Bridge River Project Water Use Plan

Lower Bridge River Spiritual and Cultural Value Monitoring

Implementation Year 2

Reference: BRGMON-16

2015 Data Report

Study Period: July 31, 2014 – June 30, 2015

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MON-16 STATUS of OBJECTIVES, MANAGEMENT QUESTIONS and HYPOTHESES after Year 2

Study Objectives	Management Questions	Management Hypotheses	Year 2 (2014-2015) Status
Collect information needed on the smell, sound, movement and interaction of people and water of the Lower Bridge River under the 6 cms/y flow regime and use this information to evaluate the cultural and spiritual objective that was discussed in the Consultative Committee process.	How does the smell, sound, movement and interaction (of people and water) on the Lower Bridge River under the 6 cms/y flow regime compare with that in the Yalakom River, an adjacent unregulated tributary of the Lower Bridge River?	The smell, sound, movement and interaction (of people and water) on the Lower Bridge River under the 6 cms/y flow regime does not differ from the Yalakom River.	Results suggested a preliminary conclusion that the spiritual and cultural values are insensitive to water flow levels
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Executive Summary

The BRGMON-16 Water Use Plan (WUP) monitoring project was undertaken to measure and monitor a set of cultural and spiritual attributes of different flow discharges in the Lower Bridge River (LBR) below Terzhagi Dam. The information is needed to incorporate non-tangible inputs into a future long-term flow decision for the LBR. Between six to nine St'át'imc elders participated as evaluators to score their perceptions of cultural and spiritual values at different water flow discharges ranging between 5.1 cubic meters per second (cms) in August'14, 1.5 cms in October'14, 3 cms in March'15 and 13 cms in May'15. The Yalakom River was adopted as an adjacent (unregulated) control river and four seasonal surveys were simultaneously conducted in the LBR and the Yalakom. A total of 9 variables were evaluated at 10 sites with a scoring system that ranged between 0 (least favorable) and 4 (most favorable).

The data were analyzed by means of a General Linear Model statistical approach which yielded the following results:

1. There were significant seasonal differences in BIRDSONG, water CLARITY, DIVERSITY of water movement, EDGE SMELL, MOVEMENT of the water and WADEABILITY.

2. There were significant between-river differences in BIRDSONG, EDGE SMELL, MOVEMENT of the water and WADEABILITY.

3. There were significant between-year differences in ACCESS and SMELL.

4. There significant interactions between-season x river in BIRDSONG, water CLARITY, EDGE SMELL, SMELL, MOVEMENT and WADEABILITY.

5. There were significant interactions between river x year in water CLARITY.

6. There were significant interactions between season x year in water CLARITY.

The 9 variables were analyzed both statistically and graphically. The statistical results indicated no significant variation in the parameter scores across the seasonal flow discharges. Similar results were shown graphically and in spite of the large variations in flow conditions which ranged in the LBR between 1.5 cms and 13 cms there was little variation in parameter values. These results suggest that spiritual and cultural values appear to be insensitive to flow variations for the range of flows that were examined.

Contents

Introduction

This project was undertaken between August 19, 2014 and May 15, 2015 to monitor some of the intangible but culturally significant attributes of higher flows in the Lower Bridge River and their influence on peoples' perceptions of river health. This work is designed to assess the influence of flow changes associated with the Water Use Plan (WUP) on biological components and human perceptions of the ecosystem (present project).

The structured decision-making framework developed by Compass Resource Management Ltd. and the former Bridge River Technical Working Group (TWG) addressed 9 different objectives or endpoints. Eight of these -- salmon, river health, riparian health, riverine birds, species of concern, financial impacts, learning, and stewardship – were measurable via empirical data or through judgments from members of the TWG (e.g., assessments of learning associated with different flows). The spiritual and cultural objective, concerned with changes in the smell, sound, movement, and interaction associated with different flows of water in the Lower Bridge River, is expressed through scales for which input is obtained only from members of the St’át’imc community. This report describes the second year of a project that St’át’imc Eco Resources undertook on behalf of BC Hydro to monitor the impact of changing Bridge River flows on spiritual and cultural values. Unlike the original project design developed by the WUP Consultative Committee in the early 2000's which involved comparative observations under 0, 3 and 6 cms Lower Bridge River flows, the average annual discharge did not depart from 6 cms during the 2014-2015 study period, rendering the original project design inapplicable. Instead, the project was modified to include comparative observations from the Yalakom River, a tributary of the Bridge River with similar flow characteristics.

Background

The Bridge-Seton Consultative Committee (BRG WUP CC) and more recently the Bridge River Technical Working Group recommended that as part of the Water Use Plan the current flow testing program now underway at Terzaghi Dam be continued and expanded from an average of 3 cms/y to a second flow level (6 cms) to empirically document the response of the ecosystem to instream flow changes in Lower Bridge River. A long term test flow release program was recommended with monitoring programs to empirically measure the environmental benefits that could arise from two alternative instream flow release regimes considered by the Bridge River Technical Working Group. The flow regimes differ in the relative shape of the delivered hydrograph and the annual water budget delivered (referred to as: 3 cms/y, 6 cms/y treatments). The 3 cms/y treatment occurred from August 2000 to April 2011, and the 6 cms/y treatment started in May 2011. While daily and monthly discharges differed from one another, the annual discharge averaged 6cms.

St’át’imc elders speak of the “spirit” or “voice” of the Lower Bridge River. They have observed that in moving from a water budget of 0 to 3 cms/y there were noticeable improvements in conditions for tangible outcomes like fish, wildlife, and riparian vegetation. But in addition, and distinct from these, there have been improvements in the “spirit” or “voice” of the river. Across the range of proposed flows (including a doubling of the average flows, from 3 cms/y to 6 cms/y), it was anticipated that there is potential for additional beneficial change to these important spiritual and cultural values.

To obtain information to better define the spiritual and cultural objective, during the TWG review process, input was collected from interviews with St’át’imc Technical Working Group members, from discussions with other members of the St’át’imc community, and from a workshop held in Lillooet in the mid-2000's to hear the views of invited St’át’imc elders and other individuals familiar with the river. From these meetings, four key qualitative components of cultural and spiritual quality were defined:

Sound:

- The voice of the water (a variable defined by the observers individually)
- Birdsong (an integration of songbird presence)

Smell:

- The smell of the river itself (as determined by the observers individually)
- The ambient smell at water’s edge (as determined by the observers individually)

Movement:

- Movement of water (seasonally appropriate)
- Diversity of movement (pools/riffles)

Interaction (of people and water):

- Shore access (ability to easily walk to the shoreline)
- “Wade-ability” (the ability to walk in and/or across the river at certain locations)

Prior to the initiation of the first session of field work in the summer of 2013, a 9th variable, water clarity, was added to the survey.

These nine components clearly do not provide a universal definition of cultural or spiritual quality. They define the aspects of cultural and spiritual quality believed to be relevant for the evaluation by St’át’imc of a suite of alternative flow regimes on the Lower Bridge River, within the (average annual) range of 0 to 6 cms/y.

This monitoring program measures these spiritual and cultural values under the 6 cms/y flow regime. For comparative purposes, the Yalakom River was adopted as an unregulated control river since it has similar flow characteristics and volumetric discharges as the Lower Bridge River. This information on spiritual and cultural values will provide an important measure that will be used along other social and environmental measures in an overall evaluation of the 6 cms/y flow regime.

The Yalakom River has been described by Komori (1997):

> "The Yalakom is 56 km in length and provides the majority of accessible stream length for salmonids within the Bridge River system....the stream gradient in the Yalakom is generally very steep, averaging 2.5% over the 15 km most commonly utilized by anadromous salmonids below the partial barrier. The typical annual hydrograph closely follows the cycle of highland snowmelt runoff causing water temperatures to be lower than the regional averages. Discharge in the Yalakom River varies from 1.4 to 28.1 cms. The torrential nature of this stream, low average temperatures and limited fish habitat reduces the production potential in the Yalakom River"

The Bridge River originates in the ice fields of the Coast Mountains and flows east for 154 km before entering into the Fraser River 5 km north of Lillooet. The Lower Bridge River is confined to a narrow valley downstream on Terzhagi Dam, partly cut in bedrock but often incised into glacio-lacustrine and glacio-fluvial deposits (Komori 1997) The Lower Bridge River floodplain was shaped by historical (pre-impoundment) flow levels of approximately 100 cms/year on average, and ranging as high as 700 cms during former freshet periods (Golder 1999). Thus the present-day flows represent approximately 3-6% of the former mean annual discharge. When compared with the Yalakom, the Lower Bridge River has a relatively broad flood plain reflecting the pre-impoundment flow discharges that were an order of magnitude larger than presently.

There are a few examples of projects which have integrated spiritual and cultural values in water resource management, notably in Australia (Collings 2012). The latter study presents the results of 6 pilot projects involving spiritual and cultural value components (Table 1). The focus of these projects is integration, while the focus of BRGMON 16 is on the measurement of variables which were selected due to their close alignment with spiritual and cultural values. Overall Collings (2012) concluded:

> *"Integrating the cultural and spiritual values of Indigenous people into water quality management requires careful and considered planning and follow-up, as well as due respect for Indigenous law, custom and traditional knowledge."*

Traditional approaches to the valuation of ecosystem services in river basins (Loomis et al. 2000) rely on "willingness to pay" interviews with local residents as a means for estimating resource values. The main methodological approach involves interviews with local stakeholders (Clain et al. (2014). During the present monitoring project monetization of spiritual and cultural values is not applicable and such considerations are not within the realm of the St’át’imc world view. Satterfield et al. (2013) concluded that:

> *"characterization of cultural benefits and impacts is least amenable to methodological solution when prevailing worldviews contain elements fundamentally at odds with efforts to quantify benefits/impacts, but that even in such cases some improvements are achievable if decision-makers are flexible regarding processes for consultation with community members and how quantification is structured."*

Table 1. Key findings from Australian case studies undertaken to integrate spiritual and cultural values into water quality management. Source: Collings (2012)

Case Study	Key Findings
Adelaide Coastal Water Quality Improvement Plan, South Australia	During the development phase of the draft ACWQIP, the South Australia EPA reports that stakeholders have been generally satisfied with the consultation and engagement processes. A key lesson is to ensure early engagement with Kaurna People to help achieve effective outcomes. The correct people need to be identified from the outset of such processes.
Police Lagoons Conceptual Model, Queensland	The conceptual models for Police Lagoons integrate science with cultural, spiritual and ecological values in order to inform integrated natural resource management of the lagoons. The objective is to support community goals to maintain and improve the wetland's values.
Engaging with and incorporating the views of the Queensland Far South West Aboriginal Natural Resource Management Group in water quality management planning, Queensland	The Far South West Aboriginal Natural Resource Management Group's values for the waters within the region will be incorporated into the future statutory environmental values and water quality objectives for the waters of south west Queensland under the *Environmental Protection (Water) Policy 2009*. The establishment of water quality objectives to protect aquatic ecosystem values is considered to generally afford protection of the cultural and spiritual values for the waters of the region.
Prioritising rock-holes of aboriginal and ecological significance in the Gawler Ranges, South Australia	One of the lessons learnt is that for projects like this, with a range of stakeholders from diverse backgrounds, it is very important to develop, implement and maintain a comprehensive communication/stakeholder engagement strategy prior to project initiation that continues throughout the project including follow-up.
Recognising indigenous cultural and spiritual values in maintaining river health of the Daly River, Northern Territory	Indigenous people possess intimate knowledge of their local environment and have complex value systems in connection with water and biodiversity. This knowledge is integral to holistic management planning to maintain river and ecosystem health.
Kungun Ngarrindjeri Yunnan engagement with natural resource management	Protocols of engagement provide an important framework to recognise the values and status of Indigenous people in managing natural resources. The KNY Agreement provides a framework to assist and guide interactions with Ngarrindjeri people and for the most culturally appropriate and sensitive way of doing business on Ngarrindjeri traditional lands and waters.

An interview approach is being undertaken as a separate component of the BRGMON 16 project to document St’át’imc Knowledge in relation to a broad spectrum of environmental resources and conditions. In this case, group or individual interviews provide a relevant approach for compiling information on spiritual and cultural resources. Both the interview activities and the present empirical approach complement each other and provide different lenses for understanding spiritual and values in relation to water resource management.

Objectives and Scope

The objective of this program is to collect the information needed on the smell, sound, movement and interaction of people and water of the Lower Bridge River under the 6 cms/y flow regime and to use this information to evaluate the cultural and spiritual objective that was discussed in the Consultative Committee process.

Management Questions

The primary management question that will be addressed by this monitoring program is:

> *How does the smell, sound, movement and interaction (of people and water) on the Lower Bridge River under the 6 cms/y flow regime compare with that in the Yalakom River, an adjacent unregulated tributary of the Lower Bridge River?*

Hypotheses Tested by the Monitoring

The primary management question will be tested using the following hypothesis:

> H_O: *The smell, sound, movement and interaction (of people and water) on the Lower Bridge River under the 6 cms/y flow regime does not differ from the Yalakom River.*

Key Water Use Decision Affected

The key water use decision affected by this monitoring program is the long term flow regime for the Lower Bridge River. Information from BRGMON 16 monitoring program will be used along with other performance measures to evaluate the 6 cms/y flow regime.

Study Area

The Study Area for this project extends between Terzhagi Dam and the Bridge River/Fraser River confluence. Consistent with the other WUP monitoring projects on the Lower Bridge River, the Study Area was divided into 4 reaches utilizing the existing reach boundaries. Reaches 2, 3 and 4 were analyzed (Figure 1) consistent with the Terms of Reference for BRGMON 16. Reach 1 was excluded from the analysis since the effect of the Terzhagi Dam release decreases in a downstream direction due increasing influence of groundwater inflows coupled with the combined Lower Bridge River tributary inputs. Several other monitoring studies (e.g. BRGMON 1: Lower Bridge River Aquatic Monitoring) have also focused exclusively on Reaches 2, 3 and 4 due to the attenuation of Terzhagi Dam flow release effects in a downstream direction from the Dam.

Reach boundaries of the Lower Bridge River and the locations of the sampling sites are shown in the map below. There were 6 observation sites in the Lower Bridge River (B1 - B6) and 4 observation sites in the Yalakom River (Y1 - Y4). Specific site locations were selected based on ease of access within reaches in order to maintain safe operating procedures and low risk of falling/injury.

The annual hydrographs for the two study rivers are shown in Figures 2.

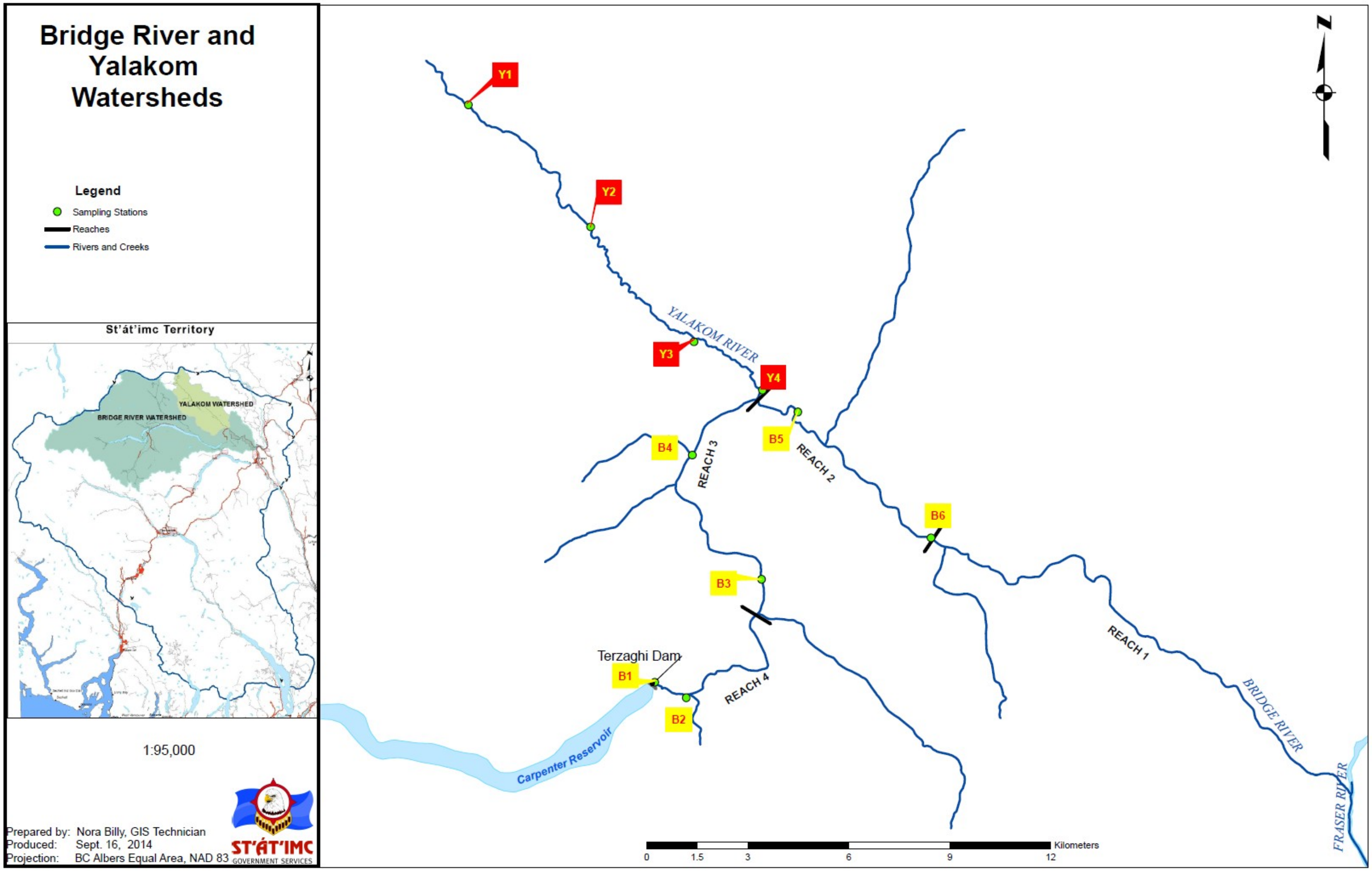

Figure 1. Location of sampling sites in the Yalakom and Lower Bridge Rivers.

The hydrograph for the Yalakom River (Figure 2) based on averaged Water Survey of Canada data for the period 1981 - 1990 (Station 08ME025) is shown in relation to the target flows for the Lower Bridge River under 3 cms and 6 cms discharges. The Yalakom River data were collected as part of a hydrology and water use investigation in the Bridge Seton Watershed (Rood and Hamilton 1995) that was commissioned by DFO during Fraser River Action Plan investigations. The Lower Bridge River flow discharges for 2013 and 2014 (Figure 3) were obtained from BC Hydro records. The selection of the Yalakom River as an unregulated control river for conditions in the Lower Bridge River was predicated on the occurrence of similar hydrographs in the two systems (Figure 2).

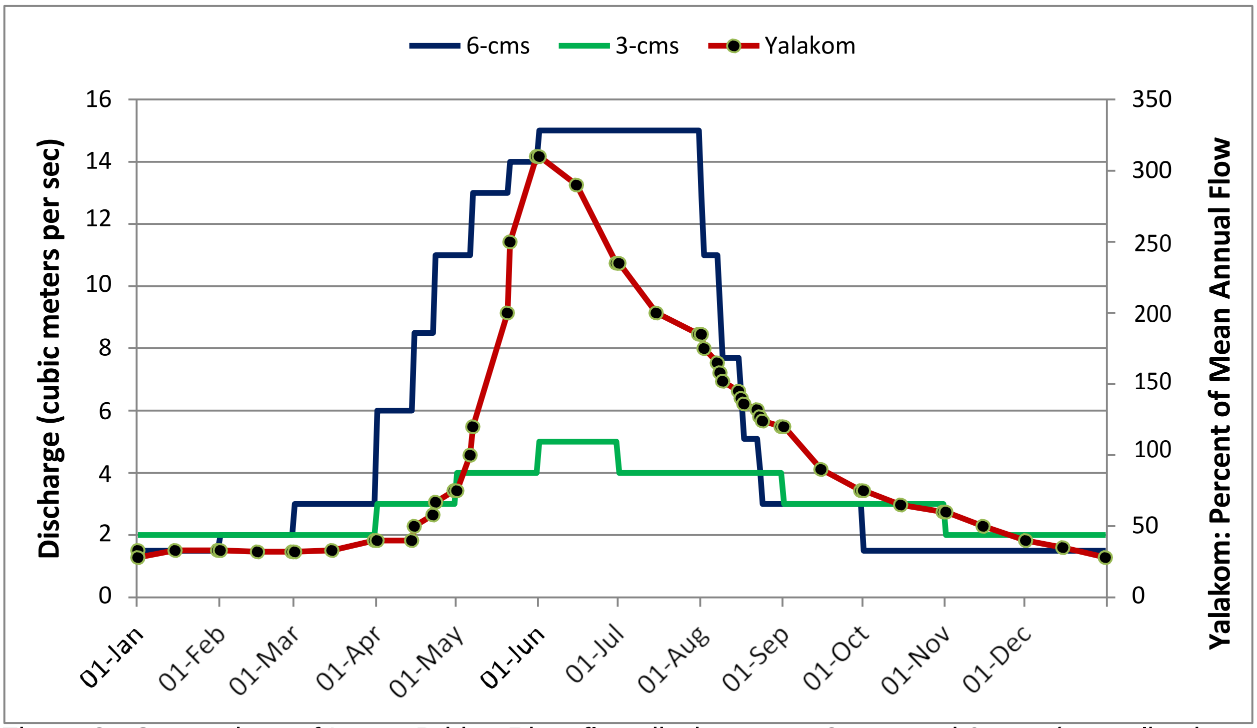

Figure 2. Comparison of Lower Bridge River flow discharges at 3 cms and 6 cms (annualized mean flow) in relation to averaged Water Survey of Canada data for the period 1981 - 1990 (Rood and Hamilton 1995). The annual mean Yalakom flow over this period was 4.11 cms.

The Lower Bridge River hydrographs (Figure 3) show the idealized flow discharges as agreed upon with the BC Comptroller of Water Rights in relation to measured flows between 2013 - 2015. Actual flows didn't depart significantly from the idealized target flows over the period of BRGMON 16 data collection between July 31, 2013 and March 7, 2015.

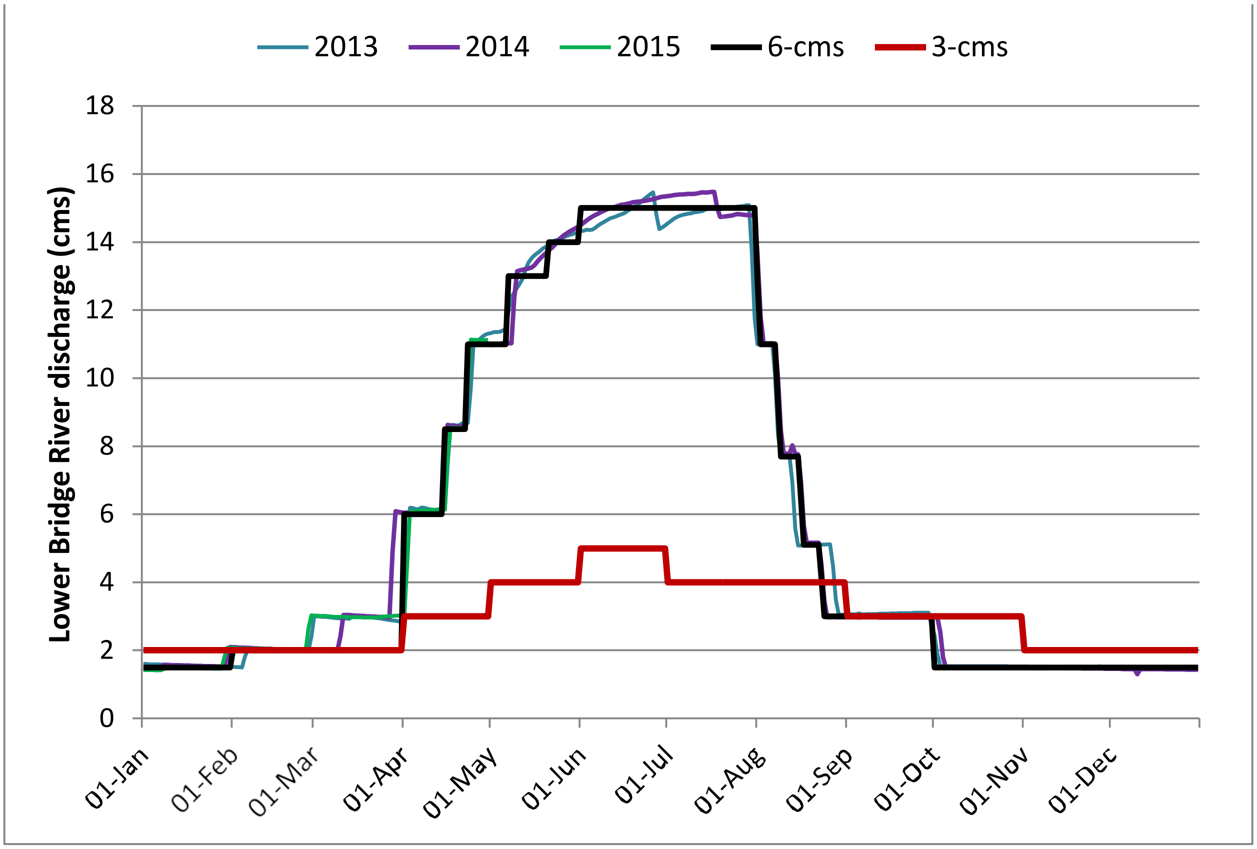

Figure 3. Actual flow discharges in the Lower Bridge River over the data collection time period. Flow discharge data provided by BC Hydro, Power Records.

Approach and Methods

To maintain consistency and transparency in assessment, a ***Cultural and Spiritual Quality Scale*** and a protocol for measuring it was utilized. The approach involved:

- a committee of 6-9 St'át'imc elders to act as observers;
- observations to be taken four times per year under a range of flows;
- observations to be taken at two Lower Bridge River sites per reach over reaches 4, 3 and 2;
- observations to be taken at four Yalakom sites;
- a simple and transparent scoring system for assigning scores to each component in each reach; and
- a plan for aggregating scores across observers, components, reaches and seasons.

Cultural and Spiritual Quality measures were evaluated at the conclusion of the field season in terms of how these measures change with respect to different flows. Results were compared with those obtained from scales that address the other eight objectives utilized in the previous Structured Decision Making process for the Lower Bridge River[1]. Further, implementation of the program will be consistent over time, so as to enable the comparison of measures taken in different seasons or in different years.

Table 2: Summary of the implementation plan.

Who	6-9 members of the St'át'imc community. Continuity in membership is maintained so that consistency in the conduct of measurements is achieved.
When	Four times per year, at flows and seasons that represent a range of conditions: September (low flows, spawning fish present) February (low flows, winter conditions) April (moderate flows, spring conditions) June (peak flows, summer conditions, relatively low fish abundance/visibility). Sampling dates adopted in 2013-2014 were replicated in the 2014-2015 surveys.
Where	Sampling sites are located on Figure 1. They include two sites per reach for each of Lower Bridge River Reaches 4, 3 and 2 as well as 4 Yalakom River sites

[1] salmon, river health, riparian, riverine birds, species of concern, financial impacts, learning, and stewardship

Individual Reach Scoring	On the designated date and site, each observer assigned a score of 0 to 4 for each of the four components (sound, smell, movement, interaction as well as water clarity), where 0 = low quality, 1 = moderately low quality, 2 = moderate quality, 3 = moderately high quality and 4 = high quality.
Aggregating Across Observers	A simple average of scores across observers was used, assuming equal weighting of observers and components.
Aggregating Across Reaches	This evaluation was analyzed statistically utilizing a General Linear Model.
Aggregating Across Seasons, Rivers and Years	This evaluation was analyzed statistically utilizing a General Linear Model.
Supporting Documentation	Conditions at each site were recorded by video camera and still photography.

Scoring from this Cultural and Spiritual Quality scale was used along with other social and environmental measures in an overall assessment of the 6 cms/y flow regime. Anticipating that the elders would be unfamiliar with the adopted scoring system, the method was calibrated during a classroom session prior to the first field trip in 2013. During the session, elders scored their preference for 3 flavors of potato chips - salt and vinegar, barbeque and regular - according to the 0-4 scoring system above. Results demonstrated clear preferences for different chip flavours with barbeque rated highest preference with salt and vinegar lowest. Thereafter, the elders had a good understanding of the method for scoring the spiritual and cultural variables.

Collected data were subjected to two different methods of analysis: 1) a graphical analysis by plotting histograms that displayed the mean and standard deviations of the spiritual and cultural attribute scores, and 2) General Linear Interactive Modelling (GLIM) a statistical software program for fitting generalized linear models (GLMs). It was advantageous to apply two independent analytical procedures to the BRGMON 16 data set to understand areas of convergence and divergence between the two methods.

The GLIM procedure involved the following procedures. First, the model with all fixed effects of interest, including interactions, was fitted to the data. Next, the least significant interaction was removed and the model was refit to the data. Lastly, the preceding step was repeated until the model only contained significant interactions and main effects (note that non-significant main effects were retained in models where they were part of a significant interaction).

Schedule

The Terms of Reference (TOR) indicated September (low flows, spawning fish present), February (low flows, winter conditions) April (moderate flows, spring conditions), and June (peak flows, summer conditions, relatively low fish abundance/visibility) as the preferred sampling schedule. The actual scheduled surveys during 2014-2015 were August 19-20 2014, Oct. 7-8 2014, March 17-18 2015 and May 14-15 2015. The timing of the surveys relative to the Lower Bridge River hydrograph, is shown on Figure 4. Minor departures from the TOR schedule were unavoidable due to logistical constraints, however, the deviations were minor and observations during 2014-2015 covered a wide range of flow conditions.

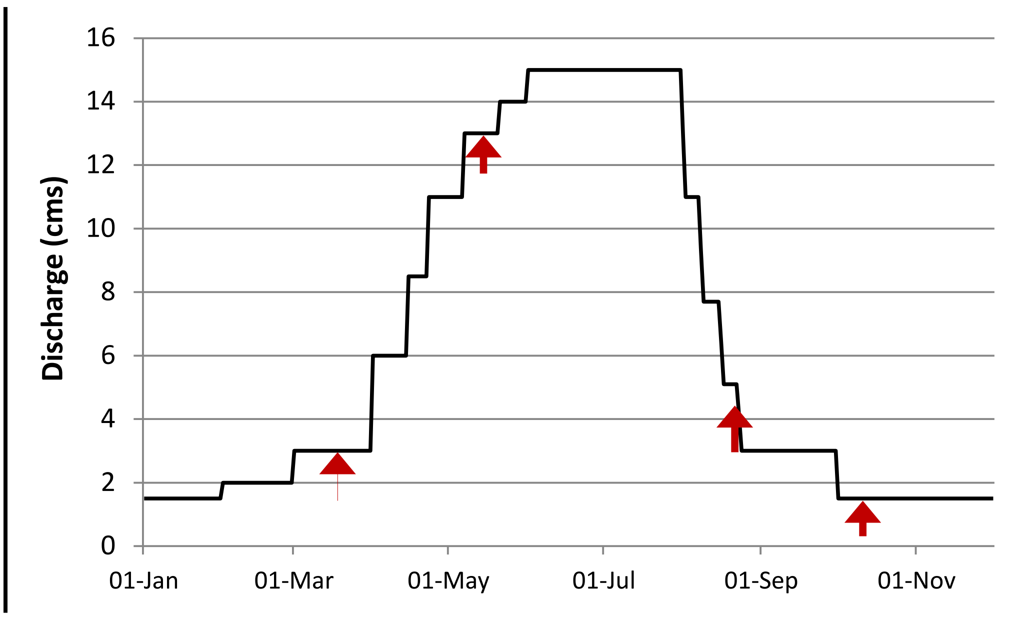

Figure 4. Timing of surveys (red arrows) in comparison with the Lower Bridge River hydrograph.

The surveys bracketed the range of Lower Bridge River flows and included the following flow conditions:

	Lower Bridge River Flow	Approximate Yalakom Flow[2]
August 19-20	5.1 cms	7 cms
October 7-8	1.5 cms	3.5 cms
March 17-18	3 cms	2 cms
May 14-15	13 cms	5 cms

[2] extrapolated from Figure 2.

Results

Mean values for the different variable were plotted as histograms and analyzed statistically using a General Linear Model (GLM - Appendix 2). Comparisons of the different measurement variables obtained in the different rivers (aggregating across sampling sites) are shown in Figures 4a and 4b.

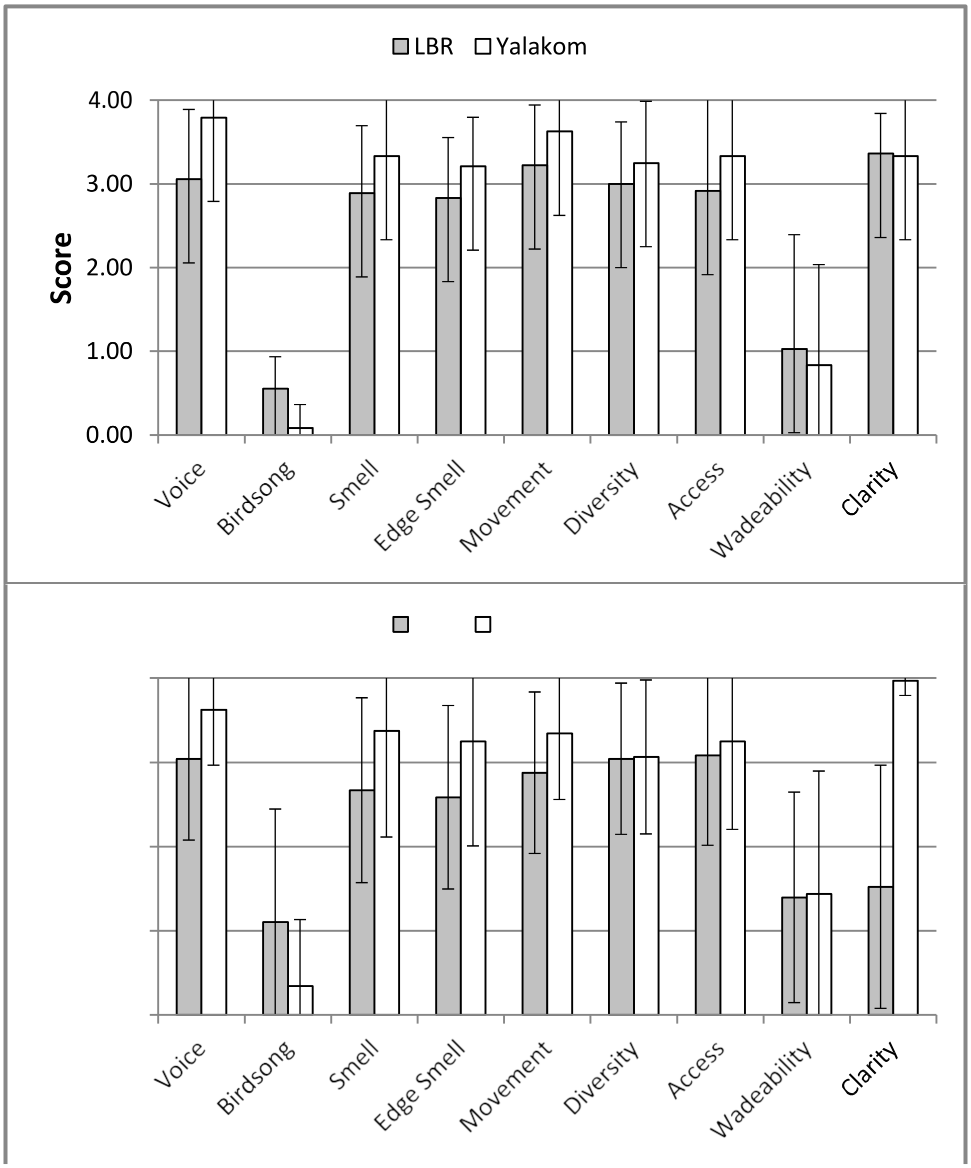

Figure 4a. Spiritual and cultural value scores in the Lower Bridge River and Yalakom River for Aug. 19-20, 2014 (upper; n = 6) and Oct. 7-8, 2014 (lower; n = 8). Error bars indicate ±1 standard deviation. Scores represent 0 = low quality, 1 = moderately low quality, 2 = moderate quality, 3 = moderately high quality and 4 = high quality.

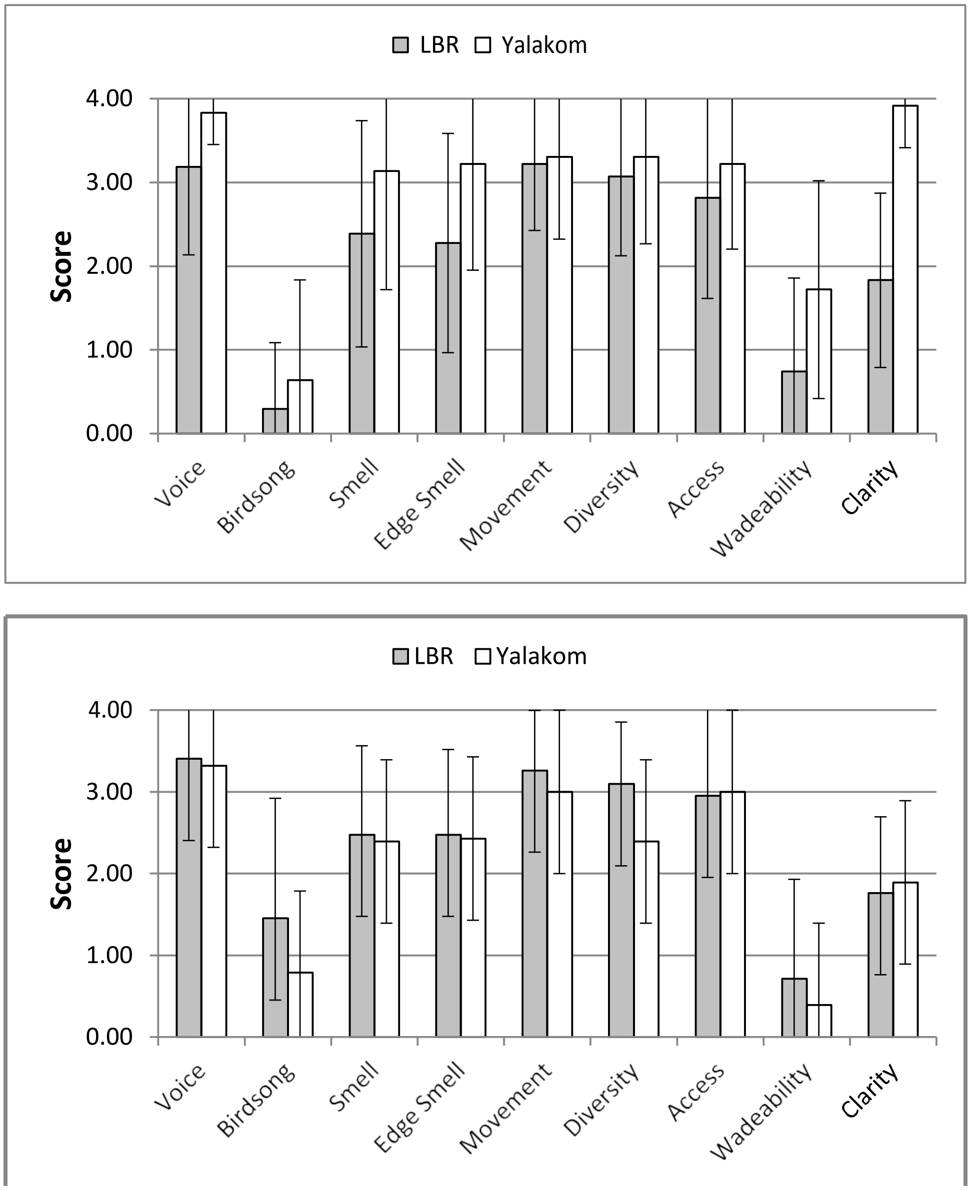

Figure 4b. Spiritual and cultural value scores in the Lower Bridge River and Yalakom River for March 17-18, 2015 (upper; n =7) and May 14-15, 2015 (lower; n = 7). Error bars indicate ±1 standard deviation. Scores represent 0 = low quality, 1 = moderately low quality, 2 = moderate quality, 3 = moderately high quality and 4 = high quality.

During the first 3 surveys most of the Yalakom scores were higher than those in the Lower Bridge River (Figure 4a and 4b). This trend wasn't evident during the latter (May 14-15'15) survey when scores were similar in the LBR and the Yalakom. There was high turbidity in the Yalakom during the final survey (Appendix 2) when the trend of higher water clarity in the Yalakom was reversed.

To obtain a qualitative evaluation of between observer variability in scoring trends, the nine different parameters were pooled and compared visually (Figures 5a and 5b).

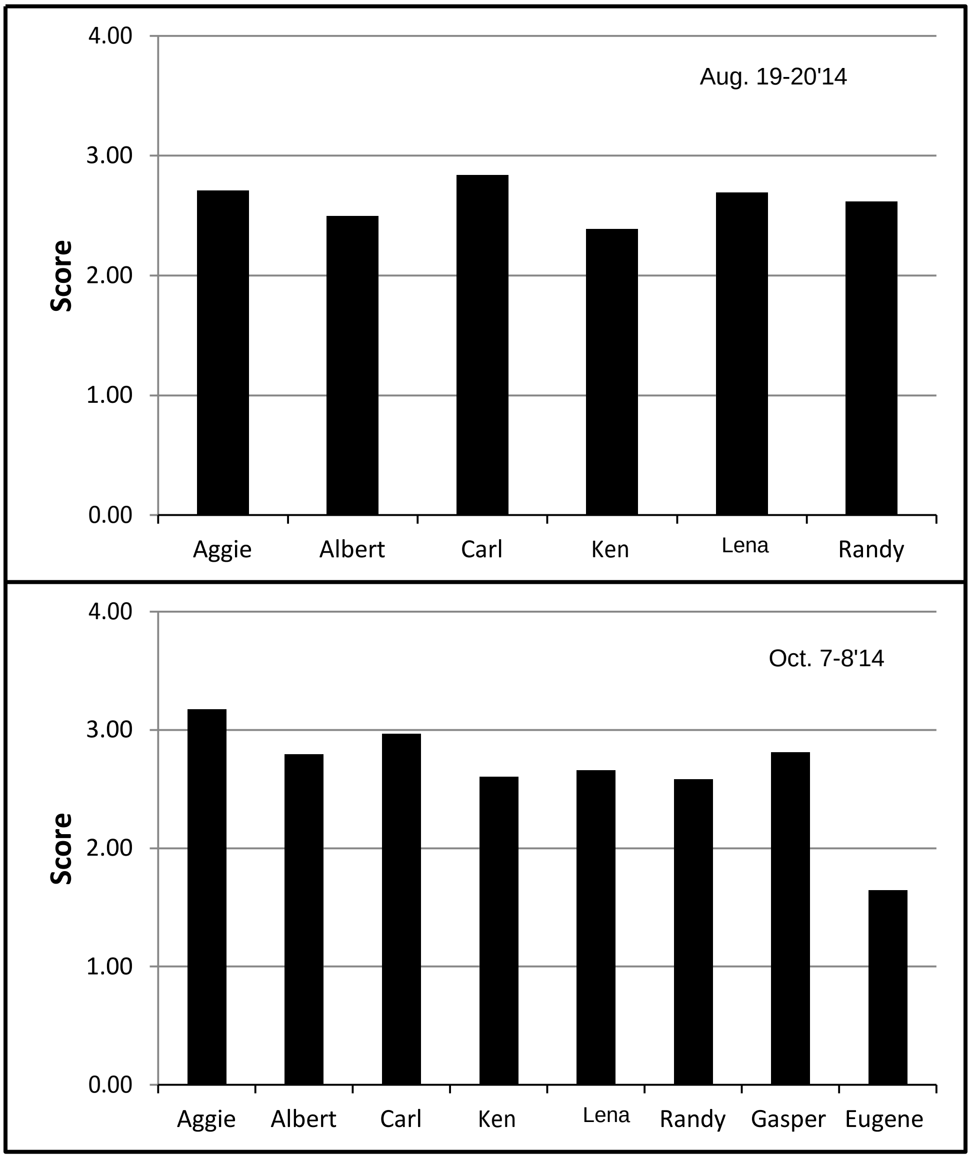

Figure 5a. Combined scores of cultural and spiritual value attributes obtained during Aug. 19-20'14 (upper) and Oct. 7-8'14 (lower).

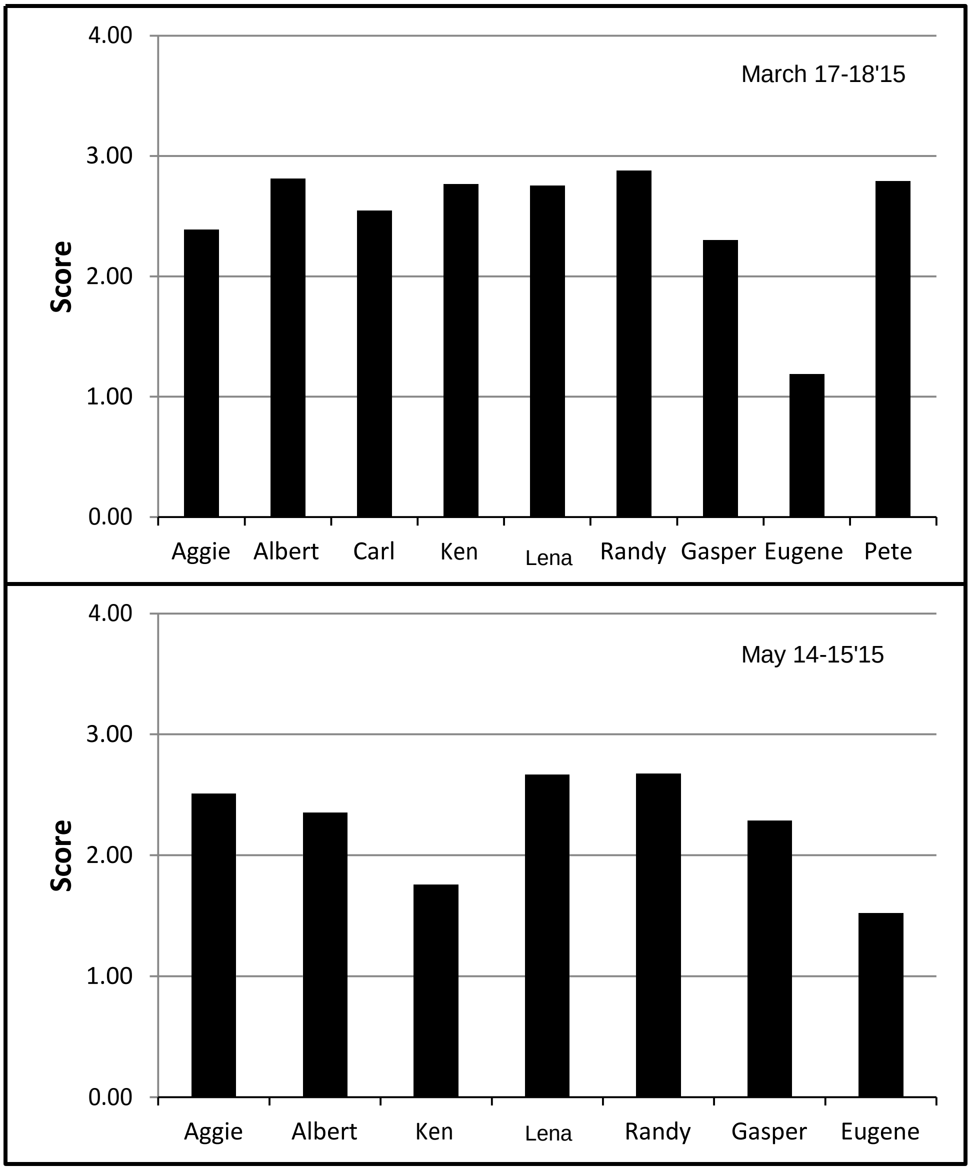

Figure 5b. Combined scores of cultural and spiritual value attributes obtained during April 7-8'14 (upper) and May 14-15'14 (lower).

Eugene participated in the latter 3 surveys and his scores were consistently lower than those of the other elders. There were no systematic differences between-elders during the other 4 surveys.

Of the 9 variables that were measured, "voice" of the river is arguably the most relevant indicator of cultural and spiritual values in relation to flow variations. The voice of the water is a variable that is defined by the elders individually and was selected as a key measure of spiritual and cultural value. Results for the voice parameter are described below. Observations for all 9 spiritual and value qualities are shown in Appendix 1.

The results for the voice parameter obtained between 2013-2015 (i.e., 8 field trips), were compiled and plotted in relation to the flow discharge conditions in the Lower Bridge River (Figure 6).

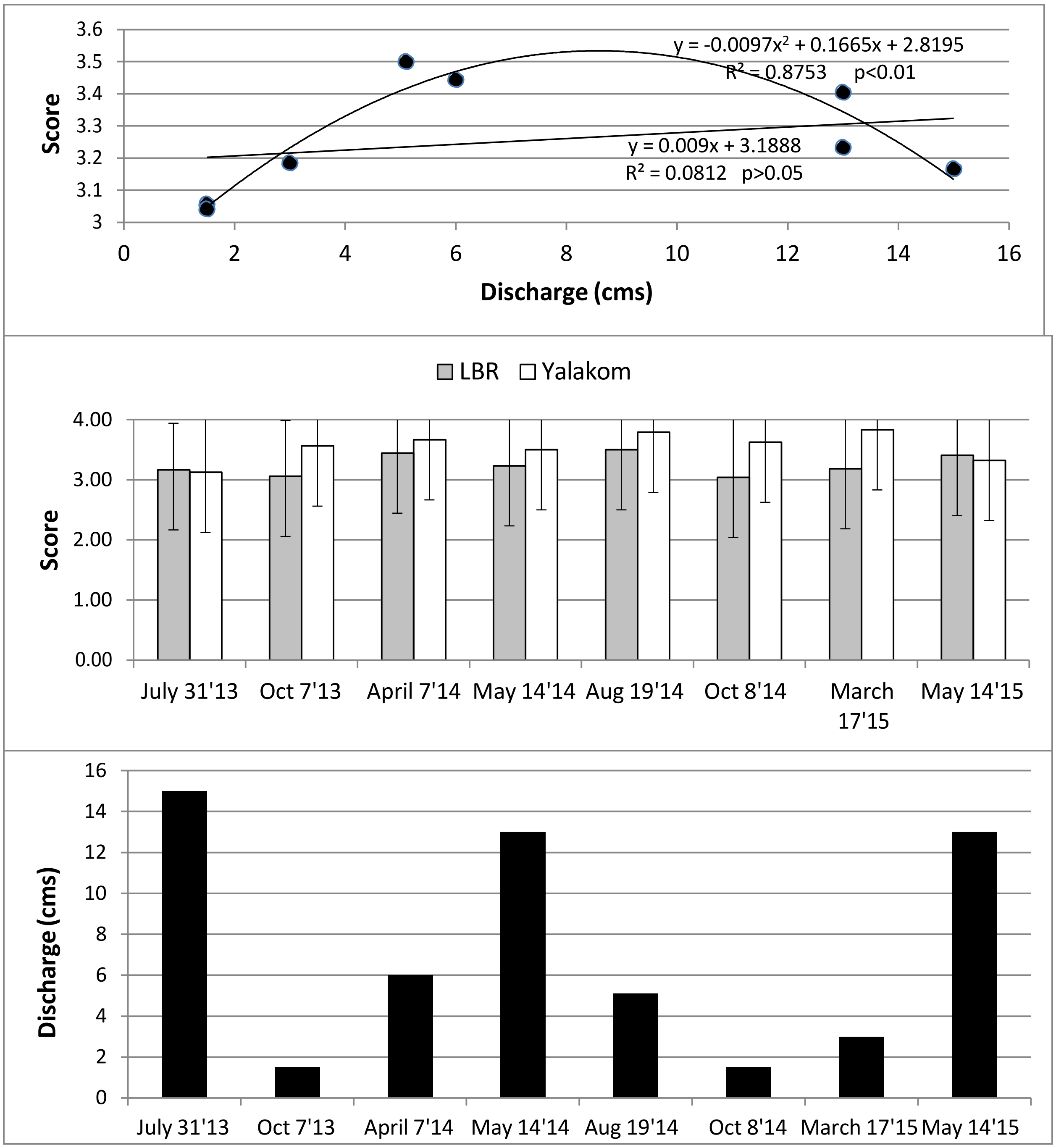

Figure 6. Upper: Voice scores in relation to discharge. Middle: Mean "voice" parameter scores in the Lower Bridge and Yalakom Rivers. Error bars indicate 1 standard deviation. Bottom: Flow discharge in the Lower Bridge River on the dates of the field surveys.

The observations suggested a preliminary conclusion that the voice variable was insensitive to flow variations. Flows ranged between 1.5 - 15 cms with no noticeable effect on the voice scores.

Results of similar analyses for the entire suite of variables that were measured are provided in Appendix 1.

Statistical Analysis Results

Detailed results of the statistical analysis are provided in Appendix 2. The analysis was prepared by Dr. Eduardo Martins from the University of BC.

The challenge with the BRGMON 16 data analysis is the presence of a large number of candidate factor variables (each with several levels) and research questions which relate to higher level interactions. In other words, if all these factors are included in the analysis, there would be too many parameters to estimate with the available data. One way to substantially reduce the number of parameters to be estimated in the analyses is the adoption of a mixed model approach by treating elders and sites as random effects. That is, the analysis would assume the sampled elders and sites are a random sample of the "population" of elders and sites; this enables the estimation of variance parameters that inform how much the intercept varies by elder and site. For BRGMON-16, two parameters (one variance for elders and another for sites) would be estimated, whereas if we treat elders and sites as fixed effects we would need to estimate 8 parameters for elders and 9 parameters for sites (i.e. n-1 parameters for each variable). Another advantage of the mixed model approach is that the inference is made for the full population of elders and potential sites, rather than to the specific elders and sites that were sampled.

The statistical models that were calculated to encompass the 8 surveys (4/year) are of the form:

Response ~ Intercept + River + Season + Year + River*Season + Season*Year + River*Year + (1|Elder) + (1|Site)

The intercepts for the models are assumed to vary randomly with Elder and Site as designated by the symbols (1|Elder) + (1|Site).

During the analysis, the response variable (score 0-4) was treated as "continuous" and bounded between 0-4, making it relatively straightforward to fit a mixed model with a normal error distribution.

Appendix 2 provides the statistical outputs. Main results are summarized below. Note: T1 = summer; T2 = fall; T3 = winter; T4 = spring. A significant reflects a coefficient that was statistically different from zero (at alpha = 0.01).

Access: The only significant effect was Year. The coefficient for Year indicates that scores for Access were on average 0.395 points larger in 2014-2015 than in 2013-2014. There was 1.1 times as much variation in scores among Elders as among Sites.

Bird Song: Interaction between Time and River as well as the main effects Time and River were significant. Multiple comparisons among sampling Times showed the following significant differences at alpha = 0.01:

- Bridge River in 2013-2014:
  - Scores in fall and winter were smaller than in summer
- Bridge River in 2014-2015
  - Scores in spring were larger than in summer and fall
  - Scores in winter were smaller than in fall
- Yalakom River in 2013-2014
  - Scores in fall were smaller than in summer
  - Scores in winter were larger than in fall
- Yalakom River in 2014-2015
  - Scores in spring were larger than in summer

Variability in scores among Elders was about 1.7 times as large as among Sites.

Clarity: All interactions were deemed significant. Multiple comparisons among sampling Times showed the following significant differences at alpha = 0.01:

- Bridge River in 2013-2014:
  - Scores in spring were smaller than in summer, fall, and winter
- Bridge River in 2014-2015
  - Scores in summer were larger than in fall, winter and spring
- Yalakom River in 2013-2014
  - Scores in summer were smaller than in fall and winter, but larger than in spring
  - Scores in spring were smaller than in fall and winter
- Yalakom River in 2014-2015
  - Scores in spring were smaller than in summer, fall and winter

There was 1.2 times as much variation in scores among Elders as among Sites

Diversity: The only significant effect in the reduced model was Season. Multiple comparisons among sampling times showed that scores in winter were significantly larger than in spring. There was just 1.1 times as much variation in scores among Sites as among Elders.

Edge Smell: Interaction between Time and River was significant and main effects were retained in the reduced model. Multiple comparisons among sampling times within rivers showed that scores were significantly smaller in spring than in summer, fall and winter within the Yalakom River only. There was nearly 4.9 times as much variation in scores among Elders than among sites, suggesting that sensing edge smell differs substantially among elders.

Movement: Interaction between Time and River was significant and main effects were retained in the reduced model. Multiple comparisons among sampling times within rivers showed that scores in winter were significantly larger than in fall within the Bridge River only. There was about 1.7 as much variation in scores among Elders as among Sites.

Smell: Interaction between Time and River as well as the main effect of Year were significant. The coefficient for Year indicates that scores for Smell were on average 0.293 points larger in 2014-2015 than in 2013-2014. Similar to the results for Edge Smell, multiple comparisons among sampling times within rivers showed that scores were significantly smaller in spring than in summer, fall and winter within the Yalakom River only. Also similar to the results for Edge Smell, there was more variation in scores among elders than among sites, with variation among elders being 6.2 times larger than that among Sites.

Voice: None of the evaluated interactions and main effects were found to be significant. Variability in scores among Elders was about 1.2 times greater as that among Sites.

Wadeability: Interaction between Time and River was significant and main effects were retained in the reduced model. Multiple comparisons among sampling Times showed the following significant differences at alpha = 0.01:

- Bridge River:
  - Scores in fall were larger than in summer, winter and fall
- Yalakom River in 2013-2014
  - Scores in winter were larger than in summer and spring
  - Scores in fall were greater than in spring

There was just slightly more variation among sites than among elders, with variability among sites being 1.1 times larger than that among elders.

Table 3 summarizes the main statistical results for the Year 1 and 2 data sets.

Table 3. Summary of statistical results (✹ indicates significant at alpha = 0.01; ns = not significant). Coefficients are provided in Appendix 2.

Parameter	Season	River	Year	Season x River	River x Year	Season x Year	Interpretation
Access	ns	ns	✹	ns	ns	ns	Access scores were on average 0.395 points larger in 2014-2015
Birdsong	✹	✹	ns	✹	ns	ns	There was significant differences between Seasons and Rivers as well as an interaction between Seasons and Rivers
Clarity	✹	ns	ns	✹	✹	✹	Water clarity varied seasonally and there were significant 2-way interactions between Seasons, Rivers and Years
Diversity	✹	ns	ns	ns	ns	ns	Scores during the spring survey were significantly larger than during the summer survey
Edge Smell	✹	✹	ns	✹	ns	ns	There were significant differences between Seasons and between Rivers as well as an interaction between Seasons and Rivers. There was nearly 4.9 times as much variation in scores among elders than among sites, suggesting that sensing edge smell differs substantially among elders
Smell	ns	ns	✹	✹	ns	ns	There were significant differences between Years and an interaction between Seasons and Rivers. Scores for Smell were on average 0.293 points larger in Year 2 than in Year 1. Similar to the results for Edge Smell, there was considerably more variation in scores among elders than among sites, with

							variation among elders being 6.2 times larger than that among sites
Movement	✹	✹	ns	✹	ns	ns	There were significant differences between seasons and rivers as well as an interaction between seasons and rivers
Voice	ns	ns	ns	ns	ns	ns	There was no significant variation in any of the parameters nor were there 2-way interactions
Wadeability	✹	✹	ns	✹	ns	ns	There were significant differences between seasons and rivers as well as an interaction between seasons and rivers

Discussion

The main objective of the BRGMON-16 monitoring program is to evaluate whether there are differences in the spiritual and cultural values associated with different seasonal flow releases in two different river systems: the LBR and the Yalakom. During Year 2, the program replicated the approach of assessing cultural and spiritual attributes associated with different water flow discharge levels. St’át’imc elders participated as evaluators of nine different parameters related to spiritual and cultural attributes. Over the past 2 years, the program has demonstrated that the approach can potentially yield valuable information for establishing a long-term flow discharge in the Lower Bridge River. A review of the available data to support a future flow decision will be undertaken in 2016 and will integrate the results of BRGMON-16 with the other Lower Bridge River monitoring programs that are presently underway.

Main results obtained in 2014-2015 are discussed below.

Histogram Plots

The following trends were evident in the histograms shown in Figures 4-6:

1. During the first survey (August 19-20), 6 of the parameters were slightly higher in the Yalakom River, 2 were similar, and one was slightly lower. The standard deviation error bars indicate that the measured differences were small in relation to the variation in the data. During the fall, 5 variables were slightly higher in the Yalakom except for water clarity which was considerably higher. Three variables showed similar scores and one (BIRDSONG) was higher in the LBR. Results during survey 3 indicated slightly higher values for all 9 variables in the Yalakom, although the differences in most cases were small in relation to the error bars. During survey 4 results were either similar or slightly higher in the LBR. Thus with the data collected to date, the conclusion is the Yalakom and LBR show similar spiritual and value scores. However, if the patterns are replicated during future surveys, there will be an opportunity to revisit this conclusion and evaluate whether parameter scores differ significantly between the LBR and the Yalakom.

2. There was no consistent trend in the between-elder scores with the exception of Eugene who scored lower than the other elders during the 3 surveys in which he participated.

3. There was no systematic variation in the voice parameter scores in relation to the seasonal flow discharges on the different dates. This suggests that the voice parameter is insensitive to flow variations.

Summary of Statistical Results

The main results from the statistical analysis are shown in Table 3. The results of the histogram analysis and the statistical analysis were consistent with each other which is to be expected since the underlying data are the same.

For ACCESS the only significant result was the between year difference which indicated slightly higher values in Year 2. There was a scoring difference of 0.395 which may have been due to the lower flow on Aug. 14, 2014 when compared with the flow on July 31'13 (15 cms vs. 5 cms). The lower flow in 2014 may have increased the ACCESS score as the LBR is considerably less accessible under 15 cms discharge conditions.

BIRDSONG observations varied seasonally and between rivers. There was also an interaction between season and river such that scores were higher in the LBR during the summer, fall and spring, but not during the winter. These results likely reflect the seasonal distribution of songbirds in the Lower Bridge River and Yalakom watersheds.

Water CLARITY results varied seasonally which was readily observable during field surveys. There were also interactions between season x river, river x year and season x year. These results indicate that in some seasons the LBR is murkier than the Yalakom, while in others, the converse is true. There were also differences between Years 1 and 2 and the timing of the clarity differences varied between years. Water clarity conditions in the two rivers on May 14-15, 2015 can be compared on the photos below.

Lower Bridge River (B3)

Yalakom River (Y2)

DIVERSITY in flow movement varied seasonally but all other statistical comparisons were insignificant. The DIVERSITY variations likely reflect the seasonal flow changes that could affect the water flow patterns. The histogram scores (Figure 4) indicated only small differences between rivers suggesting that diversity scores were similar in the Yalakom and the Lower Bridge Rivers

EDGE SMELL and SMELL showed differences in results that may be artifacts in view of the high observer variability. There was nearly 5-6 times as much variation in scores among elders than among sites, suggesting that sensing edge smell and smell differs substantially among elders.

MOVEMENT scores varied between seasons and between rivers. This result is to be expected in view of the large flow variations between seasons (Figure 6). The interaction between rivers and seasons may reflect differences in the flow hydrographs in the 2 rivers.

Measured VOICE scores did not show seasonal variation between rivers or between years.

WADEABILITY varied seasonally and between rivers. There was also an interaction between seasons and rivers. These results probably reflect the differences in flow hydrodynamics in the 2 rivers. The seasonal differences are to be expected in view of the large seasonal flow variability with wadeability being higher under low flows.

Conclusion

The main motivation for undertaking this project is to evaluate the effect of different seasonal flow variations on spiritual and cultural attributes associated with the LBR. We hypothesize that the VOICE of the water parameter may serve as an integrator of some of the measured spiritual values. The histogram analysis (Figure 6) agreed with the statistical results (Table 2) which indicated no effect of river, season and year on the VOICE parameter. Seasonal observations taken under different flow conditions did not vary significantly. This suggests a preliminary conclusion that the VOICE parameter did not vary seasonally in spite of large flow variations and may therefore be insensitive to current variations in flow discharge .

The Cultural and Spiritual Quality results can be interpreted as an overall or aggregate assessment of St’át’imc concerns related to flow regulation in the Lower Bridge River. St’át’imc will be monitoring results for objectives relating to salmon, river health, riparian health, learning, and so forth in addition to monitoring results for cultural and spiritual quality. It is conceivable that there will be trade-offs among objectives – for example, one flow alternative may prove to be less beneficial for salmon but more beneficial from the perspective of cultural and spiritual quality, in which case choices will need to be made based on the preferred balance across objectives. Further data collection under the BRGMON 16 project in 2016 and 2017 will help to inform a formal trade-off analysis utilizing a Structured Decision Making approach.

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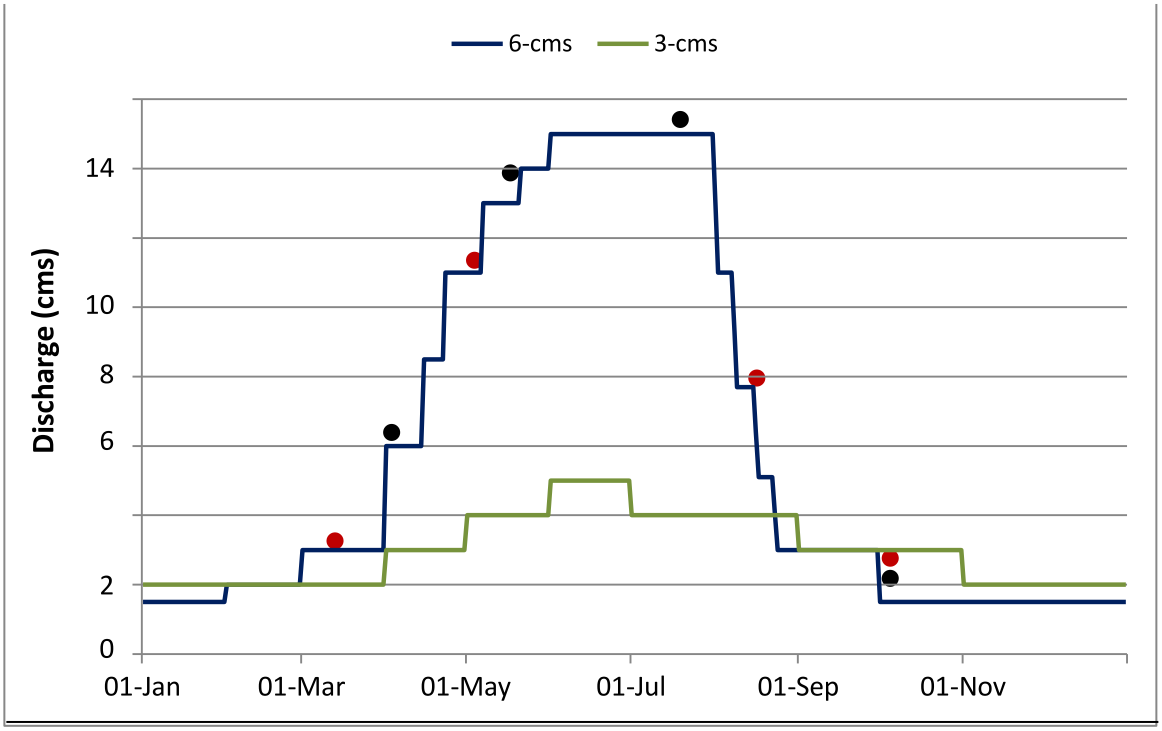
Appendix 1. Discharge Analysis Results

BRGMON 16 sampling dates are shown below in relation to the 6 cms and (former) 3 cms hydrographs:

- Year 1 sampling dates
- Year 2 sampling dates

The 8 sampling dates provide good contrast in flow conditions.



The 3 cms and 6 cms hydrographs are significantly different between April 1 - Aug. 15.
In the graphs that follow all 8 data points are analyzed in relation to the extrapolated discharge.
The 9 parameters that were examined include:

- voice of the river
- birdsong
- smell
- edge smell
- movement of the water
- diversity of flows
- shore access
- wadeability
- water clarity

Conclusions from this analysis:

1. None of the scatter plots between parameter scores and discharge were significant. The trend lines were flat with a low R^2 value.

2. There were no systematic differences in parameter scores between the Yalakom and Lower Bridge Rivers. This was also verified by the statistical analysis results.

3. Spiritual and cultural attributes were insensitive to flow discharge.

Voice

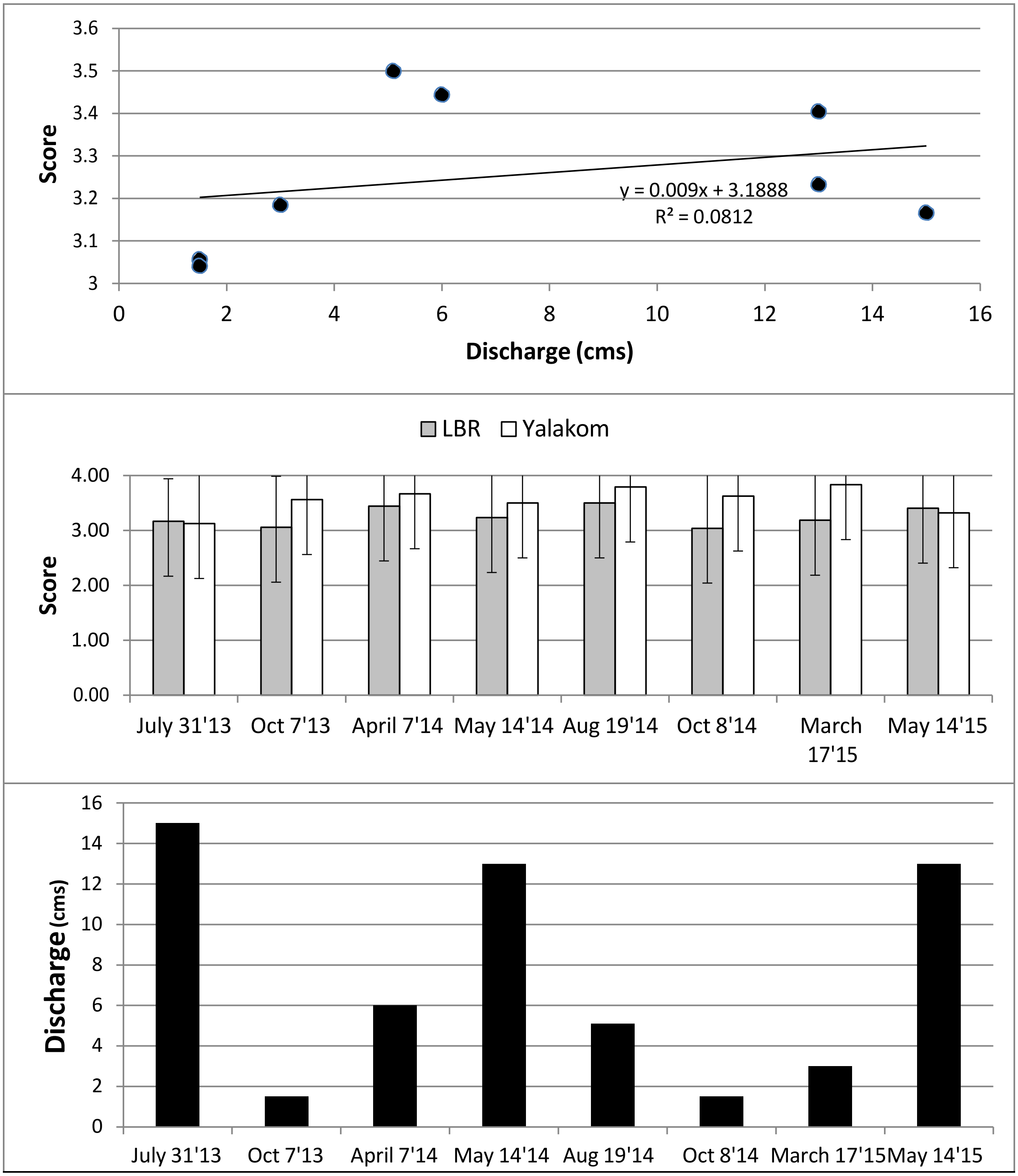


Figure A1. Relationship between discharge and voice scores. Upper scatter plot based on Lower Bridge River data only.

Birdsong

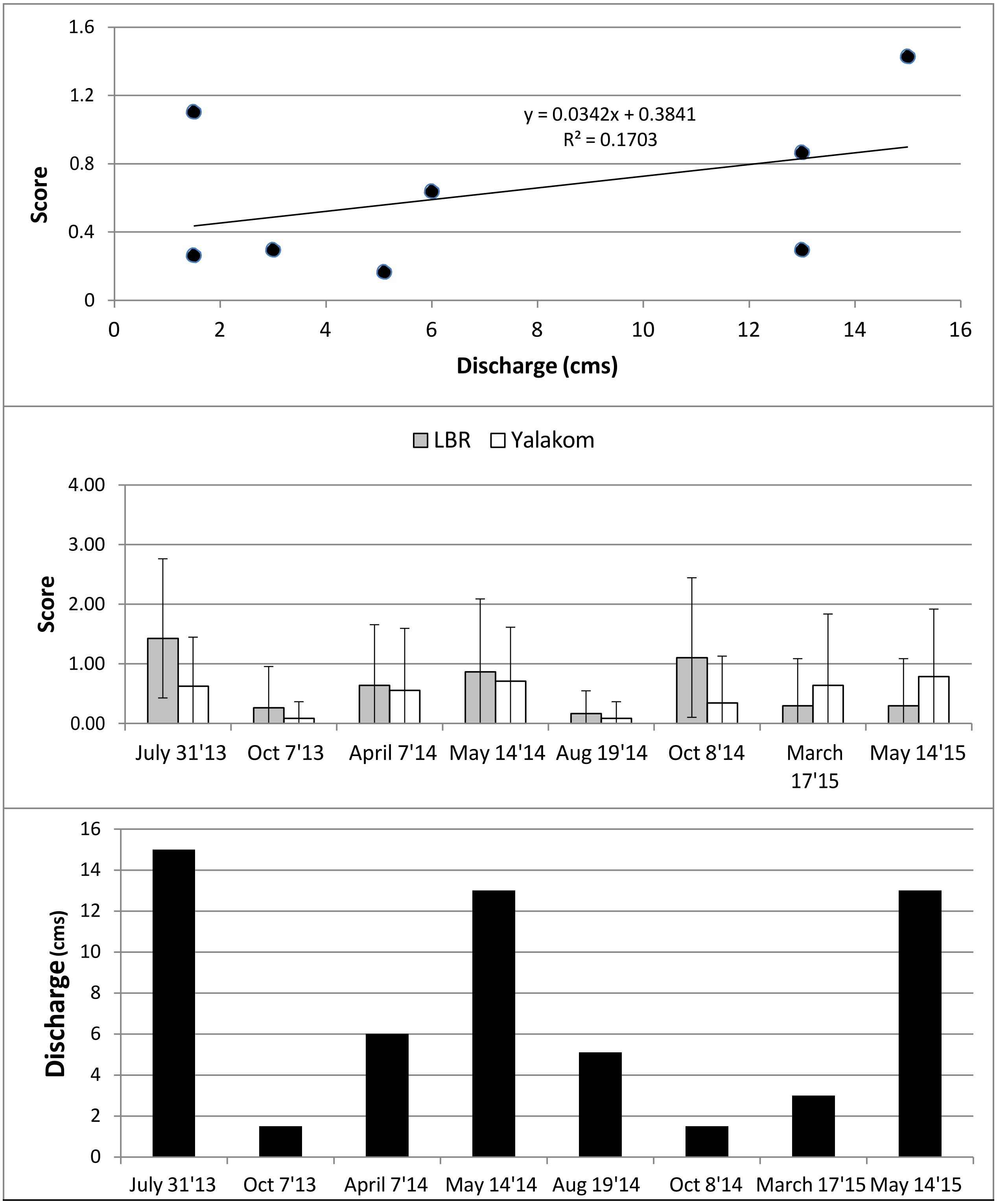


Figure A2. Relationship between discharge and birdsong scores. Upper scatter plot based on Lower Bridge River data only.

Smell

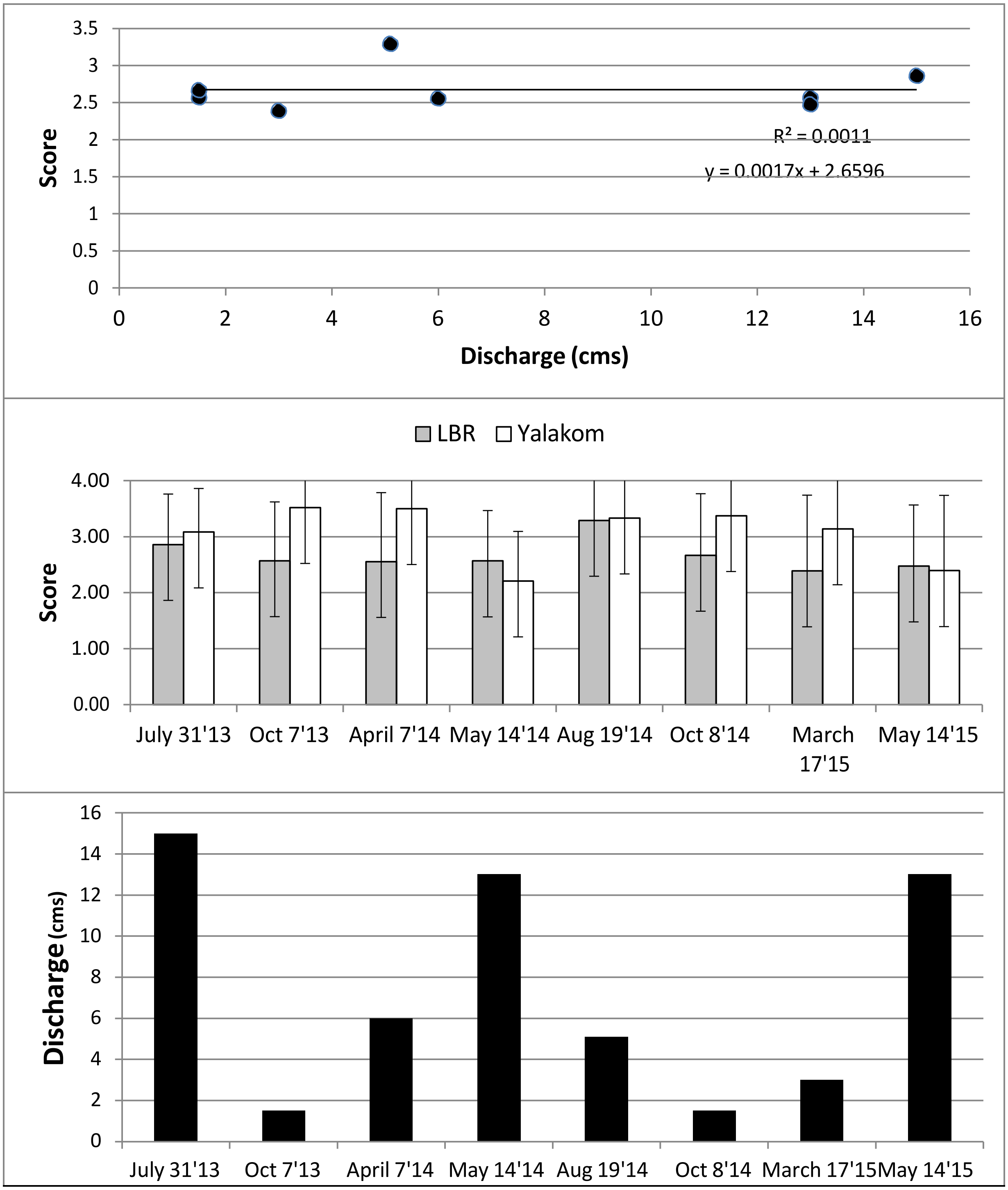


Figure A3. Relationship between discharge and smell scores. Upper scatter plot based on Lower Bridge River data only.

Edge Smell

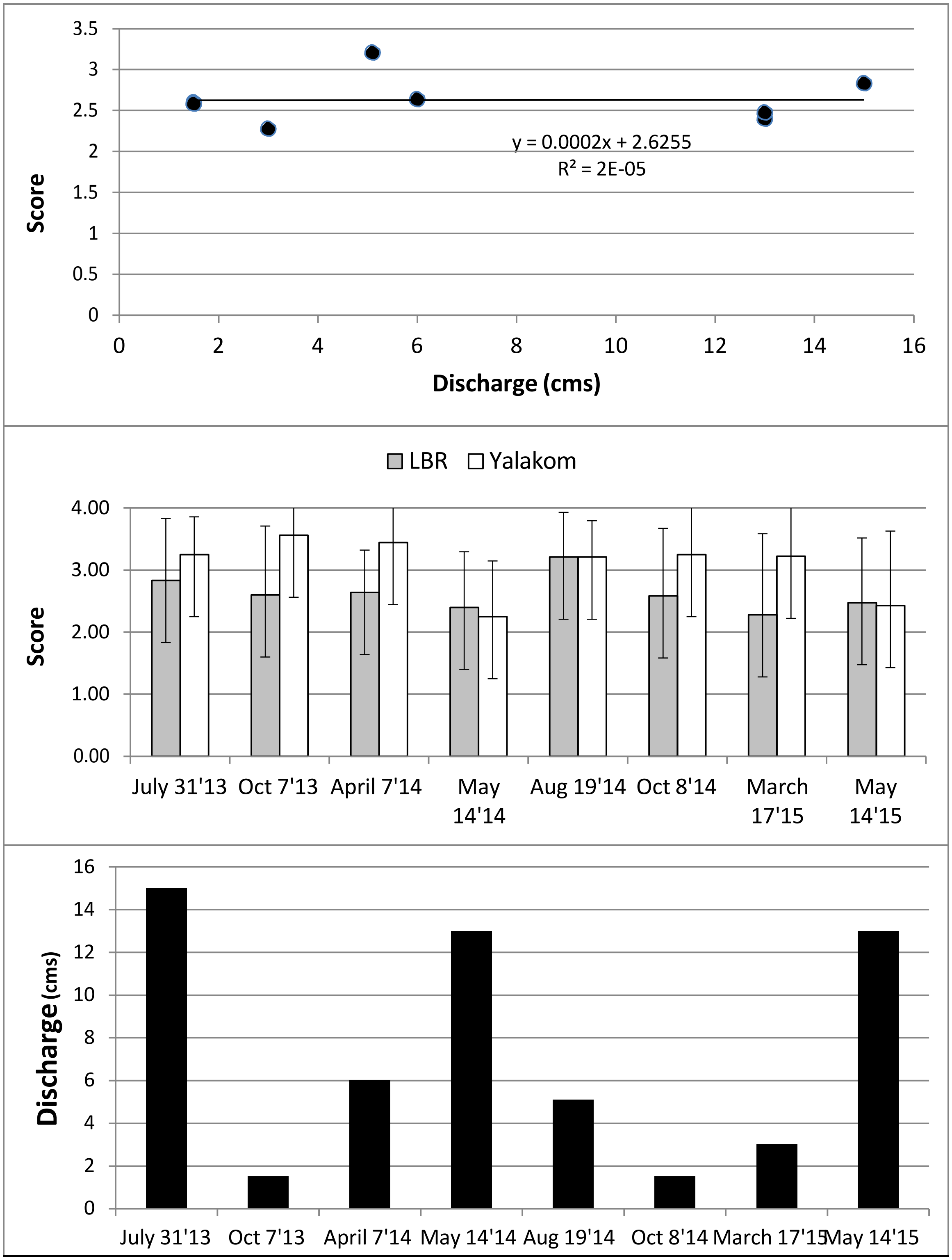


Figure A4. Relationship between discharge and edge smell scores. Upper scatter plot based on Lower Bridge River data only.

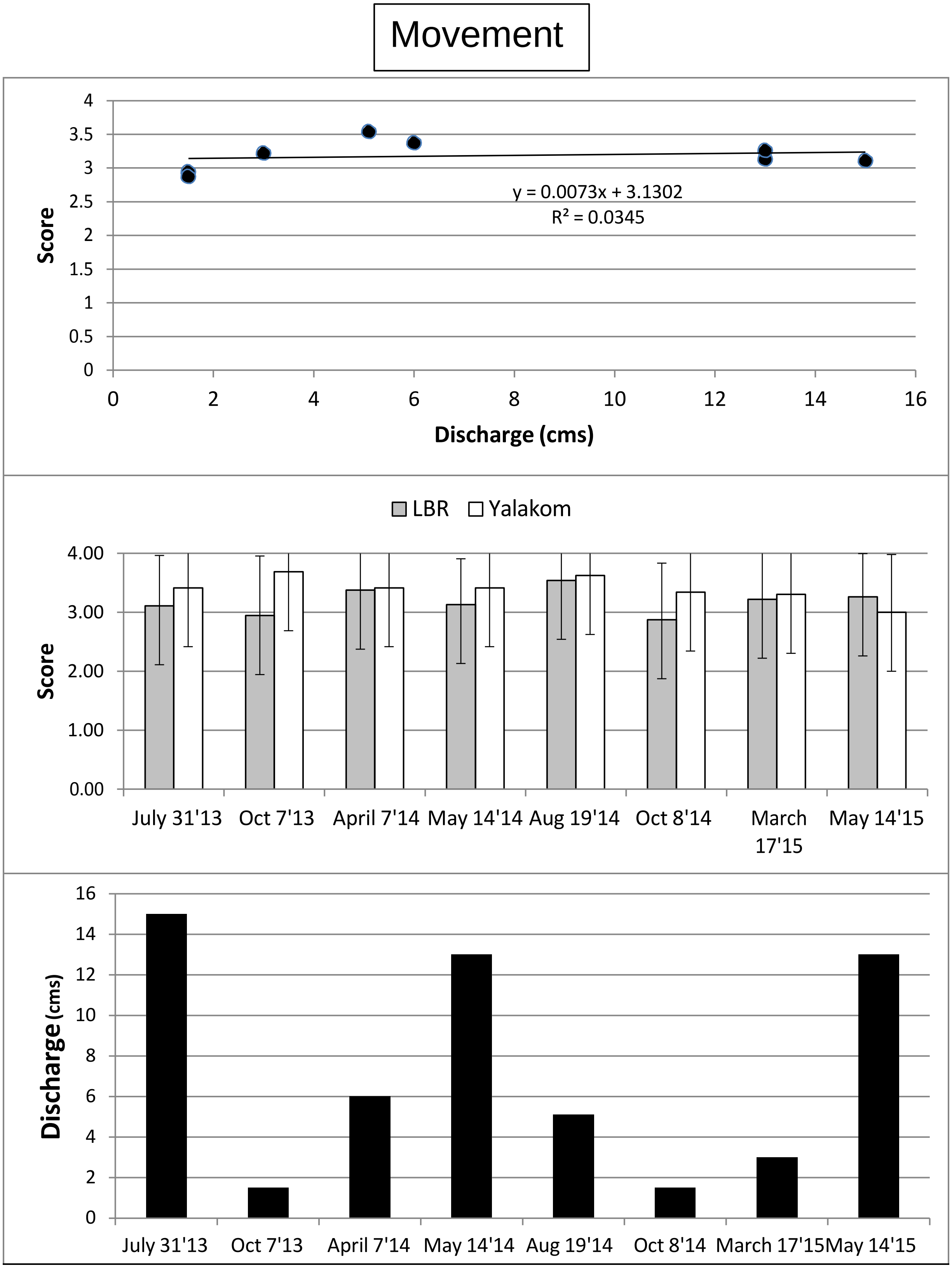


Figure A5. Relationship between discharge and movement scores. Upper scatter plot based on Lower Bridge River data only.

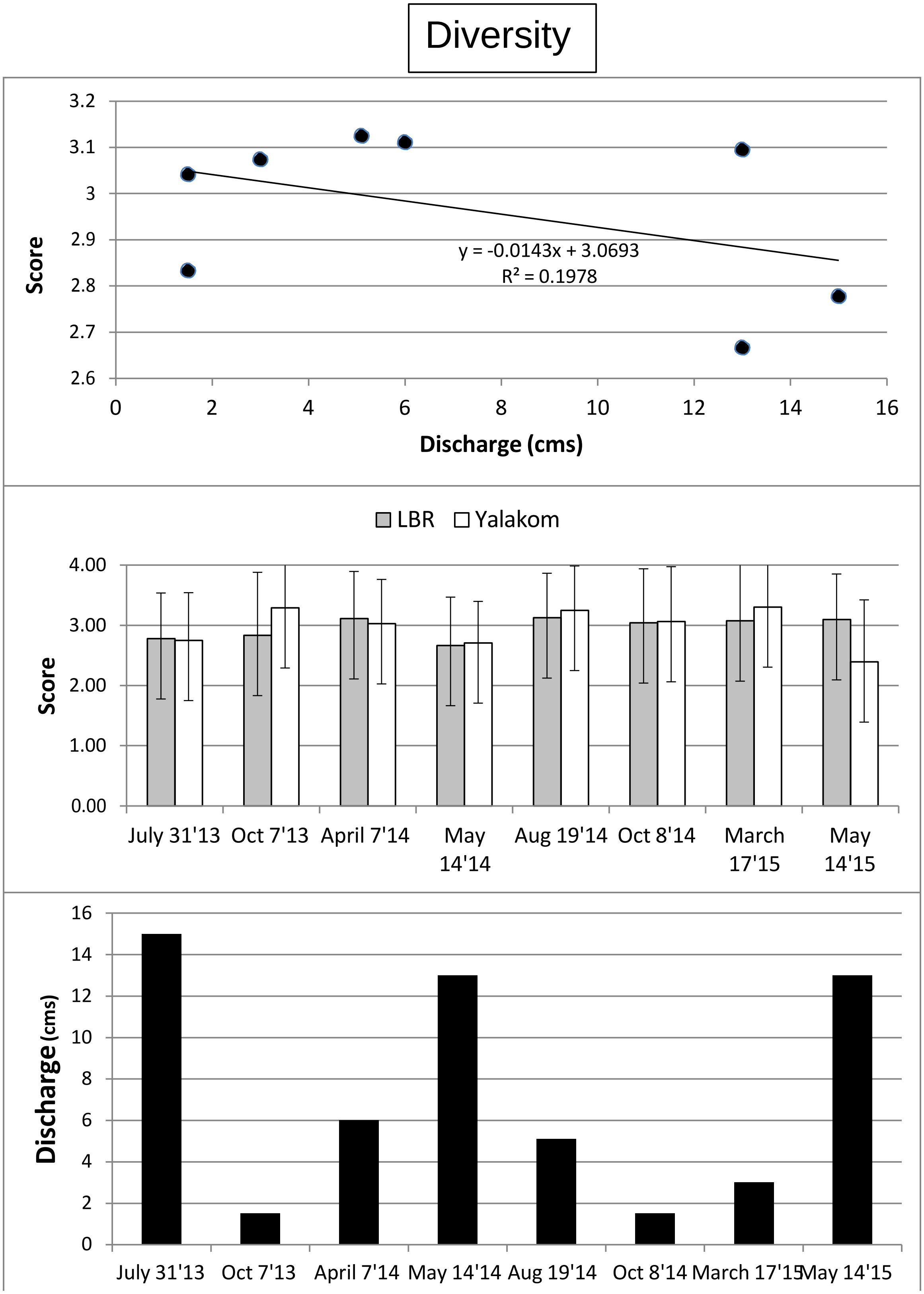


Figure A6. Relationship between discharge and diversity scores. Upper scatter plot based on Lower Bridge River data only.

Access

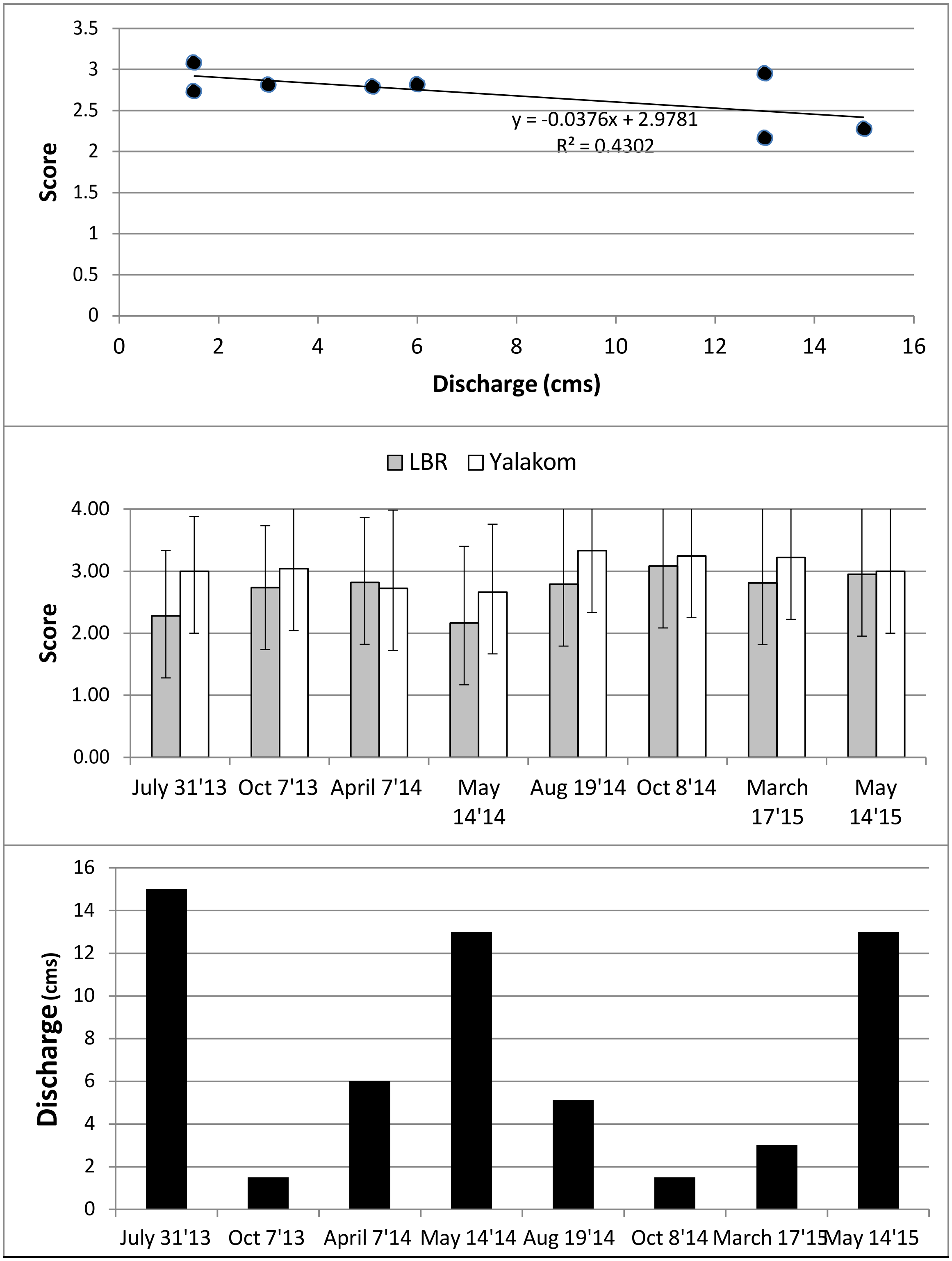


Figure A7. Relationship between discharge and access scores. Upper scatter plot based on Lower Bridge River data only.

Wadeability

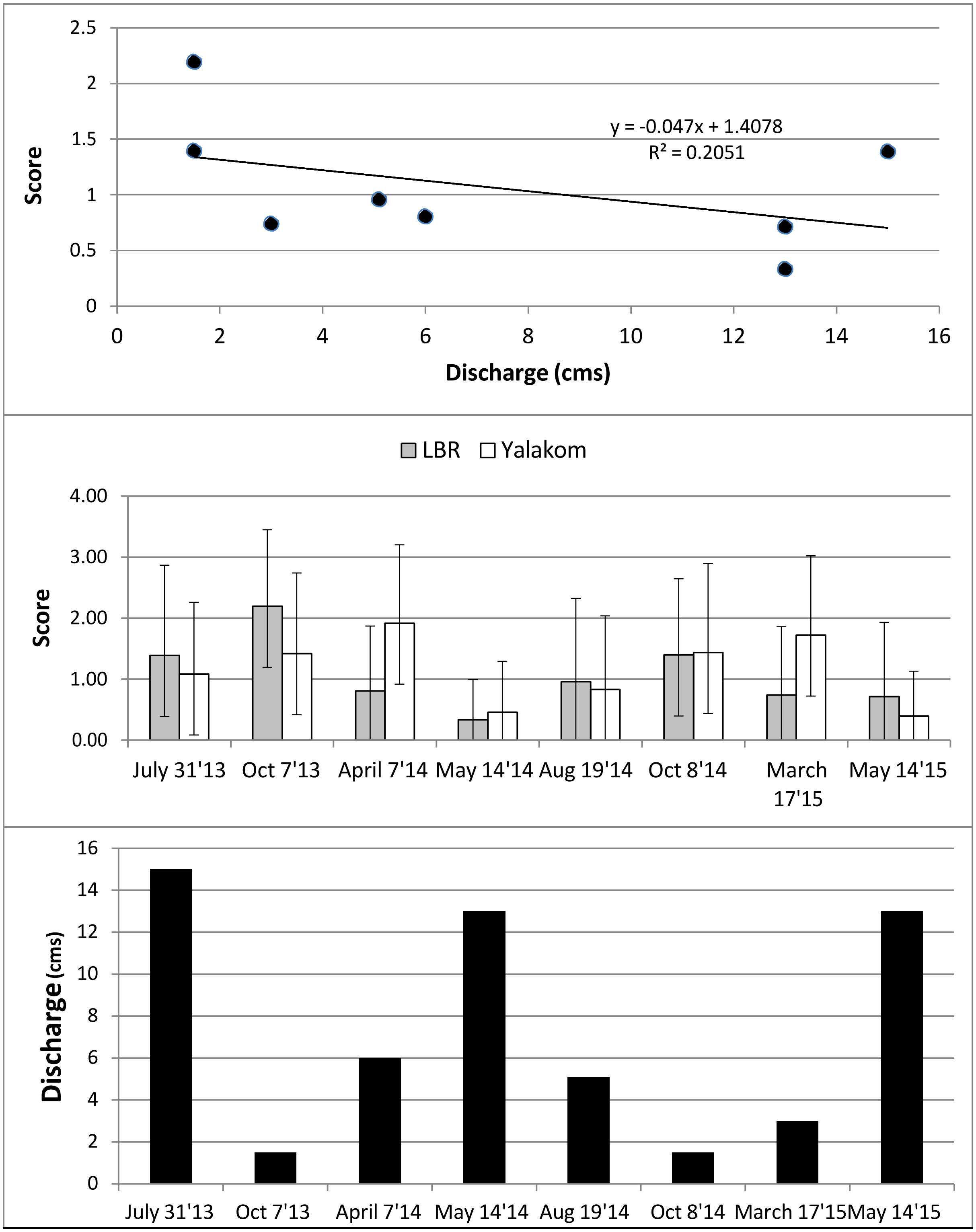


Figure A8. Relationship between discharge and wadeability scores. Upper scatter plot based on Lower Bridge River data only.

Clarity

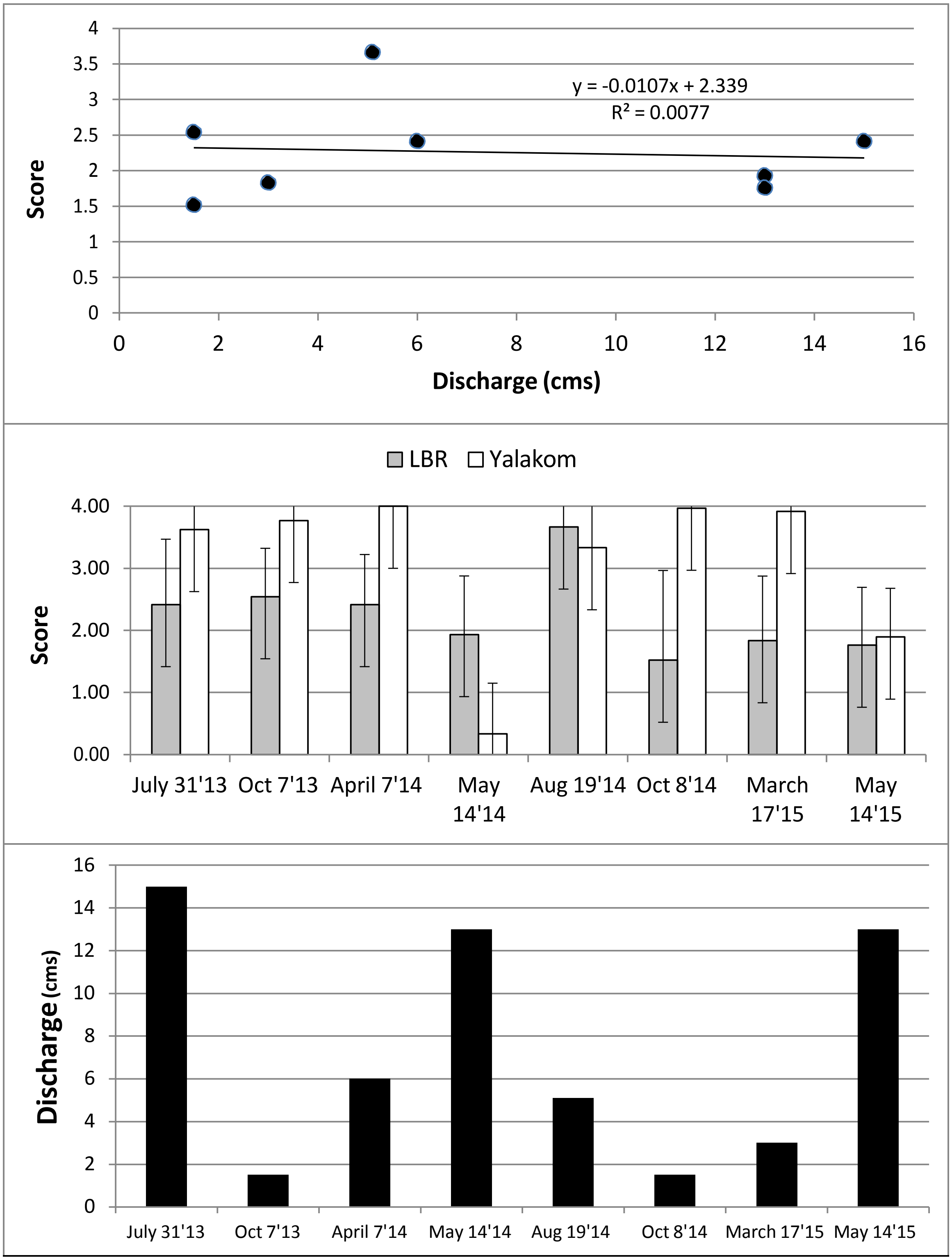


Figure A9. Relationship between discharge and clarity scores. Upper scatter plot based on Lower Bridge River data only.

Appendix 2. Statistical Analysis Results

SUMMARY for ACCESS

The only significant effect was Year, which was retained in the reduced model (TABLE 1).

The coefficient for Year indicates that scores for Access were on average 1.395 points larger in 2014-2015 than in 2013-2014 (TABLE 2).

There was just 1.1 times as much variation in scores among Elders as among Sites (see SD in TABLE 3)

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 4. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS IN THE REDUCED MODEL USING ANOVA (ALL P < 0.01)

	numDF	denDF	F-value	p-value	
(Intercept)	1	526	134.4186	<.0001	
Year	1	526	20.8729	<.0001	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Year

	Value	Std.Error	DF	t-value	p-value	
(Intercept)	2.6294206	0.25722691	526	10.222183	0	
Year2014_15	0.3954725	0.08647737	526	4.573132	0	*

TABLE 3. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.5015
Site(Int)	0.4580
Residual	0.9290

TABLE 4. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER	
Aggie	0.0805851
Albert	-0.5138430
Carl	0.1572745
Eugene	-0.7701201
Gasper	0.7852677
Ken	0.4810509
Lena	0.1715690
Pete	-0.2418767
Randy	-0.1499074

```
SITE
B1   0.5216886
B2  -0.4062259
B3   0.3903799
B4  -0.3449485
B5  -0.4062259
B6  -0.4062259
Y1   0.1859313
Y2   0.6656704
Y3   0.2269029
Y4  -0.4269468
```

SUMMARY for BIRD SONG

Interaction between Time and River as well as Time and River were significant and retained in the reduced model (including the main effects)(TABLE 1). Model coefficient estimates are shown in TABLE 2.

Multiple comparisons among sampling Times showed the following significant differences at alpha = 0.01 (TABLE 3):

- Bridge River in 2013-2014:
  - Scores in T2 and T3 were smaller than in T1
- Bridge River in 2014-2015
  - Scores in T4 were larger than in T1 and T3
  - Scores in T3 were smaller than in T2
- Yalakom River in 2013-2014
  - Scores in T2 were smaller than in T1
  - Scores in T3 were larger than in T2
- Yalakom River in 2014-2015
  - Scores in T4 were larger than in T1

Variability in scores among Elders was about 1.7 times as larger as among Sites (see SD in TABLE 4).

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS IN THE REDUCED MODEL USING ANOVA

	numDF	denDF	F-value	p-value	
(Intercept)	1	515	21.597747	<.0001	
Time	3	515	10.758743	<.0001	*
River	1	515	4.441569	0.0356	
Year	1	515	20.077852	<.0001	*
Time:River	3	515	5.681233	0.0008	*
Time:Year	3	515	17.941036	<.0001	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time + River + Year + Time:River + Time:Year

	Value	Std.Error	DF	t-value	p-value	
(Intercept)	1.4196338	0.3346716	515	4.241871	0.0000	
TimeT2	-0.9611369	0.1881592	515	-5.108105	0.0000	*
TimeT3	-0.8157739	0.1891547	515	-4.312734	0.0000	*
TimeT4	-0.3521944	0.1963182	515	-1.793998	0.0734	
RiverYalakom	-0.6349367	0.3157496	515	-2.010887	0.0449	
Year2014_15	-0.7369241	0.1641711	515	-4.488758	0.0000	*
TimeT2:RiverYalakom	0.1230320	0.2277055	515	0.540312	0.5892	
TimeT3:RiverYalakom	0.8388486	0.2280562	515	3.678253	0.0003	*
TimeT4:RiverYalakom	0.1856988	0.2338140	515	0.794216	0.4274	
TimeT2:Year2014_15	1.4825453	0.2267190	515	6.539131	0.0000	*
TimeT3:Year2014_15	0.4848328	0.2301948	515	2.106185	0.0357	
TimeT4:Year2014_15	1.2543227	0.2347942	515	5.342222	0.0000	*

Table 3. MULTIPLE COMPARISON AMONG TIMES USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)	
Bridge_2013_14 : T2 - T1 == 0	-0.96114	0.18816	-5.108	<0.01	***
Bridge_2013_14 : T3 - T1 == 0	-0.81577	0.18915	-4.313	<0.01	***
Bridge_2013_14 : T4 - T1 == 0	-0.35219	0.19632	-1.794	0.6682	
Bridge_2013_14 : T3 - T2 == 0	0.14536	0.18635	0.780	0.9981	
Bridge_2013_14 : T4 - T2 == 0	0.60894	0.19359	3.146	0.0344	*
Bridge_2013_14 : T4 - T3 == 0	0.46358	0.19456	2.383	0.2613	
Bridge_2014_15 : T2 - T1 == 0	0.52141	0.18096	2.881	0.0752	.
Bridge_2014_15 : T3 - T1 == 0	-0.33094	0.18058	-1.833	0.6405	
Bridge_2014_15 : T4 - T1 == 0	0.90213	0.18756	4.810	<0.01	***
Bridge_2014_15 : T3 - T2 == 0	-0.85235	0.16594	-5.136	<0.01	***
Bridge_2014_15 : T4 - T2 == 0	0.38072	0.17249	2.207	0.3692	
Bridge_2014_15 : T4 - T3 == 0	1.23307	0.17210	7.165	<0.01	***
Yalakom_2013_14 : T2 - T1 == 0	-0.83810	0.21304	-3.934	<0.01	**
Yalakom_2013_14 : T3 - T1 == 0	0.02307	0.22202	0.104	1.0000	
Yalakom_2013_14 : T4 - T1 == 0	-0.16650	0.21570	-0.772	0.9983	
Yalakom_2013_14 : T3 - T2 == 0	0.86118	0.21864	3.939	<0.01	**
Yalakom_2013_14 : T4 - T2 == 0	0.67161	0.21222	3.165	0.0327	*
Yalakom_2013_14 : T4 - T3 == 0	-0.18957	0.22123	-0.857	0.9962	
Yalakom_2014_15 : T2 - T1 == 0	0.64444	0.20764	3.104	0.0393	*
Yalakom_2014_15 : T3 - T1 == 0	0.50791	0.20739	2.449	0.2265	
Yalakom_2014_15 : T4 - T1 == 0	1.08783	0.21485	5.063	<0.01	***
Yalakom_2014_15 : T3 - T2 == 0	-0.13653	0.19264	-0.709	0.9991	
Yalakom_2014_15 : T4 - T2 == 0	0.44339	0.19978	2.219	0.3611	
Yalakom_2014_15 : T4 - T3 == 0	0.57992	0.19952	2.907	0.0708	.

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Adjusted p values reported -- single-step method)

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.6858
Site(Int)	0.4148
Residual	0.8953

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER	
Aggie	-0.22567152
Albert	-0.20441553
Carl	-0.05885277
Eugene	-0.61122831
Gasper	-0.61122831
Ken	0.02265003
Lena	-0.26903984
Pete	1.59488767
Randy	0.36289860

```
SITE
B1  0.8116440844
B2  0.0002232286
B3  0.2566432433
B4 -0.4371078081
B5 -0.1422636113
B6 -0.4891391370
Y1  0.0711934789
Y2 -0.1146543484
Y3 -0.1657986421
Y4  0.2092595115
```

SUMMARY for CLARITY

All interactions were deemed significant and therefore the global model was not reduced (TABLE 1). Model coefficient estimates are shown in TABLE 2.

Multiple comparisons among sampling Times showed the following significant differences at alpha = 0.01 (TABLE 3):

- Bridge River in 2013-2014:
  - Scores in T4 were smaller than in T1, T2, and T3
- Bridge River in 2014-2015
  - Scores in T1 were larger than in T2, T3 and T4
- Yalakom River in 2013-2014
  - Scores in T1 were smaller than in T2 and T3, but larger than in T4
  - Scores in T4 were smaller than in T2 and T3
- Yalakom River in 2014-2015
  - Scores in T4 were smaller than in T1, T2 and T3

There was just 1.2 times as much variation in scores among Elders as among Sites (see SD in TABLE 4)

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS IN THE REDUCED MODEL USING ANOVA

	numDF	denDF	F-value	p-value	
(Intercept)	1	514	146.69693	<.0001	
Time	3	514	14.50628	<.0001	*
River	1	514	1.43201	0.2320	
Year	1	514	1.87608	0.1714	
Time:River	3	514	66.17045	<.0001	*
Time:Year	3	514	13.47112	<.0001	*
River:Year	1	514	14.45324	0.0002	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time * River + Time * Year + River * Year

	Value	Std.Error	DF	t-value	p-value	
(Intercept)	2.6114614	0.2433805	514	10.729952	0.0000	
TimeT2	-0.3979396	0.1732843	514	-2.296455	0.0221	
TimeT3	-0.3459216	0.1731906	514	-1.997346	0.0463	
TimeT4	-1.1619112	0.1799297	514	-6.457583	0.0000	*
RiverYalakom	0.3056521	0.2667288	514	1.145928	0.2524	
Year2014_15	0.2222994	0.1619811	514	1.372379	0.1705	
TimeT2:RiverYalakom	1.3021068	0.2099105	514	6.203153	0.0000	*
TimeT3:RiverYalakom	1.2336814	0.2108360	514	5.851380	0.0000	*
TimeT4:RiverYalakom	-1.2405368	0.2151760	514	-5.765220	0.0000	*
TimeT2:Year2014_15	-0.7868866	0.2086040	514	-3.772155	0.0002	*
TimeT3:Year2014_15	-0.6646066	0.2110452	514	-3.149119	0.0017	*
TimeT4:Year2014_15	0.3473334	0.2155270	514	1.611554	0.1077	

RiverYalakom:Year2014_15 0.5692514 0.1495176 514 3.807253 0.0002 *

TABLE 3. MULTIPLE COMPARISON AMONG TIMES AND RIVER USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)	
Bridge_2013_14 : T2 - T1 == 0	-0.39794	0.17328	-2.296	0.312	
Bridge_2013_14 : T3 - T1 == 0	-0.34592	0.17319	-1.997	0.518	
Bridge_2013_14 : T4 - T1 == 0	-1.16191	0.17993	-6.458	<0.001	***
Bridge_2013_14 : T3 - T2 == 0	0.05202	0.17260	0.301	1.000	
Bridge_2013_14 : T4 - T2 == 0	-0.76397	0.17923	-4.263	<0.001	***
Bridge_2013_14 : T4 - T3 == 0	-0.81599	0.17924	-4.552	<0.001	***
Bridge_2014_15 : T2 - T1 == 0	-1.18483	0.16645	-7.118	<0.001	***
Bridge_2014_15 : T3 - T1 == 0	-1.01053	0.16572	-6.098	<0.001	***
Bridge_2014_15 : T4 - T1 == 0	-0.81458	0.17235	-4.726	<0.001	***
Bridge_2014_15 : T3 - T2 == 0	0.17430	0.15238	1.144	0.970	
Bridge_2014_15 : T4 - T2 == 0	0.37025	0.15889	2.330	0.292	
Bridge_2014_15 : T4 - T3 == 0	0.19595	0.15802	1.240	0.950	
Yalakom_2013_14 : T2 - T1 == 0	0.90417	0.19633	4.605	<0.001	***
Yalakom_2013_14 : T3 - T1 == 0	0.88776	0.20531	4.324	<0.001	***
Yalakom_2013_14 : T4 - T1 == 0	-2.40245	0.19852	-12.102	<0.001	***
Yalakom_2013_14 : T3 - T2 == 0	-0.01641	0.20198	-0.081	1.000	
Yalakom_2013_14 : T4 - T2 == 0	-3.30662	0.19566	-16.900	<0.001	***
Yalakom_2013_14 : T4 - T3 == 0	-3.29021	0.20458	-16.083	<0.001	***
Yalakom_2014_15 : T2 - T1 == 0	0.11728	0.19110	0.614	1.000	
Yalakom_2014_15 : T3 - T1 == 0	0.22315	0.19067	1.170	0.965	
Yalakom_2014_15 : T4 - T1 == 0	-2.05511	0.19751	-10.405	<0.001	***
Yalakom_2014_15 : T3 - T2 == 0	0.10587	0.17716	0.598	1.000	
Yalakom_2014_15 : T4 - T2 == 0	-2.17240	0.18405	-11.803	<0.001	***
Yalakom_2014_15 : T4 - T3 == 0	-2.27827	0.18342	-12.421	<0.001	***

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.3772
Site(In)	0.3137
Residual	0.8245

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER	
Aggie	0.04066165
Albert	0.40472635
Carl	0.25259842
Eugene	-0.70718677
Gasper	-0.44838997

```
Ken    -0.03080905
Lena   0.16449365
Pete    0.15791032
Randy   0.16599540
```

```
SITE
B1 -0.503826840
B2 -0.275788796
B3  0.075661757
B4 -0.133535001
B5  0.443848050
B6  0.393640829
Y1  0.004358567
Y2  0.072618341
Y3 -0.042603520
Y4 -0.034373387
```

SUMMARY for DIVERSITY

The only significant effect in the reduced model was Time (TABLE 1). Model coefficient estimates are shown in TABLE 2.

Multiple comparisons among sampling times showed that scores in T3 were significantly larger than in T4 (TABLE 3).

There was just 1.1 times as much variation in scores among Sites as among Elders (TABLE 4)

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS USING ANOVA IN THE REDUCED MODEL

	numDF	denDF	F-value	p-value	
(Intercept)	1	524	269.07412	<.0001	
Time	3	524	5.26635	0.0014	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time

	Value	Std.Error	DF	t-value	p-value
(Intercept)	2.9216540	0.2082453	524	14.029867	0.0000
TimeT2	0.1301802	0.1001011	524	1.300487	0.1940
TimeT3	0.2086348	0.1009463	524	2.066790	0.0392
TimeT4	-0.1592909	0.1035663	524	-1.538057	0.1246

Table 3. MULTIPLE COMPARISON AMONG TIMES USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)	
T1 - T2 == 0	-0.13018	0.10010	-1.300	0.56238	
T1 - T3 == 0	-0.20863	0.10095	-2.067	0.16411	
T1 - T4 == 0	0.15929	0.10357	1.538	0.41442	
T2 - T3 == 0	-0.07845	0.09579	-0.819	0.84540	
T2 - T4 == 0	0.28947	0.09834	2.944	0.01678	*
T3 - T4 == 0	0.36793	0.09906	3.714	0.00124	**

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.5028
Site(Int)	0.5405
Residual	0.7951

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER	
Aggie	-0.27865281
Albert	0.19373500
Carl	-0.19002310
Eugene	-1.05981435
Gasper	0.69398680
Ken	0.03116808
Lena	0.19373500
Pete	0.29574926
Randy	0.12011612

SITE	
B1	-0.038246847
B2	0.008142454
B3	0.026698174
B4	-0.023402270
B5	0.030409318
B6	-0.014124410
Y1	-0.017952388
Y2	-0.005913937
Y3	0.005178330
Y4	0.029211575

SUMMARY for EDGE SMELL

Interaction between Time and River was significant and main effects were retained in the reduced model (TABLE 1). Model coefficient estimates are shown in TABLE 2.

Multiple comparisons among sampling times within rivers showed that scores were significantly smaller in T4 than in T1, T2 and T3 within the Yalakom River only (TABLE 3).

There was nearly 4.9 times as much variation in scores among Elders than among sites, suggesting that sensing edge smell differs substantially among elders (TABLE 4).

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively. Again, note very small values.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS USING ANOVA (INTERACTION IS SIGNIFICANT)

	numDF	denDF	F-value	p-value	
(Intercept)	1	519	92.37332	<.0001	
Time	3	519	1.14031	0.3322	
River	1	519	4.52255	0.0339	
Time:River	3	519	8.33020	<.0001	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time + River + Time:River

	Value	Std.Error	DF	t-value	p-value
(Intercept)	2.5200335	0.2930836	519	8.598343	0.0000
TimeT2	-0.0354828	0.1428037	519	-0.248473	0.8039
TimeT3	-0.2231312	0.1413795	519	-1.578243	0.1151
TimeT4	-0.1672600	0.1483999	519	-1.127090	0.2602
RiverYalakom	0.3958333	0.1901571	519	2.081613	0.0379
TimeT2:RiverYalakom	0.3970268	0.2237180	519	1.774675	0.0765
TimeT3:RiverYalakom	0.4993239	0.2234462	519	2.234650	0.0259
TimeT4:RiverYalakom	-0.5009117	0.2293415	519	-2.184130	0.0294

TABLE 3. MULTIPLE COMPARISON AMONG TIMES AND RIVER USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)
Bridge:T2 - T1 == 0	-0.03548	0.14280	-0.248	0.99997
Bridge:T3 - T1 == 0	-0.22313	0.14138	-1.578	0.62894
Bridge:T4 - T1 == 0	-0.16726	0.14840	-1.127	0.89277
Bridge:T3 - T2 == 0	-0.18765	0.13514	-1.389	0.75621
Bridge:T4 - T2 == 0	-0.13178	0.14213	-0.927	0.95595
Bridge:T4 - T3 == 0	0.05587	0.14068	0.397	0.99955
Yalakom:T2 - T1 == 0	0.36154	0.17395	2.078	0.29438

```
Yalakom:T3 - T1 == 0  0.27619    0.17704   1.560  0.64173
Yalakom:T4 - T1 == 0 -0.66817    0.17729  -3.769  0.00187 **
Yalakom:T3 - T2 == 0 -0.08535    0.16931  -0.504  0.99824
Yalakom:T4 - T2 == 0 -1.02972    0.16964  -6.070  < 1e-04 ***
Yalakom:T4 - T3 == 0 -0.94436    0.17256  -5.473  < 1e-04 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Adjusted p values reported -- single-step method)
```

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.7298
Site(Int)	0.1492
Residual	0.8799

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER	
Aggie	0.3017690
Albert	0.4136345
Carl	0.2112857
Eugene	-1.7382356
Gasper	-0.5301124
Ken	0.1799116
Lena	0.3222746
Pete	0.3885495
Randy	0.4509230

SITE	
B1	-0.157076082
B2	-0.113225461
B3	-0.061974827
B4	0.012053866
B5	0.114555134
B6	0.205667371
Y1	0.001768805
Y2	0.040699926
Y3	0.040699926
Y4	-0.083168658

SUMMARY for MOVEMENT

Interaction between Time and River was significant and main effects were retained in the reduced model (TABLE 1). Model coefficient estimates are shown in TABLE 2.

Multiple comparisons among sampling times within rivers showed that scores in T3 were significantly larger than in T2 within the Bridge River only (TABLE 3).

There was about 1.7 as much variation in scores among Elders as among Sites (see SD in TABLE 4)

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS USING ANOVA (INTERACTION IS SIGNIFICANT)

	numDF	denDF	F-value	p-value	
(Intercept)	1	520	214.73144	<.0001	
Time	3	520	4.96597	0.0021	*
River	1	520	2.76974	0.0967	
Time:River	3	520	4.91653	0.0022	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time + River + Time:River

	Value	Std.Error	DF	t-value	p-value
(Intercept)	3.0324937	0.2308666	520	13.135264	0.0000
TimeT2	-0.2002976	0.1128843	520	-1.774363	0.0766
TimeT3	0.1971705	0.1120465	520	1.759720	0.0790
TimeT4	0.1004203	0.1176495	520	0.853556	0.3937
RiverYalakom	0.3541667	0.2228671	520	1.589138	0.1126
TimeT2:RiverYalakom	0.2321429	0.1771931	520	1.310112	0.1907
TimeT3:RiverYalakom	-0.2906045	0.1772577	520	-1.639447	0.1017
TimeT4:RiverYalakom	-0.3572161	0.1818523	520	-1.964320	0.0500

TABLE 3. MULTIPLE COMPARISON AMONG TIMES AND RIVER USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)	
Bridge:T2 - T1 == 0	-0.20030	0.11288	-1.774	0.4895	
Bridge:T3 - T1 == 0	0.19717	0.11205	1.760	0.4998	
Bridge:T4 - T1 == 0	0.10042	0.11765	0.854	0.9706	
Bridge:T3 - T2 == 0	0.39747	0.10677	3.723	0.0022	**
Bridge:T4 - T2 == 0	0.30072	0.11236	2.676	0.0732	.
Bridge:T4 - T3 == 0	-0.09675	0.11150	-0.868	0.9681	
Yalakom:T2 - T1 == 0	0.03185	0.13792	0.231	1.0000	
Yalakom:T3 - T1 == 0	-0.09343	0.14044	-0.665	0.9919	
Yalakom:T4 - T1 == 0	-0.25680	0.14056	-1.827	0.4529	

```
Yalakom:T3 - T2 == 0 -0.12528    0.13431  -0.933   0.9547
Yalakom:T4 - T2 == 0 -0.28864    0.13451  -2.146   0.2580
Yalakom:T4 - T3 == 0 -0.16336    0.13689  -1.193   0.8637
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)
```

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.4819
Site(In)	0.2804
Residual	0.6978

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER

Aggie	-0.170190780
Albert	0.267561097
Carl	0.204161807
Eugene	-1.013673355
Gasper	0.419519517
Ken	-0.093271551
Lena	0.600499144
Pete	-0.210884122
Randy	-0.003721757

SITE

B1	-0.54765170
B2	-0.02393336
B3	-0.20976890
B4	0.17879631
B5	0.28016115
B6	0.32239650
Y1	-0.04177796
Y2	0.01115708
Y3	0.04438401
Y4	-0.01376313

SUMMARY for SMELL

Interaction between Time and River as well as the main effect of Year were significant in the reduced model (TABLE 1). Model coefficient estimates are shown in TABLE 2.

The coefficient for Year indicates that scores for Smell were on average 1.293 points larger in 2014-2015 than in 2013-2014 (TABLE 2).

Similar to the results for Edge Smell, multiple comparisons among sampling times within rivers showed that scores were significantly smaller in T4 than in T1, T2 and T3 within the Yalakom River only (TABLE 3).

Also similar to the results for Edge Smell, there was much more variation in scores among elders than among sites, with variation among elders being 6.2 times larger than that among sites (see SD in TABLE 4).

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively. Again, note very small values for Sites.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS USING ANOVA (INTERACTION IS SIGNIFICANT)

	numDF	denDF	F-value	p-value	
(Intercept)	1	519	63.81305	<.0001	
Time	3	519	0.94873	0.4168	
River	1	519	3.16199	0.0760	
Year	1	519	11.53422	0.0007	*
Time:River	3	519	8.63064	<.0001	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time + River + Year + Time:River

	Value	Std.Error	DF	t-value	p-value	
(Intercept)	2.3461323	0.3251396	519	7.215770	0.0000	
TimeT2	-0.0360436	0.1481325	519	-0.243320	0.8079	
TimeT3	-0.2191901	0.1471109	519	-1.489965	0.1368	
TimeT4	-0.1397713	0.1543973	519	-0.905270	0.3657	
RiverYalakom	0.3333333	0.1909383	519	1.745764	0.0814	
Year2014_15	0.2926657	0.0856529	519	3.416880	0.0007	*
TimeT2:RiverYalakom	0.4791667	0.2324809	519	2.061101	0.0398	
TimeT3:RiverYalakom	0.4772959	0.2324911	519	2.052965	0.0406	
TimeT4:RiverYalakom	-0.5310179	0.2386228	519	-2.225344	0.0265	

TABLE 3. MULTIPLE COMPARISON AMONG TIMES AND RIVER USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)
T1.Bridge - T2.Bridge == 0	0.03604	0.14813	0.243	0.99997
T1.Bridge - T3.Bridge == 0	0.21919	0.14711	1.490	0.69007
T1.Bridge - T4.Bridge == 0	0.13977	0.15440	0.905	0.96075
T2.Bridge - T3.Bridge == 0	0.18315	0.14017	1.307	0.80503

```
T2.Bridge - T4.Bridge == 0    0.10373    0.14743   0.704  0.98910
T3.Bridge - T4.Bridge == 0   -0.07942    0.14638  -0.543  0.99735



T1.Yalakom - T2.Yalakom == 0 -0.44312    0.18098  -2.449  0.13175
T1.Yalakom - T3.Yalakom == 0 -0.25811    0.18426  -1.401  0.74857
T1.Yalakom - T4.Yalakom == 0  0.67079    0.18448   3.636  0.00315 **
T2.Yalakom - T3.Yalakom == 0  0.18502    0.17621   1.050  0.92145
T2.Yalakom - T4.Yalakom == 0  1.11391    0.17652   6.310  < 0.001 ***
T3.Yalakom - T4.Yalakom == 0  0.92890    0.17975   5.168  < 0.001 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Adjusted p values reported -- single-step method)
```

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.8204
Site(In)	0.1329
Residual	0.9155

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER

Aggie	0.2103382
Albert	0.5031904
Carl	0.2288862
Eugene	-1.9175920
Gasper	-0.6053932
Ken	0.1968719
Lena	0.7399645
Pete	0.2277762
Randy	0.4159578

SITE

B1	-0.131864718
B2	-0.092056501
B3	-0.072152393
B4	0.027368149
B5	0.087080474
B6	0.181624989
Y1	0.008408574
Y2	0.023474440
Y3	0.003766466
Y4	-0.035649481

SUMMARY for VOICE

None of the evaluated interactions and main effects were found to be significant and therefore the reduced model contained the intercept only (TABLE 1). The model intercept estimate (i.e. mean scores) is shown in TABLE 2.

Variability in scores among Elders was about 1.2 times as greater as that among Sites (see SDs in TABLE 3).

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 4. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS USING ANOVA (ONLY TIME IS SIGNIFICANT)

	numDF	denDF	F-value	p-value
(Intercept)	1	526	387.0137	<.0001

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ 1

	Value	Std.Error	DF	t-value	p-value
(Intercept)	3.333309	0.1929446	526	17.27599	0

TABLE 3. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.4026
Site(Int)	0.3340
Residual	0.7025

TABLE 4. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER

Aggie	-0.49114836
Albert	0.27673248
Carl	0.02133872
Eugene	-0.48418125
Gasper	0.48422510
Ken	-0.40922978
Lena	0.47295252
Pete	-0.02553606
Randy	0.15484663

SITE

B1	-0.70758891
B2	-0.16076354
B3	-0.29136917
B4	0.20493224

B5	0.06561956
B6	0.06561956
Y1	0.03565979
Y2	0.09146991
Y3	0.42523239
Y4	0.27118817

SUMMARY for WADEABILITY

Interaction between Time and River was significant and main effects were retained in the reduced model (TABLE 1). Model coefficient estimates are shown in TABLE 2.

Multiple comparisons among sampling Times showed the following significant differences at alpha = 0.01 (TABLE 3):

- Bridge River:
  - Scores in T2 were larger than in T1, T3 and T4
- Yalakom River in 2013-2014
  - Scores in T3 were larger than in T1 and T4
  - Scores in T2 were greater than in T4

There was just slightly more variation among sites than among elders, with variation among sites being just 1.1 times larger than that among elders (see SD in TABLE 4).

An estimate of how much the Intercept (equivalent to mean score) changes with Elder and Site is provided in TABLE 5. Positive and negative values mean the score given by Elders and for different Sites are consistently above or below average (i.e. Intercept), respectively.

TABLE 1. TEST OF SIGNIFICANCE OF MAIN EFFECTS USING ANOVA (INTERACTION IS SIGNIFICANT)

	numDF	denDF	F-value	p-value	
(Intercept)	1	520	18.47339	<.0001	
Time	3	520	17.98080	<.0001	*
River	1	520	0.57747	0.4476	
Time:River	3	520	11.97501	<.0001	*

TABLE 2. SUMMARY OF COEFFICIENT ESTIMATES FOR FIXED EFFECTS

Fixed effects: Score ~ Time + River + Time:River

	Value	Std.Error	DF	t-value	p-value	
(Intercept)	1.0733210	0.2908856	520	3.689839	0.0002	
TimeT2	0.6136445	0.1746073	520	3.514427	0.0005	*
TimeT3	-0.3606593	0.1729506	520	-2.085331	0.0375	
TimeT4	-0.5462509	0.1819060	520	-3.002929	0.0028	*
RiverYalakom	-0.2500000	0.3481359	520	-0.718110	0.4730	
TimeT2:RiverYalakom	-0.0595238	0.2743194	520	-0.216987	0.8283	
TimeT3:RiverYalakom	1.3163667	0.2744157	520	4.796980	0.0000	*
TimeT4:RiverYalakom	0.1155862	0.2815221	520	0.410576	0.6816	

TABLE 3. MULTIPLE COMPARISON AMONG TIMES AND RIVER USING TUKEY'S TEST

Linear Hypotheses:

	Estimate	Std. Error	z value	Pr(>|z|)	
Bridge:T2 - T1 == 0	0.6136	0.1746	3.514	0.00492	**
Bridge:T3 - T1 == 0	-0.3607	0.1730	-2.085	0.29052	
Bridge:T4 - T1 == 0	-0.5463	0.1819	-3.003	0.02818	*
Bridge:T3 - T2 == 0	-0.9743	0.1649	-5.908	< 0.001	***
Bridge:T4 - T2 == 0	-1.1599	0.1739	-6.669	< 0.001	***
Bridge:T4 - T3 == 0	-0.1856	0.1722	-1.078	0.91175	

Yalakom:T2 - T1 == 0	0.5541	0.2134	2.597	0.09053	.
Yalakom:T3 - T1 == 0	0.9557	0.2169	4.406	< 0.001	***
Yalakom:T4 - T1 == 0	-0.4307	0.2174	-1.981	0.35220	
Yalakom:T3 - T2 == 0	0.4016	0.2075	1.935	0.38090	
Yalakom:T4 - T2 == 0	-0.9848	0.2082	-4.729	< 0.001	***
Yalakom:T4 - T3 == 0	-1.3864	0.2115	-6.554	< 0.001	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Adjusted p values reported -- single-step method)

TABLE 4. SUMMARY OF STANDARD DEVIATION ESTIMATES FOR RANDOM EFFECTS

Random effects:

Groups	Std. Dev
Elder(Int)	0.4066
Site(In)	0.4400
Residual	1.0802

TABLE 5. DEVIATION OF INTERCEPT BY ELDER AND SITE

ELDER

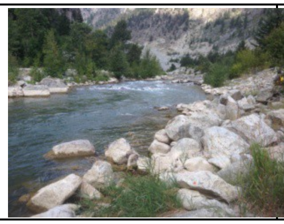
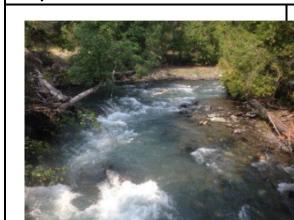
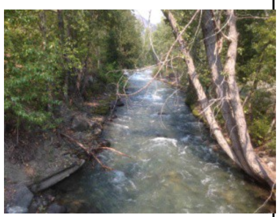
Aggie	0.65806465
Albert	0.03058599
Carl	0.32034777
Eugene	-0.39819765
Gasper	-0.50613451
Ken	0.05364328
Lena	-0.38192312
Pete	0.09425781
Randy	0.12935578

SITE

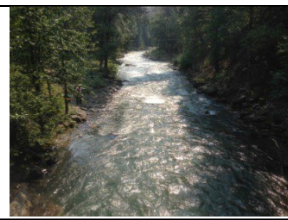
B1	0.5082433
B2	-0.1101194
B3	0.4404775
B4	-0.4320068
B5	0.1016487
B6	-0.5082433
Y1	0.3329594
Y2	0.3415888
Y3	-0.2498132
Y4	-0.4247350

Appendix 3: Photos

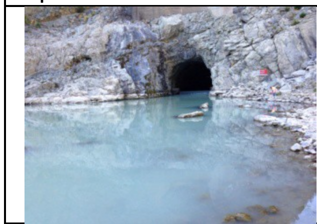
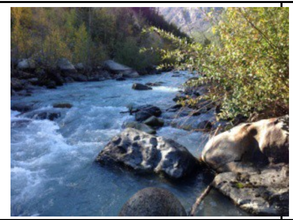
August 19 -20, 2014

B1	B2	B3	B4	B5	B6
Upstream					
					
Upstream					
					
Y1	Y2	Y3	Y4		

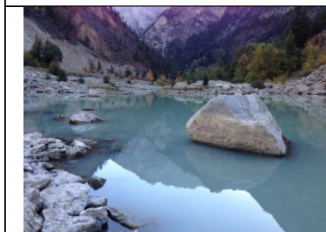
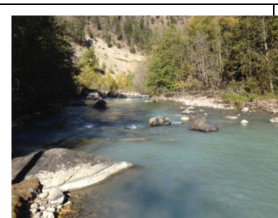
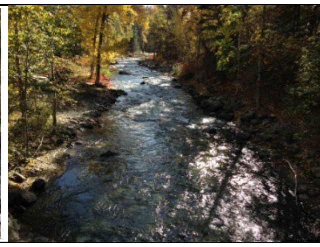
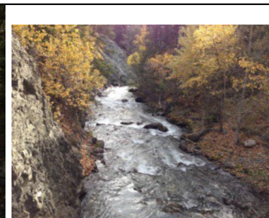
August 19-20, 2014

B1	B2	B3	B4	B5	B6
Downstream					
					
Y1	Y2	Y3	Y4		
Downstream					
					

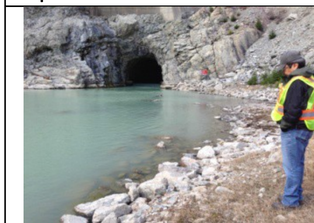
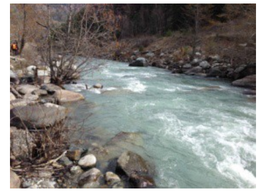
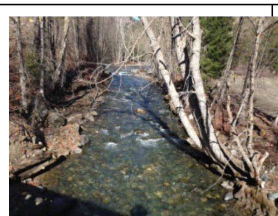
October 7-8, 2014

<table>
<tr><td>B1</td><td>B2</td><td>B3</td><td>B4</td><td>B5</td><td>B6</td></tr>
<tr><td colspan="6">Upstream</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Y1</td><td>Y2</td><td>Y3</td><td>Y4</td><td></td><td></td></tr>
<tr><td colspan="6">Upstream</td></tr>
<tr><td></td><td></td><td></td><td>
</td><td></td><td></td></tr>
</table>

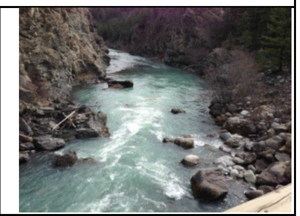
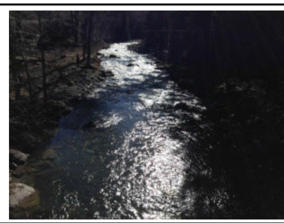
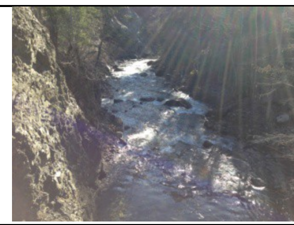
October 7-8, 2014

B1	B2	B3	B4	B5	B6
Downstream					
					
Y1	Y2	Y3	Y4		
Downstream					
					

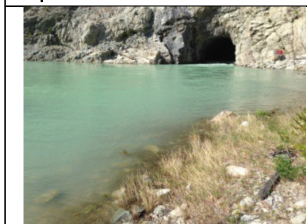
March 17-18, 2015

B1	B2	B3	B4	B5	B6
Upstream					
					
Y1	Y2	Y3	Y4		
Upstream					
					

March 17-18, 2015

B1	B2	B3	B4	B5	B6
Downstream					
					
Y1	Y2	Y3	Y4		
Downstream					
					

May 14-15, 2015

B1	B2	B3	B4	B5	B6
Upstream					
					
Y1	Y2	Y3	Y4		
Upstream					
					

May 14-15, 2015

B1	B2	B3	B4	B5	B6
Downstream					
					
Y1	Y2	Y3	Y4		
Downstream