Biology Teachers' Lived Experiences in Place

by

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B.Sc.H., Queen's University, 2011
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Abstract

A phenomenological inquiry of five place-aware biology teachers was conducted to determine how teachers' lived experiences in place influence their pedagogy, if at all. High school biology teachers from one public and private school in Victoria, British Columbia were recruited through volunteer sampling. Through in-depth interviews, journal writings and artefacts representative of lived experiences of place, teachers were invited to share their lived experience narratives of places of meaning and teaching experiences of place. Drawing on Merleau-Ponty's embodiment phenomenology, a case-by-case thematic analysis was first conducted per informant, followed by analyses of commonalities across informants as appropriate. It was found that teachers shared similar experiences in different places of meaning: a sense of mystery that there is always something to be revealed, an experience of the vastness and complexity of places, a sense of care for nature as the Other and a feeling of fondness for places as shared through close family and community members. However, the degree and manner in which such experiences transferred into teachers' pedagogies differed, as some teachers demonstrated a stronger intentionality of place-consciousness than others. The study highlights the humanness of teachers and the unique styles that individual teachers bring into their practices. I suggest that the complex and multidimensional notion of places as revealed through the study opens possibilities for holistic approaches in science education, with a focus on embodied, caring consciousness for the places that we inhabit.

Keywords: science teacher education, teacher identity, place, phenomenology, environmental ethics, caring

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Chapter 1: Introduction

Stories of Place

There is a place that I frequently recall in my mind; that of the vast, open landscape in the Northwest Territories that instilled within me a sense of wonder and awe for the arctic tundra. In the summer of 2011, I had the opportunity to participate in a plant ecology research project at the Tundra Ecosystem Research Station to investigate the effects of climate change on terrestrial biogeochemistry in the low arctic. Three hundred kilometers northeast of Yellowknife, one hundred and fifty kilometers away from the closest Tłı̨chǫ indigenous community and fifty kilometers to the closest medical centre at the Ekati Diamond Mine, I found myself at a small campsite amongst the stretches of land and ice. The Tundra Ecosystem Research Station hosted an average of five researchers in any given week from various Canadian institutions and field workers from the Department of Environment and Natural Resources from the Government of Northwest Territories. Bi-weekly, a float plane brought in a different group of researchers as well as a set of local Yellowknife newspapers, fresh fruits and vegetables to replenish our diminishing supply (Figure 1).

Figure 1. Flying into the Tundra Ecosystem Research Station in the Northwest Territories. Picture taken from a floatplane.

It is there that I was enchanted by the vastness of the arctic. While the "tundra," derived from the Finnish "tunturia" means treeless plain (University of California Museum of Paleontology, 2004), I learned over time that this quiet landscape was anything but barren. At my feet, moss and lichen abounded in rich shades of red, orange and green in the undulating valley of the tussocks (Figure 2). On our forty-minute hike to the field sites, we encountered arctic ground squirrels (affectionately called "sik-siks" amongst the Inuit people), in addition to the occasional red fox, caribou, ptarmigan, bald eagle and peregrine falcon. There was a perpetual stillness in the air that was sometimes interrupted by a melancholic call of the yellow-billed and red-throated loons, or by a herd of caribou on their migration path, maintaining a mysterious wonder of the landscape that I felt I could never quite fully comprehend. At the field sites, we were fully exposed to the elements of the weather. Being above the tree line with no human made shelter within close walking distance, we patiently waited for the rain to drench us upon seeing a storm cloud ahead.

Figure 2. Andromeda on a rich, mossy bed near the Tundra Ecosystem Research Station.

Most of all, I remember the sky after the rain. Commercial airplanes flew above us as we worked, leaving a series of interweaving contrails in the cerulean sky. With childlike naivety, I

marvelled in delight at my small cosmic existence and fleeting nature in contrast to the spatial and temporal permanence of space. While there are many places that hold a special place in my heart, the time that I spent in the arctic is particularly memorable because it heightened my visual, auditory, tactile and olfactory senses, and I became conscious of the many ways in which I could perceive this seemingly flat, empty landscape. Working as a novice ecologist at the nexus of land-based and community-based issues amongst climate change scientists, government workers, diamond mining companies and local aboriginal communities instilled within me a desire to develop a broader contextualized understanding of the places that we inhabit and change.

Winding my memories back to my childhood, I recall another place with intimate fondness, which perhaps influenced my later perspective on place-based pedagogies. Growing up in the high-altitude desert city of Sana'a, Yemen, I spent my childhood swinging on dusty see-saws, feeding chickens, hard rock climbing, and listening to the daily prayer of our next-door mosque. Located amongst the farmlands in the outskirts of the desert city, the Sana'a International School of Yemen consisted of less than 100 students from pre-K to Grade 12 with mixed-age classes (Figure 3). The traditional mud-brick school building had classrooms radiating from the central library in concentric circles like a Deweyan school (Dewey, 1907). With no fencing around the school, the playground stood in the open desert overlooking the terraced farmlands of the surrounding landscape. When I think of Sana'a, I think not of the political turmoil that has led many to flee the country in 2011 and for the school to be closed, but of quiet days lost in contemplative reverie surrounded by mountains, kids playing soccer in bare feet, soaring eagles, the smell of aromatic coffee, cacti and cotton fields; simply, soaking up the experience of the here-and-now in a playful, spontaneous manner.

I enrolled in the Sana'a International School at age 8 when the only words I knew in English were "Yes," "No," "Thank you," and "Bathroom?" As a class, we often dropped our books, worksheets and pencils to go hiking in the mountains near our school. At an altitude of approximately 2000m, the jagged mountains were covered with loose rocks and little vegetation. From time to time, my teacher turned back to see whether we were keeping up, cautioning some of us turning over rocks to look for scorpions or going off trail in search of fossil imprints. We dropped pools of sweat as we walked in the sweltering heat of the desert; but somehow, I liked the warmth of the sun blanketing me from above, the distant cityscape in the hazy horizon and the occasional cool mountain breeze that refreshed my body. Looking back as an educator now, I

cherish the playfulness of place-based learning, allowing children to “let-learn” from the land as the teacher, with the mind and the body as a whole.

Figure 3. Sana’a International School of Yemen located on terraced farmlands. The school resembled a Deweyan school.

I believe that these places have influenced the way that I teach, which leads me to wonder how, if at all, biology teachers’ experiences in places might influence their pedagogies. When I became a teacher myself, each spring I used to take a group of eleventh-grade students at Escuela Bella Vista in Maracaibo, Venezuela on a one-week interdisciplinary science field trip to the Dutch Caribbean island of Curaçao. On the trip, we visited the mangrove, coral reef, sandy beach and sea grass ecosystems and collected data on the water chemistry and fish populations at the respective sites (Figure 4). By 2015, we had ten-years worth of data collected across groups of students, contributing to the sense of community and a long line of tradition at the school. In addition to the group work, students independently designed inquiry projects related to an environmental issue such as oil pollution, plastic pollution or ocean acidification, and investigated various stakeholders involved in the issue from social, political, scientific, economic and ethical perspectives. Through engaging students in these multidisciplinary projects, I hoped

to teach the complexity of science embedded in society and bring to surface the multiple voices that comprise a place.

Figure 4. Snorkelling and collecting algae samples in the mangroves of Curaçao. A student shows me an algal sample for identification.

Over the week of exposure to the sun, wind and sand in Curaçao, I saw the students' faces begin to brighten. Curaçao was a safe place for our students to explore and walk freely along the beach in juxtaposition to the sociopolitical turmoil that had plagued Venezuela under the socialist governance of the controversial President Hugo Chavez. Given the danger of being pickpocketed or kidnapped in Maracaibo, I often saw students shuffled in and out of cars by drivers and bodyguards to and from the school. I found that many students were often isolated in an insular environment, choosing to fly to Miami to go shopping during the holidays, instead of exploring the nearby tropical grasslands in Los Llanos or the flat-topped mountains of Roraima in their own home country. While field trips to local areas were difficult because of students' safety concerns, the Caribbean island of Curaçao situated off the coast of Venezuela provided an ideal location for students to explore bioregional similarities to their own country. Together, my students and I marveled at the mysterious waters of Curaçao. We snorkelled and became excited

over spotting the curious-looking honeycomb cowfish or the venomous scorpionfish, collected samples of various dead coral skeletons on the ocean floor, and dived to a shipwreck covered with benthic algae. Intuitively, I felt that the students had developed a "sense of place" imbued with wonder and enchantment towards the world. I remember a student who shared with me that the beach had formerly been a place to lounge and sunbathe for her; enthralled by the mystique of the ocean during the trip, the ocean now instilled a different meaning for her. In this sense, teaching biology, for me, was fuelled by a passion to teach students to develop a consciousness of being in the world in which we are corporeally embedded.

Moving from place to place in my childhood and adulthood, I have often pondered the question of rootedness in place. Reminiscing on my experiences in Canada, Yemen and Venezuela, I am brought back with a flood of memories of those moments, as if I were once again re-living the experience for the first time. Like an altar in my soul, I visit and revisit these places in my mind, sometimes in a fleeting unselfconscious moment and other times in a deliberate, reflective manner. I wonder: Why do I remember particular places and not others? What is it like to have an embodied sensitivity towards a place? How do individuals implicate themselves in the meaning-making of a place? How do these conceptions of places influence pedagogy? With these questions in mind, I next provide an overview of the value of place in science education towards a synthesis of the research question of my study: *How do place-aware biology teachers' lived experiences in place influence their teaching pedagogy, if at all?*

Place and Science Education

The awe and reverence that one experiences upon encounters with the natural world is often cited among scientists as the driving force of their work (Root-Bernstein, 2002; Sagan, 1994). In *The Sense of Wonder*, marine biologist and conservationist Rachel Carson (1956) wrote about her long walks along the coasts of Maine and tracts of woodland with her nephew Roger. She described the delights experienced in looking for solitary ghost-crabs on night beaches or listening to the orchestra of insects in her garden, passionately reminding readers of the importance of keeping children's wonders towards the world alit. She wrote:

> I have already promised Roger that we'll take our flashlights this fall and go out into the garden to hunt for the insects that play little fiddles in the grass and among the shrubbery and flower borders. The sound of the insect orchestra swells and throbs night after night, from midsummer until autumn ends and the frosty nights make the tiny players stiff and

> numb, and finally the last note is stilled in the long cold. An hour of hunting out the small musicians by flashlight is an adventure any child would love. It gives him a sense of the night's mystery and beauty, and of how alive it is with watchful eyes and little, waiting forms. (p. 90)

Ecologist Bernd Heinrich also recalled his childhood in a German forest of "bumblebees humming, willow warblers and pied flycatchers snagging bugs among the pussy willows and being overcome by a delicious light-headed feeling," leading to his later interest in animal behaviour, ecology and evolution (as cited in Root-Bernstein, 2002, p. 64). Not only is the sense of place experienced in the familiar microcosms of our homes, but also in reflecting on our place in relation to the vastness of space and time. Astrophysicist Allan Sandage wrote about the night sky that he saw in his childhood:

> It was like …. going to a cathedral. I had the feeling that the world was magic… The world was spirit… I couldn't wait for night to come and for the stars to come out. I would stand in the backyard and look at the appropriate time and identify the stars as they became visible out of the twilight. It was like being, I suppose, in a sort of heaven. I can't explain it in words even today. I had that internal feeling about everything–about physics, about the way the world works, and about why we are (as cited in Root-Bernstein, 2002, p. 64).

In reading these texts, I am likewise reminded of the quiet riverside in the mountainous regions of Kobe, Japan, where I spent countless hours of my childhood dreaming of worlds only accessible to a child's imagination.

In contrast to these narrative writings of scientists' experiences in place, traditional science education has been often perceived by students and teachers alike as a set of abstract laws, theories and facts to be mastered and memorized. Over decades of research on the "nature of science" or the epistemology of science has revealed that students often hold empiricist views of science such as that scientific knowledge is absolute (Deng, Chen, Tsai & Chai, 2011; Lederman, 2007). Not only do students hold naïve perceptions of science, but many secondary science teachers also appear to emphasize science as a corpus of knowledge, thus representing science in an epistemologically privileged condition of rigor and certainty (Lederman, 2007; Lotter, Singer & Godley, 2009; Wahbeh & Abd-El-Khalick, 2014). Consequently, students and teachers often perpetuate what McComas (1996) called "myths" (p. 1) espoused in schools, for

example, that a universal scientific method exists, that science and its methods yield absolute proof, that science is procedural more than creative, and that scientists are objective individuals. Since the 1970s, an alternative approach to science education collectively known as Science, Technology, Society and Environment (STSE) has been endorsed to promote science education for citizenship (Hodson, 2010). The STSE approach broadly views science as a human activity bound within a complex nexus of social, economic, political, moral and ethical factors (Pedretti & Nazir, 2011). However, there appears to be a rhetoric-reality gap as STSE education challenges traditional ideologies of science and scientists, and requires teachers to be versed in various disciplines beyond science (Pedretti, Bencze, Hewitt, Romkey, & Jivraj, 2006). In particular, the "E" in STSE education has yet to acquire mainstream status in K-12 curricula, as critics have argued that the historic purposes of the school as an institution for mass education differs from the emergent, collaborative and multi-disciplinary approaches of environmental education (Hart 2010; Stevenson, 2007).

When the focus of science education becomes the memorization of abstract facts and concepts, students' connection to day-to-day experiences could become lost, leading to an "ontological gap" (Bencze, Carter & Krstovic, 2013, p. 2). That is, the *phenomenon* of seeing, smelling and touching a rose is different from the *representation* of a rose such as a conceptual understanding of how light intensity affects the rate of photosynthesis of a rose plant; the "ontological gap" arises from this inconsistency in translating the phenomenon to a representation, as the abstraction minimizes the phenomenal detail captured through experience. Even worse, an "ontological reversal" (Dahlin, 2003, p. 78) could occur where the abstract representations become more real than the original experiences themselves. As Weil (1990) has argued, modern science education abstracted from everyday contingencies causes an uprooting (*déracinement*) and alienation (*estrangement*) from students' day-to-day lived experiences (as cited in Roth, 2014). Instead of forcing an eradication of misconceptions through *déracinement*, educators perhaps need to navigate students to move "from the primary world to the counterintuitive world of science, while staying rooted in the primary world" (Roth, 2014, p. 19).

In *Simulacra and Simulation*, Jean Baudrillard cautioned the "hyperreality" (as cited in Blades, 2001, p. 65) of the technocultural world that many students today live in, growing increasingly distant from the natural world. Given the tendencies of science to abstract representations from the natural world, the signifier (the abstract fact) grows distant from the

signified (the natural world). Over multiple circulations between the signifier and signified, the signs themselves will eventually have no relation to reality; that is, "making reality disappear and at the same time, to mask that disappearance," (as cited in Blades, 2001, p. 69) a condition which Baudrillard called "hyperreality" (as cited in Blades, 2001, p. 65). The metaphor of hyperreality is well-illustrated by the Belgian surrealist Rene Magritte's (1929) trompe-l'oeil painting, *The treachery of images* (Figure 5). The painting depicts a picture of a pipe with a caption underneath, "Ceci n'est pas une pipe" (This is not a pipe). One is immediately perplexed by the apparent contradiction of the written words and the picture: what does it mean that this is not a pipe? The bowl where the tobacco is packed, the hollow stem extending from the pipe in a beautiful curvature ending in the mouth piece is certainly characteristic of the tobacco pipe, and for some may even conjure euphoric sensations associated with smoking the pipe. But after all, this pipe is not a pipe. It is an image of a pipe, an arbitrary signifier, signified from, the actual pipe itself. The connotation associated with the word, pipe, nor the image of the pipe is not the same as the experience of seeing, smelling and handling the pipe. "The map is not the territory" but only a representation and thus is not the same as the experience itself.

Figure 5. The treachery of images (Magritte, as cited in Sylvester, 1992)

Place-based education emerged as a countermovement to decontextualized approaches in education (van Eijck & Roth, 2010). Lacking in a single theoretical orientation, place-based education broadly refers to traditions that place locality at the center of one's learning experiences, encompassing the values and practices of experiential learning, democratic education, problem-based learning, outdoor education, indigenous education, multicultural education, environmental education and community-based education, to name a few (McInerney, Smyth & Down, 2011). Some common elements of place-based approaches include a value of (1) locally produced knowledge derived from emergent concerns, (2) teacher and student involvement in the co-creation of the curriculum, (3) a multidisciplinary approach to education and (4) merging the boundary between the school and the community, effectively embracing a holistic educational philosophy that moves beyond career-oriented goals of education (Gruenwald, 2008; Smith, 2002). Place-based nature programs may invite high school students to visit a local estuary to locate salmon habitat using GPS technology (Smith, 2002); place-based approaches with a culture focus may explore place as a "palimpsest" (van Eijck & Roth, 2010, p. 881) with various layers of hidden voices in a community to be revealed, such as those of the indigenous people. In various ways then, place-based education stresses the importance of organic learning in one's familiar environmental and sociocultural milieu to the foster the "art of living where we are" (Orr, 1992a, p. 130).

As Curtin (1991) has argued, there is a difference between caring *about* and caring *for*. One can care *about* environmental problems in an abstract, generalized manner of caring, but an authentic caring *for* occurs with attention to the immediate, relational and contextual particularity of the cared-for. That is, one might cognitively *know* that the world is perplexed with environmental issues of deforestation, water depletion and biodiversity losses, but to *be* is an embodied form of knowing that cares *for* these issues (Bai, 2009). Rachel Carson (1956) wrote in *The Sense of Wonder*:

> I sincerely believe that for the child, and for the parent seeking to guide him, it is not half so important to *know* as to *feel*. If facts are the seeds that later produce knowledge and wisdom, then the emotions and the impressions of the senses are the fertile soil in which the seeds must grow. The years of early childhood are the time to prepare the soil. Once the emotions have been aroused–a sense of the beautiful, the excitement of the new and the unknown, a feeling of sympathy, pity, admiration or love–then we wish for

> knowledge about the object of our emotional response. Once found, it has lasting meaning. (p. 56)

An environmental sensitivity that emerges from such holistic learning may encourage a deep commitment to take action that is rooted in a thoughtful reflection of the cared-for's needs. I propose that an exploration of "place" that invites contextualized approaches in science education may provide possibilities for fostering an embodied consciousness of care *for* the world that we inhabit.

Overview of Chapters

In the following literature review (*Chapter 2*), I first provide a contextual overview of science and environmental education as is currently practiced. Despite endorsement of STSE education at national and provincial levels, STSE as is often practiced neglects to incorporate the emotional, affective, ethical and character development of students (Zeidler, Sadler, Simmons & Howles, 2005; Fowler, Zeidler & Sadler, 2009); that is, students' *beings* in relation to the world. While epistemological questions such as "what to teach" or "how to teach" students are paramount in environmental education research and pedagogy, I propose an ontological turn to embrace the learner's identity in the here-and-now, emphasizing an ethic of care for immediate, familiar places.

Second, I explore the definition of a "place" as is commonly appropriated in place-based education to mean the "local." Place-based pedagogies draw on students' immediate environments, fostering a sense of belonging in a particular landscape (Arenas, 1999; Smith, 2002). However, critics have argued that such a myopic focus advocates a sense of parochialism, precluding connections that people have with other people and places (McInerney, Smyth & Down, 2011; Nespor, 2008). Furthermore, what is problematic is that place-based education typically falls within two dichotomized realms: place-as-land in the form of a nature study, or place-as community in the form of a culture study. Such idealized, romanticized and stable definitions of place create an illusionary divide between the human and non-human world, limiting one's understanding of a place (Wattchow & Brown, 2011).

Third, I argue that what makes a place a place is not necessarily its physical setting nor the activity in the "place," but the *meaning* that individuals attribute in relation to a place, i.e., the consciousness or intentionality in which individuals experience a place (Relph, 1981). That is, two individuals can occupy the same place but can have two very different experiences in an

otherwise similar place; similarly, two different places might evoke similar conceptions of a meaningful sense of place. Drawing on Merleau-Ponty's (1962) embodiment phenomenology, I propose that it is important for individuals to attune themselves to the sensualities of a particular place. While phenomenological appreciations of place exist in classic theoretical works in human geography (Relph, 1981; Tuan, 1977), few recent narrative approaches exist on what it is like to have an experience in place, particularly in the context of science education (Kudryavtsev, Stedman & Krasny, 2012).

Finally, I draw attention to the need for science teachers themselves to explore what it means to be rooted in their particular places of meaning. While there is a body of literature on teacher identity development (Beauchamp & Thomas, 2007; Rodgers & Scott, 2008), the question of what it means to be a subject-specific teacher in relation to personal and professional lifeworlds has been rarely explored (Avraamidou, 2014). As Aoki (2005) has suggested, one's "doings" (p. 160) in the classrooms flow from who we, fundamentally, are as beings in the world. Identity research in teacher education thus probes the question of what it means to be human and what it means to be a teacher. Although recent research supports the notion of a complex, contextual and multidimensional nature of teacher identity, constructed and reconstructed through narratives (Rodgers & Scott, 2008; Sachs, 2005), research on subject-specific identity such as science teacher identity, let alone biology teacher identity, is minimal.

Therefore, I pose the research question: *How do place-aware biology teachers' lived experiences in place influence their teaching pedagogy, if at all?* This question was explored through phenomenological explication of three related sub-questions: (1) what do biology teachers mean by a "place"? (2) how do biology teachers perceive and describe an experience in place? and (3) does the experience in place affect biology teachers' pedagogy? By exploring identity as a narrative, I develop an argument for biology teachers' consciousness of experiences in places and embodied sensitivities of being on the earth.

In *Chapter 3*, I outline phenomenology as an appropriate methodology for investigating the research question. In contrast to other research methodologies that focus on establishing causal explanations of a particular phenomenon bound within a particular sociocultural context, phenomenology invites descriptions of participants' lived experiences of a phenomena with a focus on the hermeneutic interpretation of participants' human experiences regardless of age, ethnicity, gender and other sociocultural factors (van Manen, 1990, 2014). Drawing on Merleau-

Ponty's (1962) phenomenology of embodiment, I further emphasize how the study focused on individual participants' experiences in places of meaning as experienced through their bodies, inviting narratives of participants' subjective, phenomenal and embodied lifeworlds. Moreover, I note how the current study did not aim to problem-solve a particular problem; rather its purpose was to shed descriptive light on the lived experiences of places.

Five biology teachers with diverse backgrounds and teaching experiences from one public and private school in Victoria, British Columbia, were selected to share their narratives of personal experiences of places and their teachings about place. Journal writings, unstructured interviews and artefacts representative of lived experiences of places were collected to explore the relationship between personal and professional lifeworlds in the context of place. In order to preserve the individuality of participants' experiences, the data were first analyzed on a case-by-case basis following Smith and Osborn's (2008) Interpretive Phenomenological Analysis approach; thereafter, similarities and differences in emergent themes were identified across participants where appropriate.

In *Chapter 4*, I present four themes that emerged from the study of teachers' experiences of places of meaning: a sense of mystery that there is always something to be revealed, an experience of the vastness and complexity of various landscapes, feeling the presence of nature as the Other that is intrinsically valuable in and of itself, and feeling a fondness for places as shared through close family and community members. Although teachers shared similar experiences in various places of meaning, the extent to which such experiences transferred into their teaching practices differed across teachers. Some participants demonstrated a stronger intentionality in transferring place values into their teaching than others; different teachers also shared experiences of place in different ways. In this way, I highlight the particularity, individuality and contextuality of teaching as a human experience.

Finally, in *Chapter 5*, I pull together the interweaving strands of the four themes, highlighting the importance of seeing the Gestalt whole that is greater than the sum of its parts (Hollway & Jefferson, 2000). Drawing on biology teachers' lived experiences in places, I propose a pedagogy of places that invites: (1) an understanding of the interconnections between nature and culture, (2) an experience of the "layers" of seeing a place through an embodied sensory approach and (3) a reflection on ethical ways of being in the world. Throughout the discussion, I draw on conversations with teachers that inspired such a pedagogy, noting

implications for future science education research and pedagogy, particularly for science teacher education.

All in all, I signify the importance of a pedagogy of places as a challenge to technical-rational ways of knowing in science education, opening possibilities for a holistic way of being in the world. The multidimensionality of "place" as explored in the study perhaps fuses the stereotypical binaries in research and pedagogy, such as object-subject, nature-culture, non-human-human, science-art, logic-emotion, science-society, knowing-being and more. I argue that such a pedagogy of places could broaden students' horizons with a sensitivity for the human and non-human Other. In doing so, I propose that we return to the heart of science education with a broadened understanding of why we teach science.

Chapter 2: Literature Review

Trends in Science/Environmental Education

> I'd like you to close your eyes and think about a place, that really means something to you deep in your heart. (Bateman, as cited in The Robert Bateman Centre, 2014)

Science, Technology, Society and Environmental (STSE) education.

Traditionally, science education has been perceived as content-laden, abstract and decontextualized with a lack of emphasis on individual students' and teachers' senses of place (Lim & Calabrese Barton, 2006). Since the launch of the former Soviet Union's satellite *Sputnik* in 1957, the United States and Great Britain reformed science education as a training for youth to become scientists and engineers, prompting product-oriented, technical-rational approaches to science education (Blades, 2016). As a countermovement against such career-oriented focus of science education, Science, Technology, Society (STS) education (and later STSE, with E as environment) emerged in the 1970s to allow science education for every citizen. In contrast to the traditional approaches of science, the STSE approach views science as a dynamic, human-laden activity bound within a particular context with a focus on the process of science rather than its products, i.e., "science in the making" as opposed to "ready-made-science" (Latour, 1991; Weaver, 2001). Broadly, STSE education explores the relationships between science, technology, society and the environment by addressing socioscientific issues (SSI) in a complex nexus of social, political, economic, ethical and moral confluences through topics such as: human health; land, water and mineral resources; food and agriculture; energy resources and consumption; industry; information transfer and transportation; and ethics and social responsibility (Hodson, 2010).

Several currents have been identified in STSE education (Pedretti & Nazir, 2011): (1) the application/design current that focuses on developing design/inquiry skills associated with solving technical problems; (2) the historical current that explores the historical lives of scientists in order to understand how scientists are people embedded within particular social contexts; (3) the logical reasoning current that focuses on developing understanding and decision-making skills related to SSI such as through stakeholder analyses; (4) the value-centered current that focuses on promoting ethical/moral reasoning of SSI such as Kohlberg's moral reasoning theory; (5) the sociocultural current that aims to deconstruct hegemonic views of Western science through exploration of non-Western worldviews such as those of indigenous populations; and (6)

the socio-ecojustice current that emphasizes civic responsibility to take action on SSI. While these strands in STSE research and pedagogy are not mutually exclusive of one another, Pedretti and Nazir's (2011) review provides a useful comparative of varying approaches in STSE education, highlighting similarities and differences in their aims of science education (e.g., problem-solving, intrinsic value, civic responsibility), dominant approaches (e.g., cognitive, affective, holistic, experiential) and examples of strategies (e.g., case studies, storytelling, debates).

There has been a large body of recent work related to the socio-ecojustice current, which views science as/for sociopolitical action with a focus on transformation, human agency and emancipation to address various SSI (Alsop & Bencze, 2010; Bencze 2013; Hodson, 2010; Roth & Lee, 2012). In a socio-ecojustice approach, students are encouraged to shift across four domains of science from *learning science and technology* (conceptual and theoretical focus on science) to *learning about science and technology* (understanding the nature of science), towards *doing science and technology* (practicing scientific inquiry in the real-world) and *engaging in sociopolitical action* (participating in responsible action in the society) (Hodson, 2003). The characteristics of action in a politicized STSE curriculum are:

> …rooted very firmly in a commitment to reject actions that are merely convenient, expedient, or solely in our own interests in favor of careful and critical consideration of what is good, just and honorable. It is driven by a deep commitment to anti discriminatory education; that is exposing the common roots of sexism, racism, homophobia, Eurocentrism and Westism (or Northism) in the tendency to dichotomize and generate a sense of the *other*; working actively to confront the "us and them" mentality that invariably sees us as the norm, the desirable and the superior (Hodson, 2010, p. 2010).

Proponents of place-based education with an STSE orientation likewise invite students to explore local socioscientific and environmental issues emerging from students' familiar contexts and challenges students to take action on such issues (Gruenwald, 2008; Smith 2002). For instance, in a case study of the Oceanside Middle School in British Columbia, students investigated the relationship between amphipod count and rate of flow in a nearby local polluted creek and presented their solutions at the Henderson Creek Open House, thereby situating their understanding in a broader context through interaction with the larger community (Roth & Lee,

2002). Through an action-oriented framework in science education, students are thus encouraged to explore the intricate links between STSE and become active citizens beyond rhetoric.

The STSE approach has been endorsed in Canada through the Common Framework for Science Education Outcomes (Council of Ministers of Education of Canada, 1997). In the Ontario science curriculum document for grades 9-12, STSE education is included as a major goal for every unit of study with an emphasis on taking practical action particularly as it relates to environmental issues (Ontario Ministry of Education, 2008a; Ontario Ministry of Education 2008b). The British Columbia science curriculum proposal for grades 10-12 includes broad curricular goals related to STSE such as the critical evaluation of social, ethical, and environmental implications of scientific investigations, and a need to care for self, others, community and the world (British Columbia Ministry of Education, 2015). However, despite endorsement of STSE education at national and provincial levels, STSE education in practice challenges positivist conceptions of science and scientists, thereby posing ideological anxiety amongst science teachers to implement STSE in the class (Pedretti et al., 2006). Student teachers with concerns for classroom survival may thus consequently opt to place a greater focus on the "nuts and bolts" of science teaching such as lesson planning, preparing laboratory activities and assessment/evaluation, and STSE may be left to the margins to be addressed "if there is time." That is, while an understanding of STSE is an important step towards implementation, that alone does not appear to guarantee that teachers will instructionally practice STSE in the classroom.

Furthermore, STSE practices with a socio-ecojustice orientation have been critiqued as simply "point[ing] out ethical dilemmas and controversies" (Zeidler et al., 2005, p. 359) without consideration of the affective, moral or character development of the students. As Fowler, Zeidler and Sadler (2009) suggested, moral considerations are central to the understanding and decision-making related to SSI. The problem of ignoring students' affective identities in an action-oriented approach to science education is that it may encourage rash action without a thoughtful consideration of what students are taking action for (Goralnik, Millenbah, & Nelson, 2012; Hadzigeorgiou, 2014). The call for taking action via the Internet, such as signing an online petition or "liking" an environmental campaign on Facebook, can lead to forms of "slacktivism" which require little time and effort to participate in action (Zouda, Nishizawa and Bencze, 2016). The concern is that if this were the case, STSE education could denigrate to the same "ready-made science" (Latour, 1991) that it initially sought to critique; that is, students may be obliged

to take action "just because." While teaching is not a value-free enterprise (Burns and Norris, 2012), teachers must be aware of striking a delicate balance between informing students of pressing socioscientific concerns and directing students to take action for the sake of taking action.

Curtin (1991) explained that there is a distinction between caring *about* and caring *for*. While caring *about* is an abstract, generalized form of care, caring *for* occurs in a particular context with an attentive attitude to respond to the particular needs of the recipient of care. One can care *about* the destruction of the Amazonian rainforest and species extinction due to global climate change, but one cares *for* one's local garden in one's immediate, familiar neighbourhood through an experience in place. From a feminist perspective, a relational ethical of caring is one in which the carer and cared-for respond to an affective awareness for each other characterized by *engrossment* (the carer's full presence for the cared-for) and *displacement of motivation* (the full motive force to attend to the needs of the cared-for) (Noddings, 2003, p. 25). Noddings explained the importance of listening to the cared-for in teaching:

> He tells me that he hates mathematics. *Aha*, I think. *Here is the problem. I must help this poor boy to love mathematics, and then he will do better at it.* What am I doing when I proceed in this way? I am not trying to grasp the reality of the other as a possibility for myself. I have not even asked: *How would it feel to hate mathematics?* Instead, I project my own reality onto my student and say, *You will be just fine if only you learn to love mathematics*. (p. 15)

In contrast to a means-oriented reasoning about why one should care, caring *for* is thus about listening without enforcing one's preconceptions about what s/he needs. If one were to provide one-time monetary contribution to an environmental organization, or participate in a one-time city march against genetically modified crops, could it be said that s/he cares *for* these issues? While participation in a city march is one avenue of exercising active citizenship, one must consider whether such an action is simply a projection of one's thoughts on what one thinks is the best the cared-for, or whether it is a form of action derived from a thoughtful reflection of the cared-for's needs.

STSE education moreover faces new pressures from developments in STEM (Science, Technology, Engineering and Mathematics) education that emphasizes the relationships across science-related disciplines. The acronym STEM originates to UK's immigration documents

when scientists, technicians, engineers and mathematicians were sought for employment and immigration in the mid 1990s (Blades, 2016). While STEM education focuses on interdisciplinary relations within the sciences and has been popularized for its practicality associated with employment needs, the historical roots of STEM suggest a career-focused approach to meet market demands of a neo-liberal political agenda (Blades, 2016; Weinstein, Blades & Gleason, 2016; Zeidler, 2014). In fact, a close look at the nature of science standards in the Next Generation document suggests that "science knowledge can describe consequences of actions but is not responsible for society's actions" or that "science knowledge indicates what can happen in natural systems–not what should happen. The latter involves ethics, values and human decisions about the use of knowledge" (National Research Council, 2013, p. 6), effectively providing counter statements against forty years of developments in STSE education with a focus on science for citizenship. In response to the myopic focus of STEM education, critics have suggested a STEAM (Science, Technology, Engineering, Arts, and Math) approach that incorporates a humanistic orientation to STEM by identifying links to the Arts such as sociology, psychology, history, fine arts and philosophy (Zeidler, 2014). Nevertheless, the STEAM approach appears to prioritize STEM, as the vast discipline of the arts is compressed into merely one letter of the acronym in what is supposed to be an integrative approach to science education.

While STEM education has gained momentum in the United States, STEM has also become ubiquitous in Canada. The redesigned science curriculum for British Columbia is described as "a concept-based, competency-driven curriculum [that] enables a variety of approaches (e.g., place-based, inquiry-based, interdisciplinary, STEM, STEAM) for teachers to use to support student learning" (British Columbia Ministry of Education, 2016). Since 2011, the BC Ministry of Education has supported progressive reforms, such as a shift from content-laden learning standards called prescribed learning outcomes (PLOs) towards an emphasis on the "big ideas" and processes of science such as "questioning and predicting," "planning and conducting," and "evaluating" various concepts in science. Mandatory provincial exams for grade 12 science courses were removed from the curriculum; in 2016, the Ministry of Education further announced a massive reduction in provincial exams to test only literacy and numeracy in students' graduation year. Despite these reforms for 21st century learning, the new BC science curriculum appears to advocate a shift from STSE education towards STEM education (Blades,

2016). While there are broad overarching goals that resemble STSE education such as fostering "scientific habits of mind" with "a consideration of social, ethical, and environmental implications—a willingness to think about personal, societal, moral, and environmental impacts of actions" (British Columbia Ministry of Education, 2016), the goal does not explicitly translate to the curricular competencies themselves, in particular those that relate to environmental issues. In this manner, the new curriculum faces issues of incorporating environmental values in the classroom, unless perhaps valued by the teacher him/herself. The challenge is therefore to re-evaluate the economic rationale for STEM and its appropriateness with other progressive reforms in the BC Ministry of Education.

Environmental education.

The current epoch has been plagued with human-induced environmental problems, such as deforestation, biodiversity losses, fisheries depletion and water deficits; reminders of such environmental crises are alerted daily on the national and global news. Since the landmark intergovernmental Tbilisi Conference on environmental education (EE) organized by UNESCO in 1977, there has been a widespread acknowledgement amongst environmental education circles for the need to endorse awareness, knowledge, values, attitudes and skills to understand and solve complex environmental issues. The goals of EE highlighted from the Conference are:

1. To foster clear awareness of, and concern about, economic, social, political, and ecological interdependence in urban and rural areas.
2. To provide every person with opportunities to acquire the knowledge, values, attitudes, commitment, and skills needed to protect and improve the environment.
3. To create new patterns of behaviour of individuals, groups, and society as a whole towards the environment. (UNESCO, 1977, p. 26)

Since 1977, there have been various pedagogical movements in environmental education. Sauvé (2005) provided a comprehensive overview of fifteen currents in EE, which includes currents with a longer tradition such as the "naturalist current" that emphasizes human relationships with nature through experiential approaches, the "conservationist current" that values conservation of resources and environmental management such as the three R's of EE (reduce, reuse and recycle), the "value-centered current" that promotes the development of moral/ethical relationships to nature, and the "problem-solving current" that identifies environmental problems and invites a call to take action. In contrast to these traditional currents, there are recent currents that have

emerged in EE, such as the "holistic current" that emphasizes individuals' phenomenological being-in-the-world, the "ethnographic current" that focuses on cultural studies of particular groups' (e.g., indigenous people) relationships to nature, and the "sustainability current" that promotes the societal wellbeing of individuals in environments. While it is more than a decade since Sauvé's (2005) outline of evolving currents in EE, her analysis provides a relevant overview of the vast range of research and pedagogy in EE, and is often referred to in the literature to provide a conceptual framework for teachers' varying perceptions of EE (Pedretti & Nazir, 2014; Steele, 2011).

Although it has been nearly forty years since the adoption of the Tbilisi Declaration, environmental education has unfortunately yet to acquire mainstream status in regular K-12 curricula (Hart, 2010). In a comprehensive mixed-methods study of environmentally conscious teachers' views of EE in Ontario, only 47% of the teachers reported that they incorporated EE at least once a week in their teaching, with the rest of the respondents practicing EE once every two weeks or less (Pedretti & Nazir, 2014). The authors noted that this group is not representative of the broader group of Ontario teachers as the majority of the informants self-reported as having a strong environmental orientation; yet even these teachers found various constraints that limited them from frequently implementing EE practices in their teaching, such as lack of support for EE amongst their colleagues. Many teachers were moreover identified as possessing traditional "naturalist," "value-centered" and "problem-solving" approaches to EE. Pedretti & Nazir (2014) explained:

> What becomes clear in this study is that EE means different things to different people and therefore is manifested in practice, in many different ways. We are not suggesting that this is necessarily a problem. Rather, we are concerned that teachers are not provided with opportunities to interrogate and explore different orientations to environmental education so that their environmental education practices are deliberate and underpinned by particular assumptions and assertions. (p. 274)

In another study of science teachers' perceptions and practices of EE, Steele (2011) likewise outlined the "naturalist" or "conservationist" current as the most dominant ideology amongst teachers in Ontario secondary schools. It was found that lessons that were identified as "EE" were often taught as "add-ons" to regular science lessons and took place in the form of an outdoor field excursion or an invited guest speaker from an environmental organization.

Teachers revealed their discomfort in addressing contemporary environmental issues at the nexus of social, economic, political, ethical and moral concerns, which they felt unequipped to teach given their specialized training in science. Through action research projects that guided teachers' practices in EE, Steele (2011) however reported how teachers began to "broaden their repertoire of teaching strategies, which provide[d] the possibility to make small but significant incremental changes in epistemology and in practice" (p. 17).

It has been suggested that there is a rhetoric-reality gap in EE: that the historic purposes of schooling that aims to maintain social order contradicts with the goals of EE that aims to develop critical thinkers capable of environmental decision-making (Bowers, 2002; Hart, 2010; Stevenson, 2007). "Traditional" curricula often reflect the values of the dominant culture such as individualism, competition, achievement and independence, and attempt to maintain the status quo through a socialization of mainstream beliefs. Thus, while EE curricula often develop from emergent, interdisciplinary, real-world problems, many "traditional" public school curricula have pre-determined, abstract objectives to be mastered by students in specified grade levels. Furthermore, while EE curricula emphasize ecological harmony and interdependent collaboration in global and local contexts, conventional school systems may (un)intentionally perpetuate capitalist and neoliberal values in alignment with nation or state sociopolitical goals. Critics have argued that given the complex nature of EE, activities such as overnight nature camping trips, planting in the school garden, or conducting research on species extinction have often been misidentified as EE practices, although lacking in the transformative discourse of deeper sociocultural, ecological, moral and ethical concerns (Gruenwald, 2004; Hart, 2010; Steele, 2011).

While it would be a sweeping overstatement to suggest that all school systems subscribe to the "traditional" ideologies above, the historic purposes of schooling with a focus on knowing contrast with those of contemporary EE values that emphasize one's being and doing in the world (Orr, 1992a; Stevenson, 2007). Science educators might inform students about abstract problems of deforestation, logging practices and acid rain with an emphasis on the "doom and gloom" of the imminent environmental crises so that students might become environmentally conscious citizens who are "greener than their parents" (Postma & Smeyers, 2012, p. 402). However, David Sobel (1996) argued in *Beyond Ecophobia: Reclaiming the Heart of Environmental Education* that:

> The motive for all this is honorable and just: if children are aware of the problems of too many people utilizing too few resources, they will grow up to be adults who eat Rainforest Crunch, vote for environmental candidates, and buy energy efficient cars. They will learn that by recycling their Weekly Readers and milk cartons, at home and in school, they'll help save the planet. My fear is that just the opposite is occurring. In our zest for making them aware of and responsible for the world's problems, we cut our children off from their roots. (p. 1)

By engaging students in a "premature abstraction" (p. 5) of environmental concerns, educators might ironically instil a sense of "ecophobia" (p. 5) amongst students: a fear of oil spills, a fear of whaling, a fear of plastic pollution, a fear of deforestation, a fear of going outside, and more. Therefore, simply pointing out such environmental problems can ironically distance students from the world that they live in, leading students to cognitively know that particular environment problems exist but not necessarily lead to a change in their being in relation to the world.

When authentic EE practices occur, they often occur in specialized programs with teachers that have a strong environmental orientation. For instance, the Environmental Studies Program (ESP) in secondary Ontario schools integrates various environmental issues through an interdisciplinary curriculum (Breunig, 2013). In a typical ESP, there are 20-25 students that form a small cohort with one or two teachers that instruct the cohort for an entire term. Through five case studies of schools that offered ESP, Breunig (2013) explained how students gained rich experiential learning opportunities through composting or growing a rooftop garden. In another rich EE program in British Columbia, Mayer-Smith, Bartosh and Peterat (2009) invited primary school students to participate in a hands-on intergenerational farming experience with adult "farm friends" at an urban farm associated with the University of British Columbia. In their six-year study, they highlighted the importance of teachers with a strong environmental focus:

> Our experiences in years three and four indicate that motivations and commitment to participating in an "environmental" farming project can vary considerably depending on how the teacher participants construct and view the experience in relation to their own teaching agenda… learning about sustainable food growing at a local farm may be deemed interesting but not necessarily "special," and it is the teacher who must "sell" students and parents on the value of such activities. (pp. 114-115)

As an environmental educator of GreenHart Education, Johnston (2009) conducted a series of arts-based outdoor environmental education workshops called "Good Neighbours Come in All Species" with primary school children in BC. The activities engaged children in a sensory awareness of nature, such as finding a "heart spot" (a favourite place) in their neighbourhood that they revisited each week with a different focus, or creating music using objects they could find in nature. In this way, EE practices appear as heterogeneous "hotspots" across Canada where particular educators that have a strong environmental ethic contribute to making a "green" school (Hart, 2010).

More recent interests in environmental education explore the process of the "subjectification" (Hart, 2010, p. 164) or how we construct our educational identities to become who we are. Discussions on environmentalism have been often been critiqued to be rooted in prescriptive language about the need to "protect," "respect," "love" and "care" for the environment (Bai, 2009). Such a moralizing attitude is problematic as conservation, protection and management of the environment could lead to an anthropocentric orientation in EE. Moreover, individuals with knowledge that one "ought" to care for the environment may not necessarily demonstrate pro-environmental behaviour. This cognitive approach to behaviour assumes a linear understanding that possession of environmental knowledge will lead to pro-environmental behaviour; however, knowledge is perhaps one part of what determines moral behaviour (Fowler et al., 2009; Kollmuss & Agyeman, 2002). Furthermore, by postulating end goals such as "environmentally-responsible" behaviour and prescribing environmental identities that learners "should have" or "ought to have," environmental educators might exclude the learners as they currently "are." As Payne (2001) suggested,

> …before environmental education and its subjects "ought to be" for x, y or z, we need to address the already "ises" of our individual and collective "being-in-the-world," or where "learners" are at, of which identity and lifestyle are key praxical conditions and, therefore, prime considerations. (p. 72)

That is, instead of pre-mediating the identities that learners should have, environmental educators perhaps need to consider the learner's identity processes and develop a mindfulness of students' being in the world.

Given the possibility for teachers to promote EE values in the classroom, a critical reflection of teachers' environmental values can be fruitful for them to begin to integrate EE in a

conscious, deliberate manner. In Pedretti and Nazir's (2011) study of teachers' perceptions of EE, teachers reported learning about EE largely through their personal studies rather than professional sources, such as pre-service teacher education courses or in-service professional development workshops. As Hart (2010) aptly commented, "Teacher education lives a kind of schizophrenic existence between advocating radical change and maintain a status quo, a space which is rapidly becoming an unsustainable fiction" (p. 167); that is, EE is not central to the mainstream discourse of teacher education, with instead a greater focus placed on research and scholarship related to preparing students for traditional school practices. Teacher identity research in the context of environmental education can therefore promote a sense of awareness and agency whereupon "finding one's voice implies not having others (researchers, school boards, textbooks) speak for us, not being silenced by authorities or normative notions of who teachers should be, in effect, to be the *author* of one's identity." (Rodgers & Scott, 2008, p. 737).

As E.F. Schumacher once said, "the real problems facing the planet are not economic or technical, they are philosophical" (as cited in Bateman, 2013). There needs to be a shift in science/environmental education discourse from a language of "preventing doom" to "anticipating care" (Postma & Smeyers, 2012, p. 409). I surmise that such a contextual and relational discourse is perhaps what is missing in environmental education, and that such changes can begin by probing science teachers to reflect about authentic places of meaning and being.

Defining Place

> To be at all–to exist in any way–is to be somewhere, and to be somewhere is to be in some kind of place. Place is as requisite as the air we breathe, the ground on which we stand, the bodies we have. We are surrounded by places. We walk over and through them. We live in places, relate to others in them, die in them. Nothing we do is unplaced. How could it be otherwise? How could we fail to recognize this primal fact? (Casey, as cited in Gruenwald, 2003, p. 622)

Dichotomous notions of place.

The notion of "place" in education has most often been explored in the context of place-based education. Place-based education stresses the importance of organic learning in one's familiar environmental and sociocultural milieu (Smith, 2002). Place, originating from the Latin *planta*, meaning the sole of the foot, can be defined as an earthly attachment to a particular space and time (Arenas, 1999). Whereas a "space" is a decontextualized realm subject to scientific

abstraction such as the Euclidian notion of space, a "place" is commonly suggested to be a contextualized arena, fostering a sense of belonging and relating (Sibley, 2010). Based on these conceptions of place contrasted with space, place-based educators often equate the notion of a "place" with the "local," such as the local playground, garden, mountain or community centre. Whether encouraging students to explore the local environment such as rivers, mountains and forests, thematically incorporating elements of social studies, language arts, mathematics and science into the living laboratory (Smith, 2002), or engaging students in sociohistorical analyses of the Indigenous land through a critical pedagogical lens (van Ejick & Roth, 2010), place-based curricula aim to cultivate an understanding of students' "situationality" (Gruenwald, 2008, p. 310) in their immediate environments.

However, as critically pointed out by Nespor (2008), place-based research typically falls within two traditional realms: (1) place-as-land in the form of a nature study or (2) place-as-community in the form of a culture study, both of which imply a stable and bounded notion of a place. In a typical place-based nature study, outdoor educators invite students on a camping, hiking or canoeing adventure to the "land," "the natural environment," "the non-human world," or the "wilderness" in order to cultivate a connection with one's local environment (Wattchow & Brown, 2011). Yet, as critiqued by Greenwood (2013), there are other "outdoor" places such as soccer fields, highways, sidewalks and farmlands that are often unvisited in nature-based place studies, thus privileging certain "natural" outdoor places while neglecting built landscapes, albeit being categorically "outdoors." One may alternatively be drawn to an aesthetically pleasing local landscape in nature-based place studies, such as a snow-capped mountain, a quiet riverside or a lush forest, while ignoring landscapes that have been degraded, such as oil fields, polluted lakes and deforested land, a manifestation of social, economic and political conflicts in an otherwise "natural" landscape (McInerney, Smyth & Down, 2011; Wattchow & Brown, 2011). Furthermore, when the focus in place-based nature studies becomes the activities and adventures in the "exotic" wilderness, the place simply becomes the background for such experiences, ironically distancing individuals from an embodied experience in a place (Wattchow & Brown, 2011). The question worth pondering in nature-based studies of place is thus not whether one is place-conscious or not but the *manner* in which we are conscious and the *kinds* of places that we consider worth studying (Greenwood, 2013).

Similarly, culturally oriented place-based studies often focus on idealized notions of a self-contained community (Nespor, 2008). Ignoring the movement of people and objects across time-space in a globalizing age, a place-as-community is often defined as a self-enclosing boundary in favour of the "commons" versus the "market," the "local" versus the "global," or the "historical" versus the "modern." In a critical analysis of the Tod Creek watershed in Victoria, British Columbia, van Eijck and Roth (2010) explored the meaning of Tod Inlet and its surrounding environment, first known to the Saanich First Nations people as SṈIDȻEŁ (pronounced as "Sneekwith") or "place of the blue grouse" (p. 874). Drawing on Bakhtin's concept of "chronotope," where time-space is defined by narratives of the community, the authors proposed a chronotopic theory of place, emphasizing the need to listen to and share the hidden voices of a community. Given the representation problem of certain voices in the community, such culture-studies of place may sometimes be sociopolitically charged, stressing, for instance, that "despite problems of appropriation, Native, Indigenous, First Nations and Aboriginal educational processes and epistemologies need to be at the *center* of place-based culturally responsive teaching" (Gruenwald & Smith, as cited in Nespor, 2008, p. 482). While a place is dialogically constructed through a multitude of voices, to suggest that one group be at the "center" of dialogue on place is oxymoronic and is associated with a nostalgic sentimentalism to recover lost heritages to the way things once were (Massey, 1994). Thus, place-based critics argue that culture studies of places that equate "place" as a bounded, historical and essential identity might ironically privilege certain heritages, segregating broader place connections with other places and people connections with other people.

Towards an understanding of experience in place.

The limitation of the notion of "place" in place-based education literature therefore seems to be that of binaries: local and global, commons and market, non-human and human world, nature and culture, and so on. First, the nature-culture dichotomization is problematic as it assumes that there is a pristine wilderness, which must be "preserved," "saved," and "managed" from humans (Wattchow & Brown, 2011). Strictly speaking, "nature," derived from the Latin *natura* means the quality or essence of an object. But when the ancient Greeks first redefined "everything" as "nature," it became possible to think about having an "everything-but," leading to the semiological divide between nature and non-nature. As Evernden (1992) wrote, "The possibility of having a thing called nature is as significant development as a fish having a 'thing'

called water: where there was once an invisible, preconscious medium through which each moved, there is now an object to examine and describe" (p. 20). The romanticized and bounded notion of "place" in nature-based studies dichotomizes the artificial divide between the human and non-human world (Gruenwald, 2008; McInerney, Smyth & Down, 2011).

Second, the local-global tension in place-based literature is problematic as it assumes that the former is associated with a form of authentic living where one feels a sense of belonging and commitment, whereas the latter is associated with inauthentic living where one is devoid of a rooted life. On one hand, place-based proponents have suggested that children must first learn to experience a sense of attachment in their immediate locale before they can begin to think about the wider global community (Smith, 2002); on the other hand, critics have argued that such a myopic vision of a "place" leads to parochialism, limiting children's understanding of a place that varies in scale from the local to the global (McInerney, Smyth & Down, 2011). While the notion of "home" is often selected as the point of reference in place-based research, meaningful places may not be necessarily tied to one's immediate locale (Manzo, 2005). We can experience a sense of belonging to many places in our lives, and these significant places can be tied to critical life issues such as love, loss, identity, substance abuse, child abuse, death, sexuality, and other interpersonal relationships; thus, a range of feelings are appropriated to places from a feeling of deep love to ambivalence to hatred.

Drawing on ethnographic studies of nomadic peoples such as the Bedouins of Asia Minor and anthropologic studies of pilgrimages, Manzo (2005) explained that nomads and pilgrims in fact place similar value on movement and travel as others place on home. Although nomads' movements can be constrained by history and custom, the feeling of home is relational as "it is not simply the places that are significant, but rather what can be called *experience in place* [emphasis added] that creates meaning" (Manzo, 2005, p. 75). American short story writer and novelist Eudora Welty (1978) likewise wrote about the meaning of a place in writing:

> Place, to the writer at work, is seen in a frame. Not an empty frame, a brimming one. Point of view is a sort of burning-glass, a product of personal experience and time; it is burnished with feelings and sensibilities, charged from moment to moment with the sun-points of imagination. It is an instrument – one of intensification; it acts, it behaves, it is temperamental. (p. 124)

Welty's reflective excerpt provides an insightful commentary: that the nature of a place is marked in the relationality between the self and place. That is, two individuals can occupy the same locale but may have two very different experiences in an otherwise familiar location. For instance, the experience of living in the Arctic left a profoundly vivid impression on me, although it would be unreasonable to expect that others would have a likewise experience in the same location. There is an element of difference in sameness, and an element of sameness in difference: "a sense of place," which is unique to individuals' lived experience, but bears similarity to other individuals in the manner in which one dwells on the earth (Relph, 1981). Thus, whether local or global, or nature or culture-oriented, the quality and intensity of an experience that an individual has in a place can be more important than the location and the time spent in one's immediate neighbourhood (Tuan, 1977).

In summary, I suggest that the either/or dichotomization of the notion of "place" in education limits a broader and deeper understanding of the concept of place. Nature-based and culture-based studies provide convenient frameworks for investigating one's immediate local milieu, but the polarization of these studies perpetuates stereotypical dichotomies. Therefore, I next turn to a phenomenological inquiry of what an *experience in place* can mean to an individual.

Phenomenology

> The world is not what I think, but what I live through. I am open to the world, I have no doubt I am in communication with it, but I do not possess it; it is inexhaustible. "There is a world," or rather: "There is the world." (Merleau-Ponty, 1962, p. xvii)

Phenomenology of place.

Phenomenology is the study of the meaning of lived experiences. As phenomenologist Merleau-Ponty (1962) wrote, phenomenology is based on the premise that "there *is* a world," or the world prior to any reflections or thoughts imposed on the world. To the phenomenologist, "The world is not what I think, but what I live through" as the "real world" that one supposes exists is in fact a phenomenal field interpreted subjectively by an individual (Abram, 1996). This is not to suggest that the world does not exist, but that there is a collective interweaving set of phenomenal fields as perceived through different individuals in an ambiguous, enigmatic and open-ended landscape. The purpose of phenomenology is hence to focus on individuals' "lifeworlds," or the world-as-lived prior to individuals' conscious participation with the world;

or as Edmund Husserl said, to return "to the things themselves" (as cited in van Manen, 2007, p. 128).

Broadly, phenomenology can be interpreted as a theory of the universal and a theory of the unique (van Manen, 1990, 2014), differing in degree of emphasis depending on the phenomenological tradition. Husserl's traditional transcendental phenomenology attempts to uncover the *universal* essence of an experience, that which "make a phenomenon what it is and without which the phenomenon could not be what it is" (van Manen, 1990, p. 107). In this view, phenomenology is perceived as a method to explore what it means to be a human in relation to the world, with the assumption that there *is* an essential world prior to human reflection, regardless of one's culture (ethnography), social group (sociology) or life history (biography). Outside from Husserl's transcendental phenomenology, Maurice Merleau-Ponty's (1962) phenomenology of embodiment emphasizes the *uniqueness* of individual experience. The focus here is on the intentionality of being by focusing on the descriptions of particular lived experiences at a particular moment in space and time; one does not simply think or feel but one thinks or feels *about* something in direct relation to *this* world through *this* body (Seamon, 1982). Thus, depending on the phenomenological tradition, the task of the researcher is two-fold: on one hand, to bracket the interpretations of lived experiences towards a thematic analysis of what it means to have an experience; on the other hand, to immerse oneself in interpreting the phenomenon as shared by the participant, elucidating the particular experience as lived.

Through a phenomenological study of place in his seminal work *Place and Placelessness*, geographer Relph (1976) explored the fundamental essence of "sense of place" as defined by three components: (1) the physical setting of a place, (2) the activities, situations and events in a place and (3) individual and group meanings constructed in a place. Drawing on this definition, Relph identified the strongest sense of place experience to be a form of "existential insideness," where one develops an unselfconscious commitment to a place, characterized by a profound sense of wholeness and completeness. "Existential outsideness," on the other hand, implies a sense of isolation and alienation from a sense of strangeness of a place that one does not belong. Thus, an authentic sense of place is associated with an unselfconscious sense of place, in an "I-Thou" form of relationship where the boundaries between subject and object disappear, in a manner where one is constituted by the place and the place is constituted by the self, as an individual and the greater community (Buber, as cited in Relph, 1976). Relph's (1976) notion of

sense of place speaks of the importance of individual identity as an inseparable quality of a place:

> The basic meaning of place, its essence, does not therefore come from locations, nor from the trivial functions that places serve, nor from the community that occupies it, nor from superficial and mundane experiences–though these are all common and perhaps necessary aspects of places. The essence of place lies in the largely *unselfconscious intentionality* [emphasis added] that defines places as profound centres of human existence. (p. 43)

Relph's work suggests that not only is a place defined by its separable physical quality, or the identity *of* a place, but the identity that an individual has *with* a place, in a dialogical meaning-making manner between the place and the individual.

In addition to place meaning, a sense of place has been suggested to involve affective attachments with the world. Coined "topophilia" or affective connections with the material world, these emotions range from a fleeting aesthetic pleasure in seeing the sun after a rain to a more permanent sense of warmth and comfort of a home (Tuan, 1974). In an example of topophilia, Tuan referred to a child's unselfconscious immersion in the world, where nature is a source of polymorphous imaginations for an individual looking inquiringly into the world. That is, not only is a place a location where one experiences a sense of meaning, but where one also extends an unselfconscious field of care. In "Building Dwelling Thinking," Heidegger (1975) began with a statement that "Not every building is a dwelling" (p. 145). Dwelling, he suggested, is an authentic mode of being amongst the fourfold of the sky, earth, mortals and divinity, whereas building is simply a structure for dwelling. To dwell authentically then, means to engage in a genuine act of "sparing" or preserving the dwelling as is, letting oneself be immersed in the experience of dwelling without attempting to exercise control or manipulation. There is a sense of humility to "let-dwell" and appreciate something *as is*, "setting [it] free in its own presencing" (p. 150). Reminiscent of Orr's (1992a) distinction between a resident and an inhabitant, a "resident" is thus a transient and temporary individual in a "building," whereas an "inhabitant" has an organic, intimate and holistic relationship with a "dwelling."

Based on such philosophical underpinnings, a body of empirical literature has spawned in geography and environmental psychology on "place attachment" (bond between people and places) and "place meaning" (symbolic meaning ascribed to places) (Kudryavtsev et al., 2012**;**

Lewicka, 2011). Research on place attachment has often been conducted through quantitative approaches, such as Likert surveys that ask participants to rate their level of attachment with a place through evaluating statements such as "I feel like this place is part of me" or "This is the best place for what I like to do" (Kudryavtsev et al., 2012, p. 231). Research on place meaning has been often similarly quantitative by asking individuals to rate the dimensions of a sense of place by rating a survey statement such as "My lake is a place of high environmental quality" (Kudryavtsev et al., 2012, p. 231); in-depth narrative studies that probe participants to recall memories of place are few (Ferguson, 2011; Worster and Abrams, 2005). The concern of the common categorical approach in empirical research is that participants' experiences are boxed into gradients of either/or categories, i.e., "I love this place" vs. "I hate this place," or "This place means a lot to me" vs. "This place does not mean a lot to me," without explicating the meanings of these self-identified attitudes towards a place, failing to encapsulate the complexity of the experience in place. Alternatively, as places have different meanings to different individuals, a place that is ranked high for being beautiful, clean or green (i.e., high environmental quality) does not necessarily imply that individuals also value the standards of the survey instrument. Thus, there is a disconnect in translating the original phenomenological spirit of "sense of place" to quantitative empirical research.

In his doctoral dissertation on cross-cultural perceptions of place in the Thelon Game Sanctuary in the Northwest Territories of Canada, Raffan (1992) similarly posited the lack of narrative empirical work in place research:

> There is, however, a problem with the bulk of sense of place research, namely that it is rarely based on primary fieldwork. Tuan, for example, writes lyrically about sense of place, drawing from the mythology and traditions of a wide variety of cultures, but in the end, one cannot ground his work in any one place. As such, the concepts are strong, but the work is almost too clean, not concerning itself with politics or the interactions within and between people. (as cited in Wattchow & Brown, 2011, p. 96)

While it is more than two decades since Raffan's dissertation, the absence of research on lived experiences of places through peoples' experiential narratives is often noted in the literature (Greenwood, 2013; Wattchow & Brown, 2011). Previous classic phenomenological research has leaned towards a Husserlian interpretation of the *essence* of a place; however, the exploration of *particular individual's* lived experience in place with an emphasis on the uniqueness of the

human being has been minimal. Therefore, there needs to be what Greenwood (2013) advocated as the "blending" (p. 460) of philosophy and experiential inquiry in sense of place research; a sense-making of conceptual frameworks with the messiness of lived experience descriptions of places bound to particular individuals in a particular space and time.

Embodiment phenomenology.

Not surprisingly, such phenomenological approaches to the meaning of place are absent in science and environmental education. In a sub-field of environmental education called "significant life experiences," Chawla (1998, 1999, 2013) identified a strong relationship between individuals' affinity towards the environment with childhood experiences in the outdoors. Often these experiences were in informal learning settings situated within an individuals' local environment: a nearby forest, field, mountain, lake or seashore, outdoor experiences such as camping, hiking or bird watching, or visits to family farms in the summer time. In a comprehensive review of significant life experiences across nine countries, Palmer et al. (1999) likewise found that childhood experiences of nature and influence of close family members were significant drivers of environmental awareness in adulthood; similar findings have been confirmed in recent studies of significant life experiences of geography educators in UK and Ireland (Catling, Greenwood, Martin & Owens, 2010) and environmental activists in Taiwan (Hsu, 2009). However, Gough (1999) cautioned against causal recommendations that are sometimes drawn from such research, such as how particular significant life experiences may serve as precursors for environmental action. Moreover, although the above studies are identified as "autobiographical" and/or "phenomenological," the categorization and generalization of life experiences in an empirical manner perhaps does not entirely align with the spirit of autobiographical and/or phenomenological inquiry.

In one of the few studies that have attempted to explore the notion of place in science education, Lim and Calabrese Barton (2006) explored how urban middle school students bring their senses of place into the science classroom. In their discussion, they highlighted the epistemological tensions (*what* students are learning) found in students' contextualized sense of place in their urban neighbourhood as compared to the decontextualized scientific ways of thinking in the classroom. For instance, while students initially developed questions that they had about pigeons in a neighbourhood "pigeon study," their questions were not pursued as it did not align with the curricular focus on pigeon colour morphs. Furthermore, procedural tensions (*how*

students are learning) were sometimes noted when students' various senses of place were not acknowledged in the science class. In an urban "playground study" where students were asked to evaluate and build a model playground, some students exhibited disinterest in the activity as some thought that it was inappropriate for their age. In this way, Lim and Calabrese Barton (2006) explained the importance of understanding students' lifeworlds as it relates to place:

> Students' sense of place is not simply about where [students] live. *More critically is about how they appropriate their lifeworlds and what kind of ecological relationship they have with their lifeworlds.* Although the class was studying about the neighbourhood where most students live, this did not mean their neighbourhood would necessarily motivate or engage the students in science learning. (p. 135)

Students' sense of place may, in this way, come from "diverse sources and dimensions of their lifeworlds" (p. 119), such as geographical, biological, historical, sociocultural and political backgrounds. While the authors studied how students bring individual sense of places into their science learning, how students construct such different place identities through lived experiences of places was not explored.

Lived experiences of places and associated sensualities of an individual's engrossment in the world are in fact often depicted in literature. In a phenomenological analysis of American novelist and agrarian farmer Louis Bromfield, Seamon (2008) analyzed Bromfield's meaning of a "teched" experience, or the experience of a "*feel* of all with which nature concerns herself… He is the man who learns *by farming*, to whom the very blades of grass and stalks of corn tell stories" (Bromfield, as cited in Seamon, 2008, p. 159). "Teched," a colloquial variation of "tetched," meaning "touched" is, in this sense, interpreted as a sensuous intimacy with the natural world. In "The Pond", a short story in a volume of stories called *The World We Live In*, Bromfield (1944) wrote about Tom Peterson, a young air fighter pilot and soon-to-be-father set in the landscape of World War II. Growing up in the flat Dakota prairie, Tom is ecstatic to see the ocean for the first time while training in the South Pacific; however, time and time again, Tom is reminded of a small pond on his family farmland. Tom experiences a teched moment as he stands in the Pacific island waters at twilight:

> He felt a sudden desire to weep, not out of any personal sorrow, but out of a sadness that was vast and incomprehensible – the sadness of the whole human race…. He would never be able to tell anyone really how he felt about the pond, how much he loved, how

> much it was a part of himself, how much it had to do with his life, as if he had been born out of its very depths. (pp. 6-7)

Later in the story, Tom finds out that his father drains the pond in his absence in order to use the land for planting more crops. One day, as Tom prepares to fly out with his squadron to face the Japanese kamikaze planes near the Pacific Islands, Tom learns through a radiogram message that his wife, Sally, had given birth to their baby boy. In a battle with the enemy plane, Tom's fighter-plane engine is hit and his plane sinks to the ocean; a few seconds before death, Tom sees the pond in his farmland again, "that strange feeling he had known for a moment on the beach, of being only a part of the universe, no more than a grain of the powdered coral beneath his feet" (p. 22), imagining what it means to be "only an infinitesimal part of something vast and splendorous which had to be carried on" (p. 7). Thinking about the pond and his boy as the plane crashes into the ocean, Tom cries out "The boy must have a pond!" (p. 22).

For Tom, it is not a pond but *the* Pond, it is not a place but *the* place, it is the particular "thisness" of the pond that he is mindful of. Not only does Tom remember the Pond and think about the Pond with fondness, but allows the Pond to live *through* him, in a manner that is reminiscent of the way Abram (1996) suggested about touching and being touched in a sensuous reciprocal manner:

> To touch the coarse skin of a tree is thus, at the same time, to experience one's own tactility, to feel oneself touched by the tree. And to see the world is also, at the same time, to experience oneself as visible, to feel oneself seen. (p. 68)

Unlike Husserl's original transcendental phenomenology that idealizes the essence of the human experience, Merleau-Ponty's embodiment phenomenology emphasizes the presence of the living, breathing and sensing body (as cited in Abram, 1996). That is, by cultivating a sense to be open to the primitive, sensuous world as it appears to us through our bodily sensations of sight, smell, sound, touch and feel, Merleau-Ponty explores the primacy of perception to allow the sensuous world to reveal itself to the individual. Thus in "The Pond," Tom is "teched" but the Pond too is "teched," letting the pond shape the individual and the individual shape the pond at the same time. It is perhaps this intentionality that urges Bromfield to bring back the Pond to Sally and his boy at the end of the story (Seamon, 2008). Five days after Tom's death, Sally and Tom's mother receive a message that Tom had been killed; looking at the date of Tom's death, Tom's mother

quietly says, “Sally, it happened on September 16… that was the night of the full moon – the same night the pond came back” (Bromfield, 1944, p. 27).

Drawing on Merleau-Ponty’s (1962) embodiment phenomenology, I suggest the need to animate the phenomenological spirit of place in science education; an invitation to not only theorize the meaning of place, but to actively participate in the corporeal attunement of the lived experience of a place in the here-and-now, so that one might begin to appreciate the world as is. C.S. Lewis (1968) wrote about the individuality of a place:

> In space and time… there are no “trees,” except beeches, elms, oaks and the rest. There is even no such thing as “an elm.” There is only *this* elm, in *such* a year of its age, at *such* an hour of the day, *thus* lighted, *thus* moved, *thus* acted on by all the past and all the present, and affording such and such experiences to me and my dog and to the insect on its trunk. (as cited in Relph, 1981, pp. 170-171)

In embodiment phenomenology, emphasis is thus placed on the intimate dialogical meaning-making of the individual and *the* particular place, allowing the self to be open to the experience of the place while allowing the place to be shaped through the individual. In a sense, there is an element of humility by acknowledging the “thisness “of the Other *as is*.

I suggest that such an emphasis on the Other in place research allows us to revive the phenomenological spirit of experience in place and of what it means to be in relation to the world. For the purposes of my study, I focused on biology as a discipline to explore the ecological connections that teachers might have in their places of meaning; similar to the study of “ecology” (derived from Greek *oikos*, meaning home or household), this study places an emphasis on how individuals may be nested within particular experiences in particular complex, interdependent ecosystems. In the next section, I suggest an ontological reorientation in biology teacher education to explore how we, as biology teachers, are nested in particular experiences of places that drive our pedagogies.

Science Teacher Identity

> To be human is to dwell on the edge. This abrupt description of the human condition reminds us of our paradoxical position in nature, a condition that contemporary culture with its emphasis on the functionality of knowledge encourages us to forget. The edge is our being with its Janus-faced project: turned outward towards the world, turned inward toward our own being. (Grange, 1974, p. 365)

Trends in teacher identity research.

Identity research in teacher education has gained increasing significance in educational theory and practice over the past few decades (Beauchamp & Thomas, 2007; Avraamidou, 2014). In contrast with methodological questions of "what should teachers know," teacher identity research places a focus on the human interiority, i.e., how one's "doings" flow from who we are as individuals (Aoki, 2005). Recent work on teacher identity has explored teacher identity as contextual, relational and emotional, shifting and narrative-oriented in various professional contexts, revealing the dynamic, fluid and multidimensional nature of identity constructs (Rodgers & Scott, 2008). As Grange (1974) suggested, on one side of the "edge" is our being faced outwards towards the world, and on the other side of the "edge" is turned inwards towards ourselves; to *be* in the world thus probes what it means to dwell at this paradoxical boundary of inner and outer worlds.

Identity work in education has commonly referred to James Gee's (2001) definition of identity as a "kind of person" in a contextual place and time. Gee (2001) suggested four ways of viewing identity: (a) nature-identity (one's natural state such as being an identical twin), (b) institutional-identity (one's position recognized by authority such as being a university professor), (c) discourse-identity (one's individual trait ascribed through dialogue of other people), and (d) affinity-identity (one's allegiance to a particular group). Gee explained how an individual's identity based on the four criteria are contextually dependent and can change across time and space, or even that one can be different "kinds of person" in the same context. However, critics have argued that Gee operationalizes a working definition of identity into distinctive categories and in doing so, marginalizes the fluid and subjective nature of identity states (Sfard & Prusak, 2005). While Gee's influential work has significant implications to tease out different aspects of identity in empirical research, the either/or boxed categorization of the "kind of person" is perhaps limiting.

The role of relations and emotions in shaping teacher identity has also been explored in the literature on teacher education. Through a post-structuralist lens, Zembylas (2005) explored how a public school teacher exercised "emotional control" (p. 939) in the school, based on the assumption that school professionals remain neutral; thus emotion was conceptualized as neither private nor universal, but constructed and reconstructed through power relations in society in accordance with "emotional rules" (p. 936). Similarly, in a study of 14 pre-service teachers over

two years, Flores and Day (2006) explored how teachers' personal and professional identities were constructed as they experienced conflicting emotional interactions through initial teacher education and actual classroom practice. While understandings of the "emotional rules" (Zembylas, 2005, p. 936) that govern teacher behaviour and identity formation are crucial, identity thus viewed primarily through a poststructural lens in conflicting professional landscapes may emphasize bounded notions of identity states, thereby removing the self as an active agent in the construction of one's identity.

More recent research has placed an emphasis on teacher identity as a dynamic construct (Beauchamp & Thomas, 2007). In this view, identity is neither fixed nor static; instead it is an open, shifting and ambiguous entity, formed and reformed through various personal and professional experiences (Sachs, 2005). Wenger (1998) suggested that identity is a "negotiated experience" (p. 149) whereby individuals participate in a conscious meaning-making of the experience, and in turn, reify the self through such participation. He explained that identity can be conceptualized as a "reconciliation" of various memberships in the community:

> By including process of reconciliation in the very definition of identity, I am suggesting that the maintenance of an identity across boundaries requires work and, moreover, that the work of integrating our various forms of participation is not just a secondary process. This work is not simply an additional concern for an independently defined identity viewed as a unitary object; rather it is at the core of what it means to be a person. Multi-membership and the work of reconciliation are intrinsic to the very concept of identity. (Wenger, 1998, p. 160-161)

In contrast to sociocultural constructions of identity that define bounded notions of identity, a re-conceptualization of identity as dynamic invites teachers to develop a sense of awareness and agency so that they themselves can (re)claim a voice in the meaning-making of their own identities (Rodgers & Scott, 2008).

Narrative identity work, moreover, explores the dialectic interactions of stories and identity, whereby storytelling shapes the individual and the individual shapes the storytelling. In Clandinin and Connelly's (1996) three-dimensional space narrative structure, identity is defined by interaction, continuity and situation where one (a) interacts with the personal self as well as the social environment, (b) situates oneself in relation to various dimensions of time such as the past, present and future, and (c) contextualizes oneself in relation to places (Downey and

Clandinin, 2010). Such a "landscape metaphor" (Clandinin & Huber, 2005, p. 44) of identity opens up the contexts and discourses in which identity is formed through various interactions with people, places and time. Viewed in this light, Sfard and Prusak (2005) suggested that identity is simply not about finding expressions in stories, but that identities themselves are collections of stories. These include first person identities (stories that an individual tells herself about herself), second person identities (stories that a second person shares with the individual about the individual), and third person identities (stories that a second person shares with a third person about the individual). Given the dynamic nature of identity itself, they suggested that to provide a static definition of identity would be oxymoronic; thus, *identity as narrative* views identity as a process of becoming rather than a finished product.

Although a body of research exists on science teacher learning, attitudes, beliefs, practices and professional development, research on identity development specific to science teachers is relatively few (Avraamidou, 2014). Given the possibility of the teaching discipline to influence teacher identity (Helms, 1998), there has however been a growing interest in the past ten years in exploring what it means to be a science teacher. Freese (2006), for instance, investigated the challenges faced by a pre-service science teacher in reconciling his image of a "logical, unbiased scientist" (p. 105) and his teaching of science. Similarly, Barrett (2007) shared her interview conversations with a beginning environmental educator whose barrier to teaching was also based on his ideas about "what it meant to be a proper teacher" versed in the language of "knowledge and knowing" (p. 213):

> One factor in this 'language of love' not really being present in dialogue between myself and students or friends, is the emotional vulnerability it leaves you exposed to…I have realized on a conscious level for some time that there are some conversations that I avoid because I would be 'putting myself out there' in a way that I'm not necessarily comfortable with. (p. 214)

Through a poststructuralist framework, Barrett analyzed how the dominant discourse of "cognitive imperialism" (Battisse and Henderson, as cited in Barrett, 2007, p. 213) perhaps makes some teachers reluctant to speak about their feelings and emotions in science. In a forum on a conversation of a "sense of place" in science teaching (Kincheloe, McKinley, Lim & Calabrese Barton, 2006), Lim and Calabrese Barton likewise reflected on the role of the language of science in shaping teachers' understanding of "sense of place":

> How we name others (and their senses of place) is grounded in who we are and what we know. It is a particularly interesting question for us because in science (or at least as science teachers) we are expected to engage in a form of communication that marginalizes our presence and participation. We wonder, if efforts to connect sense of place to science learning are truncated by the language of science that dismisses the subjectivities that constitute a sense of place. This is a difficult paradox for us as science is part of who we are – we've both been scientists before going into science education. (pp. 151-152)

The above research is therefore suggestive of how logical, objective and absolute ideologies of traditional positivistic science can influence science teachers' identities in the classroom.

Furthermore, Thomashow (1995) highlighted the importance of nurturing environmental educators' ecological identities or "the different ways people construe themselves in relationship to the Earth as manifested in personality, values, actions and sense of self" (p. 3). In his seminal book, *Ecological Identity: Becoming a Reflective Environmentalist*, Thomashow noted the tensions, contradictions, and uncertainties amongst environmental educators that experience feelings of wonder, awe and compassion for the beauty of the world in contrast *with* the grief, anxiety and despair for the many environmental problems that plague the world. As later explored by Albrecht et al. (2007), this grief has been described as "solastalgia" (p. 95), a psychological distress associated with the lack of solace due to environmental changes in one's "home" environments. Through a reflective journey of childhood memories of intimate places, disturbed places, and wild places, Thomashow (1995) encouraged educators to inquire deeply into their core environmental values to participate in a healing process of (re)constructing a holistic ecological identity. While teacher identity has often been investigated in teacher education programs, how everyday contexts such as one's intimate places of meaning can influence one's professional identity has not been fully explored (Avraamidou, 2014). I propose that such reflective practices are fruitful to understand how teachers construct their personal and professional lifeworlds and to develop teachers' consciousness for why at least some of them teach students biology.

Value of reflective inquiry.

Given the busyness of day to day teaching, teachers might place a greater focus on the "nuts and bolts" of teaching such as lesson planning, preparing laboratory activities and

assessment/evaluation, particularly amongst beginning teachers (Abd-El-Khalick & Lederman, 2000; King, 1991; Pedretti et al., 2006). In the clock-work, procedural and routine-oriented nature of traditional school systems, teachers could become habituated to particular experiences and ways of teaching (Rodgers, 2002a), losing a sense of "wide-awakeness" of a "stranger" (Greene, 1973, p. 6) who questions why we do what we do. As Maxine Greene (1973) wrote in *Teacher as Stranger*:

> To take a stranger's vantage point on everyday reality is to look inquiringly and wonderingly on the world in which one lives. It is like returning home from a long stay in some other place. The homecomer notices detail and patterns in his environment he never saw before. He finds that he has to think about local rituals and customs to make sense of them once more. (pp. 267-268)

That is, Greene (1973) questioned the possibility of reinvigorating Arendt's assertion to do "nothing more than to think what we are doing" (p. 6). Instead of accepting "truths" that have become complacent in society, Arendt proposed the need to question for oneself about why things are the way they are. Therefore by "learn[ing] to do philosophy" (Greene, 1973, p. 7), teachers can exercise a mindfulness for the commitments and actions that drive their teaching.

The value of such reflective practices is three-fold: i) developing a presence in experience, ii) learning to describe an experience and iii) participating in the meaning-making of experience. According to Rodger's (2002a) reflective cycle, the first key phase of reflection is developing a sense of presence, or "a state of alert awareness, receptivity, and connectedness to the mental, emotional and physical interactions of the individual and the group with the world and each other" (Rodgers & Raider-Roth, 2006, p. 266). In this regard, being present in an experience means that one is mindful, paying attention to the particular experience in a particular time and place. In *Art as an Experience*, Dewey (1934) provided a distinction between regular experience and having *an* experience, the latter suggestive of conscious participation in the experience. For example, whereas a crowd of visitors can experience an art gallery with a guide hurriedly pointing to the featured pieces, *an* experience is the wholesome enjoyment of the subject's interactions with the object in the moment, infusing the past-present-future in a sense of continuity. Reflection thus conceived as having *an* experience is contrasted with a "stream of consciousness" defined as "uncontrolled coursing of ideas through our heads" (Dewey, as cited in Rodgers, 2000b, p. 849), characteristic of the type of thinking that teachers often practice in their day-to-day busyness of

the school. By engaging biology teachers in a reflective inquiry of particular places of meaning, teachers can thus potentially acquire a mindfulness of being in the here-and-now, developing a conscious attitude to "see more" in an otherwise familiar place. Such an attitude may help to rekindle and reaffirm why we may love and care for this earth, and the reasons for which why at least some of us teach biology.

Such a perceptual awareness and receptivity may be cultivated by learning to describe an experience in a retrospective manner. In a short essay on "Meditation: On Description," Carini (2001) wrote:

> Describing I pause, and pausing, attend. Describing requires that I stand back and consider. Describing requires that I not rush to judgment or conclude before I have looked. Describing makes room for something to be fully present. Describing is slow, particular work, I have to set aside familiar categories for classifying or generalizing. I have to stay with the subject of my attention. I have to give it time to speak, to show itself. (p. 163)

In this manner, Carini emphasized the many layers of perception that could be revealed through slowing down and making time to engage in descriptive inquiry. In an autobiographical reflective piece called *Notes from a marine biologist's daughter: On the art and science of attention*, poet McCrary Sullivan (2000) similarly probed educators to rekindle an aesthetic sensibility by learning to pay attention to the descriptive details of one's surroundings, revealing the "perception of relations (tensions and harmonies); the perception of nuance (colours of meaning); and the perception of change (shifts and subtle motions)" (pp. 221-222). While some reflective practices in teacher education follow a prescriptive "scientific method" cycle such as identifying the problem, providing possible explanations for the problem and test various explanations to solve the problem, descriptive inquiry encourages teachers to pause and take the time to understand the multiple ways of perceiving (Rodgers, 2002). A phenomenological descriptive inquiry of biology teachers' experience-in-place can therefore cultivate teachers' habits of descriptive inquiry, encouraging moments of pause, stillness and mindfulness to reconnect with one's relationships to everyday places of meaning.

A reflective inquiry can also engage individuals in the meaning-making of an experience. *An* experience, according to Dewey (1934), is an intimate interaction with the experience, where the experience shapes the individual and the individual shapes the experience, fusing thought,

emotion and action. There is thus a sensuous, intimate contact with the subject and the object in the meaning-making of the experience through reflection, leading to the "reconstruction or reorganization of experience which adds to the meaning of experience, and which increases [one's] ability to direct the course of subsequent experience" (Dewey, as cited in Rodgers, 2002b, p.845). Drawing on Hawkin's tripartite I-Thou-It model between I (the teacher in relation to his/her teaching), Thou (the student in relation to his/her learning) and It (the subject content) in the context of the classroom, school, community or beyond in local/global environments, reflective inquiry engages participants to consciously situate themselves in the meaning-making of themselves in relation to various contextualized arenas of being (as cited in Rodgers, 2002a). While some forms of reflective practice focus on taking action to solve a problem, descriptive narrative inquiry such as the present study focuses on using personal stories as a starting point for reflecting on how such stories may relate to a broader contextualized landscape of being (Downey & Clandinin, 2010). In this sense, narrative inquiry "focus[es] *out* from any one situation to see peripherally the many situations that compose a life" (Downey & Clandinin, 2010, p. 390). Through an emphasis on the stories lived by, biology teachers can consolidate an understanding of their personal and professional identities in a contextualized landscape.

All in all, enduring questions on place, phenomenology and science teacher identity suggest opportunities for exploration of biology teachers' lived experiences in places and how such places may influence professional teaching practices. The notion of "place" in place-based education has often been conceived in an either/or manner with an illusionary divide between nature-culture, local-global, inhabitant-resident, commons-market, and so on. Such idealized and isolated notions of place ignore the complexity of a place as constructed by individuals' experience in place (Nespor, 2008). Recent empirical research on "place as meaning" and "place as attachment" does not encapsulate the dynamic nature of the relationship between the self and place (Kudryavtsev et al., 2012). Thus, a reconceptualization of science education through Merleau-Ponty's (1962) phenomenology of embodiment may cultivate a sensual awareness of the world we live in and rekindle a sense of rootedness amongst teachers. While teacher identity has been explored as a complex process of becoming, in what contexts this is formed or how it can affect professional practice has been under investigated, particularly in science teacher education (Avraamidou, 2014). Thus, an ontological reformulation of biology teachers' lived experiences in place is suggested. The reflective exercise of recalling places of meaning may

engage teachers in learning to see, describe and meaning-make their experiences in place so that they begin to look deep into themselves about what it means to care *for* a place.

Chapter 3: Methodology

To address the research question, *How do place-aware biology teachers' lived experiences in place influence their teaching pedagogy, if at all?* and the sub-questions, (1) what do biology teachers mean by a "place"? (2) how do biology teachers perceive and describe an experience in place? and (3) does the experience in place affect biology teachers' pedagogy?, a phenomenological study was conducted from December 2016 to February 2017 with five biology teachers in Victoria, British Columbia. The present section will outline the framework of the study by detailing the choice of the methodological orientation, research context and rationale, ethics considerations, data collection, data analysis and context of analysis.

Hermeneutic and Embodiment Phenomenology

Phenomenology is defined as the study of lived experiences. In contrast to other methodological orientations, the study of phenomenology does not aim to determine empirical facts nor provide objective causal explanations about who, what, when, where and how many, bounded within particular institutional, social, historical, or cultural contexts. As such, quantitative procedures such as survey methods and statistical methods run counter to the goals of phenomenological research, which aims to understand the subjective lived experiences of individuals. According to van Manen (1990, 2014), phenomenology of practice provides a descriptive (phenomenological) understanding of individuals' lived experiences while at the same time captures (hermeneutic) interpretations of these lived experiences. While such a methodological stance might appear contradictory, the contradiction is resolved by recognizing that phenomenological reflection is fundamentally retrospective in nature, i.e., one cannot recall a lived experience at the same time as living through an experience, in the same manner that one cannot, for instance, reflect on a devastating experience while living in the moment of the devastating phenomenon. Participants in the current study were invited to phenomenologically and hermeneutically reflect on their lived experience of places, and participate in the meaning-making of such retrospectively-recalled experiences.

The fascination and limitation of phenomenology is that it cannot be used to problem-solve a particular situation. That is, while phenomenology sheds descriptive and interpretive light on a human experience, it is pursued with an understanding that the lived experience itself offers more in complexity than what could be captured through recollections of lived experiences. The paradox of such an approach, as suggested by Tuan (1977), is that while thinking about the lived

experience distances one from the experience itself, it is this thought that simultaneously provides insight into what that lived experience was like. Furthermore, there is a "double hermeneutic" in hermeneutic phenomenological research, as the participant first relives and reinterprets his/her lived experiences to the researcher, and the researcher in turn analyzes the participant's interpretation. Thus, the current study did not aim to offer explicit instrumental and prescriptive solutions to the moral problem of establishing a sense of place amongst biology teachers; rather, it proffered a description of what it means to experience a place through a retrospective lens, with a focus on the meaning-making process of the participant experiencing the phenomenon as well as the meaning-making process of the researcher in dialogue with the participant.

Drawing on Merleau-Ponty's (1962) phenomenology of embodiment, the present study emphasized the uniqueness of individual experiences of phenomena. Therefore, unlike traditional Husserlian phenomenologists who emphasize the search for a common human "essence" of the phenomenal experience in an objective manner, this study emphasized particular human beings as "body-subjects" involved in their phenomenal lifeworlds. This is not to suggest the solipsist position that the experiences of individuals do not coincide and that their experiences are bound within their own bodies; while the experience of body-subjects themselves are perspectival, Merleau-Ponty (1962) suggested that these subjectivities overlap and interweave in a communal landscape. In this manner, I surmise that there are multiple ways of being in the world, which are neither mutually exclusive nor incompatible with one another. Therefore, analyses of biology teachers' personal narratives of places of meaning was conducted on a case-by-case basis to preserve the perspectival nature of different body-subjects.

Research Context and Rationale

The participants for the research were five biology teachers from one public and one private school in Victoria, British Columbia. The public school district was selected as appropriate for the study because the district included a large body of biology teachers from which potential participants could be drawn; private schools were thereafter contacted to allow for diversity in participant demographics. Participants were self-selected through volunteer sampling based on three criteria: (1) willingness to share personal stories of experience in place, (2) ability to articulate thoughts in writing and speech and (3) time to write in a journal and to be interviewed. Unlike other methodological designs that may aim for non-biased representative

sampling of certain groups of individuals according to gender, ethnicity, years of experience, and so on, the criteria of selection for the current phenomenological study was broader in nature as the purpose of the research was to explore the human experience of particular individuals. Only a few individuals were thus required to conduct in-depth conversations and detailed case-by-case analysis.

Following human ethics approval from the University of Victoria and public/private schools, biology teachers were contacted via e-mail, with the letter of invitation and consent form attached in the communication (see Appendices A and B). In some cases, biology teachers were recommended through other biology teachers. Once a teacher expressed potential interest in participating in the study, a meeting was scheduled for 30 minutes to 1 hour at a location of participant's choice (e.g., the participant's school or a local café) to discuss the role of the participant and the researcher in the research. The initial meeting was a conversational meet-and-greet style, with opportunities for the participant to ask questions about the research and the researcher to clarify any questions or concerns. As the research asks participants to share personal stories of places of meaning, I attempted to establish personal rapport so that participants would feel comfortable during subsequent interviews. If the participant was interested in volunteering, s/he was asked to sign the consent form.

The participants recruited for the current study differed in gender, age, education and professional experience. Four of the five participants recruited were female and one participant was male. Participants' ages ranged from 32 to 69 years old, from beginning teachers with less than one year of full-time teaching experience to retired teachers with thirty years of teaching experience. Some teachers had dedicated their entire career to teaching, whereas others had explored other career options prior to becoming a teacher. While some were born and raised in British Columbia, others had extensive years of living experience in other countries such as Australia, New Zealand, or the United States. However, all participants recruited were Anglo-Saxon. All teachers furthermore had a Bachelor's degree in a science-related field (except for one participant who had a Bachelor's of Art degree in English with many credits in science). Two teachers additionally had a Master's degree in education. Despite differences in demographics, all participants met the aforementioned study criteria and expressed interest in sharing their narratives of places.

Ethics

The project presented minimal risks to the participants involved. All participants were classified as competent adults according to the Tri-Council Policy Statement of the Panel on Research Ethics in Canada (Government of Canada, 2015) and were capable of providing free and informed consent. Participants' continuing consent was confirmed at every interview, and their anonymity and confidentiality were ensured in the dissemination of data. All data collected was kept in a password-protected folder on a personal computer, and is expected to be disposed seven years after the date of consent.

Despite benefits associated with reflective professional development, the study invited participants to recall memories of places, which, depending on the nature of the memory shared, could have stirred personal emotions. The purpose of the research was not to resurface undesired memories; rather, the participant was reminded that s/he had control over what experiences s/he wanted to share. Participation in the study was completely voluntary and participants had a right to withdraw from participation at any point in time without explanation. The ethical implications of the current study are detailed in the participant consent form (see Appendix B).

Data Collection

The data collected for the current study were: (1) journal entries, (2) unstructured interviews, and (3) artefacts representative of lived experiences of places. The window of data collection was from December 2016 to February 2017. Table 1 provides a summary of the approximate dates and types of data that was collected, each of which are explicated below.

Table 1

Timeline and overview of data collection from December 2016 to February 2017

Time of collection	Type of data
December	Unstructured screening interview
On-going	Journal entries (3 to 5 entries per participant), one journal entry written prior to each interview
On-going	Unstructured interviews (3 to 5 interviews per participant)

On-going	Artefacts representative of lived experiences, brought to the interview as appropriate

Journal entries.

Throughout the course of data collection, participants were asked to write lived experience descriptions of places of meaning in a journal. Asking participants to write in a diary style allowed for recall of lived experiences, allowing participants to reminisce the experience of place as if they were experiencing it again for the first time. By writing a journal entry prior to each interview, participants were prompted to think about places of meaning so that they could better articulate such experiences during the interview. These entries were then shared with me prior to the interview, so that the experience could be further explicated and elaborated in the interview process (King & Horrocks, 2010). Although not all participants had time to write prior to the interview, the prompt was shared with participants regardless so that they had time to at least think about the experience prior to the interview.

Drawing on van Manen's (1990, 2014) phenomenology of practice, participants were guided to think about a particular experience in place and describe in writing the experience they had as they lived through it, avoiding interpretations and generalizations as much as possible. Two journal prompts (see Appendix C) were provided: 1) questions asking participants to explain an experience in a place of meaning (journal entries 1, 2 and 3), 2) questions asking participants to explain a teaching experience of place, i.e., a time in which participants shared a particular experience of place with their students (journal entries 4 and 5). Participants were instructed to focus on one particular experience per prompt; each of the prompts were repeated so that participants had the opportunity to share different stories about different places. Depending on the interest and availability of the participant, the number of times in which the participant was asked to repeat the prompt was adjusted.

Interviews.

Three to five unstructured interviews were conducted per participant, one-on-one for approximately 60 to 90 minutes each, at a location of participant's choice (e.g., a local café, a school classroom, or the participant's home). The interviews were conversational to gain rapport with the participant. Interviews were audio-recorded and transcribed verbatim. Corresponding with the journal prompts, two sets of unstructured interview questions (see Appendix D) were

developed: 1) questions asking participants to explain an experience in a place of meaning (interviews 1, 2 and 3), and 2) questions asking participants to explain a teaching experience of place (interviews 4 and 5). While the nature of a phenomenological study is such that interviews flow where the conversation flows, some interview questions that were used to guide the conversation are identified in the Appendix D.

The interview questions were developed according to the free association narrative interview method outlined by Hollway and Jefferson (2000). Based on the Gestalt theory that the whole is greater than the sum of the parts, Hollway and Jefferson recommended a narrative interview method that allows participants to share their stories freely following their own sense-making processes. The following advice was thus followed during the interview with participants in my study: 1) use open-ended questions where possible, 2) elicit stories from participants, 3) do not ask "why" questions and 4) use the interviewee's ordering and phrasing of their stories to clarify their stories. By maintaining an open conversational environment as much as possible, participants in the study were therefore encouraged to elaborate on their stories of places of meaning based on their own meaning-making frames.

Artefacts representative of lived experiences.

During the interview, participants were invited to bring artefacts of lived experiences of places. These included photographs or objects representative of lived experiences of places, in order to serve as a catalyst to share stories of lived experiences. In addition, the artefacts provided an opportunity for participants to express their experiences through alternative, creative modes of expression, should they wish (Barrett, 2007). Photographs of artefacts were taken and/or shared with me upon permission.

Data Analysis

Journal entries and transcribed interviews were hermeneutically analyzed for thematic patterns. Drawing on Smith and Osborn's (2008) Interpretive Phenomenological Analysis (IPA), data analysis was conducted in four stages: 1) familiarization of the data, 2) identification of themes within a case, 3) clustering of emerging themes within a case and 4) integrating themes across cases. The transcript was first read and re-read several times to capture the entirety of the transcript as a whole, while avoiding temptations to impose interpretation at the initial stage of analysis as much as possible. This was done by identifying my own assumptions and biases through my own phenomenological writings of place, as well as detailed line-by-line or segment-

by-segment coding of participants' texts. Once the transcript became familiar, emerging conceptual themes that appeared to capture the meaning of the experience were identified. Emergent themes were then placed on a list and clustered into broader conceptual themes; the original transcript was re-consulted to review the empirical data using the new cluster of themes, and re-arranged where necessary. Finally, where appropriate, points of convergences and divergences in themes across individual cases were identified.

In order to ensure *credibility* in hermeneutic qualitative research (Guba & Lincoln, 1982), emerging themes were triangulated with a variety of sources (journal entries, interviews and artefacts of lived experiences). Emerging themes from transcribed manuscripts were returned to the participants for further insight and interpretation, and modified as appropriate. Second, *dependability* was ensured by providing a detailed description of the methods and reviewing the transcript several times with emerging themes to capture the holistic meaning of the experience. Third, c*onfirmability* was addressed by practicing reflexivity on subjectivities, assumptions and biases of the researcher, which could influence the results. Furthermore, decisions made throughout the research process as well as thoughts that emerged from conversation with the participants were noted in a reflective journal kept by the researcher. Audit trails of dependability and confirmability were thus left for findings to be appropriately interpreted at a later time if needed. As the research emphasized the uniqueness of particular human beings recounting their particular experience in a particular moment in time, the concept of *transferability* did not apply for this phenomenological study. Despite possible convergences amongst participants' narratives, it was therefore not assumed that similar experiences were shared amongst all biology teachers.

In a critique of external concepts of validation, van Manen (2014) suggested that concepts such as transferability are in fact irrelevant to a phenomenological study, as phenomenology emphasizes the individuality of participants. Rather, he suggested that the rigor of phenomenological studies is tested against its philosophical values characterized into six units: *heuristic questioning* (whether the research question is a valid phenomenological question derived from wonder), *descriptive richness* (whether the data gathered is rich in experiential detail), *interpretive depth* (whether the interpretation offered questions taken-for-granted concepts), *strong and addressive meaning* (whether the investigation addresses what it means to be a human*), experiential awakening* (whether the text illuminates the reader to insightful

interpretations through tactful language) and *inceptual epiphany* (whether the study provides original contributions to broader ethical implications about what it means to be a human). In order to ensure that the above criteria were met, the current study focused on providing in-depth experiential accounts of individuals' experience in place with detailed transcripts of conversations with participants and analysis of such transcripts, thereby leaving an audit trail of my hermeneutical interpretation of the data. The interpretive framework of hermeneutic phenomenology ensured a co-creation of meaning between the researcher and the participant. While the present research did not aim to provide deterministic answers to problems in a foundationalist manner, the resulting interpretations can therefore be claimed in confidence.

Context of Analysis

Five biology teachers of varying backgrounds and experiences were interviewed for the phenomenological study. Amy[1] (32 years old) was a beginning practitioner at a public secondary school with previous research experience in molecular biology. Rachel (46 years old) had an interest in food and nutrition, and taught science at an international private school for 16 years. Kelly (59 years old) taught science for 20 years in public secondary schools, prior to which she travelled extensively around the world and became involved in various global environmental movements. David (62 years old) taught science for 21 years in public secondary schools, after working in various parks management and wildlife research jobs. Ella (69 years old, retired) had a 30-year teaching career as an English and science teacher in public schools. All teachers interviewed had teaching experience of Biology 11 and/or 12 with the BC curriculum, in addition to other science-related disciplines such as general science, chemistry, physics, earth science, food science and mathematics ranging from grades 6 to 12, as well as adult education in English and French immersion schools. As a researcher, I also found myself implicated in the context of analysis; at the time of writing, I had three years full-time teaching experience at a private international school teaching IB biology, chemistry, and earth science with other work experience in plant ecology research. Below, I describe key decisions made during the analysis process in order to provide the context for interpretation of the emergent themes of experiences in places of meaning and teaching experiences of place.

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[1] Pseudonyms were used to protect most participants' identities, except for David who requested that his real name be used.

The places that were chosen as places of meaning by teachers were diverse. As the word "place" has a broad connotation, participants sometimes described their place in terms of a particular mountain or a particular beach; on other occasions, "place" was broadly interpreted to define a municipality, a city or an island, such as Vancouver Island. Participants were allowed to interpret "place" across varying spatial scales in order to capture the experience in the place, however large or small the place may have been for them. Furthermore, when participants were asked to recall a particular place, on certain occasions, more than one place was shared to provide examples of a likewise experience. Rachel, for instance, mentioned that there was no one particular place of meaning but a series of places that yielded similar experiences of belonging. David and Ella also recalled several places through tangential conversations of a chosen place, suggesting interconnections amongst various places of meaning. For example, Ella shared a sense of fondness for her time spent in a particular beach in her childhood, although she explained the value of translating that experience into other future experiences without dwelling on the past:

> I think of it every time I drive by…[2] I'm always aware as I drive by that that's the turnoff… But I'm not big on nostalgia as such, in the sense that it was a wonderful experience and it's morphed into its other variations. Now… people in the family have their own places to go, and I've kind of removed myself to Mexico for the winter for just two weeks… that's where I've transferred that experience to there. (Ella, personal communication, January 26, 2017)[3]

In analyzing the results, a decision had to be made as to whether or not to include conversations around tangential experiences or to focus on the particular place that the participant identified prior to the interview. As the purpose of my study was to understand the *experience* that an individual can have in a place of meaning, I decided to include all places mentioned by participants without being limited by spatial or temporal dimensions of place. Therefore, unstructured narrative conversations were invited and participants largely took the lead in sharing a variety of experiences that were meaningful to them.

In interpreting the results, it is additionally important to note the distinctive nature of the participants who volunteered in the project. Prospective participants were identified through

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[2] Fillers have been edited from participants' quotes to allow for readability.

[3] All quotes are personal communication. While APA format is used here to note the full in-text citation, a shorthand citation will be used thereafter to indicate the name of the participant only.

volunteer sampling and sometimes recommended through other biology teachers; although not intended, many participants had a passionate interest and awareness in environmental education and/or place-based education. As project participation required commitment to in-depth interviews and journal writings, participants who were interested in the concept of place may have naturally volunteered in the project. Furthermore, through conversation with these teachers, I found that most of them were driven through self-learning, keen to reflect on their teaching practices through professional development such as the current project. Here I reiterate Merleau-Ponty's (1962) phenomenology of embodiment that underpins the current research: the emphasis of analysis is on the individuality of particular participants in particular experiences in place and/or teaching of place, rather than a search for the absolute essence of experiences across a broader group of biology teachers. Therefore, while the emergent themes below are presented as commonalities across these teachers, one must remember that such commonalities are based on five particular and perhaps exceptional biology teachers committed to their teaching practices and are not meant as representative experiences of biology teachers in general.

Furthermore, while framing the analysis around similarities, I attempted to distinguish the differences found within the commonalities. For instance, while a particular theme may have been mentioned by all participants, the degree to which it was done so differed across participants. While one teacher might have lightly addressed the topic in one interview, another teacher may have addressed the topic in depth across multiple interviews; in such instances, I selectively drew on quotes from those individuals who strongly exemplified the theme, in order to align the significance of the particular experience with the particular individual. In the analysis, I moreover distinguished whether the theme was demonstrated by "few," "some," "many" or "all" participants; I use the term "some" or "many" to refer to themes discussed by three or more participants and "all" to stress the unanimity found across these teachers. On some occasions, a theme was identified as an essential experience in place and discussed in depth, although only mentioned by two participants as significant; the term "few" is used to described such an instance and examples are provided from particular individuals to illustrate the point. All other non-recurring minor themes suggested by less than three participants were not included in the present analysis.

While a relationship is suggested between personal experiences of place and teaching experiences of place, it is important to note that the relationship is one of association and not of

causation. Through journal/interview questions, participants were probed to think about relationships between their personal and professional lifeworlds, and participate in an active meaning-making process of what it means to be a biology teacher. Depending on the participant, the availability of hours for the project differed; interviews were thus held at length across more sessions for some participants than others, and some participants had time to write and reflect prior to the interviews whereas some did not. There was some variation in the openness of participants to share stories, depending perhaps on the rapport established between the participant and myself, in addition to the participant's willingness to delve into deep, contemplative conversations about one's past experiences and future practices related to place. This was reflected by the fact that some participants required more probing through specific questions whereas others were comfortable to muse aloud on their own at length, with an understanding that there was no right or wrong answer to open-ended questions. Some participants also required more redirecting to focus on detailed narratives of their experience rather than a broad reflective analysis of their place of meaning in order to stay as close as possible to the rawness of the experience as required for a phenomenological study. Thus, what follows are narratives that participants themselves were willing to share under defined circumstances; they are not exhaustive in themselves as there could have been other unexplored experiences unrelated to place that led these teachers to develop their professional identities. While themes derived from personal experiences of place and teaching experiences of place are presented in connection below, I stress that the experience in place is one of many, albeit significant, experiences that could have influenced teachers' identities.

Chapter 4: Results

Below, I present four themes that emerged from analyses of experiences in place and teaching experiences of place: (1) a sense of mystery in place that there is always something to be revealed, (2) an experience of the "whole" and the "particular" in complex, interweaving landscapes, (3) environmental ethics of care for the Other and (4) human ethics of understanding Others' ways of being. The sub-themes found within each major theme are italicized in the text below. While the themes are presented in four conceptual strands for purposes of organization and clarity, I stress the interwoven nature of these various themes that influence and are influenced by one another. Thus, I explore below the shared experiences of places and relation to teaching practices across five particular biology teachers, emphasizing how these teachers shared similar experiences in various places of meaning, although the extent to which such experiences transferred into teachers' teaching practices differed across these teachers.

Theme 1: Experience of Mystery

Personal experience of place: Mystery of natural and cultural worlds.

A recurring theme across these teachers in various places of meaning was the enigmatic and mysterious nature of place, leading to a sense of wonder, admiration and curiosity for further exploration. Drawing on nature-based places such as oceans, forests and mountains, all participants spoke of *nature as magical in its unpredictability*. For instance, participants shared the joy and thrill of unexpected wildlife encounters on their beach walk or hiking trail, such as encounters with various plants, fungi, birds and mammals. As Amy shared, "sometimes [the wildlife] chooses to come upon you," emphasizing the spontaneous and autonomous nature of wildlife, revealing a sense of unknown of the natural world in not knowing what one might come across next. In recalling the thrill of seeing wildlife on his birding adventures, David shared:

> Just talking to you makes me feel elevated. Two weeks ago, we were at East Sooke Park[4] looking out onto the ocean and we spotted humpback whales and orcas, dolphins…. And sea lions, all at our feet. How can you not be but thrilled by all of this? We were out there birding. We weren't especially looking for those.

While places were visited on multiple occasions by participants, teachers explained how cultivating a long-term relationship with a place revealed the many complex layers of the place.

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[4] East Sooke Regional Park is located on the south west coast of Vancouver Island, and is known for its beautiful hiking trails along the rocky coastline.

For example, in recalling a walk in one of her favourite parks, Kelly noted observations of changes in light, foliage and reflection of the water depending on the time of the day, month and year, each time revealing a sense of wonder for the changing landscape. Furthermore, Ella recalled the tidal pools that she visited in her childhood and revisited with her children:

> There's always something different on the beach… And even the tide pools, you can't predict what organisms you're gonna [*sic*] see in there. They still always look different, and then you know it's always exciting, right? If they're especially living creatures, you see all these different behaviours.

Across these teachers then, places of meaning were often characterized by a sense of mystery for the unknown that there is always something more to be revealed.

Occasionally, the unpredictability of nature was reported by participants as provoking a sense of fear, insecurity and danger. For instance, Rachel and Amy shared how unexpected encounters with a bear on their hiking trips triggered a temporary sense of fear and anxiety. David likewise stressed the powerful and sometimes violent forces of nature, in contrast to the comforts and insularity of the city:

> [Nature is] so much bigger than I am… Well, if I'm freezing and I'm out in nature, I'm not gonna [*sic*] get back inside for half an hour, an hour something like that… I just gotta [*sic*] live with it. I mean, even death could come very quick... You never know what could happen. We spend most of the time…in safe places. But there's times you just know that you're out of reach of everything… but that's never bothered me. I wouldn't mind dying in nature at any age.

However, like David, participants who expressed a fear of the unknown were not paralyzed by their experiences of danger in nature. While stressing the importance of being prepared and exercising caution in nature, participants shared a sense of awe and reverence for the natural world. David continued in his narrative, "I mean [nature] can strike you down but it can lift you up too… It does both, it makes you feel grand. But it's got control of you, doesn't it, from that point of view?" In this manner, the unpredictability of nature in its duality, where nature is both magical and dangerous, was embraced by participants as a part of the experience of being in nature.

In addition to the mysterious natural world, two teachers noted the *mystique of the cultural world*, particularly in reference to the First Nations history of British Columbia. For

example, Kelly shared finding evidence of human settlement such as middens, ancient dump sites consisting of mollusc shells and bones, on a walk along the beach. In recalling her meditative walks, she spoke about her "primal" and "spiritual" experiences of feeling the people on the land:

> It's that feeling of the people who were there before that's really powerful… I'm really just blown away by how strong that feels there… It really feels like the people are talking through the wind blowing through the trees there…. it's just that whole feeling of… an earlier time that people were there before, living their lives in a very different way that was more integrated with nature.

Likewise, David described his family's history of trade with the First Nations (Figure 6) and how he developed a fondness for early settlers through stories of folk heroes; the sense of mystique as told and retold through stories stirred intrigue for the cultural history of the land. David furthermore shared his encounters with First Nations youth while working for the BC Parks Branch and the BC Wildlife Service, and learning the First Nations' ways of being in the world. When such places of meaning were recalled, the mystique of culture was often intertwined with the mystique of nature, emphasizing how there is "nature in culture and culture in nature" (David). While only Kelly and David mentioned the mystique of the human landscape, such stories occupied a central piece of their narratives, thus indicating the significance of such human experiences in making places meaningful for them.

Fuelled by a sense of unknown for nature and/or culture, all participants shared a *sense of curiosity* to explore more. Participants recalled many hours spent outdoors in their childhood and/or adulthood exploring their familiar environments. Some participants spoke about the importance of waiting for wildlife to come out instead of seeking after wildlife, in a manner of letting the mystery of the natural landscape reveal itself. For instance, David recounted spending many days in the mountains conducting field work quietly watching the interactions of a mother caribou with her baby in the snow; Ella likewise explained her experience patiently waiting for the tubeworms to come out:

> We'd be right down there on our bellies… and looking, our noses practically in the water looking at them and waiting for the tubeworms to come back out as they got used to the shadow.

Figure 6. First Nations baskets passed down David's family. David used these baskets to share his stories of his encounters with the First Nations people.

Experiences in places of meaning sometimes led to an intellectual curiosity to understand why things are the way they are. Kelly shared how her archaeological findings along the beach fuelled questions about why the First Nations people settled in the particular area and how the people lived. Amy explained how finding a unique rock probed her to "see more than just a rock," fuelling a sense of curiosity about the "layers of time that went into the rock and how that rock face [got] shaped like that." Rachel furthermore shared her wonder for how salmon "know" to run upstream:

> And looking at how hard [salmon] worked and how amazing it was that they're able to get back to the same spot that they originally came from… How can that happen? … How could they know this information? …How can they be structured to be able to come back to a place where they spawn? And this is what scientists think, but they really don't know for sure.

Rachel hinted at the uncertainty of science and the many questions that experiences in place reveal. Therefore, the mystery of nature and culture fuelled a sense of wonder for the unknown amongst participants, fostering a sense of curiosity to experience more and know more.

Teaching experience of place: Exploratory learning in the real-world.

When these teachers were asked to share a teaching experience of place, all teachers shared common narratives of exploration in *students' familiar environments*. Participants identified the value of "taking a really good look at [students'] neighbourhood[s]" (Kelly) in order to foster students' sense of belonging in the world. Rachel explained how science extends beyond "tables and pencils and paper" and that science doesn't just happen in the classroom; Amy explained how students need to "familiarize themselves with clouds actually up in the sky and not just pictures of them on some slides that were projected… actually looking at them and sketching them and trying to identify them." While acknowledging the diversity of students' backgrounds and attitudes, many teachers lamented the disconnect that students in the modern techno-cultural world today experience from the natural world. For instance, David reflected:

> Do [students] know to look up at the sky and look at the moon and say that's a new moon or an old moon? Do they know their constellations outside? Do they know which way they're going in the sky? Have they ever seen a whale? Have they seen the most common birds? A lot of those answers are no, even though the birds might be in their backyard…
>
> These are things that as a biology teacher or a science teacher that you try to promote.

Ella furthermore emphasized the importance of students becoming observant of the world around them, as not all students will become biologists in the future:

> So my basic thoughts about teaching science are that… most of these students are not going to grow up and become biologists. So what is the point? What is the value for the average kid who takes biology…? And I think that's a key part for me… that they would become observant of the world around them, of their place.

To Ella, learning science was thus not a training to become a specialist, but to develop an appreciation of how science relates to one's day-to-day experiences.

In opening students' experiences to the 'real-world' beyond structural and pedagogical confines of the traditional classroom, all teachers' pedagogies tended towards *exploration and openness.* Participants shared stories of taking students outside to neighbourhood gardens, city parks, mountains or oceans, or bringing local specimens such as rocks, algae or mollusc shells into the classroom to foster students' sense of connection with the local environment. For instance, Rachel shared a "tree project" where students were assigned to find particular trees on the school campus and in the community, and then research their current and historical uses of

these trees. Ella built a marine aquarium in the class so that students might observe local organisms in their contextual environment (Figure 7). Some teachers moreover emphasized a student-centered approach, valuing student autonomy in the sense-making of their experiences. For instance, Kelly reflected on a field trip to the ocean, whereupon she allowed students to observe the ocean for themselves instead of through a teacher-directed approach:

> One of the things that I would always make [students] do is… go on the dock and lie on our bellies and look over the edge. And [ask], what is growing here? …Just kind of [be] like, this is everywhere…you're surrounded by ocean, these organisms are living here… And letting the students observe, not just being told what to do or what to look at or what to think. You know so opening that up. I think it is important.

Similarly, Amy emphasized the importance of letting students explore their own environment, instead of pointing to a particular organism and lecturing to the students about it outdoors.

Figure 7. A marine aquarium that Ella helped to build in her school to connect her students with the marine environment of local Victoria.

Reflecting on the nature of exploration, Amy shared:

> [Exploration]… adds so much magic and mystery to what you're doing… it's human nature to just want to explore and to want to go racing through the forest and to want to go climbing on tops of mountains and to want to…dive into the ocean and see what you

> can find. I think partly because it's freeing to be able to go and do what you want to do. It's kind of scary too, there is a fear element, but those two combine to form one… experience.

While a student could pick up a jellyfish and get stung by it, or could slip and fall on a seaweed, David suggested that "those things happen and they're experiences and that's actually maybe a good thing," thereby embracing such unpredictable experiences as a part of being in the natural world. Therefore, while the degree of openness and exploration differed amongst these teachers, their exploratory pedagogies encouraged students to connect with their immediate surroundings.

Finally, some teachers explored the *uncertainty and limitations of science* as a discipline. Ella, for instance, provided opportunities for students to discuss controversial socioscientific issues such as logging in Carmanah Walbran Provincial Park[5]. Through a critical exploration of stakeholders involved in the issue, Ella encouraged her students to think about how socioscientific issues often present conflicting moral and ethical values. Furthermore, while science often explains "how" particular processes occur, some teachers expressed a curiosity to understand "why" things are the way they are. Rachel shared how she and her students pondered the question of "why" in bacterial spore formation:

> …How does a [bacterium] know that the environmental conditions are going downhill and it needs to form a spore? And then how does it know to come out of it and start back again… How is that process possible? …I understand how the process happens and [the students] understand how the process happens, but then the question is, well how do [bacteria] even know when to do it? I don't know.

Similarly, Amy shared how taking students outside beyond the structural confines of the school often fuelled questions that she could not answer; she shared how it is important for teachers to openly admit to students when one does not know, thereby empowering students with a sense of ownership to embrace the unknown. In this way, the uncertainty and limitations of science led to an intellectual sense of openness in these teachers' pedagogies.

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[5] Carmanah Walbran Provincial Park is a Pacific temperate rainforest in southwestern Vancouver Island known for its large Sitka spruces. In 1988, protests were led by the Wilderness Committee to protect the forest from old-growth logging.

Theme 2: Seeing the Whole and the Particular

Personal experience of place: Experiencing the whole.

In reminiscing a personal place of meaning, some participants shared an understanding of the spatial and temporal vastness of the universe, which led them to feel a *sense of smallness* and humility of the self. Often times, the experience of smallness was felt through remote or solitary experiences in a forest, mountain or ocean; in comparison to the vast landscape, participants recalled feeling "like a speck of dust," (David) "insignificant" (Amy) or "a tiny little thing" (Rachel). Such feelings were furthermore amplified by a scientific understanding of the expansiveness of space-time. For instance, Amy shared a sense of awe for the vast continuity of geologic time, contemplating how life existed prior to humans and how life will continue without humans:

> It just… reminds you that humans weren't here… before this existed. The forest came first, we came second. And it's… a good reminder, especially as someone who is an immigrant to Canada, who is a settler to North America, that there've been many, many plant species, animal species and people that have existed here before me. …There's a certain sense of…. reverence.

Participants who mentioned feeling small were not melancholic; rather, they expressed a sense of release, freedom, relief and energy in being a part of a bigger whole. Rachel, for instance, shared how walks in nature help her to release her daily stresses by thinking about the "big picture":

> …If you feel small as a part of an environment, you know that, that environment is a very, very small part of something much larger… It's…putting that worry and that stressor into perspective at how small it must be. The big picture.

Amy likewise explained how being in nature refreshes her mindset to think openly and creatively about her teaching practices; she also shared how an understanding of the expansiveness of time instils a sense of hope that "there is more time ahead of us" to solve human-induced environmental issues. Thus, feelings of smallness encouraged participants to *let go of angst and worries* towards a hopeful perspective on how things could be better.

Personal experience of place: Experiencing the particular.

In contrast to an experience of the "whole," all teachers described an experience of the "particular" in their places of meaning, i.e., the importance of *being observant of the world* around them by taking the time to stop, look and enjoy the experience of a particular moment.

For example, Ella shared how she and her children took the time to observe the creatures in the tidal pools, noticing the retractions of tubeworms or the camouflage of sculpins on rocks. Kelly likewise explained how she would "stop and take the moment to look at the entirety of the view" on her walks along the beach to open her ears to the "music of the Earth." Emphasizing the different ways in which one can "see," David explained:

> Well I see more, probably, than another person. They might just see grass. I'll know the kinds of grasses, I'll look at the shape of the grass. When other people just walk by it, it's just grass.… I [can] look at the wood here [pointing at the ceiling] and tell you what the cut of the wood is, how it was cut… I know that's Douglas fir even just by looking at it, even though it has been stained…This is oak, or whatever, I know these things. I like that.

Attention to the particular was often experienced through *sensory attunement* to the living, breathing landscape. Rachel described "the sound of the feet on the moss, the smell of the forest and the smell of dirt" as she walked through a forest. Similarly, Ella shared "listening to the waves" and the smell of "the ocean itself. The salt…. The fire, burning the driftwood" as she recounted her ocean experiences. Kelly explained what sounds like an aesthetic attunement to the natural world:

> Just walking on the forest ground that sponginess, that softness, that earthiness really makes me feel like my whole body is alive. There's that kind of energy coming up through it and that I can just feel all these old joints moving and… resonating with the place… I've never been much of a runner but I run there… I just feel this need to run and to move through there.

Such sensual experiences instilled a variety of emotional responses amongst these participants, fostering a sense of fulfillment, nourishment, calm, peace, release and energy. Thus, in experiencing the particularities of various lifeforms, the informants shared a sense of "beauty of nature" (David), and explained how "being able to see nature and being personally filled up by nature give[s] you the ability to look for beauty" (Rachel).

All participants additionally shared a feeling of *being present* in the moment. Similar to an experience of the whole, the participants explained how focusing on the particular allowed them to *let go* of personal and/or professional worries. In reflecting on her meditative walks in nature, Rachel shared:

> It's almost like you're doing yoga, mental yoga, while you're walking because you're hearing this rhythmic wave or wind… and then you start being aware of the smell and the feel and maybe you're looking for things but you're not, you're just watching out from the distance… almost like a trance when you're there. You're aware but you're not focused on any particular thing… I always leave in a better mood. I always leave feeling like this place is super beautiful and that I'm part of them, not [that] they're a part of me.

Like meditation where one focuses on breathing, "meditation in nature" encouraged participants to "concentrate on what's around you rather than [one's] problems" (David). Kelly shared how immersive experiences in nature led her to believe in the value of "working for the Earth" rather than "self-realization," fostering a sense of humility for other beings and a feeling oneness with the natural world. David furthermore explained what it meant to "lose track of time" in nature:

> When you're in nature, you don't think the hour… When you're there, there is a disconnect and time lasts longer…. You feel each minute and that's good… In our society, time is almost the enemy, right? You're always pushing for getting as much as you can in a short amount of time as possible… I mean you can feel life, but it's… a different feeling, right?

These participants therefore expressed feeling present in a manner of letting go of the self, and sometimes losing oneself in the moment of the experience.

Teaching experience of place: Understanding the whole.

Many participants shared an understanding of the whole in their pedagogies. Informants emphasized the complexity and diversity of the natural world through an exploration of *species interconnections within their respective environments*. Rachel, for instance, explained the importance of understanding "trickle-down effects" between organisms and the land, such as the effect of bioaccumulation on particular organisms and the effect of nutrient cycling on various ecosystems. Similarly, David explained the interconnectedness between native plants and animals within their local habitat:

> It's the native nature that I'm interested in… I love plants from all over the place in the world and I find them interesting, but when… you visualize the native plants, you can envision habitat for native animals…You have the native birds here when you have native plants. And that's another thing that people don't really understand in the city is

> that when they plant all these exotics from elsewhere in the world, it's like a desert for the animals that are native to here.

Thus, while humans can sometimes bring in exotic organisms to flourish in their non-native habitats, David argued that one needs to better understand how organisms fit in their environment.

Such an understanding of the whole furthermore prompted these teachers to reflect on *human beings as biological beings* nested within our complex environments. Ella, for instance, shared:

> We are animal[s]… and our bodies, have all these same systems or … carry out the same functions in different systems… [We can] compar[e] how fish get oxygen through the gills, and how we get it through our lungs…connecting it to being alive and being a living organism and being an animal. I always wanted to emphasize that because it seems to me [that] a lot often in our culture we lose touch with that aspect of ourselves and…put ourselves in a separate category from other animals.

Similarly, on a field trip to the Science World, Amy probed students to critically think about why one might react more violently towards human body displays in the Body Works gallery as opposed to displays of non-human animals. In rethinking humans as one of the whole, these teachers therefore attempted to foster a sense of "humility and a certain connection with the natural world" (Ella) so that students might learn to "see outside themselves and be willing to take a stance for other species, not just humans" (Kelly).

In addition to the interconnections within biology, many of the teachers emphasized the *interconnections* within the sciences as well as other humanities-related disciplines. Amy reflected on how taking students outside opens opportunities for students to experience earth science, biology, chemistry and physics as a whole instead of pigeon-holed disciplines within the bounded curriculum. Additionally, Ella emphasized the biological, chemical and physical interconnections across ecosystems, which she called the "meeting of the forest and the ocean":

> The bears and the eagles bringing the salmon into the forest and… that whole nitrogen cycle… the interdependence, right? And the animals that live on the edge… animals that you don't necessarily think of as having a connection to the ocean and yet they do… When I look at it now… it's the kind of [concept] that maybe I would have found

> interesting when we were doing biomes … Usually… we divide… separate the marine from the forest.

Ella thus emphasized the complex interactions of species across various interdependent ecosystems, challenging the notion of ecological boundaries and stressing the continuity of seemingly disconnected landscapes.

As an English/science teacher, Ella shared a holistic perspective on the interrelations between English and science:

> To me, literature is an expression of human beings living in the world. And then biology is looking at the world and also how we live in it… In education, we compartmentalize things and life is not like that. [It] was good for kids to be able to see that… you're not just a scientist or just a poet.

Similarly, Amy shared her love of biology and other subjects such as human history, music and art as varying expressions of human beings' experiences in the world, emphasizing how "science is a system of beliefs and means of understanding our universe as we currently understand it." By appreciating science as one of the many ways of knowing, many teachers therefore move away from compartmentalization towards an appreciation of knowledge as a whole.

Teaching experience of place: Understanding the particular.

All teachers expressed to their students the importance of *paying attention to the particularities of the world*. Similar to their experiences in places of meaning, these teachers emphasized to students the value of taking the time to stop, look and engage in the particular moment, such as taking the time to notice the individuality of particular organisms in their local environments. Rachel, for example, encouraged her students to "look at things with a critical eye and not just say oh that's a tree… look at the cones or look at the flowers or look at the bark or how tall [it is]." Amy took students outside to make daily sketches of clouds in their "cloud journal" so that they could learn to notice subtle differences in their immediate environment. Similarly, Kelly planned live behaviour labs so that her students could learn to observe an organism in detail beyond simple memorization of its structure and the function:

> I think [live behaviour labs] are really powerful…. [instead of] just dissecting and knowing what the structures and functions [are]… [Rather], what do they do? …How do

> they actually move? Let's see that. And you know with the *Planaria*[6] lab… you put them on… the watch glass and you can look underneath and you can actually see them moving… Can you describe that movement?

David reflected on the power of observation that informed his teaching practices:

> I used to take my boys up Mt. Tolmie, when they were small, like 4 years old, 8 years old, and they knew the name of every plant on the mountain and exact location of every plant on the mountain. They wanted to know. Especially my older boy, he was really into it, so he wouldn't wanna [*sic*] go anywhere else. We would repetitively go up there for a number of years cause [*sic*] it was his favourite spot, right? …When you learn the names of organisms, then you can learn, you can start to know all the different species and varieties, variations. Power of observation can lead to a bigger admiration of what's in front of us.

David thus often instructed students to draw or take pictures of organism so that students could learn to notice the details and identify the species by name. In stressing the particularities through various observational methods, these teachers therefore encouraged students to notice the complexities and variations of nature.

Some teachers emphasized appreciation of the particular through *aesthetic and sensory attunement* to the natural world. Rachel planned a "biome project" where she instructed students to find pictures of landscapes representative of a particular biome and to describe the unique beauty found within; she moreover challenged students "to look for uniqueness and look for beauty in different ways" beyond objects that students might typically find beautiful, such as learning to see the beauty of fungi or other "weird creatures." On the other hand, Kelly shared an aesthetic experience by taking the students on a forest walk:

> One of the things that I would have [students] do in terms of senses is… we would stop and close our eyes and listen [silence]. And what was going on [silence]. And that is a very powerful tool and it would just… change our time dynamic… it would just bring them back… the smiles, the responses afterwards … What were they hearing? "Oh, I heard the highway" … "I heard this bird over here and then I heard this something, I'm

[6] *Planaria* is the genus of a common flatworm in the phylum Platyhelminthes. It is often used as a model invertebrate organism for research in biology.

> not sure if it was the brook" … just trying to connect things on a different level and bring our attentions to it in that way.

Kelly invited a sensual experience of the natural world, encouraging students to open their ears to the various sounds of the landscape. Furthermore, Kelly shared examples of imaginative play, inviting students to close their eyes and visualize physiological functions of the human body such as breathing through the trachea or feeling subtle muscle contractions in their body. Through such meditative visualization practices, Kelly encouraged students to "be grounded in thinking about where [they are] and not just thinking about the future or stuck in the past."

Theme 3: Environmental Ethics

Personal experience of place: Care for nature and humans.

Through conversations of places of meaning, all teachers expressed an affective sense of care and love for nature, valuing organisms' inherent being in and of themselves. Many participants noted feeling a *presence of nature as the Other* through encounters with wildlife. In walking through the forest, Kelly recalled immersing herself in the beauty of the surrounding trees, recalling how she "[spent] a lot of time right there with [the tree]. And just kind of be there with it," fostering a deep sense of connection and respect that "living organisms have a right to exist in and of themselves." Moreover, Amy recalled a surprise encounter with a bear with a sense of awe and wonder:

> …When you run into a bear [or] caribou or elk, they're so impressive… [you] are filled with [a] sense of awe… You can recognize, okay that is something completely different from me. That is not a pet. That is a wild animal. That is awesome.

Upon such an encounter, Amy emphasized the importance of respecting the animal's space; she stressed that "that's not my place to stand there and expect them to leave" but rather that it is her responsibility to back away and allow the animal to *"let live"* in their environment. In a similar manner, Rachel shared her intrinsic value of species:

> Jellyfish…don't have anything to do with me as a person and the sea anemones and the tide and all the intertidal creatures, all those kinds of things without the human around. … It makes me want to appreciate them and of course not touch them and leave them alone. And I think… I'm a cog, I'm not in charge.

In this way, participants demonstrated a sense of care of organisms encountered in their various places of meaning, letting them flourish and carry out their life processes in their environments without the teacher's direct human influence.

Moreover, all informants shared experiences of *human impact* on their places of meaning. As places were repeatedly visited, many teachers observed changes in the landscape, such as melting glaciers due to increasing global temperatures, deforestation due to logging or loss of habitat for wildlife as a result of urbanization. David, for instance, mentioned the problem of how humans "manicure" the landscape to introduce non-native species in native habitat:

> And that's the way the world sees things is that we manicure everything… for our tastes, but we don't know how fantastic the taste is of having, of appreciating the native organisms that live here. And I think by extension, we don't enjoy and love as much as we could… When you start to know the native plants and animals, that's when you really start to feel the land. You feel belonging.

In seeing such changes in the landscape, some teachers mentioned feeling a sense of anger, horror and sadness for the devastating impact that humans can have on the environment; such emotions prompted some teachers such as Amy to feel a need to educate the public and *take action* to protect the environment through a "solutions-based perspective," who wrote, "all of the wildlife of the wildlife, rock features, and water reminds me not only of the beauty of nature, but also of our responsibility to protect and restore the environment" (Figure 8). In particular, Kelly shared her experience of being a part of an activist movement to protest loggers from cutting down a forest. In reflecting on her experience of being at the heart of a significant environmental movement, Kelly shared:

> What made [the experience] special was the recognition that people can make a difference in terms of preserving other species… The meditation was trying to find out where to go and how to ground myself… I was looking for some answers… This made sense, more sense in terms of working for the Earth than necessarily just working for self-realization through meditation practices.

In this way, all teachers exercise awareness of the impact of humans on the planet, and in some cases, demonstrate active involvement to minimize the impact.

Figure 8. Amy's "sanctuary" in local Victoria. She shared how purple starfish population declined in this area due to wasting disease associated with rise in water temperature.

In thinking about the relationship between nature and humans, some participants shared their values of *sustainable living*. Drawing on examples from First Nations peoples' ways of being integrated with nature, David shared how "The Songhees and Esquimalt People are profoundly attached to the sea." Kelly explained how the indigenous people practiced sustainable agriculture:

> [The First Nations] didn't have Thrifty's[7]. So they were… getting everything from the area around them. They… need[ed] to maintain it so that they could go back year after year and ensure that they were getting the food and nutrients and shelter and utensils and clothing… The land provided everything they needed… They needed to make sure that they took care of the land and the ocean so that it would continue on for many generations… There is that feeling that that place was maintained for many, many generations.

[7] Thrifty's is a local grocery store in Victoria, British Columbia.

David and Kelly furthermore talked about First Nations' ways of being with others in a community, being mindful of "not tak[ing] more [than] what they needed" (David) and sharing resources with one another in a manner of gift-giving traditions such as potlatches.

Similarly, Rachel shared her experiences of growing up in a family of hunters where one ate what was hunted; she recalled how hunting licenses were only issued for animals with abundant populations and how one took care to make use of all parts of the animal that was hunted. She shared a story of how her father looked after the land and the organisms within:

> …I know my dad for sure would always be really careful… We have these new fawns that are out in the field, [and he says] I'm going to make sure that I take some extra feed down there, make sure they're not cold… I always found it funny that he was that concerned… yet at the end of the season would be out hunting them… [but] with a thought to how many are out there, how much can the land support, what are the options because we're going to starve to death if there's too many of them and not enough food.

In both narratives, the informants explained how the First Nations people and hunters shared an understanding of what it means to live on the land.

Teaching experience of place: Care for nature and humans.

Through personal experiences of places of meaning, all teachers shared a sense of care and respect for living organisms, encouraging students to become "guardians or caretakers" (Kelly) for other beings. Some teachers emphasized the *presence of nature as the Other* in the classroom by inviting animal activists to share how animals have feelings or by allowing time for students to honour animals prior to dissection. Rachel furthermore discussed the importance of humane treatment of animals, probing students to make dietary decisions based on care and respect for the animal should one choose to eat meat:

> Well where did you think that hamburger came from? Well, it came from the store. Well, where did the store get it?... Okay well that cow. Let's look at some pictures of… what high density farming situations could look like and here's the life of what that cow looks like. That's the kind of the cow that is probably in your hamburger. And then let's look… at hunting situations and where are those animals living. And… if you're worried about the ethical treatment of the animal, let's have a conversation here.

On field trips to nature such as the ocean or the forest, many teachers furthermore modeled care in gathering and release organisms into the environment; alternatively, when samples were

collected to bring back to the classroom, some teachers instructed appropriate ways of collection stressing the need to take no more than necessary. David shared his experience of taking students to the ocean and modeling a sense of care for living organisms:

> [Students] know that I'll take the bucket back out into the ocean… and not just toss the animals…. I'll pour them direct into the ocean [and] be careful… If they have like a five-foot-long ribbon worm, it's extremely delicate… [it] could easily die just by lifting it up, right?... And I get [students] to turn the boulders back over… [and] explain to them that it's a home of another organism. And that you're not supposed to take seashells from parks because there'll be other people that want to experience them, or [it] might be the home of a hermit crab, right?

By leaving organisms in their habitat, David shared the importance of *letting others be* in their environment, fostering a sense of humility to value other species' ways of being. In various ways then, these teachers invited students to develop a sense of care for organisms, valuing the intrinsic existence of species as they are.

All teachers furthermore emphasized an understanding of *human impact* on the environment in their teaching practices. Teachers explored various ecological and environmental issues such as oil spills, invasive species, deforestation, ocean acidification and melting glaciers. Ella, for instance, invited speakers from the Streamkeeper's[8] initiative to share their work on aquatic restoration of a polluted waterway to allow salmon to return to its creek. Moreover, the same few teachers who shared a sense of activism in their places of meaning emphasized the need for students to *take action* in their local community. Drawing on current environmental concerns such as the projected increase in tanker traffic resulting from the Kinder Morgan pipeline project into British Columbia, David encouraged his students to take action by writing a letter of opinion to the government emphasizing the importance of "follow[ing] through with practical things." Similarly, Kelly planned opportunities for students to participate in invasive species removal in a local mountain:

> If we just took [students to a mountain] and if they just looked at [the invasive species], it doesn't do much. But if you're actually… clearing the whole area and then you come back and it's full of flowers, that's huge… You're feeling that what you've done is

[8] The Pacific Streamkeepers Federation is a non-profit organization that promotes protection and restoration of aquatic habitats in local environments.

> worthwhile, there's… [a] tangible result… [a] measurable process that's… really powerful. I think [that] as people we need to feel like [what] we're doing actually has an outcome and… an impact.

By working towards a purpose together, as she herself did in her place of meaning, Kelly encouraged her students to be a part of the solution to make changes for the better.

Lastly, the same few participants who shared narratives of *sustainable living* demonstrated interest in sharing such ways of being with their students. Kelly, for instance, invited a First Nations speaker to guide students on an interactive workshop about First Nations' ways of being, such as catching clams using a wooden stick or using nettle as traditional medicine. Furthermore, she shared her interests of ethnobotany:

> I always take students out into natural areas and talk about the uses of plants… [You can] talk about... the use of materials, how you get a fire going, how you light, how you would … put together your ferns and your leaves and layer them so you're separating your food… You don't have baking pans, you don't have aluminum foil.

Rachel drew on her hunting experiences to engage students in a conversation about how to control overpopulation of deer and rabbits in students' local neighbourhoods. By engaging students in a relevant, local and controversial topic, she probed students to think critically about the sustainability of the land and how controlled hunting might in fact be a viable method to suppress overpopulation during particular periods of predator-prey cycles. In these ways, these teachers actively incorporated values of sustainability in their pedagogies and invited students to think about how humans can live on the planet.

Theme 4: Human Ethics

Personal experience of place: Sharing a way of being.

While experiences in the natural world were featured prominently in participants' places of meaning, all participants described a love of nature as *shared through their family or community's cultural practices*. Ella, for example, described her multiple visits to a beach where she spent many summers camping with her parents and later with her children, sharing a multi-generational love for the outdoors. David likewise reflected on how he saw his place of meaning "through his mother's eyes" as it was through his mother's fondness for her extended family and community that they revisited her small hometown for many years (Figure 9). David reflected on his experience of spending time with his family:

> [The family] went for long walks, prided themselves for knowing not only the identity, but the ways of animals. They took the time to smell draw and press flowers and were ecstatic every time a Red-tailed Hawk was sighted circling in the sky or a Mountain Bluebird discovered entering a nest box on some fence post. They sat out on the front porch in the evening and listened to the frogs in the slough on the other side of the infrequently travelled gravel road that passed in front of their unpainted, weather-beaten wooden home and old barn.

Throughout the interviews, David shared "stories within stories"; stories shared by his mother, aunts, grandmothers and others, leading him to develop a strong interest in family history and their ways of being.

Figure 9. A painting of David's family house in Malakwa[9], British Columbia.

Like being a part of a "family", Kelly described her fondness for the community that she became a part of in an environmental protest against logging. As an on-site cook at the protest

[9] Malakwa is a small community in the interior of British Columbia, located between Sicamous and Revelstoke.

camp, Kelly recalled the days that she spent cooking, eating and interacting with people who were united for a common purpose. She reminisced:

> It was a highlight of my life… Just in terms of the amount of empowerment… It's really quite invigorating and [a] relief that you're doing something that's right with a lot of people who agree…. you're really making a voice be heard.

Amy and David likewise shared meeting and spending time with like-minded people in the community, such as bird lovers, scientists, hikers and activists, with a love for the natural world. Amy recalled how such interactions with others made her "feel human"; that spending time face-to-face with others instead of "spending most of my day on a computer, with my phone, scrolling through, looking at a screen" invigorated her to "feel alive and more at peace with everything." Therefore, through various interactions with family and community members, these teachers developed and reconnected their passion for the natural world.

Through such human interactions, many participants explained how they themselves were inspired to *share their passion for the natural world with others*. In particular, teachers with children and/or grandchildren recalled their time spent in nature with the younger generations. David related how he shared his enthusiasm for his many birding experiences with his son, also an avid birder, and Ella likewise fondly recalled her times spent babysitting her granddaughter, picking parsley or chives in her garden or noticing various plants and animals on their walks to the park. Kelly shared how her experience of being a part of the organizing team for an environmental protest against logging inspired her to continue to share her expertise with leaders of other environmental protests, leading her to be a part of a global network of individuals committed to environmental protection. When Amy was asked what made her experience in place special, she reflected:

> …I feel the need... to share with other people… I hope I get to share with my children should I have any, or… with our friend's kids that like to come and climb over the rocks, scrape up their knees.... It makes you want to share it with other people. And so maybe that's makes it so special.

In this manner, these teachers' shared their passions for places with others, emphasizing how they took an active role in sharing their ways of being as others had likewise shared their ways with them.

Teaching experience of place: Understanding Others' ways of being.

All teachers emphasized teaching as a human experience. In particular, informants spoke about the value of *understanding different perspectives*, or as Rachel said, "different ways in which you can choose to be as a human." In sharing her personal experiences of hunting with her students, Rachel stressed the need for her students to understand and respect different customs:

> Different parts of the world have different… practices. And where it might be common in one country to do a certain thing, here we might view it as being disgusting… I think it's important to expose students [to that] as part of any…well-rounded education to what's out there.

By discussing controversial topics related to science and ethics such as hunting, Rachel encouraged her students to reflect on individual biases and understand that there is no strictly "right or wrong way here." Similarly, Ella recalled her experience of taking students on a field trip to Carmanah Walbran Provincial Park to expose students to controversial socioscientific issues such as logging. By inviting an environmental representative and a representative from the logging industry to speak to the students about their perspectives on the issue, Ella stressed how students began to "see what was there and who those people were, the 'enemy,' you know," emphasizing the need to humanize individuals and be open to other ways of seeing. David furthermore explained the need to explicitly teach students to respect others' ways of being regardless of social, cultural or religious differences and "just let it be cause the other need to be heard":

> All these kids are from different parts of the world and they have all sorts of different faiths or no faith… They all get to interact with each other and hopefully the school is a place where kids come to respect each other despite their differences… just as human beings. And that they learn to respect the environment as well and realize that there's a cost to everything we do on the planet.

Therefore, "place" to David meant not only learning to care for the environment but also learning to be inclusive towards other human beings, thereby showing students about the various ways in which one could be in the world.

These teachers also demonstrated an *understanding of differences amongst their students*. Many teachers explored personalized learning approaches by providing students' choice of topics and choice of expression such as drawing or writing in various assessments, thereby

allowing students to draw on their personal interests and exercise different modes of intelligence. Amy and Kelly furthermore stressed how students have different frameworks of understandings that they bring into the classroom; Amy explained how the word "dog" may conjure particular images to one student's mind whereas the same word may present different images to another student depending on their prior experiences. In order to honour such differences in sense-making experiences, Kelly emphasized "letting the students observe, not just being told what to do or what to look at or what to think" so that students develop a self-awareness of their own sense-making experiences. Amy emphasized the importance of facilitating students' experiences without enforcing the teacher's personal experiences of place:

> One of the things that I find really interesting about place in particular, especially taking your students to a place, is that you've already discovered that place. You've explored it yourself, you have your own connection to it that you've developed and I think it is important that we keep in mind that our students also want the opportunity to do those things.

Amy shared the importance of student-centered experiential approaches by encouraging students to articulate their experiences of places, asking questions such as "What did you see?" "What did you feel?" or "What did you smell?" Using various pedagogical approaches, these teachers demonstrated an appreciation of student differences, allowing space for students to experience and make decisions for themselves.

Furthermore, some informants expressed the importance of *sharing ways of knowing and being* within and beyond the school community. Some teachers invited students to share their knowledge with their peers so that students could contribute to a pool of knowledge as a community of learners. In some instances, students were encouraged to participate in community research projects; Kelly, for instance, shared stories of student involvement in invasive species removal in local neighbourhoods, working together for the purpose of removing particular species and visiting local neighbourhoods to inform the public about the problems of invasive species. In reflecting on the power of sharing, Amy said:

> Being a giver of knowledge and a possessor of knowledge is something that… humans value… It takes a certain degree of ingenuity, a certain degree of willingness, a certain degree of wanting to teach people… [It] has led to a lot of different innovations in terms of human technology and… human understanding.

Amy also shared the value of connecting with students as individual human beings with various stories to live by, noting how tangential conversations with students that "happen on the bus, [that] happen on the sky train, [that] happen when you're hiking… that then come back to inform your teaching practice." Some teachers also explained how they shared their personal stories of various adventures in places, invoking the power of storytelling to connect with students. David shared:

> I tell them that I'm not so interested in tests and marks and all that. I'm not. I mean, sure I am but it's not the only thing… I like to talk to them about the beauty of nature, getting out in nature. I'll tell them stories, bear stories that make them laugh.

Likewise, Kelly explained how "making things personal is very, very powerful… everything stops when you get into a powerful story like that or a powerful sharing like that. [The students] know when it's real."

In addition to community building through sharing experiences, all teachers shared with their students their *powerful admiration for nature*. When asked in my final interview what inspired these teachers to teach biology, there was a unanimous response for the love of living things. Referring to living organisms broadly as "life," Kelly stated "I love life. And I love to connect kids with life." Rachel likewise explained:

> Oh you know, I just love living stuff… I like the wonder of it all… I enjoy being able to expose the kids to all the different things that are around them … How weird and wonderful… those different creatures [are] and how they manage to survive… all the diversity that's out there. And so, I think that's probably why I teach [biology] more than anything else.

Teachers passionately explained their senses of "excite[ment]" (Kelly), "wonder" (Rachel) and "fascinate[ion]… that our world is made up of living organisms" (Ella). Furthermore, Amy reflected on how students often feed off a teacher's passion for his/her subject, and how that passion can encourage students to become excited to learn. Kelly likewise explained:

> When we're outside, I get really excited…The feedback I've had over the years is [that] when you're excited… when you really get into it, it draws [students] along. And I really truly feel that.

In this way, these teachers shared their passion for nature with students, perhaps in the hopes that they, too, would learn to see the world with love.

Chapter 5: Discussion

Revisiting the Research Question

The purpose of the current phenomenological study was to explore if place-aware biology teachers' lived experiences in place influenced their teaching pedagogies through three related sub-questions: (1) what do biology teachers mean by a "place"? (2) how do biology teachers perceive and describe an experience in a place of meaning? and (3) does the experience in place influence biology teachers' pedagogy? While the concept of place has been explored in place-based education research and pedagogy (McInerney, Smyth & Down, 2011; Smith, 2002), "place" has often been dichotomized into nature-based or culture-based place studies (Nespor, 2008). By allowing participants to openly recall places of meaning with a focus on *experience* in place, I attempted to capture varying conceptualizations of place unbounded by spatial or temporal dimensions. Moreover, previous research on science teacher education has largely focused on epistemological questions of "what to teach" or "how to teach" with a limited ontological exploration of "who we are" as individuals that influences our professional science teaching practices (Avraamidou, 2014). Through open-ended conversations of places of meaning in personal and professional contexts, I therefore invited teachers to reflect on border crossings between such lifeworlds and to participate in the meaning-making of one's identity. Below, I revisit themes from the study in the context of the research question, noting similarities and differences in experiences of places and pedagogies of places found across five biology teachers.

The analyses of conversations with teachers revealed shared themes between places of meaning and teaching practices: (1) a sense of mystery, (2) seeing the whole and the particular, (3) environmental ethics of care and (4) human ethics of understanding Others' ways of being. While themes are presented as four strands in Chapter 4, it is essential to note the interconnections and interdependencies amongst these emergent themes that are expansive, revealing and broadening in themselves. That is, the difficulty of the current phenomenological study was to attempt to conceptualize lived experiences of participants that were more complex than what could be captured. As van Manen (1990, 2014) wrote, the paradoxical task of the phenomenological researcher is two-fold; on one hand, the researcher needs to let the participants freely narrate their lived experiences without imposing one's agenda; on the other hand, the researcher needs to carefully interpret the experiences and tease out participants' phenomenal, interweaving lifeworlds. I experienced the difficulty of writing and analyzing what

appeared to be non-representable, as what I wrote seemed too fragmented, too clean and too incomplete in comparison to the participants' inexhaustible lifeworlds that I encountered. Drawing on Blanchot (1982), van Manen (2014) admitted that the "perfect book" would in fact have no words as "…it is impossible to truly 'say' something. The writer desires to capture the meaning in words, but the words constantly substitute themselves, destroying the things that they are meant to evoke" (p. 371). There is therefore a tension between presentation (the experience of understanding) and representation (the interpretation of understanding), as the researcher's hermeneutic task distances oneself from the immediate presentation of the participants' lifeworld. I thereby emphasize the interconnectedness of themes to acknowledge the Gestalt whole that is greater than the sum of its parts.

A key feature of the study that allowed such interconnected themes to emerge was the "principle of free association" through open-ended narrative interviews (Hollway & Jefferson, 2000). By allowing participants to recall stories in an unstructured manner, they were encouraged to freely associate their narratives with the broader life story that informed who they were as individuals and teachers. In listening to the audio recording post-interview, I was often surprised at how tangential narratives that seemed irrelevant to me during the interview later made sense once I learned to see the "whole" from the perspective of the participant. I thus learned to listen without enforcing my own agenda, with the hope that the narratives would somehow connect in the participants' minds and would later make sense to me once I revisited the transcript with a different lens. Similarly, I began my first few interviews by asking participants to recall stories of places of meaning separately from their professional practices; I soon learned to loosen such interview structure where appropriate as I realized that participants' life stories were not categorically compartmentalized into "personal" and "professional" lifeworlds as I had rationalized from a researcher's perspective. Therefore, I learned to elicit participants' stories intact within minimal re-directing to allow the Gestalt whole to emerge from conversations. Although participants' stories were teased apart into themes for analytic purposes, I emphasize how there is an interconnected whole that cannot even be represented through writing.

With these cautionary notes in mind, I explore the possible interconnections amongst the aforementioned emergent themes. For example, many participants shared the importance of patient observation in their place of meaning (*seeing the particular*) in a manner of letting the

enigmatic wildlife reveal itself (*sense of mystery*). In particular, David recalled how he learned to "sit out in nature and wait for organisms to come out to [him], rather than seek" (*sense of mystery*) from stories that his mother shared of his aunt's way of being in nature (*human ethics*); Ella likewise shared how she and her children got "right down there on [their] bellies… our noses practically in the water… waiting for the tubeworms to come back out" (*sense of mystery, human ethics*). Kelly recalled how in noticing a living tree on a forest walk she "totally [fell] in love with the tree… spend[ing] a lot of time right there with it. And just kind of be there with it… seeing and immersing myself in the beauty of that living being" (*environmental ethics*). Given the complex, interweaving nature of participants' lifeworlds, I therefore had to make difficult decisions to tease apart, combine and recombine emergent themes in what seemed to represent participants' lived experiences of place; yet here I emphasize the fluidity of these emergent themes that perhaps influence and are influenced by one another. The themes, in this manner, are not mutually exclusive; a different individual with a different interpretive lens could have reorganized the themes in a different manner. In this sense, these themes are not a discovery of a fundamental "essence" of human experience as is commonly pursued amongst transcendental phenomenologists, as they are in fact *my* interpretations of participants' narratives that reflect my sense-making process of what has been shared.

Furthermore, there were overlapping themes across participants' personal and professional lifeworlds. In a similar manner to exercising patient observation in their places of meaning, many teachers shared the importance of their students paying attention to details in and of their immediate surroundings through focused observation. Rachel, for example, encouraged her students to look beyond a tree and "look at the cones or look at the flowers or look at the bark or how tall [it is]." Kelly likewise planned live behaviour labs for her students so that they could closely observe organisms on "the watch glass and you can look underneath and you can actually see them moving." Moreover, all teachers expressed a strong passion for nature in a similar manner that perhaps close family and community members had previously shared with them in their childhood and/or adulthood. According to Chawla's (1998, 1999, 2013) research on significant life paths into environmental action, many environmentalists attributed sources of environmental commitment to largely two factors: spending time outdoors in one's special place of meaning and an influence of an adult that valued nature. In teachers, too, there appeared to be a sense of continuity of past experiences in personal places of meaning to inform future teaching

practices; perhaps these teachers attempted to instil a sense of care for the world in their students, as they themselves had experienced in their places of meaning.

Despite such interweaving confluences between teachers' personal and professional lifeworlds, I wish to emphasize that the findings here are associations rather than causations. That is, while teachers shared an ethic of care with students, why teachers did so or what prompted teachers to do so remains unknown, as such motivational questions were beyond the scope of the current descriptive study. Amy, for instance, wrote about other places that evoke a similar sense of belonging and connection to the land:

> It is hard to limit yourself to one specific location that carries personal meaning, let alone try to do this twice. My struggle to pick a place really has to do with the fact that there are so many places, particularly in BC, that generate a sense of awe, wellbeing, and connection to the Earth and my humanity.

David likewise hinted at the continuity of experiences in other places of meaning:

> I had a whole life other than Malakwa growing up… Malakwa was just one aspect. You're asking me for a profound place, maybe a place that marked me, I could do the same with other places, like Mt. Assiniboine when I was 16… It was a *continuation of Malakwa* [emphasis added]. And I think with Malakwa there's the human association, like family, people who you loved very much.

In this sense, the current study explored one dimension of participants' lived experiences, albeit profound, that could have influenced teachers' pedagogies. The current phenomenological study did not attempt to provide deterministic answers as to "how" specifically these biology teachers' lived experiences in place influence their pedagogy; rather, the experiential data provided a descriptive richness of the meaning of place and an "experiential awakening" (van Manen, 2014) that the participants' lifeworlds perhaps offer more complexity than what could be captured in analysis.

While there seems to be a relationship between this group of teachers' experiences in places and their choice of pedagogies, the manner in which such experiences transferred into their teaching practices differed across teachers, illustrating the individuality of these teachers' styles that they brought into their teaching. For instance, all participants identified a strong ethic of care for their places of meaning; however, they demonstrated such ethical sensitivities towards lifeforms in different ways, such as modeling a careful release of organisms into their habitat,

honouring organisms prior to dissection, or facilitating a class discussion about animal ethics. Sometimes, themes that emerged from places of meaning strongly transferred into teachers' practices, such as the value of paying attention to the particularities of the world or sharing ones' passion for nature in both personal and professional lifeworlds. In other instances, themes were loosely connected and were restructured in different forms in teachers' pedagogies, such as the sense of mystery in places of meaning and exploratory learning approaches in their teaching practices. Some teachers also emphasized how they altered their teaching practices depending on the personalities and learning styles of the student cohort, highlighting the dynamic, adaptive and creative manner in which teachers continuously shapes and reshapes their practices. Therefore, while participants shared similar experiences in their places of meaning, they brought their personal styles into the classroom, leading to different pedagogies across teachers and sometimes within teachers themselves.

David and Kelly exhibited a particularly strong relationship between their lived experiences of place and teaching pedagogies. While many participants reached a point of saturation after three interviews, Kelly and David continued to share how they actively implement the concept of place in their practices. Furthermore, most teachers reflected on how stories of place emerged tangentially in conversations with students or how some experiences in place were planned in relevant ecology-based units. On the other hand, Kelly reflected on how "place" plays a central role in her teaching practice:

> I teach about place. And it's interesting cause [*sic*], I'm…thinking about [what I should share] and kind of going, there's all this place-based learning. Well, I think I've been doing it… I think it's important. We live here, you need to know about the place where you live.

Likewise, when asked to reflect on moments when David shared experiences of places with his students, he stressed the difficulty of locating a particular instance as it is "all the time" through "the way I speak. Kids know that." When asked to reflect on her personal place of meaning, Kelly spoke about how past experiences in place shape who we become in the future:

> It's in the background, it's part of the layers that makes up our lives and our persona. So I feel like it's a really important foundation piece, it's like a keystone that's holding up the wall that is me. And without that, I don't think I would have developed into the person

> that I am… I have to maintain and nourish that part of myself by getting out into nature and by holding these connections.

Therefore, some participants demonstrated a stronger intentionality in transferring place values into their teaching practices than others.

Implications for Science Education Research and Pedagogy

Drawing on teachers' places of meaning and their teaching practices, I next explore three implications of the study for science education research and pedagogy: (1) understanding the interconnections between nature and culture, (2) exploring different layers of "seeing" through an embodied sensory approach and (3) reflecting on ethical ways of being in the world. In what follows, I discuss themes that were strongly expressed by teachers in their places of meaning, elaborating on instances in which such themes were repeated in their pedagogies; furthermore, I explore instances where particular strong experiences in places of meaning were minimally transferred into teachers' pedagogies, thereby identifying opportunities for future research and practice in science education. In conclusion, I propose "a pedagogy of places" modelled on biology teachers' experiences in place. Like Wattchow and Brown (2011), I emphasize that this is *a* pedagogy *of* places, not *the* pedagogy of places in a deterministic, universal sense as all places are unique and teachers that implement the pedagogy are different; moreover, it is a pedagogy *of* places, with an emphasis on fostering an embodied connection with a "place" rather than having place as a mere backdrop where activities occur outside the classroom. In this manner, I reflect upon a pedagogy that could broaden students' horizons to understand that there is more to see and experience than what can be imagined, in the hopes of fostering a sense of humility and care for the Other.

Interconnections between nature and culture.

Nature and culture, self and place, science and society.

In conversations with teachers about place, the notion of "place" emerged as a complex, multidimensional construct interweaving elements of "nature" and "culture." When participants were asked to recall a place of meaning without defined boundaries of what "place" could be, teachers often shared narratives of human interactions in nature. When asked to explain what place meant to him, David described:

> It's all those connections. It's not just the place, that's only one dimensional. This is multidimensional, right? It's… [the] human interactions between two people…it's very complex.

While solitary, isolated and remote experiences in the wilderness were sometimes shared as meaningful in themselves, participants recalled sharing experiences of being in place with others and learning others' ways of being in place; for participants, these experiences invigorated a sense of wonder and belonging for the place. In later recalling their teaching experiences of place, these teachers expressed how they shared their stories of places with students, as others in their lives had previously shared with them.

Some participants furthermore recalled a dialectical relationship between the self and place. Amy, for instance, reflected:

> [When] we talk about place, we talk about the way that it's impacted our lives…[place] can impact your wellness of being, it can impact how you address certain concepts… But I think too that place also, if we weren't there in that one place in that one time…. how do our lives change? … I also think too, a lot of our experience of place is based upon what is going on in our lives outside of that place, what we bring into that place, too.

Amy explained how the self is shaped by the place, but also how personal and sociocultural factors could shape one's experience in place. A phenomenological exploration of place in the current study thus reveals that it is the *experience* that individuals have in places that makes places meaningful, a point that is often neglected in quantitative explorations of "place" (Kudryavtsev et al., 2012**;** Lewicka, 2011). In this manner, participants did not compartmentalize "nature" and "culture" boundaries in their narratives, illustrating how meaning in place is found not only in its separable and physical qualities of place but in the intersection of the object and subject.

In recalling teaching practices of place, some teachers furthermore identified the interrelationships between science and society. Some teachers reflected on the limitations of science as a discipline by introducing controversial socioscientific issues, contextualizing students' understandings of science where social, political, economic, ethical and moral concerns intersect in society. In relevant ecological topics, some teachers also emphasized human beings as biological organisms nested within complex environmental, ecological and sociocultural spheres across varying scales of space and time. Other teachers emphasized science as a way of

knowing amongst other ways of knowing such as English or art, appreciating varying expressions of human beings' relationships in the world. While traditional positivistic perspectives might espouse science as an absolute, linear, objective and abstract corpus of knowledge, centering conversations on "place" perhaps invited some participants to deconstruct such epistemologically privileged notions of science, allowing multiple controversies and perspectives to be included in the study of science (Gruenwald, 2008; van Ejick & Roth, 2010). As Amy emphasized, "science is *a* [emphasis added] system of beliefs and means of understanding our universe as we currently understand it"; science in this way is viewed a dynamic human and social activity bound within a contextual space-time with a sense of tentativeness and potential multiplicity of "truths." The concept of "place" is therefore a potentially expansive pedagogical orientation, one that resists easy containment within one discipline or one way of thinking.

Cross-cultural and cross-disciplinary approaches.

In challenging the boundary between nature and culture, a pedagogy of places opens possibilities for cross-cultural sensitivities, such as incorporating Traditional Ecological Knowledge (TEK) of the First Nations people into science education. In contrast to universal, rational, and abstract conceptions of Western Science (WS), TEK emphasizes contextual, place-based, holistic and moral understandings of the world where humans and nature are intricately connected (Wanosts'a7 Lorna & Snively, 2016). TEK has been associated with indigenous science such as developments in medicine, architecture, engineering, wildlife management, plant breeding, nautical design pharmacology and more. Given the conceptual differences between WS and TEK, Aikenhead (2001) emphasized how teachers need to act as "cultural brokers" (p. 339) to bridge different ways of knowing without assimilating traditional worldviews into Western ways of thinking. For instance, the Cree "wapahtam" is often translated into English as "to observe," although "wapahtam" implies that there is an intimate relationship between the "observed" and the "observer," in contrast to the detached notions of "observe." Thus, while a fact-based question such as "What is the classification of the wolf?" (Answer: *Canis lupis*) makes sense in WS, the more relevant question in TEK is "Who is mahihkan?" (mahihkan, translated as wolf) with an emphasis on the inter-relationality of beings in a particular context as opposed to a thing-oriented, nature of WS.

Here I clarify that neither WS nor TEK is more relevant than the other; rather, there are different questions that can be posed from TEK and WS, respectively, that serve different purposes. For instance, the WS question "What is the classification of the wolf?" can help scientists to understand the evolutionary relationships of wolves in relation to other species, while "Who is mahihkan?" may offer insights about mahihkan's behaviour, a question that is important for trappers in First Nations communities (Aikenhead, 2001). Echoing Nespor (2008)'s critique of culture-based place studies, I caution against neo-romanticism and sentimentalism associated with TEK; as cultural indigenous knowledge has often been assimilated into WS, I emphasize that indigenous science can in fact enrich WS when placed on an epistemological par with WS (Carter, 2007). If TEK is to be included in science education curricula, perhaps this poses questions about other ways of knowing to be included in science education; while an in-depth discussion of such a rich question is beyond the scope of the current thesis, I suggest that it is important to expose students to a holistic curriculum that embraces other ways of thought without indoctrinating particular ways of thinking, a point I shall return to later. I particularly expand upon TEK here, as First Nations ideologies and practices were discussed by informants in my study, and has relevance to place-based approaches in science education.

A study of "place" thus invites cross-disciplinary thinking towards a holistic understanding of how humans relate to the world. In conversations about pedagogies of places, Kelly and Rachel shared examples of practices such as plant harvesting or hunting, and challenged students to understand what it means to have an embodied consciousness of human impact on the land. Both teachers shared the need to think about the land, thereby exercising mindfulness for "knowing where food comes from" (Rachel) and "tak[ing] care of the land and the ocean so that it would continue on for many generations" (Kelly). In contrast to compartmentalized approaches to present science education, a transdisciplinary field called "sustainability science" explores the complex nature-society interactions in its non-linear, shifting and interconnecting manner, with the understanding that humans inevitably influence and are influenced by interactions in nature (Carter, 2007). As Berry (1987) argued, one must realize that the division between nature and culture is perhaps illusionary:

> People cannot live apart from nature; that is the first principle of conservationists. And yet, people cannot live in nature without changing it. But this is true of *all* creatures; they

> depend upon nature, and they change it… The making of these differences is the making of the world. (p. 7)

Berry speculated that the debate of conservation science is typically two-sided: on one hand, conservationists argue for the protection of species, communities and ecosystems *from* humans, whereas industrialists prioritize anthropocentric, individualistic and economic values for the well-being *for* humans, thereby manipulating nature in ways that are often harmful to the environment. However, the central question in sustainability science is how humans can live *with* the environment with the understanding that "we're part of nature and nature is a part of us" (David).

However, there are conflicting definitions and approaches even within sustainability science (Miller, 2013): the "universalist" definition of sustainability science defines sustainability science as a conceptual problem of meeting current and future human needs while at the same time maintaining the environment; the "procedural" definition, in contrast, emphasizes the negotiated experiences of humans and the environment in particular contexts in particular places. Moreover, the "coupled systems" approach in sustainability science focuses on producing scientific knowledge related to the human-nature dynamics, whereas the "social change" approach emphasizes the role of stakeholders and contextual systems in understanding how to enact social change. Both approaches exist at the boundary of science and society; the difference is rather in the focus (science *or* society). The future challenge is thus to identify overlapping knowledge, goals and values in these domains of sustainability science. In this manner, an exploration of sustainability science in the class can provide rich opportunities for students to explore the artificial boundary between nature and non-nature, inviting them to consider how humans can ethically coexist with others on the land.

"Seeing" through an embodied approach.

Focused attention and "slow" pedagogy.

Another pedagogy of places that emerged from conversations with teachers was the "power of observation" (David) in science education. In reflecting on their personal places of meaning, participants recalled the importance of taking the time to pause and immerse oneself in the moment of being in the place; these experiences inspired teachers to plan activities such as making careful biological drawings or noting daily observations in nature journals so that

students take the time to notice the particularities of the landscape. When asked to elaborate on what Kelly meant by "paying attention to detail," she explained:

> Paying attention to detail… is a very personalized thing because we're going to see different details at different times. You know, how you even walk into a room and you see everything that's going on in there, then all of the sudden you go, oh! How long has that been there? Oh, 5 years.

Kelly emphasized the importance of conscious attention in learning to see, in a manner reminiscent to Dewey's (1934) definition of "having *an* experience" (p. 35) whereupon the subject actively interacts and engages with the object instead of a peripheral recognition upon some "previously formed scheme" (p. 52). As Bai (2009) wrote, using brain-based pattern recognition systems, one might recognize objects as a "grass," "flower," "sky" or "wave" without paying attention to the particularities, such as the shape, texture, space, movement and form. In a fast-paced, techno-cultural and routine-oriented society, it has been suggested that that in fact an average American adult spends 50% of his/her activities "mind wandering" (Davidson, as cited in Powietrzynska, Tobin and Alexakos, 2015, p. 66) through habituated, desensitized and routine activities. In a similar manner, an abstract approach to science education without subjective participation of the individual has been suggested to sometimes extinguish students' senses of wonder for the products of scientific inquiry (Hadzigeorgiou & Skoumios, 2013; Østergaard, 2014).

All participants furthermore reflected on being present in their places of meaning, allowing one to concentrate on "what's around you rather than your personal problems" (David) in a manner of letting go of one's self-consciousness. These meditative experiences in place closely resembled that of "flow" (Csikszentmihalyi, 2014, p. 129), or a state of consciousness where one is fully immersed in the experience with a lack of awareness of time, invigorating the self with energy in an autotelic activity. Such senses of flow are often found to be associated with subjects such as art or physical education, while anxiety is often expressed in science and math due to high challenge and ability levels related to these disciplines. Given the capacity in which flow-like experiences were enthusiastically shared in participants' places of meaning, perhaps it is surprising that only David and Kelly discussed the value of such meditative, mindful and self-awareness experiences in science education. In recalling First Nations people's sense of

time in contrast to the "European watch," David promoted a pedagogy of "losing track of time" in nature:

> There's a lot of people in Oak Bay[10] that they're busy all the time. But I wonder do they ever lose track of time? They must. People do. You can't always just be thinking about time. But that's a quality of life that I think that could be, just talking to you, thinking maybe that should be promoted. Lose track of time in Oak Bay! Enjoy nature on the oceans, stand on the ocean and look out. See the whales and the birds.

Furthermore, he stressed the need to relax our sense of time in school:

> …With the school, the curriculum, the way it is, so much is timelines. It's different than if I had more time for kids. I think meditation in nature, things like that, should be part of the program. You know, we need to have the time.

Payne and Wattchow (2009) emphasized a "slow pedagogy of place" (p. 16) in their undergraduate environmental/outdoor education course, stressing the value of patient observation and slow engagement with the world through beachcombing or careful sketching of living organisms. Similarly, Bai (2015) shared her experiences of Frederick Franck's Zen drawing, leading to a deep immersive concentration of the ivy plant that she drew, allowing the ivy plant to "come alive" (p.144) in a curiously vivid and animistic manner. While research exists on nature therapy in restoring one's mental concentration (Kaplan, 1995; Mayer, McPherson Frantz, Bruehlman-Senecal & Dolliver, 2007) or mindfulness practices on improvements to students' academic performance (Powietrzynska, Tobin & Alexakos, 2015), there seems to be a limited exploration of how a slow, meditative pedagogy of places could be practiced in science education. I suggest that "flow" experiences in nature are not only beneficial for therapeutic purposes, but in revitalizing students' attention to their day-to-day experiences of the world.

(Re)vitalizing aesthetic sensualities.

Many participants described a sensuous experience of the living, breathing landscape with reference to the sight, sound, touch, smell and feel in their places of meaning, which in turn seemed to foster among participants a sense of nourishment, energy and vitality of being. In fact, the manner in which these teachers reflected on the aesthetic beauty of places was reminiscent of many scientists' musings on aesthetics in science (Carson, 1956; Root-Bernstein, 2002). It is perhaps then surprising that the value of aesthetics was explicitly mentioned in only two teachers'

[10] Oak Bay is a municipality in Victoria, British Columbia.

pedagogies: Rachel, who probed students to find beauty in the uniqueness of various lifeforms, and Kelly, who invited students to attune to the sensory experiences of being in nature. Girod, Rau and Schepige (2002) lamented the paucity of aesthetic-based pedagogies in science education, emphasizing how "science is not only the process of stepping back and analyzing the world with cold logic and rigorous methods" but that "science is also stepping forward in an attempt to 'get inside' of objects, events and ideas; it involves a surrendering to experience" (p. 577). A small number of recent studies have investigated the influence of aesthetically-crafted pedagogies on students' values, perspective and attitudes towards science (Blades, 2015; Girod Twyman & Wojcikiewicz, 2010) or the role of the body in sensory attunement of the shifting, aesthetic and collective landscape (Bai, 2009; Payne and Wattchow, 2009). Drawing on David Applebaum's *The Stop*, Bai (2009, 2015) suggested that a phenomenological reorientation in environmental education may invite students to experience a "stop": a halt in the ordinary world that encourages students to develop an embodied connection with the "soil (the earth), soul (the sensitive, empathic quality," and sole (the body and senses)" (p. 146).

I wish to clarify here that my critique is not that abstractions and conceptualizations should be removed from science education; my objection is to the sole teaching of these abstractions and conceptualizations. Science and art have been sometimes critiqued as non-congruous disciplines that exist at opposite poles of knowledge; that of the objective, naturalistic and logical view of a scientist's world versus the subjective, aesthetical and emotional view of an artist's world (Orr, 1992b; Girod et al., 2010). A reductionist understanding of the world that science has sometimes offered us has been argued to take away the wonder and awe for the natural world, as Francis Bacon, the father of empiricism, noted: "No man can marvel at the play of puppets, that goeth behind the curtain and adviseth well of the motion" (as cited in Hepburn, 1984); positivistic views of science are still often perpetuated by science students and teachers today (Deng et al., 2011; Lederman, 2007). However, physicist Richard Feynman argued against such stereotypical dichotomies of scientists and artists in the BBC documentary interview, *The Pleasure of Findings Things Out* (Skyes, 1982):

> I have a friend who's an artist and has sometimes taken a view which I don't agree with very well. He'll hold up a flower and say "look how beautiful it is," and I'll agree. Then he says "I as an artist can see how beautiful this is but you as a scientist take this all apart and it becomes a dull thing," and I think that he's kind of nutty. First of all, the beauty

> that he sees is available to other people and to me too, I believe…I can appreciate the beauty of a flower. At the same time, I see much more about the flower than he sees. I could imagine the cells in there, the complicated actions inside, which also have a beauty. I mean it's not just beauty at this dimension, at one centimeter; there's also beauty at smaller dimensions, the inner structure, also the processes…. It only adds. I don't understand how it subtracts.

Feynman speculates on how a seemingly reductionist, mechanistic and conceptual understanding of the cogs and wheels could in fact lead one to appreciate the complexity and diversity of the universe. In other words, a conceptual understanding of science perhaps contributes to what Cavanaugh (2014) called the "scientific sublime" (p. 57), or the beauty and awe as experienced through a deep, conceptual understanding of the products of scientific inquiry.

In fact, some teachers interviewed for the current study also expressed how a scientific conceptual understanding of the vastness of space-time fuelled a sense of humility for one's smallness in comparison to the expansiveness of the universe. David, for instance, wrote:

> [Science] can change faith and perception of place. The world is not flat, the Earth is not at the centre of the universe, and there are billions of galaxies with. Billions of stars with possible lifeforms on them–facts that show us just how insignificant we are. Should we not be striving for some level of humility?

A conceptual understanding of various ecological connections of various organisms within and across ecosystems likewise fostered a powerful admiration for the complexity of the natural world. Rachel expressed a sense of wonder for "the beauty of how it all works… whether it's an individual organism or the ecosystem as whole"; Ella shared her wonder for the biological, chemical and physical interconnections across ecosystems such as the forest and the ocean, challenging the concept of ecological boundaries in biology. Reminiscent of Charles Darwin's (1859) poetic final paragraph on *The Origin of Species*, the informants seemed to emphasize the awe, wonder and beauty of nature found in the diversity and complexity of the metaphorical "tangled bank":

> It is interesting to contemplate a tangled bank, clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms,

> so different from each other, and dependent upon each other in so complex a manner, have all been produced by laws acting around us. (p. 528)

While an overwhelming emphasis on the abstract, analytical and conceptual ways of knowing in science could be seen as reducing the scope of wonder, the teachers in my study implicated that such ways of understanding can sometimes broaden one's layers of "seeing" to counteract the mundane ways of experiencing the world.

Ethical ways of being in the world.

Caring for the Other.

Lastly, a key theme that emerged from conversations with teachers on place was an ethical focus on care for beings in natural and cultural worlds. In recalling personal places of meaning, teachers expressed an openness and receptivity for the Other *as is* regardless as to whether it is a human or non-human Other. Such sensitivities towards various living organisms were subtly manifested in teachers' ways of being in the classroom, through modeling care of organisms, such as careful handling of organisms in their natural habitat, or emphasizing the need to understand the "different ways in which you can chose to be human" (Rachel). Reminiscent of Heidegger's (1975) concept of "dwelling" (p. 145), or an authentic manner of being amongst the fourfold sky, earth, mortals and divinity, teachers identified the importance of what it means to "dwell":

> To save really means to set something free into its own presencing. To save the earth is more than to exploit it or even wear it out. Saving the earth does not master the earth and does not subjugate it, which is merely one step from spoliation… To spare and preserve means: to take care under our care, to look after the fourfold in its presence. (pp. 150-151)

To dwell authentically then means to engage in a genuine act of "sparing," or preserving the Other *as is* without attempting to control or subjugate the Other. Similarly, Noddings (2003) noted the importance of revitalizing an ethic of care in education, emphasizing the value of being present, listening and attending to the needs of the Other without enforcing one's agenda on the cared-for. David shared the importance of listening to the Other through an open, non-judgmental awareness:

> Another thing I've learnt about meditation is that, to not be judgmental when you listen. Just let it be, cause *the Other needs to be heard* [emphasis added]. And I think those

> things need to be taught… When you're judgmental, then there's forces, one against the other, right? … You're on guard, you're much more vulnerable because you're on guard.

In this manner, caring for the Other is an opening of a dialogue between the self and the Other without projecting one's preconceptions and realities of what the Other may be.

While informants broadly shared an ethic of care in their teaching, David and Kelly were the only participants to consciously reflect on and act upon the need to engage students in ethical ways of being. In a fast-paced, virtual, globalized, linear and career-oriented society with a growing demand for STEM-related careers in which many students live today, the emphasis in traditional science education has largely been on the transfer of knowledge and skills for preparation of the future (Payne, 2006; Zeidler, 2014). David lamented on the instrumental, technical and practical values of the school that teaches students to be "good workers":

> There's so many kids who are stressed today because of school…. You've gotta get a career, whatever, you know? They're taught to be good workers but… they're not being taught to enjoy nature, enjoy the moment and how that can make them feel better.

When asked what an ideal curriculum would be like for David, he shared:

> [We need] to have time for the spiritual. I think that's the most important aspect of everything because I think, sure we can be very mathematical about what we want to teach but the mathematical doesn't teach you the respect. It's another kind of respect, right? …You're teaching kids to be good workers maybe, but life is supposed to be much more than that… Inner being is more important than any fact… the inside is so important for the human being and their feeling for their space in this world…. But I often feel that we neglect what's inside of us.

Like David, I also believe that the problem of "inner being" needs to be more at the heart of science teachers' practices, addressing ethical questions of "so what" beyond the abstract, symbolic and discursive world.

The question that naturally arises then is: How can we foster ethical ways of being in the world? Science, Technology, Society and Environment (STSE) education, which emerged as a countermovement against technical-rational approaches to science education, invites students to explore complex socioscientific and environmental issues at the nexus of social, economic, political, and ethical factors (Pedretti & Nazir, 2011). However as Zeidler et al. (2005) critiqued, STSE education simply "points out ethical dilemmas or controversies" (p. 359) without

consideration of emotive, epistemological, moral or character development of the students. Given the many human-induced environmental problems such as deforestation, biodiversity losses, fisheries depletion and water deficits, educators might emphasize the "doom and gloom" of the ecological crises so that students are empowered to take action (Postma & Smeyers, 2012). In an action-oriented science education curricula with deterministic end goals such as "environmentally responsible behaviour" or "citizenship action skills," there is therefore the danger of prescribing the ecological identity that learners "should have" and "ought to have," ironically excluding learners themselves in developing their own ethical relationships to the world (Payne, 2001).

While teaching is not a value-free, objective and sterile activity, Fien (1997) argued that "teachers have a responsibility to promote particular values, but they do not have a license to direct the attitudes that can be formed from these values" (p. 446). That is, teaching becomes indoctrination when authority figures in an educational system reinforce close-mindedness amongst students (Taylor, 2017). Working in a secular school environment, David shared how "it's a good thing in schools that… there's a school act about religion. You're not allowed to manipulate young minds about your thoughts on religion, you keep out of it." Similarly, Kelly explained how she needs to be mindful of the dangers of indoctrination:

> We can't be preaching things... [because students] may have different backgrounds or you have different perspectives… [I] bring in a recognition [of my perspective] without imposing what my own value set is…. you can't push it too much but at least again just open that little crack of "Oh, I wonder?" … What could that be or is there another way of looking at this?

Kelly therefore talked about the possibility of sharing her personal ethic of being, without moralizing, preaching and inculcating such environmental attitudes on students.

As Hannah Arendt (1954) wrote in *The Crisis of Education*, educators today face a two-fold responsibility. Every new generation is born into a paradoxically old and new world; on one hand, the responsibility of the educator is to teach students the traditions of the old world so that students might learn the trials and tribulations of the generation past; on the other hand, the responsibility of the educator is to allow the next generation to shape their open, unpredictable future. She wrote:

> Education is the point at which we decided whether we love the world enough to assume responsibility for it and by the same token save it from that ruin which, except for renewal, except for the coming of the new and young, would be inevitable. And education, too, is where we decided whether we love our children enough not to expel them from our world and leave them to their own devices, nor to strike from their hands their chance of undertaking something new, something unforeseen by us, but to prepare them in advance for the task of renewing a common world. (pp. 13-14)

Therefore, while science educators need to prepare students to face the environmental problems of the present world, there also needs to be an openness to allow students to appreciate the wonder for the world *as is* by valuing the here-and-now; that is, a shift from a problem-solving orientation towards a values-based orientation in environmental education (Sauvé, 2005). Such a shift can perhaps be fostered through an embodied, phenomenological reorientation to the world, implicating oneself in the sensuality of lived experiences of place.

Play in science education.

maggie and milly and molly and may
went down to the beach (to play one day)

and maggie discovered a shell that sang
so sweetly she couldn't remember her troubles, and

milly befriended a stranded star
whose rays five languid fingers were;

and molly was chased by a horrible thing
which raced sideways while blowing bubbles: and

may came home with a smooth round stone
as small as a world and as large as alone.

For whatever we lose(like a you or a me)
it's always ourselves we find in the sea

(Cummings, 1994)

While many teachers in my study valued exploratory learning approaches by taking students outside to experience the "real-world," Amy and Kelly were the only teachers to consciously reflect on students' embodied, sense-making experiences through play. Kelly reflected on the openness of space and time in her childhood that allowed her to engage in spontaneous, imaginative play in nature:

> It was open, we roamed. We had kind of a set area where we knew we could roam in, but sometimes we would go pretty far together …. But [today] it feels like sometimes we're really, really constrained…. If kids are going out to play, well they're going to a wonderful playground. It's a built playground… They're amazing what you can do on them, but it's not the same as going into the bush and having to work your way through and find a tunnel and imagine that you're somewhere in the deep jungle.

Kelly's comments are reminiscent of E.E. Cummings's (1994) poem, "maggie and milly and molly and may" where Cummings mused on the importance of nature for children in the way that nature appeals to each child differently.

In contrast to a means-oriented activity, an important characteristic of a child's play is that it is intrinsically motivated and is done for the sake of the experience (Postma & Smeyers, 2012). A child may therefore build a tower of blocks, only to tear it down and build it up again; yet, each reiteration informs a deeper experience of the previous such that the past informs present and future experiences in a cyclical manner. Bonnett (2004) explored the difference between "linear time" and "spiral time": linear time is "a time so linear that in its unreturning moments objects can be defined and the past simply left behind. There is a sense in which in such time we constantly escape the consequences of our living" whereas in spiral time "the sense of responsibility is enforced in cyclical time… [and] there is no escaping from the returning consequences of one's actions" (p. 73). Using children's play as a model, Postma and Smeyers (2012) therefore suggested the possibility of fostering a deep-rooted ethical sensitivity for the world as enforced through spiral time.

Unfortunately, such slow, open-ended and exploratory approaches characteristic of "play" often contrast with the fast-paced, goal-oriented and time-constricted nature of traditional school systems (Payne & Wattchow, 2009). Although play-like flow experiences are sometimes found in alternative or elementary programs, such opportunities often diminish in traditional secondary

schools where the focus of instruction becomes a preparation for a future career (Csikszentmihalyi, 2014; Postma & Smeyers, 2012). Amy elaborated on the paradox of an open-ended pedagogy in traditional schools:

> There's the need to prove that [exploration] has value. And I think unfortunately when we think of exploring our environment… a lot of people would say "Oh well, you're just going around and fussing about in the forest, what's the point?" Or "Oh, you're just going to go to the beach and look at some rocks. You can do that in the classroom. What's the point?" So, I think proving that point is what makes teachers tend to be more concept-based than exploratory.

While open-ended learning embraces the unknown, means-oriented learning stresses predictability in controlled environments, thus resulting in a conflicting tension between two learning approaches; as Amy suggested, there is a sense of irony in demanding a tangible, predetermined outcome for open-ended exploration.

Furthermore, Amy explained the difference between "concept-based" learning and "exploratory" learning:

> …A lot of the time we take our students to specific places… to the forest or to the beach, to different places where we can actively demonstrate the concepts that we are talking about. So, it does seem to be more concept-based and then we link it to the place.

In this manner, "concept-based' teaching is a transfer of traditional classroom experiences into outdoor settings where perhaps students "get off the bus, walk for five minutes… [the teacher] point[s] about something and lecture[s] on it, and then get back on the bus… you're seeing it but you're not exploring it, you're not engaging with it" (Amy). Likewise, Wattchow and Brown (2011) critiqued how outdoor/environmental education practices often use the physical location as a backdrop for which traditional classroom lessons occur, thereby retrofitting a place to fit the objectives of the prescribed curricula in a different setting. They cautioned decontextualized pedagogies such as a simulated caving experience using interconnected shipping containers that emphasize the novel and the exotic; in turn, they advocated a pedagogy *of* places with a focus on one's embodied experiences of place in and of themselves, invoking the individuals in the meaning-making of the place. I propose that such place-based learning could foster a participatory consciousness of care in the way that students relate to the world; with these

musings in mind, I next provide a summary of future recommendations for science teacher education.

A Vision for Science Teacher Education

All in all, *a* pedagogy *of* places invites students to broaden their horizons, fostering a receptivity, sensitivity and openness to the Otherness of place. First, an understanding of the interconnections between nature and culture fosters the potential for cross-cultural and cross-disciplinary approaches in science education. I suggest that an important component of future science education perhaps lies at this interface of "nature" and "culture," where one may begin to imagine pedagogies that exist in this rich, fertile world of the "between" (Aoki, 2005, p. 297) As a few teachers shared in their teaching practices, framing one's teaching units on sustainability science that emphasize nature-society interactions such as ethnobotany, sustainable agriculture or renewable energy (Carter, 2007; Miller, 2013), invites holistic, interdisciplinary ways of thinking into the classroom. Furthermore, focusing STSE education on the concept of place, such as the sociopolitical and environmental controversy on the Kinder Morgan pipeline in BC, can provide natural opportunities for contextualized learning to occur. Despite the oft-fragmented nature of university education where science teachers take science methodology classes, history teachers take history methodology classes and so on, I moreover imagine possibilities for interdisciplinary projects across traditional teaching disciplines that may challenge artificial boundaries between nature and culture.

The new BC curriculum emphasizes the relationship between nature and culture by defining "scientifically educated citizens" as those with "place-consciousness" that are "able to see themselves as a part of the planet rather than rule of the planet, stay informed about scientific developments and are aware of the impact of science on the planet and its systems" (British Columbia Ministry of Education, 2016). Despite intended efforts to interweave aboriginal education across various disciplines in the new curriculum, the First Nations are cited as a mere example of cultures that embrace such place-consciousness. The challenge for future science teacher education is therefore to move beyond knowing about First Nations people towards an understanding of their perspectives, attitudes and values that inform such epistemologies. I propose that science teachers need to engage in sometimes uncomfortable but important conversations about one's preconceptions, beliefs and ideologies of science and begin to explore

other ways of knowing and being, such as Traditional Ecological Knowledge, in addition to Western Science.

Second, exploring the various "layers" of the world through embodied, sensory approaches can invite holistic perspectives in science education. As biologist and geologist Louis Agassiz once said, "study nature, not books" (as cited in Kohlstedt, 2005, p. 325). Drawing on Payne and Wattchow's (2009) "slow pedagogy of place" (p. 16), I advocate activities that engage students in slow, patient observation of their immediate surroundings, such as collecting experiential data in the form of writing, sketching or poetry, or "meditation in nature" programs that allow students to "lose track of time" in nature (David). Amy and Kelly's nature journals provided opportunities for students to attune to their familiar environments on a daily basis and notice subtle particularities in their daily experiences. Like Kelly, science teachers can also encourage students to attune to the sensualities of the aesthetic landscape by designing opportunities for students to describe what they see, hear, smell, touch and feel in the living, breathing landscape. As shared by the participants of the current study, there are a plethora of opportunities to explore how aesthetically-crafted pedagogies can reanimate students' sense of wonder for the world, such as discussing "big ideas" that relate to the scientific sublime (e.g., ecological interconnections), providing opportunities for aesthetic expression (e.g., poems, drawings, writings) or modelling passion and wonder for nature.

Third, I invite teachers to engage in conversations of ethics and morality in science education. I propose that such ontological and ethical conversations as related to their discipline are fundamental in order to guide pre-service teachers' professional training beyond a focus on practical, technical and methodological procedures of teaching. This is a difficult task as not many science teachers have training in the history and philosophy of science, let alone ethics (Abd-El-Khalick & Lederman, 2000; Wahbeh & Abd-El-Khalick, 2014); however, such courses could be taught as a part of pre-service teacher education or identified as a requirement to enter the teacher education program. Moreover, I invite science teachers to incorporate open-ended caring involvements in their science instruction, such as gardening, farming, cooking, animal care or nature conservation that may engage students in slow, spiral time modelled on children's play (Bonnett, 2004; Postma & Smeyers, 2012). As unstructured time and space become slowly diminished in education, there is perhaps a need to seriously reconsider the implications of such

fast-paced, fragmenting, linear and product-oriented aims of contemporary education in the name of progress (Orr, 1996).

It is important to note that my study did not aim to offer instrumental, definitive and practical answers on exactly how biology teachers' experiences in places influenced their teaching practices; rather it was a quest to understand particular biology teachers' sense-making experiences to find wholeness in their personal and professional lifeworlds. Thus, the study leaves some methodological questions on the pedagogy of places unanswered, such as "how to" develop a lesson plan to emphasize the interconnection of nature and culture or "how to" develop a lesson plan to engage students in an affective, corporeal and slow experience of the world. In future studies, teachers could be invited to participate in collaborative projects to design a "slow pedagogy" or "meditation in nature" program, as an example for the many ways that place-based approaches could be practiced in science education. As emphasized throughout, there are many ways in which teachers could infuse such sensitivities in their practices, thereby making prescriptive, deterministic and procedural ways of teaching impossible. As Parker Palmer (1998) once said, we often remember our favourite teachers for who they are as individuals infused with their subject matter as they shared an integral piece of themselves with us. In this manner, the current study places a focus on the individuality, multiplicity and verisimilitude of teaching, as there are many ways that teachers can choose to *be* in the classroom.

Furthermore, the descriptive nature of phenomenology does not provide answers to questions of "why," such as why there is a difference in the extent to which some teachers transferred their experiences of place into their practices. A follow-up poststructural analysis that explores the reasons for teachers' differences in the transfer of place-based approaches to their practices may be fruitful to understand the situational factors that mediate the translation of teachers' experiences of place into practice. Moreover, the study explored one dimension of participants' lifeworlds that influenced their pedagogies, which captures one of the many kaleidoscopic experiences that drive their pedagogies. While there is evidence to suggest how teacher education programs and school contexts impact teacher identity (Avraamidou, 2014), how everyday informal contexts such as family environments, hobbies or community activities influence science teacher identity development have not been fully explored, providing opportunities for future research to explore these aspects of the teacher identity. The participants in the study also largely recalled positive experiences in their places of meaning, although a few

described how negative changes in their places of meaning led to feelings of anger, horror and sadness. An exploration of "solastagia" (Albrecht et al., 2007, p. 95), or a sense of grief associated with environmental change in one's places of meaning, may provide further insight into how such difficult experiences in place can contribute to the making of teachers' negotiated identities.

In the current study, teachers were moreover invited to retrospectively recall places of meaning and teaching experiences of place. The focus was not on documenting the actuality of events as they unfolded but in capturing teachers' active meaning-making processes of their past experiences. During the study, many informants shared how reflecting on these experiences in place inspired them to try new place-based practices in the future; a follow-up case study that explores how teachers' pedagogies of places are enacted in practice may be useful to document changes in teachers' pedagogies. In addition, the present study focused on teachers' senses of place in relation to their teaching, and did not explore students' senses of place that they might bring into the classroom. Drawing on Lim and Calabrese Barton's (2006) ethnographic study of urban middle school students' senses of place, future research could focus on how teachers may invite students' multiple senses of place into the classroom to connect students to their immediate, familiar places of being. Moreover, teachers' and students' senses of place interact in the school, shaping and reshaping their identities through reciprocal interaction (Lauriala & Kukkonen, 2005). Research on how various senses of place intersect to form negotiated identities could be insightful to capture teachers' and students' identities as processes of becoming.

My pedagogical reflections on place may moreover be fruitful in pre-service teacher education. When asked about the experience of participating in the research in an informal debrief, participants shared:

> [It] made me think about [place]…to get [it] into perspective and be able to also…communicate that across and where exactly am I going. So it's just helping me clarify where I'm going and where I'm coming from…It was like a really good counselling session, only on something that's really important to me. (Kelly)
>
> By having these conversations, I've been able to… put things in place and see beginnings and endings and how things have fit together over the years. (Ella)

In the day-to-day busyness of teaching, teachers can adapt to the humdrum, ritualistic and procedural experiences and expectations of the school, and habituate to particular ways of being in the classroom (Rodgers, 2002a). By engaging teachers in a phenomenological inquiry of place in the current study, participants were encouraged to develop a perceptual awareness and mindfulness of the here-and-now, and participate in the meaning-making process of reconstructing previous experiences for future practices. In pre-service teacher education, teachers can likewise be asked to reflect on similar phenomenological questions about their origins and trajectories, such as their personal experiences in places of meaning and their future teaching experiences of place. While pre-service teachers may not yet have teaching experiences of place, they can be probed to imagine possibilities about future practices to explore future trajectories in line with their personal senses of self.

In *Teacher as Stranger*, Maxine Greene (1973) invited teachers to exercise "wide-awakeness" like a "stranger" (p. 6) looking inquiringly at the world, so that teachers begin to question why we do what we do:

> As we have said, we do not philosophize to answer factual questions, establish guidelines for our behaviour, or enhance our aesthetic awareness. We philosophize when we can no longer tolerate the splits and fragmentations in our pictures of the world, when we desire some kind of wholeness and integration, some coherence which is our own. (p. 11)

In this manner, Greene encouraged teachers to question the taken-for-granted perspectives to develop a consciousness for questions of why. These reflective practices therefore open more questions than answers, inviting teachers to ask, for example: Why do we teach science the way we do? Why do we value reason and logic as a way of knowing? Why do we not discuss issues of ethics and morality in science? How does our teaching relate to an authentic way of being? Why do we teach biology? In practicing such reflectivities in teacher education, teachers can gain a sense of consciousness for how one's identity is formed and an awareness for one's own agency in the meaning-making of their identities (Rodgers & Scott, 2008). Such a phenomenological turn in science education with an emphasis on the humanness of teaching can encourage teachers to frame their pedagogies towards a clear-sighted understanding of "what they are teaching *for*, and what they are teaching *against*" (Ayers, 2004, p. 18), which to me is an emphasis on relational caring *for* place and *against* decontextualized ways of teaching. I believe

that possibilities for thinking about science differently begins with our personal reflexivities of who we are and what we believe in relation to our teaching subjects.

Final Thoughts

These questions of why are what prompted me to return to graduate school and inquire for myself about what it means to be a biology teacher. As a science teacher in a private school, I found myself spiralled in a vortex with time constraints to "deliver and cover" the standards; over time, I became disoriented and disillusioned as I found teaching to be too procedural, too future oriented and too fragmented, as if the students were on a production line to be boxed into certain ways of knowing and being without consideration of the human element of teaching. Students, for instance, openly shared with me their aspirations for the future, such as how one planned to study science in a post-secondary institution because of high demand in STEM careers; others confided how they did not take senior science classes because they felt that they were not "good enough" to excel in the academic rigor often associated with "hard" science. My heart ached in such conversations where students seemed to make future decisions and judgments about themselves based on perceptions of science and its relationship to the society they inhabit, assuming the value of reductionist ways of knowing over holistic ways of being.

In those moments, I found myself reflecting on my core values and particular experiences in places that made me initially "fall in love" with biology. As I collected narratives of other teachers' places of meaning in this study, I was surprised to find common interweaving human experiences, albeit differences in how such experiences manifested in our teaching practices. Through such deep, passionate conversations with teachers about what inspired their practices, I realized what was missing in my approach to science education: an opening of the heart, the body and the spirit in (re)animating, (re)invigorating and (re)vitalizing our love for the world. Caught in linear time in a bounded, fragmented and knowledge-oriented society, I realized my neglect for the affective, emotional and artistic half of myself and in the students as well. In this sense, this study was a pursuit to understand for myself about what it means to experience a holistic, coherent sense of a whole as a human being immersed in the world.

All in all, *a* pedagogy *of* places challenges technical-rational ways of knowing and being in traditional science education. The notion of "place" in its complexity and multidimensionality refuses to be contained within stereotypical boundaries and binaries such as science-art, object-subject, nature-culture, non-human-human, intellect-emotion, mind-body, science-society and

knowing-being. While conventional conceptualizations of science often relate to the former counterparts of the aforementioned dualisms, often privileging its way of knowing as *the* way of knowing, a pedagogy of places challenges such dichotomies, seeking for a coherent experience of the whole. As Dewey (1934) wrote in *Art as Experience*, having *an* experience integrates the mind and body of the individual in the meaning-making of the experience, leading to a holistic "completeness of living" (p. 26) in the perceiving and the perceived. Similarly, Whitehead (1929) suggested that "there is only one subject-matter for education, and that is Life in all its manifestations" (p. 10), cautioning the dangers of "half-digested theoretical knowledge" (p. 6) pigeon-holed into its disconnected, abstract disciplines.

As Maxine Greene (2000) elegantly wrote in *Releasing the Imagination: Essays on Education, the Arts and Social Change*, we must learn to "see things or people big" and "see things or people small" (p. 9); that is, one must learn to see both the abstract representations of the whole (seeing small) and the individual everyday applications which make up the abstract (seeing big). Hence, what is required is the ability to navigate back and forth between seeing big and seeing small, or in seeing the abstract and the concrete across various spatiotemporal scales of science, and in interpreting the world of symbols without forgetting what the symbols mean; the map is not the territory, as the symbol is a representation and is not the same as the experience had in developing the representation. I argue that a phenomenological experience of place in science education encourages a re-rooting of one's place in the world, perhaps humbling the self that there is always more to see, understand and experience. I believe that such a philosophical "wide-awakeness" (Greene, 1973, p. 6) invites teachers to return to the heart of what it means to teach biology with the mind and the heart as whole. In sharing these stories of places with the broader teacher education community, I begin to humanize teachers as unique human beings with diverse stories to live by in a shifting, collective landscape.

Every now and then, I am reminded of the caribou migrating across the vast Arctic landscape in my place of meaning, the "sik-siks" (Arctic ground squirrels) emerging from a long hibernating winter and the mirror reflection of the cerulean sky on the stillness of the Arctic lake (Figure 10). I think about the dusty desert landscape of my childhood in Yemen; the scorching desert heat, the smell of freshly roasted coffee beans and chirping European bee-eaters in the mountains, reinvigorating a sense of reverie and belonging for the living landscape. As I reimagine my experiences in places, I see a mosaic, shifting and intersubjective landscape that

has shaped and reshaped my mindscape, defining who I am and who I wish to become as a teacher.

Figure 10. A silhouette of a caribou in the arctic tundra. Picture taken near the Tundra Ecosystem Research Station.

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Appendices

Appendix A: Letter of Invitation for Participants

November 24, 2016

RE: Invitation to participate in UVic biology teacher education research project

Dear Biology Teacher,

I am writing to invite you to participate in a research study entitled *Biology Teachers' Lived Experiences in Place*, conducted as a Master's of Arts project in the Department of Curriculum and Instruction at the University of Victoria.

As a high school biology teacher with international teaching and learning experiences, I have often pondered about the meaning one discovers in places, and one's sense of rootedness in relation to science education. For this research study, I turn to biology teacher colleagues to invite a conversation about what it means to have a sense of place. In the same way that ecology is a study of living organisms nested within complex interdependent ecosystems, I wish to understand how we, as biology teachers, are perhaps nested in particular memories of places. Why do we remember particular places and how do we implicate ourselves in the meaning-making of a place? How do these experiences drive teaching pedagogy, if any?

Participation in the study involves open conversations and journal writings about your lived experiences of places. All biology teachers in School Districts X, Y and Z[11] who are willing to share personal stories of places are invited. The study is an opportunity for teachers to engage in deep conversations on what a sense of place means to our personal and professional selves. The study may contribute to advancing current reforms in science education, such as place-based education. I believe that it is important to bring the voices of current practitioners to the research community; your contributions will be noted in the dissemination of data.

[11] District names have been removed to preserve the anonymity of participants.

The details of the study are outlined on the participant consent form attached. Should you have any questions, please do not hesitate to contact me (tnishiza@uvic.ca or xxx xxx xxxx) or my thesis supervisor, Dr. David Blades (dblades@uvic.ca or xxx xxx xxxx). If you are interested in participating in the study, please let me know at your earliest convenience. I look forward to hearing from you.

Kind regards,

Tomo Nishizawa

M.A. Candidate
Educational Studies (Science)
Department of Curriculum and Instruction
University of Victoria

Appendix B: Participant Consent Form

Dear Biology Teacher,

You are invited to participate in a study entitled *Biology Teachers' Lived Experiences in Place*. Should you have any questions or concerns, please contact Tomo Nishizawa, biology teacher and Master's of Arts candidate in Science Education in the Department of Curriculum and Instruction at the University of Victoria (tnishiza@uvic.ca or xxx xxx xxxx) and/or my thesis supervisor and professor of Science Education and Curriculum Studies, Dr. David Blades (dblades@uvic.ca or xxx xxx xxxx).

Purpose

The purpose of this study is to explore biology teachers' lived experiences of place of meaning and determine if these experiences influence their teaching pedagogy.

Significance of research

Science education has often been conceptualized by students as a set of abstract facts to be mastered and memorized for an exam. In the modern techno-cultural world today, many students are becoming increasingly disassociated from familiar, contextualized places of meaning. The study therefore invites biology teachers to explore the concept of place through their own exploration of places of meaning, and share how they do/may begin to contextualize the teaching and learning of science. The study investigates the possibilities of better understanding biology teachers' personal and professional identities by drawing on their experiences of places.

Participants selection

Biology teachers in School Districts X, Y and Z are invited to participate in the study. The selection criterion is based on participants' willingness to share personal stories of places.

What is involved

You will be asked to keep a journal to recall memories of places. Conversational meetings will be scheduled 3 to 5 times, approximately 1 hour each at a location of the participants' choice (e.g., local café). You will be invited to bring in objects or photographs that may represent your

sense of place. Conversations will be audio-recorded, photographs of artefacts (which do not include identifiable persons) will be taken, and photocopies of journal entries will be made. The duration of the study is approximately 1 to 2 months.

Inconvenience

The study involves personal time commitment to the activities described above. Please let me know if adjustments need to be made to the activities; I ask that you contribute as much as you are willing and able.

Risks

The study invites you to recall memories of places, which, depending on the nature of the memory shared, may stir personal emotions. The purpose of the research is not to resurface undesired memories; rather, you will have control over what memories you would like to share.

Benefits

The study is an opportunity for you to engage in rich contemplation of what a sense of place means to yourself and how this may have implications for your pedagogy. The study provides opportunities to pause, reflect and engage in deep conversations about who we are in relation to particular places, and may be fruitful to rekindle and/or reaffirm our understandings of what it means to be a biology teacher. Furthermore, the findings may have significant implications for advancing current reforms in science education, such as place-based education.

Voluntary participation

Participation in the study is voluntary. The study asks for your ongoing consent throughout the duration of the study, and your ongoing consent will be confirmed verbally at each interview. However, should you wish to withdraw at any point in the study, you may do so without any explanation. Data collected up until that point will be automatically removed and deleted from the study.

Anonymity & Confidentiality

Pseudonyms will be used to protect your identity. Your school of employment will also remain anonymous. Confidentiality will be protected by saving all collected data in a password-protected folder.

Dissemination of data

The results of the study may be shared with the wider teaching and research community, such as through conference presentations and written publications (e.g., journal articles).

Disposal of data

The data collected in the study will be disposed seven years after the date below.

Should you have any questions or concerns, please contact Tomo Nishizawa or Dr. David Blades for further information about the study. Alternatively, please contact the Human Research Ethics Office at the University of Victoria (ethics@uvic.ca or 250 472 4545).

By signing below, you indicate that you have read and understood the conditions of the study and that you consent to participate in the research study.

_____

Name of Participant

_____

Signature

_____

Date

Appendix C: Journal Entry Prompts

Journal entry prompt 1.

I'd like you to close your eyes and think about a place, that really means something to you deep in your heart. – Robert Bateman

Think about a place that means a lot to you. This place of meaning may have been encountered at any point in your lifetime, and could be anywhere, in any context. What was this place like? Think back to the experience that you had in the place. What was this experience like?

Try to focus on a single place and let your thoughts flow, as if you were experiencing the place again for the first time. Detail this experience as much as you can. Simply reminisce the moment as you lived it and let the pen flow.

Here are some additional questions to think about. These questions do not need to be all answered; there are simply guiding questions to probe your initial thoughts about your place of meaning.

- Where was the place?
- What were you doing in the place?
- When did you visit the place? How often did you visit the place?
- Were you with someone or were you alone?
- How did the experience in the place make you feel?
- How often do you remember this place?
- When do you think about this place?

If you have any artefacts related to your experience in this place (e.g., photographs or objects) that you would like to share, please bring them to our meeting.

Journal entry prompt 2.

We have recently been talking about places that mean a lot to you as a person. Now think about your places of meaning in relation to yourself in the classroom as a biology teacher. Was there a time in your teaching career when you shared a particular experience of place with your

students? Think back to this particular experience that you had with your students. What was this experience like?

Here are some additional guiding questions to think about. These questions do not need to be all answered; there are simply guiding questions to probe your initial thoughts about your experience.

- What were you doing? What were the students doing at that time?
- Where was the place?
- Did you plan this experience for your students?
- How did the teaching experience make you feel?
- What do you think the students were feeling and experiencing?
- How often do you remember this experience?

If you have any artefacts related to your experience in this place (e.g., photographs or objects) that you would like to share, please bring them to our meeting.

Appendix D: Interview Questions

Interview questions 1: Experience in place of meaning.

Tell me a story of a place that means a lot to you.

- What is it like to have an experience in a place?
- Where was the place?
- What were you doing in the place?
- When did you visit the place? How often did you visit the place?
- Were you with someone or were you alone?
- How did the experience in the place make you feel?

Why *this* place and not another?

- How often do you remember this place?
- When/in what situations do you think about this place?
- How does it make you feel when you think about this place?
- Did the experience in the place influence you in anyway? If so, how?
- Anything that you took away from this particular experience that you "carry" with you still?

Interview questions 2: Teaching experience of place.

Tell me about a time in your teaching career when you shared a particular experience of place with your students.

- What is it like to share an experience of a place?
- What were you doing? What were the students doing at that time?
- Where was the place?
- Did you plan this experience for your students?
- How did the teaching experience make you feel?
- What do you think the students were feeling and experiencing?
- How often do you remember this experience?

Why *this* experience and not another?

When/in what situations did you share this experience?

- How often have you shared this experience?

- Did the experience influence you in anyway? If so, how?
- Why do you teach biology?
- What does it mean for you to be a biology teacher?
- To what extent do these experiences in place drive your teaching practice?
- What advice do you have for the science teacher education program?
- Any other comments/questions that you'd like to add that has not been addressed in our conversation?