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June 29, 2010

Bureau of Reclamation
Attention: ALB-111
Albuquerque Area Office
555 Broadway Blvd NE
Albuquerque, New Mexico 87102

Re: Solicitation No. R10PS40039 – Middle Rio Grande Endangered Species Collaborative Program: Adaptive Management Plan Development

ESSA Technologies Ltd., in association with Headwaters Corporation, is very pleased to enclose our **Proposal (Volumes I and II)** for the aforementioned Request for Quotations (RFQ), which we believe fully meets all of your requirements. Together, our firms have extensive experience with adaptive management plan development, implementation, and assessment. Specific examples include:

- 1) ESSA led development of the Integrated Assessment Plan, an adaptive management framework for the Trinity River Restoration Program (2004 – present);
- 2) ESSA led development of the Columbia River Collaborative Systemwide Monitoring and Evaluation Project, focused on improving Columbia Basin adaptive management (2003 - 2008);
- 3) ESSA and Headwaters Corporation work independently on the Platte River Recovery Implementation Program (PRRIP). Headwaters provides the independent Executive Director and staff for the PRRIP, including the Science and Adaptive Management Plan Implementation Coordinator (Chad Smith). I currently serve as Chair of the Independent Scientific Advisory Committee, and previously served on an expert panel to review the Adaptive Management Plan (2005 – present); and
- 4) ESSA (myself) and Headwaters (Chad Smith) worked jointly as members of an Expert Review Panel for the Comprehensive Everglades Restoration Program's Adaptive Management Integration Guide (2010).

Our small team of independent experts in adaptive management, science, statistics, facilitation, and western water resources is eager to work closely with the signatories of the Middle Rio Grande Collaborative Endangered Species Program to develop an implementable Adaptive Management Plan. We have organized our proposal to be consistent with the structure specified in the RFQ and we have complied with all necessary certifications. We are excited about the project and very passionate about the power and utility of adaptive management (when done properly), and we look forward to your decision.

If you require further clarification on any aspect of this proposal, do not hesitate to contact me.

Yours sincerely,

A handwritten signature in black ink that reads 'David Marmorek'.

David R. Marmorek, President



Middle Rio Grande Endangered Species Collaborative Program: Adaptive Management Plan Development

Volume I: Technical Proposal

Solicitation No. R10PS40039

[May 12th Original Synopsis (Presolicitation) and June 8th Modification/Amendment (Solicitation)]
Proposals due at 4:30pm local time on Thursday July 1st, 2010



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June 29, 2010

Confidentiality

This proposal and all materials submitted by ESSA Technologies Ltd. and Headwaters Corporation are confidential. All information contained within this document is considered proprietary and not to be disclosed. ESSA Technologies Ltd. and Headwaters Corporation require that this proposal not be distributed to any other party without the prior written consent of our companies.

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2.0 Index

Evaluation Criteria in the RFQ	Location in this proposal
Technical Capabilities to Meet the Government Requirement: The proposal clearly and sufficiently demonstrates offeror's capability to perform the work identified so there is no risk that work will not be completed within the identified schedule	5.0 Technical Capabilities to Meet the Government Requirement
Constituency of proposed personnel, labor categories, and expertise fully demonstrate complete understanding of the requirement.	5.4 Key personnel 5.1 Approach , under "Middle Rio Grande River Background – Our Understanding" heading
The proposed schedule is realistic and does not indicate any potential issues.	5.3 Schedule
If issues are identified, proposal offers measures, alternatives, and solutions for mitigation.	5.2 Project management plan / task list , Table 2, "Challenges expected in this project, and approaches for dealing with them"
Relevant experience and lessons learned are sufficiently cited and successfully related or connected to the Government requirement.	5.1 Approach , under "Adaptive Management Plan Development – Our Technical Approach" heading 5.2 Project management plan / task list , scattered throughout task descriptions 5.4 Key personnel
The proposal offers innovative approach that, if pursued, is sustainable, manageable, and adaptable to future needs of the program	5.1 Approach , with some highlights summarized under "Summary of Innovations" heading
Company Experience	Appendix 1: Company Experience
Past Performance	Appendix 2: Past Performance

Elements from Attachment A - Statement of Work in the RFQ	Location in this proposal
3.0 Objectives	5.1 Approach , under "Adaptive Management Plan Development – Our Technical Approach" heading
4.0 Tasks	5.2 Project management plan / task list
5.0 Delivery (deliverables and schedule)	5.2 Project management plan / task list (for description of tasks and deliverables) 5.3 Schedule , Table 3, "Proposed project schedule" (for schedule by task and deliverable)
7.0 Qualifications	5.4 Key personnel , throughout but also summarized in Table 5, "Alignment of our key project personnel with the team qualifications in the RFQ" Appendix 1: Company Experience Appendix 2: Past Performance Appendix 6: CVs
8.0 Place of performance	5.2 Project management plan / task list , first paragraph
9.0 Period of performance	5.3 Schedule , Table 3, "Proposed project schedule"

3.0 Enclosures

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4.0 Executive Summary

ESSA Technologies, Ltd. and Headwaters Corporation are pleased to submit this proposal for technical assistance with development of an Adaptive Management Plan (AM Plan) for the Middle Rio Grande (MRG) Endangered Species Collaborative Program (Program). We have assembled a small, highly qualified team comprised of independent scientists, leading adaptive management practitioners, statistics experts, western water resources experts, and other staff to assist with and facilitate the development of a draft and final AM Plan. Our team reflects many years of experience developing and implementing AM Plans; working with AM theory and practice nationally and internationally; utilizing decision analysis tools; designing statistically robust field data collection and assessment plans; working with western water operations in over-appropriated basins; and facilitating and leading large groups of multi-discipline stakeholders on complex adaptive management processes in large river basins.

We envision an AM Plan consistent with both the historical context of work in the Middle Rio Grande and the best practices of AM developed over the last three decades. In summary, our understanding of the Project need includes:

- Independent expert assistance with writing the Program's AM Plan
- Facilitation of signatory, Program scientist and manager, and other stakeholder input into AM Plan
- Details of experimental design, sampling design, data analysis, and decision analysis

We intend to follow the six-step adaptive management cycle (assess, design, implement, monitor, evaluate, adjust) to develop the AM Plan, building on the good work already completed on the MRG regarding objectives, indicators, and other critical components of robust AM. Ongoing work related to the development of a new Program Long Term Plan and new ESA consultations will also be important guides. The AM Plan will focus on "need to know" information pertaining to monitoring and response actions for the Rio Grande silvery minnow and Southwestern willow flycatcher in the context of Endangered Species Act compliance and water supply and management concerns.

Our team is ready and willing to work with a large group of broad interests on the development of an AM Plan. We have done this exact work before and will follow a similar process on the MRG:

- Extensive review and research of existing documents and information
- Kick-off meeting
- Signatory interviews
- Facilitated adaptive management planning meetings and workshops
- Expert input
- Draft AM Plan and Memoranda of Agreement (MOAs)
- Response to questions and comments
- Final AM Plan and MOAs

Our team has extensive experience developing and implementing AM plans, including monitoring indicators, monitoring protocols, decision criteria and thresholds, identifying initial assumptions, framing monitoring and research needs, responsibilities, authorities, start time, response time, and funding needs. We will also bring to the table expertise in statistical design, field methods, sampling frequency, and data analysis. We will contract with silvery minnow and flycatcher experts to make sure data collection and assessment methodologies are realistic for the species.

Our team has unmatched experience with developing and implementing adaptive management, including applications to the Platte River, Trinity River, Columbia River, Sacramento River, Everglades, Missouri River, and many other aquatic systems. This will ensure that the MRG Program is provided with a rigorous and practical adaptive management plan that has strong stakeholder support.

5.0 Technical Capabilities to Meet the Government Requirement

5.1 APPROACH

Middle Rio Grande River Background – Our Understanding

The Middle Rio Grande River (MRG) contains the endangered Southwestern willow flycatcher (*Empidonax traillii extimus*) and the endangered Rio Grande silvery minnow (*Hybognathus amarus*). The area of interest includes roughly 300 mainstem miles of the Rio Grande River and its tributaries from the New Mexico-Colorado state line south to Elephant Butte Reservoir. The MRG includes numerous dams and diversions and important regional water uses such as irrigation, municipal water supply, and flood control.

The U.S. Fish and Wildlife Service issued a Biological Opinion (BiOp) in 2003, a revised silvery minnow recovery plan in 2010, and a flycatcher recovery plan in 2002. The BiOp concluded that Bureau of Reclamation (Bureau), Corps of Engineers (Corps), and other non-federal river operations may affect and are likely to adversely affect the silvery minnow and flycatcher and may adversely modify silvery minnow critical habitat. The BiOp recommends a Reasonable and Prudent Alternative (RPA) to avoid jeopardy to the species and adverse impacts to silvery minnow critical habitat. The RPA, as well as the recovery plans for both species, involve numerous potential actions designed to aid species recovery including a spawning spike, providing surface water to flycatcher breeding sites, continuous minimum river flows, fish passage and salvage, habitat restoration, and monitoring.

Most, but not all, recovery actions are taking place under the oversight of the Middle Rio Grande Endangered Species Collaborative Program (Program). Since 2002, the Program has assisted the Bureau and Corps with BiOp compliance and ensuring Endangered Species act (ESA) compliance for federal and non-federal water and river maintenance operations affecting the silvery minnow and flycatcher. The collaborative Program is governed by an Executive Committee currently comprised of the following signatories or “Program participants” (<http://middleriogrande.com/Default.aspx?tabid=178>):

- Bureau of Reclamation
- U.S. Fish and Wildlife Service
- U.S. Army Corps of Engineers
- New Mexico Interstate Stream Commission
- New Mexico Department of Game and Fish
- New Mexico Attorney General's Office
- Pueblo of Santo Domingo
- Pueblo of Sandia
- Pueblo of Isleta
- Pueblo of Santa Ana
- Middle Rio Grande Conservancy District
- City of Albuquerque
- Albuquerque-Bernalillo County Water Utility Authority
- Assessment Payers Association of the Middle Rio Grande Conservancy District
- New Mexico Department of Agriculture
- University of New Mexico

The Executive Committee established a Coordinating Committee to identify concerns associated with Program activities and to develop consensus recommendations for action to the Executive Committee. The Program Management Team provides management and technical support to the Executive Committee and Coordinating Committee, as well as to additional Program Work Groups. Current Program goals include: 1) alleviate jeopardy to the listed species in the Program area; 2) conserve and contribute to the recovery of listed species (stabilize existing populations; develop self-sustaining populations); and 3) protect existing and future water uses.

The Executive Committee adopted a Long Term Plan in 2006 to guide implementation of Program actions. The current Long Term Plan describes activities within the scope of the Program, provides budget estimates through the year 2014, and identifies measurable objectives and an annual Program assessment process. In 2009, the Executive Committee decided to restructure Program goals and outcomes to transition from activities focused on avoiding jeopardy to those of a Recovery Implementation Program. Non-federal Program members are pursuing additional authorizing legislation to identify the Program as a recovery

program. While the Bureau and the Corps are in the process of developing new Biological Assessments (BAs) in coordination with the Program, the Program is developing a new Long Term Plan. The new Long Term Plan will be the primary compliance vehicle for actions under the new ESA consultations. An integral component of the Long Term Plan will be an Adaptive Management Plan (AM Plan) that will serve as the science framework of the Program.

There are uncertainties regarding the effectiveness of most BiOp, Program, and non-federal management actions related to the silvery minnow and flycatcher. In this case, the MRG has engineering uncertainties (e.g., ability to manage water supply to provide a spawning spike of the proper magnitude, duration, timing, frequency, and rate of change), biological uncertainties (e.g., will RPA actions improve silvery minnow and flycatcher populations?), and operational uncertainties (e.g., how to meet both human and species needs for water within each water year). For some problems related to uncertainty, adaptive management can be a helpful approach, provided certain conditions are fulfilled (i.e., it is ecologically feasible to conduct a test of management actions, there is the potential for learning about action effectiveness within a reasonable time frame, management actions can be changed based on learning). This proposal addresses the Program's need to develop a formal AM Plan with independent, technical facilitation. The AM Plan would be developed to guide implementation, monitoring, and research activities over the duration of the new Long Term Plan. It would be iteratively revised based on what is learned from those activities. The participants in the development of the AM Plan would be the same technical representatives of Program participants who have worked together up to this point. Those participants and the independent technical facilitators developing the AM Plan would also collaboratively interact with other interested stakeholders in the MRG basin.

Adaptive Management – Our Philosophy

Adaptive management (AM) is a rigorous approach for learning through deliberately designing and applying management actions to maximize learning. It was first developed under the name “Adaptive Environmental Assessment and Management” in the 1970s by C.S. “Buzz” Holling and Carl Walters and associates at the University of British Columbia and the International Institute for Applied Systems Analysis in Vienna (Holling, 1978). It has since been applied to a wide range of resource and ecosystem management problems throughout North America and elsewhere (ESSA, 1982; McDonald et. al, 1999; Bouris, 1998; Gregory et al., 2006). AM is an approach to management that involves synthesizing existing knowledge, exploring alternative actions, making explicit predictions of their outcomes, selecting one or more actions to implement, conducting monitoring and research to see if the actual outcomes match those predicted, and then using these results to learn and adjust future management and policy (Walters, 1986; Walters, 2007; Taylor et al., 1997; Murray and Marmorek, 2003; Williams et al., 2007; Smith, *accepted*). This sequence is summarized in a six-step process (Figure 1).

Table A3.1 (Appendix 3) lists the basic elements in each of the six steps in the AM cycle. Inclusion of the elements in each step depends on the specific context of the issue at hand; we do not use all elements every time. However, each element has an important function and there are consequences for leaving any out. As elements are dropped, the application of AM becomes less rigorous and begins to move out of the domain of AM into a less rigorous and potentially much less effective learning paradigm.

The AM process is intended to be iterative. After management actions are completed and rigorously assessed, the knowledge gained should be applied to improve the next round of management. However, it is often not possible to resolve all uncertainties through a single set of management actions. Also, the influence of external drivers of the ecosystem should be expected to change over time, influencing the effectiveness of management strategies. Consequently, subsequent rounds of management should also be treated as formal management evaluations, leading to subsequent iterations of the AM cycle.

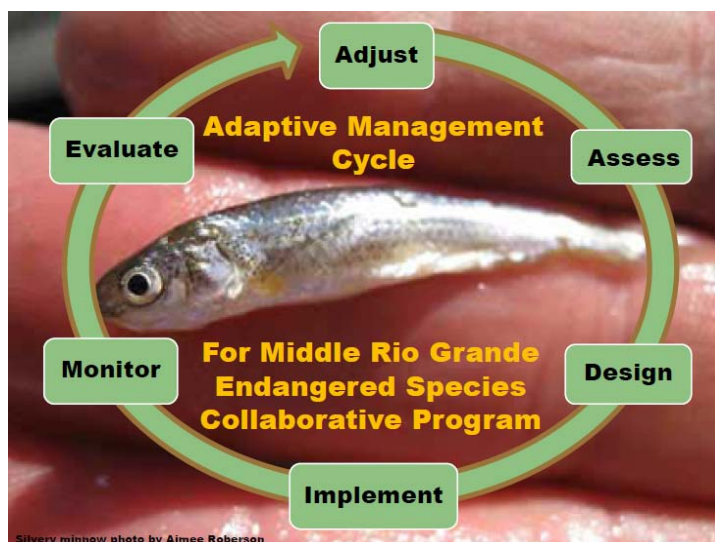


Figure 1. Adaptive management cycle.

Our technical approach will be to begin in **Step 1** (“Assess”) by working closely with all Program participants, other stakeholders, and species (silvery minnow and flycatcher) experts to identify clear goals and objectives, uncertainties, assumptions, possible actions, indicators, conceptual models, hypotheses, decision criteria, and other key elements necessary to build an AM Plan that can be understood, implemented, evaluated, and, most importantly, be useful to managers and decision-makers. The AM Plan itself will build on that foundation, developed via **Step 2** in the AM cycle (“Design”).

Adaptive Management Plan Development – Our Technical Approach

Over the course of the 230-day period of performance our team will work with the specific AM Plan objectives listed in the RFQ Scope of Work squarely in mind:

1. *Identifies Program and/or action agency responsibilities for monitoring and response actions necessary to meet the biological needs of the silvery minnow and flycatcher and Program requirements for ESA compliance* – The AM Plan will link directly to silvery minnow and flycatcher RPA elements, the Long Term Plan, and other Program actions, clearly stating who will do what (and to the degree feasible, how they will do it). The process of developing the AM Plan will engage agency regulators throughout to ensure both ESA compliance and buy-in. We have direct experience with this process through our team’s ongoing experience leading the revision and implementation of the AM Plan for the Platte River Recovery Implementation Program.
2. *Focuses on recovery of the silvery minnow and flycatcher, and conservation of and improvements to their designated critical habitats* – The AM Plan will center on actions that contribute directly to silvery minnow and flycatcher recovery. It will be set up to test hypotheses directly related to management objectives, using indicators and targets for habitat conditions, species status, and species response.
3. *Addresses the effective management of water supplies* – The AM Plan will prioritize water-related actions that respect water supply limitations, state law, compact delivery obligations, local and regional water use, Tribal obligations, and other constraints necessary to uphold the Program’s goal to “protect existing and future water use”. Again, our team’s ongoing experience implementing the Platte River Recovery Implementation Program gives us direct experience with AM in this context, since a fundamental goal of the Platte River Recovery Implementation Program is providing ESA compliance for existing and new water related activities.

4. *Provides a framework for opportunistic adaptive management projects and hypothesis testing* – The AM Plan will provide the basis for Program hypothesis testing and implementing management actions in a “learning by doing” approach. We are aware that current and future commitments to water use may constrain the range of alternatives that can be feasibly implemented, as in other systems where our team has developed AM approaches (i.e. the Platte, Trinity, Columbia, and Sacramento Rivers). Under such constrained conditions, it is particularly important to take advantage of unexpected ‘natural experiments’ created by unusual water years or events that can yield valuable insights on habitat and species responses. In addition, small-scale ‘safe-fail’ actions in habitat restoration can provide excellent opportunities for learning.

As a matter of course, the AM Plan should focus on “**need to know**” information instead of “**nice to know**” information, considering the relevance of each proposed research and monitoring activity (i.e., if you knew this, what would you do differently?) and the feasibility of testing a given hypothesis or conducting a particular assessment (i.e. statistical, logistical, and financial feasibility). The AM Plan will ensure that Program money, staff, and effort are directed at tasks on the “need to know” side that reduce *critical* uncertainties about silvery minnow and flycatcher response to management actions (either directly or via changes to their habitats and the processes that maintain them). This will provide decision-makers with the most useful and reliable information for adjusting management actions in response to the accumulated science learning. We recognize that prioritization of activities is both difficult and essential, and have learned some useful strategies for making such decisions.

Additionally, it is important to note that we strongly believe in building on past and current work and not continually “reinventing the wheel”. Much has been done along the MRG, including development of Program objectives and metrics in the 2006 Long Term Plan, objectives and actions outside of the Program related to the BiOp and work by other entities, and the ongoing development of an updated Long Term Plan. These efforts are to be commended and will serve as important building blocks for a comprehensive but realistic AM Plan that can be implemented, evaluated, and linked to Program decision-making.

We will use the following first-cut “straw outline” for the Program’s AM Plan, which is based on the structure of the AM Plan currently being developed by ESSA for Dry Creek in the Russian River watershed of California’s central coast. This is merely a preliminary draft. We expect it to be revised many times over. We will use the outline as an overall framework to assist with compiling information and will work with Program scientists and managers to fill the outline in with details to keep track of how complex information is linked and to clearly identify on a regular basis priority information gaps that need to be filled to ensure the AM Plan is completed on schedule.

Middle Rio Grande Endangered Species Collaborative Program – AM Plan “Straw” Outline

1.0 Executive Summary

2.0 Introduction

- 2.1 Program background, need for adaptive management plan
- 2.2 Purpose of the AM Plan

3.0 AM Cycle Step 1 – Problem Assessment (What story are you trying to tell?)

- 3.1 Fundamental Program management objectives –focus on silvery minnow and flycatcher
 - a. Objectives in: current Long Term Plan (Program Executive Committee, 2006); Long Term Plan now in development; BiOp (USFWS, 2003); silvery minnow recovery plan (USFWS, 2010); and flycatcher recovery plan (USFWS, 2002).
 - b. Objectives of each Program signatory; c. Objectives hierarchy
- 3.2 Spatial extent and temporal horizon of the project
- 3.3 Alternative actions under consideration for enhancing habitat
- 3.4 Conceptual models for Middle Rio Grande system, silvery minnow, and flycatcher
- 3.5 Critical uncertainties

- 3.6 Candidate performance measures / indicators and target levels
- 3.7 Priority hypotheses (competing hypotheses, prioritization, sequencing – see Table 1)
- 3.8 Decision rules for revising hypotheses, management actions, and monitoring
- 4.0 AM Cycle Step 2 - Design of Implementation, Monitoring, and Evaluation**
 - 4.1 Alternative designs for implementing the management actions
 - 4.2 Analyses of alternative designs for action implementation, monitoring, & evaluation
 - a. Criteria for evaluation; b. Methods; c. Results; d. Recommended design
 - 4.3 Decision tree outlining next steps under alternative outcomes
 - 4.4 Implementation design
 - 4.5 Conservation Monitoring and Evaluation Plan
 - a. Implementation; b. Effectiveness; c. Validation
 - 4.6 Data Management Plan
 - 4.7 Data Analysis and Evaluation Plan
 - 4.8 Decision Analysis Plan
 - 4.9 Reporting schedule
- 5.0 AM Cycle Step 3 – Implement**
 - 5.1 Project oversight
 - 5.2 Project management
 - 5.3 Project reporting
- 6.0 AM Cycle Step 4 – Monitor**
 - 6.1 Monitoring responsibilities and tasks
 - 6.2 Data QA/QC and warehousing
 - 6.3 Revise monitoring and research protocols and approaches as necessary
- 7.0 AM Cycle Step 5 – Evaluate**
 - 7.1 Analysis methods and procedures
 - 7.2 Integrate results with decision analysis tools
 - 7.3 Reporting process
 - 7.4 Tell the Middle Rio Grande AM story
- 8.0 AM Cycle Step 6 – Adjust (Tell your story!)**
 - 8.1 Presentation of analysis and results to Executive Committee
 - 8.2 Assessment of decisions, hypotheses, and objectives
 - 8.3 Adjust management actions and associated budget and priorities
 - 8.4 Independent science review

Table 1. Example format for prioritizing and sequencing hypotheses.

Hypothesis (and alternative hypotheses)	Quantitative Management Objective ¹	Time Needed for Measuring a Response & Testing Hypothesis	Qualitative Rating of the Feasibility of Testing the Hypothesis (Low, Medium, High)	Relevant Publications on Methods, Monitoring Protocol	Relative Priority (Low, Medium, High)	Logical Sequence ²

We will write the Program's AM Plan to include each of the components listed below, which encompass the specific objectives and work efforts included in the RFQ Scope of Work. A description of the key elements and the likely approach to be employed to accomplish each component follows:

¹ Levels of key performance measures associated with different outcomes, and adaptive management decisions.

² Some hypothesis tests or assessments may be *contingent* upon the outcome of other hypothesis tests / assessments (e.g. complete habitat selection research before committing to specific habitat restoration efforts or data collection).

1. Clearly state the management objectives in measurable terms.

Objectives are often best structured as a hierarchy, with progressively more specific objectives lower down in the hierarchy, ultimately with numerical targets for specific performance measures (e.g., TRRP and ESSA, 2008). Andrews et al. (2008) suggest that statements of objectives (and associated hypotheses) should be concrete and specific, and include the following components:

- 1) What entity is to be monitored (species, habitat features, water quality, etc.)?
- 2) Location
- 3) Attribute of the entity (e.g., growth)
- 4) Action (will attribute increase, decrease, maintain)
- 5) Quantity or status (measurable state or amount of change expected for the attribute)
- 6) Time frame (the time expected for the change to occur)

Much work has been done in the MRG to identify objectives for guiding Program actions. To capitalize on that work and accelerate development of the AM Plan, we will use the following process for developing clear Program management objectives:

- Assess progress toward objectives in the 2006 Long Term Plan
- Determine the status of objectives now in development for the new Long Term Plan
- Evaluate overlap or potential for coordination with objectives outside of the Program – additional BiOp requirements and activities of other entities outside Program
- Identify objectives of each Program signatory (ecological and socio-economic)
- Work with Program participants to develop a broad set of objectives and performance measures that will likely include both socio-economic and ecological indicators

AM Plan management objectives might include providing an annual silvery minnow spawning spike and the expected associated improvements in population metrics (e.g., year 0 age-class fish). Other objectives might include: maintaining flycatcher territories in the Middle Rio Grande management unit; reducing encroachment of salt cedar; and maintaining reliable water supplies for residential, agricultural, and other uses along the MRG. There are clearly tradeoffs amongst these various objectives, but all of them are of interest to one or more stakeholders. It is important to distinguish between fundamental objectives (what you want) and means objectives (how to get it). In the Missouri River and other places, RPA actions can be framed as AM management objectives (or tests of actions) – our experience in this regard should be particularly useful in developing specific Program objectives.

2. Describe the spatial and temporal scales of the AM Plan, in map and text form.

This includes the full spatial scale of the Program (Rio Grande River and its tributaries from the New Mexico-Colorado state line south to Elephant Butte Reservoir). It is difficult to make choices about commitments to monitoring, research, and data analysis based on expectations of species response, especially when working with small sample sizes. Is the time horizon being considered for the new Long Term Plan sufficient to observe responses of the silvery minnow and the flycatcher to the actions identified in that plan and the BiOp RPA? Application of rigorous AM provides the ability to speed learning, often on an annual basis and certainly before the end of the time increment to be covered by the new Long Term Plan. There may be a shorter time for monitoring the effectiveness of efforts to restore and maintain habitat, especially if proxy indicators can be developed.

3. Describe the alternative management actions (“treatments”) to be undertaken, and how they relate to critical Program uncertainties.

All actions to be taken under the leadership of the Program must be clearly articulated and linked to hypotheses and decision criteria. Management actions considered during the assessment stage but not included in the AM Plan, if any, should also be identified and the reasons for their elimination should be documented. If the Program employs a passive AM approach, the plan should indicate the initial management action to be explored, the duration of monitoring required to evaluate that action, and the likely sequence of alternative management actions thereafter depending on the outcome of the monitoring and evaluation steps (i.e. a series of *if-then* statements). If the sequence of alternatives is not specified, then the criteria for selecting alternatives for subsequent investigation should be described. In

the case of the Middle Rio Grande, there may be a decision tree of alternative management actions, depending on the observed responses to the first set of actions.

4. Document conceptual models, including external confounding factors beyond Program control.

Such models are best presented in terms of diagrams that illustrate pathways through which the effects of alternative management actions are thought to occur, accompanied by descriptive text to explain the meaning of the linkages in the pathway diagrams. As appropriate to the context of the AM Plan, such models should clearly illustrate the specific spatial / temporal boundaries and dynamics. Discussion / presentation of the models should clearly state the assumptions made in developing the experimental design. Examples of conceptual models can be found in TRRP and ESSA (2005, 2008) and the Platte River Recovery Implementation Program Adaptive Management Plan (2006). We will build on the previous work done to describe conceptual models for the MRG and the focal species (e.g., Save Our Bosque Task Force 2007, others).

5. List the key uncertainties (management questions) to be addressed.

This requires candor, as it is sometimes difficult for management entities to admit uncertainty concerning the effectiveness of proposed actions. Yet if there were no uncertainty in these actions, there would be no need for AM. Uncertainties might include the amount of flow sufficient to support silvery minnow populations, or flycatcher response to habitat restoration projects.

6. Describe indicators that will be measured to assess the effects of management treatment(s).

Developing indicators is also an iterative process. At first, participants will identify general descriptions (e.g., flycatcher numbers). Later, these indicators need to be made much more specific (e.g., annual productivity, annual survival, population growth rate over X period of time). These indicators should be accompanied by a statement of key assumptions and data gaps that are inherent in the application of adaptive management on the Middle Rio Grande and how those assumptions and data gaps will be addressed or could potentially influence results. Efforts should be made to connect indicators for both the silvery minnow and the flycatcher to population metrics and models that result in more effective assessment of population sustainability or viability, and long-term recovery.

7. Clearly state all hypotheses to be tested.

Building on work to date, Program participants will develop hypotheses regarding species response to management actions, as well as river form and function. These hypotheses should include competing hypotheses to ensure the AM Plan reflects uncertainty about necessary actions and potential responses. Hypotheses should be sequenced in such a way so that Program resources are focused on the questions most important to managers and those that are most feasibly assessed. Examples of hypotheses and sequencing strategies can be found in TRRP and ESSA (2005, 2008) and the Platte River Recovery Implementation Program Adaptive Management Plan (2006, 2010).

8. Predict outcomes of the management treatments.

This should include not just the most likely expectation, but the possible range of expected outcomes, and a description of the next steps to be taken in response to each outcome. This is especially important for any designs that may employ a tiered approach (e.g., initial monitoring is designed to detect a problem, triggering either the implementation of corrective management actions, or increased monitoring to further identify the cause of the problem). Our experience on the Trinity, Platte, and other systems suggests one potentially useful tool for organizing thinking is a *decision tree* or flowchart that outlines the sequence of decisions that would be made depending on the outcomes of various pilot actions, monitoring and evaluation methods, or experimental designs. Decision makers on the Executive Committee should be asked about the key inputs to future decisions, and if the decisions and possible outcomes are being properly bounded by the AM Plan.

9. Describe the sampling design (locations, timing / frequency of sampling for each indicator).

This is particularly important for habitat and species management actions like those proposed under the Program for the silvery minnow and the flycatcher. The time required to reliably detect the direction and magnitude of changes in population performance (e.g., growth) affects the cycle time of iterative

changes to management actions. The sampling design should rigorously identify variables to be measured, degrees of change to be detected, and thresholds for assessing hypotheses and objectives.

10. If the MRG Program will employ an active AM approach (ideal) then the AM plan should describe the contrasts, replications, and controls to be employed.

Adaptive management actions in places like the Middle Rio Grande River are generally implemented less formally, where the ideal statistical tenets of randomness, control, and replication are not always available or achievable (e.g., implementing multiple actions on a linear system, many factors outside the control of the Program, focus is on species recovery rather than ecosystem rehabilitation). For the RPA proposed for the silvery minnow and flycatcher, it may be quite challenging to implement an active AM approach with multiple treatments over space and / or time, and replication. However, an effort should be made to consider implementing habitat restoration actions in different parts of the Middle Rio Grande, phase actions in over time, or take other measures to try to obtain a level of contrast that will provide an acceptable level of statistical performance.

11. Describe how the AM Plan treatment(s) will be implemented.

This description should be provided in sufficient detail that persons responsible for implementation of the management action(s) can successfully implement it / them as intended by the architects of the design. This would for example include a sufficiently detailed description of the management methods to be employed, their location and timing (and clear instructions to document any deviations that might be unavoidable; although implementation monitoring as described in the monitoring plan should also be sufficient to catch this). If various alternative actions are under consideration, each of those alternatives should be described. The AM Plan should clearly articulate who is responsible for developing monitoring protocols, implementing management actions and monitoring protocols, data analysis, annual reporting, and reporting to decision-makers.

12. Develop a monitoring plan.

To focus on “need to know” information, the AM Plan should include a specific monitoring and research plan linked directly to key Program questions / decisions and hypotheses. Often called directed or conservation monitoring, the AM Plan should include a monitoring approach that incorporates protocols aimed at answering specific questions rather than simply focusing on long-term trend or surveillance monitoring. Important monitoring components include:

- A description of project (construction) *implementation monitoring* to be done (where, how, by whom, how often, for how long) and reporting formats to track and document the implementation of the prescribed management treatment(s), and any deviations from the intended implementation.
- A description of the intended *effectiveness monitoring* (physical habitat response) (sampling locations, timing / frequency / duration by indicator, methods of data collection, methods for securing, transporting and analyzing samples, etc).
- A description of the intended *validation monitoring* (biological response) (sampling locations, timing / frequency / duration by indicator, methods of data collection, methods for securing, transporting, and analyzing samples, etc).

13. Develop a data management plan.

- Data formats, locations, backup security
- Planned design of the statistical analysis of results
- Planned reporting formats, and planned timing of analysis and reporting
- Planned methods for data sharing and review

14. Describe the plan for data analysis, evaluation, and reporting (i.e., path from data to decisions).

How will the scientists and technical personnel engaged in the Program tell the story of species response to management actions? This is absolutely critical to ensure that monitoring information is transformed into management insights in a timely and rigorous fashion, and in a way that is most useful to decision-makers. The AM Plan should clearly articulate performance measures and decision criteria, and then before implementation begins technical personnel should discuss this information with the signatory

decision-makers to see if this is the kind of information they want and expect. In addition, the data analysis plan should include decision trees, *if-then* scenarios, mock data, and other methods to provide decision-makers with alternative outcomes and possible responses to Program management actions for comparison and decision purposes.

15. Describe the involvement of stakeholders, scientists, and managers in the development of the design of the AM Plan (who was involved, the methods of involvement, and their contributions).

For the Program, this would presumably include technical personnel representing all signatories and other interested parties. The AM Plan should be approved by the signatories with an agreement to stand behind the adaptive management approach as the Program's applied science strategy.

16. Draft and final AM Plan.

This information would be gathered through intense background research, meetings, workshops, one-on-one interviews, and consultation with both stakeholders and species experts to ensure that a robust draft AM Plan is produced on schedule. A final AM Plan would be produced within 30 days of receipt of Program review comments. All comments will be responded to in writing, even if those comments do not result in changes to the final AM Plan. We would greatly prefer to have a synthesized set of comments from all participants. An example of how our team would approach responding to questions and comments can be found in the Platte River Recovery Implementation Program Response to Findings in the Final Independent Scientific Advisory Committee (ISAC) Report to the Governance Committee (PRRIP, 2009)

Summary of Innovations

Our approach incorporates several innovations:

- *Tell the AM story* – be prepared to convey MRG science learning to Program decision makers in a way that translates into management changes
- *Decision tree and other decision analysis techniques* – utilize silvery minnow, flycatcher, and other data to make better science and management decisions on the MRG
- *Implementing AM in a Recovery Implementation Program framework* – Platte River experience is direct extension to MRG efforts
- *Outline following AM six-step cycle and AM elements (see Appendix 3) to frame early discussion* – ensures the MRG operates with a “true” AM plan
- *Individual interviews* – knowledge mapping of Program Executive Committee will help ensure linkages between science learning and decision-making in AM Plan

5.2 PROJECT MANAGEMENT PLAN / TASK LIST

We will complete the work through a set of six **tasks and subtasks** described below. Place of performance: we will undertake preparation, review, and writing tasks at our own facilities. All interviews, meetings, and workshops described below will take place in Albuquerque at existing federal, state, or local facilities.

Task 1: Review government furnished property.

We will begin by reviewing the documents listed in Section 6.0 of Attachment A in the RFQ:

1. MRG Endangered Species Collaborative Program Interim Monitoring Plan, *Draft*, Sept. 2006
2. Statement of Work for Program's Pilot Habitat Restoration Effectiveness Monitoring Plan
3. FWS Recovery Plans for silvery minnow (2010) and flycatcher (2002)
4. 2003 Biological Opinion (BiOp) and associated updates; 2003 Biological Assessment (BA)
5. U.S. Bureau of Reclamation Supplemental Water Program Reports (2003-2009)
6. Rio Grande Compact Commission Reports (2003-2009)
7. Recent species monitoring surveys for silvery minnow and flycatcher
8. Population viability assessment scopes of work or available products
9. Draft Long Term Plans, 2004 and 2006; 2001 BA/BO

The objectives will be to: (i) gain a greater understanding of the background, context, and rationale for the AMP; and (ii) generate a list of additional documents to review in Task 2.

Task 2: Research and review of relevant Program documents.

We will then review relevant documents specific to the MRG Program. We expect that most of these documents will be identified and provided by the Program management staff, but there may be others that we request based on insights gained from Task 1. The objectives of this review will be to help us: (i) better understand the overall Program; (ii) start to flesh out the scientific, economic, political, and regulatory framework for the AM Plan; (iii) begin to develop a schedule and approach for the AM Plan that best suits the Program and that correlates to the schedule for development of the new Long Term Plan and the new ESA consultations; and (iv) prepare for rich, detailed, and productive discussions in Task 3. While this task will begin immediately following Task 1, it will continue in parallel with Task 3 and early stages of Task 4 as more information comes to light. We will design and use a set of simple review templates to aid us in the systematic capture and organization of key content from these documents that is most closely related to our work.

Task 3: Convene project initiation meeting.

We envision convening a full-day project kick-off meeting in Albuquerque between key personnel on our team and: Program management staff; scientists and managers from Program committees and workgroups (including the Executive Committee); and agency leads for the new ESA consultations. We anticipate that the meeting agenda (to be circulated 7 days prior to the meeting) will:

- introduce participants, including their roles, history with the Program, local area, and the issues;
- present our knowledge of adaptive management (brief summary to get all on the same page);
- present our approach and schedule for this project;
- discuss the issues and challenges to be addressed in the AM Plan, and in developing it;
- revise our draft schedule for the interviews, planning sessions, and workshop in Task 4; and
- discuss whom to invite to which planning sessions, and in what combinations, considering histories, relationships, interests, knowledge, and locations.

While in Albuquerque for the kick-off meeting, we also hope to arrange a one-day field visit, perhaps looking at a few key structures and at stretches of the river that might be classified as good habitat between Cochiti and Elephant Butte Reservoirs (the silvery minnow habitat area). This will allow us to see some examples of restored habitat, and gain a better sense of the river and riparian environment. We also hope to reserve a third day for additional follow-up meetings that seem most urgent given what we learn during the kick-off meeting.

Task 4: Facilitate AM planning sessions and final workshop.

We propose to do this task in three stages:

- 1) individual interviews with each Program signatory,
- 2) facilitated planning sessions and workshops with small groups of Program participants, and
- 3) a final workshop for the whole Executive Committee.

Total meeting time: Stage 1, four (4) days; Stage 2, seven (7) days; Stage 3, two-four (2-4) days (for a maximum of 15 days, or 120 hours).

Stage 1: Individual interviews. We will conduct individual structured interviews with each of the Program signatories as soon as possible after the kick-off meeting. We envision four (4) consecutive days of 90-minute meetings³ per signatory, if schedules permit. Structured interviews will offer a valuable source of insight into the collective mind of the Executive Committee (EC) (we are assuming that each signatory has one member on the EC). This knowledge mapping can help the team uncover

³ We envision booking these in 2-hour blocks, allowing us 30 minutes for summarizing notes between interviews.

areas of potential misalignment between the EC's adaptive management goals and objectives and those of the Coordinating Committee and work groups. Interviews can also highlight issues that deserve special consideration due to their strategic importance to the Program. Individual interviews are preferred at this early stage over group interviews, because in the latter participants all hear each other's opinions – that can quickly lead to discussion and compromise, and even to squelching some opinions. In individual interviews, we can focus on the specific concerns and issues of the individual signatories and they are free to be open regarding their opinions or concerns. Ample opportunity exists later in this task for interchange of ideas among participants, but at this stage it is very important that specific and possibly unique perspectives of each signatory be heard and understood.

We anticipate that these interviews will include questions about the following:

- degree of knowledge about AM and support for the AM Plan;
- key interests of their organization in the Middle Rio Grande;
- objectives, success criteria, and potential performance measures⁴ for the Middle Rio Grande;
- key challenges, opportunities, concerns, and other issues;
- resources (financial, technological, political, human) they can mobilize for the AM Plan; and
- availability for facilitated planning sessions and the final workshop.

The interview results will also give us information from which to conduct a power / leadership analysis that identifies signatories having the greatest potential to affect the success of the AM plan, and insights on whether there may be any important stakeholders not at the table.

Stage 2: Facilitated planning sessions. We will begin planning sessions with an educational component articulating our approach to AM and common aspects and examples of “true” AM – a rigorous process of learning by designing management actions to maximize learning. We will utilize the preliminary draft outline structure for the AM Plan contained in this proposal (with edits and rough annotations based on what we learn from Tasks 1-3 and Stage 1 of Task 4) to seed discussion during a first round of planning sessions. These sessions will include small groups of Program scientists and managers who will flesh out key aspects of the outline, iteratively adding to the annotations. This process will serve as a bridge between our AM approach and Program activities that will clearly be part of the AM Plan, and to ensure we connect to specific response actions:

- Short-term rapid response actions – The AM Plan will clearly identify a sequence of actions that begins quickly and that will address the most important Program questions and hypotheses.
- Long-term contingency actions – The AM Plan will include guidance on using decision support tools such as an *if-then* process to, for example, articulate that if certain indicator responses occur (to species or habitat), then the Program should implement additional long-term actions.
- Triggers and decision-making processes – As noted in Section 3.8 of the draft AM Plan outline above, the AM Plan will include decision criteria for addressing when a response fits criteria for revising action or moving on to a different action.
- Implementation responsibilities and funding requirements – The AM Plan will clearly identify which Program actions will be implemented, who will take the lead and manage each action, the funding structure and sources for each action, and how this relates to available or projected long-term Program funding.
- Communication processes – The AM Plan will clearly identify how Program information will be housed, maintained, and communicated to Program participants and the public. This is likely to be addressed in Sections 5.0 and 6.0 in the AM Plan outline above and will be linked to the existing Program web site and other tools being utilized or developed by the Public Information and Outreach workgroup.

⁴ We envision these will include both ecological and socio-economic indicators.

- Action plan – The AM Plan will document the process of AM Plan development, complete with hypotheses, actions, and other components that were proposed and either dropped from further consideration or actually included in the AM Plan. This may become an appendix to the AM Plan but will provide a clear roadmap of discussions and decisions.

We anticipate grouping some participants (groups yet to be identified, but based on common interests) such that all will participate in one of six (6) half-day (four-hour) sessions, for a total of three (3) full days. If, during the interviews or planning sessions, other individuals or agencies are identified that need to be engaged in the process, we will make contacts and set up meetings with additional parties to ensure their voices are clearly heard and integrated into the process of developing the AM Plan.

At the end of this first round of sessions we will compile the results into a full draft annotated outline for the AM Plan, and use what we have learned to date (from resource documents as well as during meeting, interview, and session discussions) to write a rough preliminary draft⁵ of the plan according to the draft outline. We will then convene a two-day workshop with a core group of Program participants (targeting technical staff) to review the draft outline, review the preliminary contents, build on the contents, and discuss issues, challenges, and gaps. We will use these results to prepare a second rough draft and convene an additional two (2) days of planning sessions if / as needed to address any remaining gaps or issues. The objective of proposing three sets of planning sessions, with our team writing and advancing the draft AM Plan contents in between each, is to work through as many of the technical issues as possible in order to make the final workshop in Stage 3 more effective and to make it easier for the Program reviewers in Task 5.

Stage 3: Final workshop. We will convene and facilitate a two (2) day workshop with the Program's EC (at a minimum) and other Program participants involved so far in Stages 1 and 2. The objective of this workshop will be to present and discuss all elements of the rough-draft AM Plan (including the framework, schedule, and implementation approach). The workshop setting will provide the EC with an additional opportunity to have input on: the direction of adaptive management in the MRG; the details of the AM Plan; whether what we have written accurately reflects the results of the interviews, planning sessions, and revisions of the draft AM Plan to that point; and how the information gained with the AM Plan will serve as key inputs into future Program management and policy decisions. This workshop will also include discussions of executive level decision-making and memoranda of agreement (MOAs) on implementation. We may choose to arrange up to an additional two (2) days of meetings with a smaller group of participants if necessary to work through particular issues that may arise at the final workshop.

Task 5: Draft AM Plan Preparation.

We will prepare a formal draft AM Plan for review by the Program. It will be written in a simple, clear, consistent, and concise manner, with all scientific and technical terms described in a glossary. We will also submit a draft MOA for each designated initial and response action with funding responsibilities. We will submit five (5) hard copies and one electronic copy (in both MS Word and Adobe PDF format) of the AM Plan and the MOAs. We understand that comments on the draft AM Plan will be collated by the Program Management Team (PMT) and provided back to our team for consideration.

Task 6: Final AM Plan Preparation.

We will revise the draft AM Plan based on the review comments and submit twenty (20) hard copies and (2) electronic copies (in both MS Word and Adobe PDF format) of a final AM Plan to the Program through Reclamation's designated Contracting Officer's Representative (COR). Whether incorporated or not into the final AM Plan, we will also provide a written response to each comment received on the draft AM Plan, and how it was addressed, in PDF and / or Excel spreadsheet format. We will also

⁵ In our experience, it is important to (i) keep the AM Plan brief at this stage, which will make it easier to read, and also to (ii) keep it fairly rough, in order to avoid wasting time word-smithing.

submit final MOAs. We understand that we will be retained for at least 90 days following submission of the final plan so that potential additional tasks may be negotiated.

We recognize several **challenges or difficulties** with this project, for which we believe we have effective approaches based on our past experience (Table 2).

Table 2. Challenges expected in this project, and our proposed approaches for dealing with them.

Challenges	Our Proposed Approaches for Dealing With These Challenges
Large number of stakeholders with multiple, and likely competing, objectives.	Clarify all interests and objectives, acknowledging that many of them will be competing. Encourage all stakeholders to creatively explore many options that could meet all stakeholders' multiple, competing objectives, rather than defending a few tightly defined positions. Separate disagreements on policies and goals (i.e., what people want, which involves negotiation) from disagreements on the <i>means</i> of achieving fundamental objectives (which involves applied science including AM). The monitoring and evaluation pillars of AM can be put in place even while negotiations on objectives and alternative actions continue. Encourage open exploration of a wide range of alternatives using models to build a common understanding of tradeoffs among competing objectives, while stressing that exploration does not imply implementation.
Large number of stakeholders.	Our 1-on-1 meetings will be very helpful to understand the stakeholder landscape, including differences in objectives and intended outcomes of the AM Plan process. This will help us to design appropriate task processes for subsequent meetings. We will use various facilitation techniques to ensure involvement of everyone at large meetings (e.g., small groups deal with sub-topics, silent generation and then sharing of ideas to avoid problems with dominant personalities, internal peer review of interim products).
A lack of trust among some stakeholders.	Our team is independent and used to situations with a lack of trust. Our 1-on-1 meetings with each stakeholder will build their trust in our facilitation team and in the process that we intend to use. Encourage all to be "hard on the problem and easy on the people". Use an open and transparent process in all meetings and documents to gradually rebuild trust, acknowledging points of agreement and disagreement. The 3-stage process in Task 4 is designed to systematically build trust. Outdoor meetings (e.g., river trips) are excellent for building trust and understanding. Use a staged process in the AM Plan (e.g., smaller, safe-fail AM actions) to build trust in both the actions and the process for evaluating them.
"Turf" issues; worries about possible loss of control of the AM plan for individual agencies.	Clarify the mandates and responsibilities of each entity, both for implementing the AM Plan, and for conducting related activities that support it. Clarify the decision process for approving the AM Plan. Create AM Plan forums, check-ins, and review processes to diminish fears of loss of control during implementation.
Technical disagreements about the best methods for recovering species and their habitats.	This is the heart of AM. Work to achieve a triage on technical questions: a) issues that are well understood; b) questions that cannot be answered (i.e., simply not feasible to conduct research and monitoring); and c) questions that could be resolved with research, monitoring, or AM actions and would help managers make decisions. Frame disagreements as alternative hypotheses, seeking to develop AM tests of these hypotheses on small scales (safe-fail tests).
Highly endangered species.	This may constrain some candidate AM actions and hypothesis tests due to concerns about increasing extinction risk, and may make it difficult to gather data on performance measures due to small population sizes. Seek to design safe-fail actions for improving species' habitats while concurrently rigorously monitoring population status and trends.
Conflicts between local indigenous knowledge and western science.	Acknowledge all sources of knowledge. Recognize value of long-term observations by local residents, which are invaluable additions to much shorter-term studies by scientists.

5.3 SCHEDULE

Table 3 lists our proposed tasks and deliverables according to the timeline requirements as specified in the RFQ. This schedule assumes that expected project participants for particular tasks (e.g., representatives from the Program signatories) will be available during the required periods, and that Program review comments on the draft AM Plan will be completed as per the timeline in Table 3. The listed deliverables include all of

those from the RFQ, plus a few additional ones we feel are helpful to identify explicitly. We will remain available for 90 days beyond submission of Deliverable 6.1 to carry out potential additional tasks that may arise during the project agreed to by ESSA/Headwaters and the Bureau of Reclamation. If events occur beyond our control which necessitate a change to the schedule outlined below (e.g., a majority of the stakeholders request more time for document review and this change is agreed to by the contracting authority), then we will adapt our schedule accordingly.

Table 3. Proposed project schedule.

Tasks and Deliverables	Timeline specified in the RFQ	Proposed # of days from NTP
Task 1: Review Government Furnished Property ⁶		1-14
Task 2: Research & Review of Relevant Program Documents		15-60
Task 3: Convene project initiation meetings		10-15
Deliverable 3.1: Project kickoff meeting and follow-up meetings	Within 15 days after NTP	10-15
Deliverable 3.2: Schedule for planning meetings, workshop, intermediate products, appendices, and final products ⁷		15
Task 4: Facilitate AM planning sessions and final workshop	Within 150 days of NTP	15-150
<i>Stage 1: Individual interviews</i>		
Deliverable 4.1: Materials (questions) for individual interviews		18-38
Deliverable 4.2: Individual interviews		25-45
Deliverable 4.3: Proposed framework and alternatives for the Program's AM Plan		50-55
<i>Stage 2: Facilitated planning sessions</i>		
Deliverable 4.4: Materials (e.g., agendas, questions, background readings) for planning sessions	At least 7 days prior to each meeting ⁸	55-110
Deliverable 4.5: Planning sessions		65-120
<i>Stage 3: Final workshop</i>		
Deliverable 4.6: Materials for final AM workshop (e.g., agenda, compiled rough draft elements of AM plan)	At least 7 days prior to the workshop	130-140
Deliverable 4.7: Final AM Workshop	Within 45 days of final planning session	140-150
Task 5: Draft AM Plan Preparation		80-180
Deliverable 5.1: Draft AM Plan outline and Table of Contents		80-90
Deliverable 5.2: Draft AM Plan & MOA for each designated initial and response actions with funding responsibilities, plus meeting notes, references, correspondence	Within 60 days of final AM Workshop	180
<i>Client task: Program Review of the draft AM Plan</i> <i>Deliverable to our team: collated Program review comments</i>		180-200 200
Task 6: Final AM Plan Preparation		200-230
Deliverable 6.1: Final AM Plan and MOAs	30 days after receipt of Program Review comments	230
Additional deliverables, to be determined, if optional tasks are initiated after submission of the final AM Plan.	90 days after submission of Final AM Plan	320

5.4 KEY PERSONNEL

We have assembled a small, highly qualified team comprised of independent scientists, leading adaptive management practitioners, statistics experts, western water resources experts, and other staff to assist with

⁶ Some of this review has already occurred during the preparation of this proposal.

⁷ We include a *tentative* schedule for these meetings and products, which will be refined as part of this deliverable.

⁸ We heartily agree with this convention and already practice this in our AM work on the Platte River.

and facilitate the development of a draft and final AM Plan for the MRG Program. Our team has many years of experience in the key domains demanded by this project: developing and implementing AM Plans; working with AM theory and practice nationally and internationally; utilizing decision analysis tools; designing statistically robust field data collection and assessment plans; working with western water operations in over-appropriated basins; and facilitating and leading large groups of multi-discipline stakeholders on complex adaptive management processes in river basins.

ESSA Technologies Ltd., based in Vancouver, Canada, will be leading our team, with Headwaters Corporation, based in Kearney, Nebraska, subcontracting to ESSA. David Marmorek of ESSA will serve as Principal-in-Charge, responsible for the overall performance of the team and service quality. Carol Murray of ESSA will serve as Project Manager and be the primary client contact. In addition, Carol Murray together with Chad Smith of Headwaters Corporation will serve as co-leads in the development and production of the AM Plan. Table 4 lists all key project personnel and their responsibilities, as well as the level of effort contributed by each (in days). Table 5 shows how our team meets the qualifications in the RFQ, and is followed by a brief biographical description of each member of the core team.

As the AM Plan facilitation and development process begins, our team will contract with at least one Rio Grande silvery minnow (silvery minnow) expert and at least one Southwestern willow flycatcher (flycatcher) expert to provide independent expert review and assessment of monitoring details. These species expert subcontractors will provide our team and the Program participants with independent information on sampling protocols, estimation of precision, logistical constraints, and other important aspects of the sampling design for the silvery minnow and flycatcher. It is standard in such projects to let the names of such experts emerge through the interview process and then select those that are most impartial.

The leading role played by Headwaters and ESSA with the PRRIP is of particular significance to development of an AM Plan for the MRG Program. The Middle Rio Grande River and the Platte River are remarkably similar river systems. Key hydrologic and geomorphic similarities include: snowmelt sources in the Rocky Mountains; flow through semi-arid to arid regions with local inflow from precipitation; trans-basin imports of water; sand bed streams with heavy sediment loads and a braided stream form; alluvial aquifers; reservoir regulation; irrigation diversions; and high seasonal and year to year variability in hydrographs. Commonalities in water resource management include multiple conflicting uses, over-appropriation problems, governance largely by the prior appropriations doctrine embodied by complex interstate compacts and state laws, but also by federal laws, state and federal regulations, and local customs. In the case of the Rio Grande an international treaty with Mexico, tribal sovereignty issues, and the rules of the *acequias* add additional elements not found on the Platte. The water resources of both rivers are governed by complex operating rules involving significant physical facilities and the cooperation of large water organizations serving specific purposes for specific constituencies.

Table 4. Key project personnel, their roles and responsibilities, and level of effort (LOE) in days.

Name	Project Role(s)	Responsibilities	LOE
Key Personnel – ESSA Technologies, Ltd.			
David Marmorek , BSc, MSc	Principal-in-Charge, senior AM Plan design advisor, technical writer / editor	<ul style="list-style-type: none"> Attend kick-off meeting Advise on all tasks Attend final workshop Review/edit AM Plan; and help draft portions of Plan 	26
Carol Murray , BSc, MSc, RPBio	Project Manager, senior facilitator, technical writer / editor	<ul style="list-style-type: none"> Lead and manage the team; primary client liaison Background research Attend kick-off meeting Co-lead preparation and delivery of interviews, AM planning sessions and final workshop Co-write AM Plan 	84
Lorne Greig , BSc, MSc	Expert advisor in institutional aspects of AM, & cumulative effects	<ul style="list-style-type: none"> Attend kick-off meeting Advise on all tasks Review/edit AM Plan 	15
Sub-total LOE			125
Key Personnel – Headwaters Corporation			
Chad Smith , BS, MPA, PhD (candidate)	Senior AM Plan implementation advisor, technical writer / editor	<ul style="list-style-type: none"> Background research Attend kick-off meeting Co-lead preparation and delivery of AM planning sessions and final workshop Co-write AM Plan 	54
Bridget Barron , BA, MS, MBA, PhD	Facilitator, technical writer / editor	<ul style="list-style-type: none"> Advise on group dynamics and cultural factors Attend kick-off meeting Co-lead preparation and delivery of interviews Assist with first set of AM planning sessions Review/edit AM Plan 	31
Beorn Courtney , BS, MS, PE	Water resources advisor	<ul style="list-style-type: none"> Assist with water-related objectives and actions in AM Plan 	15
Sub-total LOE			100
Key Personnel – Independent Experts			
Carl Schwarz , BSc, MSc, MMath, PhD, PStat	Senior statistical and sampling design advisor	Assist with statistical aspects of AM Plan, including experimental and sampling designs	7
Yet to be named	Expert silvery minnow advisor	Assist with biological/habitat/monitoring design aspects of the AM Plan	7
Yet to be named	Expert flycatcher advisor	Assist with biological/habitat/monitoring design aspects of the AM Plan	7
Sub-total LOE			21
Support Personnel – ESSA Technologies, Ltd. and Headwaters Corporation			
Additional ESSA and Headwaters staff	Statistics, fisheries & avian biology, experimental design, water resources management, administrative support	Assist with AM Plan specifics on statistics, silvery minnow, flycatcher, experimental design, sampling design, and water resources management; administrative support for meeting/workshop logistics and AM Plan writing	43
Sub-total LOE			43
Total LOE			289

Table 5. Alignment of our key project personnel with the team qualifications in the RFQ.

Qualifications from the RFQ	Marmorek	Murray	Greig	Smith	Barron	Courtney
Master of Science Degree (or higher) in Biology, Hydrology, or Ecology, or related natural, social or physical science with a minimum of 5 years experience	✓	✓	✓	✓	✓	✓
Educational and working background in adaptive management, scientific study design, field data collection, and statistical analysis tools	✓	✓	✓	✓		
Experience designing, implementing, and analyzing the results of natural resources monitoring, statistical analysis including threshold and trend analysis, population viability assessment modeling, decision analysis	✓		✓	✓		
Facilitation experience with demonstrated ability to work with a diverse group of people to achieve common goals	✓	✓	✓	✓	✓	✓
Recent experience developing and/or implementing AM Programs	✓		✓	✓		
Knowledge of western states water law and coordinated water operations in large, over appropriated river basins.	✓			✓		✓
Demonstrated skills and experience with at least 3 years of technical writing and/or editing of scientific and/or technical planning documents such as Adaptive Management Plans, Monitoring Plans, or ESA and/or National Environmental Policy Act (NEPA) compliance documents.	✓	✓	✓	✓		

David Marmorek is an aquatic ecologist, President of ESSA Technologies Ltd, and an Adjunct Professor at the School of Resource and Environmental Management at Simon Fraser University. Mr. Marmorek has spent the last three decades combining his technical knowledge (simulation modeling, ecological risk assessment, aquatic ecology, experimental design, adaptive management, decision analysis) with his skills and experience in the human dimension (facilitation, team leadership). Much of his work has focused on developing tools to predict, manage and monitor the impacts of human actions on fish populations and their ecosystems, including such stressors as acid rain, forestry, dams, agriculture, fishing and industrial pollution. He was awarded the EPA's Bronze Medal for his design work on the National Surface Water Survey, part of the National Acid Precipitation Assessment Program, and co-designed the Indicator Development Strategy for EPA's Environmental Monitoring and Assessment Program (EMAP).

Mr. Marmorek's recent work has focused on the rehabilitation and monitoring of aquatic ecosystems using rigorous adaptive management approaches. This includes projects in California (Clear Creek, Trinity River, Sacramento River, San Joaquin River, Bay-Delta, Russian River), the Columbia Basin (U.S. and Canadian portions), British Columbia (Cheakamus, Coquitlam and Okanagan Rivers) and Vietnam. Over the last 6 years, he has led five large, multi-agency projects focused on improving monitoring and evaluation: an adaptive management experiment to re-introduce sockeye into Skaha Lake; [a multi-watershed evaluation of the ability to detect the benefits of habitat restoration projects on fish populations](#); the Columbia Basin's [Collaborative Systemwide Monitoring and Evaluation Project](#); an [Integrated Assessment Plan for the Trinity River Restoration Project](#); and the USFWS bull trout [Recovery Monitoring and Evaluation Group](#). Mr. Marmorek is the author of over 20 peer-reviewed publications, and over 100 technical reports. He chairs the Independent Science Advisory Committee for the Platte River Recovery Implementation Project, serves on the Science Review Panel for the Puget Sound Nearshore Ecosystem Restoration Project, and recently co- led a major evaluation of the Moore Foundation's Wild Salmon Ecosystem Initiative.

Carol L. Murray has a B.Sc. in biology (with distinction) and an M.Sc. in zoology. She has over 20 years of experience in the field of environmental consulting in North America and overseas. She has led more than 100 projects in a wide range of natural resource management and environmental management domains,

and has many repeat clients who highly value her advice and products. She is extremely consistent in completing projects on time and within budget.

Ms. Murray has an in-depth understanding of adaptive management, is a highly skilled facilitator and is a very accomplished technical writer. She has co-authored several papers (Murray and Marmorek, 2004a, 2004b) and a book chapter (Murray and Marmorek, 2003) on AM, designed and delivered numerous AM training workshops, written Adaptive Management Plans for two forest-related initiatives, and has been retained by both tribal and government clients to review adaptive management plans for a variety of development projects.

Ms. Murray has led more than 80 workshops during her career, with groups ranging in size from 10 to 100, from local to national in scope, from several hours to five days' duration, and across a broad spectrum of technical and non-technical topics. Participants at these workshops have included scientists and managers from government, industry, NGOs and tribes, as well as other stakeholders, who are either *learning* something (e.g., tools, skills, methods/approaches, including adaptive management and EIA), or *designing* something (e.g. decision tools, research plans, frameworks, best practices).

Her technical writing experience includes many state of environment reports, analyses of the ability to successfully implement adaptive management for forestry and salmon conservation, decision support tools for invasive species management in Garry oak and associated ecosystems, reviews and analyses for Canada's Wild Salmon Policy, and studies on how to include traditional and local ecological knowledge in the management of Pacific salmon.

Lorne Greig is a Senior Systems Ecologist and leader of ESSA's Environmental Management Team. He has a B.Sc. and M.Sc. in biology, with a focus on ecology. Since joining ESSA in 1982, Mr. Greig's consulting practice has focused on applying evidence-based approaches and ecological modeling to adaptive management plans and environmental risk analysis, for freshwater, marine and forest ecosystems. Much of Mr. Greig's work has involved collaborative analysis with multi-disciplinary groups of scientists, resource managers, aboriginal participants and stakeholders, including many projects with environmental-economic tradeoffs. He is a highly accomplished facilitator with 28 years of experience guiding multi-agency scientific meetings and workshops. His facilitation expertise is also applied in his work on environmental conflict resolution, and facilitation of public advisory groups. He has an uncommon ability to find consensus in situations where it appeared unlikely prior to his involvement.

Examples of some of Mr. Greig's recent experience include: analysis of the effectiveness of adaptive forest management in public and private forest management entities; development of an adaptive management strategy for placer mining in the Yukon; recommendations to improve adaptive management and cumulative effects assessment in Canada; a guide for the preparation of adaptive management plans in Canada's Arctic; a conceptual ecosystem model of the Lake Ontario fish community; a model based management approach to the Sea Lamprey control program in the Great Lakes; decision analyses for American eel in the Great Lakes; Pathways of Effects models for Fisheries and Oceans Canada; and advice to the Mackenzie Gas Project Joint Review Panel on matters related to cumulative impact assessment.

Dr. Carl Schwarz is a Professor in the Department of Statistics and Actuarial Science at Simon Fraser University. The focus of his research is in capture-recapture experiments and statistical consulting in environmental impact studies. It is motivated by real problems encountered by ecologists and health researchers. His current research projects in ecology are in the estimating of animal abundance, survival, movement and related parameters using mark-recapture methods. Mark-recapture involves the marking of animals (e.g., rings on bird legs; tags on fish; radio collars on large mammals) and then releasing these animals back to their population. Subsequent resightings or recaptures of the marked and unmarked animals allow us to estimate the survival rate, the population size, and the movement rates of the animals. His environmental impact research interests lie in designing and analysing environmental impact studies. This is motivated by his extensive consulting work with environmental consulting companies. Dr. Schwarz has

worked closely with ESSA since 2004 on a variety of projects in the Columbia Basin, Trinity River watershed and British Columbia.

Chad Smith is an ecologist and Director of Natural Resources for Headwaters Corporation. Mr. Smith is a leading AM practitioner, serving as Science and Adaptive Management Plan Implementation Coordinator for the Platte River Recovery Implementation Program (PRRIP). In this capacity, Mr. Smith coordinates all phases of adaptive management on the Platte River, including experimental design; prioritization and sequencing of hypotheses; facilitating numerous technical workshops and meetings comprised of multi-discipline stakeholders; data collection, management, and analysis; developing decision criteria and utilizing decision analysis tools; directing all monitoring and research; and managing the PRRIP's Independent Scientific Advisory Committee and independent peer review. He recently served as a member of an Expert Review Panel for the Comprehensive Everglades Restoration Program's (CERP) Adaptive Management Integration Guide, providing expert assessment for the U.S. Army Corps of Engineers (Corps), South Florida Water Management District, and other CERP participants on the design and implementation of AM in the Everglades.

Mr. Smith has 14 years of experience in river management, science, and policy. He is a PhD candidate and one of the first students in the country's only adaptive management graduate program at the University of Nebraska-Lincoln's (UNL) School of Natural Resources. His work focuses on moving science learning into management decision-making and utilizing decision analysis tools to help move through complete iterations of the AM cycle. He studies under former C.S. Holling student Craig Allen and Lance Gunderson, a leading international expert in AM and resilience. Mr. Smith served as graduate assistant for a Corps adaptive management standards of practice seminar on the Missouri River in 2009, providing expert advice and counsel to the Corps on the design and implementation of AM in the context of BiOp RPA constraints. He is currently a member of the Core Advisory Group of the Collaborative Adaptive Management Network (CAMNet), a nationwide network of AM practitioners, and helped lead a CAMNet AM training workshop at the National Conference on Ecosystem Restoration (NCER) in 2009. He is the co-chair of the Program Committee for the 2011 and 2013 NCER. Prior to Headwaters, Smith was Nebraska Field Office Director for American Rivers from 1998-2007 where we worked extensively on Missouri River AM issues and Nebraska water policy. He recently taught courses in environmental planning and policy in UNL's Community and Regional Planning Department.

Bridget Barron is a clinical psychologist, licensed in both Colorado and Nebraska. She currently serves as the Director of Outreach and Communications for the Platte River Recovery Implementation Program (PRRIP). As director, she is responsible for creation of media and education materials regarding the PRRIP. She serves as the subject matter expert for public affairs and media relations and acts as the spokesperson for community relations issues. Her primary focus is to effectively tell the PRRIP story to a variety of target audiences. Dr. Barron is also the Chief Operating Officer of Headwaters Corporation. As COO, she manages the operations of the corporation for the Colorado and Nebraska offices including; fiscal, human resources, contracting, and supervision of support and contract staff.

Dr. Barron has over 21 years experience in clinical services and administrative management in psychology. She received her Bachelor's degree in psychology from the University of Denver in 1981. She received her Master's in clinical psychology in 1985 and her Ph.D. in clinical psychology in 1989, both from Washington State University. Her areas of psychological expertise include; interpersonal and group dynamics, conflict resolution, cross-cultural dynamics, team building, and communications. In addition to her clinical training, Dr. Barron received a Master of Business Administration and a Master of Science in Health Administration from the University of Colorado at Denver in 1996. Her educational background and experience result in a unique blending of psychological insights and management skills. Dr. Barron draws on her expertise in scientific knowledge related to human behavior to assist multidisciplinary groups to reach their project goals.

Beorn Courtney is a professional engineer, licensed in Colorado. She serves as the Director of Water Resources Engineering for Headwaters Corporation and manages the water resources staff and Denver office. She is responsible for executing the Platte River Recovery Implementation Program (PRRIP) Water Plan, including coordination with the adaptive management and land aspects of the PRRIP. Ms. Courtney also manages several other projects, which include water rights and water conservation services for local water providers and state agencies. She has experience in a broad range of water resources planning and modeling, water rights investigations and litigation support, hydrologic and hydraulic investigations, and water conservation planning. Presently, she serves as Treasurer for Colorado WaterWise, a non-profit whose mission is to promote the efficient use of Colorado's water.

Ms. Courtney has over 14 years experience in civil engineering, focusing on water resources projects. She received her Bachelor's degree in chemical engineering in 1995 and Master's degree in civil engineering in 1997, both from the University of Colorado at Boulder. Ms. Courtney has testified in the Colorado water court system and was recently involved in changing Colorado legislation to allow rainwater harvesting pilot projects, based largely on research conducted in New Mexico. Her expertise in western water law continues to expand under the PRRIP, as the state of Nebraska and the PRRIP are both working to improve flow and ecological conditions in fully and over-appropriated river basins. Ms. Courtney excels at providing technical services, project management, project team coordination, and in developing and maintaining client relationships.

Appendix 1: Company Experience

This section summarizes our team's experience directly relevant to this project. This experience occurred on the Platte River, Trinity River, Columbia River, Everglades, and other systems, all involving developing, implementing, and assessing adaptive management plans. In all cases, key team members were the lead facilitator, scientist, and/or practitioner. The underlined text below provides hyper-links to various documents and web pages. Ten (10) specific projects are included.

1. Development of a Scientific Framework and Integrated Information Management System for the Trinity River Restoration Program

Trinity River Restoration Program, US Bureau of Reclamation

Contract Number, Data, and Type: Task orders 01CS20210D and 06A9204097G with North State Resources (Redding CA) as part of their IDIQ with BoR.

Date Completed: 2004 – ongoing

Team: David Marmorek (lead facilitator), Darcy Pickard, Marc Porter, Katherine Wieckowski, Diana Abraham, and Clint Alexander

Budget: \$846K USD

The Trinity River Restoration Program (TRRP) is a large-scale, adaptive management experiment which seeks to recreate the geomorphic processes required to create and maintain salmonid habitat, in the 40 miles below Lewiston Dam. Actions include direct channel and watershed rehabilitation, as well as more variable flow releases to build gravel/cobble bars, scour sand from fish spawning areas, provide adequate temperature/habitat conditions for fish and wildlife, and control riparian vegetation encroachment. ESSA was engaged by the TRRP to facilitate the development of a scientific framework (conceptual model, monitoring strategy, and adaptive management plan) in support of implementing watershed restoration actions designed to restore the Trinity River in northern California. This ongoing project is a multi-year effort involving the participation of approximately 15-20 local and invited scientists in an iterative series of scientific workshops, facilitated by ESSA, and tasks to develop scientific guidance documents and data management tools. The scientific framework process focuses on collaboratively developing an integrated conceptual model of the Trinity River system, identifying appropriate assessment criteria, and generating reliable designs for monitoring habitat and populations of Trinity River fish, birds, amphibians and reptiles. ESSA's role has been to lead the scientists through this process and to provide expert advice to scientific teams with specific analyses. All these elements were incorporated into an [Integrated Assessment Plan](#) to assure that funded restoration projects for the Trinity River collect data that will increase knowledge, reduce uncertainties, and incorporate adaptive management into all planning, design, implementation and monitoring phases of the TRRP. ESSA is also leading the design and development of a TRRP Integrated Information Management System (IIMS) in coordination with the science framework conceptual models and monitoring plans. The IIMS will bring together frequently used datasets and support their analysis as a means to inform TRRP management decisions.

This project demonstrates ESSA's technical expertise/experience in:

- operational development of monitoring and evaluation designs for adaptive management;
- technical facilitation of difficult scientific disputes amongst federal, state and tribal fish agencies;
- technical expertise/experience in fisheries, aquatic science/ecology, surface water hydrology, habitat restoration related to the geomorphic and biological impacts of dams;
- large-scale monitoring and statistical design;
- data management expertise; and
- integration of diverse inputs into consolidated, scientifically rigorous reports.

References:

Nina Hemphill, TRRP/BoR, 530-623-1812, nhemphill@mp.usbr.gov
Andreas Krause, TRRP/BoR, 530 623-1807, akrause@mp.usbr.gov

Joe Polos, USFWS, 707-825-5149; Joe_Polos@fws.gov
Mike Berry, CDFG, 530-225-2131; MBerry@dfg.ca.gov

2. Collaborative Systemwide Evaluation and Monitoring Project (CSMEP)

Columbia Basin Fish & Wildlife Foundation (CBFWF) and Bonneville Power Administration (BPA)

Contract Number, Data, and Type: Contract for Mainstem Systemwide Project 35033 with CBFWF, renewed annually during the period from 2003 to 2008.

Date Completed: 2003 – 2008

Team: David Marmorek (lead facilitator, coordinator), Marc Porter, Darcy Pickard, Katherine Wieckowski, Diana Abraham

Initial Contract Amount / Final Contract Amount: \$900K USD (\$200K for each of 4 years; then \$100K for final year)

Rigorous monitoring and evaluation (M&E) is absolutely critical to the feedback loop of the adaptive management cycle. ESSA was the lead facilitator and coordinator of [CSMEP](#), a collaborative effort to improve fish population and habitat monitoring data and data evaluation methods in the Columbia Basin, involving federal, state and tribal agencies. This decision-focused effort utilized EPA's Data Quality Objectives process and other methods to assess the impact of different M&E approaches on habitat and fish management decisions. CSMEP documented and integrated existing monitoring data on fish species of concern, critically assessed the strengths and weaknesses of these data, and designed and implemented improved monitoring and evaluation methods to fill information gaps. ESSA led several multi-agency monitoring design workshops to integrate existing programs with innovative approaches being developed in ongoing large-scale federal monitoring 'pilot' studies. CSMEP products included: subbasin metadata inventories of fish population monitoring, strength and weakness assessments of fish monitoring within 13 subbasins of the Columbia Basin, pilot M&E designs for the Snake River Basin (for status & trends, as well as action effectiveness monitoring for habitat, hatcheries, harvest and hydro), and two software tools: the Salmon Viability Monitoring Model ([SVMM](#)), and the Integrated Costs Database Tool ([ICDT](#)). The hydrosystem analyses involved analyses of alternative designs for PIT-tag studies to answer questions related to hydrosystem survival, smolt-to-adult return rates, and transportation effectiveness. ESSA was the lead author on all multi-authored CSMEP reports (e.g., [Volume 1](#) and [Volume 2](#)), which provide 'design templates' that can be applied to the M&E throughout the Columbia Basin. In 2008, CSMEP received a very positive technical review of its accomplishments by the Independent Science Review Panel ([ISRP 2008-1](#)), who stated that "the project has made much progress in a relatively short time".

This project demonstrates ESSA's technical expertise/experience in:

- study design, statistical design and large scale research and monitoring for adaptive management;
- technical facilitation, coordination and leadership of federal, state and tribal fish agencies;
- integration of diverse inputs into consolidated, scientifically rigorous reports;
- fisheries, aquatic science/ecology;
- passage analysis, including analysis of PIT-tag data;
- ecological simulation modeling for salmonids; and
- database development.

References:

Kenneth D. MacDonald, CBFWA lead (now with USFS), 503-808-2994, kmacdonald@fs.fed.us
Chris Jordan, NOAA Fisheries, 541-754-4629, chris.jordan@noaa.gov
Tracy Yerxa, BPA contract monitor, 503-230-4738, tyerxa@bpa.gov
Jay Hesse, Nez Perce, 208-843-7145, jayh@nezperce.org

3. Independent Scientific Advice for the Platte River Recovery Implementation Program

Platte River Recovery Implementation Program (PRRIP)

Contract Number, Data, and Type: 2005 letter contract between WEST, Inc and ESSA; 2009 letter contract between Nebraska Community Foundation and ESSA; no contract numbers in either case

Date Completed: 2004-2006; 2009-present

ESSA Team: David Marmorek, Carol Murray

Initial Contract Amount / Final Contract Amount: \$100K USD

ESSA worked from 2004 to 2006 in conducting an independent review of the PPRIP's draft Adaptive Management Plan or AMP. We worked as part of a team of leading practitioners in adaptive management across North America, including Scott McBain (Trinity River Restoration Program), Denis Kubly (Glen Canyon Adaptive Management Program), Nick Aumen (Central Everglades Restoration Program), and Ed Hanna (various adaptive management programs in Ontario). Our roles included: educating the PPRIP Governance Committee and Technical Advisory Committees on methods to implement adaptive management; commenting on the CEMs, hypotheses and monitoring protocols developed in the AMP; and suggesting improvements to the overall structure of both the PPRIP and AMP. These comments had a substantial effect on the final AMP. In 2009, the PPRIP formed an Independent Science Advisory Committee (ISAC), under the chairmanship of David Marmorek of ESSA, with terms of reference developed by Headwaters Corporation, as the executing entity that's implementing the PPRIP. Other ISAC members include Drs. Robb Jacobson (USGS), John Nestler (USACE-retired), David Galat (U. Missouri), Kent Loftin (HydroPlan) and Philip Dixon (Iowa State U.). The ISAC has been involved in detailed reviews of *how* the PPRIP is implementing the AMP, focusing on such issues as: expanding CEMs to include potentially confounding factors outside of the Platte watershed; prioritizing hypotheses; experimental design challenges; re-evaluating AMP management objectives in light of the realities of monitoring; data analysis, synthesis and reporting; and modeling. The first ISAC report in the fall of 2009 (ISAC 2009) was welcomed by both the PPRIP Governance Committee and Technical Advisory Committees, and the Program is rapidly moving forward to implement its recommendations. The positive interactions between ESSA and Headwaters lay the foundation for this joint proposal on the Middle Rio Grande. The ISAC is continuing its activities in 2010.

This project demonstrates ESSA's technical expertise/experience in:

- independent expert review of adaptive management plans;
- institutional aspects of adaptive management;
- integration of diverse inputs into consolidated, scientifically rigorous reports;
- endangered species issues (piping plovers, least terns, whooping cranes, pallid sturgeon); and
- water and land management.

References:

Dale Strickland, WEST Inc., 307-634-1756, dstrickland@west-inc.com

John Lawson, Bureau of Reclamation, 307-261-5671, jlawsen@usbr.gov

4. Bull Trout Recovery: Monitoring and Evaluation Guidance

United States Fish and Wildlife Service

Contract Number, Data, and Type: 5-year IDIQ for provision of Bull Trout Analytical and Facilitation Services to USFWS by ESSA; Order # 1011813D039

Date Completed: 2005-2010

Team: David Marmorek, Marc Porter

Initial Contract Amount / Final Contract Amount: \$200K USD (\$40K for each of 5 years)

Bull trout (*Salvelinus confluentus*) in the coterminous United States were listed as threatened, under the Endangered Species Act (ESA) in 1999 due to declines in distribution, abundance, and habitat quality over their entire range. The US Fish and Wildlife Service (USFWS) subsequently (2002) released a draft recovery plan for bull trout. Proper monitoring and evaluation are considered critical to characterize the ongoing status of bull trout populations, and to allow for an assessment of recovery action effectiveness in an adaptive management cycle. There is however considerable uncertainty in how, where and when to best monitor bull trout population attributes and their habitats. In addition, there is much work to do in defining

which analytical techniques will yield statistically reliable and rigorous estimates of key population and habitat performance measures.

To help address these monitoring and evaluation challenges the USFWS established a bull trout Recovery Monitoring and Evaluation Technical Group (RMEG). The RMEG is a multi-agency body chaired by USFWS technical staff and independently facilitated by ESSA Technologies. In association with recovery planning for bull trout the RMEG has four primary tasks: 1) recovery program review; 2) guidance on monitoring designs; 3) guidance on specific monitoring techniques; and 4) review of analytical methods. ESSA has lead a continuing series of workshops over 2005-2009 to advance technical discussions of bull trout monitoring issues and to develop analytical tasks that would help to reduce monitoring uncertainties. A series of workshop reports produced by ESSA document the results of work to date, and describe the continuing development of RMEG questions, approaches, designs and analyses. In 2008 ESSA, in conjunction with the USFWS and RMEG participants, synthesized this work into a general guidance document for bull trout monitoring and evaluation that will be used by U.S. federal, state and tribal fish and wildlife agencies

This project demonstrates ESSA's technical expertise/experience in:

- development of M&E plans to support adaptive management of endangered fish species;
- technical facilitation of federal and state scientists on large-scale research and monitoring;
- integration of diverse inputs into consolidated, scientifically rigorous reports;
- technical expertise/experience in fisheries, aquatic science/ecology; and
- simulation modelling.

References:

Dr. Howard Schaller, USFWS, 360-604-2543, howard_schaller@fws.gov

Dr. Tim Whitesel, USFWS, 360-604-2500, Timothy_Whitesel@fws.gov

5. Development of Decision Support Software for Fish/Water Management in Okanagan Basin (OKFWM) www.ok.fwmt.net

Canadian Okanagan Basin Technical Working Group (COBTWG) and Okanagan Nation Alliance

Contract Number, Data, and Type: Series of contracts under the title "Okanagan Fish Water Management Tool" (no contract numbers).

Date Completed: 2002 – 2008

Team: David Marmorek (lead facilitator), Clint Alexander (lead modeler), Diana Abraham and others

Initial Contract Amount / Final Contract Amount: \$356K CDN over several contracts

Perhaps the most well respected and state-of-the art example of the value of decision support systems in achieving a better balance amongst water objectives is the Okanagan Fish-Water Management Tool (OKFWM). In 2001, the COBTWG hired ESSA to assist with the design and implementation of an Internet-accessible software application (OKFWM) as the central tool for realizing improved in-stream flows in this arid region of British Columbia. The resultant OKFWM system provides a multi-user decision making framework based on five coupled "state-of-the-science" biophysical models (hydrology, socioeconomic water management rules, water temperature, kokanee and sockeye) that address lake and down-river considerations at a variety of sites. These sub-models are routinely updated with: (i) daily real-time data on lake elevations, water temperatures and discharge; and (ii) annual information derived from ongoing field monitoring programs. In 2004, ESSA led a comprehensive 25 year *retrospective* analysis that showed significant fisheries gains were possible from routine use of this tool without adversely impacting flooding and economic interests. ESSA is presently engaged in a small, but very relevant *prospective* Okanagan climate change study led by Dr. Kim Hyatt (Fisheries and Oceans Canada, Chair FWMT Steering Committee). The process of developing OKFWM has produced significant technical and cognitive advances in fish/water management in the Okanagan basin. Given OKFWM's ease of use since 2004 and demonstrated potential, water and fisheries managers representing private industry, First Nations, federal and provincial interests have enthusiastically adopted the tool for in-season management use. The result has

been to greatly improve in-season water release decisions occurring at Okanagan Lake dam (see http://www.essa.com/tools/okfwm/index_fish.html).

This project demonstrates ESSA's technical expertise/experience in:

- development of real time, in-season approaches to adaptive water management;
- facilitation of multi-agency analyses of tradeoffs amongst competing objectives;
- technical expertise/experience with aquatic science, fisheries and hydrosystem impacts; ;
- integration of diverse inputs into consolidated, scientifically rigorous reports; and
- modelling of fish populations.

References:

Dr. Kim Hyatt, Fisheries and Oceans Canada, 250-756-7217, Kim.Hyatt@dfo-mpo.gc.ca

6. Use of Decision Analysis to Design Adaptive Flow Management Experiments in Clear Creek, Northern California

US Department of Interior, U.S. Bureau of Reclamation & U.S. Fish and Wildlife Service

Contract Number, Data, and Type: Most recent contract number from USFWS is 101813D039 (Order number 101815Y613, Reference number 8142050360)

Date Completed: 2000 – 2007 (with gaps)

Team: David Marmorek (lead facilitator), Clint Alexander (lead modeller)

Initial Contract Amount / Final Contract Amount: \$350K USD

The CALFED Ecosystem Restoration Program (ERP) has adopted an ecosystem-based management approach, with an emphasis on adaptive management, for restoring the Bay-Delta ecosystem. ESSA was engaged to develop a quantitative tool that uses decision analysis and a computer simulation model to evaluate alternative flow management experiments for Clear Creek. The project focuses on the design and simulation of flow releases from Whiskeytown Reservoir to Clear Creek, and evaluation of trade-offs inherent in different flow release policies for all interests (e.g., fish, wildlife, riparian, power generation, temperature control, and recreation). Development of this kind of model required the support and participation of local experts in biology, geomorphology, hydrology, and economics that are familiar with the issues specific to flow management on Clear Creek. ESSA was responsible for facilitating technical meetings and formal workshops to solicit their input and ensure that the model would adequately capture all relevant issues. There were some very challenging differences in objectives between some of the participating agencies, which were handled by ensuring that all objectives had associated model outputs.

This project demonstrates ESSA's technical expertise/experience in:

- development of adaptive flow management experiments to support habitat enhancement;
- technical facilitation;
- quantitative understanding of tradeoffs between fisheries and power production;
- integration of diverse inputs into consolidated, scientifically rigorous reports;
- technical expertise/experience in fisheries, aquatic science/ecology, and surface water hydrology; and
- data management and modelling

References:

Dr. Matt Brown, USFWS, 530-527-3043 (ext. 238), Matt.Brown@fws.gov

Dr. Campbell Ingram, TNC, 916-449-2850 (ext. 4129), c Ingram@tnc.org

7. Platte River Recovery Implementation Program (PRRIP)

Contract Number, Data, and Type: Cooperative Agreement No. 99-FC-60-11870, Technical and Administrative Support to the Governance Committee and Executive Director for the Platte River Recovery Implementation Program

Acquiring Agency / Customer: Governance Committee / Nebraska Community Foundation

Initial Contract Amount / Final Contract Amount: Five-year contract (2007-2011); 2007 – \$348,700; 2010 – \$1,599,900

Date Completed: 2007-ongoing

Team: Headwaters Corporation – Jerry Kenny (Executive Director), Chad Smith (Director of Natural Resources), Beorn Courtney (Director of Water Resources), Bridget Barron (Director of Outreach and Communications), Jason Farnsworth (Director of Technical Support), David Baasch (Biologist), Justin Brei (Biosystems Engineer), Bruce Sackett (Land Specialist), Tim Tunnell (Land Manager), Steve Smith (Water Resources & Environmental Engineer), Laura Belanger (Water Resources & Environmental Engineer), Donna Narber (Administrative Assistant)

Headwaters Corporation provides the independent Executive Director and staff for the [PRRIP](#), a major national species recovery program focused on three bird species (least tern, piping plover, whooping crane) and one fish species (pallid sturgeon). This includes facilitating, coordinating, and leading all aspects of Program implementation; supporting the Governance Committee and all advisory committees; providing guidance on science, land, and water decisions; and public information and outreach. Mr. Smith is the lead facilitator and implementation coordinator of the Program's Adaptive Management Plan, managing all aspects of AM including experimental design; prioritization and sequencing of hypotheses; facilitating numerous technical workshops and meetings comprised of multi-discipline stakeholders; data collection, management, and analysis; developing decision criteria and utilizing decision analysis tools; directing all monitoring and research; and managing the PRRIP's Independent Scientific Advisory Committee and independent peer review. Headwaters is leading efforts to achieve PRRIP's water objective of 130,000-150,000 acre-feet a year and land objective of 10,000 acres of habitat. Headwaters manages an annual Program budget of over \$17 million; directs the efforts of numerous contractors; serves as the public face of all Program activities; and interacts with other AM and species recovery programs around the country to share information and ideas.

This project demonstrates the Headwaters' technical expertise/experience in:

- technical facilitation, coordination, and leadership of federal, state, private, and NGO entities;
- adaptive management plan implementation and revision;
- integration of diverse inputs into consolidated, scientifically rigorous reports;
- study design, statistical design, and large scale research and monitoring;
- developing and implementing monitoring and research protocols;
- decision analysis;
- hypotheses prioritization and sequencing;
- fisheries and avian ecology;
- governance of AM Plans and species recovery programs;
- land management;
- water resources management;
- coordinating water operations in large, over-appropriated river basins; and
- data warehousing and management.

References:

John Lawson, Bureau of Reclamation, 307-261-5671, jlawson@usbr.gov

Mike Thabault, U.S. Fish and Wildlife Service, 303-236-4252, michael_thabault@fws.gov

8. Collaborative Adaptive Management Network (CAMNet) Adaptive Management Training Workshop

Contract Number, Data, and Type – Volunteer effort

Acquiring Agency / Customer: CAMNet / Workshop attendees at 2009 National Conference on Ecosystem Restoration

Initial Contract Amount / Final Contract Amount: Volunteer effort

Date Completed: 2009

Team: Chad Smith

Mr. Smith was a member of a five-person CAMNet team that delivered a workshop on AM principles, components, and implementation at the 2009 National Conference on Ecosystem Restoration in Los Angeles. Mr. Smith helped lead discussion on AM principles, components, and how science learning can inform decision-making. Fifty people representing entities and ecosystem rehabilitation programs from around the country participated in the workshop. The workshop included instruction on conceptual models, hypotheses, experimental design, and decision-making in the AM process.

This project demonstrates Headwaters' technical expertise/experience in:

- adaptive management plan design, implementation, and assessment;
- instruction on AM components such as conceptual models, hypotheses, experimental design, and decision-making; and
- facilitating AM education.

References:

Kent Loftin, HydroPlan LLC, 772-546-1269, kloftin@hydroplanllc.com

Tom St. Clair, PBS&J, 904-232-1774, gstclair@pbsj.com

9. Comprehensive Everglades Restoration Program

Contract Number, Data, and Type – letter contract from Meridian Institute (no contract number)

Acquiring Agency / Customer: Meridian Institute / Jacksonville District, U.S. Army Corps of Engineers

Initial Contract Amount / Final Contract Amount: \$16,040 (\$8,020/per person)

Date Completed: 2010

Team: ESSA (David Marmorek) and Headwaters (Chad Smith)

Mr. Marmorek and Mr. Smith jointly served on an Expert Review Panel for the Comprehensive Everglades Restoration Program's Adaptive Management Integration Guide. The Jacksonville District of the U.S. Army Corps of Engineers contracted Mr. Marmorek and Mr. Smith to provide expert review of and advice on implementation of adaptive management in the Everglades and how best to utilize adaptive management as the science framework for CERP. Mr. Marmorek and Mr. Smith provided extensive written comments on the CERP AM integration guide and attended a one-day meeting of the Expert Review Panel in south Florida to provide additional assessment and input for the Corps, South Florida Water Management District, U.S. Fish and Wildlife Service, and other CERP participants.

This project demonstrates the ESSA/Headwaters team's technical expertise/experience in:

- adaptive management plan design, implementation, and assessment;
- designing and implementing AM in the context of a major, complex ecosystem rehabilitation program;
- study design, statistical design, and large scale research and monitoring;
- developing components of a "true" AM Plan; and
- governance of ecosystem rehabilitation programs and science in an AM framework.

References:

Jennifer Pratt-Miles, Meridian Institute, 970-513-8340 (ext.213), jprattmiles@merid.org

Andy Loschiavo, U.S. Army Corps of Engineers, 904-232-2077, Andrew.J.Loschiavo@usace.army.mil

Dennis Kubly, Bureau of Reclamation, 801-598-8146, dkubly@usbr.gov

10. A Multiple Watershed Approach to Assessing the Effects of Habitat Restoration Actions on Anadromous and Resident Fish Populations

Bonneville Power Administration

Contract Number, Data, and Type: BPA contract to ESSA for Innovative Project 34008

Date Completed: 2003 – 2005

ESSA Team: David Marmorek (lead facilitator), Marc Porter, Calvin Peters, Ian Parnell, Clint Alexander, Christine Pinkham plus Joel Hubble (Yakama Fisheries), Charlie Paulsen and Tim Fisher

Initial Contract Amount / Final Contract Amount: \$200K USD

Habitat protection and restoration is a cornerstone of current strategies to restore ecosystems, recover endangered fish species, and rebuild fish stocks within the U.S. Columbia River Basin. While the *idea* of adaptive management is generally accepted, the reality is that few habitat restoration projects are sufficiently well monitored to yield clear insights on their effectiveness. Following a series of facilitated workshops with basin biologists, ESSA performed an intensive analysis of selected areas with the best biological data for evaluating the effects of restoration actions on fish survival rates. The study (which involved 80 scientists and managers) also included a review of “blue ribbon” studies (those with relatively strong experimental designs and time series data with adequate duration for detecting the impacts of habitat restoration actions on fish survival). The bottom line conclusions of this work were as follows: 1) there are inadequacies in existing research and monitoring for all restoration techniques; 2) there is a need for comprehensive physical and biological evaluations of most watershed restoration strategies; 3) there is a need to know more about fish survival benefits of restoration actions; and 4) it is important to extend existing successful adaptive management experiments to learn more about the longer-term benefits of those actions.

The retrospective study also found that few restoration projects have explicitly stated hypotheses and structured monitoring to test them, recommending that more attention be paid to where restoration projects and reference areas are located, and the timing of restoration projects. Efforts on these issues need to be made at a much higher level than that of an individual restoration project, so that groups of similar actions in comparable areas can be jointly evaluated in a strategic and rigorous manner (across multiple reaches or multiple watersheds). This will involve both technical and institutional advances, including improved experimental designs, more consistent monitoring protocols, and much better collaboration across multiple projects and institutions. [ESSA’s multi-watershed report](#) was cited by the ISRP as an excellent example of use of the Innovative Projects Fund of the Northwest Power and Conservation Council:

“The retrospective review by ESSA Technologies (Marmorek et al. 2004; Innovative Project 34008) of past habitat improvement actions and their effect on salmon survival and abundance led directly to many recommendations on data needs, and coordination among projects that are currently being addressed by the developing Research, Monitoring, and Evaluation plan.”

This project demonstrates ESSA’s technical expertise/experience in:

- practical assessment of the ability to conduct adaptive management for habitat restoration projects
- technical facilitation and collaborative work with federal, state and tribal scientists on large-scale research and monitoring;
- integration of diverse inputs into consolidated, scientifically rigorous reports;
- fisheries, aquatic science/ecology related to habitat projects;
- monitoring study design; and
- statistical design and analysis, including analysis of PIT-tag data for parr-smolt survival.

References:

Jessica Wilcox, BPA COTR (202 586-5656), jdwilcox@bpa.gov

Bruce Rieman, USFS-emeritus (406 677-3813), brieman@blackfoot.net

Appendix 2: Past Performance

Table A2.1. Past Performance information. Projects are listed in the same order as in Appendix 1, which contains detailed information on each project.

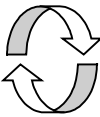
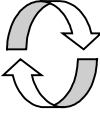
Project and Timing	Budget Performance	Schedule Performance	Key Challenges Overcome	Client Satisfaction	Contact Information
ESSA: Trinity River Restoration Program Integrated Assessment Plan (2004-ongoing)	All tasks completed within the \$846K budget	<ul style="list-style-type: none"> Original schedule for completion of IAP was revised by client to ensure buy-in by all parties, particularly the Hoopa Valley Tribe, and to accommodate an RFP process for detailed proposals on particular assessments (events beyond Contractor control) Project completed according to the final revised schedule (end of 2009) 	<ul style="list-style-type: none"> Greatly improved communication and trust amongst TRRP entities Substantially increased rigor of sampling design and monitoring methods Provided leadership on prioritization of assessments 	Very high level of satisfaction on ESSA's role from agency scientists, COTR, TRRP Executive Director, independent Science Advisory Board and Trinity Management Council	<ul style="list-style-type: none"> * Nina Hemphill, TRRP, 530-623-1812, nhemphill@mp.usbr.gov * Joe Polos, USFWS, 707-825-5149; Joe_Polos@fws.gov
ESSA: Collaborative Systemwide Monitoring and Evaluation Project (CSMEP)	All ESSA tasks completed within the \$900K budget	<ul style="list-style-type: none"> All ESSA tasks were completed on schedule according to the work plans formulated at the start of each fiscal year with CBFWF and BPA 	<ul style="list-style-type: none"> Greatly improved rigor of adaptive management, including sampling design, monitoring and assessment methods for salmonid populations Coordinated large number of collaborating federal, state and tribal scientists, as well as expert consultants 	Very high level of satisfaction regarding ESSA's performance from main client (CBFWF), as well as co-participating federal, tribal and state agencies and Independent Science Review Panel (ISRP)	<ul style="list-style-type: none"> * Kenneth D. MacDonald, CBFWA lead (now with USFS), 503-808-2994, kmacdonald@fs.fed.us * Chris Jordan, NOAA Fisheries, 541-754-4629, chris.jordan@noaa.gov * Jay Hesse, Nez Perce, 208-843-7145, jayh@nezperce.org
ESSA: Independent Scientific Advice for Platte River Recovery Implementation Program	All ESSA tasks completed within the \$100K budget (several phases)	<ul style="list-style-type: none"> All ESSA tasks were completed on schedule according to the work plan 	<ul style="list-style-type: none"> Independent science panels reviewed a great deal of information, and clearly synthesized their conclusions, in a very short period of time. 	Very high level of satisfaction regarding the panels' reports, from both scientists on Technical Advisory Committees, and managers on the Governance Committee	<ul style="list-style-type: none"> * Dale Strickland, WEST Inc., 307-634-1756, dstrickland@west-inc.com * John Lawson, Bureau of Reclamation, 307-261-5671, jlawson@usbr.gov

Project and Timing	Budget Performance	Schedule Performance	Key Challenges Overcome	Client Satisfaction	Contact Information
ESSA: Bull Trout Recovery, Monitoring and Evaluation Guidance	All ESSA tasks completed within the \$200K budget	<ul style="list-style-type: none"> All ESSA tasks completed on schedule according to work plans developed with the USFWS; some workshops needed to be rescheduled to fit participant schedules 	<ul style="list-style-type: none"> Coordinated a 14-member group of federal, state and academic experts on monitoring and evaluation Facilitated group's development of innovative approaches to monitoring bull trout distribution, status, connectivity and abundance. 	Very high level of satisfaction regarding ESSA's performance from main client (USFWS), as well as co-participating federal, state and academic scientists	<ul style="list-style-type: none"> * Dr. Howard Schaller, USFWS, 360-604-2543, howard_schaller@fws.gov * Dr. Tim Whitesel, USFWS, 360-604-2500, Timothy_Whitesel@fws.gov
ESSA: Development of Decision Support Software for Fish/Water Management in Okanagan Basin	Almost all ESSA tasks have been completed within their designated budgets; ESSA co-funded first year of software development.	<ul style="list-style-type: none"> All ESSA tasks completed on schedule according to work plans developed with the client, with a few minor exceptions due to factors beyond ESSA's control 	<ul style="list-style-type: none"> Integrated hydrological, biological and economic information into a manager-focused AM decision support system that is being used weekly for in-season water management by federal, provincial and tribal agencies 	Very high level of satisfaction regarding ESSA's performance from main client (COBTWG), as well as participating federal, provincial and tribal scientists and managers. Received an Innovation and Excellence Award from Premier of B.C.	* Dr. Kim Hyatt, DFO, 250-756-7217, Kim.Hyatt@dfo-mpo.gc.ca
ESSA: Use of Decision Analysis to Design Adaptive Flow Management Experiments in Clear Creek, Northern California	Almost all ESSA tasks have been completed within their designated budgets; ESSA co-funded some software development.	<ul style="list-style-type: none"> All ESSA tasks completed on schedule according to work plans developed with the client, with a few minor exceptions due to factors beyond ESSA's control 	<ul style="list-style-type: none"> Integrated hydrological, biological and economic information into an AM decision support system to explore the feasibility, costs and benefits of generating geomorphic flows Collaborated with many scientists and managers 	Very high level of satisfaction regarding ESSA's performance from main client (USFWS), as well as participating federal, state, regional and NGO scientists and managers.	<ul style="list-style-type: none"> * Dr. Matt Brown, USFWS, 530-527-3043 (ext. 238), Matt.Brown@fws.gov * Dr. Campbell Ingram, TNC, 916-449-2850 (ext. 4129), cingram@tnc.org
Headwaters: Platte River Recovery Implementation Program	<p>All tasks completed within 2007-2009 annual budgets</p> <p>Within annual budget to date in 2010</p>	<ul style="list-style-type: none"> Greatly accelerated implementation pace of all PRRIP actions On pace for major AM Plan action implementation in 2010 and 2011 	<ul style="list-style-type: none"> Greatly improved communication and trust amongst PRRIP entities Greatly improved details of AM Plan implementation, experimental design, and decision support Provided leadership on all aspects of PRRIP implementation 	Very high level of satisfaction on Headwaters' role Governance Committee members, PRRIP scientists and managers, and Independent Scientific Advisory Committee	<ul style="list-style-type: none"> * John Lawson, Bureau of Reclamation, 307-261-5671, jlawson@usbr.gov * Mike Thabault, U.S. Fish and Wildlife Service, 303-236-4252, michael_thabault@fws.gov

Project and Timing	Budget Performance	Schedule Performance	Key Challenges Overcome	Client Satisfaction	Contact Information
Headwaters: CAMNet AM Training Workshop	Volunteer effort	All tasks completed on schedule	<ul style="list-style-type: none"> Delivered large amount of information in clear, concise manner Provided concrete examples of key AM components Provided leadership within small, technical team of AM practitioners and facilitators 	Very high level of satisfaction on Headwaters' role from workshop team members and workshop participants	* Kent Loftin, HydroPlan LLC, 772-546-1269, klloftin@hydroplanllc.com * Tom St. Clair, PBS&J, 904-232-1774, gstclair@pbsj.com
ESSA / Headwaters: CERP AM Integration Guide	All tasks completed within the \$16,040 budget	All tasks completed within a very short timeline and on schedule	<ul style="list-style-type: none"> Synthesized a large amount of information on AM to deliver thorough and constructive advice on AM design and implementation Provided guidance for integrating AM into science framework of major ecosystem rehabilitation program 	Very high level of satisfaction on ESSA's and Headwaters' role from Corps and South Florida Water Management District scientists and managers, Meridian Institute, senior CERP AM advisor (Kent Loftin), and other CERP scientists and managers	* Jennifer Pratt-Miles, Meridian Institute, 970-513-8340 (ext.213), jprattmiles@merid.org * Andy Loschiavo, U.S. Army Corps of Engineers, 904-232-2077, Andrew.J.Loschiavo@usace.army.mil * Dennis Kubly, Bureau of Reclamation, 801-598-8146, dkubly@usbr.gov
ESSA: A Multiple Watershed Approach to Assessing the Effects of Habitat Restoration Actions on Anadromous and Resident Fish Populations	All ESSA tasks completed within the \$200K budget	<ul style="list-style-type: none"> All ESSA tasks were completed on schedule according to the work plan formulated with BPA 	<ul style="list-style-type: none"> Assembled diverse data sources to complete an innovative analysis of the effectiveness of habitat restoration projects in the Columbia Basin Involved over 80 federal, state and tribal scientists 	Very high level of satisfaction regarding ESSA's performance from main client (BPA), as well as co-participating federal, tribal and state agency scientists and the Independent Science Review Panel (ISRP)	* Jessica Wilcox, BPA COTR (202 586-5656), jdwilcox@bpa.gov * Bruce Rieman, USFS-emeritus (406 677-3813), brieman@blackfoot.net

Appendix 3: Additional Tables and Figures

Table A3.1. Elements within each step in the adaptive management cycle.

AM Steps	Ideal Elements within each Step
Step 1. <u>Assess</u> and define the problem	a. <u>What story are you trying to tell?</u> b. Clearly state management goals and objectives c. ID key uncertainties (what are the management questions?) d. Explore alternative management actions (experimental “treatments”) e. ID measurable indicators f. ID spatial / temporal bounds g. Build conceptual models h. Articulate hypotheses to be tested i. Explicitly state assumptions j. State up front how what’s learned will be used k. Involve stakeholders, scientists, and managers 
Step 2. <u>Design</u>	a. Use active AM b. When and where possible, include contrasts, replications, controls c. Obtain statistical advice d. Predict outcomes e. Consider next steps under alternative outcomes f. Develop a data management plan g. Develop a monitoring plan h. Develop a formal AM plan (for all of the remaining steps) i. Peer-review the design j. Obtain multi-year budget commitments k. Involve stakeholders 
Step 3. <u>Implement</u>	a. Implement contrasting treatments b. Implement as designed (or document unavoidable changes) c. Monitor the implementation
Step 4. <u>Monitor</u>	a. Implement the Monitoring Plan as it was designed b. Undertake baseline (“before”) monitoring c. Undertake effectiveness monitoring
Step 5. <u>Evaluate</u> results	a. Compare monitoring results against objectives b. Compare monitoring results against assumptions, uncertainties, and hypotheses c. Compare actual results against model predictions d. Receive statistical or analysis advice e. Have data analysis keep up with data generation from monitoring activities
Step 6. <u>Adjust</u> hypotheses, conceptual models, and management	a. <u>Tell your story!</u> b. Meaningful learning occurred, and was documented c. Communicate this to decision makers and others d. Actions or instruments changed based on what was learned

Appendix 4: References Cited in this Proposal

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- ESSA Environmental and Social Systems Analysts Ltd.** 1982. Review and Evaluation of Adaptive Environmental Assessment and Management. Prepared for Environment Canada, Vancouver, British Columbia, 116 pp.
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- Smith, C.B.** (Accepted). Adaptive management on the central Platte River – science, engineering, and decision analysis to assist in recovery of four species. J. Environmental Management.
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Appendix 5: Certifications

We are in full agreement with all terms, conditions, and provisions included in Solicitation No. R10PS40039. This includes, but is not limited to, the following requirements in the RFQ:

- Regarding RFQ section 1, **52.212-4, CONTRACT TERMS AND CONDITIONS – COMMERCIAL ITEMS**, part (r) *Compliance with laws unique to Government contracts*:
We agree to comply with [31 U.S.C. 1352](#) relating to limitations on the use of appropriated funds to influence certain Federal contracts; [18 U.S.C. 431](#) relating to officials not to benefit; [40 U.S.C. 3701](#), *et seq.*, Contract Work Hours and Safety Standards Act; [41 U.S.C. 51-58](#), Anti-Kickback Act of 1986; [41 U.S.C. 265](#) and [10 U.S.C. 2409](#) relating to whistleblower protections; Section 1553 of the American Recovery and Reinvestment Act of 2009 relating to whistleblower protections for contracts funded under that Act; [49 U.S.C. 40118](#), Fly American; and [41 U.S.C. 423](#) relating to procurement integrity.
- Regarding RFQ section 3, **FAR 52.244-6, Subcontracts for Commercial Items**, part (c) (1), ESSA (as contractor) will insert the following clauses in subcontracts for commercial items:
 - (i) 52.203-13, Contractor Code of Business Ethics and Conduct (Dec 2008) (Pub. L. 110-252, Title VI, Chapter 1 (41 U.S.C. 251 note).
 - (ii) 52.203-15, Whistleblower Protections Under the American Recovery and Reinvestment Act of 2009 (Section 1553 of Pub. L. 111-5). Applies to subcontracts funded under the Act.
 - (iii) 52.219-8, Utilization of Small Business Concerns (May 2004) (15 U.S.C. 637(d)(2)(3)), in all subcontracts that offer further subcontracting opportunities. If the subcontract (except subcontracts to small business concerns) exceed \$550,000 (\$1,000,000 for construction of any public facility), the subcontractor must include 52.219-8 in lower tier subcontracts that offer subcontracting opportunities.
 - (iv) 52.222-26, Equal Opportunity (Mar 2007) (E.O. 11246).
 - (v) 52.222-35, Equal Opportunity for Special Disabled Veterans, Veterans of the Vietnam Era, and Other Eligible Veterans (Sep 2006) (38 U.S.C. 4212(a));
 - (vi) 52.222-36, Affirmative Action for Workers with Disabilities (Jun 1998) (29 U.S.C. 793).
 - (vii) 52.222-39, Notification of Employee Rights Concerning Payment of Union Dues or Fees (Dec 2004) (E.O. 13201). (Flow down a required in accordance with paragraph (g) of FAR clause 52.222-39.)
 - (viii) 52.222-50, Combating Trafficking in Persons (Feb 2009) (22 U.S.C. 7104(g)).
 - (ix) 52.247-64, Preference for Privately Owned U.S.-Flag Commercial Vessels (Feb 2006) (46 U.S.C. Appx 1241 and 10 U.S.C. 2631) (flow down required in accordance with paragraph (d) of FAR clause 52.247-64).
- Regarding RFQ section 4, **WBR 1452.223-82, PROTECTING FEDERAL EMPLOYEES AND THE PUBLIC FROM EXPOSURE TO TOBACCO SMOKE IN THE FEDERAL WORKPLACE -- BUREAU OF RECLAMATION**, part (a):
In performing work under this contract, the contractor shall comply with the requirements of Executive Order 13058, dated August 9, 1997, which prohibits the smoking of tobacco products in all interior space owned, rented, or leased by the executive branch of the Federal Government, and in any outdoor areas under executive branch control in front of air intake ducts.
- Regarding RFQ section 6, **52.212-5, CONTRACT TERMS AND CONDITIONS REQUIRED TO IMPLEMENT STATUTES OR EXECUTIVE ORDERS – COMMERCIAL ITEMS**:

We will comply as required with all relevant parts.

- Regarding RFQ section **8, 52.212-1, INSTRUCTIONS TO OFFERORS -- COMMERCIAL ITEMS**, part (k) *Central Contractor Registration*:

ESSA Technologies Ltd. is already registered in the CCR database.

- Regarding RFQ section **14, 52.212-3, OFFEROR REPRESENTATIONS AND CERTIFICATIONS - COMMERCIAL ITEMS**:

Part (b): ESSA Technologies Ltd. has completed the annual representations and certifications electronically via the ORCA website at <http://orca.bpn.gov>. After reviewing the ORCA database information, we verify by submission of this offer that the representations and certifications currently posted electronically at FAR 52.212-3, Offeror Representations and Certifications—Commercial Items, have been entered or updated in the last 12 months, are current, accurate, complete, and applicable to this solicitation (including the business size standard applicable to the NAICS code referenced for this solicitation), as of the date of this offer and are incorporated in this offer by reference. The certifications below are consistent with those on the ORCA website.

Part (c):

- (1) *Small business concern.* ESSA **is** a small business concern.
- (2) *Veteran-owned small business concern.* ESSA **is not** a veteran-owned small business concern.
- (4) *Small disadvantaged business concern.* ESSA **is not** a small disadvantaged business concern as defined in 13 CFR 124.1002.
- (5) *Women-owned small business concern.* ESSA **is not** a women-owned small business concern.
- (8) Small Business Size for the Small Business Competitiveness Demonstration Program and for the Targeted Industry Categories under the Small Business Competitiveness Demonstration Program.

Number of Employees	Average Annual Gross Revenues
<input checked="" type="checkbox"/> 50 or fewer	<input type="checkbox"/> \$1 million or less
<input type="checkbox"/> 51–100	<input type="checkbox"/> \$1,000,001–\$2 million
<input type="checkbox"/> 101–250	<input checked="" type="checkbox"/> \$2,000,001–\$3.5 million
<input type="checkbox"/> 251–500	<input type="checkbox"/> \$3,500,001–\$5 million
<input type="checkbox"/> 501–750	<input type="checkbox"/> \$5,000,001–\$10 million
<input type="checkbox"/> 751–1,000	<input type="checkbox"/> \$10,000,001–\$17 million
<input type="checkbox"/> Over 1,000	<input type="checkbox"/> Over \$17 million

- (10) *HUBZone small business concern.* ESSA represents, as part of this offer, that—
 - (i) It **is not** a HUBZone small business concern listed, on the date of this representation, on the List of Qualified HUBZone Small Business Concerns maintained by the Small Business Administration, and no material change in ownership and control, principal office, or HUBZone employee percentage has occurred since it was certified by the Small Business Administration in accordance with 13 CFR Part 126; and
 - (ii) It **is not** a joint venture that complies with the requirements of 13 CFR Part 126, and the representation in paragraph (c)(10)(i) of this provision is accurate for the HUBZone small business concern or concerns that are participating in the joint venture.

Part (d): Representations required to implement provisions of Executive Order 11246

- (1) *Previous contracts and compliance.* ESSA represents that—

- (i) It **has** participated in a previous contract or subcontract subject to the Equal Opportunity clause of this solicitation, but as a Canadian company ESSA is not subject to this clause; and
- (ii) It **has not** filed all required compliance reports. As a Canadian company, ESSA Technologies is not required to do so.

(2) *Affirmative Action Compliance.* ESSA represents that—

- (i) It **has not** developed and does not have on file, at each establishment, affirmative action programs required by rules and regulations of the Secretary of Labor (41 cfr parts 60-1 and 60-2), and as **Canadian company, ESSA Technologies is not required to do so.**
- (ii) It **has not** previously had contracts subject to the written affirmative action programs requirement of the rules and regulations of the Secretary of Labor.

Part (e): Certification Regarding Payments to Influence Federal Transactions: By submission of this offer, **ESSA certifies to the best of its knowledge and belief that no Federal appropriated funds have been paid or will be paid to any person for influencing or attempting to influence an officer or employee of any agency, a Member of Congress, an officer or employee of Congress or an employee of a Member of Congress on his or her behalf in connection with the award of any resultant contract.**

Part (h): Certification Regarding Responsibility Matters (Executive Order 12689). ESSA certifies, to the best of its knowledge and belief, that ESSA and/or any of its principals—

- (1) **Are not** presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency;
- (2) **Have not**, within a three-year period preceding this offer, been convicted of or had a civil judgment rendered against them for: commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a Federal, state or local government contract or subcontract; violation of Federal or state antitrust statutes relating to the submission of offers; or commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, tax evasion, violating Federal criminal tax laws, or receiving stolen property;
- (3) **Are not** presently indicted for, or otherwise criminally or civilly charged by a Government entity with, commission of any of these offenses enumerated in paragraph (h)(2) of this clause; and
- (4) **Have not**, within a three-year period preceding this offer, been notified of any delinquent Federal taxes in an amount that exceeds \$3,000 for which the liability remains unsatisfied.

Part (j): Place of manufacture. The place of manufacture of the end products we expect to provide in response to this solicitation is predominantly—

- (1) **In the United States ✓**
- (2) Outside the United States.

Part (k) *Certificates regarding exemptions from the application of the Service Contract Act.* [The contracting officer is to check a box to indicate if paragraph (k)(1) or (k)(2) applies.]

[] (2) Certain services as described in FAR 22.1003-4(d)(1). ESSA **does** certify that—

- (i) The services under the contract are offered and sold regularly to non-Governmental customers, and are provided by the offeror (or subcontractor in the case of an exempt subcontract) to the general public in substantial quantities in the course of normal business operations;
- (ii) The contract services will be furnished at prices that are, or are based on, established catalog or market prices (see FAR 22.1003-4(d)(2)(iii));
- (iii) Each service employee who will perform the services under the contract will spend only a small portion of his or her time (a monthly average of less than 20 percent of the available

hours on an annualized basis, calculated based on the calendar year), or less than 20 percent of available hours during the contract period if the contract period is less than a month) servicing the Government contract; and

(iv) The compensation (wage and fringe benefits) plan for all service employees performing work under the contract is the same as that used for these employees and equivalent employees servicing commercial customers.

(3) If paragraph (k)(1) or (k)(2) of this clause applies—

(i) If the offeror does not certify to the conditions in paragraph (k)(1) or (k)(2) and the Contracting Officer did not attach a Service Contract Act wage determination to the solicitation, the offeror shall notify the Contracting Officer as soon as possible; and

(ii) The Contracting Officer may not make an award to the offeror if the offeror fails to execute the certification in paragraph (k)(1) or (k)(2) of this clause or to contact the Contracting Officer as required in paragraph (k)(3)(i) of this clause.

Part (l): Taxpayer Identification Number (TIN) (26 U.S.C. 6109, 31 U.S.C. 7701).

(3) *Taxpayer Identification Number (TIN).*

Offeror is a nonresident alien, foreign corporation, or foreign partnership that does not have income effectively connected with the conduct of a trade or business in the United States and does not have an office or place of business or a fiscal paying agent in the United States; ESSA Technologies is a Canadian corporation, which pays tax in Canada. ESSA does however have a TIN listed on CCR: 98-0613363

(4) *Type of organization.*

- o Sole proprietorship;
- o Partnership;
- o Corporate entity (not tax-exempt);
- o **Corporate entity (tax-exempt); ✓**
- o Government entity (Federal, State, or local);
- o Foreign government;
- o International organization per 26 CFR 1.6049-4;
- o Other _____.

(5) *Common parent.*

- o Offeror is not owned or controlled by a common parent;

o **Name and TIN of common parent: ✓**

Name ESSA Nueva Holdings Ltd.

TIN n.a.

Part (m): Restricted business operations in Sudan. By submission of its offer, **ESSA certifies that it does not conduct any restricted business operations in Sudan.**

Part (n): Prohibition on Contracting with Inverted Domestic Corporations.

(2) *Representation.* By submission of its offer, the offeror represents that it is **not** an inverted domestic corporation and is not a subsidiary of one.

Appendix 6: CVs

David R. Marmorek

President, ESSA Technologies Ltd.

Suite 300, 1765 W. 8th Avenue, Vancouver, BC V6J 5C6

Ph. (604) 733-2996 Fax (604) 733-4657 email dmarmorek@essa.com

Birthdate: December 6, 1952

Citizenship: Canadian

Post-Secondary Education

- **Leadership Laboratory**, University of British Columbia, Vancouver, BC, 1989
- **M.Sc. Zoology**, University of British Columbia, 1983. Thesis topic: Effects of lake acidification on zooplankton community structure and phytoplankton-zooplankton interactions: an experimental approach. 397 pp. Course work included advanced ecology, population dynamics, limnology, oceanography, adaptive management, multivariate statistics, and fish biology.
- **B.E.S. (Honors), Man-Environment Studies and Mathematics**, First class honours, University of Waterloo, 1975. Course work included physics, chemistry, ecology, psychology, environmental impact assessment, computer science, probability and statistics, calculus, and simulation modelling.

Awards

- Environmental Protection Agency - Bronze Medal for Commendable Service, 1987.
- University of British Columbia Graduate Scholarship, 1980.
- Natural Science & Engineering Research Council - Post-Graduate Scholarship, 1979.
- Rene Descartes Mathematics Bursary, University of Waterloo.
- Ontario Scholarship, York Mills Collegiate, Toronto.

Research Interests

- melding my group leadership and facilitation skills with my knowledge of scientific methods (aquatic ecology, data analysis, modelling, experimental design, monitoring, adaptive management, decision analysis)

Professional Experience

2002 – now **President**, ESSA Technologies Ltd.

1993 - 2002 **Director**, ESSA Technologies Ltd.

1991 - now **Adjunct Professor**, School of Resource and Environment Management, Simon Fraser University.

1983 - 1993 **Director**, ESSA Environmental and Social Systems Analysts Ltd.

1981 - 1983 **Systems Ecologist**, ESSA Environmental and Social Systems Analysts Ltd.

Adaptive Management of Aquatic and Terrestrial Ecosystems

- leading the development of an adaptive management plan for Dry Creek, Santa Rosa CA, to restore habitat for listed coho and steelhead populations (ongoing)
- led an ESSA team and 25 scientists in the Trinity River Restoration Program to develop conceptual models, restoration objectives, sampling designs, and monitoring methods, all organized into an adaptive management plan called the Integrated Assessment Plan (ongoing)

- Chair of the Independent Science Advisory Committee (ISAC) for the Platte River Recovery Implementation Program, and the ISAC's expert on adaptive management and decision analysis (ongoing)
- member of the Strategic Science Peer Review Panel (SSPRP) for the Puget Sound Nearshore Ecosystem Restoration Project, serving as the Panel's expert on adaptive management (ongoing)
- member of an expert review panel to review two drafts of a guide to implementing adaptive management in the Central Everglades Restoration Program (for the U.S. Army Corps of Engineers)
- led a 5-year, \$5 million (U.S.) multi-agency project (CSMEP) to improve adaptive management in the Columbia Basin, developing consistent, reliable methods of monitoring and evaluating the status of fish populations and their habitats, including responses to hydro, habitat, hatchery and harvest actions
- led a major study in the Columbia Basin to retrospectively evaluate the effects of habitat restoration actions on fish population survival rates, which recommended a stronger approach to regional restoration design, monitoring and evaluation, applying adaptive management principles
- led the development of a decision analysis model of alternative operations and adaptive management plans for maintaining both mountain whitefish populations and power production at BC Hydro's Keenleyside Dam on the Canadian Columbia River
- led an interagency group of 25 fisheries scientists, policy advisors and peer reviewers in a 6-year program to evaluate alternative recovery measures for endangered Columbia River salmon stocks (PATH: Plan for Analyzing and Testing Hypotheses), including adaptive management experiments
- led the completion of a workshop-based, multi-authored interdisciplinary study to evaluate the evidence for delayed mortality in salmon populations as a result of passage through dams on the Columbia River, as part of the adaptive management of the Columbia River hydrosystem
- lead facilitator and project manager for two projects on the Okanagan River (Canadian Columbia Basin): the successful re-introduction of sockeye into Skaha Lake (an adaptive management experiment prior to their potential re-introduction into Okanagan Lake), and the development of a model for adaptive in-season management of water releases from Okanagan Lake
- lead facilitator for research, adaptive management, monitoring and modelling activities to restore salmonid populations in Kennedy Lake, BC, working with native bands, fisheries agencies, logging companies, and local community groups
- facilitated the multi-agency development of conceptual and computer models to assess the impacts of forest operations in Northern Ontario on fish and wildlife populations, which led to the design and implementation of several innovative adaptive management experiments
- led the public-private-academic development of an integrated watershed simulation model for British Columbia's Fish Forestry Interaction Program (FFIP) to understand stream channel dynamics and guide timber management decisions within an adaptive management framework
- led a multi-agency effort to determine the best methods to assess the relative sensitivity of watersheds and streams to forest activities across the province of British Columbia
- facilitated workshops and gave presentations on how to better incorporate adaptive management into: BC's Watershed Restoration Program, BC's Landscape Unit Planning process, the management of Okanagan River sockeye, watershed restoration near Mexico City, and salmon conservation in the Pacific Northwest
- contributed to the development of a training course in Adaptive Management for the BC Forest Service, and delivered adaptations of the course in Washington, California and Mexico
- facilitated scientific and stakeholder committees in a 3-year decision analysis of operating alternatives for a BC Hydro dam on the Cheakamus River, BC, including adaptive management alternatives.
- led the development of a decision analysis modelling tool to assist with the design of restoration and adaptive management strategies for salmonids and fluvial ecosystems in Clear Creek, CA
- facilitated the development of a detailed conceptual framework to guide restoration planning and adaptive management strategies for the San Joaquin River, CA

- designed or built simulation models of to assist with the adaptive management of salmon harvest on the South Coast of BC (including biological and economic indicators), livestock grazing in Nevada (including vegetative and aquatic impacts), and lake trout in Ontario.

Environmental Impact Assessment, Research and Monitoring

- used maximum likelihood estimation models and decision analysis to assess the impacts of power plant water withdrawals on Hudson River fish species (for the New York Dept. of Environmental Conservation)
- led a population modelling team in a comprehensive evaluation of impacts on Delaware River fish populations of cooling water withdrawal operations at the Salem Nuclear Generating Station (for the New Jersey Department of Environmental Protection)
- developed a framework for guiding impact evaluation and research/monitoring of fisheries impacts of BC Hydro facilities on the Columbia and Peace rivers
- played major roles in the overall management and environmental monitoring component of CIDA's 15-year, \$35-million project to build Vietnam's capacity to manage industrial and urban pollution (VCEP and VPEG)
- developed a detailed 4-year monitoring plan for the Fraser River Basin Assessment Program, assessing contaminants, point and non-point sources and overall ecological condition.
- co-ordinated a large team of government and ESSA scientists and led the writing of the first BC State of Environment report, of which over 15,000 copies have been published (and another 40,000 planned)
- led a team of 7 ESSA scientists in the facilitation and synthesis of a large workshop on ecosystem goals and objectives, attended by over 100 government environmental managers
- worked with scientists and native groups to develop monitoring plans to assess the impacts of oil and gas development on the Beaufort Sea (1982-84), and to develop an ecosystem modeling strategy (2009)
- developed monitoring strategies for groundwater contamination, toxic chemicals in the Great Lakes Connecting Channels, pulp mills on the western coast of Canada
- major author of a strategy to guide the development and selection of ecological indicators for the U.S. EPA Environmental Monitoring and Assessment Program (EMAP), and an approach to the development of data quality objectives
- built simulation models for the development of adaptive management approaches to deal with the impacts of gypsy moth in eastern forests, drilling muds in coastal ecosystems, and cottage development in Ontario
- led a project which used modelling workshops to develop research priorities for understanding the fate and effects of pulp mill effluents in the Fraser River system
- project manager and major contributor to a study which assessed the pre-development environmental impact predictions for eleven Canadian hydroelectric reservoirs
- conducted a field, laboratory, and empirical modelling study of mercury contamination of fish in hydroelectric reservoirs

Acidic Deposition

- designed and implemented the receptor monitoring and modelling program for an acid deposition study in Northern Thailand
- principal or primary author of state-of-science reports on models for projecting water chemistry conditions, acidic episodes in surface waters, effects of snowmelt episodes, role of organic acids in acid lakes, target loadings for western Canada, effects of acidic deposition on dissolved organic carbon, use of zooplankton for biomonitoring
- directed the development of a regional model to assess the effects of acidification and fishery management actions on Atlantic salmon in Nova Scotia rivers, and a linked chemical model to simulate alternative deposition scenarios (for Fisheries and Oceans Canada)

- major contributor to the 1990 NAPAP Integrated Assessment. Responsibilities included critical analysis and synthesis of studies of impacts of acid deposition on aquatic systems, simulation modelling, and co-ordination of a team of 15 scientists and modellers
- facilitated workshops, designed and wrote research plans, and defended those plans at peer review meetings for the EPA National Surface Water Survey, Direct/Delayed Response Project, Watershed Manipulation Project, and the Episodic Response Project (over \$50 million in research activities)
- developed and published a protocol to determine lake acidification pathways
- worked with a team of EPA scientists to apply the critical load concept to establishing pollutant loading standards
- primary author of a study of the applicability of the target loading concept to Western Canada
- served as modeller, facilitator and data analyst for a series of projects which resulted in the development of a regional model of aquatic effects of acidic deposition with a focus on fisheries and six other classes of aquatic biota
- coordinated and contributed to a review of the effects of acidic snowmelt episodes on scientists studying this topic, and a workshop to develop new research initiatives
- contributed to a review of the relative importance of internal (catchment-derived) and external (atmospherically-derived) sources of acidity.

1979 - 1980 **Consultant**, facilitating AEAM workshops.

- facilitated workshops on the effects of logging on salmon habitat, and effects of oil spills on crab populations in the Bering Sea.

1975 - 1978 **Applied Ecologist/Urban Planner**, Proctor and Redfern Ltd.

1975 **Researcher**, Metropolitan Toronto Hospital Planning Council.

1974 **Researcher**, Regional Municipality of Waterloo Planning Department.

1973 **Computer Analyst**, Minerals Research Branch, Ontario Ministry of Natural Resources.

1971 - 1972 **Computer Programmer**, University of Waterloo Computing Center.

Refereed Journal Articles and Book Chapters

Alexander, C.A.D., C.N. Peters, D.R. Marmorek and P. Higgins. 2006. A decision analysis of flow management experiments for Columbia River mountain whitefish management. *Can. J. Fish. Aquat. Sci.* 63: 1142-1156.

C. Murray and D.R. Marmorek. 2003. Adaptive Management and Ecological Restoration. *In Ecological Restoration of Southwestern Ponderosa Pine Forests*. P. Friederici, ed. Ecological Restoration Institute, Flagstaff, AZ. p. 417-428.

Marmorek, David R. and Calvin Peters. 2001. Finding a PATH towards scientific collaboration: insights from the Columbia River Basin. *Conservation Ecology* 5(2): 8. [online] URL: <http://www.consecol.org/vol5/iss2/art8>

Deriso, R.B., Marmorek, D.R., and Parnell, I.J. 2001. Retrospective Patterns of Differential Mortality and Common Year Effects Experienced by Spring Chinook of the Columbia River. *Can. J. Fish. Aquat. Sci.* 58(12) 2419-2430

Peters, C.N. and Marmorek, D.R. 2001. Application of decision analysis to evaluate recovery actions for threatened Snake River spring and summer chinook salmon (*Oncorhynchus tshawytscha*). *Can. J. Fish. Aquat. Sci.* 58(12):2431-2446.

Peters, C.N., Marmorek, D.R., and Deriso, R.B. 2001. Application of decision analysis to evaluate recovery actions for threatened Snake River fall chinook salmon (*Oncorhynchus tshawytscha*). *Can. J. Fish. Aquat. Sci.* 58(12):2447-2458.

Marmorek, D.R., G. Lacroix, J. Korman, I. Parnell, and W.D. Watt. 1998. Modelling the effects of acidification on Atlantic salmon: a simple model of stream chemistry. *Can. J. Fish. Aquat. Sci.* 55(9): 2117-2126.

- Marmorek, D.R., R.M. MacQueen, C.H.R. Wedeles, J. Korman, P.J. Blancher, and D.K. McNicol.** 1996. Improving pH and alkalinity estimates for regional scale acidification models: incorporation of dissolved organic carbon. *Can. J. Fish. Aquat. Sci.* 53: 1602-1608.
- Korman, J., D.R. Marmorek, G. Lacroix, P.G. Amiro, J.A. Ritter, W.D. Watt, R.E. Cutting, D.C.E. Robinson.** 1994. Development and evaluation of a biological model to assess regional scale effects of acidification on Atlantic salmon. *Can. J. Fish. Aquat. Sci.* 51:662-680.
- Marmorek, D.R. and J. Korman.** 1993. The use of zooplankton in a biomonitoring program to detect lake acidification and recovery. *Water, Air, and Soil Pollution* 69: 223-241.
- Marmorek, D.R., J. Korman, M.L. Jones, R.M. Macqueen, C.K. Minns, B.W. Kilgour, and K.J. Heltcher.** 1992. Assessing the potential extent of damage to inland lakes in eastern Canada due to acidic deposition. V. Validation tests of a simple regional scale model of lake acidification. To be submitted to *Can. J. Fish. Aquat. Sci.*
- Sullivan, T.J., R.S. Turner, D.F. Charles, B.F. Cumming, J.P. Smol, C.L. Schofield, C.T. Driscoll, B.J. Cosby, H.J.B. Birks, A.J. Uutala, J.C. Kingston, S.S. Dixit, J.A. Bernert, P.F. Ryan, and D.R. Marmorek.** 1992. Use of historical assessment for evaluation of process-based model projections of future environmental change: lake acidification in the Adirondack Mountains, New York, U.S.A. *Environ. Pollut.* 77: 253-262.
- Turner, R.S., P.F. Ryan, D.R. Marmorek, K.W. Thornton, T.J. Sullivan, J.P. Baker, S.W. Christensen, and M.J. Sale.** 1992. Sensitivity to change for low-ANC eastern U.S. lakes and streams and brook trout populations under alternative sulfate deposition scenarios. *Environ. Pollut.* 77: 269-277.
- Holdren, G., J. Cosby, D. Marmorek, R. Santore, C. Hunsaker, D. Bernard, J. Aber, C. Driscoll, and R. Turner.** 1992. A national critical loads framework for establishing pollutant loading standards: IV. Model selection, application, and critical loads mapping. *Environmental Management*. Volume 17:
- Jones, M.L., C.K. Minns, D.R. Marmorek, and K.J. Heltcher.** 1991. Assessing the potential extent of damage to inland lakes in eastern Canada due to acidic deposition. IV. Uncertainty analysis of a regional model. *Can. J. Fish. Aquat.* 48(4): 599-606.
- Baker, J.P., D.P. Bernard, S.W. Christensen, M.J. Sale, J. Freda, K.J. Heltcher, D.R. Marmorek, L. Rowe, P.F. Scanlon, G.W. Suter II, W.J. Warren-Hicks, and P.M. Welbourn.** 1990. NAPAP Report 13: Biological Effects of Changes in Surface Water Acid-base Chemistry. 392 pp. and appendices.
- Jones, M.L., C.K. Minns, D.R. Marmorek, and F.C. Elder.** 1990. Assessing the potential extent of damage to inland lakes in eastern Canada due to acidic deposition. II. Application of the regional model. *Can. J. Fish. Aquat. Sci.* 47: 67-80.
- Marmorek, D.R. and D.P. Bernard.** 1990. Response to K.C. Krug and W.L. Warnick's comments on: A protocol for determining lake acidification pathways. *Wat. Air and Soil Poll.* 50: 209-213.
- Marmorek, D.R., M.L. Jones, C.K. Minns, and F.C. Elder.** 1990. Assessing the potential extent of damage to inland lakes in eastern Canada due to acidic deposition. I. Development and evaluation of a simple "site" model. *Can. J. Fish. Aquat. Sci.* 47: 55-66.
- Thornton, K., D. Marmorek, P. Ryan, K. Heltcher, and D. Robinson.** 1990. Methods for projecting future changes in surface water acid-base chemistry. State-of Science/Technology Report 14. Prepared for National Acid Precipitation Assessment Program. 271 pp.
- Marmorek, D.R., D.P. Bernard, C.H.R. Wedeles, G.D. Sutherland, J.A. Malanchuk, and W.E. Fallon.** 1989. A protocol for determining lake acidification pathways. *Wat. Air and Soil Poll.* 44: 235-257.
- Marmorek, D.R., M.L. Jones, C.K. Minns, and F.C. Elder.** 1989. Assessing the potential extent of damage to inland fisheries in eastern Canada due to acidic deposition: I. development and evaluation of a simple "site" model. *Can. J. Fish. Aq. Sci* 47(1): 55-66.
- Marmorek, D.R.** 1984. Changes in the Temporal Behavior and Size Structure of Plankton Systems in Acid Lakes. In: *Early Biotic Responses to Advancing Lake Acidification*. G.R. Hendrey (ed.), Butterworth Publishers, pp. 23-41.
- Marmorek, D.R.** 1983. Effects of Lake Acidification on Zooplankton Community Structure and Phytoplankton-Zooplankton Interactions: An Experimental Approach. M.Sc. Thesis, University of British Columbia, 397 pp.

Refereed Technical Reports and Conference Proceedings

- Marmorek, D., I. Parnell, T. Webb, M. ZGraggen, W. Kurz, and J. Korman.** 1998. The Fish/Forestry Interaction Program Simulation Model (FFIPS). In: D.L. Hogan, P.J. Tschaplinski, and S. Chatwin (eds.). *Carnation Creek and Queen*

Charlotte Islands Fish/Forestry Workshop: Applying 20 Years of Coast Research to Management Solutions BC Ministry of Forests, Research Branch, Victoria, BC. Land Management Handbook No. 41. pp. 231-243.

Baker L.A., J.P. Baker, A.T. Herlihy, P.R. Kaufmann, D.H. Landers, D.R. Marmorek, M.J. Sale, T.J. Sullivan, K.W. Thornton, and P.J. Wiggington. 1990. NAPAP Integrated Assessment. Question 1 - Aquatic Effects of Concern and the Relationship between Acidic Deposition and Aquatic Effects. 57 pp.

Knapp, C.M., D.R. Marmorek, J.P. Baker, K.W. Thornton, J.M. Klopatek, and C.P. Charles. 1990. The indicator development strategy for the environmental monitoring and assessment program. U.S. Environmental Protection Agency. 78 pp.

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Turner R.S., P.F. Ryan, J.P. Baker, S.W. Christensen, D.R. Marmorek, M.J. Sale, T.J. Sullivan, and K.W. Thornton. 1990. NAPAP Integrated Assessment. Question 3 - Sensitivity of Aquatic Effects to Changes in Future Acidic Deposition. 75 pp.

Bernard, D.P., D.B. Hunsaker Jr., and D.R. Marmorek. 1989. Tools for improving predictive capabilities of environmental impact assessments: structured hypotheses, audits, and monitoring. In: The Scientific Challenges of NEPA: future directions based on 20 years of experience. (Eds: S. Hildebrand and J.B. Cannon). Based on the Ninth Oak Ridge National Laboratory, Life Sciences Symposium, Knoxville, TN, October 24-27, 1989. Lewis Publishers. Ann Arbor. pp. 547-564.

Cook, R.B., M.L. Jones, D.R. Marmorek, J.W. Elwood, J.L. Malanchuk, R.S. Turner, J.P. Smol. 1988. The effects of Acidic Deposition on Aquatic Resources in Canada: An Analysis of Past, Present and Future Effects. Oak Ridge National Laboratories. Environmental Sciences Division Publication No. 2894.

Marmorek, D.R., D.P. Bernard, and J. Ford. 1988. Biological Monitoring For Acidification Effects: U.S.-Canadian Workshop. Final report from the Burlington Workshop prepared for U.S. Environmental Protection Agency, Environmental Research Laboratory, 66 pp.

Marmorek, D.R., D.P. Bernard, M.L. Jones, L.P. Rattie, and T.J. Sullivan. 1988. The Effects of Mineral Acid Deposition on Concentrations of Dissolved Organic Acids in Surface Waters. Report prepared for U.S. Environmental Protection Agency, Environmental Research Laboratory, 110 pp.

Thornton, K., J.P. Baker, D.R. Marmorek, D.P. Bernard, M.L. Jones, P.J. McNamee, C.H.R. Wedeles, and K.N. Eshleman. 1988. Episodic Response Project: Research Plan. Prepared for U.S. Environmental Protection Agency.

Marmorek, D.R., D.P. Bernard, M.L. Jones, C.S. Davis, N.W. Reid, A.R. Fradkin, and R. Caton. 1987. Interim Target Loadings for Acidic Deposition in Western Canada: A Synthesis of Existing Information. Technical Committee for the Long-Range Transport of Atmospheric Pollutants in Western and Northern Canada. Victoria, British Columbia, 214 pp. and appendices.

Marmorek, D.R., D.P. Bernard, M.L. Jones, L.P. Rattie, and T.J. Sullivan. 1987. The Effects of Mineral Acid Deposition on Concentrations of Dissolved Organic Acids in Surface Waters. Final report prepared for U.S. Environmental Protection Agency, 110 pp.

Jones, M.L., D.R. Marmorek, B.S. Reuber, P.J. McNamee, and L.P. Rattie. 1986. "Brown Waters": Relative Importance of External and Internal Sources of Acidification on Catchment Biota — Review of Existing Knowledge. Report prepared for Environment Canada and Department of Fisheries and Oceans, 85 pp.

Marmorek, D.R., K.W. Thornton, J.P. Baker, D.P. Bernard, and B. Reuber. 1986. Acidic episodes in surface waters: the state of science. Final report for the U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon. 232 pp.

Thornton, K.W., D.R. Marmorek, D.P. Bernard, P. Shaffer, D. McKenzie, and J. Malanchuk. 1986. Watershed Manipulation Project: Research Plan. Final report for the U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Oregon.

Turner, R.S. J.L. Malanchuk, R.J. Olson, and D.R. Marmorek (eds.). 1986. The Effects of Acidic Deposition on Aquatic Systems: 1985 Assessment. Report prepared for Environmental Protection Agency, 161 pp.

Church, R. D.R. Marmorek, K.W. Thornton, M.L. Jones, J. Malanchuk, P. Shaefer, B. Rochelle. 1985. Direct/Delayed Response Project. Long Term Response of Surface Waters to Acidic Deposition: Factors Affecting Response and a Plan for Classifying Response Characteristics on Regional Scales. Part B. Implementation Plan. Report prepared for Corvallis Environmental Research Laboratory, Environmental Protection Agency.

Marmorek, D.R., G.L. Cunningham, M.L. Jones, and P. Bunnell. 1984. Snowmelt Effects Related to Acidic Precipitation: A Structured Review of Existing Knowledge and Current Research Activities. Report prepared for Environment Canada and Department of Fisheries and Oceans, 80 pp.

Andrews, A.K., G.T. Auble, R.A. Ellison, D.B. Hamilton, J.E. Roelle, D.R. Marmorek, and O.L. Loucks. 1981. Impacts of Acid Precipitation on Watershed Ecosystems: An Application of the Adaptive Environmental Assessment Process. In: W.J. Mitsch, R.W. Bosserman, and J.M. Klopatek (eds.), *Energy and Ecological Modelling*, Elsevier Scientific Publishing Company, pp. 393-400.

Recent Conference Presentations

- Adaptive Environmental Assessment and Management in the Trinity River Restoration Program: Progress, Challenges and Opportunities (Trinity Science Symposium, Weaverville CA Jan 2010; Klamath River Basin Science Conference, Medford OR Feb 2010)
- Manejo adaptivo (gestion adaptativa) y salmon en la Canada y Los Estados Unidos (Adaptive management for salmon in Canada and the United States), invited presentation at *New developments in the management of coastal fisheries in Canada and Spain: from participatory management to adaptive management*. Santiago de Compostela, Spain (Feb 2009)
- The Sacramento Ecological Flows Tool (SacEFT): Ecological modeling to support river management decisions that meet multiple objectives (CALFED Science Conference, Sacramento CA, October 2008)
- Using hydro-ecological models to design resilient policies: principles and examples, including the Sacramento River Ecological Flows Tool (SacEFT) (CALFED Science Board, Sacramento CA, May 2008)
- Integration – the *holy grail* of Columbia Basin monitoring and evaluation: Challenges, examples and lessons learned from the Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) – (AFS Portland OR, May 2008)
- True vs. Pretend Adaptive Management (2nd National Conference on Ecosystem Restoration, Kansas City, MO, April 2007)
- Enabling Adaptive Forest Management (AWRA, Missoula MT, June 2006)
- The Collaborative Systemwide Monitoring and Evaluation Project – CSMEP (AFS Anchorage AK, September 2005)
- Implementing Adaptive Management for Salmon Recovery at a Regional Scale: Insights from the Columbia Basin (Invited Presentation at: *Navigating the Course to Puget Sound Salmon Recovery*, Seattle WA, February 2005)
- Guidance in Applying Quantitative Tools to Adaptive Management Decisions (AAAS, Washington DC, February 2005)
- A Multiple Watershed Approach to Assessing the Effects of Habitat Restoration Actions on Fish Populations (AFS Skamania WA, November 2004)
- Adaptive Management: Theory and Practice (Invited Presentation at *Real World Experiments*, Bielefeld, Germany; September 2004)
- The Okanagan Fish-Water Management (OKFWM) Tool: Balancing Water Objectives in Real-Time for Sockeye Smolt Production Gains (AFS Vancouver BC April 2003; AFS Skamania November 2004, AFS Victoria BC October 2005; AWRA Missoula MT, June 2006 – a sequence of updated presentations with new findings)
- Challenges and Opportunities in Testing the Effectiveness of Habitat Restoration Actions (AFS Eugene OR, Feb 2003)
- Strengths and Weaknesses of the Endangered Species Act (ESA): Some Insights from the Columbia Basin (Vancouver Salmon Summit, BC; June 2003)
- Moving at Glacial Speed toward Adaptive Management in the Columbia River (AFS Spokane WA, April 2002)
- Methods of Testing Models Used for Major Decisions (AFS Spokane WA, April 2002)
- A Decision Analysis of Adaptive Management Experiments for Whitefish Management in the Columbia River: Is it Worth Varying Flows to Reduce Key Uncertainties? (AFS Spokane WA, April 2002)

Other Recent Publications

Trinity River Restoration Program, ESSA Technologies Ltd. 2009. Integrated Assessment Plan, Version 1.0 – September 2009. Final report prepared for the Trinity River Restoration Program, Weaverville, CA. 285 pp.

- Pickard, D., M. Porter, K. Wieckowski, and D. Marmorek.** 2009. Workplan to Pilot the Fisheries Sensitive Watershed (FSW) Monitoring Framework. Report prepared by ESSA Technologies Ltd., Vancouver, BC. for BC. Ministry of Environment, Victoria. 16 pp.
- ISAC (Independent Science Advisory Committee).** 2009. 2009 Report on the Platte River Recovery Implementation Program. Prepared for the PRRIP Governance Committee. 38 pp.
- Collaborative Systemwide Monitoring and Evaluation Project (CSMEP) - Marmorek, D.R., M. Porter, D. Pickard and K. Wieckowski (eds.).** 2007. Snake River Basin Pilot Study: Volumes 1 and 2. for Columbia Basin Fish and Wildlife Authority, Portland, OR. 47 pp (Volume 1) and 216 pp (Volume 2).
- Greig, L., D.R. Marmorek, C. Murray and D. Robinson.** 2006. Enabling Adaptive Forest Management. *Manuscript in preparation for J. Forestry.*
- Marmorek, D.R., D. Robinson, C. Murray and L. Greig.** 2006. Enabling Adaptive Forest Management – Final Report. Prepared for the National Commission on Science for Sustainable Forestry by ESSA Technologies Ltd., Vancouver, B.C. 94 pp.
- Nelitz, M., C. Murray, M. Porter, and D.R. Marmorek.** 2006. Managing Pacific salmon for ecosystem values: Ecosystem indicators and the wild salmon policy. Final Report prepared by ESSA Technologies Ltd., Vancouver, B.C. for Pacific Fisheries Resource Conservation Council, Vancouver, BC. 76 pp.
- Porter M. and D.R. Marmorek.** 2006. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 5 (January 3-4, 2006) – USFWS Regional Office, 911 NE 11th Ave., Portland, Oregon - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 98 pp.
- Marmorek D.R., I. Parnell and M. Porter, eds.** 2005. CSMEP DQO Status & Trends, Habitat, Harvest, Hatchery and Hydrosystem Assessments - Policy Interpretations (Snake River Pilot) Prepared by ESSA Technologies Ltd., Vancouver, B.C. for CSMEP Monitoring Design Workshop, Napa, ID. 125 pp.
- Porter M. and D.R. Marmorek.** 2005. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 4 (June 27-28, 2005) – USFWS Regional Office, 911 NE 11th Ave., Portland, Oregon - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 100 pp.
- Porter, M. and D.R. Marmorek.** 2005. Bull Trout Recovery Monitoring and Evaluation Technical Working Group (RMEG) Workshop 3 (Dec. 16 - 17, 2004) – USFS Regional Office, 333 SW First Ave., Portland, Oregon - Workshop Report. Report prepared by ESSA Technologies Ltd., Vancouver, BC for the US Fish and Wildlife Service, Vancouver, WA. 113 pp.
- Marmorek, D.R., I.J. Parnell, M. Porter, C. Pinkham, C.A.D. Alexander, C.N. Peters, J. Hubble, C.M. Paulsen and T.R. Fisher.** 2004. A multiple watershed approach to assessing the effects of habitat restoration actions on anadromous and resident fish populations. Prepared by ESSA Technologies Ltd., Vancouver, B.C. for Bonneville Power Administration, Portland, OR. 420 pp.
- Parnell I.J., D.R. Marmorek, B. Lister and J. Korman.** 2003. Cheakamus Water Use Plan: Quantitative evaluation of the statistical and cost performance of alternative salmonid monitoring design options. Final report prepared by ESSA Technologies Ltd., Vancouver, BC. for BC Hydro, Burnaby, BC. 81 pp.
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- ESSA Technologies Ltd.** 2003. Phase 1: User Needs Assessment and Design Recommendations. Development of an Aquatic and Terrestrial/Riparian Data Management System. Functional Requirements. Volume 1. March 14, 2003. Prepared by ESSA Technologies Ltd., Vancouver, B.C. for B.C. Hydro, Burnaby, B.C. 32 pp.

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- Alexander, C.A.D., D.R. Marmorek, and C.N. Peters.** 2000. Applying decision analyses to whitefish management in the Columbia River: Is it worth varying flows to reduce key uncertainties? Model description and preliminary results. Prepared by ESSA Technologies Ltd., Vancouver, BC for BC Hydro, Burnaby, BC. 52 pp. and appendices.
- Alexander, C.A.D., D.R. Marmorek, and C.N. Peters.** 2000. Clear Creek Decision Analysis and Adaptive Management Model: Results of a model design workshop held January 24th - 26th, 2000. Draft report prepared by ESSA Technologies Ltd., Vancouver, BC for CALFED Bay-Delta Program, 1416 Ninth Street, 1155 Sacramento, CA 95814, 96 pp. and appendices.
- Marmorek, D.R. and I. Parnell.** 2000. Summary of progress on Cheakamus River Impact Hypotheses. Fisheries Technical Committee. Draft report prepared by ESSA Technologies Ltd., Vancouver, BC for BC Hydro, Vancouver, BC. 78 pp.
- Parnell, I. and D.R. Marmorek (compl).** 2000. Technical Reports: 1) American Shad; 2) Atlantic Tomcod; 3) Bay Anchovy; and 4) Striped Bass. Discussion draft prepared by ESSA Technologies Ltd., Richmond Hill, ON, for NYSDEC, Albany, NY.
- Peters, C.N. and D. Marmorek (compls./eds.).** 2000. PATH Preliminary evaluation of the learning opportunities and biological consequences of monitoring and experimental management actions. Prepared by ESSA Technologies Ltd., Vancouver, BC. 154 pp.
- ESSA Technologies Ltd. and Columbia Basin Research.** 1999. Model design document for chinook model improvement and enhancement. Prepared by ESSA Technologies Ltd., Vancouver, BC and Columbia Basin Research, Seattle, WA. Prepared for Pacific Salmon Commission / Chinook Technical Committee. 48 pp. + appendices.
- Marmorek, D.R., and 19 co-authors.** 1999. PATH: Scoping of candidate research, monitoring and experimental management actions: concurrently reducing key uncertainties and recovering stocks. Working draft prepared by ESSA Technologies Ltd., Vancouver, BC. 232 pp. Available from: <http://www.efw.bpa.gov/Environment/PATH/>
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- Alexander, C.A.D., T.M. Webb, and D.R. Marmorek.** 1998. The Fish Forestry Interaction Project C Management Model (FFIP-MM): Preliminary model description and an application to Carnation Creek, British Columbia. Prepared by ESSA Technologies Ltd., Vancouver, BC and Lookfar Solutions, Tofino, BC. 50 pp.

Carol L. Murray

Senior Systems Ecologist, ESSA Technologies Ltd.

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POST SECONDARY EDUCATION

- M.Sc. Zoology/Environmental Studies, University of Toronto, Ontario, 1984 - 1987.
- B.Sc. Biology (with distinction), McGill University, Montreal, Quebec, 1981 - 1984.

PROFESSIONAL ASSOCIATION

- Registered Member in the Association of Professional Biologists of British Columbia
- Canadian Society of Environmental Biologists

SPECIAL SKILLS/EXPERIENCE

- Adaptive management planning/advice/training
- Environmental indicators/reporting/SOE
- Environmental assessment reviews
- Research/information synthesis
- Training design/development/delivery
- Needs assessments
- Meeting/workshop facilitation
- Writing/editing
- Decision support
- Project management

COUNTRIES OF WORK EXPERIENCE

Canada	Viet Nam	Thailand	Jordan	Trinidad & Tobago
United States	Malaysia	Philippines	Australia	Bangladesh

PROFESSIONAL EXPERIENCE

1988–present **ESSA Technologies Ltd.** Senior Systems Ecologist and Principal of ESSA, leading a range of projects in the environmental/resource management domain. Has managed more than 100 projects both domestically and internationally, facilitated more than 85 workshops, and written over 100 technical and non-technical reports. A brief description of selected projects is provided below.

Clients include:

- | | |
|--|--|
| ▪ CRD Parks | ▪ World Bank |
| ▪ BC Ministry of Environment | ▪ Asian Development Bank |
| ▪ BC Parks | ▪ Canadian International Development Agency |
| ▪ BC Ministry of Forests and Range (MOFR) | ▪ World University Service of Canada |
| ▪ BC Treaty Commission | ▪ Garry Oak Ecosystems Recovery Team |
| ▪ Ontario Ministry of Natural Resources | ▪ David Suzuki Foundation |
| ▪ Department of Indian and Northern Affairs | ▪ Cowichan Tribes |
| ▪ Fisheries and Oceans Canada (DFO) | ▪ Katzie First Nation |
| ▪ Environment Canada | ▪ Okanagan Nation Alliance |
| ▪ Public Works Canada | ▪ Hul'qumi'num Treaty Group |
| ▪ BC Hydro | ▪ First Nations Environmental Assessment Technical Working Group |
| ▪ U.S. Forest Service | ▪ Burrard Inlet Environmental Action Program |
| ▪ Oregon Department of Forestry | ▪ BC Invasive Plant Council |
| ▪ US National Commission on Science for Sustainable Forestry | |

1988 **PCB Inspector**, Contract with Waste Management Branch, British Columbia Ministry of Environment.

1988 **Assistant Environmental Scientist**, Hazardous Contaminants Coordination Branch, Ontario Ministry of the Environment.

1985–1986 **Independent Consultant**, Contracts with Royal Society of Canada Commission on Lead in the Environment, and City of Toronto Department of Public Health.

Selected Adaptive Management Projects (which include technical writing &/or facilitation):

Adaptive Management Training Workshops – *BC Ministry of Forests and Range, 2006-2009*

Designed, developed and delivered seven “basic” and one “advanced” training workshops on adaptive management. They are participatory and activity-based, and include case studies to ensure relevance for the intended audience.

Review of Adaptive Management Plan for a quarry – *Coalition of Concerned Citizens (Caledon ON), 2009-2010*

Reviewed the Adaptive Management Plan for a proposed rock quarry, wrote a review report, and attended hearings held by the Ontario Municipal Board on the issue to advise our clients’ lawyer on cross-examinations of expert witnesses for the proponent.

Review of Adaptive Management Plans for three diamond mines – *Fisheries and Oceans Canada, 2008-2009*

Reviewed the recent Adaptive Management Plans for the Diavik, EKATI and Snap Lake diamond mines in Canada’s North, and clarified how AM best fits into an effectiveness evaluation framework.

Adaptive Management Training Workshop – *American Fisheries Society, 2008*

Delivered a half-day training workshop on adaptive management during the final day of the AFS Annual General Meeting in Bellingham. Washington.

Review of Adaptive Management Strategy – *Hulqumi’num Treaty Group, 2006*

Reviewed an adaptive management strategy for the Deltaport Third Berth Project (port expansion) and provided recommendations for its improvement.

Adaptive Forest Management – *National Commission on Science for Sustainable Forestry, 2005-2006*

Identified key factors that hinder or enable adaptive management in the forest sector, through interviews and then a workshop with both public and private forest management organizations.

Decision Support Tool for Invasive Species Management – *Garry Oak Ecosystems Recovery Team, 2001-2002*

Designed a framework for a DST to help managers decide whether, and how, to manage invasive species in Garry oak and associated ecosystems. Also designed an adaptive management strategy for implementing the tool. In association with R. Keith Jones and Associates.

Script for Adaptive Management Tutorial – *BC Forest Service, 2001-2002*

Designed and wrote a script for a self-guided tutorial, through which users can learn and “practice” adaptive management.

Adaptive Management and the Landscape Unit Planning Process – *BC Ministry of Forests, 2001*

Facilitated a workshop of staff from the Ministry of Forests and representatives from the forestry industry to explore how the application of the Landscape Unit Planning Guide – and in particular, the design of wildlife tree patches and old growth management areas – might benefit from an adaptive management approach.

Adaptive Management and the Watershed Restoration Program – *BC Ministry of Forests, 2001*

Facilitated a workshop of managers and field staff from MOF and MELP to explore how the WRP might benefit from operating within an adaptive management framework. Key issues were explored and next steps highlighted for proceeding with this approach. Also developed a framework and terms of reference for integrating adaptive management into the Effectiveness Evaluation framework.

Pine Forest Restoration Workshop – *Northern Arizona University Ecological Restoration Institute, 2001*

Facilitated a workshop of researchers and managers to identify the key research questions that need to be addressed through adaptive management experiments to be able to better understand how restoration efforts affect ponderosa pine ecosystems and the threat of catastrophic fire.

Adaptive Management Training – B.C. Ministry of Forests, 1998-1999, 2000

Designed, developed and delivered a training course and training materials for the incorporation of Adaptive Management in forestry management activities in British Columbia, Canada.

Selected Additional Workshop Facilitation Projects (some of which included technical writing):

- **Cumulative Effects Assessment Workshop – Watershed Watch and Sto:lo Tribal Council, 2009-2010**
- **Communications and Awareness-raising Workshops in Viet Nam for Provincial Environmental Governance Project – Canadian International Development Agency (with SCN Lavalin), 2009-ongoing**
- **Annual First Nations EA Best Practices Forum – First Nations Environmental Assessment Technical Working Group, 2006, 2007, 2008, 2010**
- **Participatory Scenario Development Workshop (Bangladesh) for Climate Change Visioning – World Bank, 2009**
- **Community-Level Environmental Assessment Awareness – First Nations Environmental Assessment Technical Working Group, 2008-2009**
- **Environmental Assessment Training Workshops for Government – Canadian Environmental Assessment Agency, 2008-2009**
- **First Nations Environmental Assessment Awareness Workshops – First Nations Environmental Assessment Technical Working Group, 2004, 2005-2008**
- **Natural Resource Workshops – Hul'qumi'num Treaty Group, 2007**
- **Framework and Capacity Needs Assessment for Aquatic Ecosystems Management – Okanagan Nation Alliance and the Canadian Columbia River Inter-Tribal Fisheries Commission, 2005**
- **BC Hydro Dam Footprint Impact Workshop – Columbia Basin Fish and Wildlife Compensation Program, 2005**
- **Organizational Learning for Salmon Conservation – Olympic Natural Resources Centre, 2001-2002**
- **Consultation Workshop on Proposed Pacific Water Shrew Best Management Practices Guidelines – FORREX, 2004**
- **Workshops to Introduce the First Nations Environmental Assessment Toolkit – First Nations Environmental Assessment Technical Working Group, 2004**
- **Georgia Basin Action Plan Annual Partner's Workshop – Georgia Basin Coordination Office, 2004**
- **Design Workshops for a Non-Timber Forest Products Management Pilot – BC Ministry of Forests, 2002-2003**
- **Knowledge Engineering Workshops for Invasive Species Management Strategies – Garry Oak Ecosystems Recovery Team, 2001-2002**

Selected Additional Relevant Project Descriptions:**Reporting on the BC Conservation Framework – BC Ministry of Environment, 2009-2010**

Wrote a discussion paper on how to report on progress by the BC MOE and conservation partners towards implementation and effectiveness of the Conservation Framework.

Fish Habitat Indicators – Fisheries and Oceans Canada, 2009

Assisted with a report on suggested habitat indicators for Strategy 2 of the Wild Salmon Policy.

Traditional and Local Ecological Knowledge in Fisheries Management – Pacific Fisheries Resource Conservation Council, 2008-2009

Used case study analyses to determine how to incorporate Traditional and Local Ecological Knowledge into Pacific fisheries management.

Taking Stock of Environmental Monitoring – BC Ministry of Environment, 2007-2008

Undertook a metadata assessment of environmental monitoring and reporting initiatives/programs within the Ministry to determine how well these align with the ministry's Strategic Framework for Environmental Monitoring and Reporting.

Technical Review of a National Marine Conservation Area – Hul'qumi'num Treaty Group, 2008

Conducted a metadata assessment of the Feasibility Study work done to date towards the proposed designation of an NMCA for the Southern Strait of Georgia.

Economic Valuation of Invasive Plant Impacts – Invasive Plant Council of BC, 2007-2009

Assessing the impacts of invasive plants in BC, determining the economic value of these impacts, and then comparing alternative impacts under different management scenarios.

Status Assessment of the Wild Salmon Policy – David Suzuki Foundation, 2007

Assessed the status of the implementation of the first three strategies of the Wild Salmon Policy, and identified gaps and opportunity for filling them.

Strategic Framework for Monitoring and Reporting – BC Ministry of Environment, 2007

Assisted the Corporate Monitoring and Reporting Committee to develop a draft strategic framework for monitoring and reporting across the ministry, and undertook a scan summarizing current developments in other jurisdictions.

Environmental Indicators for Burrard Inlet – Burrard Inlet Environmental Action Program, 2006-2007

Evaluated metadata for biodiversity indicators for the Inlet, and provided recommendations for data collection and data analysis towards the preparation of the first State of Environment Report for Burrard Inlet. Subsequently led the acquisition of data and the generation of indicators for the SOE report.

Scientific Panel Review of Forest Management Models – Oregon Department of Forestry, 2006

Organized and facilitated a scientific panel review of harvest and habitat models developed to help guide forest management decisions in Oregon's state forests.

Ecosystem Indicators for the Wild Salmon Policy – Pacific Fisheries Resource Conservation Council, 2005-2006

Identified the contributions (nutrients, food chain) that spawning salmon make to riparian and terrestrial ecosystems, and identified ecosystem indicators to help verify and track these effects in watersheds where increased escapement is being considered to benefit these ecosystems.

Biodiversity Monitoring Questions Development – BC Ministry of Environment, 2005-2006

Worked with the Ecosystem Branch to help identify the priority biodiversity monitoring questions for ESD to focus on for the next 3-5 years. In association with R. Keith Jones and Associates.

The State of Aquatic Ecosystems in Selected Canadian Watersheds – Environment Canada, 2005

Drafted the first national report on the state of aquatic ecosystems in Canada's major watersheds, as part of the national indicator reporting strategy.

Conceptual Ecosystem Models and Indicators of Ecological Integrity – Parks Canada, 2005

Developed a training session on how to build Conceptual Ecosystem Models for use in guiding management and monitoring decisions specific to maintaining and measuring ecological integrity.

Biodiversity Indicators for Coast and Marine Environment Report – BC Ministry of Water, Land and Air Protection, 2005

Prepared a technical background document for indicators of biodiversity for this BC SOE report.

Canadian Biodiversity Index – Environment Canada, 2002-2005

Solicited a wide range of national input to develop a framework for a tool to help determine whether we are meeting commitments under the Canadian Biodiversity Strategy. Subsequently prepared a methodology for calculating the index, and a manual for initial proof-of-concept testing; and advised on testing of the index.

Ecological Assessment – Hul'qumi'num Treaty Group, 2004

Organized and led an assessment of the abundance and distribution of plants and animals of cultural interest to the Hul'qumi'num people, in support of negotiations for the treaty right to harvest these species.

Biodiversity Monitoring and Reporting Strategy – BC Ministry of Water, Land and Air Protection, 2002-2004

Assisted with the preparation of the draft Biodiversity Monitoring and Reporting Strategy for British Columbia, and the preparation of draft action plans for early implementation of the strategy. In association with R. Keith Jones and Associates.

First Nations Land and Resource Information Needs Assessment – BC Treaty Commission, 2001

Surveyed 43 First Nations in Stage IV of the Treaty process in British Columbia, to learn whether any impediments to completing Interim Measures Agreements and/or Agreements in Principle are related to land, marine and resource information needs.

State of the Environment Indicators – B.C. Ministry of Environment, Lands and Parks, 1996, 2000

Wrote two indicator sheets, on groundwater and water supply in the province.

Data Analysis and Environmental Reporting Course for Viet Nam - Canada Environment Project (VCEP) – Canadian International Development Agency, 1999

Designed and delivered a 5-day course on the analysis, presentation & reporting of environmental monitoring data.

State of Environment (SOE) Reporting Course – World University Service of Canada, 1998

Designed an SOE reporting course for a training-of-trainers project in Jordan. Prepared training materials and coached Jordanian trainers in course delivery. Led a 3-week study tour for them in Canada to meet SOE practitioners at the national, provincial and municipal level. Evaluated their first delivery of the course in Jordan.

State of the Banff-Bow Valley Report – Banff-Bow Valley Task Force, 1994-1995

Wrote and edited chapters of the State of the Banff-Bow Valley Report which examined the ecological impacts of past and current development pressures in the Bow Valley with Canada's Banff National Park.

British Columbia State of the Environment Report – B.C. Ministry of Environment and Environment Canada, 1993-1994

Wrote Plants and Animals and Southern Interior chapters, which required synthesizing, writing and editing massive amounts of text and data, and liaison with an advisory committee of 50 domain experts.

Selected Publicly-available Publications and Reports

- Sacramento River Watershed Program. 2010. Sacramento River Basin Report Card & Technical Report, Feather River Watershed. Available at: <http://www.sacriver.org/monitoring/reportcard.php>
- Stalberg, H.C., Lauzier, R.B., MacIsaac, E.A., Porter, M., and Murray, C. 2009. Canada's policy for conservation of wild Pacific salmon: Stream, lake, and estuarine habitat indicators. Can. Manuscr. Fish. Aquat. Sci. 2859: xiii + 135p.
- Frid, L., D. Knowler, C. Murray, J. Myers and L. Scott. 2009. Economic Impacts of Invasive Plants in BC. Prepared for the Invasive Plant Council of BC by ESSA Technologies Ltd., Vancouver, BC. 105 pp. Available at: www.invasiveplantcouncilbc.ca/images/stories/documents/reports/Report12_Econ_Impacts.pdf
- Decision support tools for invasive species management in Garry oak and associated ecosystems – specifically, a General Decision Process, and Best Practices guides for 5 plant species, available at www.goert.ca/pubs_invasive.php.
- Nelitz, M., C. Murray and K. Wieckowski. 2008. Returning Salmon: Integrated planning and the Wild Salmon Policy in B.C. Prepared for the David Suzuki Foundation, Vancouver, BC, 44 pp. Available at: www.davidsuzuki.org/Publications/returning_salmon.asp.
- Murray, C. and M. Nelitz. 2008. Review of Diavik and EKATI Adaptive Management Plans. Prepared by ESSA Technologies Ltd., Vancouver BC, for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, Yellowknife, NT. 23 pp. <http://www.monitoringagency.net/LinkClick.aspx?fileticket=5ucjCF4oG0U%3d&tabid=89&mid=425>.
- Nelitz, M., C. Murray, M. Porter, and D.R. Marmorek. 2006. Managing Pacific Salmon for Ecosystem Values: Ecosystem Indicators and the Wild Salmon Policy. Prepared for the Pacific Fisheries Resource Conservation Council. Available at: http://www.fish.bc.ca/files/EcosystemIndicators_2006_0_Complete%20for%20web.pdf.
- Marmorek, D.R., D.C.E. Robinson, C. Murray and L. Greig. 2006. Enabling Adaptive Forest Management – Final Report. Prepared for the National Commission on Science for Sustainable Forestry by ESSA

Technologies Ltd., Vancouver, B.C. 93 pp. Available at
http://ncseonline.org/CMS400Example/uploadedFiles/NCSSF/NCSSF%20Project%20D1_Adaptive%20Forest%20Mgmt%20Final%2018%20May%2006.pdf.

- Murray, C. and D.R. Marmorek. 2004. Adaptive Management: A spoonful of rigour helps the uncertainty go down. In: Proceedings of the 16th Annual Society for Ecological Restoration Conference, Victoria, BC, 24-26 August, 2004. Available on CD from SER or from
http://www.essa.com/documents/Murray_Marmorek_adaptive_management_SER_conference.pdf.
- Murray, C. and D. Marmorek. 2003. Adaptive Management and Ecological Restoration. Chapter 24, in: Freiderici, P. (ed.). 2003. Ecological Restoration of Southwestern Ponderosa Pine Forests. Island Press (Washington, Covelo CA, London), pp. 417-428.
http://www.essa.com/documents/Murray_&_Marmorek_Ponderosa_Pine_2003.pdf.

More available on request.

Lorne Greig

Principal, Environmental Management Team Leader, ESSA Technologies Ltd.

77 Angelica Avenue, Richmond Hill, ON L4S 2C9. (905) 770 6334 lgreig@essa.com

Post-Secondary Education

M.Sc., Biology (Ecology), York University, Toronto, Ontario, 1974.

B.Sc., Biology, York University, Toronto, Ontario, 1970.

Languages	Speak	Read	Write
English:	Native	Native	Native
Spanish:	Limited	Limited	Limited

Countries Of Work Experience

Canada	United States	Mexico	Czech	Hungary
Argentina	Philippines		Republic	

Special Skills / Experience

- Adaptive management
- Decision analysis / decision support
- Environmental policy analysis
- Research design / synthesis
- Meeting / workshop facilitation
- Environmental Conflict resolution
- Writing / editing
- Project management

Professional Experience

2005 - present **Environmental Management Team Leader / Principal** ESSA Technologies Ltd.

1987 - 2005 **Senior Systems Ecologist / Principal** ESSA Technologies Ltd.

1983 - 1987 **Systems Ecologist**, ESSA Environmental and Social Systems Analysts Ltd.

Since joining ESSA in 1983, Mr. Greig has gained extensive experience in the application of Adaptive Environmental Assessment and Management (AEAM), and systems analysis techniques to a wide variety of resource management issues. His project experience includes the design of research and monitoring programs, workshop facilitation and public consultation, strategic planning and policy analysis, environmental assessment, systems modelling and analysis, and the development of computer software tools. Mr. Greig's clients include:

- Alberta Environment
- Athabasca Tribal Council
- Asian Development Bank
- Canadian Electrical Association
- Canadian Environmental Assessment Agency
- Canadian International Development Agency
- Connecticut Department of Environmental Protection
- Environment Canada
- Environmental Council of Alberta
- Fisheries and Oceans Canada
- Great Lakes Fishery Commission
- Government of Northwest Territories
- Government of Yukon – Placer Mining Secretariat
- Hul'qumi'num Treaty Group
- International Joint Commission (Canada – US)
- Kinectrics Incorporated
- Joint Review Panel – Mackenzie Gas Project
- Latinoconsult – on behalf of Government of Argentina
- Manitoba Model Forest Inc.
- New York State Department of Environmental Conservation
- Ontario Hydro / Ontario Power Generation
- Ontario Ministry of Natural Resources
- Oregon Department of Forestry
- Parks Canada
- Statistics Canada
- Thompson, Dorfman, Sweatman Barristers and Solicitors (on behalf of Manitoba Hydro)
- USDA Forest Service
- World Bank

Examples of Mr. Greig's consulting engagements, include:

Environmental Assessment and Monitoring

- advisor to Argentinean scientific team in assessment of potential effects of proposed pulp mills on Rio Uruguay,
- advisor to Athabasca Tribal Council regarding cumulative effects assessment,
- advisor to Mackenzie Gas Project – Joint Review Panel on matters related to cumulative effects assessment,
- staff consultant to the Asian Development Bank to develop a discussion paper and draft guidelines for cumulative impact assessment in multilateral development bank operations,
- lead author of a research monograph on the use of alternative future scenarios in cumulative impact assessment for the Canadian Environmental Assessment Agency Research and Development Program,
- critical review of EA for underwater hydroelectric transmission for Hul'qumi'num Treaty Group,
- critical review of effects of entrainment and impingement of fish by the Salem Nuclear Generating Station (New Jersey), the Delaware City Refinery (Delaware), and the Millstone Nuclear Generating Station (Connecticut),
- project leader – guidance for scoping of cumulative impact assessments in Yukon,
- manager of a project to critically review a draft environmental impact statement on the effects of cooling water withdrawal operations of three generating stations on the Hudson River and recommending improvements to the draft statement,
- assisted with the development of principles and procedures for environmental effects monitoring, and wrote a comprehensive environmental effects monitoring manual for the Canadian federal government, and
- training in screening projects through the use of Calyx⁷ (environmental screening decision support system) for staff at Instituto Nacional Ecologia, Mexico City, Mexico.

Workshop Facilitation and Systems Modelling

- project leader – development of a model of the Lake Ontario Salmonid fishery (Chinook and Atlantic Salmon) for estimation of the socio-economic cost-benefit of listing the Lake Ontario stock of Atlantic Salmon under SARA,
- project leader – decision analysis of alternatives for mitigating the effects of downstream passage mortality on American eel in the upper St. Lawrence River – Lake Ontario system,
- project leader for conceptual modeling of selected park ecosystems for Parks Canada, and advice on the use of such models in selecting indicators of ecological integrity,
- project leader – scoping of decision analysis for management of Lake Erie Walleye and Yellow Perch,
- lead facilitator for development of study designs for assessing the effectiveness of proposed mitigation strategies in managing development impacts on fisheries habitats,
- scientific facilitation for development of a research design for assessing the effect of hydrological ramping rates on fish populations (for Fisheries and Oceans Canada),
- lead facilitator for developing a framework for cumulative effects assessment in the Moose River Basin of northeastern Ontario
- scientific facilitation for assessing effectiveness of timber management guidelines for resource protection –modelling impacts of timber management on tourist operations – scoping of adaptive management strategy for guideline evaluation,
- scientific facilitation for conceptual modelling of the Lake Ontario fish community,
- project leader – analysis of potential electricity demand in Canada [1988] to 2020, based on scenario analyses of possible social and technological developments,
- project leader – simulation modelling of lamprey and lake trout population dynamics linked to a treatment selection system that covers the full range of lamprey treatment options and sites within the Great Lakes,
- modelling dynamics of migratory salmon and the commercial fishery along the south coast of B.C.,
- simulation modelling of the effects of potential remedial actions for the Bay of Quinte remedial action plan,
- manager of several projects for Ontario Hydro to develop monitoring strategies based on the development of simulation and conceptual models of the effects of nuclear and hydro-electric generating stations.

Adaptive Management

- peer review of Rockfort Quarry Adaptive Management Plan; expert testimony before the Ontario Municipal Board on the deficiencies in the plan
- develop guidance for development of adaptive management plans for Fisheries and Oceans Canada
- adaptive management advisor / facilitator for development of adaptive management framework for placer mining in Yukon
- facilitation of assessment of the institutional factors that enable or inhibit effective adaptive forest management

- author of chapter on adaptive management in guide to managing natural channel systems in Ontario
- facilitation of evaluation of adaptive management of salmonid-lamprey interactions in the Great Lakes
- facilitation of scoping of adaptive management strategy for assessing effects of timber management on non-timber resource values

Fisheries Resource Management

- policy analysis of approach to compensation for harmful alteration, disruption or destruction of fish habitat by development projects in Canada,
- critical review of the mass balance model used by Northeast Nuclear Company to assess the effects of the Millstone Nuclear Power Station on Niantic River Winter flounder,
- facilitated a working group charged with identifying valued ecosystem components (VECs) and energy path linkages for Lake Erie,
- developed decision-making framework for assessing impacts of proposed development projects on fish habitat,
- facilitated development of a resource management strategy for the recreational fishery in New Brunswick including a comprehensive framework for public involvement.

Forestry & Wildlife Resource Management

- project leader to develop a research program for effects of timber management on wildlife,
- analyst and project leader to assess the current "state-of-the-art" of habitat supply analysis/modelling and examine the feasibility of HSA/M as an operational tool in Ontario,
- scientific facilitation for development of a model of the effects of root-rots and other forest pests on the growth and survival of north-western U.S. forests,
- scientific facilitation for design of a major monitoring program to investigate the causes of spruce fir die-back in the eastern U.S. - adapted a statistical model of mixed-wood stand growth and development for use in analysing alternative hypotheses,
- modelling and scientific facilitation to develop strategies for the management of Spruce budmoth in plantation forestry in Atlantic Canada.

Strategic Planning, Policy Analysis

- project leader for the Great Lakes Fisheries Commission to develop a protocol for the Integrated Management of Sea Lamprey (IMSL),
- consultant to the USDA Forest Service in the development of a charter for a National Forest Health Management Institute,
- consultant to Fisheries and Oceans Canada in development of the Recreational Fisheries Strategy for New Brunswick,
- project leader / lead facilitator for review and refinement of the Strategic Plan for Ontario's Fisheries (SPOF),
- consultant to the USDA Forest Service in the development of strategic priorities and a strategic plan for technology development for the management of forest pests, and
- consultant to the Alberta Environment Council in a policy exercise to consider water policy futures.

Social Impacts & Conflict Management

- facilitation advisory committee for St. Raphael signature site in NW Ontario – dealing with conflict between First Nations and the forest industry
- facilitation of agreement between First Nations in south-western Ontario and Ontario Ministry of Natural Resources to pursue co-management of Thames River Walleye
- facilitated conflict resolution for the Parry Sound Public Advisory Committee (PAC) and the Ontario Ministry of Natural Resources,
- facilitation of various public advisory committees with diverse groups of stakeholders charged with recommending management actions to correct fisheries over-harvests,
- manager of a project for the Canadian Electrical Association to develop a futures analysis of potential electrical energy demand in Canada to the year 2020 based on scenarios of both technological and social futures.

1980 - 1983 **Ontario Fisheries Information System (OFIS) Specialist**, Fisheries Branch, Ontario Ministry of Natural Resources.

- systems analysis, project management, performance of feasibility studies for a major project to develop data management and information systems to support fisheries management,
- manager of adaptive management modelling project regarding effects of acidic precipitation on fisheries,

- member of inter-agency modelling team for development of adaptive management strategies for managing salmonid-lamprey interactions in the Great Lakes.

1974 - 1980 **Unit Biologist**, Lake Huron Fisheries Assessment Unit, Owen Sound, Ontario.

- design and supervision of fisheries assessment programs, and
- design and development of computer database management, data communications and analysis software.

Conference & Workshop Presentations

Refocusing Cumulative Effects Assessment. November 2008. Presented at the International Association for Impact Assessment conference on Assessing and Managing Cumulative Environmental Effects, Calgary, AB.

Cumulative Impact Assessment. 2008. Presentation to Athabasca Tribal Council Workshop on Cumulative Impact Assessment.

Cumulative Impact Assessment and Adaptive Management – Challenges to Cumulative Impacts Assessment in Canada. 2006. Invited paper to Canadian Water Network Annual Conference, Session on Cumulative Impact Assessment and Adaptive Management.

Building on Success Factors: A Capacity Development Model for Environmental Management in Vietnam. May 2006. By Kim Pawley, Mary Ellen MacCallum, John Patterson and Lorne Greig. Presented to the 26th Annual Conference of the International Association for Impact Assessment, Stavanger, Norway.

The Impotence of Cumulative Effects Assessment in Canada: Ailments, and Ideas for Redeployment. April 2004. by Peter N. Duinker and Lorne Greig. Presented to the 24th Annual Conference of the International Association for Impact Assessment, Vancouver, British Columbia, Canada. (subsequently published in *Environmental Management*).

What is Adaptive Management? March 2004. Keynote address to the annual conference of the Oregon Department of Forestry, Corvallis, Oregon, USA.

Adaptive Management and Monitoring. May 2003. Presented to the Conference on Regional and Strategic Environmental Assessment and Monitoring sponsored by Environment Canada Atlantic Region. Halifax, Nova Scotia, Canada.

Publications and Reports

Books and Refereed Journal Publications

Greig, L., C. Murray, D. Robinson and D. Marmorek. (In preparation) Enabling Adaptive Management.

Murray C., and L. Greig. (In preparation) The Role of Adaptive Management in Environmental Assessment.

Greig, L., and P.N. Duinker. (In preparation) Strengthening Science in Environmental Impact Assessment: Glimmers of Hope in Canada.

Greig, L. (In preparation). Refocusing Cumulative Effects Assessment.

Duinker, P.N. and L. Greig. 2007. Scenario analysis in environmental impact assessment: improving explorations of the future. *Environmental Impact Assessment Review* 27: 206 – 219.

Duinker, P.N. and L. Greig. 2006. The Impotence of Cumulative Effects Assessment in Canada: Ailments and Ideas for Redeployment. *Environmental Management* 37(2): 153-161.

Jones, M. and L. Greig. 1985. Adaptive Environmental Assessment and Management: A New Approach to Environmental Impact Assessment. Pages 21-42. *In* V.W. MacLaren and J.B. Whitney (eds.). *New Directions in Environmental Impact Assessment in Canada*. Methuen Publications, Toronto, Ontario.

Greig, L.A. 1983. Commodities Submodel. Pages 22-29. *In* D.R. Talhelm and R.L. Johnson (eds.). The Role of the Great Lakes in Michigan's Economic Future: A Conceptual Framework. Michigan State Univ., 39 pp.

Goddard, C.I., M.H. Goodwin, and L.A. Greig. 1975. The Use of Artificial Substrates in Sampling Estuarine Benthos. *Trans. Am. Fish. Soc.* 104: 50-52

Kitchell, J.F., M.G. Johnson, C.K. Minns, K.H. Loftus, L.A. Greig, and C.H. Olver. 1975. Percid Habitat: The River Analogy. *J. Fish. Res. Board Can.* 34: 1936-1940

Conference Proceedings and Technical Report Series

Greig L., K. Pawley and P. Duinker. 2004. Alternative Scenarios of Future Development: an Aid to Cumulative Effects Assessment. Research Monograph supported by Canadian Environmental Assessment Agency. Ottawa, ON. 60 pp.

Greig, L. 2003. Adaptive Management and Regional Monitoring. In Proceedings of a Workshop on Regional EIA and Strategic EIA. Environment Canada, Atlantic Region. In prep.

Gillespie, G., L. Carl, R. Mackereth, L. Greig, D. Ming, M. Boivin, and T. Allison. 2002. Design Standards for Improving Fish Habitat Management. *Can. MS Rpt. Fish. Aquat. Sci.* 2592: v + 81 pp.

Lester, N.P., K.J. Cornelisse, L. Greig, C.K. Minns and M.L. Jones. 1997. Proceedings of the 1997 Science for Fish Habitat Management Workshop. *Can. MS. Rep. Fish. Aquat. Sci.* 2439: vi+36 pp.

Greig, L.A. and P. Duinker. 1997. Toward a strategy for caribou habitat management in Northwestern Ontario. Final Report of the Northwest Region Caribou Strategy Advisory Panel. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for the Northwest Region Caribou Strategy Advisory Panel and the Ontario Ministry of Natural Resources. 46 pp.

Minns, C.K., J.D. Meisner, J.E. Moore, L.A. Greig, R.G. Randall. 1995. Defensible methods for pre- and post development assessment of fish habitat in the Great lakes: a prototype methodology for headland and offshore structures. *Can. MS Rep. Fish. Aquat. Sci.* No. 2328. xiii + 65 pp.

McNamee, P.J., M.L. Jones, L.A. Greig, T.M. Webb, G. Hertel, and S.J. Zarnoch. 1987. Research Planning for the Spruce-Fir Research Co-operative. Pages 5-18. *In* Proceedings of the US/FRG Research Symposium: Effects of Atmospheric Pollutants on the Spruce-Fir Forests of the Eastern United States and the Federal Republic of Germany, October 19-23, 1987. USDA Forest Service Northeastern Forest Experiment Station General Technical Report NE-120. 543 pp.

Casselman, J.D., L.A. Greig, V. Macins, and T. Millard. 1979. Strategic Planning for Ontario Fisheries: Socio-economic Data Requirements for the Management of Ontario's Fisheries - Commercial. *Ont. Min. Nat. Resour.*

Project Reports (selected – full list available on request)

Greig, L. 2010. Geospatial Risk Characterization Workshop I: Tools for Ecosystem Based Approaches to Support Decision Making – Workshop Summary. Prepared by ESSA Technologies Ltd., Richmond Hill, ON. Prepared for Fisheries and Oceans Canada, Oceans and Science Branch, Gulf Fisheries Centre [Moncton, NB]. 11 pp + Appendices.

MacGregor, R., J. Casselman, L. Greig, W. A. Allen, L. McDermott, and T. Haxton. 2009. Recovery Strategy for the American Eel (*Anguilla rostrata*) in Ontario (Draft). Ontario Recovery Strategy Series. Prepared for Ontario Ministry of Natural Resources, Peterborough, Ontario. 69 pp.

Greig, L. 2009. Integrated Oceans Risk Analysis Framework – Workshop Summary. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Oceans Policy and Planning Branch, Ottawa, ON, 9 pp + Appendices.

L. Greig. 2009. Pathways of Effects [conceptual models] to Support Integrated Oceans Management – Workshop Summary. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Oceans Policy and Planning Branch, Ottawa, ON, 11 pp + Appendices.

Greig, L. and C. Murray. 2008. Peer Review of Rockfort Quarry Adaptive Management Plan. Prepared by ESSA Technologies Ltd., Richmond Hill, ON, for Caledon Coalition of Concerned Citizens, Terra Cotta, ON. 12 pp.

Greig, L., D. Marmorek and C. Murray. 2008. Guide for Preparation of Adaptive Management Plans. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Western Arctic Area, Central and Arctic Region, [Yellowknife, NT], 8 pp.

Robinson, D.C.E., Beukema, S.J. and L.A. Greig. 2008. Vegetation models and climate change: workshop results. Prepared by ESSA Technologies Ltd., for Western Wildlands Environmental Threat Assessment Center, USDA Forest Service, Prineville, OR. 50p.

Greig, L. 2007. Habitat Management Implementation Plan for American Eel – Workshop Summary. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for Fisheries and Oceans Canada, Habitat Management and Sustainable Development, Ottawa, ON. 18 pp.

Greig, L. and P.N. Duinker. 2007. Scenarios of Future Developments in Cumulative Effects Assessment: Approaches for the Mackenzie Gas Project. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for the Joint Review Panel for the Mackenzie Gas Project, [Inuvik, NT], 32 pp.

Marmorek, David R., Lorne Greig, Carol Murray and Donald Robinson. 2006. Enabling Adaptive Forest Management. Prepared for the National Commission on Science for Sustainable Forestry by ESSA Technologies Ltd., Vancouver, B.C. 94 pp.

Greig, L. and D.R. Marmorek. 2006. Yukon Placer Mining Environmental Management Regime – Adaptive Management Framework, Workshop Report. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for for the Yukon Placer Secretariat, Whitehorse, Yukon. 18 pp

Greig, L. I.J. Parnell, and D.R. Marmorek. 2006. Developing an Action Plan for American eels in the St. Lawrence River – Lake Ontario Region: Decision Analysis. Prepared by ESSA Technologies Ltd., Richmond Hill, ON, for Hydro Quebec, Fisheries and Oceans Canada, Ontario Ministry of Natural Resources, Ontario Power Generation, and the US Fish & Wildlife Service, on behalf of the Passage and Associated Habitat Subcommittee of the Canadian Eel Working Group. 153 pp.

Greig, L.A. 1997. Adaptive Environmental Assessment and Management - Chapter for Natural Channel Systems Report. Prepared by ESSA Technologies Ltd., Richmond Hill, ON for the Credit Valley Conservation Authority, Meadowvale, ON. 18 pp.

McNamee, P.J., L.A. Greig, and M.L. Jones. 1987. Effects Monitoring Strategies for Timber Management Guidelines in Ontario: Final report of Moose, Fish, and Tourism Technical Meetings -- June 15-16, 1987. Prepared for Ontario Ministry of Natural Resources, 71 pp.

Koonce, J.F., L.A. Greig, B.A. Henderson, D.B. Jester, C.K. Minns, and G.R. Spangler. 1982. A Review of the Adaptive Management Workshop Addressing Salmonid/Lamprey Management in the Great Lakes. Prepared for Great Lakes Fish. Comm.

Chadwin B. Smith



Director of Natural Resources, Headwaters Corporation

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Post-Secondary Education

- **Ph.D. Natural Resources – Adaptive Management (candidate)**, University of Nebraska-Lincoln. Dissertation topic: Science-policy interface in adaptive management – translating science learning into policy decisions utilizing decision analysis tools. Course work included adaptive management, modeling and assessment for adaptive management, ecological resilience, ecological statistics, mark-recapture analysis, and water law and policy.
- **M.P.A. Environmental Policy and Natural Resources Management**, Indiana University-Bloomington, 1996. Course work included conservation biology, lake and watershed management, natural resources management and policy, natural resources law, environmental economics and policy, and data analysis and modeling.
- **B.S. (Highest Distinction) Fisheries and Wildlife**, University of Nebraska-Lincoln, 1994. Course work included wildlife ecology and management, wildlife management techniques, biology of wildlife populations, principles of ecology, integrated resource management, environmental law, wildlife biology and conservation, vertebrate zoology, botany, and field parasitology.

Research Interests

- Transition of science learning acquired through process of adaptive management into policy and management decision-making
- Decision support for adaptive management; data synthesis and decision-making
- Successes and failures completing iterations of adaptive management six-step process
- Experimental design and assessment strategies for successful adaptive management

Special Skills / Experience

- Adaptive management design, implementation, and assessment
- Experimental design
- Management of monitoring and research
- Technical facilitation
- Decision support
- Integration of independent science review into science decision-making

Professional Experience

2007 – now	Director of Natural Resources , Headwaters Corporation
2006 – 2007	Special Faculty Appointment , Community and Regional Planning Department, University of Nebraska-Lincoln
1998 - 2007	Director of Nebraska Field Office , American Rivers
1996 - 1998	Conservation Policy Analyst and Outreach Coordinator , American Rivers

Professional Involvement

2009 – now	National Conference on Ecosystem Restoration , Program Committee Co-chair (2011) and Chair (2013)
2008 – now	Collaborative Adaptive Management Network , Core Advisory Group
2008 – now	Ecological Society of America , Member
2008 - now	The Wildlife Society , Member

Adaptive Management Projects

- leading implementation of the Adaptive Management Plan for the Platte River Recovery Implementation Program (Program); includes facilitating technical meetings and workshops, revising and updating conceptual models, sequencing hypotheses, setting restoration objectives, developing performance measures and decision criteria, establishing experimental and sampling designs, managing monitoring and research, and assessing progress toward management objectives and hypotheses regarding four listed target species – interior least tern, piping plover, whooping crane, and pallid sturgeon (ongoing)
- member of an expert review panel to review draft of a guide to implement adaptive management in the Comprehensive Everglades Restoration Program for the U.S. Army Corps of Engineers and South Florida Water Management District (2010)
- instructor for workshop on using adaptive management to facilitate decision-making at National Conference on Ecosystem Restoration in Los Angeles (2009)
- instructor at adaptive management standards of practice seminar for implementing adaptive management in the Missouri River Restoration Program for the U.S. Army Corps of Engineers (2009)

Additional Projects, 1996-now

- assist Platte River Recovery Implementation Program Executive Director with budget and work plan development and management, RFP development, contract development and negotiation, and general Program administration
- facilitate and provide staff support for Program's Governance Committee, Finance Committee, Adaptive Management Working Group, Technical Advisory Committee, and Independent Scientific Advisory Committee (ISAC)
- lead Program independent science review efforts, including management of ISAC and all independent peer review
- co-instructed upper level undergraduate / graduate course in environmental planning and policy
- led efforts to begin collaboration in Missouri River basin as member of Mediator Selection Team, Core Planning Group, and Plenary Group for developing a consensus recommendation for implementation of 2006 bi-modal spring rise on Missouri River (for the U.S. Army Corps of Engineers)
- participated in efforts to establish and ensure stakeholder involvement in Missouri River Recovery Implementation Committee
- participated as member of Nebraska Water Policy Task Force and Instream Flow Subcommittee
- participated as member of Platte River Basin Overappropriated Basin Group
- contributed to development of draft rule for fully appropriated basin designations in Nebraska as member of negotiated rulemaking committee
- coordinated and led American Rivers' multi-year Missouri River *Voyage of Recovery*sm restoration campaign, including budget management, work plan development, serving as chief spokesperson for all Missouri River management issues, and delivering numerous public presentations and lectures across the nation

Recent Refereed and Professional Publications

Smith, C.B. (Accepted). Adaptive management on the central Platte River – science, engineering, and decision analysis to assist in recovery of four species. *J. Environmental Management*.

Smith, C.B. 2009. Active adaptive management on the Platte River. *Water Resources IMPACT, Journal of the American Water Resources Association*, 11(3): 8-10.

Platte River Recovery Implementation Program. (*in process*). Adaptive Management Plan Update – Conceptual Models, Hypotheses, and Decision Support. ED Office, Kearney, NE.

Platte River Recovery Implementation Program. 2010. Year Four Target Species Assessment – Pallid Sturgeon. ED Office, Kearney, NE. 7 pp.

Platte River Recovery Implementation Program. 2010. Responses to Findings in the *Final 2009 Independent Scientific Advisory Committee (ISAC) Report to the Governance Committee*. ED Office, Kearney, NE. 22 pp.

Platte River Recovery Implementation Program. 2009. Strategic Science Plan for Adaptive Management Plan Implementation, 2009-2015. ED Office, Kearney, NE. 17 pp.

Platte River Recovery Implementation Program. 2009. Structured Decision Making Final Report. ED Office, Kearney, NE. 14 pp.

Recent Conference Presentations

- “Learning by Doing” on the Platte River – Science and Engineering for Species Recovery
 - Audubon Rivers and Wildlife Celebration, Kearney NE, March 2010
 - Adaptive Management Symposium, 70th Midwest Fish and Wildlife Conference, Springfield IL, December 2009
 - Platte River Basin Science & Resource Management Symposium, Kearney NE, October 2009
- Land, Water, and Adaptive Management – Science and Engineering for Species Recovery on the Platte River (National Conference on Ecosystem Restoration, Los Angeles CA, July 2009)
- Adaptive Management Decision Support and Collaboration on the Platte River (American Water Resources Association Adaptive Management Specialty Conference, Snowbird UT, June 2009)
- Adaptive Management Discussion Panel (American Water Resources Association Adaptive Management Specialty Conference, Snowbird UT, June 2009)

Bridget M. Barron, Ph.D.



Chief Operating Officer, Headwaters Corporation

4111 4th Avenue, Suite 6, Kearney, Nebraska 68845

Ph. (308) 237-5728, email barronb@headwaterscorp.com

Education and Professional Licenses

- **Ph.D. Clinical Psychology, Washington State University, 1989.**
- **Master of Business Administration and Master of Science in Health Administration, University of Colorado Denver, 1996.**
- **M.S. Clinical Psychology, Washington State University, 1985.**
- **B.A. Psychology, University of Denver, 1981.**
- **Clinical Psychologist, Colorado, License Number 1495.**
- **Clinical Psychologist, Nebraska, License Number 700.**

Profile

Bridget Barron is a licensed clinical psychologist who offers a remarkable combination of clinical skills, business administration skills and expert knowledge of motivating and influencing others, managing conflict and team building. Dr. Barron has exceptional listening and communication skills, as well as proven excellence in working with persons from diverse backgrounds. She has a demonstrated record of increasing responsibility in system evaluation and reorganization, budget development and oversight, and personnel management. Dr. Barron is skilled in recognizing, defining, and creatively solving problems. She has proven ability to clearly articulate a vision and then motivate and lead team members into effective action and change.

Professional Experience

2007 – current	Chief Operating Officer, Headwaters Corporation, Kearney, NE.
2004 – 2007	Division Director – Division of Food & Energy Assistance, Department of Human Services, State of Colorado, Denver, CO.
2001 - 2004	Director of Program Quality - Division of Mental Health, Department of Human Services, State of Colorado, Denver, CO
1998 - 2000	Director of Adult Clinical Services, Colorado Access – Access Behavioral Care, Denver, CO.
1996 – 1998	Director of Access Services, Mental Health Corporation of Denver, Denver, CO.
1989 – 1994	Adult Division Psychologist, Staff Psychologist, Fort Logan Psychiatric Hospital, Department of Human Services, State of Colorado, Denver, CO.

Key Accomplishments

- **Business Administration/Organizational Management**
 - Managed the business operations of a \$30 million business unit servicing 7,000 customers a year.
 - Developed and implemented the business plan for a start-up company, enabling company to bill \$1.2 million in first full year of operation and grow from three to 12 employees in two and a half years.

- Executed a plan for a \$14 million contract for services for a targeted membership of approximately 48,000 customers.
- Managed all operations of a federal program that annually distributed \$600 million in public assistance benefits.
- State of Colorado received \$1.2 million federal bonus for performance during my tenure as Division Director for Division of Food and Energy Assistance.
- **Human Resources/Employee Development/Training and Facilitation**
- Developed position specifications, evaluated market compensation levels, interviewed, and recruited talented employees.
- Created and executed human resources policies and procedures.
- Hired, trained, and managed a multidisciplinary and diverse staff of 50.
- Appointed to Colorado partnership to develop the state mental health disaster and bioterrorism plan, partners included federal, state, and community based organizations. Served as subject matter expert for cultural competency of plan and responsible for incorporating cultural competency into all aspects of disaster plan.
- Promoted a new line of business in an existing health maintenance organization. The HMO was awarded a \$28 million contract to serve the behavioral health needs of the Medicaid population in the city and county of Denver. Designed and presented training sessions for the provider network regarding general information, authorization and denial process, and utilization management. Met the contractual obligation of increasing the percentage of customers using service from 8% to 12% in first year of business.

Recent Presentations

- “Platte River Recovery Implementation Program: Overview and Update”. Presented to the Understanding the Platte – Osher Lifelong Learning Institute. York, NE, May 2010.
 - Platte River Recovery Implementation Program: Interactive Poster Presentation. Presented at the CAMNet Annual Rendezvous. Tucson, Arizona, March 2010.
- “Platte River Recovery Implementation Program: History and Update”. Presented to the Society for Applied Anthropology Annual Meeting. Santa Fe, New Mexico, October 2009.

Beorn A. Courtney, P.E.



Director of Water Resources, Headwaters Corporation

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Ph. (303) 918-5096, email courtneyb@headwaterscorp.com

Education and Professional Licenses

- **M.S. Water Resources Engineering, University of Colorado at Boulder, 1997.**
- **B.S. Chemical Engineering, University of Colorado at Boulder, 1995.**
- **Professional Engineer, Colorado, License Number 35810, 2001.**

Profile

Beorn Courtney is a water resources engineer with experience in a broad range of water resources planning and modeling, water conservation planning, water rights investigations and litigation support, and hydrologic and hydraulic investigations. Ms. Courtney is skilled at project management including project team coordination, developing and maintaining client relationships, and providing technical oversight and review. She manages the Headwaters Corporation water resources staff and Denver office.

Expert Testimony

City of Black Hawk, January 18, 2002 – Division 1 Water Court, Greeley, CO

Case No. 92CW058, Black Hawk Direct Flow and Storage Rights

Case No. 92CW059, Black Hawk Exchange

City of Black Hawk, June 18, 2002 – Division 1 Water Court, Greeley, CO

Case No. 94CW036, Black Hawk Plan of Augmentation and Change of Water Rights

Professional Experience

2008 – now	Director of Water Resources Engineering , Headwaters Corporation, Denver, CO.
2000 – 2007	Project Manager , Leonard Rice Engineers, Inc., Denver, CO.
1997 - 2000	Water Resources Engineer , Exponent, Boulder, CO.

Professional Involvement

2007	Colorado Foundation for Water Education Water Leaders Program
2007 – now	Colorado Water Wise Council, Treasurer and Management Team
1998 – now	American Water Resources Association, Colorado Section (previous positions of President, Secretary, Scholarship Committee Chair).

Representative Projects

Platte River Recovery Implementation Program (Headwaters Corporation). Responsible for integrating the Water Plan of the Platte River Recovery Implementation Program, a cooperative effort of the Department of the Interior, the states of Colorado, Nebraska, and Wyoming, and several water user and environmental organizations to address endangered species issues in the Platte River basin. Provide coordination of water-related committees, developing requests for proposals and consultant contracts, managing consultants, and providing technical review. Developed the Program's 2009 Water Action Plan update, identifying water projects capable of creating 50,000 to 70,000 acre-feet per year of water retimed to the pattern specified by the Fish and Wildlife Service within the first increment of the Program.

Sterling Ranch/Dominion Water and Sanitation District (Headwaters Corporation). Responsible for water conservation planning and coordination of team of water consultants. Developed water conservation approach for proposed new development in Douglas County, Colorado in support of a zoning application. Coordinated team of water consultants to develop a Water Plan, integrating water conservation with water demand and supply planning at the land use phase.

Update to the Water Conservation Section of the Statewide Water Supply Initiative (Headwaters Corporation). Worked with the Colorado Water Conservation Board Office of Water Conservation and Drought Planning to update water conservation portions of the Statewide Water Supply Planning Initiative, focusing on adding scientific basis for future active water conservation savings.

State of Colorado Rainwater Harvesting Criteria & Guidelines (Headwaters Corporation). Assisted legal counsel, Colorado Water Conservation Board, and the State Engineer's Office in providing comments on proposed rainwater harvesting legislation and in developing Criteria and Guidelines for the State's Pilot Project Program authorized under HB 09-1129.

Colorado Water Conservation Board Drought Planning (Headwaters Corporation). Developed Drought Toolbox Scoping for the 2010 State of Colorado Drought Plan update. Included a review of drought planning approaches in other states and recommendations for the State of Colorado to assist water providers in developing drought plans.

CWCB Grant Study on Outdoor Water Conservation and Rainwater Harvesting (Leonard Rice Engineers,, Inc.). Assisted client in obtaining a grant from the Colorado Water Conservation Board for the study titled: Holistic Approach to Sustainable Water Management in Northwest Douglas County. Responsible for project coordination between sub-consultants and with Advisory and Peer Review Committee participants and led the technical research aspects of the study related to rainwater harvesting and water rights.

City of Walsenburg (Headwaters Corporation). Provide water rights engineering and water supply planning services to the City of Walsenburg, Colorado, including: historical consumptive use analyses of water rights for change of use applications and augmentation plans, preparing substitute water supply plans, evaluating demands and water supply projections, and working with legal counsel to evaluation potential injury associated with other applications.

South Platte Decision Support System (Leonard Rice Engineers, Inc.). Developed surface water and consumptive use model data collection for the Colorado Water Conservation Board and the Colorado Division of Water Resources in conjunction with the Colorado Decision Support System. The data management interface tools with the State's relational database were utilized and operational information was obtained from water users.

State of Colorado's Consumptive Use Model, StateCU (Leonard Rice Engineers, Inc.). Worked with staff from Colorado Water Conservation Board and the Colorado Division of Water Resources to design and implement program enhancements and provide user training.

Publications and Presentations

"Platte River Recovery Implementation Program Water Plan Update and Look Ahead". Presented to the Colorado Water Congress. Denver, Colorado, January 2010.

"Integrating Land Use Planning & Water Conservation". Presented to the Colorado Water Congress. Denver, Colorado, January 2010.

“Opportunities for Water Efficiency in Land Use Planning”. Presented to the Colorado Section of the American Water Resources Association. Denver, Colorado, October 2009.

“Rainwater Harvesting in Colorado”. Panel presentation to Front Range Sustainable Landscaping Coalition Conf., Muddy Waters: Who Owns the Rain? Denver, Colorado, February 2009.

“Holistic Approach to Sustainable Water Management in Northwest Douglas County”. Testimony Provided to Colorado Senate Agriculture, Natural Resources & Energy Committee. Denver, Colorado, January 2008.

Holistic Approach to Sustainable Water Management in Northwest Douglas County. Prepared for the Colorado Water Conservation Board, et al. by Leonard Rice Engineers, Inc. with Meurer and Associates and Ryley Carlock & Applewhite, January, 2007.

Dr. Carl Schwarz

Dept of Statistics and Actuarial Science

Simon Fraser University, Burnaby, BC, CANADA V5A 1S6

Educational Background

2004 P.Stat.	Statistics, Statistical Society of Canada, Canada (the P.Stat. designation represents accreditation as a Professional Statistician by the Statistical Society of Canada.)
1988 Ph.D.	Statistics, University of Manitoba, Canada Post-release stratification and migration models in band-recovery and capture-recapture models
1981 M. Math	Statistics, University of Waterloo, Canada
1980 M.Sc.	Computer Science Simulation and modeling, University of Manitoba, Canada
1978 B.Sc.	Computer Science, University of Manitoba, Canada

Employment History at Academic Institutions

September 2001 - Current	Professor, Statistics and Actuarial Science, Simon Fraser University
September 2001 - August 2004	Chair, Department of Statistics and Actuarial Science, Simon Fraser University
January 1994 - August 2001	Associate Professor, Department of Statistics and Mathematics, Simon Fraser University
July 1988 - December 1993	Assistant Professor, Department of Statistics, University of Manitoba
September 1987 - July 1988	Lecturer, Department of Statistics, University of Manitoba
September 1984 - July 1988	Consultant, Statistical Advisory Service, University of Manitoba
September 1984 - August 1987	Sessional Lecturer, Department of Statistics, University of Manitoba

Current Research Interests

Statistics - experimental design ANOVA STATISTICAL CONSULTING

My research program is in three areas: capture-recapture modeling of animal population dynamics; statistical consulting; and linear and generalized linear models. The research in capture-recapture models requires the development of new stochastic models, the development of model fitting and testing procedures, and the development of computer software. In large part, it is motivated by real problems encountered by ecologists. My interest in statistical consulting involves assistance in experimental design and analysis in complex experimental situations where the "standard textbook" results are not appropriate. Both of these areas give rise to my interest in linear and generalized linear models.

My current research projects are:

- the development of capture-recapture methodology to estimate population parameters of temporally stratified populations. This has applications in estimating salmon escapement; in estimating salmon smolt runs; and in estimating sable fish populations.
- the development of capture-recapture methodology to estimate population parameters of long-lived animal populations that have temporary absences from the sampling areas. This will be applied to estimate the population size and survival rates of the seal herd on Sable Island, Nova Scotia. This population consists of

long-lived animals with year-to-year temporary absences from the breeding colony, and within-year temporary absences from the beaches during multiple within-year surveys. The development of tag-recovery methodology to study migration among geographically-stratified populations. This has been used to study the movement of herring among spawning areas in B.C. and the movement of mallards among wintering areas in the southern United States. A new study is underway to examine the movement of hatchery released salmon from the coded-wire returns obtained from the fishery.

- the provision of statistical advice (through the Statistical Advisory Service) to graduate students and faculty at the University and to researchers off campus. For example, we are currently involved in a project to investigate the relationship between forest inventory data stored in a GIS and habitat data obtained by ground crews.
- the development of statistical methodology to study the effects of restrictions on randomization upon analysis of variance models. This is being done by a Ph. D. student under my supervision.

Dissemination of the research findings is through publications in refereed journals. However, because of the time lag between completion of a research project and the eventual publication in a journal, I also regularly give presentations at conferences where the users of the research are most likely to attend and have given workshops to transfer the results to ecologists. My work in statistical consulting is important for similar reasons - to ensure that modern methods in statistics are effectively used in other disciplines.

- [capture-recapture, statistical ecology, experimental design, statistical consulting]
- Statistics - experimental design COMPLEX EXP DESIGN
- Statistics - statistical ecology MARK-RECAPTURE
- Statistics - statistical ecology TAGGING
- Statistics - statistical ecology BAND RECOVERY

Completed Works

Refereed Publications (in the past 5 years)

Chavarie, L., Dempson, J.B., Schwarz, C.J., Reist, J.D., Power, G., and Power, M. (2010). Latitudinal variation in growth among Arctic charr in eastern North America: evidence for countergradient variation? *Hydrobiologia*, **, ****-****. DOI: 10.1007/s10750-009-0043-z

Lettink, M., Norbury, G., Cree, A., Seddon, P.J., Duncan, R., and Schwarz, C. J. (2010). Removal of introduced predators, but not artificial refuge supplementation, increases skink (*Oligosoma maccanni*) survival in coastal duneland, New Zealand. *Biological Conservation* 143, 72-77.

Sutherland, J. M., Castelluccio, P., and Schwarz, C. J. (2009). A multi-level model for continuous time population. *Biometrics* 65, 841-849. DOI: 10.1111/j.1541-0420.2008.01129.x

Cowen, L., Walsh, S., Schwarz, C. J., Cadigan, N., and Morgan, J. (2009). Estimating exploitation rates of a migrating population of yellowtail flounders using multi-state mark-recapture methods incorporating tag-loss and variable reporting rates. *Canadian Journal of Fisheries and Aquatic Sciences*, 66, 1245-1255. DOI:10.1139/F09-082

Schwarz, C. J. (2009). Migration and movement -- the next stage. Pages 325-350 in *Modeling Demographic Processes in Marked Populations Series: Environmental and Ecological Statistics*, Vol. 3. Thomson, David L.; Cooch, Evan G.; Conroy, Michael J. (Eds.). Springer, New York.

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Skibo, K. M., Schwarz, C. J. and Peterman, R. M. (2008). Evaluation of sampling designs for red sea urchins (*Strongylocentrotus franciscanus*) in British Columbia, Canada. *North American Journal of Fisheries Management* 28, 219-230. DOI: 10.1577/M06-293.1

Muthukumarana, S., Schwarz, C. J., and Swartz, T. B. (2008). Bayesian analysis of mark-recapture data with travel-time-dependent survival probabilities. *Canadian Journal of Statistics* 36, 5-28.

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Schwarz, C. J. (2007). Computer-aided statistical instruction - multi-mediocre techno-trash? *International Statistical Review* 75, 348–354. DOI:10.1111/j.1751-5823.2007.00035.x

Sutherland, J. M., Schwarz, C. J., and Rivest, L. P. (2007). Multi-List Population Estimation with Incomplete and Partial Stratification. *Biometrics* 63, 910-916. DOI: 10.1111/j.1541-0420.2007.00767.x.

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Anthony, R.G., Forsman, E.D., Franklin, A.B., Anderson, D.R., Burnham, K.P., White, G.C., Schwarz, C.J., Nichols, J.D., Hines, J.E., Olson, G.S., Ackers, S.H., Andrews, L.S., Biswell, B.L., Carlson, P.C., Diller, L.V., Dugger, K.M., Fehring, K.E., Fleming, T.L., Gerhardt, R.P., Gremel, S.A., Gutiérrez, R.J., Happe, P.J., Herter, D.R., Higley, J.M., Horn, R.B., Irwin, L.L., Loschl, P.J., Reid, J.A., and Sovern, S.G. (2006). Status and trends in demography of northern spotted owls, 1985–2003. *Wildlife Monographs* 163, 1-47.

Computer Software and On-line WWW Materials (in the past 5 years)

Bonner, S.J. and Schwarz, C. J. (2009) BTSPAS - Bayesian Time Stratified Petersen Analysis System. An R package submitted to the CRAN with software using the Trinity River Restoration Program (TRRP) project.

Contract and Consulting Reports (in the past 3 years)

Schwarz, C. J. (2010). Analysis of preliminary creel survey and recommendations for a creel survey of Kootenay Lay, British Columbia. Prepared for Fish & Wildlife Compensation Program – Columbia Basin. 46pp.

Schwarz, C. J. (2010). A review of the use of safety factors in environmental toxicology. Prepared for B.C. Ministry of Environment. 10 pp.

Moore, D. L., Schwarz, C. J., and Bercovitz, I. (2010). A proposed survey to estimate the vehicle kilometers driven in BC for use in estimating carbon dioxide emissions. Prepared for the B.C. Ministry of Environment. 2010-05-20. 38 pp.

Schwarz, C. J. (2010). Review of “Effects of Selenium on American Dippers and Spotted Sandpipers in the Elk River Valley, British Columbia” and “Accumulation of Selenium and Lack of Severe Effects on Productivity of American Dippers (*Cinclus mexicanus*) and Spotted Sandpipers (*Actitis macularia*)”. Prepared for the B.C. Ministry of Environment. 5pp. 2010-05-07.

Schwarz, C. J. (2010). Review of “Uptake of selenium and productivity in waterfowl in the Elk River Valley, British Columbia”. Prepared for the B.C. Ministry of Environment. 4pp. 2010-05-06.

Schwarz, C. J. (2010). Review of “Evaluation of Selenium Related deformities among Columbia Spotted Frog tadpoles in wetlands downstream of coal mines in the Elk Valley, BC”. Prepared for the B.C. Ministry of Environment. 2pp. 2010-05-11.

Bercovitz, I. and Schwarz, C. J. (2010). Proposed methods for auditing returned beverage containers in British Columbia. Prepared for Encorp BC. April 2010. 10 pp.

Schwarz, C. J. (2010). A simulation study to examine the performance of a proposed tagging program on MilleLacs, MN. Produced for the Minnesota Department of Natural Resources. February 2010. 10pp.

Schwarz, C. J. (2010). Review of “Canadian Water Quality Guidelines for Cadmium: Scientific Criteria Document dated 2010-02-02”. Performed for the B.C. Ministry of Environment. February 2010. 10 pp.

Jones, R., Jeffery, S., DeFrootas, B. and Schwarz, C. J. (2009). Estimation of reference points and a precautionary harvest strategy for the razor clam (*Siliqua patula*) fishery at Haida Gwaii. Submission to the Pacific Stock Assessment Review Committee, December 2009.

Schwarz, C.J., D. Pickard, K. Marine and S.J. Bonner. 2009. Juvenile Salmonid Outmigrant Monitoring Evaluation, Phase II– December 2009. Final Technical Memorandum for the Trinity River Restoration Program, Weaverville, CA. 155 pp. + appendices.

- Schwarz, C. J. (2009). Review of Development of Site-Specific BAFs for Se in the Elk Valley: Summary of Statistical Analyses. Contract report for the B.C. Ministry of Environment, 6 pp.
- Schwarz, C.J. (2009). A review of the "California Coastal Salmonid Population Monitoring Plan: Overall strategy, design and methods". Report produced for the California Department of Fish and Game, 5pp.
- Schwarz, C. J. (2009). Review of "Wildlife Effectiveness Monitoring of Revegetation in Kinbasket Reservoir – Draft Technical Report (Version 2) – 2008" performed for B.C. Hydro. 2009-05-19. 9 pp.
- Schwarz, C. J. (2009). Review of Coggins and Walters (2009) "Abundance trends and status of the Little Colorado River population of Humpback Chub: An update considering data from 1989-2008". Conducted for the U.S. Geological Survey, Grand Canyon Monitoring and Research Center. 10pp.
- Schwarz, C. J. (2009). Analysis of the Petitot River Walleye telemetry study. Prepared for the B.C. Ministry of the Environments. Dated 2009-03-20. 34 pp.
- Schwarz, C. J. (2009). Considerations in design a long-term tagging program to monitor the Walleye population in Mille Lacs, Minnesota. Prepared for the Minnesota Department of Natural Resources dated 2009-01-20. 6 pp.
- Schwarz, C. J. (2009). Analysis of the mark-recapture studies for walleye in Mille Lacs, Minnesota: 2008 report. Prepared for the Minnesota Department of Natural Resources dated 2009-01-20, 33 pp.
- Schwarz, C. J. (2008). A Sensitivity Analysis of various scenarios on the estimation of the HC5 in Species Sensitivity Distributions (SSD). Prepared for the B.C. Ministry of Environment. 2008-12-08. 17pp.
- Schwarz, C.J. (2008). Review of book proposal on use of Bayesian methods for ecologists using WinBugs for Elsevier, Science and Technology Books. 10 pp.
- Schwarz, C. J. (2008). A review of the protocol for the derivation of water quality guidelines, especially through the use of Species Sensitivity Distributions (SSD). Prepared for B.C. Ministry of Environment. 19 pp.
- Schwarz, C. J. (2008). Review of "Potential Bias of Spawning Adult Walleye Mark-Recapture Population Estimates". Prepared for the Great Lakes Indian Fish and Wildlife Commission (GLIFWIC). 2008-09-24. 4 pp.
- Marine, K., Pickard, D., and Schwarz, C. J. (2008). Trinity River Restoration Program: Juvenile salmonid outmigrant monitoring evaluation. Final Technical Memorandum. Prepared for Trinity River Restoration Program. 82pp.
- Schwarz, C. J. (2008). Analysis of Moyie Burbot data -2008 report. Prepared for BC Ministry of Environment. 6 pp.
- Schwarz, C. J. (2008). A template for the analysis of vegetation monitoring studies. Prepared for FORREX. 50pp.
- Schwarz, C. J. (2008). Review of "Protocol for a line-transect evaluation of the availability of terrestrial lichen forage for Norther Caribou". Prepared for the B.C. Ministry of Environment. 6pp + Detailed comments on actual review protocol.
- Schwarz, C. J. (2008). Survey Selection for Camping Satisfaction Survey of B.C. Parks. Prepared for B.C. Ministry of Parks. 5 pp + computer code.
- Bonner, S. J. and Schwarz, C. J. (2008). Analysis of Variability in Water Quality, Sediment Quality, and Abundance of Benthic Organisms in Two Lakes of the Koala Watershed. Report for Rescan Environmental Services Ltd. 71pp.

Works Submitted for Refereed Publications

- Huston, C. and Schwarz, C. J. (2010). Hierarchical Bayesian strategy for modelling correlated compositional data with observed zero counts. Submitted to Biometrics, June 2010.
- Bonner, S.J., Schwarz, C. J., Pickard, D., Marine, K. (2010). A Bayesian hierarchical model with splines for Time-Stratified Petersen experiments. Canadian Journal of Fisheries and Aquatic Sciences. Submitted 2010-03-01.
- Bonner, S.J. and Schwarz, C.J. (2010). Smoothed estimates for time-stratified mark-recapture experiments using Bayesian P-splines. Biometrics. Submitted 2010-03-10.

Conferences, Workshops and Presentations (in the past 10 years)

Invited Talks (in the past 5 years)

- July 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Schwarz, C. J. (2009). Discussant of "Misspecifying a random effects distribution: Why getting it wrong probability doesn't matter."
- March 2009 Resource and Environmental Management Graduate Student Colloquium. Schwarz, C. J. (2009). Bayesian analysis of mark-recapture data with travel- and spatial-dependent survival probabilities.
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland, 9-11 July 2008. Schwarz, C. J. (2008). Designed experiments in capture-recapture studies.
- July 2008 Canadian Integrated Program for Antimicrobial Resistance (CIPARS) meeting July 2008, Guelph, Ontario. We were invited to the CIPARS meeting after CIPARS received the M.Sc. thesis of Wu. Wu, H. and Schwarz, C. J. (2008). The analysis of Minimum Inhibitor Concentration (MIC) data from CIPARS.
- July 2008 International Biometrics Conference, Dublin, Ireland, 13-18 July 2008. Sutherland, J. M. and Schwarz, C. J. (2008). Multi-List Methods Using Incomplete Lists in Closed Populations.
- June 2008 The International Environmetrics Conference, Kelowna, BC. 8-13 June, 2008. Schwarz, C. J. (2008). The analysis of designed experiments in capture-recapture studies.
- June 2008 B.C. Centre for Disease Control. Schwarz, C. J. (2008). Multi-list methods: methodological problems and advances.
- September 2007 Pacific Salmon Commission Workshop on Genetic Stock Identification and its use for Pacific salmon management. 11-13 September 2007. Vancouver, B.C. Schwarz, C. J. (2007). The use of small area estimation with Genetic Stock Identification.
- March 2007 Institut Fédératif de Recherche, Faculté des Médecine, Toulouse, France. 23 March 2007. Schwarz, C. J. (2007). Estimating population sizes using multi-list methods.
- March 2007 Centre d'Ecologie Fonctionnelle et Evolutive, Montpellier, France 28 March 2007. Schwarz, C. J. and Muthukumarana, S. (2007). Estimation of travel times and related parameters using capture-recapture methods.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Schwarz, C. J. (2007). Formal experimental design and capture-recapture studies.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Schwarz, C. J. (2007). Migration and movement - the next stage.
- December 2006 A Taste of Pi. Schwarz, C. J. (2006). One fish, two fish, ... How to estimate the size of animal and human populations using mark-recapture methods.
- June 2006 PRIMES workshop on Bayesian methods in Ecology. Schwarz, C. J. and Dupuis, J. A. (2006). A Bayesian approach to the Stratified Jolly-Seber Model.
- May 2006 Capture 2006 - A conference on capture-recapture methods. Université Laval, Quebec City, 2006-05-01. Schwarz, C. J. and Dupuis, J. A. (2006). The Stratified Jolly-Seber Model.
- May 2006 Capture 2006 - A conference on capture-recapture methods. Université Laval, Quebec City, 2006-05-01. Schwarz, C. J. (2006). Multi-state capture-recapture models. Past, present, and future.
- April 2006 Western Enviro-Agricultural Laboratory Association. Edmonton, Alberta, 2006-04-19. Schwarz, C. J. (2006). Statistical Considerations for Designing Monitoring Studies.
- March 2006 Science Subcommittee of the Wood Buffalo Environmental Association. Calgary, AB. 2006-03-01. Schwarz, C. J. (2006). Statistical Considerations for Designing Monitoring Studies.
- January 2006 UBC/SFU Graduate Student Workshop. 2006-01-16. Vancouver, BC. Schwarz, C. J. (2006). A (very) short tour of mark-recapture.

Presentations (in the past 5 years)

- March 2010 Automobile Fuel Cell Corporation. Burnaby, B.C. Schwarz, C. J. (2010). Beyond simple regression.

- January 2010 Trinity River Science Symposium. Weaverville, CA, 13-14 January 2010. Schwarz, C. J., Pickard, D., Marine, K., and Bonner, S. J. (2010). Trinity River Restoration Program Juvenile Salmonid Outmigrant Monitoring Program Evaluation.
- June 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Bonner, S. and Schwarz, C. J. (2009). Capture-recapture, Jolly-Seber, and the Horvitz-Thompson Estimator: ML Estimates of Abundance for populations with variable capture probabilities.
- June 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Challenger, W. and Schwarz, C. J. (2009). Occupancy modelling with multiple states and multiple seasons.
- June 2009 Statistical Society of Canada Annual Meeting, Vancouver, 1-3 June 2009. Huston, C. and Schwarz, C. J. (2009). Spatial CAR models and compositional data. **Huston won a student paper award for her paper and presentation.**
- April 2009 Graduate student seminar series. Dean, C.D., Lockhart, R.A., Schwarz, C. J. (2009). "Peer-Reviewed Publishing: the writing, submission and review process". Presentation to graduate students. 2009-04-17.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Wu, H., Schwarz, C. J., and de With, N. (2008). Linear Models for Minimum Inhibitory Concentration (MIC) Data on Anti-microbial Resistance. Prepared and presented by Schwarz based on M.Sc. thesis by Wu.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Challenger, W. and Schwarz, C. J. (2008). Mark-recapture Jolly-Seber Abundance estimation with classification uncertainty. Poster.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Huston, C. and Schwarz, C. J. (2008). Interpretation of Acoustic Tag Signals of Transplanted Black Rockfish. Poster.
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland. 9-11 July 2008. Challenger, W. and Schwarz, C. J. (2008). Optimal designs for the multinomial mixture model: a power analysis. **This presentation won a Student Best Presentation Award at the conference.**
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland. 9-11 July 2008. Huston, C. and Schwarz, C. J. (2008). Estimating stock proportions in Fraser River salmon runs using a multivariate CAR model.
- July 2008 International Biometrics Conference, Dublin, Ireland. 13-18 July 2008. Cowen, L. and Schwarz, C. J. (2008). Estimating Exploitation Rates of a Migrating Population of Yellowtail Flounders using Multi-state Mark-recapture Methods incorporating Tag Loss and Variable Reporting Rates. Poster.
- July 2008 International Statistical Ecology Conference, St. Andrews, Scotland, 9-11 July 2008. Cowen, L. C. and Schwarz, C. J. Estimating exploitation rates using multi-state mark-recapture methods incorporating tag loss.
- May 2008 Institut Mediterrani d'Estudis Avançats (IMEDEA), Mallorca, Spain. Schwarz, C. J. (2008). The analysis of designed experiments in capture-recapture studies.
- May 2008 Statistical Society of Canada Annual Meeting, 25-29 May 2009. Ottawa, Canada. Wu, H., de With, N., Schwarz, C. J., and Loughin, T. (2008). Statistical inference for Minimum Inhibitory Concentration (MIC) data. Poster presented at the SSC meeting.
- May 2008 Statistical Society of Canada Annual Meeting, 25-29 May 2009. Ottawa, Canada. Bonner, S. J. and Schwarz, C. J. (2008). Hierarchical Bayesian Modelling of Two-Stage Capture-Recapture Experiments. **This presentation won the Student Presentation Award at this meeting.**
- January 2008 Review panel for the Trinity River Restoration Project. Redding, California, 2008-01-22. Schwarz, C. J. (2008). Review of estimation methodology for the Trinity River Restoration Project
- August 2007 American Statistical Association Annual Meeting, Salt Lake City, Utah, 2 August 2007. Sutherland, J.M., Schwarz, C.J., Rivest, L.-P. (2007). Multi-list Population Estimation with Incomplete and Partial Stratification.
- June 2007 Statistical Society of Canada Annual Meeting. St. John's, NL. 11-13 June 2007. Huston, C. and Schwarz, C. J. (2007). Finding the fish: Straying trends between B.C. Pacific herring (*Clupea pallasii*) populations.
- June 2007 WNAR/IMS Annual Meeting, University of California, Irvine. June 26 2007. Bonner, S.J. and Schwarz, C.J. (2007). Bayesian Smoothing of the Stratified-Petersen Model.
- January 2007 EURING 2007, Dunedin, New Zealand, 14-20 January 2007. Bonner, S.J., Thomson, D., and Schwarz, C. J. (2007). Time-varying covariates and semi-parametric regression in capture-recapture studies.
- January 2006 UNBC Department of Statistics, Mathematics, and Physics. 31 January 2006. Schwarz, C. J. (2006). A (very) short tour of mark-recapture.