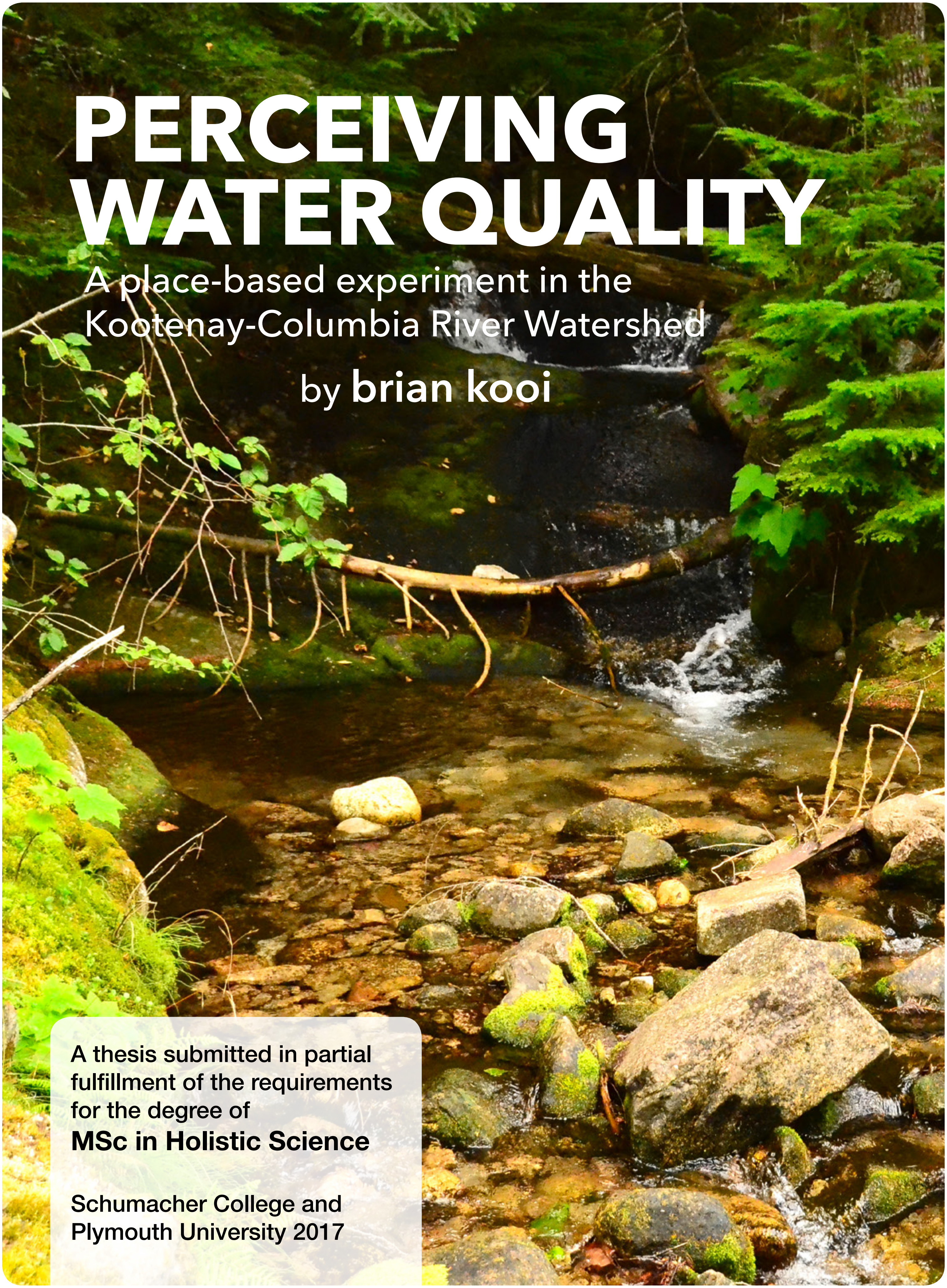

PERCEIVING WATER QUALITY

A place-based experiment in the Kootenay-Columbia River Watershed

by **brian kooi**

A thesis submitted in partial fulfillment of the requirements for the degree of
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ABSTRACT

For thousands of years the traditional peoples of the Kootenay region drank water freely from lakes, streams and rivers with little fear of ever becoming ill from such actions. In the wake of industrialization however, our waterways have become transformed by modern activities, and the water quality has suffered substantially. Today, few people would feel comfortable drinking untreated water from many of the places that not long ago were seen as sacred and safe. And yet, the capacity to discern clean, healthy water and dangerous, polluted water surely lives inside all of us.

Using a 100km long segment of the Kootenay-Columbia river watershed, this thesis attempts to shed light on the innate ability to reasonably discern whether running wild surface water is appropriate for human consumption or not. By engaging the senses, this research focuses on which qualities help us assess water as healthy or hazardous. Employing several participants at a variety of locations, the question 'would you drink this water?' is asked, and then correlated to bacteriological laboratory testing, in an attempt to synthesize qualitative and quantitative testing. While quantitative testing rules the current paradigm, I want to show that qualitative inquiry has value, as it did in pre-colonial times. The results indicate that this approach has some merit, although the invisibility of microorganisms severely limits the accuracy of this method without supplementing it with laboratory testing.

Furthermore, the participants collectively generated their own terms to describe specific water landscapes at a variety of sites, and then scored the presence or absence of these qualities independently. These scores were then analyzed using Principle Component Analysis (PCA) to measure agreement. The results of the statistics show remarkable agreement among participants regarding contextual water qualities consistently throughout a wide variety of sample landscapes. There is, however, insufficient evidence to support the notion that persons can accurately assess the water quality of running surface water to any degree for safe consumption.

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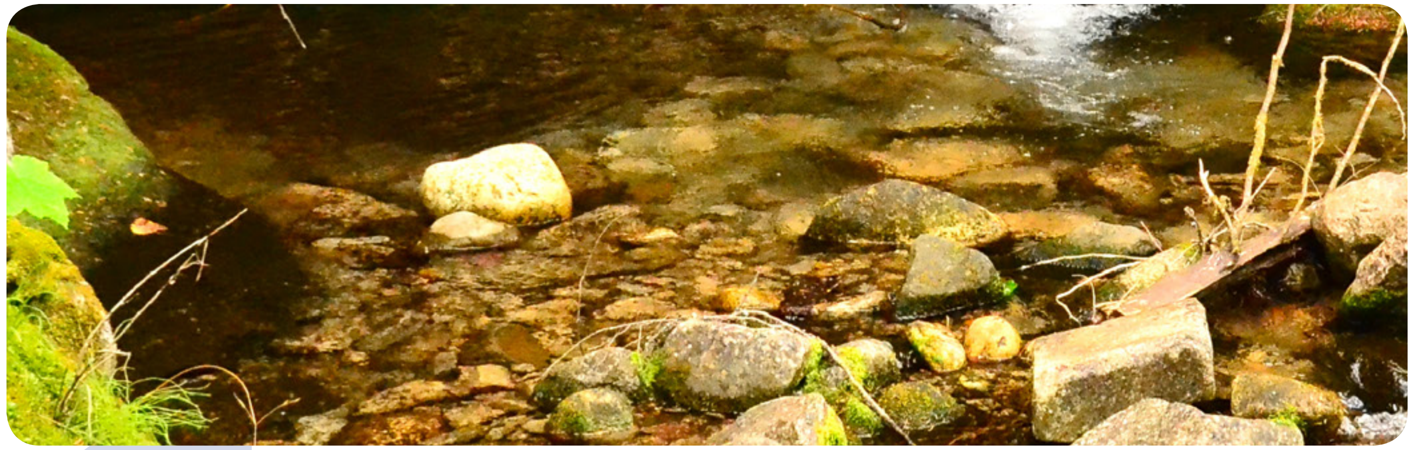


1

INTRODUCTION

Why Holistic Science?

(There are specific) modes of perception which help in our effort to grasp the infinite – Goethe

Holistic Science as taught at Schumacher College is an attempt at reunifying the whole spectrum of ways of knowing that are available to us as humans – thinking, feeling, sensing, and intuition - as identified by psychologist C.G. Jung. The idea is to incorporate all of these faculties in the process of scientific inquiry, rather than primarily by the predominant form of thinking employed in modern reductionist science, in order to get a more holistic vantage of phenomena. Another way of seeing it is to think of investigating qualities rather than strictly quantities. My experiences while attending the Holistic Science program has demonstrated that, when employing all of the resources available, a different picture emerges – one that can often reveal information that at first may seem obscured, due to a lack of perceiving different qualities, which is undeniably valuable.

Since the Cartesian split of consciousness that separated mind from matter, modern science heavily favors the faculty of thinking in the pursuit of rational, objective knowledge. This methodology has afforded civilization vast advancements in the amount of knowledge regarding biological, chemical and physical phenomena, which in turn has lead to tremendous technological innovations in the fields of science, medicine and engineering. As a result, our ability to procure natural resources and increase material production has greatly impacted the quality of life for many global citizens. The dominance of this method, however, comes at an increasingly alarming cost. Degradation of the natural world, climate change, and growing economic inequality are strong indicators that something is wildly out of balance. There seems to be a lack of wholeness in our total approach, as other values and ways of beings are consistently encroached upon by this dominant point of view. The over-objectification of the phenomenal world creates a reality of extensive disconnection for a world of people who actually experience the world subjectively. This leaves us feeling alienated and fragmented; yet immersed in a universe that is fundamentally interconnected and unified. For example, feeling is something that no doubt plays an important role in our everyday lives, but is largely withheld from the modern scientific paradigm. Denial of feelings helps concede the clear-cutting of ancient forests and the decimation of oceanic ecosystems, allowing us to justify the purely rational.

The problem lies in seeing only part of the whole picture, as western culture has been practicing for centuries now. The impending ecological crisis is a symptom of this myopic point of view "which sees the world as objects, sets of objects, and objects acting and reacting upon one another" (Schreuder, 2014). As a species that is inextricably linked to each other and to the encompassing world around us, we would be wise to make a shift that rebalances our impact on the world we live in. Part of that solution would include shifting our faculties of perceptions by giving renewed validity to sensing, feeling, and intuition which would enable a more holistic perspective. Such is the methodology of phenomenology. Phenomenology is a way of exploring the world that utilizes conscious experience and intentionality as a means of discovery. As envisioned by Husserl, phenomenology is a method of philosophical inquiry that rejects the rationalist bias that has dominated Western thought since Plato in favor of a method of reflective attentiveness that discloses the individual's "lived experience." (Husserl, 1970)

> "...we would be wise to make a shift that rebalances our impact on the world we live in."

This project makes an attempt to reconciling the impending global issue of clean drinking water by attempting to engage our other faculties of sensing, feeling and intuition in order to discover whether there is any evidence which might support the notion that our other ways of knowing are reliable in discerning the quality of water for human consumption. The irony of the transformational journey that takes place when we plunge deeply into the subjective in order to discover something objective is a desired outcome of this projects process of inquiry.

RATIONAL FOR PROJECT

I have had the good fortune of growing up in southern British Columbia's water-rich regions including Vancouver Island, the Coastal Mainland and the Interior Kootenays. As such, I have never much had to worry about shortages of clean drinking water. As I expanded my horizons and began travelling, I quickly realized how this was simply not the case in many other places around the world. In India, I became terribly ill from drinking tap water on my first day there, and battled a parasite for several weeks before getting better. In Thailand and Mexico it was essential to purchase bottled water for safe consumption. Even in my home province of British Columbia I noticed I was sensitive to different kinds of water. I eventually realized that if the municipal water supply didn't come from mountain runoff, it was less appealing for me to drink. I began honing this sensitivity to the taste and quality of water. An avid outdoorsman, I often drink untreated water from streams and creeks, and thus far have never become sick from doing so. I became curious about the criteria I employed to determine whether water was appropriate to drink or not.

This past winter I travelled in Spain and began predicting whether I would like the water I'd be drinking according to the various geographies and landscapes I found myself in. With a remarkable degree of accuracy, I surmised that the geographical context of a watershed correlated strongly with the water quality of a particular place. This train of thought seemed to tie in nicely with the Holistic Science framework I was immersed in at the time, and thus the seeds of my dissertation topic began to take root.

I decided to apply my hunch to my current home in the Kootenay region of British Columbia, Canada and the local watershed. I felt compelled to investigate whether other people shared this aptitude. Do others share this ability to discern whether running surface water from streams, creeks, rivers or lakes are essentially clean enough to drink untreated? I wanted to compare the outcome of that question with actual quantitative laboratory analysis, which test for drinking water quality. I thought the idea was a nice synthesis of qualitative and quantitative research, thus embracing the Holistic scientific path of inquiry.

Historically speaking, Indigenous peoples of this region have engaged in this type of assessment for thousands of years, as laboratory testing has only been available in very recent times. My project aims to shed light on the notion that we all possess at least some inherent ability to discern the quality of drinking water to within a reasonable degree of accuracy. I readily acknowledge that nearly all harmful bacteria are invisible, which limits our ability to come to completely accuracy. Yet, in my own personal experience, I have accurately assessed time and time again, wild water sources that are indeed safe to drink. I maintain that if we connect with wild water within its own unique context, and take the time to connect with it employing all of our faculties and 'meet' it, we can acquire a much more informed impression of the water quality and thus whether it is safe for us to drink.

During my time at Schumacher College, I was particularly impressed with the presentation of Dr. Francoise Wemelsfelder on Qualitative Behavior Assessment (QBA) in regards to farm animal health and welfare. She believes that animals express themselves on the level of the whole animal, not just in specific parts such as tail wagging or ear position, which is the approach of conventional science. As such, she set on to test and validate her suspicion, testing her hypothesis scientifically with remarkable success. By instructing people properly and getting them to tune into animal behavior she was able to demonstrate impressive levels of agreement around which emotions the animals exhibit. I wanted to apply a similar method in discerning drinking water health within its own context. The assumption is that in order to properly assess drinking water quality it has to be tested. My interest lies in discovering whether I can attain similar results from getting people to interpret water qualities with significant agreement. Dr. Wemeldsfelder utilizes Free Choice Profiling and Multivariate Statistics as the methodologies for her work. After a thorough consultation, it became clear that Principle Component Analysis (PCA) would make the most appropriate research method for this project, as it allowed an important community building component to the project. Whereas Free Choice Profiling would allow participants to choose their own terms to describe water quality, PCA required participants to agree on the qualitative terms together via discussion in a focus group, which I felt was a valuable part of the process.

Figure 1. Columbia River Watershed

GEOGRAPHICAL BACKGROUND

"As long as the sun shines and the waters flow, this land will be here to give life to men and animals."–Chief Crowfoot, Siksika (1825-1890)

The Kootenay and Columbia Rivers drain a massive watershed that encompasses an area roughly the size of France and extends into one Canadian province and seven US states. The Kootenay River's headwaters begin in the Rocky Mountains, and travels south into the U.S., then U-turns north back into Canada before it joins the Columbia at Castlegar, B.C. The Columbia river runs northwest from its origin in the Rocky Mountains before turning south and crossing into Washington State, where it eventually heads west forming the border between the states of Washington and Oregon until its terminus into the Pacific Ocean. At a total distance of 2000km's it is the second longest river system in Western North America and the largest by discharge volume.

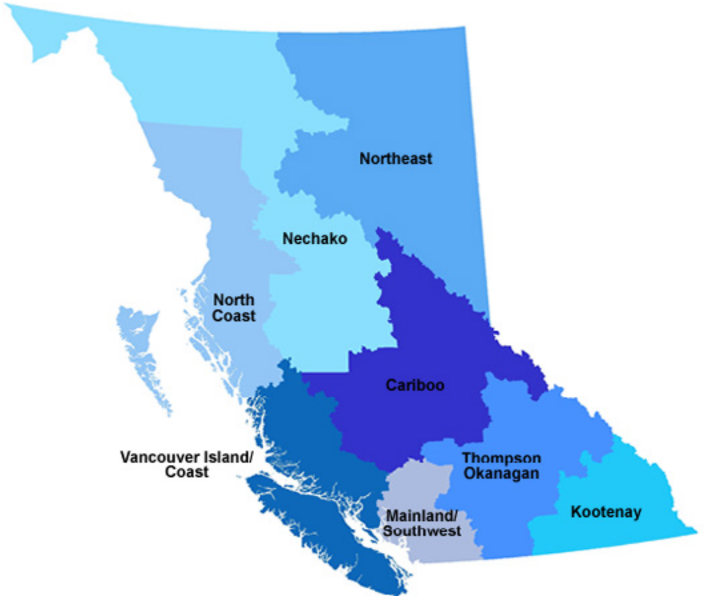


Figure 2. British Columbia Regions

The Kootenay-Columbia Geographical Region, 600 kilometers inland from the coast, occupies 7.6 million hectares (comparable to the Czech Republic) in the southeastern corner of British Columbia, Canada. It is a region with a topography that is dominated by the majestic snow-capped spires of the Columbia and Rocky Mountains, dense, lush coniferous forests and abundant fresh water in the form of glistening glaciers, deep lakes, mighty rivers and countless creeks.

The mountainous terrain captures moisture-laden air moving eastward from the Pacific Ocean, giving rise to the world's only Inland Temperate Rainforest. The predominantly coniferous forests consist largely of Western red cedar (Thuja plicata) and Western hemlock (Tsuga heterophylla) in the highly productive valley bottoms, but also consist of Ponderosa pine, Douglas fir, Western larch, Lodgepole pine, and Western white pine. In drier ecosystems, Paper birch and Trembling aspen thrive, while Subalpine fir and Engelmann spruce grow in cooler and wetter areas at higher elevations. Mosses, ferns and lichens are also prevalent.

The rich, humid forest is an ideal habitat for deer, elk, moose, caribou, bear, and wolf, as well as a wide variety of birds. The lakes and rivers provide homes for trout, sturgeon, and the Kokanee or redfish salmon, a landlocked variety of Sockeye found throughout the regions waterways.The climate is classified as Humid continental (Köppen Dfb), which is characterized by long, warm summers and cool, wet winters. Much of the precipitation that falls over the course of a year (around 800mm) comes in the form of snow, covering mountain peaks for many months of the year. Nearly all of the precipitation eventually makes its way into the Kootenay and Columbia rivers.

The western portion of the region is the traditional territory of the Sinixt and Ktunaxa Indigenous peoples. While their exact origin is debated, it is likely that these peoples have been living in this region continuously for around 10,000 years. Relationship to the land is often understood to be central to the Indigenous way of life. All of their resources were procured from fishing, hunting and gathering, as well as trading with neighboring groups. For thousands of years, Indigenous peoples depended on the rivers and lakes for transportation as the most logical trade and migration routes. The abundance of fish within the rivers and lakes, especially salmon, provided the main food source.

In modern times the rivers provide transportation routes and shipping lanes, enabling commerce, fisheries, as well as providing an ideal geographic setting for implementing hydroelectric dams due to rapid decreases in elevation over short lengths of distance. All told, there are 14 major dams on the Columbia River, and over 60 throughout the entire watershed. Although traditional cultures never faced the modern day reality of industrialization and pollution, and therefore weren't generally concerned with water quality, today we face a very different picture.

Parts of the watershed remain relatively wild and pristine, specifically within more isolated mountainous tributaries where there is little population. However, most of the main waterways are impacted by heavy use and exploitation, mostly due to hydroelectric dams and urban build up, but also by intensive agriculture and industrial infrastructure such as the metal smelter in the town of Trail, B.C. The collective impact of industrialization has resulted in an increasing degradation of the water quality, due to many pollutants accumulating in the river waters' long journey to the sea.

This thesis focuses on a small (approximately 100km) segment of the Columbia River watershed exclusively within Canada beginning at Kokanee Creek Provincial Park and finishing in Waneta, B.C. a site just north of the US border. This segment was chosen due its relatively quick change of water quality from very good to very poor as it flows from the alpine mountain streams of a protected provincial park into a river system which passes through the communities of Nelson, Castlegar, and Trail, B.C. As the water makes its way downstream, it is subjugated to urban settlements impacts, sewer outfalls, several hydroelectric dams, and the metal smelter in the town of Trail, which is the largest non-ferrous lead and zinc smelter in the world.

Figure 3. Interior Rainforest

2 METHODS AND DESIGN

"Though you roam the woods all your days, you will never see by chance what he sees who goes on purpose to see it." – Henri David Thoreau

Essentially, this project consisted of taking participants to various outdoor sites along a segment of the Kootenay-Columbia watershed.

In Phase 1, participants travelled to the 5 northerly (L1-L5) sites in person, as well as watching video and photographs of landscapes from the 5 more southerly (L6-10) sites, to gain a strong sense of the different types of environments they could encounter. They were asked to write down words they felt were descriptors of the waters' qualities at each site, privately on their own. At the end of that exercise they discussed and debated many of the words they came up with, and ultimately settled on 31 descriptor terms.

During Phase 2, participants visited the 5 southern sites (L6-10) and observed video and still photographs of the northerly sites they had already visited. The reason behind not visiting each of the 10 sites twice, in both phases, was logistical. Since the sites required visiting in random order, it was regarded as inefficient to drive up and down repeatedly, and so digital video and photography were supplemented for the real thing, simultaneously complying with the effort for all participants to encounter all of the landscapes in person at least once. Participants scored each of the 31 terms they had collectively generated for all 10 of the landscape sites on a sliding scale. In addition, they were asked to write down whether they would feel comfortable drinking the water from each of those sites in a simple yes or no format.

Phase 3 entailed the collection of water samples from the 10 landscape sites and their laboratory testing.

THE LANDSCAPE SITES

Ten landscape sites were selected for the project. This was largely an outcome of logistics as it was the minimum number to enable statistical analysis, as well as the maximum number we could reasonably reach by car in a day while respecting voluntary participants time constraints. This number seemed to be an acceptable compromise in terms of good science and practicality. The criteria for selecting each site pertained to several factors:

1) each individual landscape had to represent a relatively significant change or difference from each other whilst travelling down the watershed.

2) as a whole, I wanted the segment to represent the larger watershed of the entire Columbia river, as the landscape transforms from mountain streams, to creeks, to a small river, and ending with a large river.

3) the sites had to be accessible by car and reached easily and safely by varying levels of fitness and within given time constraints.

The image below shows the approximate 100km segment in a large-scale context, showing it in relation to recognizable urban centers such as Vancouver, Seattle and Calgary, as well as the Pacific Ocean on the left. The long horizontal line near the center of the map represents the US/Canada border.

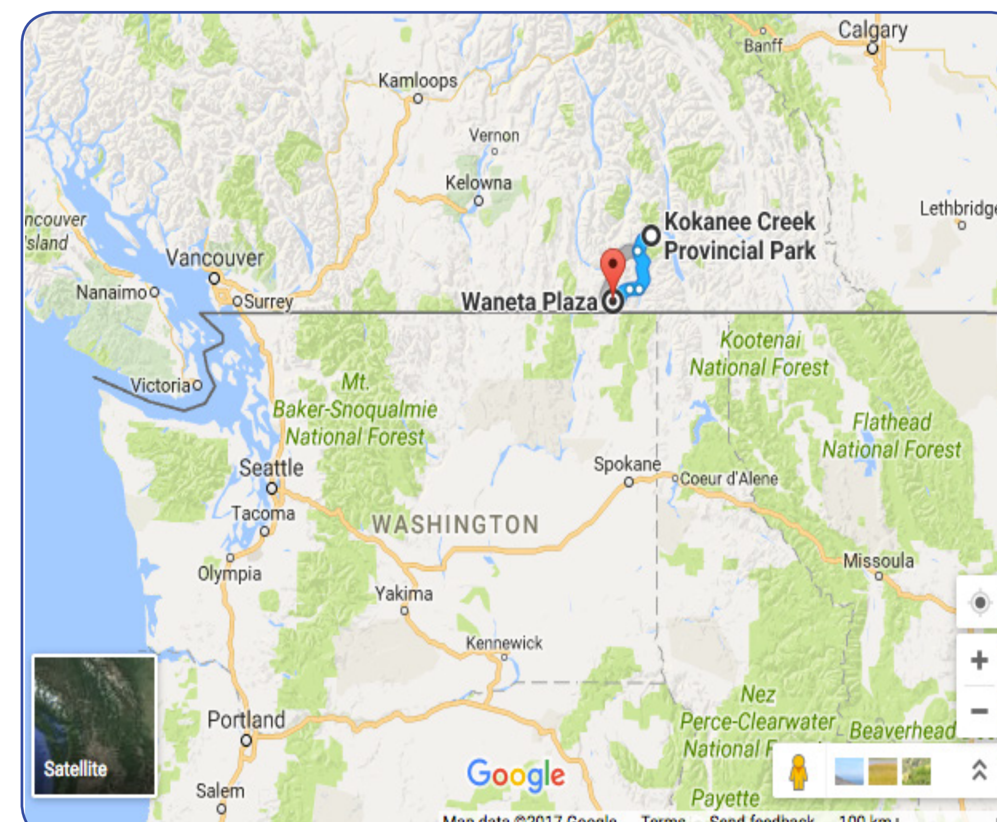


Figure 4. River Study Segment – Large Scale

The following image is a zoomed in map of the waterway segment in much greater detail. Notice how the topography is dominated by mountainous terrain shown by the relief shading. In each valley bottom fresh water is flowing in the form of creeks and rivers, largely from snow melt. North is at the top of the map, and the water flows southward gaining volume as it heads for the US border. The map reveals the locations of most of the landscape sites, with the exception of the first four (L1-L4). The first four sites are contained within Kokanee Creek Provincial Park, a protected area that was chosen for both its relatively easy access, and pristine conditions.

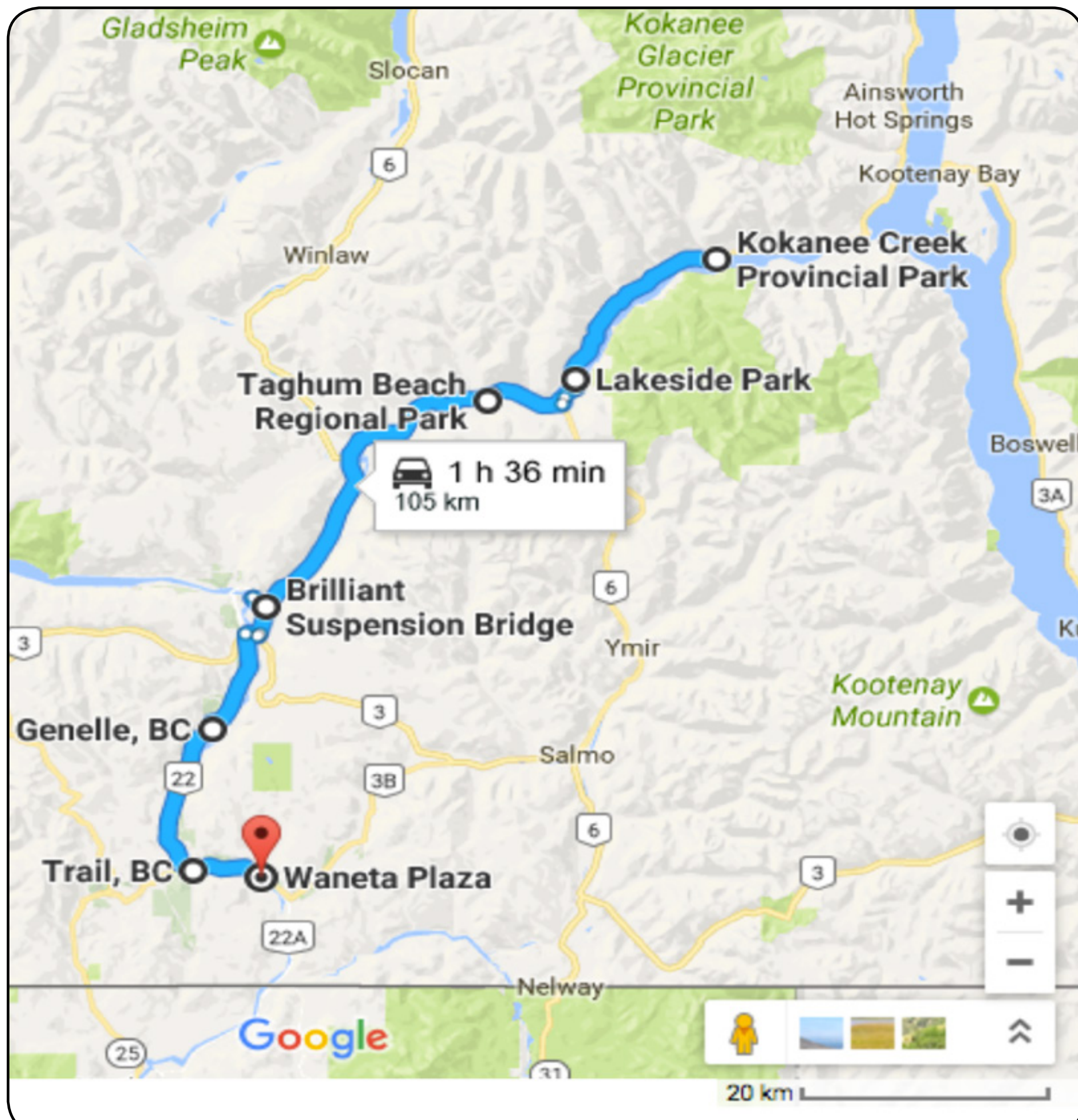


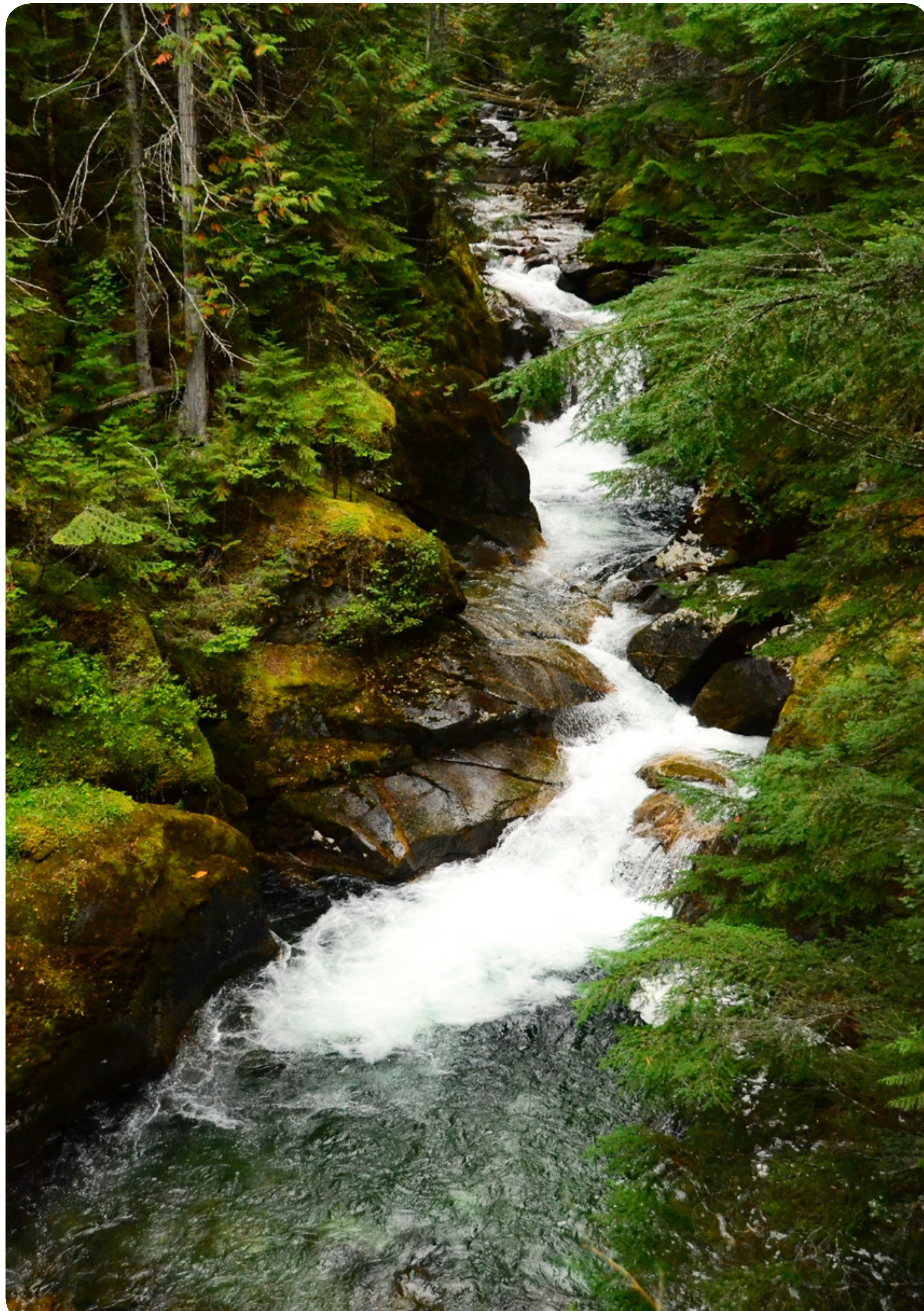
Figure 5. River Study Segment - Small Scale

LANDSCAPE 1 (L1)
Kokanee Creek Canyon

Latitude: 49°36′35.6″ N Longitude: 117°07′44.2″W
Elevation: 591m/1939ft.

SITE DESCRIPTION

Kokanee Canyon is located at the end of a rugged foot trail that winds its way upstream from the parking lot area through a lush forest of fir and spruce within the borders of Kokanee Creek Provincial Park (Fig.4). The creek is funneled into bedrock walls creating this small moss-lined canyon. There is little to no development upstream of this site, save for a recently developed commercial zip-line venture, and road that roughly follows the path of the creek to the upper area of the park into the subalpine hiking area of Kokanee Glacier Provincial Park. On its own, the site captures a pristine and wild setting, with roiling, clear waters and thick mossy banks amidst a dense forest.



Kokanee Creek Canyon

Looking upstream towards Kokanee Creek footbridge

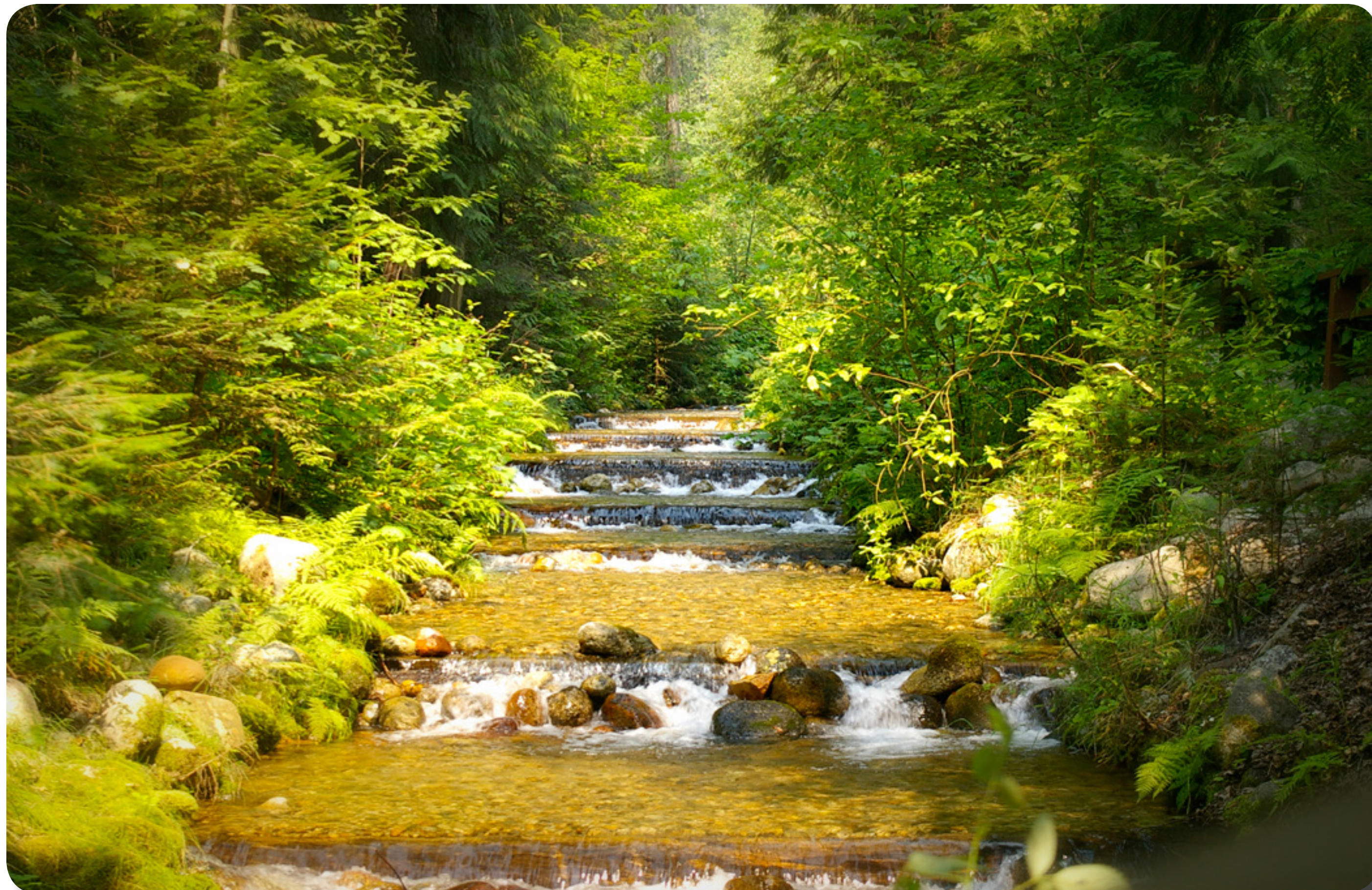
LANDSCAPE2 (L2)

Kokanee Creek Footbridge

Latitude: 49°36’11.27’’ N   Longitude: 117°07’35.59” W
Elevation: 538m/1765ft.

SITE DESCRIPTION

Kokanee Canyon is located at the end of a rugged foot trail that winds its way upstream from the parking lot area through a lush forest of fir and spruce within the borders of Kokanee Creek Provincial Park (Fig.4). The creek is funneled into bedrock walls creating this small moss-lined canyon. There is little to no development upstream of this site, save for a recently developed commercial zip-line venture, and road that roughly follows the path of the creek to the upper area of the park into the subalpine hiking area of Kokanee Glacier Provincial Park. On its own, the site captured a pristine and wild setting, with roiling, clear waters and thick mossy banks amidst a dense forest.



Kokanee Creek Spawning Channel

LANDSCAPE 3 (L3)

Kokanee Creek Spawning Channel

Latitude: 49°36′06.24′′ N   Longitude: 117°07′28.39″ W
Elevation: 535m/1755ft.

SITE DESCRIPTION

This site is located at the transition between the estuary and the spawning channel. The spawning channel is an artificial side channel that was built by conservation efforts to create an ideal habitat for the spawning salmon pictured here. The photo above looks upstream into the spawning channel. The photo below looks downstream towards the estuary. This area marks a transition zone from the rushing creek into the meandering estuary area. And while the impact of human intervention is obvious, it retains a wild feel from the abundant natural activity of spawning salmon, a frenzy of feeding birds, and lush green overgrowth on the channels' banks.

Spawning Salmon at beginning of the Kokanee Creek Estuary

Kokanee Creek Estuary

LANDSCAPE 4 (L4)

Kokanee Creek Estuary

Latitude: 49°35'58.21'' N   Longitude: 117°07'33.67" W
Elevation: 532m/1745ft.

SITE DESCRIPTION

The Kokanee Creek Estuary, also known as Kokanee Point, sits at the confluence of Kokanee Creek as it merges with Kootenay Lake after meandering through a good-sized alluvial plain. This is a quiet spot that requires crossing marshy areas to access it, and therefore, likely limits the number of human visitors. In terms of impact, there would be little additional influences from the last site, save the mixing of water from the west arm of Kootenay Lake. At the time of sojourn, there was evident bird activity, as crows, seagulls and osprey were observed, and bald eagles are known to be frequent visitors. The calm, clear waters revealed salmon carcasses at varying levels of decay, either lying still on the muddy bottom, or slowly floating by suspended in midstream. The mood was tranquil and wild, and seemed rich with biological life as estuaries often are. The long view right to the subalpine cast a gaze many kilometers afar, revealing a direct connection to a far away landscape.

Lakeside Park as seen from the orange bridge

LANDSCAPE 5 (L5)

Lakeside Park (City of Nelson)

Latitude: 49°30'30.96'' N   Longitude : 117°16'53.28" W
Elevation: 530m/1738ft.

SITE DESCRIPTION

Lakeside Park Beach is the local beach for the City of Nelson, B.C. (pop 10,800). It is located 15km west and downstream of Landscape 4, on Kootenay Lake, where, at this point the lake begins narrowing to once again become the Kootenay River. The site is subject to heavy use, mostly in the summer months; as it hosts a city beach and swimming area, boat launch, and adjacent community park. It also lies in the shadow of the connecting bridge to the north shore communities, and therefore faces constant traffic for many hours of the day. Lakeside conveys an open and expansive feel, that maintains a quality of beauty, but also begins to mark significant impact by humans to the point that it could be called domesticated, and loses the wild quality of earlier landscapes.

Lakeside Park in Nelson

Taghum Beach in summer

LANDSCAPE 6 (L6)

Taghum Beach Regional Park

Latitude: 49°29’21.55’’ N   Longitude : 117°22’53.56” W
Elevation: 529m/1735ft.

SITE DESCRIPTION

Located 8.5 km’s west of the city of Nelson, Taghum is another popular sandy beach in the warmer months. Although it has a more rural feel than Lakeside Park, which resides right in the heart of the town of Nelson, Taghum too looks across a large bridge that crosses the river here for Highway 3A traffic including freight trucks bound for Nelson. Also visible from the beach are power lines, train tracks, and clear-cut logging blocks across the opposing valley. What is not visible but known to some is the sewer outfall from the City of Nelson wastewater treatment plant at Grohman Narrows, just a few kilometers upstream. While the regional government closely monitors the water quality with regular testing, it is discernably murkier than Lakeside, as suspended particles collect on the river bottom. Recently, the regional government has issued swimming advisories for unacceptable levels of bacteria in the water in 2012, 2013, 2014, and 2015.

Looking upstream from suspension bridge towards Brilliant Dam

Bird's eye view of Brilliant Dam and Kootenay / Columbia Rivers confluence

LANDSCAPE 8 (L7)

Brilliant Suspension Bridge

Latitude: 49°19'02.76'' N   Longitude: 117°37'47.89" W
Elevation: 418m/1371ft.

The Brilliant Suspension Bridge is a historic bridge that was built by the local Doukhobor community in 1913 and used until 1966 after the construction of a new bridge. Nearly 30 kms downstream from Taghum beach and 40kms from Nelson, the river system has undergone perhaps its most dramatic change in quality of landscape. The water in the Kootenay River has now crossed 5 dams, as it is about to merge with the larger Columbia just a few hundred meters downstream. The river at this site moves artificially slow, being newly discharged from the Brilliant Dam half a kilometer upstream just visible above. The lower image shows more clearly the dam in the foreground, and the bridges downstream, as well as the Columbia River flowing out of the west. The Kootenay and Columbia rivers meet here, in the town of Castlegar, B.C. (pop. 7960). The feeling here is decidedly industrial, with the dam, generating station and other hydroelectric infrastructure dominating the landscape, as well as a noisy, busy highway overpass nearby.

Genelle Bar boat launch

LANDSCAPE 8 (L8)

Genelle Bar (Columbia River)

Latitude: 49°12′40.38′′ N Longitude : 117°41′00.21″ W
Elevation: 412m/1351ft.

SITE DESCRIPTION

Community of Genelle

The Genelle sand bar is part of a small community by the same name that lies 14km south of the confluence of the Kootenay and Columbia Rivers, approximately halfway between the towns of Castlegar and Trail. The Columbia River has taken a decided turn to the south, where it will head towards the US border, just over 30 kms away. The community of Genelle is situated along the bank of the Columbia River immediately adjacent to the sand bar. At the time of our visit here, the feeling here seemed decidedly bleak, the vegetation more bare and impoverished along the riverbank and the mountainside than upstream. A large mobile home park nestles beside the river, and locals use the shallow entry as a boat launch.

View of Trail, BC and Teck Operations

LANDSCAPE 9 (L9)

City of Trail (Columbia River)

Latitude: 49°06′00.07′′ N Longitude : 117°42′25.37″ W
Elevation: 408m/1338ft

SITE DESCRIPTION

The city of Trail (pop. 7600) straddles both banks of the Columbia River and lays 15km south of Genelle and just 18kms north of the US border. The town's main employer and industry is Teck Resources, seen above from the riverbank. Teck is Canada's 5th largest mining company and it operates the industrial behemoth seen here. The metallurgical operations produce refined zinc and lead, a variety of precious and specialty metals, chemicals and fertilizer products. The Waneta Dam, located downstream from Trail, immediately before the border, provides hydroelectric power to the facility.

Everything about this site comes back to the smelter operations here. Despite the water appearing surprisingly clean and clear, the presence of the smelter completely dominates the landscape, emulated by the distant grinding sounds and belching steam from the smoke stacks. At the time of our visit, there was little presence of bird or aquatic life here, and one of the participants pointed out a strange film on the rocks close to the shore.

Shoreline view of Teck's Trail Operations

View of Rock Island from Glen Merry bench

LANDSCAPE 10 (L10)

Waneta/Rock Island (Columbia River)

Latitude: 49°06′00.07′′ N Longitude : 117°42′25.37″ W
Elevation: 408m/1338ft

SITE DESCRIPTION

Waneta is a small village area 6km southeast of the city of Trail. Rock Island refers to the island you can see in the photo that emerges from the middle of the river. The city and the smoke stacks of the smelter facility are out of view here, but the memory remains. Again, the waters look clear and clean, but common sense would tell you it is not. Regardless, it was an interesting site, with beautiful larch emblazoned banks, and wonderful exposed rock features.

A participant encountering water near Rock Island

THE PARTICIPANTS

The process of selecting the participants was a fairly straightforward affair. Over the course of the summer I asked people I thought might be interested in participating, or if they in turn expressed interest after I spoke with them about the project. I also put out a post on social media to reach a larger audience and had about half of my responses that way. I hoped to gather about 10 participants, but wound up getting commitments from only 7, as their involvement required the better part of two separate days to carry out Phases 1 and 2. Fortunately, the statistics didn't suffer from a lower number of participants. The criterion of selection therefore, was simply a willingness to participate in the experiment. In the end I managed to recruit 4 females, and 3 males. All participants lived locally (within 20kms of Nelson) with the exception of one who travelled 50km to Nelson, where we began Phase 1. Culturally speaking, participants were middle age (32-46), 6 of Caucasian decent and 1 Asian, and all native English speakers, besides one native Chinese speaker who is bilingual.

Participants near the spawning channel during Phase 1

EXPERIMENTAL PROCEDURES

The basis of the experiment occurred over three separate field events, designated as Phase 1, 2 and 3. The focus group participated in Phases 1 and 2, but was not needed for Phase 3. Before Phase 1 transpired, participants were informally briefed as to what the goals and outcomes for both Phase 1 and 2 were. Phase 3, which was simple water sample collection and subsequent quantitative testing, was carried out by myself, and with the help of Passmore Laboratories, who specialize in analytical water testing services.

PHASE 1 – TERM GENERATION

Phase 1 of the experiment happened on Sunday, October 16th, 2016. The objective was to travel to some of the sites to get a sense of the variety of landscapes that would be visited in Phase 2. Participants were instructed to come up with descriptive terms akin to the different settings of water landscapes in different locations and contexts. These proceedings are similar to the Free Choice Profiling (FCP) methods utilized by Dr. Wemelsfelder. In FCP, participants gather in a focus group to independently determine terms that describe the exhibited qualities of the identified phenomena. Principal Component Analysis (PCA) uses the same focus group but rather than determining terms individually, the focus group *collectively* decides on the terms via a discussion. Participants are allowed to choose any terms of their liking if there was at least a general consensus that term definitions made sense to everyone. This phase represents the most qualitative aspect of the experiment.

I instructed the participants to use all of their senses to gather information, so besides the obvious faculty of vision, the use of smell, listening, touch, and intuition were highly encouraged to gain a more holistic perspective for each encounter. Further instruction was given to take an open-minded approach and "envision the water as a living being that is capable of communication, expressiveness, and health. Water can speak to us about its state of being. What qualities does the water seem to communicate to you about its state of being within the specific contexts? -as if it could express itself in ways that are normally reserved for humans, as *living qualities*". One of the important questions I asked them to consider was, "what does it feel like to be the water here?" Taking care to describe 'the water's qualities and not your own,' was another important instruction. The example given was, "if you choose 'disgusted' this would indicate your feeling towards the water, and therefore was not a true descriptor." It was important to distinguish between the perspective of the participants and that of the water's. Even though I assured the participants this was a valid feeling, it was not the point of the exercise.

Participants were asked to engage individually on their own and without discussion for about 5 minutes with each landscape, and tune into the whole scene, taking in the sights, the sounds, the textures, and the feelings of each unique place. They wrote down their terms for each of the different landscapes presented after interacting and taking the time to 'meet' each landscape as a unique entity unto itself. Although a challenge to some at first, as questions arose about whether they were 'doing it right', I assured them there was no wrong way to do it, and to trust the terms that arose in the process.

My sense at this point in the experiment was that this is an example of what happens to us as participants immersed in a culture which is so accustomed to perceiving phenomena in a prescribed way. Wandering away from the usual confines of making sense of the world leads, initially at least, to discomfort and second-guessing. As described in the introduction of this thesis, our culture is more familiar with thinking and describing what we see and observe plainly, as objects. Tapping into the more subtle senses of subjective intuition and feelings takes a little longer for most to describe, although certainly, these impressions are there. To wit, upon presentation of a particular landscape, we are at once struck with an overall impression. Articulating them as a whole, however, may take some time and practice to materialize, because we do not routinely describe the unseen; the hidden intangibles. Part of the intention of this study was to engage the participants in this way of knowing that we all subconsciously share, but are less familiar with portraying through language. Introducing students to phenomenological method is always a considerable challenge because, typically, there are no certain means to know if we are really seeing and understanding the phenomenon we are claiming to (Seamon, 1999).

As the exercise wore on, participants became more comfortable and less unsure, and were further encouraged to go beyond the regular perceptions normally ascribed to landscapes. Given this freedom of expression, the whole was able to appear through the parts.

Phase 1 at Kokanee Creek

During our hike up and down Kokanee Creek the focus group visited the four sites (L1-L4) within the park, but were also cued to stop and observe other areas that were deemed to be of interest by way of exemplifying differing qualities within the contiguous landscape. Afterwards, the group also visited Lakeside Park in Nelson. This was followed by slides and video taken by myself at an earlier date of the more southerly/downstream sites at Brilliant, Genelle and Trail.

Once all terms were presented, care was taken to eliminate as many synonyms as possible, and to represent a wide variety of terms for the diversity of landscapes to be encountered. As a guideline, it was suggested that terms be categorized into four distinct quadrants, the first division being positive and negative terms, and secondly, high and low energy terms. For example, *clear* and *muddy* would be considered positive and negative terms respectively, while *rushing* and *stagnant* would be considered high energy and low energy respectively.

I was pleasantly surprised by the variety of terms the participants came up with. While initially, the early terms were more simple descriptors such as *flat*, *stagnant*, or *powerful*, upon encouragement to conjure less obvious choices and tap into more unseen and felt qualities the group offered up others such as *manipulating*, *permeating*, and *magical*. It was fascinating to sit and listen while participants described where and how these terms came into being and specifically how they defined them contextually, and then how that would resonated with other group members with nods of understanding. The results were satisfying, and even a little bit surprising.

PHASE 1 - TERMS FOR WATER QUALITY STUDY • 31 TOTAL

POSTIVE HIGH ENERGY - 8 (+)

CRISP
PERMEATING
OXYGENATED
POWERFUL
MAGICAL
DRIVEN
DYNAMIC
WILD

NEGATIVE HIGH ENERGY - 5 (−)

TURBID
MANIPULATING
DISRUPTIVE
IMPACTED (by HUMANS)
CONTROLLED

POSTIVE LOW ENERGY - 9 (+)

CLEAR
CALM
STILL
ODOURLESS
PURE
NOURISHING
COLD
GENTLE
ANCIENT

NEGATIVE LOW ENERGY - 9 (−)

CONSTRAINED
STAGNANT
STINKY
POLLUTED
FLAT
WARM
DENSE
EXPANSIVE
TEMPORARY

Figure 6. Phase 1 Results

PHASE 2 – TERM SCORING

During the course of Phase 2, which occurred two weeks later on Sunday, October 16th, 2016, the 5 southern sites (L6-L10) were visited by car. The northern sites, which had been visited during Phase 1 were re-examined by projected digital video clips. This again, was due to logistics, and a time constraint expressed by participants. The importance of not going to the sites from upstream to downstream was relayed by Dr. Wemelsfelder, hence the sites were visited in a random order beginning with Taghum Beach (L6), followed by Genelle (L8), Waneta (L10), Trail (L9), and finally Brilliant (L7). The northern landscapes were also randomly viewed as 1-2 minute video clips, beginning with the Kokanee Footbridge (L2), Kokanee Spawning Channel (L3), Lakeside Park (L5), Kokanee Canyon (L1), and concluding with Kokanee Estuary (L4).

Phase 2 at Genelle

Instructions were handed out as follows:

Perceiving Water Quality Study   Phase 2

Two weeks ago you created common terminology as a group for describing expressive qualities that you observed in different water dominated landscapes; your perception of what it is like to be water within the context of those landscapes; the quality of its presence, its personality.

All done very well, interesting range of terms. So a good beginning.

Today is Phase 2: use the terms you've created to score the waters' expressions on a quantitative basis. These scores will provide the data for a statistical analysis that I will do, to see to which extent you agree and have interpreted what you saw in a similar way.

You are going to visit 10 sites (some via video) all within the Kootenay/Columbia River watershed in a random order. Essence: Score each point on each of your terms.

Look at the form:

I have taken all of your terms, and added a line of 12.5 cm. to each term. There are 31 lines, 1 for each term. So you must score all sites we visit on all of your terms!!

Please do not skip any, you cannot change them or add any additional terms.
Now look at all your terms and see if you understand them all or have any questions.

How do we use the line for scoring?

- It is a continuous line, no divisions or categories. You can use it and interpret the scale as you like, intuitively.

- The left point is the 0-point, or Minimum represented by 'Min'. If you choose to score '0' that means that characteristic is absent, or not present at all. The right point is 'Maximum', represented by 'Max' which means it is completely dominant.

- A continuous increase of scale in between, you can devise your own way of working with this. There is no 'objective' measurement scale.

- You tick the line at the appropriate point; make sure it crosses the line at one point only. The measurement is distance from the 0 point in millimetres.

Scoring is not an easy thing to do. Some comments to help.

- Be careful when scoring negative terms. The score gets more negative as the score gets higher. For example – a high score of 'Polluted' means water is very polluted.

- It's important to be consistent in the way you use a term. Gradually form an image of each term and try and use it consistently, particularly when meanings are close. For example – Powerful and Driven. Try to not let meanings drift, swap or change. Be consistent.

- No need to compare your scores for different terms. For example, if you give a high score on one term, don't automatically give a low score on other term. Qualities can coexist in different ways. So assess each of your terms independently of other terms, and focus on the meaning of that term for that specific site.

- It is also possible that certain water landscapes have different elements which express different qualities. You can account for subtle differences between elements because you have so many different terms. For example – water can display being 'Powerful' or 'Polluted' in different ways.

- What you do: Take in all the different elements that you see in the 5 minutes, and then when you score each term, you weigh up your impression of the total intensity of that particular expression of water within the context of the landscape.

What to do

- At each of the sites: take some time connecting with each place, using all of your senses, your vision, smells, touch, listening, feelings, impressions of each landscape for about 5 minutes or so.
- Next, begin scoring the landscape on your terms until you are finished. Please do not discuss scoring or impressions with other participants. The connection and scoring are to be done on an individual basis. If possible, complete the exercise in contemplative silence.
- This is likely a new exercise for most of us, so take your time to get the hang of it at the beginning. You can gradually go faster as you develop a sense of how to use the scale.
- Please ask questions if unclear during scoring or any other time.

ANY QUESTIONS?

Terms were scored along a 12.5 cm line with the far left hand side meaning a 'complete absence' of that quality, while the far right-hand side represents a 'completely dominant' presence of that quality. A simple perpendicular line was to be drawn along the line that most precisely corresponds to the particular quality for each landscape as interpreted and perceived by each participant. At each site as much time as was needed was allowed, although this generally took 5-10 minutes, depending on the site. A caveat was given about 'negative scoring', which referred to scoring a negative term. For example, rating "dirty" with a high score means that the water is VERY dirty while a low score of "dirty" would indicate that the water is less dirty but still NOT clean, unless marked 0. I had the impression participants were very engaged in the exercise, and completed the surveys thoughtfully. Spirits were high for the duration of the fieldtrip, despite the drizzle. (See appendix 1 for Phase 2 worksheet)

Colorful umbrellas during Phase 2 at Taghum Beach

PHASE 3 – WATER SAMPLING

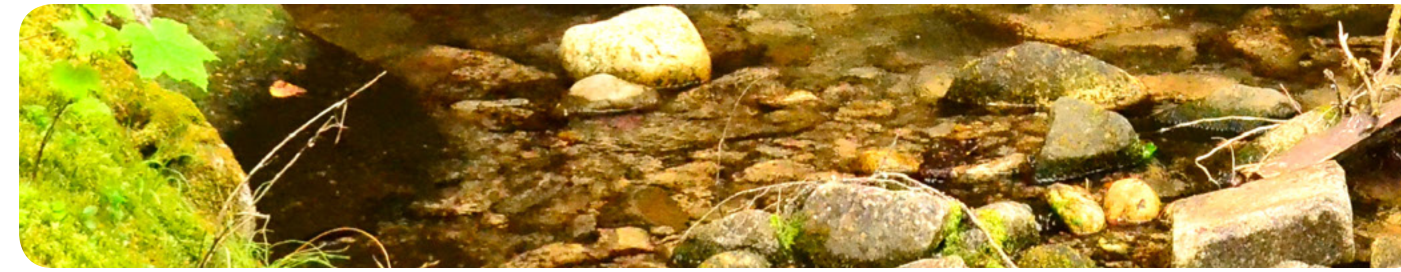
Phase 3 was the final phase of the fieldwork which consisted of collecting water samples from the different landscape sites. Initial cost estimates of testing 10 water samples were restrictively high, so I decided to reduce the number of samples where it was best determined that water quality would not fluctuate significantly. For example; the difference between landscape 1 and 2 was in my mind negligible, as the distance between the sites is only several hundred meters apart with no major impacts between them, save for the bridge going over the creek. For this reason, I elected to forego sampling Landscape 1 Kokanee Canyon, and also because actually acquiring a sample from that site might be substantially hazardous. I also discovered that local government agencies regularly test water at both Lakeside Park in Nelson and at Taghum Beach for public health reasons, and so I sought to obtain test results for those respective areas. Although I was successful, unfortunately the testing ceased near the end of summertime and therefore would not accurately represent the actual water quality around the time that Phase 1 and 2 were carried out. I decided collect the samples anyway to bolster the efficacy and thoroughness of the study.

What I have learned from doing background research is that there are many different types of water testing. I knew that no single factor would be able to assess the water's overall health and in order to procure a sample result that is comprehensive is extremely expensive, as it requires immediate shipping via courier to a major lab for a complex analysis that produces results for over 50 parameters. For the purpose of this study this was not necessary.
Some of the types of tests that are commonly done for drinking water include bacteriology, dissolved oxygen, pH, conductivity, temperature, and metal analysis, among others. I had to narrow it down, and because my query had to do with drinking water in relation to safe consumption I chose to go with bacteriology. I would have also liked to test for metals, as the test site in the city of Trail would surely reveal the impact of the smelter on the river, but it was simply not feasible given the scope of this project. I concluded that bacteriology would be the most suitable test parameter, and was fortunate enough to discover a local laboratory that could analyze the water samples in a timely and affordable manner. Passmore Laboratory tested the water samples for three different parameters which include *Total Coliforms, Fecal Coliforms* and *E.coli*. Bacteriology testing is both time and temperature sensitive, with samples needing to be kept cool (<10 C°) and arrive at the lab within 24 hours of collection. Without following these specifications bacterial colonies can grow and skew the results.

I was new to water testing, and had no idea there was a very specific technique to sampling in order to achieve the best results but fortunately, I had a crash course by a friend who was well versed in the proper procedure. Armed with this new knowledge, I headed out in the early morning of November 7th, 2016 and went from north to south, collecting samples from 9 sites, skipping the canyon, as it would be very problematic to safely obtain a sample from that sight regardless of cost. The entire trip went well. I reached the laboratory and dropped the samples off in to the refrigerator by 2:30 pm. The lab analyzed the samples but due to some unfortunate circumstances beyond my control I was not able to obtain the results until Dec 12th, 2016. The lab made amends by providing two free samples (of which I thought I could obtain the results from local government agencies). They also gave me a student discount, which was deeply appreciated.

DATA PROCESSING

In order to process the data statistically, all of the values scored by the participants needed to be deciphered. The data points are expressed as millimeters, which were measured from the left-hand MIN point (*see appendix 1*). Since the line was 125 millimeters long the scores ranged from 0 -125, with a score of 44 meaning 44 millimeters in from the left. These results were entered into a data matrix arranged in 70 rows (7 participants x 10 landscapes) x 31 columns (31 terms), resulting in 2170 values. This data sheet became the input for the Principle Component Analysis (PCA).



FINDINGS AND DISCUSSION

LABORATORY RESULTS

After an initial poor impression of the lab due to unnecessary delays of receiving results, I finally had a meeting with the owner Jennifer Yeow after she returned home from holiday. We had a wonderful conversation about the results, and then afterwards about her legacy of work in the nearby Slocan Valley around water testing, which was instrumental in coming to the conclusions of this study, which I will share later.

In the standard drinking water bacteriology tests that they offer, three parameters are tested - *Total Coliforms, Fecal (Thermotolerant) Coliforms,* and *Verified E.coli.* Results are measured in the unit CFU/100ml, which is shorthand for *Colony-forming units per 100 milliliters*. Mostly, the lab deals with groundwater from wells, although some people test creek water before filtering it for household use and consumption. Expected results from treated water are obviously different from untreated water. The standards set by government agencies in Canada are very high, as the threat of liability looms large and there is no incentive to take unnecessary risks. In general, any results greater than '0' for both Fecal Coliform and E.Coli are considered 'unacceptable.' As for Total Coliforms, Jennifer stated that results of <10 CFU are okay to drink. Therefore, in order to pass, tests had to yield zero's in both Fecal Coliforms and E.Coli, as well as <10 in the Total Coliforms column. It is this standard that I used to determine whether the samples I collected were safe to consume or not. One can see by the results below that only two samples passed and are considered 'acceptable' according to these strict standards. It would be interesting to explore what people can actually tolerate without getting ill.

	Total Coliforms	Fecal Coliforms	Verified E.Coli	PASS?
Landscape 1				NOT TESTED
Landscape 2	14	10	10	NO
Landscape 3	5	0	0	YES
Landscape 4	11	4	4	NO
Landscape 5	4	0	0	YES
Landscape 6	7	2	2	NO
Landscape 7	150	11	6	NO
Landscape 8	95	3	3	NO
Landscape 9	45	10	8	NO
Landscape 10	80	12	12	NO

Figure 7. Laboratory Results (all units in CFU per 100ml)

Although these laboratory results were initially disappointing, further contemplation led to the insight that two samples actually passed a government standard without *any* treatment. whatsoever. This might be a point of interest to people who are used to expecting all drinking water to be treated. If anything, it at least points to the wealth of clean water within the region.
In contrast, where this result fails to impress, is when looked at from the point of view of the traditional cultures that occupied this region for thousands of years previous. In a brief conversation with local Sinixt elder, Marilyn James, she claimed that her people knew that, “all water was sacred and all water was good.” She claims that even ‘sulphur water’ near hot springs was safe to drink. “There was no need for testing, ever” she stated (James, 2016).

Jennifer informed me that there is no strong correlation between *Total Coliforms* and human infection. What this means is that even if the sample came back with a high count of *Total Coliforms*, it does not strongly correlate with unsafe drinking water. Coliforms occur naturally in soil and vegetation, as well as the intestines of mammals. However, she communicated that there certainly is a strong correlation between *Fecal Coliform* and *E. coli*. As she explained, “most of the fecal coliforms that are detected are E. coli, and *all* of the E. coli detected were fecal coliforms.” (Yeow, 2017) Fecal Coliforms refer to the group of bacteria that originate in feces. Escherichia coli, more commonly known as E. coli. is a genus of Fecal Coliform. While many Escherichia are commensal gut flora, particular strains of some species, in the serotypes of Escherichia coli most notably, are human pathogens (Guentzel, 1996). *E. coli* originates in the gut of warm-blooded animals and humans, and subsequently, their feces. Therefore, the presence of *E. coli* in water indicates contact with infected feces, usually from agriculture or sewage sources, making it unsafe to drink.

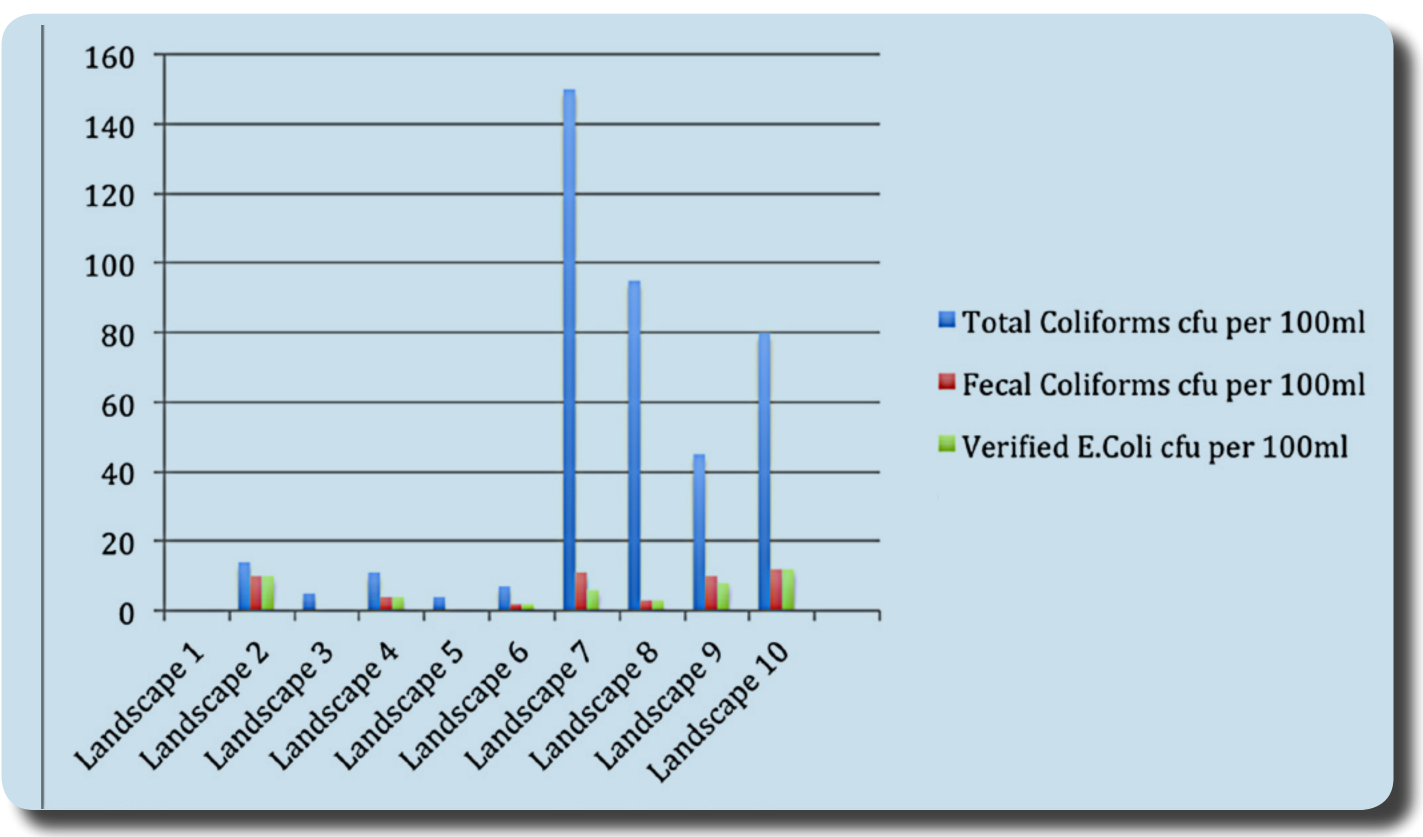


Figure 8. Laboratory Results (Graphical)

When pondering where these standards actually come from Jennifer mentioned that cultural impacts are a factor in scoring what water is safe to drink. She referenced the Walkerton, Ontario E. coli outbreak of 2000, which was responsible for several deaths while making 2,300 people ill after E. coli bacteria penetrated a community water source, and escaped detection and proper treatment (En.wikipedia.org, 2017). Due to this incident and others, compounded by similar outbreaks in food-borne bacteria, the public perception has forced the policies to become much stricter, to the point that the only acceptable result for both *Fecal Coliform* and *E. coli* is nil. Therefore any test sample with any result in *Fecal Coliform* or *E. coli* is automatically unacceptable for a treated water source. As is evident from the test results, 7/9 samples came back positive with the presence of those bacteria. This is not to say that small counts could not be tolerated by certain intestinal flora of some individuals, but under the jurisdiction of increasingly scrutinized public agencies and the daunting shadow of legal liability, the acceptable levels have been safeguarded to a value of zero. The widespread use of chlorine to treat drinking water is perhaps an outcome of this perception.

Other factors that influence the outcome of these tests include water testing techniques and seasonality, as well as geology, topography, and vegetation. Because all of the sample sites were taken from running water, the water supply was constantly changing. As was the exact location of where the water was taken from, whether it was taken from the shoreline, midstream, or near the surface, it can all impact the bacteriology result. For example, if a water sample is taken from shore with a muddy bottom, the very act of entering the water can stir up the bottom and include bacteria that live on settled mud or vegetation. The guidelines recommend getting into the main flow of the stream and taking a sample of a column of water from the surface to the bottom and up to the surface again while facing upstream. This was simply not possible in most cases, as the majority of the test sites were substantial rivers.

It was assumed at the outset that possibly only the first two or three sample sites would pass in terms of being safe to consume. My best guess said that once the water would mix with the larger lake at the estuary, the factors of complexity would override the purity of the mountain runoff, and become contaminated, largely the result of human impacts, most notably sewage. In retrospect, the results are somewhat disappointing, especially in the case of the first sample. It was assumed this would be the cleanest water, but in fact failed on all three parameters.

As mentioned previously, there are a number of factors that could have influenced this outcome. The presence of dogs and their use of the park as a bathroom is one possible cause. There are also a considerable number of wild animals living in and around the park, and any one of these could have contributed to the verified fecal bacteria. The sample was taken not long after the autumn salmon run, when hundreds of fish die and decompose, simultaneously attracting predators ranging from scavenging seagulls to bingeing black bears. The specific sample site (for L2) was one in which I was unable to venture far from the shore, and therefore obtained a sample within about a meter of the water’s edge where the flow was significantly slower than the rushing main body of water upon which participants based their answers. Nevertheless, the results points to the assumption that it is enough to determine the quality of the water by simply looking at it. Many of the pollutants that water can carry are invisible to the naked eye, and although our vision can give us an idea of the clarity of the water as well as detect the presence of substantial suspended particles (turbidity) which may harbor dangerous microorganisms, we are literally blind when it comes to detecting the bacteria themselves.

The other surprise was the result of the sample taken at Lakeside Park in Nelson (L5), which actually yielded the cleanest water from all samples. When sampling, I ended up walking out to the end of the dock (which can be seen in the foreground in the photo on pg. 21), laying on my stomach and dipping the sample bottle as deep as I could as per the proper protocols. The water here moves steadily west at a moderate rate. When the participants encountered this site, they focused on the beach area very near to the shore where the water behaves differently as it is somewhat of a back eddy where water is more still. Had either the water sample been taken from within this area, or the participants encountered the water at the end of the dock the results may have differed. Regardless, the test results being what they were, they may have been different if I was able to test at the same time the surveys were completed. The fact that nearly three weeks elapsed between phase 2 and 3 could have skewed the outcome, but could have gone either way, I will never know.

The table below compares the participants' responses to the simple yes or no answer to drinking the water at each site untreated to the quantified laboratory results. L1, L2… refers to the landscape number beginning with the northerly sites (Canyon, Footbridge, etc.) moving south/downstream and each participant's response. Those numbers are then compared to the lab result, which was also determined to be a simple yes or no (acceptable or unacceptable) result.

Would participants drink water from these sites?

Site	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Anna	Y	Y	N	N	N	N	N	N	N	N
Shanna	Y	Y	N	N	N	N	N	Y	N	N
Jeff	Y	Y	Y	Y	N	N	Y	Y	N	Y
Paul	Y	Y	N	N	N	N	N	Y	N	N
Scarlet	Y	Y	N	N	N	N	N	N	N	N
Lorne	Y	Y	N	N	N	N	N	N	N	N
Heather	Y	N	N	N	N	N	N	N	N	N
Lab Result	Not tested	N	Y	N	Y	N	N	N	N	N
Correlation		*1/7	*1/7	*6/7	*0/7	*7/7	*6/7	*4/7	*7/7	*6/7
Overall	*38/63 = 0.60/60%									

Figure 9. Comparison of Lab Results with Participant's Answers

Interestingly, among the participants themselves there was tremendous agreement for each individual site, with 9 out of 10 sites yielding 6/7 or 7/7 agreement, meaning the group generally agreed >86% of the time. Only landscape 8 (Genelle) generated a mixed response. That means that of the total 70 questions asked, the participants agreed 62 times – a remarkable 88.6% agreement. The agreement with the lab results are significantly lower 38/63 (lower because L1- Canyon was not tested), yielding only 60% agreement. I feel strongly that if the Canyon and Kokanee Footbridge were both sampled properly, they likely would have tested favorably, which would have significant impact on the correlation, pushing it up to 73%.

So, how do we make sense of the outcome here? L1 and L2 were presumed to be the cleanest water, as they flowed out of a protected park into another park, and other than the solitary 'No' by Heather for L2, everyone perceived the water to be clean enough to drink. The negative result of the test foiled that notion, and because L1 was unable to be tested I was forced to carry the same result upstream. This is by far the most surprising outcome, but helps to reinforce the validity of exercising caution when drinking any untreated water. My feeling is that because of the time of year, a creek full of spawning salmon, and those animals feeding upon them, can impact the water quality significantly enough. However, had the water sample been taken from the fast flowing water near the middle, the test result might have been cleaner. My sentiment is informed by the result for L3, which passed easily, due to the fact that I was able to wade into midstream at that site. And yet, at this point most participants chose to begin altering their comfort with freely drinking from the sites. To be fair, when assessing L3 participants were directed to look downstream, as seen in the photo (pg. 19) which featured dead fish and a cluster of seagulls – I wouldn't drink from that environment either. But if we simply turn and look up stream as is evident in the previous photo (pg.18) the scene looks very different. Perhaps it was a failure of the instructions at this site to take in the entire scene both up and downstream in their assessment. Hindsight is always 20/20.

The results for L4 in the Estuary are finally unanimously agreeable, but perhaps not surprising as dead fish carcasses were visible and the water slowed to a crawl. At L5, Lakeside Park, most of the participants were probably familiar with the beach and how it is used in the summer. Perhaps they were thinking of the downstream effect from the last two sites as well as the numerous lakefront homes and their septic tanks accumulating in the water, as I had suspected they would. To add a bit of background, Lakeside Park had been closed just months before due to extremely high *E. coli* counts from standard testing. There was no surprise from the responses, but again, a surprising test sample showed the water was very clean, albeit from a different area than the participants interacted with. Where I tested, the water was very active and moving, and where the beach is, the water is much more still. They are approximately 50 meters apart.

The rest of the landscapes (L6-L10) yielded 90% '**No**' responses from all participants, with just a few outliers, especially evidenced by Jeff's responses. He was willing to drink the water 7/10 times, 4 more than the next closest persons (Shanna and Paul at 3/10) - and yet only two of those would have been safe for him according to government standards. Jeff demonstrates a bucking of the trend. If we remove his data we see that the rest of the participants agree a remarkable 57/60 times or 95% for all sites. Excluding Jeff, we have very high agreement between participants and lab results for the second half (downstream L6-10) sites with 30/35 or 86% correlation.

STATISTICAL RESULTS AND INTERPRETATION

The following explanation of the statistical data stem from a phone call I had with Françoise Wemelsfelder on January 16, 2017. All of the statistical procedures and outcomes were generated by her and sent to me via email.

The results of Phase 1 and 2 of the study are much more complicated than Phase 3. As described earlier, the term generation of Phase 1 resulted in 31 commonly decided descriptors of differing water landscape qualities. Participants then scored those terms for each landscape and those scores were statistically analyzed using PCA software for correlation. Principal component analysis (PCA) is a technique used to emphasize variation and bring out strong patterns in a dataset (Powell and Lehe, 2016).

The Components, also called dimensions, are the Principle Components from which the method gets its name. These are mathematically determined patterns that show significant correlation. The outcome is determined purely numerically as the software deals only with numeric values and has no comprehension of which language is used. The computer software calculates thousands of components, but only those whose output is significant are of interest. As the significance gets smaller and smaller, it can be said that they are just as likely related by chance than by any real relationship. The data I received produced 3 significant components, labeled PC1, PC2 and PC3. The correlations, or loadings of each term with each of the three components are listed in Figure 9. The terms with the highest loadings on either the positive or negative side of a component (highlighted) are used to interpret the meaning of that component. Those terms are then used to compare components along the axis of the Loading Plot (Fig.10).

The components can also be presented graphically where we get a much better sense of the relationship between terms and what they reveal. The loading plot provides a framework for meaning, which has to be interpreted in light of the particulars and what patterns emerge.

Variable	PC1	PC2	PC3
calm	-0.205	0.234	0.047
stinky	-0.146	-0.145	0.327
powerful	0.254	-0.202	0.063
flat	-0.223	0.169	0.053
clear	0.101	0.236	-0.022
polluted	-0.169	-0.295	0.071
pure	0.214	0.25	0.026
crisp	0.231	0.175	0.002
still	-0.218	0.222	0.066
dense	0.173	-0.028	0.31
controlled	-0.037	-0.147	-0.044
nourishing	0.151	0.273	0.1
disruptive	0.172	-0.138	0.207
wild	0.032	0.173	0.164
constrained	0.076	-0.17	0.165
manipulating	0.191	-0.119	0.263
odourless	0.142	0.102	-0.205
stagnant	-0.19	0.147	0.184
oxygenated	0.26	0.04	0.127
warm	-0.196	0.055	0.328
permeating	0.166	0.131	0.286
cold	0.214	0.018	-0.216
turbid	-0.073	-0.086	0.278
gentle	-0.226	0.247	0.038
driven	0.258	-0.161	0.014
temporary	-0.035	0.006	0.359
ancient	0.178	0.155	-0.092
impacted	-0.18	-0.251	0.02
magical	0.141	0.306	0.12
dynamic	0.246	-0.046	0.178
expansive	-0.074	0.224	0.097

PC1 explains 32% of variation between landscapes
PC2 explains 15% of variation between landscapes
PC3 explains 10 % of variation between landscapes

Figure 10. Statistical Output Results

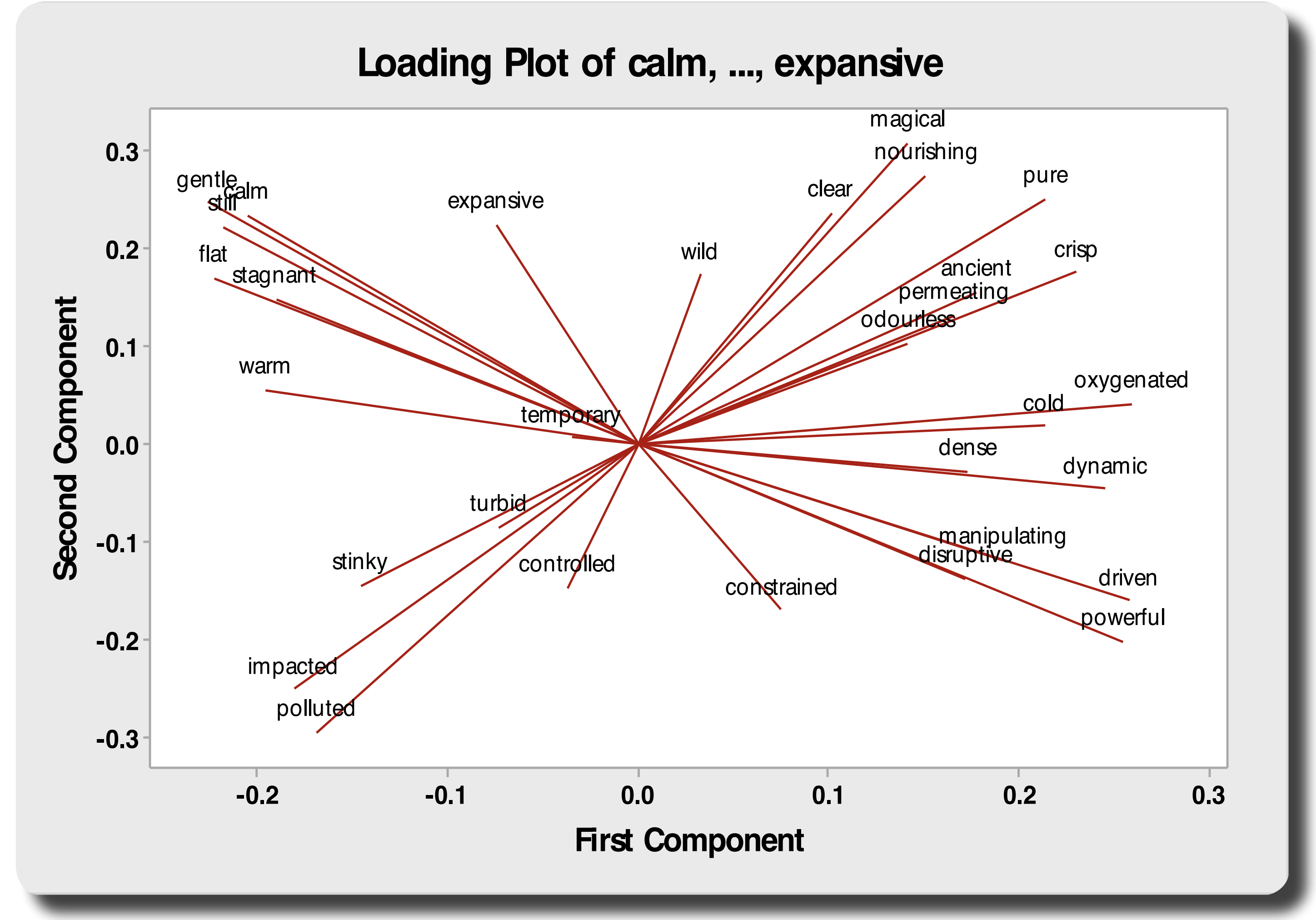


Figure 11. Loading Plot

LOADING PLOT

I will refer to the table previous as the Loading Plot graph. The first component (PC1) results are plotted on the x-axis, and the second component results (PC2) on the y-axis. These two components represent the greatest explanation of variance found by the statistical analysis (32%+15%=47%). The graph displays the results of how each term loaded in relationship to each other over the first and second components. What that means, in particular, is that where certain terms were scored high in a specific landscape, other terms scored low, concurrently. For example, on the far right it can be interpreted that when terms such as ***oxygenated***, ***cold*** and ***dynamic*** were scored high along the first component axis, the terms ***gentle***, ***calm*** and ***still*** scored low (on the far left). This is evident in relationship along the x-axis or horizontal axis, labeled '**First Component'**. If we were to draw a vertical line at the center (0.0), this delineates the comparison of terms, which scored in opposition to each other. The higher the scores are, the more of the variance between landscapes they are attributed to explaining. Similarly, if we draw a horizontal line along the y-axis (or vertical axis) again at the zero value, this highlights the variance found in the '**Second Component**.'

Each term is plotted on the co-ordinates of their scores from both components 1 and 2. For example, the term ***powerful*** generated a score of 0.254 in the first component and -0.202 in the second component (see Fig.9). These values (0.254, -0.202) become the "x" and "y" co-ordinates of the term ***powerful***, and similarly for every term.

PC1 INTERPRETATION

What the loading plot sheds light on are the landscape qualities that arise/stand out from the participants' observations. For example, PC1 demonstrates clearly the contrast of terms between the right and left-handed sides of the loading plot. On the far right hand side we see terms like ***powerful***, ***driven***, ***dynamic***, ***oxygenated***, ***crisp***, and ***pure***. These terms suggest landscapes in which the water is moving, and fairly quickly at that. Conversely, on the left hand side of the loading plot we see terms such as ***calm***, ***gentle***, ***still***, ***stinky***, ***polluted***, ***stagnant***, and ***warm***. Landscapes with such qualities would tend to be from those where water is moving much more slowly or even standing still. It is apparent that landscapes in which water is moving rapidly and tumultuously cannot simultaneously also exhibit qualities of being still or stagnant, as these qualities contrast each other significantly. The statistics demonstrate that the difference between rapidly moving water landscapes and much slower moving water landscapes is well understood and highlight one of the major contrasts participants noticed among all landscapes.

PC2 INTERPRETATION

PC2 highlights another interesting contrast among landscapes if we again divide the graph in half, this time horizontally. Terms with the highest contrasting scores reveal another major trend in the dataset which allude to the perceived cleanliness of the water quality. The 3 highest scoring terms ***pure***, ***nourishing***, and ***magical***, (Fig.9 orange highlight) again oppose the lowest scoring terms ***impacted*** and ***polluted*** (Fig.9 green highlight). Again, it seems clear that participants correctly observed landscapes that scored high in terms of seeming ***polluted*** and ***impacted*** compared with landscapes that scored high in appearing ***pure***, ***nourishing***, and/or ***magical***. While ***magical*** is probably the most subjective term of the bunch, the loading plot reveals that landscapes were interpreted strongly with regards to their perceived water quality. If water is perceived to be very clean one could predictably use terms like ***pure*** and ***nourishing*** to describe it, whereas, if water quality is perceived to be poor, terms such as ***polluted*** and ***impacted*** accurately convey that perception.

PC2 demonstrates another clear contrast in water landscapes, and that is the perception along the continuum of whether the water within it is considered to be clean and pure or polluted and fouled. There is in reality, of course, a spectrum in which these results must fall, for wild water can surely exhibit an enormous variation of quality. And what is interesting at this point, based on the obtained laboratory results, is that the *perception* and the *reality* of water quality are not necessarily correlated. For example, as mentioned previously, the presumed cleanest water landscape failed to test safely. Furthermore, I also discovered that the water around the Teck smelter is monitored regularly and tests surprisingly cleaner than most people would guess. Nevertheless, the perception of water quality clearly plays an influential role. As Coughlin states, "The perception of water quality has a reality of its own which is just as valid, and perhaps of more importance in human decision-making than the reality of the measurement of physical and chemical properties of a water body". He goes on to say that, "we cannot avoid concluding that man's (*sic*) perception of water pollution is a central consideration in measuring water pollution" (Coughlin, 1976).

PC3 INTERPRETATION

PC3 unveils yet another distinction in the interpretation of the water landscapes which has to do with the perceived *temperature* of the water, and interestingly, its relationship to water quality. PC3 is not plotted, but a simple glance at the highlighted terms (Fig.9 ignoring ***temporary***) in pink and grey reveal ***warm*** and ***stinky***, polarizing with ***cold*** and ***odorless***. I found it interesting (not that cold and warm oppose each other) that they are respectively associated with water's smell. Participants were permitted and even encouraged to touch and get close to the water, and smelling it was certainly within the realm of possibilities, so that may have influenced the result. Whether cold water corresponds to being odorless and cleaner, and warmer water begins to emit odor and therefore is not as clean is an interesting anecdote of the study. The validity of such a notion is beyond the scope of the project. However, a similar study done in France on river water supports the idea that if water smells, it is judged to be polluted (Moser, 1984). While it is easy to conceive the perception that warmer water favors the growth of bacteria, cold temperatures don't actually kill bacteria; whereas high temperatures (boiling) is the only assurance all disease causing bacteria and parasites are eliminated (Shepherd, 2003).

An overall trend I notice is that the terms which scored the most extremely (either high or low in any component) are the same terms that were offered up initially during the Phase 1 term generation. They are, in effect the more obvious descriptors for water landscapes – ones that would come to mind first. Is the water ***gentle*** and ***still***, or is it ***powerful*** and ***driven***? Is the water ***clean*** and ***pure***, or is it ***polluted***? Is the water ***warm*** or ***cold***? The differences are self-evident.
To briefly contrast this clarity we can look to the term ***temporary***, which lies near the center of the Loading Plot. Its position indicates that it does not explain much of the variation between landscapes. I was personally confused by this term and fail to recall the context in which it was presented. It is clear that it was not a very useful term in describing variance among landscapes.
Another question that may be asked is "How do these four quadrants interact with each other via component 1 and 2?" What I found to be interesting is that if we look again to the results of Phase 1 and the terms generated, (Fig. 5 pg.33) there is a significant correlation between terms that were deemed 'high energy' and the positive area of PC1. Recall the division of the graph in PC1 to positive and negative hemispheres. Of the 13 terms that were defined as 'high energy' (either positive or negative) 10 appear in the positive half of PC1, or 77%. Furthermore, of the 18 terms described as 'low energy', 14 appear in the positive hemisphere of PC2, or 78%. I believe this points to the notion that general qualities (such as high or low energy and positive and negative) are very well understood by the group in this case, and suggests that such qualities would similarly be understood at large. So-called 'high energy' water was strongly associated with being ***powerful***, ***driven***, ***oxygenated***, and ***dynamic***.

In sum, PC1 highlights the strong contrast between water landscapes that were perceived as being ***powerful***, ***crisp***, ***oxygenated***, ***driven*** and ***dynamic*** to those perceived as ***gentle***, ***still*** and ***flat***. I get the sense that moving water is more closely associated with healthy water, compared to water that exists in landscapes of lower energy, as water gets more still. PC2 illuminates the difference in perceiving water landscapes as ***pure***, ***nourishing***, and ***magical*** with those described as ***impacted*** and ***polluted***.
Certainly, describing water considered for consumption as ***pure***, ***nourishing*** and ***magical*** supposes preferable qualities over water perceived as ***polluted*** and ***impacted*** by humans.

SCORE PLOT 1

The Score plot shows the scores of each landscape, again in a comparison of the first and second component. The results of each component become the co-ordinate points for each landscape by each person. Hence the score plot contains 70 points (7 participants x 10 sites). The landscape scores for each site for each person (represented by PC1 followed by participants' first initial) are below for the first component. Figure 12 illustrates an example of the numbers that are calculated by the software. The same results are calculated for each component. The Score Plot (fig.11) compares principle components 1 and 2, similar to the Loading Plot.

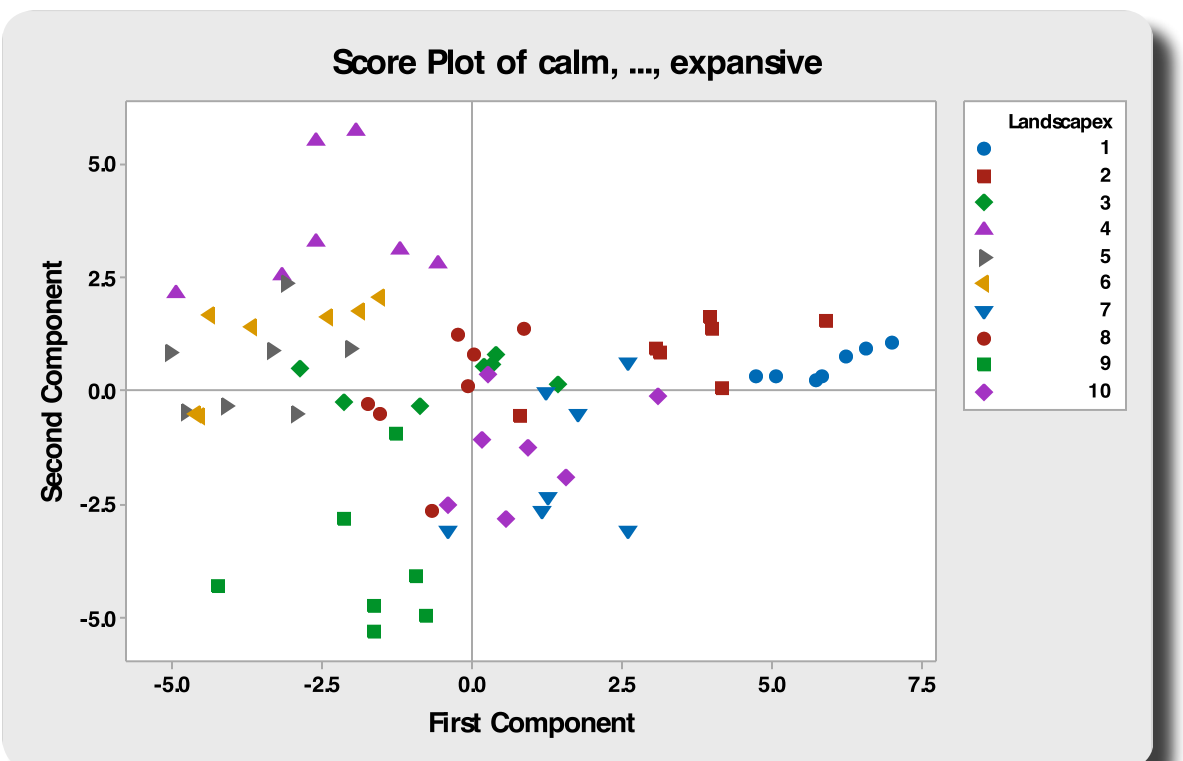


Figure 12. Score Plot 1

PC1J	PC1SH	PC1H	PC1A	PC1P	PC1S	PC1L	PC1AVERAGE	LANDSCAPE
6.27	7.04	4.76	6.59	5.10	5.86	5.77	5.91	1
3.10	4.00	0.81	5.91	3.17	4.03	4.20	3.60	2
0.35	-2.85	2.11	1.48	0.23	-0.85	0.42	-0.48	3
-1.18	-3.13	4.91	-1.91	-0.54	-2.56	-2.59	-2.40	4
-5.02	-3.31	4.74	-2.02	-3.06	-2.91	-4.09	-3.59	5
-4.34	-1.83	4.56	-3.63	-1.51	-2.37	-4.51	-3.25	6
1.80	1.27	0.37	1.19	2.63	2.64	1.31	1.50	7
-0.03	0.07	1.51	-1.72	-0.20	0.90	-0.63	-0.45	8
-1.60	-2.09	4.20	-1.60	-1.24	-0.90	-0.73	-1.77	9
0.30	0.20	0.36	0.61	0.98	3.12	1.61	0.92	10

Figure 13. Average Landscape Values for PC1

Overall, if we look generally, we can see that each Landscape (same shapes) tends to cluster in proximity to each other fairly well. The distribution seems to demonstrate a fairly consistent pattern. We can see, for example, that:

- Landscapes 1 and 2 are both nearly entirely contained within the top right quadrant, save for one value (red square) of Landscape 2.

- Landscape 4 (Estuary/purple triangle), are all contained within the top left quadrant,

- Landscape 9 (Trail/green square) are all within the bottom left.

Dr.Wemelsfelder mentioned that if landscapes appear in the same quadrant then participants essentially agree in their interpretation, and score them in a similar way. I believe that the score plot demonstrates good agreement among all participants in regard to each landscape, and that at least nominal variation should be expected due to peoples' cultural beliefs, experiential and perceptual differences.

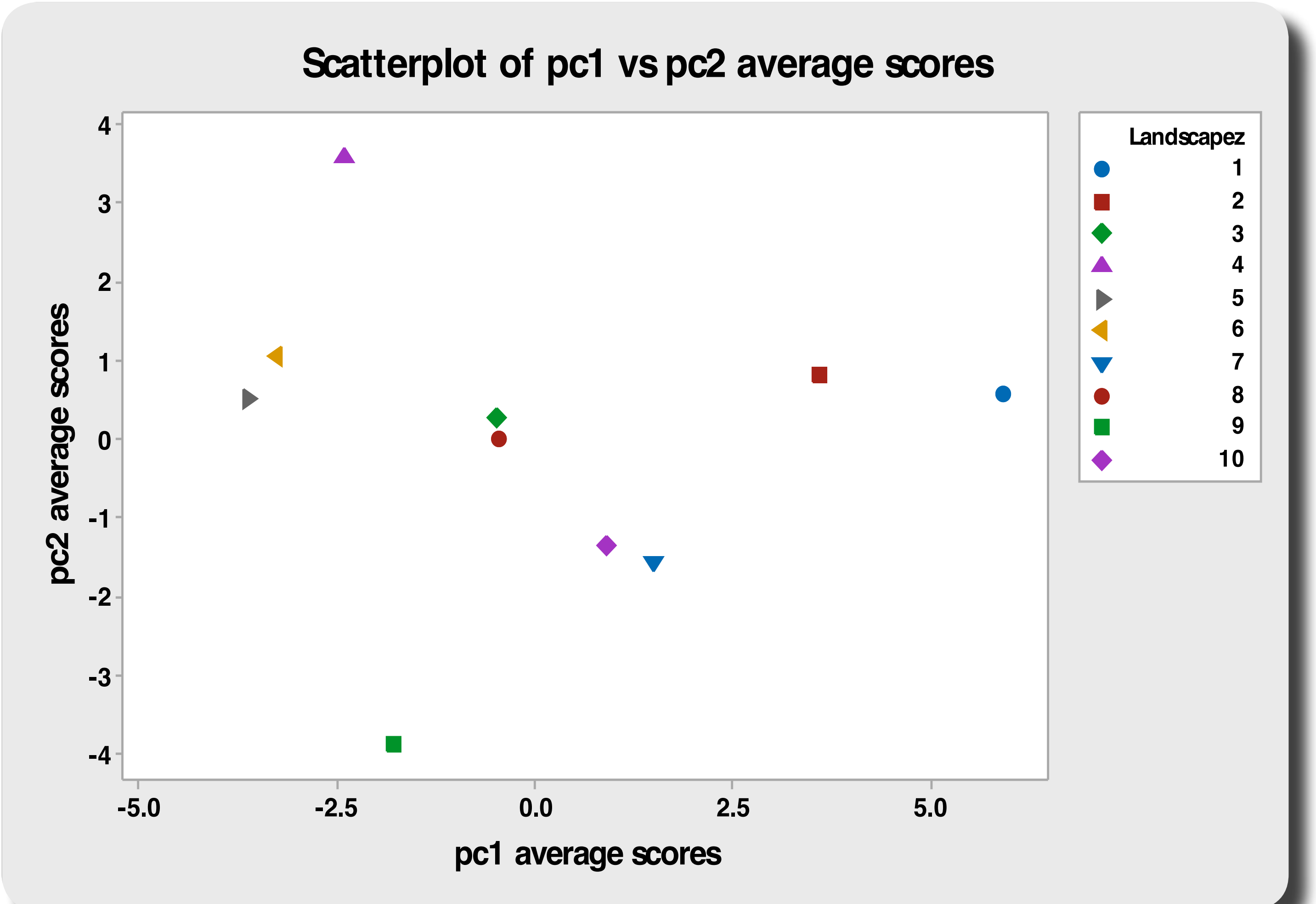


Figure 14. Score Plot 2

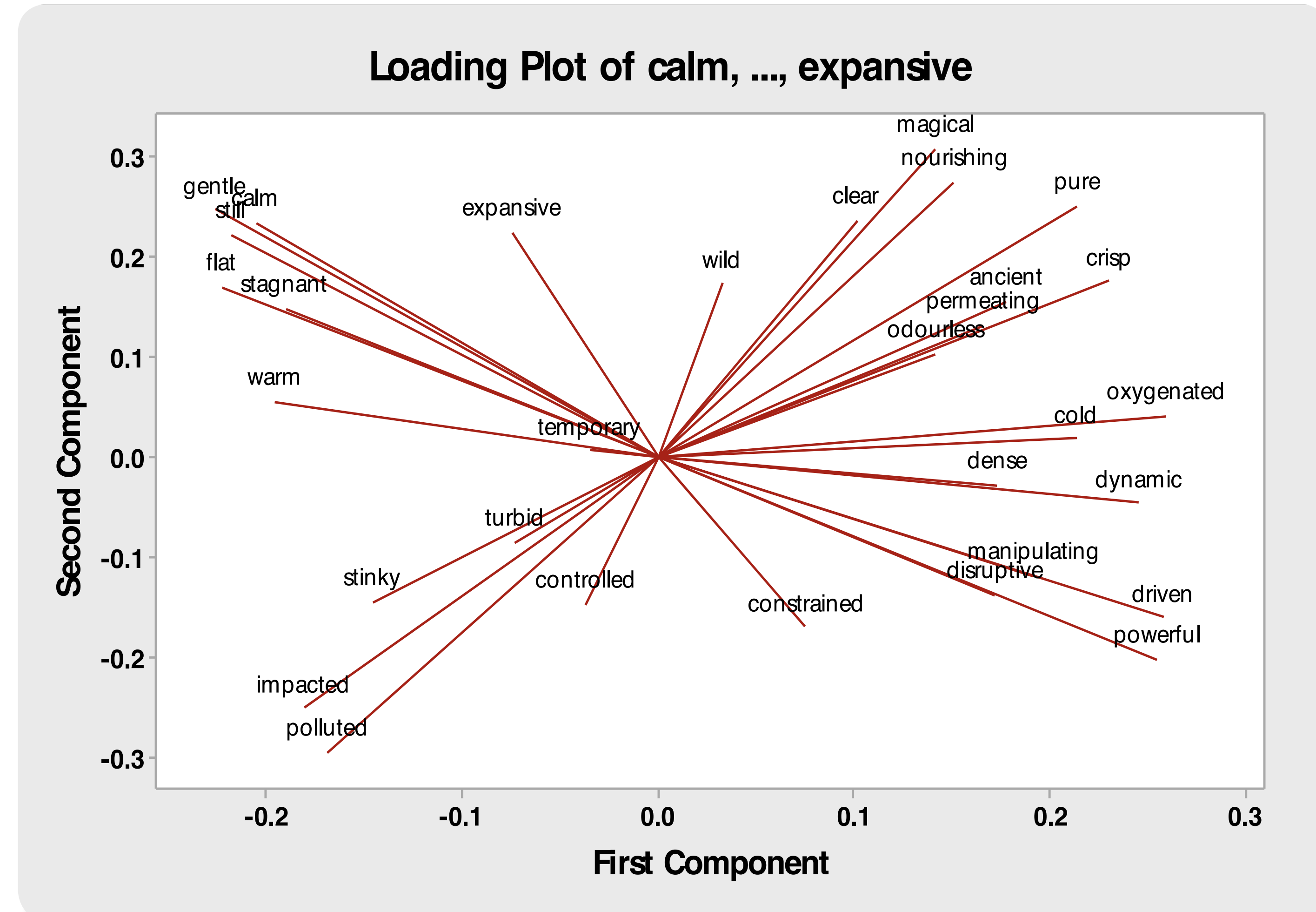


Figure 11. Loading Plot

SCORE PLOT 2

Score Plot 2 simply takes the average of all the values from the landscape scores of Score Plot 1 (Fig.11) and gives them a single value, so that their overall score can be compared much more easily between each landscape. In Score Plot 2, each colored point represents the average score for each landscape compared for PC1 and PC2. Again, it helps to divide the graph into quadrants through the zero value axes to quickly assess how each landscape was perceived in relationship to the terms. For example, in the PC1 results (drawing a vertical line at 0.0) we see that Landscapes 1,2, 7 and 10 scored positively (especially L1 and 2) while Landscapes 4,5,6 and 9 scored negatively. We would expect that Landscapes 1 and 2 would score high especially compared to Landscape 9, which was the smelter, and the statistics support this notion. It is important to remember that the values on the X and Y-axes are arbitrary, and are *relational* to each other in light of how they were scored compared to others.

The four quadrants of the Score Plot also correspond to the same quadrants in the Loading Plot. (compare Fig. 14 to Fig. 11) For example, Landscape1 (blue circle) scored the highest for terms that are close to the same position in the loading plot (***oxygenated, cold, dynamic***) while Landscape 9 (green square) scored the highest for the correlating terms in its quadrant, namely ***impacted, polluted*** and ***controlled***. Furthermore, we can see that Landscape 4 (Lakeside Park/purple triangle) scored the highest for the terms ***expansive***, ***calm***, ***gentle*** and ***still***. These results reflect well the actual conditions/phenomena on the ground.

KENDALL RANK CORRELATION COEFFICIENT

In statistics, the Kendall rank correlation coefficient, commonly referred to as Kendall's tau coefficient (after the Greek letter τ), is a statistic used to measure the ordinal association between two measured quantities (En.wikipedia.org, 2017), that is the ranking between values. Kendall measures the agreement in terms of ordinal ranking.

The Kendall Correlation Coefficient (notated as ***W***) values can vary from 0 (no agreement at all) to 1 (complete agreement), with values higher than 0.6 showing substantial agreement. ***W*** values above 0.7 are considered very good and act as a cut off value for good agreement. Value above 0.6 is considered moderate, whereas values below 0.5 are deemed poor agreement.

The Kendall results from the output for each component were as follows;
PC1 = 0.91
PC2 = 0.75
PC3 = 0.63

During our conversation regarding the Kendall results, Dr. Wemelsfelder remarked that in over 20 years of studies she had rarely seen values this high. So, without a doubt they represent a very, very significant level of agreement in terms of how participants ranked the landscapes.

The results show, especially in the first 2 dimensions, that the amount of agreement is very high. With regards to the first component, the agreement is over 90% - a remarkable result. What this means is that in light of the variance described by component one, the participants' scores were nearly identical with regards to how they assessed each landscape through all of the terms. To me, this supports the notion that the observers' senses function and interpret each landscape in an analogous way. When participants observe and interact with a rushing stream, they all witness and describe the same thing. Their senses are informing them reliably of the so-called objective, albeit with some subjective variation. By applying the phenomenological approach, participants correctly interpreted the objective reality, by utilizing their own subjective methodology. There is no tangible way to determine who employed which faculties to interpret the data (be it feeling, or smell, or touch or taste), and yet, their senses demonstrate a tangible reliability of perception and interpretation of the particular phenomenon.

CONCLUSION

"The world is full of magic things, patiently waiting for our senses to grow sharper."
W.B. Yeats

Does carefully and intuitively honing our senses actually help us determine if running water is safe to drink or not? The results of this project seem to support the idea that our senses are a reliable means of garnering at least aspects of objective reality, as is evidence by the remarkable levels of agreement by the participants in how they were witnessing ecosystem qualities across a vast swath of a mountainous Canadian watershed. However, using those same senses in determining whether water is safe to drink or not, cannot be significantly supported by the results of this project.

One thing that struck me in my conversation with Jennifer Yeow, the owner of Passmore Labs, was the wide variation of results she had accrued over more than a decade of collecting water samples within the Slocan Valley of British Columbia. While some people feel that the Slocan Valley retains one of the highest quality water sources in the province, if not the country, in reality there is a wide-ranging variety of quality throughout the valley which also changes seasonally, and sometimes dramatically. Sources that tested well in the later part of the year could deviate completely during the spring runoff when creeks swell with snowmelt and pick up the soil and decomposing vegetation still strewn about from the previous autumn.

Another important factor is the topography and geology that the water travels over and through. Do creeks travel exclusively over bedrock, and if so which kind? If, for example, water travels over limestone, as is the case in the northern portion of the Slocan valley, the water will become high in alkalinity. This is not something one could intuit independently, but would require intellectual faculty and working localized knowledge of the various effects of bedrock on running water.

While the visual impression of a landscape within its specific context will no doubt yield clues and reveal conditions about the quality of the water, it cannot by itself inform us of the conditions as a whole. Water that seems pristine can easily be infected by unseen factors, while water that has previously been contaminated may have, over time and distance, filtered and purified itself again. Water as a whole phenomenon, seems to have an infinite variety of chemical and elemental make up, the entirety of which would be impossible to discern in every instance. Yet be that as it may, Indigenous peoples have evidenced a long history of success at surmising effective water quality simply on the merit of their continued successful lineage. It might be interesting to run this experiment again using Indigenous peoples within their local bioregion and discovering what knowledge and senses they would use to determine water health, and compare lab results. While it is true that pre-industrial cultures did not face the intensity of pollution that continually impact drinking water sources in the Pacific Northwest and the world over, they did survive and endured for centuries without the modern filtration and treatment technologies that we employ today. Surely, their carefully honed senses played a major role in discerning clean drinking water. This knowing was also certainly bolstered by traditional ecological knowledge. If the tribe you were raised in said it is safe to drink water from here and here and here, but not there, surely common sense would heed that advice, or suffer the consequences.

The pre-industrial gut flora of Indigenous peoples was likely more apt and resilient at dealing with a larger variety of bacteria because of exposure to a wider variation of such (Schnorr, 2013). Considering the stringent standards we are forced to comply with presently, exposure to decreasing levels of bacterial variation is likely. The antiseptic furor has gone so far that the goal of utter banishment of all bacteria and the movement towards living in a sterile world might actually work against us, by making us more susceptible to infections we previously carried antibodies for. Although government authorities formally recommend against drinking untreated water from any source in Canada, the pure, primal act of tasting wild running water from a mountain creek is a joy and freedom that no commercially bottled water or kitchen tap can equal. It is even more satisfying when considering that clean water sources around the world are increasingly under threat from the endless expansion of civilization and relentless industrial growth. In Canada, one only has to look to the tar sands in Alberta to realize this tragedy where the production of 'dirty oil' comes at the expense of whole rivers being poisoned. The simple pleasure and opportunities of drinking wild water is diminishing here, and the world over. What must the Indigenous peoples of the world be thinking when, through their oral histories, they can recall a time when this was nearly completely the opposite, as is the case in our bioregion?

> "...water remains a vast and dynamic phenomenal riddle that is not easily solved..."

While the results illustrate that there is very good agreement between all participants in terms of interpreting landscape qualities and the perception of the waters' health, there is insufficient evidence to draw any substantial conclusion to extending that interpretation to the actual measurable quality of the water regarding bacteriology and the absence or presence of harmful bacteria. This does not even consider the presence of metals, fertilizers, pesticides, and other pollutants, which are likely present, yet was not feasible to be tested for.

On the other hand, the results strongly support the idea that, when called upon, our senses function incredibly well in deciphering landscapes qualities; participants demonstrated a strong understanding and agreement of the context within which water flowed throughout a wide variety of terrain and ecosystems. I may have initially harbored a romantic notion that if we connect with water and landscapes by allowing it to speak to us, we could discern whether we could safely partake of its life-giving essence. I feel I also over-simplified the assumption of the correlation between water that is upstream in the watershed compared to water that is lower downstream as a general indicator of health. I did learn something important – and that is that there are many factors that affect waters' health, many of them invisible.

Although there should be little doubt that there is much to discover by tuning in and utilizing our subjective senses to connect with the world at large, water remains a vast and dynamic phenomenal riddle that is not easily solved in the increasingly complex framework that is the 21st century.

Clean, fresh water is under greater pressures and threat than ever before in human history. Heeding back on simpler times of the Indigenous peoples now in the past seems sentimental, if not idealistic. And yet, as Heraclitus said, "the only thing that is constant is change." This is especially true for water. Water constantly changes its make up over time, over distance, over geography - which conveys the impression that it could take on infinite variations. Therefore, being able to consistently determine whether water is safe to drink seems a risky endeavor at best. One thing does remain constant however, and that is all of life's dependence on this marvelous substance for its very existence.

We would be wise to look to our cultural predecessors, who for thousands of years, successfully managed to keep this precious resource from becoming corrupted and fouled, by recognizing it as sacred. The very belief that all phenomena are sacred still eludes the modern scientific worldview. Yet, the sacred nature of water is perhaps something that arises into consciousness when taken into consideration by virtue of the realization of the interconnectedness and interdependence of all living things. To a great extent, the scientist is water, after all. Could contemporary scientists not set off into the realm of inquiry carrying with them a sense that investigating of the inner workings of the world as an unveiling of something sacred, as phenomenologists seem to do? My experiences at Schumacher College and the approach of the Holistic scientist reveal that certainly it is not only possible, it is a pathway to reconnecting with the whole spectrum of tools we all possess, which will allow us to reconnect to the wholeness of nature our world desperately needs. If there is something that connects all of humanity and indeed all of life, it is the need for clean, healthy water.

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Appendices

APPENDIX I. *PHASE 2 WORKSHEET*

Perceiving Water Quality Study **October 2016**

NAME:

SITE:

CALM	Min.	Max.
STINKY	Min.	Max.
POWERFUL	Min.	Max.
FLAT	Min.	Max.
CLEAR	Min.	Max.
POLLUTED	Min.	Max.
PURE	Min.	Max.
CRISP	Min.	Max.
STILL	Min.	Max.
DENSE	Min.	Max.

Based on your observations of this site, would you feel comfortable drinking the water here? YES / NO

APPENDIX II. *PASSMORE LABORATORY RESULTS*

PASSMORE
LABORATORY LTD.

4240 Passmore Upper Road
Winlaw, B.C. V0G2J0
250-226-7339 passmorelaboratory@columbiawireless.ca

Client: Brian Kooi
Date: December 12, 2016

We have tested the samples of water submitted by you and report as follows:

Method of Testing:
Tests were performed in accordance with methods outlined in the "Standard Methods for the Examination of Water and Wastewater", 21st Edition, 2005 published by the American Public Health Association.

Sample Information:

#1	Sample Site:	Kokanee Creek Footbridge
	Date/time collected	November 7, 2016, 8:46 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	Creek

Results of Testing:

Total Coliforms cfu per 100ml	14
Fecal (Thermotolerant) Coliforms cfu per 100ml	10
Verified E.coli cfu per 100ml	10

Sample Information:

#2	Sample Site:	Kokanee Spawning Channel
	Date/time collected	November 7, 2016, 8:53 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	Creek

Results of Testing:

Total Coliforms cfu per 100ml	5
Fecal (Thermotolerant) Coliforms cfu per 100ml	0
Verified E.coli cfu per 100ml	0

Sample Information:

#3	Sample Site:	Kokanee Estuary
	Date/time collected	November 7, 2016, 9:00 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	Creek Mouth

Results of Testing:

Total Coliforms cfu per 100ml	11
Fecal (Thermotolerant) Coliforms cfu per 100ml	4
Verified E.coli cfu per 100ml	4

Sample Information:

#4	Sample Site:	Lakeside Park
	Date/time collected	November 7, 2016, 8:00 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	Lake/River

Results of Testing:

Total Coliforms cfu per 100ml	no result as request of client
Fecal (Thermotolerant) Coliforms cfu per 100ml	no result as request of client
Verified E.coli cfu per 100ml	no result as request of client

Sample Information:

#5	Sample Site:	Taghum Beach
	Date/time collected	November 7, 2016, 8:00 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	River

Results of Testing:

Total Coliforms cfu per 100ml	no result as request of client
Fecal (Thermotolerant) Coliforms cfu per 100ml	no result as request of client
Verified E.coli cfu per 100ml	: as request of client

Sample Information:

#6	Sample Site:	Columbia River at Brilliant
	Date/time collected	November 7, 2016, 8:00 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	River

Results of Testing:

Total Coliforms cfu per 100ml	150
Fecal (Thermotolerant) Coliforms cfu per 100ml	11
Verified E.coli cfu per 100ml	6

Sample Information:

#7	Sample Site:	Columbia River at Genelle
	Date/time collected	November 7, 2016, 8:00 AM
	Date/time on test	November 7, 2016, 4:30 PM
	Temperature on arrival:	12
	Matrix:	River

Results of Testing:

Total Coliforms cfu per 100ml	95
Fecal (Thermotolerant) Coliforms cfu per 100ml	3
Verified E.coli cfu per 100ml	3

Sample Information:

#8	Sample Site:	Columbia River at Trail
	Date/time collected	November 7, 2016, 8:00 AM
	Date/time on test	November 7, 2016, 4:45 PM
	Temperature on arrival:	12
	Matrix:	River

Results of Testing:

Total Coliforms cfu per 100ml	45
Fecal (Thermotolerant) Coliforms cfu per 100ml	10
Verified E.coli cfu per 100ml	8

Sample Information:

#9	Sample Site:	Columbia River at Waneta
	Date/time collected	November 7, 2016, 11:50 AM
	Date/time on test	November 7, 2016, 4:45 PM
	Temperature on arrival:	12
	Matrix:	River

Results of Testing:

Total Coliforms cfu per 100ml	80
Fecal (Thermotolerant) Coliforms cfu per 100ml	12
Verified E.coli cfu per 100ml	12

cfu= colony forming units

Passmore Laboratory Ltd. complies with methods and certification through the Province of British Columbia Enhanced Water Quality Assurance (EWQA) Program and the Clinical Microbiology Proficiency Testing (CMPT) Program.

Analyst: Aviad Bar