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| From: | Dr. Andrew Paul  Provincial Environmental Flow Specialist  Alberta Environment and Parks  Kenton Neufeld  Senior Fisheries Biologist  Alberta Environment and Parks  Rocky Mountain House  kenton.neufeld@gov.ab.ca | Our File Reference: |  |
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| Your File Reference: |  |
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| To: | Dr. Carl Schwarz  StatMathComp Consulting by Schwarz, Inc  625 Bentley Road  Port Moody, BC V3H 3A4 | Date: | 7 January 2019 |
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| Email: |  |
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| Subject: | **Proposal to develop analytical methods in R for before-after control-impacted watershed experiments** | | |

**Background**

Intensive OHV reclamation activities and reductions in public motorized access have been initiated in Alberta to support native trout recovery. “Intensive” efforts are defined as those improving >50% of highly degraded trout habitat. Extensive restoration is required to deliver measurable changes in fish abundance; others have predicted restoring 20% of a degraded stream was required to achieve a 25% increase in smolt production for coho salmon and 100% of the habitat would need to be restored to be 95% certain of achieving a 25% increase in smolt production. In Alberta, three HUC 10 watersheds targeted for remediation: Rocky Creek, Fall Creek, and Mackenzie Creek. It is the goal of Alberta Environment and Parks to monitor fish populations in these watersheds and detect if the reclamation activities result in a measurable change to the density of immature and adult fish, particularly bull trout. For Rocky Creek, there are three HUC 10 control watersheds; for Mackenzie Creek there are two HUC 10 control watersheds; and, for Fall Creek, there are no control watersheds.

In addition to reclamation activities on these watersheds, landscape-level experiments are being used to evaluate management actions on fish populations throughout the province. Similar to reclamation activities on Rocky, Fall and Mackenzie, the study design of these landscape-level experiments can follow one of several permutations in the spectrum of before-after, control-impacted or multiple treatments. Having a statistically rigorous framework for evaluating these studies will be important both scientifically and to stakeholders.

**Objective**

The objective of the proposed work is to develop analytical methods in R to statistically evaluate the unbalanced multiple treatment BACI design of the OHV reclamation projects on Rocky, Fall and Mackenzie creeks. The analytical methods must include:

1. a matched before-after control-impact (mBACI) design for evaluating a single watershed treatment;
2. a pooled mBACI design using a Bayesian hierarchical approach to allow sharing of information across watersheds;
3. update previously completed power analysis for BACI designs if methods change; and,
4. an approach to deal with treatment responses that change both magnitude or trend in observed data.

As the experimental reclamation projects have only started, the above designs are to be illustrated using simulated data for differing response levels to restoration. Although, the analysis is focussed on reclamation activities in three watersheds. The analytical approach should be made generic to facilitate application to other landscape-level experiments.

**Deliverables**

There are two deliverables from the proposed works:

1. The R code necessary to evaluate the Rocky, Fall and Mackenzie creeks OHV reclamation study using BACI designs outlined in the above objectives. The R code must be sufficiently commented to guide knowledgeable users in applying the methods to new BACI datasets with varying numbers of treatments and controls.
2. Supporting documentation that are sufficient for an independent scientific review to understand and evaluate the methods developed.

**Budget**

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| --- | --- | --- | --- |
| **Task** | **Days** | **Cost per day** | **Cost** |
| Preparation of R code | 2 | $1000 | $2000 |
| Preparation of draft document | 1 | $1000 | $1000 |
| Preparation of final document | 1 | $1000 | $1000 |
|  |  | Total (including GST) | $4000 (AB is GST exempt) |

**Timeline**

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| --- | --- |
| **Task** | **Date** |
| R code complete |  |
| Draft document complete |  |
| Comments/edits on document and R code from AEP returned to Dr. Schwarz |  |
| Final document and R code submitted | 31 March 2019 |