Salmon People

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Abstract

This article explores the research and production processes for my public art new media project, called *Salmon People*, and the ethics of interspecies creativity that emerged. The research includes knowledge on the ecologies dependent on the Fraser River — a water system that supports aquatic life, and forests, grasslands and marshlands that run along its sides, and Sockeye salmon populations' migration projects. This article presents knowledge from marine biology on the various migrations of Sockeye during their lifetime, and how an understanding of these can expand our respect for this keystone species. The essay describes methods used in the production stages: care ethics, indeterminacy and generative art techniques, and how these informed the development of an interspecies project for public audiences.

Keywords

Salmon, Fraser River, Ecology, biophilic ethics, interspecies art, indeterminacy, generative art

"Who knows what admirable virtue of fishes may be below low-water-mark, bearing up against a hard destiny. . .?" — Henry David Thoreau[1]

Salmon Lesson

In the summer of 2015, I was sitting at my computer in my studio examining video footage I had recorded in the fall of 2010 of sockeye salmons[2] preparing to spawn in their natal streams at the Adams River, a tributary of the Fraser River. The footage was recorded using an underwater camera and showed details of the salmons' spawning activities. I was looking at these clips in the process of creating *Salmon People*,[3] a project in collaboration with Simon Lysander Overstall, commissioned by Surrey Urbanscreen, an off-site venue for the Surrey Art Gallery that uses an exterior wall of the Chuck Bailey Recreation Centre as an outdoor projection surface for large-scale moving imagery.[4] The intention was to create a site-specific project, exploring human and salmons goings-on within the ecologies of the Fraser River near the Surrey Urbanscreen location. As I followed the imagery in one of the video clips, an event caught my eye. The salmons were doing things I didn't remember seeing when I looked at the videos five years ago. I scrolled back to the beginning and looked again. The imagery wasn't bright enough to include in the project, but it provided a lesson about interspecies art processes.

The clip was underexposed, and the frame moved slightly as the camera vibrated in the force of the moving stream. It showed a group of salmons huddled together on the left side of the frame. Bright red male and female bodies oscillated together in the current. They used skillful micro-movements to hold their position. The way they clustered together made me think that they were avoiding something. I looked at the direction of their gaze — they were looking right at the camera. This had the effect of them looking at me now, as I watched them. Then, one salmon separated from the group and quickly crossed in front of the camera and exited the frame. The remaining fishes jostled to rearrange themselves, and again, watched and waited. Then, another darted across. I realized what had happened. The fishes had been waiting to gather enough courage to swim by the camera and the cinematographer. When I became aware of this, an image came to mind of a bear poised atop a waterfall grabbing at salmons as they leapt up the falls. In my recorded clip, the salmons were similarly forced to swim past a perceived threat. My crew and I had not intended to present difficulty for them, but it was clear that the camera was creating another temporary obstacle in the last portion of their journey to spawn. This realization helped me understand that the salmons and I, our crew, our equipment, and processes were entangled in the production of meaning.

This article explores the research and production processes for our public media art project *Salmon People*, and the ethics of interspecies creativity that emerged out of those processes. It provides knowledge on the ecologies dependent on the Fraser River — a water system that supports aquatic life, and forests, grasslands and marshlands that run along its sides — and the Sockeye salmons' spawning and migration projects. The article describes how care ethics, indeterminacy and generative art techniques informed this interspecies project for public audiences.

River

The Fraser River is a large and important ecosystem in the province of British Columbia (BC). Its tributaries support coastal rainforests, grasslands and the endangered inland rainforest.[5] The Fraser's water system sustains more than 150 salmon populations.[6] It supports both land and aquatic biodiversity, and is the province's largest watershed, draining one quarter of its rain, snow and glacial waters, which send 113 cubic kilometres of fresh water yearly into the Pacific Ocean — three times the amount of water used annually by Canadians.[7] It also sends 17 million tonnes of sediment, containing plant matter and minerals that support the ocean's ecosystems, into the Salish Sea at the mouth of the River.[8] The Fraser is also the province's most endangered and polluted river, a result of large-scale human activities. It is used for 48% of the province's forestry, 44% of farm land, and 80% of annual economic production.[9] Because of these industries, its sediment also contains fossil fuels, phosphates, nitrates and other contaminants.

The Fraser not only supports industries along its waters, but is continually under stresses due to expanding human development. Proposals for industrial shipping in the lower Fraser have increased significantly in the past few years. Some of these have been halted through the work of environmental advocates, but the ones that have been approved bring intrusions into marine habitat, and increases in toxic cargo shipped daily on or near the Fraser. In 2012, a new coal port was proposed at the Fraser Surrey Docks that would have increased yearly river traffic with 640 open barges containing US coal — each the length of a football field — towed down the river to the Salish Sea. Fortunately, this proposal was not approved because of criticism about its environmental impact.[10] In 2011, Deltaport Terminal 2 was proposed as a new container terminal to sit on critical salmon and orca habitat and lands for migratory birds. Despite Environment Canada's negative review of the proposal, a public hearing process is currently underway.[11] In 2014, a WesPac terminal on the Fraser near Surrey was proposed that would send 120

tankers and 90 barges of liquid natural gas out on the River each year. This project is also currently under public review.[12] A jet fuel terminal at the South Arm of the Fraser River has been approved and will see 70-120 tankers per year travel with volatile toxic jet fuel to the Fraser River docks.[13] The fuel will then travel 13 km via pipeline to the Vancouver International Airport.[14] This project has been criticized by scientists and the public for its threat to the Fraser River salmons. A spill caused by any one of these projects will have devastating effects on the salmons and other marine life who are already suffering from the stresses of climate change, human development and over-fishing.

The Fraser system is populated by a variety of different salmon species — Pink, Chum, Chinook, Coho, Sockeye — each with unique biological traits and migratory traditions carried out in relation to the qualities of their natal streams, lakes, rivers and the Pacific Ocean. Pink are more tolerant of warm waters; stream-type Chinook spend more time in fresh water, sometimes years; ocean-type Chinook leave the streams for the ocean almost immediately upon hatching. For Chum, the most successful breeders are five to six years old, compared to the typical four-year-old Sockeye. Recent research shows that in places where salmon diversity is supported, their overall abundance remains high from year to year. This is because different salmon populations have evolved to flourish in different ecosystems. However, shifts in climate conditions will challenge these species. Today's salmon populations in the province are endangered — with 90% of total salmons originating from less than ten nursery lakes.[15]

The Fraser River is home to the largest number of distinct Sockeye salmon populations of any watershed on earth.[16] A salmon population is defined as a group of salmons native to a specific stream, and who do not breed with salmons from other natal streams.[17] Salmon populations associated with the Fraser River spawn in more than 150 natal areas throughout this watershed. A typical life cycle of Sockeye born in the streams and lakes feeding the Fraser include a number of migrations. These embody the ecological connections between land and sea, fresh and salt waters, human and more-than-human life, but they are significantly challenged by today's industrial, climatic and development changes.

Sockeye populations that migrate back to their natal streams surrounding the Fraser are highly variable, and have generally been in steep decline over the past decade. The decline is due to human-imposed challenges, such as overfishing and climate change. The years 2007-2009 had some of the lowest returning population numbers on record.[18] In 2009, only 1.5 million Sockeye returned to the Fraser, the lowest count since 1947.[19] As a result, the

Cohen Commission was established to examine the current status of 32 genetically distinct populations of Fraser Sockeye populations. Scientists found that eight populations are already extinct or nearly extinct.[20] Of the 24 remaining populations, at least seven were in the "red zone" — at risk of extinction. Only four were clearly in the "green zone."

Salmons are generally intolerant of warm water. If the river water reaches 20 degrees Celsius, the fishes are likely to die of heart failure during their migration within the River's system. Over the past fifteen years, Fraser River Sockeye have experienced an increase in pre-spawning mortality. The challenges of warm water and low water levels from climate change have contributed to this high mortality rate. A warmer climate results in lower water levels in the River, higher water temperatures and increased pathogens.[21] All of these challenges cause energy depletion for the salmons. The Fraser is now two degrees Celsius warmer than it was ten years ago.[22] In 2014, the Fraser was recorded at four degrees Celsius above average, and the River's volume level was 30% lower than average. That fall, 1.7 million late-run Sockeye were counted as having gone upriver, but never reached their natal streams.

In the summers from 2015-18, forest fires raged and the province sweltered, and this had an effect on the Fraser. Snow packs were zero in many tributaries. Historically, snow packs melt slowly at higher elevations, replenishing streams and rivers with cold water during the hottest summer months — crucial events for salmon migrations. Because of the warmer winters and lack of snow, there is less cool water entering into the River. In 2015, the volume of the Fraser near Hope (a town at the confluence of the Fraser and Coquihalla rivers) was 17 per cent below normal. In the main arm of the Fraser, right around Surrey, the water temperature hovered above 19.8 Celsius.[23] That autumn, the total Fraser Sockeye was 2.1 million, far below the forecast of 6.8 million fishes.[24]

Ocean temperatures also play a critical role in salmons' survival. Even a small increase in temperature will have drastic effects on the their growth due to reductions in available food. Unusually warm ocean temperatures were observed in the northeast Pacific Ocean throughout 2014 and into 2015.[25] It is predicted that the years 2018 - 2022 will see extreme warm events in the Pacific Ocean surface temperatures.[26] In a warmer ocean, the food supply for salmons is reduced during their years spent there. A warm ocean affects their abundance, their age-at-return, their health, and therefore their success during migration to their spawning grounds. In the last few years, even the Adams River Sockeye — one of the most successful populations — has been dramatically affected. Tens of

thousands of fishes died and washed up on the River's banks before spawning. Imagine swimming hundreds of kilometers up the Fraser to the natal grounds, and not having the energy to spawn.

Salmons at the Adams River spawning grounds

In 2010, the Adams River Sockeye salmon run was predicted to be the largest in 100 years, with an estimated nine million returning salmons. It was described as a once-in-a-lifetime opportunity to witness a migration of that magnitude. I decided to make the trip to the Adams, along with graduate students, Elisa Ferrari and Paolo Pennuti, to record underwater video. At the time, I did not have an idea of what form the art project would take, but I developed an interspecies indeterminacy method to inform the recording stages.

It was a clear warm October afternoon when we arrived at Tsútswecw Provincial Park that surrounds the Adams River spawning grounds (Figure 1). The parking lot was packed, and Park employees guided arriving visitors to available spots. We parked and entered the trail that runs along the Adams River. Within a few hundred metres, we came to the first viewing platform overlooking the water 30 meters below. Just under the river's surface, a group of bright red salmons — thousands of them — crowded up against the bank. They were resting against the current before their final move to their natal stream beds.

2010 was considered a 'dominant' year, when the number of returning salmons to the Adams River would be substantially greater. Dominant years include runs that are significantly larger than other years.[27] During dominant years, Tsútswecw Provincial Park hosts a "Salute to the Sockeye" celebration that typically accommodates 150,000 visiting humans.[28] That fall was a gathering of salmons and humans like no other. It was estimated that 8.6 million fishes returned.[29]

Most visitors to the Park keep to the main trail and the viewing platforms. From there, visitors can see the salmons at the water's edge, but it's difficult to get a sense of the scale of the migration. To get a better sense, one has to walk the smaller trails beside the streams.

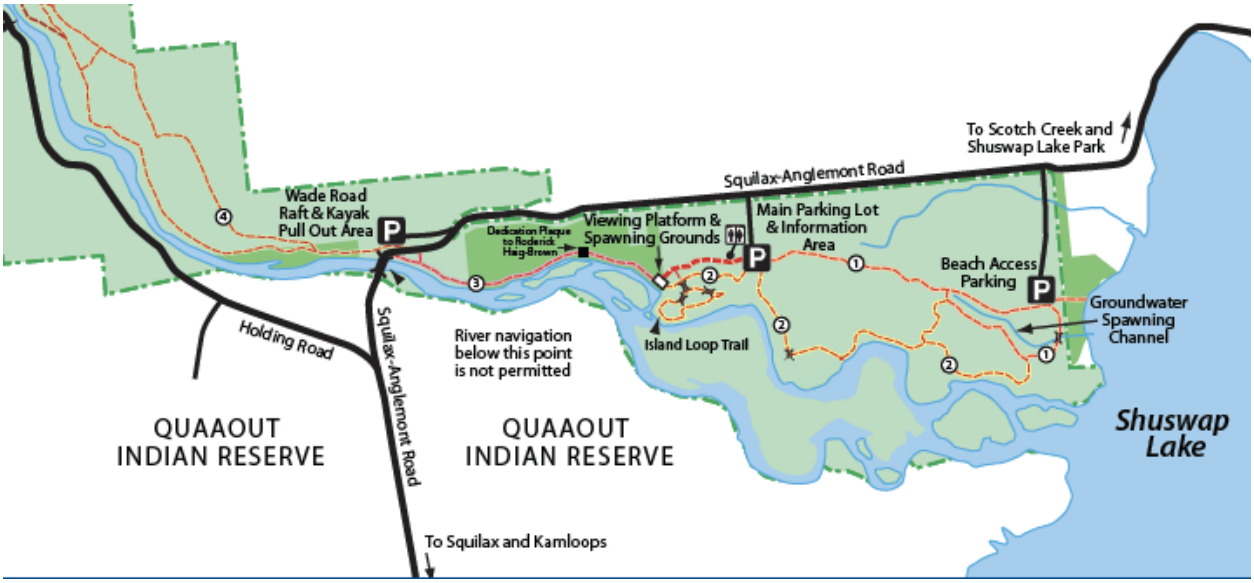

Figure 1. Detail of Province of British Columbia BC Parks' Trail Map for Tsutswecw Park. Copyright (c) Province of British Columbia. All rights reserved. Reproduced with permission of the Province of British Columbia.

The streams were shallow and exposed to the sun. The waters' surface sparkled, and sun-lit yellow pebbles and sand formed their beds, creating a golden backdrop for the red fishes (Figure 2). Some salmons still worked their way up stream, some were paired and already spawning. I looked closely at the bottom and could see pink colored eggs. In this intimate location, I felt like an intruder, and the salmons were aware of my presence. They gazed up at me as I looked at them.

Figure 2. Still from video showing salmons in spawning channel. Photo courtesy of Elisa Ferrari and Paulo Pennuti.

Returning to the main trail, we headed to a spawning channel shaded by surrounding trees. Other visitors seemed less interested in this area, so we were alone with the fishes. The channel was fed by cool water that gently percolated up from the stream bed. In these tranquil waters, the salmons appeared larger, and they looked back at us standing on the bank. We continued along the trail to the end where it opened up to Shuswap Lake. There, we got a clearer sense of the magnitude of the Sockeye migration.

A crowd of people stood on the rocks at the edge of the lake. A scuba diver with an underwater camera rig stood in the water. We looked further along the lake's edge and saw vast quantities of dead salmons. We needed to get a closer look, so we walked back to the truck to get the canoe, brought it back to the lake, and paddled out into the waters. From there, we could look down into the Shuswap's depths, and back at its banks. Salmon bodies lined the shore in the tens of thousands. As we canoed for an hour along the lake's edge, a continuous accumulation of red bodies marked the shore. The dead fishes were deposited by the action of the lake's waves and currents. Looking down into water's depths we could see salmons everywhere, floating just a few meters below the surface. Some, with gills flaring, arced their bodies in their final moments of life.

We paddled back, past the launch area, and watched a team of marine biologists counting the dead fishes' bodies. Because of the declining numbers, these biologists were studying the challenges facing the returning salmons. The workers on the shore were estimating salmon numbers and recording how many had successfully spawned.[30] Each held up a dead salmon, examined it for a tag, determined the salmon's sex and whether it had spawned. This took only a few seconds. Then, to make sure the fishes wouldn't be counted twice, they'd slashed the body in half with a machete: a final human gesture inscribing yet another mark on the bodies of these aquatic individuals. The whole process had a mechanical quality of calculated efficiency. Suddenly, I was filled with respect and wonder at how these small-but-mighty beings were able to carry out their tremendous migrations under such extreme conditions.

Salmons' migration projects

The Adams River Sockeye have a variety of migration projects they undertake over their lifetimes, in response to the rhythms and geography of the Earth. I call these migrations 'projects' to emphasize the undertakings as intentional with specific objectives. Projects include micro-migrations when they first hatch, to their epic river migrations to and from the Pacific Ocean. Knowledge from marine biology can create greater public respect for these remarkable animals, and for their ecological roles in connecting water and land habitats over great distances. If we look at the details of each migratory stage, we can come to appreciate the salmons' remarkable abilities.

Sockeye salmon begin their lives in the fall when adult females lay their eggs in their natal streams, and males fertilize the eggs with their milt. In mid-winter, the eggs hatch into their alevin stage. These tiny larvae sense the depth of the water and either migrate deeper into the gravel or move away from the stream margins if water levels have dropped.[31] In deeper water they won't freeze or dry out. The alevin live off the yolk still attached to their bodies.

In the spring, the alevin hatch into fry and immediately migrate out of the safety of the gravel and up to the water's surface. They take in a gulp of air to fill their swimbladders.[32] This migration is enacted at night to avoid predators.[33] Also at night, the fry migrate from the stream to their nursery lake[34] through the use of rheotaxis — a sense that allows them to orient their bodies in relation to the water current.[35] Once they reach the nursery lake, they spend the next few weeks in waters of the riparian areas, where dead trees and logs decomposing in the water provide nutrients, cool water, and hiding places from predators.[36] The juvenile salmons make vertical migrations

within the lake's waters, according to day-night rhythms, in order to forage for food and avoid predators, such as bigger fishes, kingfishers, otters, and terns.[37]

After one or two years, the young salmons prepare themselves for their Fraser River migration by undergoing physical changes called smoltification, and by refining their senses that assist them in their journey to the Pacific Ocean.[38] The smolt use the downstream current to carry them on their way combined with active swimming that assists them to travel 10-20 km per day. The smolt don't eat much on this migration, instead relying on their stored energy.

Challenges along the way significantly affect their migration and therefore survival. For instance, hydroelectric dams and agricultural development can pose lethal challenges. Some dams are fitted with bypass structures that allow the fishes to migrate. However, these can cause delays of several weeks for the smolts' arrival to the ocean. Any delays can take a toll on the smolt who may die from exhaustion and starvation. Even under favorable conditions, smolt usually arrive at the entrance to the Ocean in a malnourished state.[39] Smolt that do make it to the Fraser estuary, need to spend time acclimatizing to the ocean waters.[40] Overall stresses along their journey would have resulted in elevated cortisol levels which can cause the smolt to enter the ocean before they're fully acclimatized.[41] Early entry can result in young fish unprepared to survive the salt water.[42]

The ones that survive migration into the salt water feed in bays and coastal environments until they are ready to enter the oceanic system. They'll need to avoid predators such as seals, flounder, gulls, sea lions, mackerel, shark, dolphin, orcas, and humans. When they're ready to move into deeper water, they will spend two or three years moving in counter-clockwise migrations around the northeast Pacific.[43] During their ocean lives, their specially adapted senses and cognition will assist them in their travels.

Salmons create a mental map of the Earth's magnetic fields, sensing the intensity and inclination of these fields to determine their travels.[44] In the Pacific Ocean, they forage for favorable feeding sites that provide them with optimal nourishment. During the last six months of their life in the Pacific, they will gain about half their adult mass. Fishes evaluate whether their weight condition is appropriate for the challenges of the return Fraser River migration.[45] Some may decide to stay another year in the Ocean in order to gain more mass and fat for the journey.

Adult salmons who are ready to undertake spawning migration pay attention to the seasons, sunlight and water scents in order to time their arrival at the mouth of the Fraser. They find their way back to the River with their highly refined olfaction. They make vertical and horizontal movements within the layers of the Ocean's water to

find the appropriate scent to guide them. Salmons can detect the scent of their natal stream in the ocean; they can sense 1 drop of water from their natal stream in 8 million liters of water.[46]

To find their way to the River, the salmons depend on the light and landmarks to assist them, and the changes in water's salinity levels. When they are 700 - 250km away from the Fraser's entrance, they begin another physical adaptation, this time to fresh water. They sense the flow and temperature of the River to help them choose the best moment to enter the fresh water. They wait and feed at the River's mouth for this moment.

The river migration may be the most challenging one for the Adams River Sockeye. When they enter the Fraser, the fishes do not feed for the remainder of their lives. All the energy for their physical changes, travel, and spawning comes from stored ocean nutrients. Their blue-gray ocean-bodies transform into brilliant crimson river-bodies. The males develop a hooked jaw and prominent teeth to use to defend their future spawning sites.

The Adams River Sockeye travel 485 km back to their natal grounds, a journey that includes swimming east up the Fraser River past Mission, Chilliwack, and Hope, through Hell's Gate — a narrowing of the River with extreme rapids — through Lytton, where the Thompson River joins the Fraser, and east up the Thompson River, through Ashcroft and Kamloops Lake and out the other end into the South Thompson River.[47] They swim through Little Shuswap Lake and into Shuswap Lake where they head west to the Adams River spawning grounds. This journey is accomplished at approximately 37 km per day over a 14 -17 day period.[48] The round-trip lifetime migrations for an Adams Sockeye totals an incredible 4,000 km.

Each surviving female Sockeye locates her birth stream, and begins preparations for spawning. They examine the stream's gravelly bottom; too much silt or sand will smother the eggs. A location with relatively calm water is best. Each female digs a nest by turning on their side and repeatedly striking the stream bed with her tail. This removes silt and sediment and creates a depression. When the nest is ready, the female is approached by a male salmon. When she chooses a suitable mate, the pair will quiver above the nest simultaneously laying eggs and depositing milt. The female then moves upstream to dig the next nest. In the process of digging the new nest, she covers the previous one. She creates three to seven nests to form a redd, each with 500-1100 eggs — 4000 eggs total.[49] Once spawning is finished, females stay with their redd until they die, protecting it from other females who may dig up the eggs in their own nest building activities. The males may try to find new mates and continue to spawn until they too die.

The Adams River is one of the largest remaining Sockeye salmon migrations in the world. However, even this relatively abundant population is suffering from the effects of human activity. Of the 4,000 eggs deposited by a single female Sockeye, only about 800 hatch. Of the fry, only 200 survive their migration to the Ocean. Of those, ten may survive to adulthood, and only two may survive the migration back to the spawning grounds where their lives began.[50] These low returns are due to the anthropogenic stresses of warm water from climate change, over-fishing, dams and industrial and agricultural development.

The Province's forestry practices are reducing snow accumulation and therefore affecting the water levels necessary for the salmons' flourishing.[51] Land clearing for forestry, agriculture, urban development and industry produces sediment in the streams. This can smother eggs and affect the gills of small fishes. Developments that remove riparian vegetation can diminish shade that cools the water and provides safe areas for the fry. Pollutants from road run-off, household products, farming and industrial spills make their way into streams and rivers causing toxic stresses on the fishes. Improperly installed water structures, such as culverts, dams and channels can block salmon migrations. Salmon runs like the Adams used to happen in rivers throughout the world — in Scotland, Norway, on the Atlantic coast. Those other big runs are now gone.

Sockeye are considered a keystone species because they are critical contributors to the complex land and water ecologies around the River. Their bodies feed other wildlife — wolves, bears, coyote, eagles — and the surrounding ecosystems. Forests connected to watersheds contain ocean-originating carbon and nitrogen from the salmons that are consumed by land-based predators.[52] The forest ecosystems depend on these ocean nutrients; the ones that have salmon migrations have greater biomass and biodiversity.[53] Salmons who successfully spawn even become food for the next generation; their bodies feed insects and zooplankton, which in turn feed young fishes.[54] The salmon's lifetime migrations link varied ecosystems over vast distances. Their migration projects support the flourishing of other animal and plant beings, including humans. Respect is owed to these fishes who provide lessons in ecological consciousness.

Until recently, it was believed that fishes were not sentient. However, current consensus among marine biologists is that fishes are conscious and do feel pain.[55] They even experience joy, rage, frustration; they form social pacts; enjoy the pleasure of touch; and have communities and ancient cultures.[56] This new knowledge of fishes' experiences suggests that humans need to reconsider their relationship with fishes. A public understanding is

needed of how these animals have rich lives and traditions. This speaks about a need for biophilic ethics — a consideration of nonhuman others' intrinsic value and projects in the world, beyond their utility to humans.

Biophilic ethics calls for an openness to difference based on species-specific sensing, perceptual and cognitive capacities, without valuation based on human traits.[57] Claims of "higher" or "lower" lifeforms in relation to humans have no validity when considered through the lens of evolution — each species has evolved the capacities needed for flourishing within the ecosystems they inhabit. Nonhuman animals' traits have adapted for them to survive and flourish within conditions of their ecological niche. For instance, Sockeye know the materiality, geography, and forces of the Earth; they sense magnetic fields, ocean currents, the scent-specifics of water. They navigate using the sun, seasons, landmarks, ocean currents, and they follow the scent of their natal stream. Through sensing, perceiving and minding, these fishes problem-solve, learn, remember, and initiate short-and-long-term migration projects. Their species-specific capabilities help them carry out the projects necessary for their survival and growth. Salmons also connect with the flourishing of other beings and ecosystems — humans, birds, ocean predators, grasslands, forests. Their migration projects co-create the relational phenomenon that is the living Earth.

Biophilic ethics is an ecological view that values diverse minds that are world-forming.[58] If we consider the complexity of salmons demonstrated by their migration projects, and their linkages to other lifeforms, renewed respect for these wild-living beings is brought to bear.

Salmon People

Public art can participate in creating improved understandings of fishes and our shared ecologies. This section of the article will detail the processes used to produce *Salmon People*, and the methods and techniques that informed this interspecies art project.

In the fall of 2010, while preparing to record the underwater footage of the Adams River Sockeye spawning, I experimented with indeterminacy processes informed by Fluxus artists of the mid-twentieth century. Indeterminacy, used for interspecies art, can allow for a reconsideration of human authorship by making space for more-than-human creativity in the production processes. In the processes of *Salmon People*, I developed a method of interspecies indeterminacy to use in projects involving other animals, and I continue to use this method in current projects.

Interspecies indeterminacy is informed by aspects of twentieth century modern art practices that used instructional systems to allow for indeterminate results. Fluxus, a group of artists working from 1960s to the late 1970s, are best known for developing participatory events called *happenings.* They believed that art had reached a limit through constraints of mainstream culture, and that it did not reflect the complexity and vitality of everyday life.[59] For instance, mainstream cultural productions use substantial constraints to determine the outcome of the final production. Movie productions employ highly controlled conditions such as script, screenplay, cinematographic direction, actors' direction, editing, and soundscape composition. These constraints provide predictability for the movie's final form, and therefore reflect the original vision of the artist-director. Similarly, in classical music there are detailed constraints provided by a score and the conductor's direction. The musicians perform within the bounds set by these constraints, and they are afforded only a limited amount of flexibility. In the presentation of these productions, the audience is also constrained. The viewers or listeners experience the film or performance, but do not significantly contribute to its content. These constraints produce *determinate* results, and provide control for the director-writer-composer-conductor who claims authorship.

In contrast, Fluxus artists experimented with participatory processes that allowed for *indeterminate* aspects to significantly contribute to the art. They called these events, initiated by a set of simple instructions conceived in advance, and enacted by audience participants, *happenings*.[60] The variability of the participants' interpretation of the instructions would allow for unexpected — indeterminate — aspects to emerge. This is a participatory method that calls into question assumptions about the role of the artist and the audience. The performance of the instructions, not instructions themselves, are consider to be the artwork. Fluxus artists proposed that using indeterminacy methods through instructional systems could provide for occurrences reflecting the relational complexity of everyday life.

Yoko Ono and John Cage, artists of the Fluxus movement, used instructional systems that also explored nonhuman creativity. Cage (1912-1992), a sound and performance artist, integrated methods described as "chance operations" which allowed for indeterminate sonic results. Cage's methods were a departure from conventional music conventions that favored compositional constraints such as key, melody, harmony, rhythm, etc. Instead he used the *I Ching* hexagram as a system to create the final form of his sound works. For example, in the process of making *Bird Cage* (1972), Cage used an *I Ching* hexagram to sequence and mix sets of recordings into a final soundscape.[61] In preparation, he made recordings from three sources: birds in aviaries, a recording of himself singing a piece based on the writings of Thoreau, and a variety of environmental sounds. These recordings were set

up into eight channels of sound, and the playback sequence of the recordings was determined by another *I Ching* hexagram. The channels' output was recorded onto sub-master tapes and these were also subject to *I Ching* chart to process the type, duration and timing of electronic effects on the sounds.[62] The result was a twelve-channel blend of human, bird, environmental and technological sounds. The system allowed for indeterminate results to emerge for the audience, creating a complex listening experience similar to those within everyday sonic environments. This system also allowed for a democratic production process where all contributors to the recordings — human, birds, synthetic, environmental — participated in the creation of the final form.[63]

In 1964, Yoko Ono (b.1933) printed 150 instructional pieces published in a book called *Grapefruit*.[64] *Secret Piece* (1953) is one of the works, and involves human participants performing a set of instructions in relation to wildlife. The instructions for *Secret Piece* are: "Decide on one note that you want to play. Play it with the following accompaniment: The woods from 5 a.m. to 8 a.m. in summer."[65] This work is an adaptation of Fluxus' participatory methods by involving free-living nonhuman beings. Here, the context of the woods sets the conditions for contributions from wildlife within a situated ecology. One can imagine playing a note accompanied by bird and plant sonics. The specified time and season present probabilities in terms of nonhuman contributions; likely birds would be enacting a dawn chorus and leafed-trees would be sounding in the early morning breeze. The resulting event emerges as a co-creation between the artist, human performer and the nonhuman contributors.

In *Secret Piece*, Ono's instructions support an indeterminate event where the woods' accompaniment is not controlled by the artist or human performer. Each time *Secret Piece* is enacted, a richly different result is generated by the complexity of its site-specific location and timing. Assumptions about [human] participants and audiences are also called into question by providing opportunities for other beings to listen and participate. *Secret Piece* is an early example of an artwork that uses interspecies indeterminacy methods where all beings and forces site-specific to the location can contribute to the art event. Birds communicate, trees make soundings with the forces of the moving air, humans offer up a sustained note as an experiment to create in relation to one another. Both Cage's and Ono's art works draw attention to more-than-human creativity. These interspecies indeterminacy methods inform the *Salmon People* production processes.

In 2010, I developed an instructional system for the cinematographers to follow while recording the underwater footage of Sockeye on-site at Adams River. These instructions set the conditions for the participation of the cinematographers and fishes to generate indeterminate results: "Without disturbing the salmons, set up an

underwater video camera in a fixed position on the bed of a natal stream. Record for approximately two minutes. Repeat many times and in many locations over the course of two days."

This instruction did not pre-determine the details of what to record, as would conventionally occur in a film production, but instead allowed for indeterminate outcomes based on the participation of the fish in front of the camera. The recording sessions resulted in clips that captured the complexity of salmons in action in relation to features of the locale: a female on a nest being circled by a male, hundreds of yellow salmons' fins piercing the water's surface, red eggs floating in dark water, shimmering bodies running powerfully against the current, fishes looking back at the camera. When I reviewed what we recorded I recalled my first snorkeling experience: dipping my head into the ocean water took my breath away as I saw the underwater world of fishes busy with their daily lives and with each other (Figure 3).

Figure 3. Still from video footage from *Salmon People* recording processes showing salmons running against the current. Photo courtesy of Elisa Ferrari and Paulo Pennuti.

At the time of recording the footage, we had no preconceived idea about the art project's final form. Would it be an installation, a documentary video, an interactive interface, a performance? The final artwork did not fully emerge until five years later, informed by research about salmons and their migration projects, about ecologies of the Fraser River, and the human development undertaken within these systems.

In 2015, when Simon Lysander Overstall and I were invited to create a project for Surrey Urbanscreen, we researched how to create an artwork that could be site specific in relation to the exhibition location. The footage from 2010 was a good fit because of the exhibition site's proximity to the Fraser River — the River's south bank defines Surrey's northern boundary. The salmons in the 2010 recordings would have swum by Surrey in their migration up the Fraser to the Adams River spawning grounds. The commission presented opportunities to explore the interconnections of salmons and humans within the ecology of the Fraser, and be site-specific in relation to Surrey Urbanscreen.

To depict the interconnected human and fish ecosystems of the Fraser, we decided it was important to record video showing the human activities on the River. For this stage, like for the Adams video recordings, I created an instructional system for the cinematographer, an undergraduate student, Jonathan Nunes: "In the morning or evening hours over the span of a week, record two-minute video clips from a variety of locations on the north bank of the Fraser. Use a fixed camera point of view looking across the river at Surrey. The south bank of Fraser should be in the same position in each clip, and form the horizon line within the frame*."*

The instructions provided indeterminate outcomes that depicted the happenings on the Fraser. These video recordings included workers sorting log booms bundled at the River's edge, a massive paddle-wheel tour boat motoring under the Alex Fraser Bridge, trains shuttling industrial freight cars along the River's south bank, rush-hour traffic clogging the Pattullo Bridge linking New Westminster to Surrey, and a vast barge carrying industrial material crossing the River to dock at the Seaspan terminal (Figure 4). The recordings revealed the intensive use on the Fraser's waters by industry and leisure, and it provided visual confirmation about the use of the Fraser by humans that I had read about in my research. Both the footage of the salmons and of the human activities were edited to their key features, and sorted into two separate folders. We needed to decide on the next step to see how the final project would emerge.

Figure 4. Still from video footage for *Salmon People* showing Seaspan freight on the Fraser River. Photo courtesy of Jonathan Nunes.

The instructional systems by Fluxus previously described can be considered early examples of generative art, an art genre recently theorized in relation to computational methods. Generative art is described as using an instructional system — a set of natural language rules, a computer program, or other procedural invention — that initiates the circumstances for the generation of an art work.[66] For *Salmon People* at Surrey Urbanscreen, we created a computational system to generate the final display arrangement. Simon wrote the software to join the video recordings of the underwater salmons with the recordings of the above water human activity.[67] The software included a set of constraints determined by the exhibition site and the recorded videos: the size and shape of the projection wall at Surrey Urbanscreen, the horizon line in the above-water clips, the positioning of above- and below-water clips. We realized that we needed to create a third type of footage — the waterline clips — from remnants of the Adams River videos, in order to visually join the above-water and below-water realms. Then, we had three types of video clips representing realistic space — humans' activities above water, waterline, and salmons' activities below water. The software combined these three types into a fixed grid determined by the projection surface dimensions. The final outcome portrayed an ever-changing land-water-scape of the River reflecting the complexity of the real ecosystem (Figure 5).

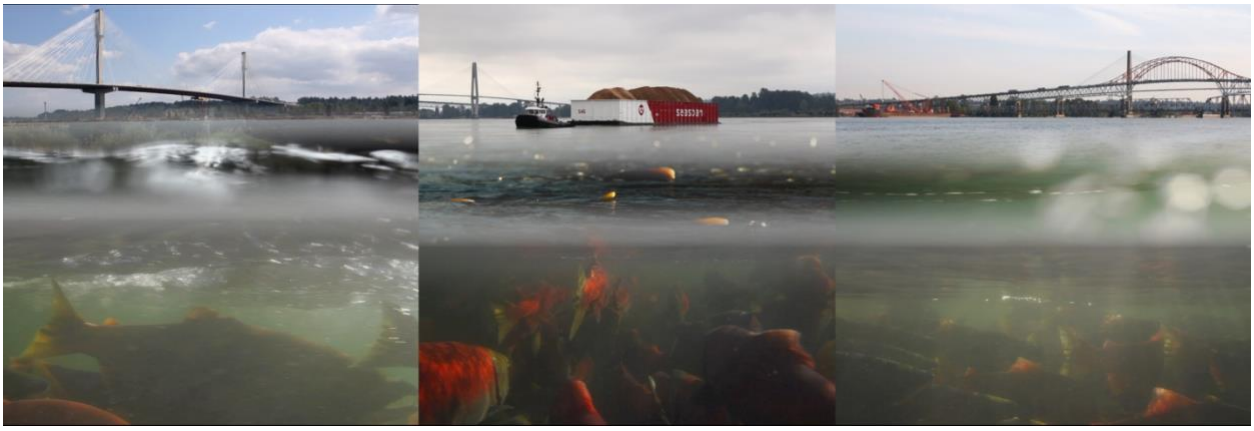

Figure 5. Still from *Salmon People* generative software output showing recombinant panorama. Photo courtesy of Simon Lysander Overstall.

Using a similar method, we created generative software to produce the project's soundscape. This involved using our sound recordings of the activities on the Fraser, and synthesizing sounds to evoke a speculation on the underwater communications of the salmons. Recent marine biology research finds that fishes do produce sounds for communication. [68] We speculated that the participating Sockeye would have been communicating with each other in their pre-spawning moments. The software played these synthesized sounds, along with the recorded sounds, in indeterminate combinations, complementing the recombinant panorama of the visual display. On site, the soundscape could be accessed via FM frequency using a car radio.

These interspecies indeterminacy methods for *Salmon People* provided for emergent more-than-human creativity, and for a rumination on interspecies ethics. What the fishes did in front of the camera nudged me to consider their agency and intentions. They watched, waited and decided. They went about their projects, and they *looked back.* My new understanding of their intentionality inspired me to do a salmon's-life-time of learning — five years to study up on how to appropriately represent them. Marine biology provided knowledge on salmon's perceptual differences and minding, and climate science provided information on how salmons are affected by human action. For audiences, this information can seem distant; the magnitude of ecological impact too vast and the forecast too bleak. The salmons' struggles can remain unrecognized. An experiential understanding is needed, and this realization is what drove us to produce the *Salmon People* as a public art project.

Salmon People was exhibited at Surrey Urbanscreen from October 23, 2015 to January 31, 2016 (Figure 6). The Surrey Art Gallery hosting the exhibition scheduled events to coincide with World Rivers Day. It collaborated

with the City of Surrey fish protection programs and invited the public to participate as volunteers to take stream samples from Bear Creek, a creek that runs by the gallery and is part of the Fraser River water system. These activities, and the exhibition, drew thousands of visitors to the project.[69] The project was also inadvertently seen by many individuals who passed by the site. The projection was visible from the Skytrain, the above ground transit system that services the Greater Vancouver Regional District. As they traveled along the Surrey section of the Skytrain passengers could catch a glimpse of *Salmon People*.

We received comments about the exhibition, including from a marine biologist who said he appreciated seeing Sockeye represented in a realistic way that drew attention to their struggles. The exhibition gained interest from graduate students and faculty at the School for Interactive Art and Technology (SIAT) at Simon Fraser University, Surrey Campus. The SIAT researchers featured the work in a scholarly essay presented at the International Society of Electronic Arts (ISEA 2017), Columbia.[70] The exhibition gained added international recognition from our neighboring Washington state arts community. We were invited to exhibit the work in an international exhibition called *Endangered Species: Artists on the Front Line of Biodiversity* at the Whatcom Museum in Bellingham, 2018.[71] Overall, the public display of *Salmon People* at Urbanscreen entered the imaginations of local, regional and international art communities and publics, creating an expanded understanding about the local salmon populations and their challenges in the shared ecology of the Fraser River.

Salmon People is a realist representation that makes more tangible the otherwise imperceptible struggles of the Sockeye. The watery membrane normally separating humans from fishes was plunged through by the camera. The project joins crucial locations and species together — the Adams River Sockeye and the Fraser River humans. Here, things are presented as they are — salmons swimming amongst the burdens of human activity. Seeing and hearing fishes and humans in this realist relation, in the form of public art, foregrounds the need for public responses to the salmons' hard destiny. By presenting this ecology in an accessible public art forum, a possibility is opened for a new level of reciprocal looking. *Salmon People* and its processes present a biophilic ethics of aesthetics by calling for public response to the anthropogenic forces affecting this remarkable keystone species.

Figure 6. Installation of *Salmon People* at Surrey Urban Screen. 2015. Photo courtesy of Blaine Campbell.

NOTES

1. Henry David Thoreau quoted in Carol Gigliotti, "Hard Destiny: Julie Andreyev's and Simon Overstall's Salmon People." Surrey: Surrey Art Gallery, 2016. https://www.surrey.ca/files/Salmon%20People%20open%20book.pdf (accessed 3 Jun. 2019).

2. Balcombe uses the term 'fishes' in contrast to the more conventional 'fish' in order to draw attention to these beings as individuals rather than populations. I've adopted his usage, and additionally used 'salmons' instead of the more conventional term 'salmon'. Jonathan Balcombe, *What a Fish Knows: The Inner Lives of Our Underwater Cousins*. (New York: Scientific American / Farrar, Straus and Giroux, 2016).

3. The title of the project, *Salmon People*, is inspired by Jay's essay that relates Westcoast indigenous stories of salmon who are described as people living in an underwater world. Tom Jay, "Salmon of the Heart," in *Working the Woods Working the Sea: An Anthology of Northwest Writings,* eds. Wilcox, Finn and Jerry Gorsline. Port Townsend, WA: Empty Bowl, 2008. Pg. 245-276.

4. For documentation of the project, including video clips, see Julie Andreyev's webpage, http://julieandreyev.com/salmon-people/ (accessed 3 Jun. 2019).

5. The British Columbia inland rainforest, more than 500 km from the nearest ocean, abutts the Rocky Mountains. It is home to grizzly bears, ancient trees and plant species of oceanic affinity, and mountain caribou.

6. Mike Lapointe, et al, "Late-run Sockeye Salmon in the Fraser River, British Columbia, are Experiencing Early Upstream Migration and Unusually High Rates of Mortality — What is Going On?" Conference Proceedings (Georgia Basin/Puget Sound Research Conference, 2003).

7. Canadian Geographic, "The Health of the Fraser," http://www.canadiangeographic.ca/magazine/jun13/british_columbia_fraser_river.asp (accessed 3 Jun. 2019).

8. Ibid.

9. Sierra Club of Canada, BC Chapter Education Program, "Lesson Plan: Impacting our Watersheds: Focus on the Fraser River.," https://sierraclub.bc.ca/wp-content/uploads/2015/08/Coasts-Mountains-and-wolves_Understanding-Watersheds_Fraser-River_5-7.pdf (accessed 3 Jun, 2019).

10. Rafferty Baker, "Proposed Surrey coal shipping terminal cancelled by port authority," *CBC news.* 1 Feb 2019, https://www.cbc.ca/news/canada/british-columbia/fraser-surrey-docks-coal-facility-cancelled-1.5003348 (accessed 3 Jun. 2019).

11. Larry Pynne, "Environment Canada strikes potential death blow to port's $2b container expansion at Roberts Bank," *Vancouver Sun*. 19 Mar. 2018, https://vancouversun.com/news/local-news/environment-canada-strikes-potential-death-blow-to-ports-2b-container-expansion-at-roberts-bank (accessed 3 Jun. 2019).

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13 . Peter O'Neil, "Port of Vancouver's jet-fuel pipeline approval surprises minister," *Vancouver Sun*, 19 Apr. 2016, https://vancouversun.com/news/national/port-of-vancouvers-jet-fuel-pipeline-approval-surprises-minister (accessed 3 Jun. 2019).

14 . Cathy Kearney, "Beginning phase of 13 km jet fuel pipeline to YVR underway," *CBC News*, 23 May 2018, https://www.cbc.ca/news/canada/british-columbia/jet-fuel-pipeline-yvr-1.4675302 (accessed 3 Jun. 2019).

15. Mike Lapointe, et al..

16. Misty MacDuffee, "Report shoes Fraser River sockeye salmon stocks in poor health," Raincoast Conservation Foundation, 3 Oct. 2011, https://www.raincoast.org/2011/10/fraser-river-sockeye-salmon-cus/ (accessed 3 Jun. 2019).

17. Lapointe, et al.

18. M.R. Johannes, et al., "Fraser River sockeye habitat use in the Lower Fraser and Strait of Georgia," *Cohen Commission Tech. Rept. 12*, 2011. https://www.watershed-watch.org/wordpress/wp-content/uploads/2011/07/Exh-735-NonRT.pdf (accessed 3 Jun. 2019).

19. Ibid.

20. Ibid.

21. High water temperatures increase the abundance of the parvicapsula parasite that infects salmons. Salmons are exposed to these parasites when they enter the Fraser. They can affect the salmons' kidneys and gills and lead to premature death. Jude Isabella, *Salmon: A Scientific Memoir* (Victoria: Rocky Mountain Books, 2014)

22. Ibid.

23. Bethany Lindsay, "Fraser River salmon fishing closes," *The Vancouver* Sun, 16 Aug. 2015, www.vancouversun.com (accessed 15 Sep. 2015).

24. Jeff Nagel, "Bad sockeye run has salmon watchers worried: Fraser return of 2.4 million far less than forecast," *Burnabynow*, 5 Sep. 2015, https://www.surreynowleader.com/news/bad-sockeye-run-has-salmon-watchers-worried/ (accessed 3 Jun. 2019).

25. Fraser River Panel of the Pacific Salmon Commission, http://www.psc.org (accessed 3 Jun. 2019).

26 . Isabella O'Malley, "Earth will enter an abnormally warm period from 2018-2022," *Weather Network*, 17 Aug. 2018, https://www.theweathernetwork.com/news/articles/earth-will-enter-an-abnormally-warm-period-2018-2022-climate-change/109546 (accessed 3 Jun. 2019).

27. Fraser River Panel of the Pacific Salmon Commission.

28. Ibid.

29. Adams River Salmon Society, "Adams River Salute to the Sockeye General Interpretive Program," 2013. www.salmonsociety.com (accessed 3 Jun. 2019).

30. Ibid.

31. Cooke S.J., G.T. Crossin, and S.G. Hinch, "Pacific Salmon Migration: Completing the Cycle," in *Encyclopedia of Fish Physiology: From Genome to Environment*, volume 3 ed. A.P Farrell (San Diego: Academic Press, 2011), 1945–52.

32. Ibid.

33. Ibid.

34. Ibid.

35. Ibid.

36. Adams River Salmon Society.

37. Cooke, Crossin, and Hinch.

38. Ibid.

39. Ibid.

40. Adams River Salmon Society.

41. Ibid.

42. Cooke, Crossin, and Hinch.

43. Adams River Salmon Society.

44 . Geoffrey Giller, "Salmon Use Magnetic Field-Based Internal Maps to Find Their Way," *Scientific American*, 7 Feb. 2014. https://www.scientificamerican.com/article/salmon-use-magnetic-fieldbased-internal-maps-to-find-their-way/ (accessed 3 Jun. 2019).

45. Cooke, Crossin, and Hinch.

46. Isabella.

47. Adams River Salmon Society.

48. Ibid.

49. Ibid.

50. Ibid.

51. Ibid.

52. Isabella.

53. Adams River Salmon Society.

54. Ibid.

55. Victoria Braithwaite, et al., *Do fish feel pain?* (New York, NY: Oxford University Press, 2010). Brown, C., Laland, K. & Krause, J., eds. *Fish cognition and behavior*, 2nd ed. (Chichester, UK: Wiley-Blackwell, 2011).

56. Ethologist Jonathan Balcombe summarizes numerous studies by marine biologists on various fish species behaviors and cultural traditions. Balcombe, *What a Fish Knows.*

57. Biophilic ethics is a practice of recognizing that other lifeforms are interested in their lives, their families, communities, and cultures beyond human-centric values. I elaborate on biophilic ethics in my Ph.D. thesis. Andreyev (Burnaby: Simon Fraser University, 2017).

58. World-forming is here used specifically to critique Heidegger's thought on only humans being world-forming. Kelly Oliver, *Animal Lessons: How They Teach Us to Be Human* (New York: Columbia University Press, 2009).

59. Rudolf Frieling, et. al. *The Art of Participation: 1950 To Now* (San Francisco: San Francisco Museum of Modern Art, Thames & Hudson, 2008).

60 Frieling discusses Fluxus' happenings in *The Art of Participation: 1950 To Now* (San Francisco: San Francisco Museum of Modern Art, Thames & Hudson, 2008).

61. Listen to samples at AllMusic. http://www.allmusic.com/album/cage-bird-cage-mw0001942198 (accessed 29 Jul. 2015).

62. The process is described by Don Gillespie, in *John Cage Bird Cage* (Albany, NY: Electronic Music Foundation,1972). CD liner notes.

63. In a curious anthropocentric turn, Cage proposed that the final installation of "Bird Cage" take place in a gallery space where live pigeons were to be let loose to interact with the human listeners. He complained that even though he promoted the National Audubon Society in his publicity, he was not able to get any birds for the installation. I haven't been able to find any discourse on the problematic nature of this original proposal. Don Gillespie, in *John Cage Bird Cage* (Albany, NY: Electronic Music Foundation,1972). CD liner notes.

64. This set of works was originally produced as a short edition artist's book. It has since been reproduced by the Museum of Modern Art, NY, As Yoko Ono, *Grapefruit*. (New York: Museum of Modern Art, 2015).

65. Cameron Foote, "Yoko Ono's Secret Piece," *Insite/Out,* MoMA, http://www.moma.org/explore/inside_out/2014/04/30/yoko-onos-secret-piece (accessed 3 Jun. 2019).

66. Philip Galanter, "What is Generative Art? Complexity Theory as a Context for Art Theory," GA2003 – 6th Generative Art *Conference*. https://philipgalanter.com/downloads/ga2003_what_is_genart.pdf (accessed 3 Jun.,2019).

67 . Custom software programmed by Simon Lysander Overstall using Cycling '74 "Max/MSP." Simon Lysander Overstall, http://www.simonlysander.net (accessed 3 Jun. 2019).

68. Balcombe summarizes numerous studies on different fishes that use sound to communicate. Balcombe, *What a Fish Knows.* While I have not found research on salmons' sonic communications, there is no reason to rule out the potential that they too make sounds to communicate.

67. Prophesy Sun, et al., "Urban Mesh: Exploring Data, Biological Processes and Immersion in the Salmon People," *Bio-Creation and Peace, Proceedings, ISEA2017*, Manizales, Columbia, http://www.isea2017.disenovisual.com (accessed 3 Jun. 2019).

68. "Endangered Species: Artists on the Front Line of Biodiversity," curated by Barbara Matilsky, Whatcom Museum, Bellingham, WA, https://www.whatcommuseum.org/exhibition/endangered-species/ (accessed 3 Jun. 2019).

69. From correspondence with the Surrey Art Gallery curatorial staff, they conservatively estimate 10,000 visitors per year to the Surrey Urbanscreen exhibitions.

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BIOGRAPHICAL NOTE

Julie Andreyev is an artist-activist, researcher and educator. Her art practice called *Animal Lover* investigates more-than-human creativity using interspecies participation and collaboration to explore seeing, listening, and feeling for ecological and compassionate potential. Her projects have been shown locally, nationally and internationally and are supported by the Canada Council for the Arts and the Social Sciences and Humanities Research Council of Canada. Andreyev has published essays in academic journals, books, catalogues and magazines. She enjoys walking with her canine collaborators, Tom and Sugi, paying attention to the liveliness of the local animals, trees and plants, and Earth forces. She is currently working on a creative co-production with birds including the crow family whose territory includes her home (see *Bird Park* at http://julieandreyev.com/bird-park/), and investigating the creation of immersive media depicting experiences within old-growth forest ecologies (see *Wild Empathy* at http://julieandreyev.com/wild-empathy/). Andreyev has a PhD from Simon Fraser University.