereby allowing lake clarity credits for stream restoration projects within the Lake Tahoe Basin. The

¹ The primary pollutant of concern in Lake Tahoe is inorganic particles smaller than 20µm in diameter. The Lake Tahoe Lake Clarity Crediting Program will initially be based on the number of fine particles reduced as a result of water quality improvement projects. However, analyzing each water sample collected for # of particles < 20µm is not cost-effective. Currently, Lake Tahoe researchers are developing reliable conversions to estimate # of particles < 20µm per mass of sediment < 20µm. In order to stay consistent with other data collection and PLRM outputs, the Stream Load Reduction Tool proposed here, as well as all proposed water sample analysis and reporting, will be conducted as the mass of total suspended sediment and mass of fine sediment < 20µm. The fine sediment results from the Stream Load Reduction Tool can be easily converted to # of particles as other researchers develop the most appropriate and applicable conversion techniques. In addition, the 2NDNATURE team will coordinate with DRI and/or TERC researchers and make all stream samples collected and analyzed from our studies available for subsequent analysis to improve the mass to # of particles conversion for Lake Tahoe streams.

2NDNATURE research team has been and will continue to consider and evaluate potential stream observations and data collection with respect to the applicability and data input needs of this simple predictive tool. The 2NDNATURE team is informed of the protocols and approach of the UCD TERC stream floodplain predictive modeling tool development (*Potential of engineered floodplains and wetlands as fine particle best management practices: Case study of Trout Creek and the Upper Truckee River*, funded by SNPLMA Round 8) and we will continue to collaborate and share data with these researchers.

Hypothesis, Goals and Objectives

Hypothesis. The proposed study would solidify and integrate previously funded SNPLMA research efforts by implementing, validating and testing both the rapid assessment and event-based sampling techniques developed by 2NDNATURE SNPLMA research on Lake Tahoe streams.

- a. The refinement and implementation of stream rapid assessment techniques on Trout Creek will validate the techniques being developed under 2NDNATURE 2008 (Round 8) and characterize the “desired condition” analog of stream/meadow restoration within Lake Tahoe.
- b. The implementation of the cost-effective event-based sampling techniques developed under 2NDNATURE 2007 (Round 7) on Trout Creek will spatially expand the quantitative dataset and improve the predictive capability of the data analysis.
- c. The integration of existing and new data can facilitate a simple tool to predict the water quality benefits of stream restoration for direct integration into the Lake Clarity Crediting Program.

Goals.

1. Characterize the “desired condition” analog of stream morphology and function in the Lake Tahoe Basin (Trout Creek) by directly applying techniques developed by 2NDNATURE for Lake Tahoe streams.
2. Create a simple empirical methodology to quantify the water quality benefit of stream restoration, using reaches of Trout Creek and Upper Truckee River as tangible examples.

Objectives.

- (1) Build upon existing SNPLMA research products and others to define and then document the restored Trout Creek physical and chemical conditions.
- (2) Generate event-based and geomorphic parameters from Trout Creek to further refine the indicators and metrics used to characterize the geomorphic, ecological and water quality benefits of stream restoration projects.
- (3) Analyze and apply the data available to create the Stream Load Reduction Tool to standardize how the water quality benefits of stream restoration projects are estimated in the context of the Lake Tahoe TMDL.
- (4) Identify opportunities to employ the Stream Load Reduction Tool to evaluate restoration alternatives and future project effectiveness.

Approach, Methodology and Location of Research

Location of Research

The research will be conducted on the restored reach of Trout Creek bound by Pioneer Trail and Martin Avenue in South Lake Tahoe, CA (see cover of proposal).

Approach and Methodology

The approach and methodology employed to characterize Trout Creek will directly follow the approach and methodology developed, outlined and implemented in the current 2NDNATURE SNPLMA Round 7 and Round 8 contracts. The data collection parameters implemented to characterize Trout Creek will be a combination of (1) rapid assessment measurements and observations, (2) fluvial geomorphic topography and morphology characteristics, and (3) a set of hydrologic and water quality measurements that are repeated numerous times annually, typically focusing on elevated streamflow events when floodplain deposition will occur. The stream rapid assessment methodology developed

under 2NDNATURE's SNPLMA Round 8 contract will be conducted 2 to 3 times at Trout Creek. The USGS streamflow and water quality sampling data, both current and historic, will be integrated into the data analysis as appropriate. The more frequent measurements will evaluate hydrologic, geomorphic and water quality conditions during a multitude of high flow events. These measurements will include the floodplain and vertical water column sediment sampling protocols developed by 2NDNATURE (Figure 1) and implemented on the Upper Truckee River since December 2007 (funded via SNPLMA Round 7)². The inclusion of Trout Creek data to this existing dataset will allow for a more robust, paired-watershed analysis of sediment transport and sediment-floodplain interactions, greatly improving our dataset and subsequent understanding. The Trout Creek characterization will document the values and conditions of the best representative stream and meadow restoration project in Lake Tahoe.

Both the rapid and long-term parameters will be collected and maintained in a manner that will be directly integrated into a Stream Load Reduction Tool to predict the water quality benefit of stream morphologic modifications. The researchers will implement a simple and repeatable methodology by which physical, chemical and hydrologic characteristics of existing and proposed stream morphology can be integrated to estimate the relative water quality benefit and cumulative total and fine sediment load reduction as a result of morphological stream modifications (i.e. restoration actions). Figure 2 presents a schematic of the primary inputs, outputs and losses of water and sediment to a stream reach and the associated floodplain. The incoming hydrology and sediment loading characteristics of the stream reach in question will be estimated using USGS, 2NDNATURE and other available data. The pre- and post- restoration floodplain inundation frequency, duration and areal extent can be estimated for a range of flood recurrence intervals using available hydrologic and geomorphic data for the reach in question. Similar rating curves can be created for a number of alternative morphologic conditions to compare the water quality benefit of different stream channel configurations during restoration alternatives analysis. The predictive Stream Load Reduction Tool will be demonstrated using specific sections of Trout Creek and Upper Truckee River as the tangible examples.

The Stream Load Reduction Tool will allow precise and relatively accurate total and fine sediment load reduction estimates. The consideration of the fate and transport of nutrient species will not be included in this effort, but future build-out versions of the Stream Load Reduction Tool could certainly incorporate nutrient predictions. The researchers are not proposing a detailed high-resolution empirical model, but rather a relatively accurate simple mass-balance tool that incorporates pre- and post-project data and assumptions of pollutant transport and floodplain retention dynamics for different geomorphic configurations over a range of stream flood recurrence intervals. The integration of these datasets and basic fluvial processes will allow the development of a consistent approach to estimate the total and fine sediment load reductions of various restoration morphologic alternatives for a given stream reach. Existing total and fine sediment loading budgets developed for the Lake Tahoe TMDL by source category group and subwatershed will be used to constrain the load reduction estimates and ensure consistency with outputs from urban catchments as estimated by the PLRM.

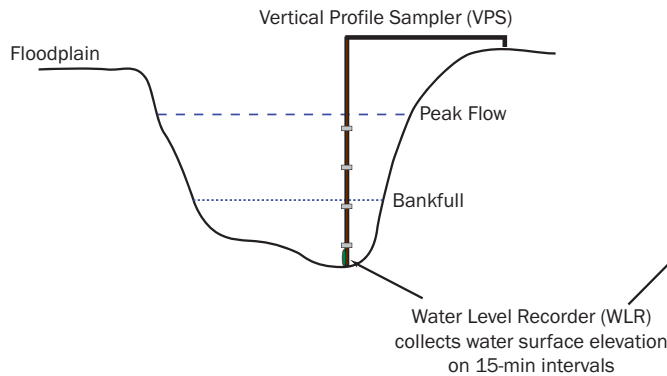
Relationship of Research to Previous Relevant Research, Monitoring, and/or Environmental Improvement Efforts

The proposed research will build upon existing research and data collection efforts in the following ways:

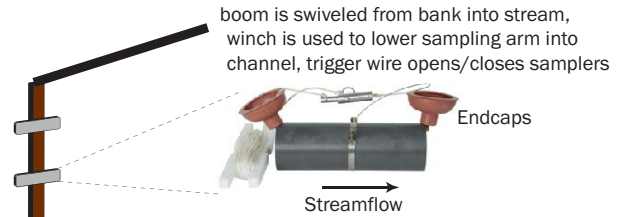
1. Existing pre- and post-restoration observations and monitoring data collected on the Trout Creek restored reach over the past decade will be synthesized and integrated to determine the state of our existing knowledge on the Trout Creek condition and stream restoration effectiveness.

² A detailed Data Collection Sampling Plan developed for SNPLMA Round 7 can be found at http://www.fs.fed.us/psw/partnerships/tahoescience/documents/Beck_SamplingPlan.pdf

ENTRENCHED CHANNEL
 LOW Width to Depth Ratio
 LOW Likelihood of Overbank Flow

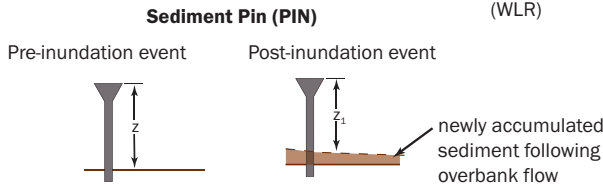
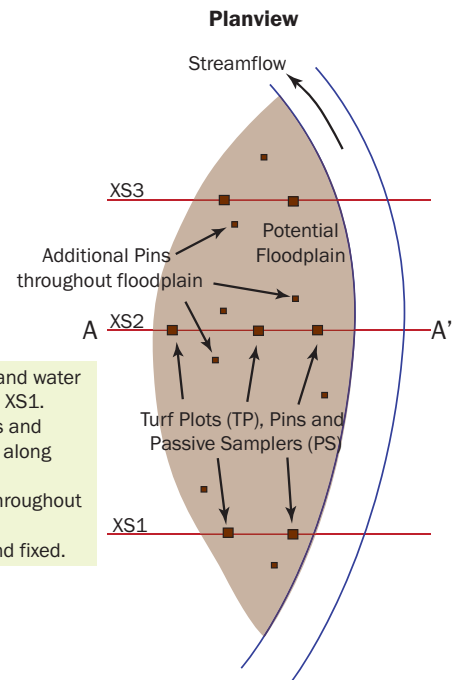
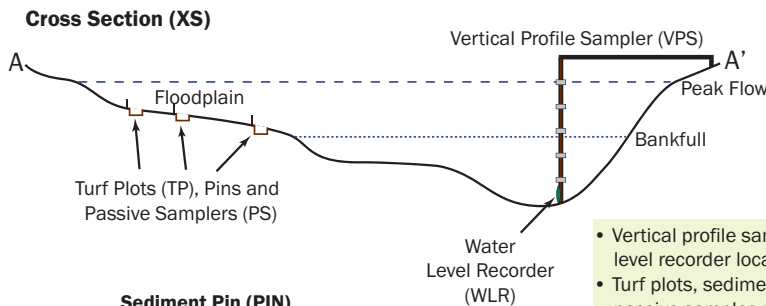


Vertical Profile Sampler (VPS) Schematic



- 4 spring-loaded samplers are attached to a boom secured to the channel bank.
- Bottom sampler elevation is fixed; other 3 sampler locations can be adjusted given stream stage (sampler elevations are recorded for each sampling event).
- During sampling event, field personnel deploy boom parallel to streamflow and trigger samplers (red plungers are released from 'up' position (shown above) and snap down to seal both ends of sampler).
- Surface water grab sample is taken concurrently from stream surface at location of boom.

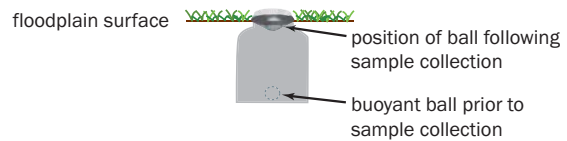
NON-ENTRENCHED CHANNEL
 HIGH Width to Depth Ratio
 HIGH Likelihood of Overbank Flow



- Pins sunk 1-2' into ground to prevent issues due to scour.
- Pin locations and elevations are surveyed and fixed.
- Following an inundation event, height from pin head to floodplain surface (z_1) is measured.
- Difference in height measurements ($z-z_1$) is the depth of newly accumulated sediments due to overbank flow.
- Provides simple calculation of volume of floodplain sediment deposition.

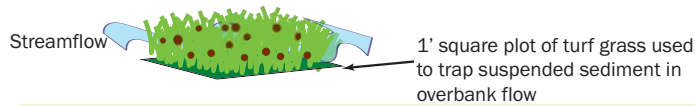
- Vertical profile sampler and water level recorder located at XS1.
- Turf plots, sediment pins and passive samples placed along cross sections.
- Additional pins placed throughout floodplain.
- All locations surveyed and fixed.

Floodplain Passive Sampler (PS)



- Floodplain passive samplers are placed either at or above grade of floodplain surface to trap samples as overbank flow occurs (see Figure 4 for details).
- Sampler locations are surveyed and fixed.
- Flange installed over mouth of sampler to reduce contamination of sample by aeolian sediment.
- Buoyant ball floats to top of jar as sample is collected and seals sample closed.

Turf Plot Sediment Trap (TP)



- Turf plot is secured at grade with floodplain with 6" nails.
- Turf plot locations and elevations are surveyed.
- During an inundation event, suspended sediment is trapped within the turf.
- Samples collected and analyzed for grain size distribution.

These techniques were initiated in the Spring 2008 on the Upper Truckee River and will continue through Spring 2009 (2NDNATURE SNPLMA Round 7.) A detailed Data Collection Sampling Plan developed for SNPLMA Round 7 can be found at http://www.fs.fed.us/psw/partnerships/taohoscience/documents/Beck_SamplingPlan.pdf

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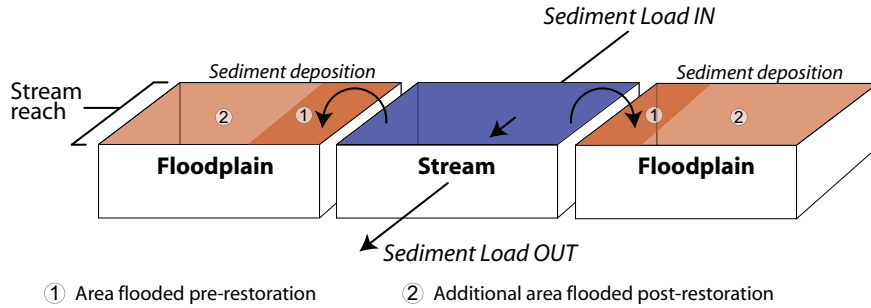
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SCHEMATIC OF PROPOSED SEDIMENT SAMPLING TECHNIQUES

FIGURE 1

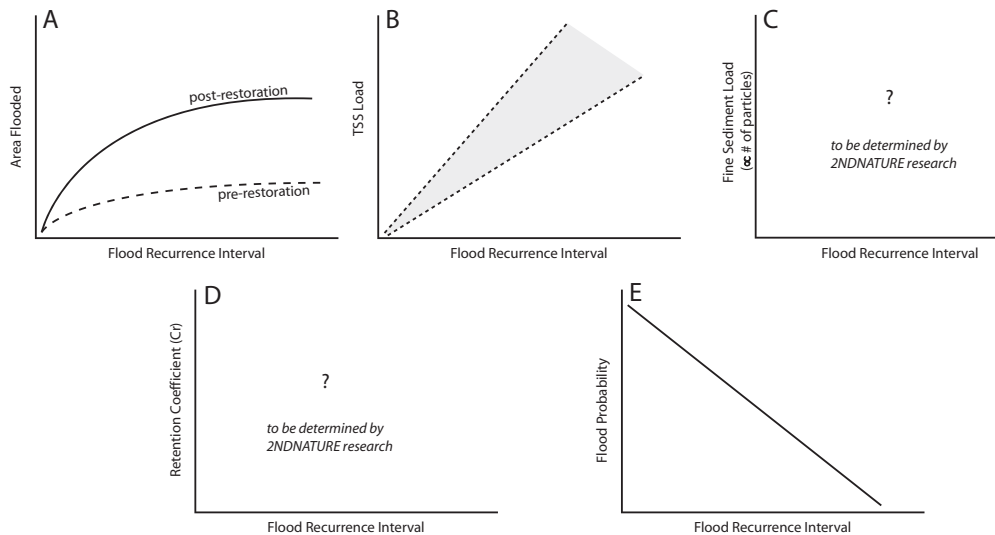
$$\text{Sediment Deposition} \propto \text{Sediment Load IN} * \text{Area Flooded} * \text{Retention Coefficient (Cr)}$$



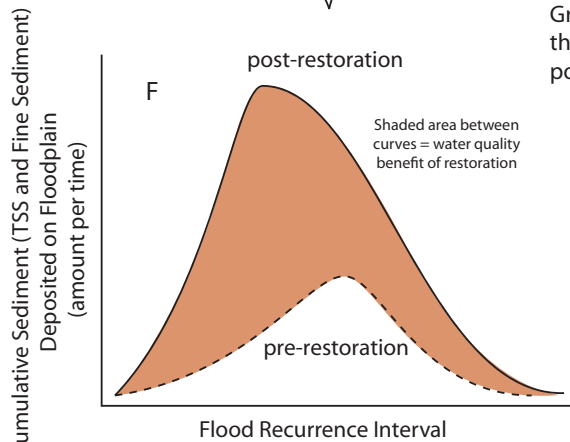
For a given stream reach and a specific flood recurrence interval, transfer of mass (i.e., total and fine sediment) occurs from the stream to the floodplain. The amount of sediment sequestered on the floodplain depends upon the area flooded, the TSS and fine sediment load coming into the stream reach, and a retention coefficient (Cr) that reflects the physical processes acting on sediment that result in deposition.

Mass Balance to Predict Cumulative Sediment Deposition on Floodplain, Pre- and Post-Restoration

Existing hydrologic, geomorphic and water quality data will be combined with 2NDNATURE fine sediment stream and floodplain sampling results to develop the rating curves below (Graphs A-E) for Trout Creek and the Upper Truckee River. The primary objective will be to devise a Stream Load Reduction Tool that captures our improved understanding of the primary factors that influence the amount of total and fine sediment retained on a floodplain for any given recurrence interval.



These rating curves will be integrated to estimate the water quality benefit of the reach in question (Graph F).



Graph F represents a hypothetical summary output of the Stream Load Reduction Tool. The third-order polynomial shape illustrates the following concept:

- Small floods are common but do not deposit much sediment.
- Large floods are uncommon but deposit a lot of sediment over a much greater area.
- It is assumed that the intermediate-sized events that have a moderate deposition potential and a moderate probability of occurring will provide the greatest load reductions (Wolman and Miller 1960).
- The shaded area between the two curves on Graph E can be integrated over any time interval to estimate the water quality benefit of stream restoration (i.e., sediment load reduction) and calculate average annual benefits.

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2. The event-based data collection and management protocols implemented on Trout Creek will be identical to those established by 2NDNATURE on the Upper Truckee River (and funded by SNPLMA Round 7 ²). Data will be directly comparable and allow for a paired-watershed analysis of sediment transport and floodplain interactions.
3. The rapid assessment field observations and data management techniques used to evaluate Trout Creek will correspond to those being developed by 2NDNATURE as part of a SNPLMA Round 8 contract. Observations on Trout Creek will be added to the existing dataset, building our knowledge base of stream condition.
4. The integration of existing data into a simple empirical framework to estimate the water quality benefit of stream restoration projects will directly contribute to the Lake Clarity Crediting Program, the Lake Tahoe TMDL, as well as integrate the key load reduction outputs with PLRM. This information will also enable the EIP to report the overall benefits of stream restoration projects to policy makers and politicians responsible for making project prioritization and funding decisions.
5. Tight collaboration and communication between the 2NDNATURE team and the UCD researchers currently funded to develop a detailed floodplain depositional model has been established and will continue in an effort to synchronize hydrologic and water quality characterization protocols, understand the distinct data needs of UCD's numerical modeling efforts, and ensure that efforts are not duplicated and remain synergistic.

Strategy for Engaging with Managers

2NDNATURE has involved the Lahontan Regional Water Quality Control Board, California Tahoe Conservancy, California State Parks, and USFS Lake Tahoe Basin Management Unit in the scoping of this research proposal. There is a clear need for managing agencies to have (1) a standard, defensible definition of effectiveness, (2) a reliable methodology to compare pre- and post-restoration data and (3) a simple tool to quantify the potential and verify the actual water quality benefit of a stream restoration project. The research team will form a technical advisory committee (TAC) to oversee and provide comment throughout the research. Members will be recruited from UTRWAG members and from the science and regulatory communities in Tahoe, including federal, California, Nevada, and local personnel.

Description of Deliverables/ Products

The research will consist of 4 tasks completed in succession. The scope of work for the proposed research will symbiotically utilize the knowledge gained as well as the products developed in the SNPLMA Round 7 and Round 8 2NDNATURE research efforts.

Round 7 research has resulted in the refinement and testing of the vertical water column and floodplain sediment sampling techniques and protocols. These refined protocols² will be employed at strategic locations within the restored Trout Creek reach to spatially expand the existing datasets. Round 8 research deliverables include an inventory and synthesis of existing stream restoration projects and effectiveness evaluations, a stream restoration conceptual model, the development of a working draft rapid assessment methodology (Stream RAM) for Lake Tahoe streams, and general recommendations on how to standardize and focus future effectiveness evaluations of stream restoration projects. The year lag of the proposed Round 9 study will provide greater efficiency of resources and build upon the momentum gained from the 2NDNATURE Round 7 and Round 8 research.

Task 1. Trout Creek Characterization Plan

Building upon the knowledge gained and the products developed by the Round 7 and Round 8 efforts, the research team will produce a detailed sampling and observation approach to be implemented on Trout Creek during 2009-2011 to collectively characterize the Trout Creek condition and meet the goal and objectives of this research.

The Trout Creek Characterization Plan will serve two distinct purposes: (1) refine the working draft of the Stream RAM and recommended data collection strategy from the Round 8 study that will be completed in the summer of 2009 and (2) ensure data collection efforts will directly lend to rapid evaluation of stream condition and/or serve as input parameters into a simple empirical predictive tool to standardize the quantification of the water quality benefits of hydrology and geomorphology modifications to impaired stream reaches. The parameters selected will be developed to directly inform the effectiveness of Trout Creek to meet specific hydrologic, geomorphic and water quality goals and objectives as outlined by UTRWAG. In addition, the values and characteristics obtained from Trout Creek will formulate our target conditions for future restoration efforts.

A Draft Trout Creek Characterization Plan will be created based on the approach and efforts described above and circulated to the TAC for review. The researchers will arrange and facilitate a TAC meeting to discuss and comment on the draft Trout Creek Characterization Plan. The comments and suggestions from the TAC will be considered and integrated into the Final Trout Creek Characterization Plan, which will be posted on the USFS research website and TIIMS.

Task 2. Trout Creek Characterization

Following the approval of the Final Characterization Plan, the research team will implement the field observations per the protocols and techniques outlined in Task 1. A small portion of the resources allocated in Task 2 (20%) will be used to expand the event-based sampling within the currently instrumented Upper Truckee River stations to ensure event overlap with Trout Creek data collection. Data will be managed using the current database framework and build upon the data organization and management techniques developed under the Round 7 and Round 8 SNPLMA research. The continued goal of the 2NDNATURE team is to organize and facilitate the integration of future observations at additional stream/meadow systems in a consistent and accessible manner, and existing datasets will be posted and available on TIIMS at the completion of this research. We anticipate data collection to continue for no more than 20 months following the onset of sampling in Trout Creek, with the primary goal of sampling at least 2 spring snow melt conditions. Where feasible, resource managers and members of the TAC will be included in the data collection and field observations to build the collaborative value of these tools.

Task 3. Data Analysis and Stream Load Reduction Tool

Task 3 will include the integration of the detailed data collection efforts from this proposed research, the previously funded SNPLMA research data and other existing and relevant datasets to (1) characterize the Trout Creek condition using quantitative metrics and (2) develop a simple framework to predict and quantify the relative water quality benefit of stream restoration efforts. The existing datasets may include, but are not limited to: USGS discharge and water quality data from Lake Tahoe LTIMP stations, previous topographic surveys of Trout Creek and Upper Truckee River, and other applicable physical, chemical, vegetation and/or biological data collected from Trout Creek and Upper Truckee River. The existing data will be integrated with the newly obtained data from 2NDNATURE research. The researchers will recommend a simple and repeatable methodology by which physical, chemical, biological, and hydrologic characteristics of existing and proposed stream morphology can be integrated to estimate the relative water quality benefit and associated load reductions as a result of morphological stream modifications (i.e., Stream Load Reduction Tool). The Stream Load Reduction Tool will be demonstrated using specific sections of Trout Creek and Upper Truckee River as tangible examples.

Task 4. Technical Report: Trout Creek Characterization and Quarterly Reporting

Task 4A. Technical Report

Following the execution and analysis of the data collection and site observation efforts (Tasks 2 and 3), the researchers will produce a Technical Report: Trout Creek Characterization. The Technical Report will provide a clear, organized and precise communication of existing Trout Creek conditions. These conditions may serve as the future values of “desired conditions” for other comparable

stream/meadow systems. Based on the value and comparability of existing pre-restoration project data from Trout Creek, the researchers will evaluate the effectiveness of restoration efforts to the extent possible. The Technical Report will also include a distinct chapter outlining the recommended methodology, data and procedures of the Stream Load Reduction Tool to empirically predict the relative water quality benefit of future stream restoration projects. The Technical Report will include the protocols, methods, station locations, data management techniques, and other components developed in the Characterization Plan (Task 1). The database of data generated will be provided to the USFS and uploaded on TIIMS. A draft will be submitted, circulated and evaluated with the TAC prior to the completion of the Final Technical Report.

Task 4B. Quarterly Progress Reports

As required by the contract, quarterly progress reports will be created and submitted to the USFS by the 1st of September, December, March and June.

Deliverables

The main deliverables of the research will be a Detailed Characterization Plan (Task 1) and a Final Technical Report (Task 4A). The research team will conduct two formal TAC meetings. Quarterly progress reports (Task 4B) will also be submitted throughout the duration of the research.

Schedule of Milestones/Deliverables

Task		Begin: (time since contract award)	End: (time since contract award)
1	Obtain any additional and applicable Trout Creek physical, chemical and/or biological data that 2NDNATURE may not have.	0 months	3 months
	Draft Trout Creek Characterization Plan and present to TAC.	0 months	5 months
	Revise and finalize Final Characterization Plan. (Ideally by early 2010)	5 months	7 months
2	Instrument and maintain sites. (Ideally completed before snowmelt in Spring 2010)	7 months	9 months
	Evaluate sites using both rapid assessments and event-based data collection. (Ideally continues from Spring 2010 through June 2011)	8 months	23 months
	Manage database and data.	8 months	23 months
3	Integrate all relevant existing hydrologic, geomorphic and water quality data from Upper Truckee River and Trout Creek.	0 months	23 months
	Conduct data analysis to provide a simple relatively accurate technique to estimate the water quality benefit of distinct hydrologic, geomorphic and flood plain characteristic changes.	0 months	23 months
4	Draft Technical Report and present to TAC.	25 months	28 months
	Revise and finalize Final Technical Report.	28 months	30 months
	Quarterly progress reports	1 st of September, December, March and June throughout project duration	
	Invoicing	Ongoing monthly	

Literature Cited

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