

Project Report

Okanagan Waterways Past, Present and Future: Approaching Sustainability through Immersive Museum Exhibition

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Abstract: This paper presents *Waterways Past, Present and Future*, a research project and exhibition in Okanagan Syilx territory, aimed at increasing awareness of the relationship between people and water towards catalyzing sustainable water practices. The exhibition's multi-channel audio-visual media was designed to immerse, provoke, destabilize, transform and move visitors to take responsibility for water. Drawing on many ways of knowing and doing in the creative process, the exhibition opens different entry points to the research, thus encouraging an interdisciplinary and cross-cultural audience to engage with it. *Waterways'* contribution to sustainability discourse lies in its empowerment of collaborative inquiry as a way of knowing, understanding and representing our world. The epistemological dimensions of the exhibit present multiplicities embedded in the social life of water, inviting dialogues, shaping cultural narratives and developing new forms of creativity. Through the sensual process of immersion and activation of lateral thinking, the exhibition facilitates connections across cultures, connections that act as agents for social transformation. *Waterways'* experiential journey transcends our personal and dominant socio-cultural patterns, reaching beyond normative structures to new creative realms shared ethical space.

Keywords: community design; dynamic systems; interdisciplinarity; collaboration; environmental science communication; immersion; museum exhibition



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1. Introduction

Climate change, as reflected in the long-term shifts in temperatures and weather patterns caused primarily by human activities and the burning of fossil fuels, is the most pressing issue of our time [1]. Immersive multi-sensory museum exhibitions make the complexity of climate change more tangible by embedding the viewer in locally relevant spaces grounded in experiential learning [2–7]. Hybrid design spaces between the traditional museum and computational art practices facilitate associative modalities to engage visitors in challenging concepts [8–10].

As an experiential learning environment, interactive museum exhibits can facilitate a space for the “ontological reflexivity” [11] that enables alternative ways of knowing through multisensory experiences and interactions. They activate lateral thinking and an intuitive grasp of concepts: “*Experiential knowing equally offers all the possibilities to see and understand the world and ourselves within that world in polyphonic, symbolic, artful and imaginative ways*” [12] (p. 79). Immersive multi-sensory environments also provide a space for connection with participants in collaborative activities, renewing a sense of being part of a larger social structure [13]. The experiential aspect of immersive media highlights the transformative capacity of creative spaces of inquiry.

Conceptions of sustainability involve imagining new ways to live and relate to each other and our environment. Sasha Kagan [14] writes about cultures of sustainability that reach across all areas of our being, knowing and doing. The change process entails identifying and developing cultural narratives of sustainability that are energizing and motivating narratives that nurture human energy and promote activities that positively influence human and environmental health. Success stories and visions focusing on reciprocal relationships between people and the environment empower sustainability practices [15]. Given the cultural roots of the climate crisis, its resolution requires new and renewed creative cultural approaches. As catalysts, art and culture can significantly contribute to social transformation for a better quality of life for all living beings [16].

Social change happens incrementally within our place as things transform through practice. Social shifts evolve in how we organize and relate to one another to transform cultural and societal institutions and build communities. Change processes that affect our collective and individual behaviors and worldviews have many influences [17–19]. Some are explicit, and some are subtle. The assumptions and metaphors we use to reconcile our experiences characterize how we see the world.

How can we come together as communities to realize environmental resilience, defined as the capacity of a socio-ecological system to withstand and recover from disturbances while maintaining its function and well-being [20]? How can contemporary media add to themes of sustainability and transformative processes we need to engage in response to the environmental crises we created? We explore these questions through a discussion focused on *Waterways—the Past, Present and Future*, a research-creation project and exhibition aimed at communicating water sustainability concepts via immersive experiences of the local Okanagan environment and community (hereafter referred to as *Waterways*, see Figure 1). The *Waterways* exhibit was created on the territory of the Syilx (Okanagan) Nation, a transboundary people in British Columbia and Washington State that have resided in the Okanagan region for millennia.

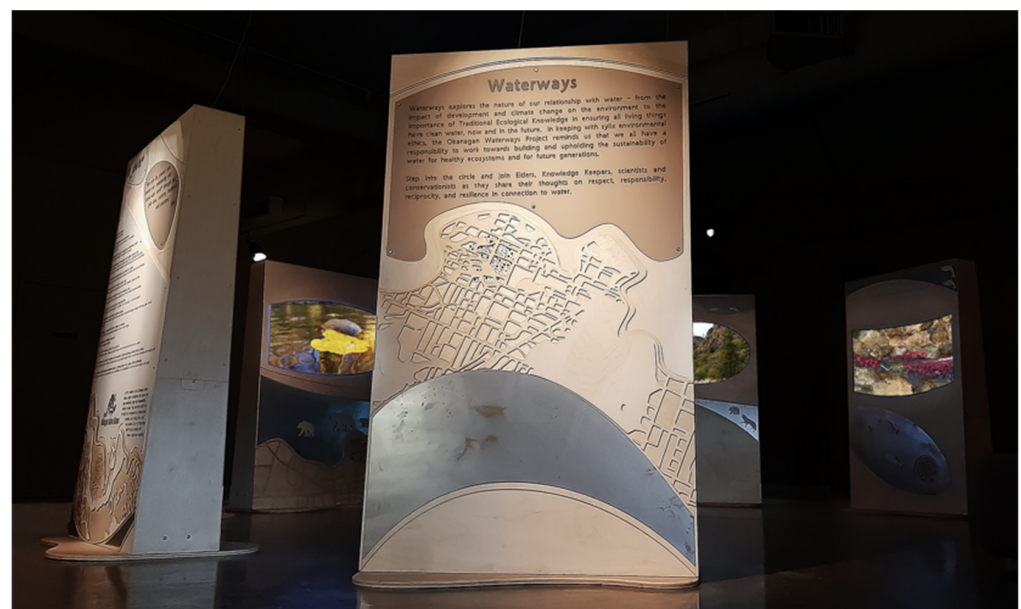


Figure 1. The *Waterways* Exhibition at Okanagan Heritage Museum, Kelowna, in September 2021. The image shows seven modules in a circular arrangement designed for touring across Okanagan. Source: Photographed by: Sepideh Saffari.

The *Waterways* exhibit represents a collaboration between a team of Syilx and non-Indigenous scholars and community partners that came together in 2017 to explore the relationship between people and water in Okanagan Valley, one of the most water-stressed regions of Canada. The four-year collaborative research project was aimed at promoting

sustainable water practices in the Okanagan through an interactive, immersive museum exhibition that exposes the public to different values, worldviews and ways of thinking about and caring for water, as well as establishing spaces for water sustainability engagements across cultures.

The paper comprises three main sections. The first provides background, including a synthesis of key concepts and contextual and methodological features of the research. The second introduces Waterways and its key design characteristics. And the third brings all the stands of the paper together, providing lessons from the research and exhibit design on cross-cultural collaboration in a real-world context. We end the paper with some brief conclusions.

In the paper, the term Okanagan refers to the name of the Syilx Okanagan people and the geographic location (valley, lake, river) of Syilx traditional lands. In the Canadian context, Aboriginal Peoples include First Nations, Inuit and Métis peoples. First Nation refers to Aboriginal Peoples of Canada who are ethnically neither Métis nor Inuit [21]. We capitalize these terms following guidelines for writing about Indigenous Peoples [21,22].

2. Background

This section provides an overview of key concepts related to exhibition design, including Community Design, Interdisciplinary, Dynamic Composition, Museum and Okanagan context, which all play a crucial role in sustainability discourse, immersive exhibition development and computational design.

2.1. Community Design

Through collaboration and learning with communities about different ways of sustainable living, researchers can connect to new meaningful ideas that contribute to developing new concepts, aesthetics and algorithms uniquely crafted from the community engagement processes. In today's social-ecological context, no single group or person has the lone knowledge, skills and capacity to identify and implement solutions to complex sustainability challenges [23]. The community design process engages all participants as experts based on their lived experiences, with unique contributions, critical knowledge and skills to add to real-world contexts [24]. The collaborative approach can draw from multiple ways of knowing to create sustainable community-controlled, nonexploitative and ecologically grounded solutions and outcomes where social and environmental justice is addressed through the design process and results. The designer is positioned as a facilitator in framing and reframing design solutions [25], using creative processes to sustain, heal, empower and identify effective practices at the community level. The design process seen through the lens of justice provides an environment where the voices of those impacted are prioritized, and the influence on the community is valued over the designer's intention. Design justice as a method [26] honors traditional, Indigenous and local knowledge by integrating wisdom, perspectives and contributions in the design co-creation process. As a process, it positions traditional knowledge systems as invaluable expertise to structure design practices and outcomes, which is critical for sustainability discourse. The focus is placed on both process and product of the collaborative design. Today, design is present in all industries and affects every level of societal structure. Design justice helps us understand the interplay between design, power and social outcomes and reflect on overcoming the reinforcement and reproduction of societal and structural inequalities [26].

In the context of the Waterways project, collaborative design and learning with communities, Syilx Knowledge Keepers, water scholars, scientists and artists who contributed to the exhibit allowed new connections and meaningful ideas to emerge. The meaning-making processes layered within the exhibit are amplified with immersive and sensual media communication strategies. The development of the Waterways exhibit demonstrates how immersive media can express collaborative action and how the community engagement process plays out in the design of the exhibition to enable a reciprocal relationship of exchange, engagement and mutual benefit for the community [27–29].

2.2. Interdisciplinarity

Interdisciplinarity is essential to approaching sustainability, but the term interdisciplinarity still implies a relationship between individuals with different backgrounds. Indeed, the sustainability of individuals makes little sense in isolation. Civilizations and species live and die as groups, forming “cultures of sustainability” [14] essential in formulating sustainable futures. Robinson [30] notes the importance of strengthening challenge-driven interdisciplinarity. The challenge-driven research refers to an inquiry conducted with diverse groups and individuals as co-creators rather than audiences of knowledge and focuses on the practice of co-creation. Establishing external alliances builds understanding through multiple ways of knowing and doing and embraces complexity through connection. Kagan [16] notes that this opens the possibility of collaboration by inviting participants to engage at the intersections of disciplines, which he refers to as transdisciplinary research. Interdisciplinarity offers the potential to combine knowledge from reductionist disciplines and gain a more holistic understanding of complex issues; from a practical standpoint, interdisciplinary studies can help address these complex tasks while also considering the intricate and dynamic nature of the challenge at hand [31]. Struggles in conducting interdisciplinary studies persist through differences in disciplinary language [32,33], assumptions, values and goals [33,34], as well as institutional and methodological barriers [30,35]. Sciences, for example, gravitate to quantitative research compared to humanities, preferring qualitative and interpretive validation approaches [36,37].

In the Waterways exhibition, interdisciplinarity reinforced the creation of reflective space for addressing water challenges and brought forward the community’s vision of water sustainability solutions in the Okanagan context. The interdisciplinary engagement was critical as it brought people from different disciplines together to work on a shared challenge. The resulting work also opened new space for interdisciplinary dialogue using multimodal communication strategies. By drawing on many ways of knowing in the creative process, the resulting work opens different entry points, thus encouraging a disciplinarily diverse audience to engage with it. These types of collaborations and dialogical spaces are essential resources for addressing sustainability.

2.3. Dynamic Composition

Sustainability as a field of study and computationally driven immersive media art have a reciprocal relationship of exchange, engagement and mutual benefit. Computation allows video, audio and photography to effectively create relational and emergent compositions that articulate new patterns through novel juxtapositions of media modes. As an extension of mass media communications, digital technologies embody shifting innovations in hardware and software, enabling new expressive platforms for social and cultural interactions and research. Expanding means for data collection and manipulation provide field researchers with new recording approaches, sophisticated databases, diverse processing techniques, and efficient transcription and translation software [38–40]. Concurrently, new representational possibilities afforded by computation can convey cultural meaning as a complex product constructed from multiple sources and contributions to create vivid, sensual narratives [41,42]. Computational affordances of digital media allow creators to design integrative dynamic processes that respond in correlated and co-dependent ways to the environment and each other, expressing equilibrium, which can act as a powerful narrative device [43]. Sustainable practices require attention to relationships in flux, events that need reimagining, and conditions that demand multiple responses and weaving of different perspectives, including shared values, contradictions and competing interests.

As a flexible media journey, Waterways integrates multiple voices and cross-cultural perspectives to critically reflect on our actions and relationships and point to shared values and worldviews necessary for integrated community response. The input capture mode is also a multimodal media source representing the study results. Digital data collection, analysis, and display locate collaborative Waterways research and exhibition development. The Waterways exhibit provides an example of community-engaged interdisciplinary

collaboration resulting in a dynamic exhibition that addresses water sustainability in the Okanagan from multiple community perspectives.

2.4. Immersive Exhibition Context

The sustainability of socio-environmental well-being in the age of the Anthropocene is a complex and dynamic environmental, cultural and political challenge. Climate change is restructuring how we live, our relationship to nature and humanity's place on earth in the present and the future. It is a global force with local effects, requiring place-based and community action. The climate change responses are more effective if aligned with sociocultural values that frame the solution development through community engagement processes [44]. Community dialogues at all levels and scales of human activity are critical as climate change affects every aspect of life. Museums, as reliable sources of information in the public sphere, are uniquely positioned to take an essential role in public social-environmental sustainability discourse and community-based climate change visioning.

The use of digital media in museums extends from a long tradition of material immersion and communication, blurring the boundaries between physical and virtual objects and experiences [45,46]. However, as with other sectors that are adapting to emerging media in the time of the Anthropocene, the abundance of new forms of technological platforms and designs raises questions regarding how new forms of museum exhibits can stay relevant for the places and communities they serve [47,48] and how can they promote trust, diversity and socioenvironmental justice through new forms of engagement while supporting personal agency, identity and social interactions in acquiring knowledge and creating spaces for community dialogue [49].

Immersive museum exhibits can combine process-driven computational modelling and visualizations, thus providing a valuable format for expressing sustainability practices through aesthetic experiences, allowing multiple ways of knowing and understanding our environment to intertwine. As applied to mediated audio-visual experiences, immersion can be defined as a psychological concept rather than a property of a technological system [50]. Immersion is a state of deep mental involvement. The individual may experience disassociation from the awareness of day-to-day life due to a shift in their attentional state. Immersion is a subjective experience of being surrounded by multi-sensory stimulation. Immersion can be achieved through various means, including technology, art and storytelling. The goal is to create an engaging, memorable and impactful experience that leaves lasting impressions. Immersive museum exhibits engage audiences and visitors using cognitive and affective strategies to reach the public across cultures and generations and play an active role in co-creating narratives with exhibits that facilitate discussions and enable affective engagement with challenging concepts [51,52].

Examples of museum exhibits focused on sustainability are discussed in detail in Appendix A. These cases aim to empower creative response action in the context of their place. The works discussed include *Arcadia Earth* (2019–2023), *Eye of the Climate 2* (2020–2023), *Reefs on the Edge* (2012–2017) and *InterANTARCTICA* (2008–2010). These interdisciplinary exhibits relate to the Waterways' experimentation and use of scientific data, photography, video, sound, computational compositions and tangible user interfaces to provide immersive educational space for reflection on climate change challenges. These works share the creative element in designing immersive spaces that foster creative thinking and thoughtful multi-sensory experiences to evoke participants' unique memories and associations in the place-based cultural and environmental context to motivate personal action.

2.5. Okanagan Waterways Context

Water security is one of the most critical issues in the Okanagan Valley of BC, a region that is one of the most water-deprived in Canada. Despite increased water stresses and the compounding effects of climate change, there is a continued reluctance to embrace sustainable water practices, as evidenced by the region's highest per capita water usage

in Canada. The Syilx Okanagan Nation, in contrast, has endorsed its *siwłk^w* (Water) Declaration [53]. This living document clearly articulates the centrality of water and the Syilx People's responsibilities to always relate to water sustainably and respectfully. Syilx Peoples have an intrinsic relationship with *siwłk^w* (water), equating water with life and considering water a sacred relation, which must be protected and kept healthy to ensure resiliency and relationship to *tmix^w* that translates as the ecology of the land [54] including the land, water, insects, people, animals, plants and medicine [53].

The Okanagan basin is classified as semi-arid [55], with over 80% of the valley's average annual rainfall lost to evaporation. Despite these water conditions, Okanagan domestic per capita water use is more than twice the national average [56]. Given current water usage patterns and projected population growth, the valley will face significant and persistent water shortages by mid-century [56–58]. While longer, drier summers and more frequent droughts have become the “new normal” in the Okanagan, a pervasive “myth of water abundance” persists among many residents, impeding public understanding of the gravity of the situation [59,60] and the required mitigative actions [61]. The general inertia cannot be blamed on the inaccessibility of information. Water sustainability has been the subject of extensive research and awareness raising in the Okanagan, particularly since the early 1970s with the creation of Okanagan Basin Water Board (OBWB). Instead, inaction on climate change is more likely related to the lack of perceived relevance at the local and personal level and cultural and social norms [62,63].

The complexity of these issues and their cultural, physical and political interdependencies mean that multiple actors must pool expertise and resources to identify, communicate and implement solutions at the local level. Working across Traditional and Western knowledge systems, meaningful collaboration with Indigenous Peoples and local communities is critical for climate-resilient development and action [44,64]. The Okanagan Nation Alliance (ONA) and their member bands have been at the forefront of environmental restoration following decades of development-motivated land-use practices, population growth, and their corollary damage to ecosystems. Some of these initiatives have been a focus of the Waterways exhibit.

3. Waterways: Past, Present and Future

Waterways—the Past, Present and Future is a four-year research-creation project involving researchers from the University of British Columbia Okanagan (UBCO), Syilx Knowledge Keepers and local partners (Supplementary Materials).

The Waterways research and exhibition aim to foster sustainable water practices by exploring the human–water relationships in the Okanagan Valley. The Waterways exhibition opened in September 2021 at the Okanagan Heritage Museum in Kelowna, BC and is touring across the Okanagan Valley (see Figure 2).

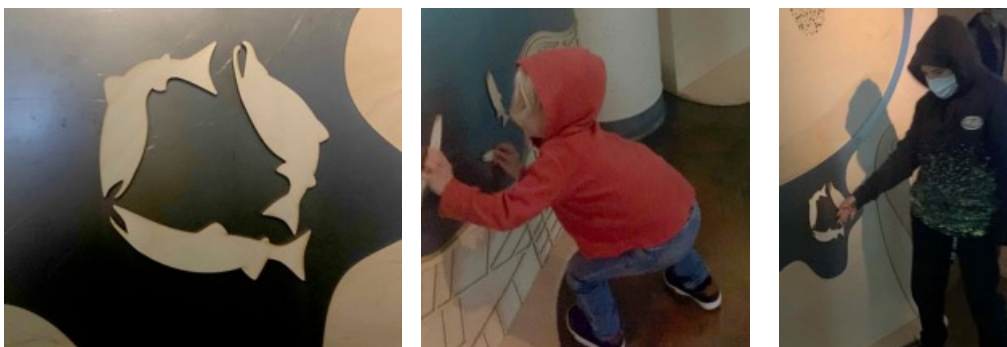


Figure 2. Waterways Exhibition at Okanagan Heritage Museum, showing kids playing with exhibition elements. Source: Photographed by: Aleksandra Dulic.

Waterways research was conducted by a large interdisciplinary group of artists and scientists, both Indigenous and non-Indigenous, with expertise in Indigenous studies,

fine arts, media studies, environmental anthropology, environmental science, computer science, social-ecological complexity and architecture. Scholars with extensive experience in collaborative design, immersive technologies, participatory research, complexity science and Indigenous research led the team. Syilx scholars worked with non-Indigenous scholars to guide and oversee critical junctures, including methods and exhibition design. The museum installation reflects the contributions of the interdisciplinary, cross-cultural team, integrating immersive media design to share multilayered narratives representing the exhibition's core concepts of human–water relations. The importance of bridging intercultural and interdisciplinary ways of knowing is reflected in recorded audio and video of interviewees and documentation of the environmental and cultural detail of the Okanagan landscapes, soundscapes and communities.

3.1. Inner Space

The Waterways exhibit's internal walls are designed as a circular space with screens showcasing ongoing narratives from Syilx Knowledge Keepers from Okanagan and Colville Confederated Tribes and Western specialists discussing the significance of water and water stewardship. These screens are layered with audio and video clips of Okanagan water, land and soundscapes.

The space is designed as an immersive multi-channel sound and video media installation. The inner walls of the panels comprise seven modules with five video screens where visitors experience imagery of the Okanagan landscape (Figures 3 and 4).



Figure 3. Okanagan Hills: Five side-by-side frames showing an example of Waterways system-generated video composition. Source: Photographed by: Aleksandra Dulic.

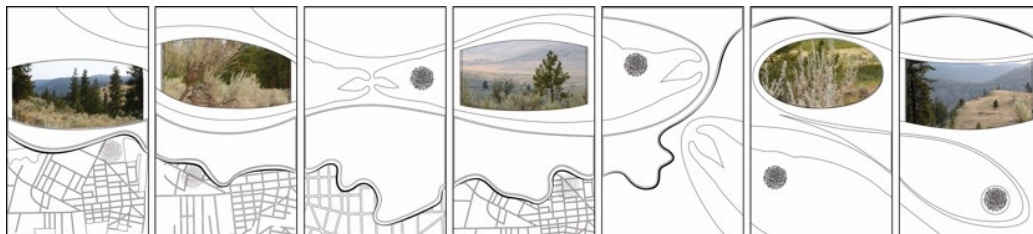


Figure 4. A diagram of the Waterways Inner space module design. Source: Created by: Sepideh Safari and Aleksandra Dulic.

The audio-visual media impress the beauty and sensitivity of various ecosystems throughout the Okanagan region. The exhibition environment provides an immersive cinematic experience that brings diverse voices together around common themes of personal and collective water responsibilities in the Okanagan. The media and exhibition design framework were collected through a four-year process of shadowing Indigenous Knowledge Keepers and experts on the Land at the En'owkin Center, focusing on Syilx values, protocols and land-based knowledge. The recorded material includes the environmental and cultural detail of the Okanagan environments, soundscapes, community events and interviews.

Narratives include descriptions of Syilx Indigenous-led best practices in water stewardship and ecological resilience, including riparian restoration along Shingle Creek and Okanagan River and the restoration of Sockeye Salmon (Taʔanya; *Oncorhynchus Nerka*) populations in Okanagan waterways. These initiatives demonstrate how Traditional Ecological Knowledge (TEK) is applied along with Western science and how Indigenous institutions have worked effectively with partner agencies to lead and co-manage these restoration

efforts. TEK can be summarized as Indigenous systems of knowledge and the cultural practices and methodologies related to knowledge production based on land-based systems of beliefs and practices. ONA defines TEK as *“The intergenerational history and oral record of the Syilx Okanagan people, the collective laws, teachings, governance structures and principles that, together, define and inform Syilx Okanagan title, rights and responsibilities to the land and their culture, passed on through direct contact with the environment”* [53]. Conceptually, these success stories and examples of environmental restoration provide seeds of hope and point to the best practices rooted in local ecology and relationships critical to sustainable futures.

The Waterways research team interviewed Syilx Knowledge Keepers, community members and Western-trained experts to communicate these stories. Interviewees discussed the meaning of water, innovations in water ecosystems management and sustainability, new co-management arrangements for caring for our water and ecosystems and lessons from these practices for the future (e.g., Figure 5). Twenty-five interviews and two focus groups with 32 participants were conducted, analyzed and included in the exhibition.



Figure 5. Dr. Jeanette Armstrong’s focus group with underwater footage of Sockeye Salmon in Shingle Creek. Five side-by-side frames show an example of Waterways system-generated video composition showing a community reflection on one screen. Source: Photographed by: Aleksandra Dulic and Miles Thorogood.

Interviews: A mixed research team comprising Syilx and non-Syilx scholars conducted and analyzed fourteen interviews in the Okanagan. Seven interviews focused on the return of Sockeye Salmon and seven on restorations and resilience in the Okanagan, including a focus on the ECommunity Place. Interviews were semi-structured and open-ended to prompt conversation and video-recorded. The interviewing protocol brought a bi-cultural perspective to the interpretation and meaning-making of interviews and helped to bring cross-cultural understanding and nuance from interview data. A Syilx scholar conducted the remaining eleven interviews with Syilx members of the Colville Confederated Tribes from Washington State in the US.

Focus groups: A Syilx team member conducted two focus groups used in the exhibition. The first focus group comprised ten non-Indigenous participants with scientific backgrounds from Washington State, USA, with a discussion that focused on the Columbia River system. The second focus group comprised three Syilx Knowledge Keepers and scholars and one scientist focusing on Okanagan waterway systems.

The audio-visual modules are arranged in a circle to incorporate the gallery’s entire floor area, allowing visitors to travel inside or outside the circle (Figure 6). The circular arrangement aims to generate an additional sense of tangible experience that gives visitors a sense that they are a part of the exhibit conversation. The content is organized through themes that allow diverse community voices to interplay around a common topic. Each voice occupies one screen at a time and is accompanied by footage of Okanagan ecology related to the conceptual framework on display (Figure 5).

Waterways’ flexible and custom-designed composition system comprises multi-screen networked displays integrating non-linear sequencing. The system uses the re-combinatory approach to vary viewers’ media experiences continuously. The stochastic video and audio sequences are displayed from discrete media segments over a distributed network of modules. Each of the five modules includes a computer, an LCD screen and two-channel audio embedded in a constructed display, with one speaker at the front of the box and another on the rear side to spatialize sound in installation contexts.

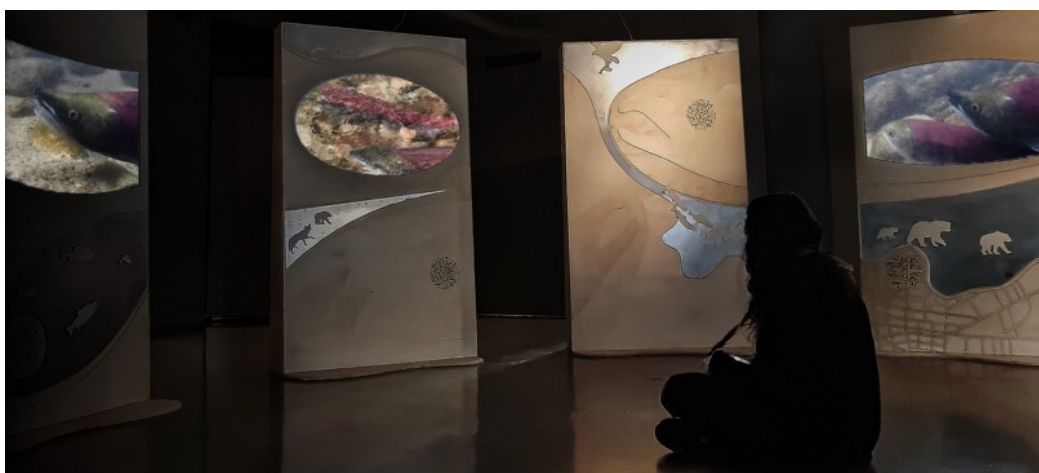


Figure 6. The Waterways Exhibition at Okanagan Heritage Museum shows four modules positioned in a circular arrangement designed for touting purposes. Source: Photographed by Sepideh Saffari.

Media content includes a database of video and audio clips indexed by tags representing a particular concept. The system chooses a topic from the database, plays a sequence of interview clips and selects accompanying environmental footage and audio recordings to disperse across the screens and speakers in the system. The system conductor analyzes the database and, at run-time, moves between concepts based on a specified interval. A local Wi-Fi network provides the infrastructure for communication between the conductor and players. Each video and audio channel are addressed independently, with the system management computer that acts as the conductor, serving file requests to the modules in the audio-video orchestra (Figure 7).

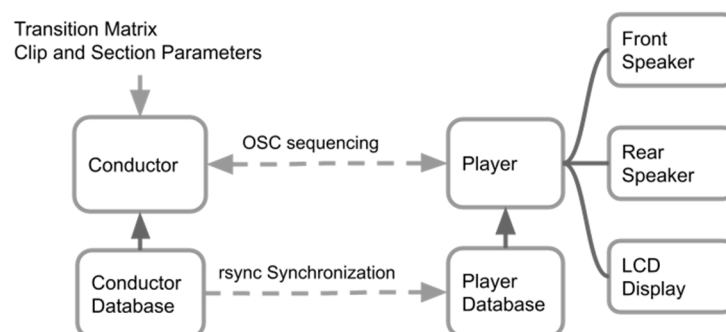


Figure 7. A diagram of the Waterways composition system [65]. Source: Created by Miles Thorogood.

Inner Space Themes

The resulting experience emerges through ever-changing conversations around core exhibition themes. Interview clips are conceptually and spatially linked to environmental images and sound structured according to the following themes:

The value of water integrates Syilx Indigenous and settler perspectives, stressing concepts that equate water with life and an essential relation. Syilx Peoples' responsibilities as caretakers of Okanagan waterways are highlighted in this section.

Traditional Ecological Knowledge (TEK) focuses on what this knowledge–practice–belief system comprises, its contemporary significance for understanding how ecosystems work, and how TEK and Western science can complement one another in dealing with the critical environmental and natural resources issues we face today.

The successful return of Sockeye Salmon to the Okanagan waterways after the canalization and damming of the Okanagan River, north of the Canada–US border and Columbia River system and its tributaries and the near-disappearance of Sockeye Salmon. Syilx leaders spearheaded this 20+ year endeavor.

Adaptive co-management of environment and natural resources, a power-sharing arrangement between governments, local resources and stewards, brings structured learning by doing and adaptation to environmental and natural resource practices (Figure 8).

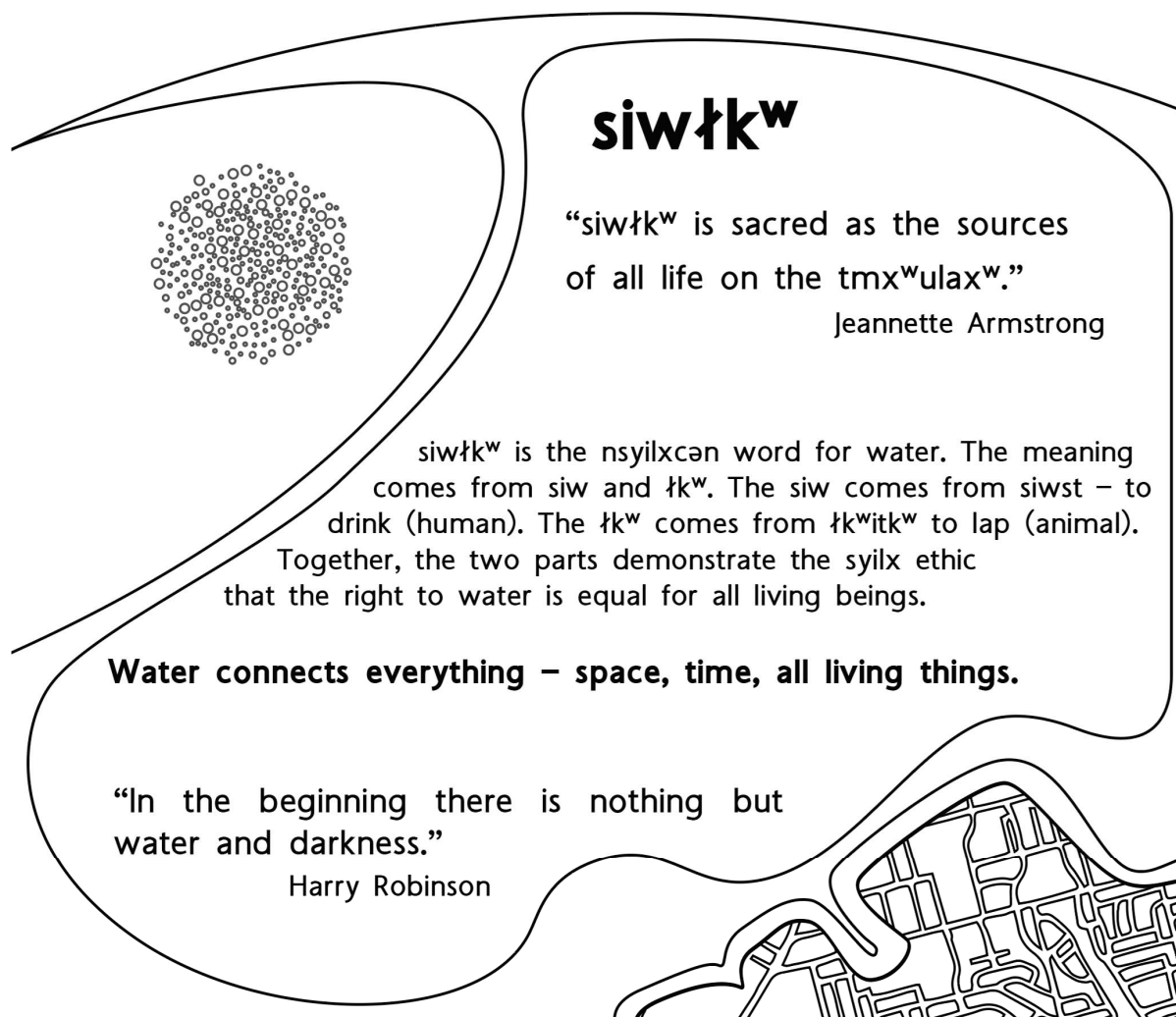


Figure 8. Design diagram of one of the Outer panels showing an interpretive text focused on the Nsyilxcn expression of water—siwłkʷ word and concept. The meaning of the word embodies the Syilx ethic of the right to water for all living beings. Source: Drafted by Sepideh Saffari.

The Columbia River Basin, of which the Okanagan River is a part, includes the status of the Columbia Basin Water treaty, being re-negotiated between Canada and the US and stories of change and destruction of water and land habitats from Elders who have lived through the changes.

Restoring habitats, such as cottonwoods and riparian systems, to increase the productivity of yellow-breasted chats (xwaʔłqwiləm, *Icteria virens auricollis*) and other species at the ECommunity Place between the Okanagan River Channel and Shingle Creek on the Penticton Indian Reserve.

Injustice and racism endured and experienced by Syilx Indigenous communities in their efforts to restore their relations with Syilx Lands and Waters, and the resilience of the Syilx Nation in the face of this mistreatment and injustice.

3.2. Outer Exhibit Space

The outer panels of the exhibit highlight Indigenous Syilx teachings and wisdom related to human–water relations and the value of water through five interpretive panels.

Visitors also encounter two touch screens showing a realistic 3D virtual world depicting pre-contact Kelowna.

The Waterways Project reminds us that we all have a responsibility to work towards building and upholding the sustainability of water for healthy ecosystems and future generations, according to Syilx environmental ethics. The five interpretive panels include the text and quotes focusing on key concepts in the exhibition (Figure 8).

One of the outer panels displays the Okanagan Nation siw̓łk^w (Water) Declaration. In 2014, members of the Okanagan National Alliance signed a declaration that asserts their relationship, rights and responsibilities relating to water. They declare siw̓łk^w “has the right to be recognized as a familial entity, a relation, and a being with a spirit who provides life for all living things.” ONA [53] (p. 3). The declaration affirms Syilx Peoples’ relationship with water and their responsibilities as caretakers of lands and waters to ensure accessible, clean and healthy water for future generations. Syilx sovereignty and the right to self-governance and self-determination are affirmed in Syilx laws and customs. The declaration sets out the resolve and path forward for Syilx leadership in water governance.

In addition to interpretive panels, Waterways exhibit visitors experience two units displaying interactive 3D visualizations of Okanagan landscapes and waterways before colonial development that show dramatic ecological changes to flood plains, wetlands and riparian habitats in the last 100 years. Visualizations depict the entire core of the city of Kelowna between Mission Creek and Mill Creek floodplain (Figure 9). The locales focus on the historical characteristics of Mission Creek, Mill Creek, their tributary creeks, wetlands and the floodplain areas of the Okanagan Lake system. The touch-screen interface affords exploration of the diverse sensitive Okanagan ecosystems, including plant, animal and insect species Indigenous to the region.

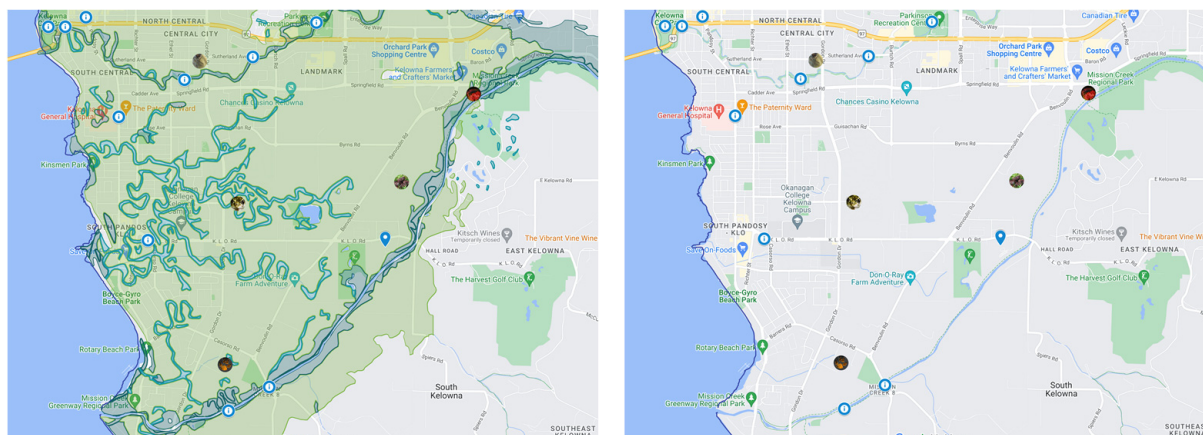


Figure 9. Left: Modified Google map of Kelowna layering the creek systems from 1800 over the City of Kelowna. Right: Google map showing Kelowna today <https://waterways.ok.ubc.ca/Experience/Waterways-Map.html> (accessed on 19 October 2023). Source: Created by Alex Lake.

The interactive virtual environment enables the exploration of two layers: historical and contemporary (Figure 10). It overlays the current urban and agricultural development over ecological history visualizations, providing an essential understanding of what we have lost and how much we have transformed our environment. The information and stories embedded in the visualizations offer a creative platform for dialogue and learning diverse cross-cultural, community-based, poetic, traditional and scientific water knowledge and values.



Figure 10. From the same angle in the visualization, the left image shows the historical layer, while the right image shows the contemporary layer with current Kelowna development. Source: Screenshot by Jordan Pike and CarlaMather.

The Historical Layer is based on diverse records that refer to the Okanagan landscapes before settlers developed the valley, based on scientific, GIS and environmental history data before colonial times. We referenced the list of plants and animals from the En'owkin Center, Okanagan Heritage Museum archives and environmental history literature of the Okanagan basin. Data gathered include plants and animal species provided by Indigenous Syilx Knowledge Keepers, naturalist records [66–72], historical agricultural descriptions [73] and the Okanagan Historical Society's publications of local historical writings since 1925. Historical aerial photographs and archival land tenure maps are combined to re-construct terrestrial ecosystem mapping [65] for 1800 and 1938 with the raw data. We used available 3D animal and plant models and built assets for location-specific characteristics for the Okanagan species to account for missing items (Figures 11–13).



Figure 11. A diagram of the Waterways Outer space module design. Source: Sepideh Saffari.

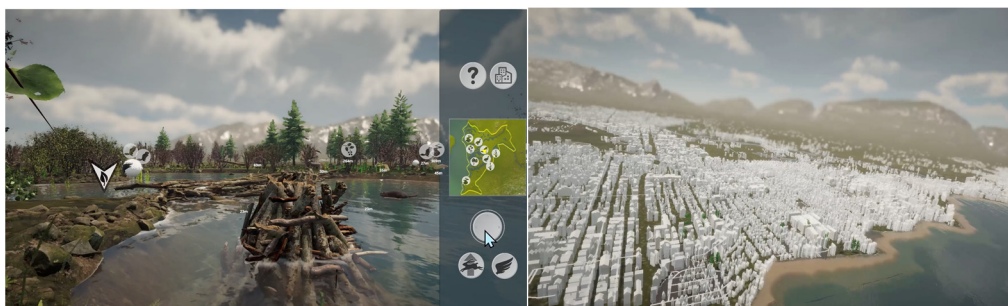


Figure 12. The left image shows pre-contact visualization of a beaver dam. The right Image shows the contemporary layer with the current Kelowna development. Source: Screenshot by Jordan Pike and Carla Mather.



Figure 13. From left to right, top to bottom: 1. Stunx—Beaver swimming; 2. Beaver dam; 3. Sq'əq'ax^w—The Western Screech Owl; 4. S'úlk'č'a?—Mule Deer; 5. sník'č'a?—Elk; 6. Sk əm 'xist—Black Bear; 7. S'itwn—Sandhill Crane; 8. Panel showing information for each animal and plant in the world. Source: Screenshot by Jordan Pike and Carla Mather.

The Contemporary Layer is constructed based on publicly accessible geospatial data from the BC Data Warehouse and Google map records. This provides information detailing terrestrial ecosystem mapping, vegetation resource inventory, sensitive ecosystems inventory, lakes and streams and community water-shed boundaries (Figures 10 and 12).

The visualization enables an imaginative space for *Okanagan futures*. The present overlays the past, pointing to possible restoration opportunities in the future. Kelowna's urban neighborhoods can be viewed with the representations of local sensitive riparian ecosystems of the past. The content shows the past and what we have lost with rapid development. It represents knowledge regarding ecological changes within the floodplain area to express possibilities for better care for creeks, wetlands and riparian habitats today and in the future. The project has the potential to mobilize and inspire the public for grassroots re-wilding of the city.

Interactivity allows learning and engagement by providing accessible and experiential representations of the complex environment across space and time. Historical visualizations offer a virtual space for reflection, discovery and exploration, enabling experiential learning through immersion in the past. Participants can explore historical wetland habitats and microenvironments.

Each local plant and animal encountered provides an opportunity to learn about the species and their Nsyilxcn name. Nsyilxcn is the language of the Syilx Okanagan People and belongs to the Salish language family [74].

Information for each species conveys their interdependence across the Okanagan's sensitive ecosystems and their role in providing water security and resilience for an interconnected living system. Audiences can listen to the Knowledge Keeper's reflections on the past and compare the natural habitats against the current agricultural and urban development. Two Knowledge Keeper's reflections were used with permissions from the interviews recorded and conducted by Dr. Sam's (2008) [75], and one interview was recorded by our team in 2021.

Understanding what we have lost and how much we have transformed our environment is essential. We live in a world of continually shifting baselines where our collective memory forgets what things were like more than the length of a human lifetime ago. The immersive environment allows us to step back and think about what it might have looked like in the area for people who lived here less than 100 years ago. As you walk through the floodplain, what might you encounter? So many species of plants and animals cannot be found in Kelowna anymore. Grizzlies, caribou and elks were all moving through what is now an urban and agricultural environment.

4. Discussion: Bringing the Threads Together

Galanter [76,77] argues that computationally driven media “*is uniquely positioned to negotiate between science and the humanities*”. He defines it in terms of complexity theory, a branch of study that deals with “*how relationships between parts give rise to the collective behaviours of a system, and how the system interacts and forms relationships with its environment*”. He argues that, while science traditionally holds a modernist viewpoint and the humanities have tended towards postmodernism and an organizing worldview, complexity as a worldview is the synthesis of modern and postmodern modes of thinking, indicating the critical need to develop new language, metaphors and worldviews that can support us in addressing the environmental challenges we created. Complexity opens up a third space for science and humanities to engage with each other through the world they represent and make it accessible for community reflection.

Immersive media’s potential for interactivity, and multivocality, in spatialized representations of sensitive cultural narratives, demands community-based collaborative development. The constant re-exploration of the media materials within the work resonates with a culture of sustainability, where social practices can directly contribute to community regeneration. Through the experience of flexible media art, perhaps we can learn what it means to re-imagine our actions and relationships continuously and critically with our community context. Understanding the sustainability challenge through this multiplicity of viewpoints enables cross-cultural dialogue to reveal a shared ethical space from which we can act as a community. From individual experiences to shared community values and worldviews, communities can shape their places to create significant societal change.

Cultures of sustainability hold many simultaneous, complementary and contradictory worldviews, and each of these lenses is valuable and incomplete. These multiple cross-cultural viewpoints and disciplinary perspectives give rise to further diversity of values, beliefs and needs. It informs how we understand our world in the context of the whole, to diverse communities of practice and how we interact with each other and our environment. Through creativity and sensual experiences, immersive media art provides a ground for meeting and grasping those diverse worldviews simultaneously, informing our place in the world and enabling us to position our actions as cognizant and compassionate for the diversity surrounding us. The sustainability we address through the Waterways exhibit focuses on a mindset, worldviews and relationality. We see sustainability as a holistic idea constantly shifting to accommodate new understandings of the mutual impacts between our surroundings and ourselves. In the remainder of this section, we explore the notion of Community Design, Interdisciplinarity and Dynamic Composition in the context of the Waterways exhibit. As we do so, we position them through the sustainability discourse.

4.1. Community Design

Community-engaged collaborative design involves engaging participants as partners in mutual learning and knowledge creation [23]. However, cross-cultural collaboration and knowledge sharing between Indigenous and settler communities require careful consideration. Canada’s legacy of colonialism has left an indelible mark on Indigenous and Aboriginal peoples, which continues to affect their psychological, social, cultural, and economic well-being [78,79]. Moreover, in British Columbia, where most of the provincial territory is unceded [80], the rights of Indigenous people and their singular role in society are foundational for any collaboration. Furthermore, the environmental issues directly or indirectly affect Indigenous lands pointing to the significance of effective cross-cultural collaboration approaches.

Divergent worldviews and relationality to the land profoundly influence cross-cultural collaboration in the Canadian context. Characteristics of worldviews shared across Indigenous groups include the world being seen as a whole, as an interdependent and interconnected living system in which humans are an integral part of nature, grounded in a philosophy of egalitarianism towards all life forms and non-human entities [54,81–83]. Features of the Western worldview, in contrast, are based on anthropocentrism. This philo-

sophical viewpoint places humans as the world's most central and significant entities and regards humans as separate from and superior to nature [84]. At the same time, other living and non-living things (e.g., animals, plants, minerals) are resources that may justifiably be exploited for the benefit of humankind, wealth generation and comfort. This dominant, hierarchical and detached relationship between humans and nature contrasts sharply with the Indigenous worldviews based on equal partnership with all living beings inhabiting the land and waters.

Waterways media and interviews subsequently used for the museum installation reflected the Syilx People's cultural protocols, values and beliefs to include the needs of the whole living system of *tmix^w*. Armstrong points out that in the Nsyilxcin language *tmix^w* refers "to the ecology of the land, including all life forms of a place, consisting of many relationships" [54] (p. 96)—the land, water, insects, animals, plants, people and medicine where humans are an equal part of *tmix^w*. "Sustaining, strengthening, and protecting each *tmix^w* in an equality of existence through the cycles of days, seasons, and years requires the knowledge that being human is a *tmix^w* responsibility" [54] (p. 96). Armstrong discusses the parallel between aspects of a deep ecology paradigm and the Syilx perspective, particularly concepts of interrelatedness with the environment as an epistemology of ecological egalitarianism towards all life forms, which represents a philosophical foundation for engagement with the Syilx community. The Nsyilxcin word Syilx similarly refers to "responsibilities that individuals have to take care of this land and its people through songs, prayers, ceremonies, language, and traditional practices" [85] (p. 23). Syilx is derived from the root word Yil, which signifies taking many-stranded fibers and weaving them together to form one unit to convey the idea of continuously binding with others, extending beyond humans to encompass all forms of life that make up the land. This emphasizes the interconnectedness of all beings and the importance of collective unity. The x at the end of the word signifies a command directed at the individual level. Each individual is instructed to actively participate in and contribute to binding and unifying with each other and the land [86]. The non-negotiable obligation of Syilx stewardship of the *tmix^w* is to act as caretakers of their lands. Embedded within this principle is the concept of respect and reciprocity. "Caretaking" and "stewardship" share protocols in which humans approach the world with the attitude of respect to interconnected entities and collectives, which have reciprocal relationships with one another [87].

The *captik^w* (i.e., stories) provide an ethical roadmap and system of intergenerational knowledge transmission [54,81]. According to Armstrong, "*captik^w* conveys the Syilx people's inextricable connection to the natural world and is fundamental to the dissemination of the Syilx environmental ethic" [76] (p. 106). Furthermore, the convention of *captik^w* is a method for humans to continuously learn, understand and be guided to implement the life principles required to sustain a regenerative environmental ethos.

Indigenous values equating *siwłk^w* (water) with life and as an essential sacred relation of all things in *tmix^w* were reflected in the exhibition. The exhibition materials highlight the Syilx cultural and existential significance of restoring Sockeye Salmon and the cultural imperative of restoring Okanagan habitats, riparian systems and biodiversity. Furthermore, the artwork generated through Waterways focused on creating an imaginative space of engagement and reflection on multiple realities and worldviews embedded in the "place" of the Okanagan.

The design of the Waterways exhibits reinforced cross-cultural and interdisciplinary understandings, collaboration, knowledge sharing and multidirectional communication discourse on water responsibility (Figures 14 and 15). Research participants brought their views and perspectives into the collaborative knowledge-generation process as a prerequisite for cross-cultural understanding. This collaborative knowledge generation process nurtured shared understanding and supported the team's ability to work together effectively. Iterative shared working processes were central, from conceptualization and design to museum production.



Figure 14. Salmon Release Ceremony in Penticton in May 2018, displayed in the exhibition. Columbia River Salmon Ceremony engages youth to encourage the next generation to continue the work to bring the salmon home. Around 10,000 young salmon are released into the Penticton River Channel annually as part of the Okanagan Nation's efforts to rejuvenate the local salmon population. Source: Photographed by Aleksadra Dulic.



Figure 15. Chief Chad Eneas with his nephew, May 2018. Used with permission. Source: Photographed by Aleksadra Dulic.

The collaboration and learning with communities, Syilx Knowledge Keepers, water scholars and scientists who contributed to the exhibit content and design allowed new connections and meaningful ideas to emerge. The meaning-making processes layered within the exhibit are amplified with the uniquely designed software applications responsible for media control and display. Thus, the collaborative design process contributed to cross-cultural sharing enabled by algorithms and aesthetics framework uniquely crafted from the community engagement processes. The development of the Waterways media exhibit demonstrates how computationally driven media art and the fields of sustainability have a reciprocal relationship of exchange, engagement and mutual benefit [27–29]. Concurrently, communities and those individuals have access to the techniques and ways of understanding the world that bring value through developing new modes of public engagement. As an experiential journey, the Waterways exhibit transcends dominant norms by sharing diverse perspectives and successful partnerships to elucidate shared ethical space.

4.2. Interdisciplinarity

Immersive media afford numerous ways of representing sensitive knowledge, requiring unique expertise. Collaborations among artists, Indigenous scholars, scientists, anthropologists and computational experts proliferate how we can communicate knowledge about people, habitats and places, articulating ideas through landscapes, soundscapes and interactions that create sensual experiences. An expanded sensorium of knowledge articulating cultural meaning is commonly experienced in galleries and museums [40]. These trends reflect and represent many ways cultural anthropology, technology design and fine arts are embedded in the contemporary media ecology.

The transformation toward sustainable, reciprocal and responsible relationships with the natural world is a complex challenge with many interconnecting and often competing facets. It is critical to have interdisciplinary perspectives when addressing sustainability and open spaces for dialogue and synergies across diverse viewpoints to facilitate new ways of approaching the challenge, finding common ground and considering a full range of goals. As a complex media system, the Waterways exhibit used an interdisciplinary approach to explore liminal spaces between and around disciplinary fields. The Waterways research team comprising a large multi-disciplinary group of artists and scientists from UBCO, both Syilx and non-Indigenous, as well as community partners, reflected the aim of collaboration and transdisciplinary research. The partners included the En'owkin Center, the ONA, the Kelowna Museums Society, the Okanagan Collaborative Conservation Program and the Okanagan Basin Water Board. At UBCO, Waterways worked out of the Center for Culture and Technology to bring together researchers on complex environmental systems and adaptation, de-colonization and Indigeneity, biodiversity and resilience (Figure 16). An iterative and collaborative creative process was applied throughout the research and design to capture the richness of interdisciplinary practice. New knowledge and artwork developed for the museum exhibition, for example, evolved through collaboration between cross-functional team members and were shaped by research and community partners. Waterways served as a design container for interdisciplinary views and sources of scientific, anthropological, artistic and community knowledge, from which meaning and multiple ways of knowing were derived.



Figure 16. The outer panels of the exhibit highlight Indigenous Syilx teachings and wisdom related to human–water relations and the value of water through five interpretive panels. Visitors also encounter two touch screens showing a realistic 3D virtual world depicting pre-contact Kelowna. UBCO team testing the installation in the museum. Source: Photographed by Joanne Gervais.

The Waterways Project reminds us that we all have a responsibility to work towards building and upholding the sustainability of water for healthy ecosystems and future generations, according to Syilx environmental ethics. The five interpretive panels include the text and quotes focusing on key concepts in the exhibition.

One of the outer panels displays the Okanagan Nation siwłk^w (Water) Declaration. In 2014, members of the Okanagan National Alliance signed a declaration that asserts their

relationship, rights and responsibilities relating to water. They declare *siwłk*^w “has the right to be recognized as a familial entity, a relation, and a being with a spirit who provides life for all living things.” ONA [53] (p. 3). The declaration affirms Syilx Peoples’ relationship with water and their responsibilities as caretakers of lands and waters to ensure accessible, clean and healthy water for future generations. Syilx sovereignty and the right to self-governance and self-determination are affirmed in Syilx laws and customs. The declaration sets out the resolve and path forward for Syilx leadership in water governance. Moule with 3D pre-contact visualization at the Okanagan Heritage Museum 2021.

For example, the Waterways 3D pre-contact visualizations’ design explicitly implements scientific and humanist methods, bridging these interdisciplinary streams with the design processes to co-create interactive 3D environments for communicating culturally grounded perspectives. The unique aspect of our research-creation methodology is bringing different streams of science and design with Indigenous knowledge and philosophy into 3D visualizations. The visualization demonstrates how scientific, academic and practice-based communication can delve deeply into place-based concepts and water sustainability challenges and solutions through collaborative development. As a gathering point for people with diverse backgrounds, the processes behind the creation of elaborate immersive media artwork can provide valuable insights regarding models of working across and between disciplines. Waterways was created in this mode and required that the work consists of an ongoing dialogue between the parties involved in its creation and community validation of the work.

4.3. Dynamic Composition

Kagan writes: “Cultures of sustainability may inspire hope, but their strength is also their vulnerability. As soon as they crystallize into fixed states, closing their boundaries and fixing their borders, they risk losing their elasticity and porosity down the path of autopoiesis. Cultures of sustainability are a matter of dynamic self-critical exploration. They require a continuous re-actualization of reflexive competencies. For this reason, they demand an artful practice of life” [14] (p. 10).

Process-driven immersive media emerges through the constant state of becoming. Often interactive, computationally driven artwork can provide a conceptual framework to engage with the active socio-environmental inputs that provide an endless source for varied representations. When interactivity is introduced, the work moves from a single creator and viewer to a responsive system, enabling a multifaceted conversation within a given environment. Computational composition and visualizations in the context of studying and representing cultures of sustainability enable researchers to design immersive experiences that evolve over time and in response to the audiences engaged in the results of the inquiry.

If we position computationally driven, dynamic exhibits as a distinct media type, what forms of messages are embedded in its structure? What themes and ideas are built into dynamic compositions because of their very nature? How does it produce spaces for reflection, re-imagination and grasping the complexity of our place and the world? Can it reveal new relationships between seemingly disparate entities? Does it allow participants to experience new avenues for understanding socio-environmental relationships? How can dynamics in form and content contribute to the process of making meaning?

As a site for disseminating research results, the Waterways exhibit provides a cross-cultural cultural encounter that integrates affect, cognition and meaning using human-computer interaction and media display methods to represent the sensual complexity of cultural knowledge and experience, enabling a complete immersion of audiences in the knowledge and practice that emerges from Okanagan Waterways. The Waterways content, software, hardware and spatial infrastructure were created from the community participation process to enable communication and dissemination of sensory and cultural research that can profoundly impact cross-generational and cross-cultural audiences and the public, taking full advantage of computation’s performative and interactive potentials.

Various relationships embedded in the diverse water knowledge, including interviews and audio-visual documentation of the environmental and cultural significance, scientific and historical modelling and visualizations, provide a creative platform for dialogue and learning (Figure 17). The improvisational re-combinatory poetics nurtures new insights and connections to emerge across diverse cross-cultural, community-based, poetic, traditional and scientific water knowledge and values, placing the viewer in the centre of these conversations.

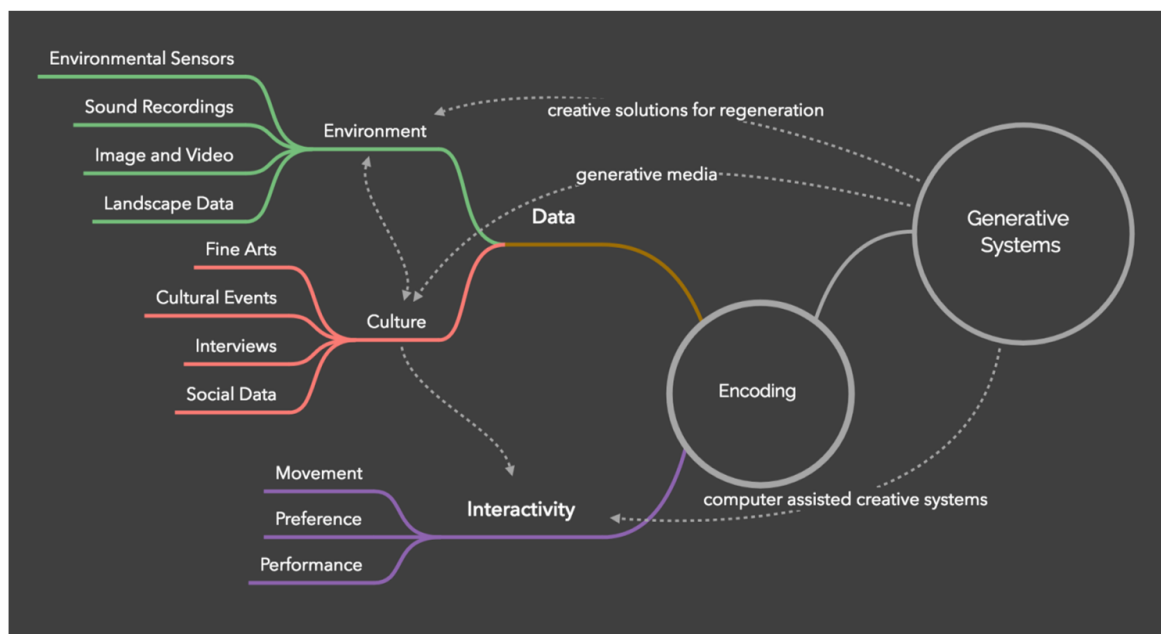


Figure 17. A diagram that demonstrates the relationships between the environment, culture and interactivity mediated through encoded processes by generative systems and reflected in the Waterways project. Source Diagram Created by Miles Thorogood and Aleksandra Dulic.

The computational media enable dynamic, flexible and responsive expressions and composition. This feature provides a fruitful ground for engaging with complex problems. The exhibition is formed through an equilibrium across multiple elements within the system that act together in a co-dependent yet flexible way. This characteristic of computational art is a crucial narrative device to enable an imaginative space of engagement and reflection on the realities embedded in our place: geopolitical issues, histories, futures, resource availability, conflicts, demography, biodiversity and beauty. The renderings of multiple relationships across its components within the art system provide a unique conversational space for a creative engagement with place-based sustainability thinking and practices. The dynamic composition of the Waterways exhibit enabled the poetic search for common ground and cross-cultural engagement to foster sustainable water practices in one of the most water-stressed regions of Canada. The diverse voices in the exhibition exposed the public to different values, worldviews and ways of thinking about and caring for the water.

The contribution of Waterways' research-creation project to sustainability discourse lies in its powers as a means of collaborative inquiry, as a way of knowing, understanding and representing our world. Immersive media exhibits can provide awareness beyond the conceptual framework, building on the capacity to sense the world, which exceeds the ability to categorize the world. The epistemological dimensions of immersive media art can present realities as constructed rather than fixed to invite new cultural dialogues, shape new cultural narratives and develop new forms of creativity. In that regard, immersive media inherit a language of fine arts to create an embodied experience that enables the reception of ideas in a fluid cycle across the sensual and conceptual, facilitating a space for the ontological reflexivity [11]. We approach the Waterways immersive exhibition as a source of ontological reflexivity and an agent of transformation and social change, where

foundational knowledge of how communities connect across cultures with water and all living beings is brought into play through a multi-sensory experience that activates lateral thinking and an intuitive grasp of concepts.

The Waterways exhibit creates an experiential journey that transcends our personal and socio-cultural customs to reach beyond our normative structures to new creative territories through the sensual process of immersion. This transcendence through a process of perception means co-evolving with social and personal structures due to improvisational experiences enabled by the artistic system. This empowers the creative engagement of participants to reach perceptual transcendence through immersion in concepts of water reasonability.

5. Conclusions

Waterways exhibit aimed to create a space for exploring water sustainability in the Okanagan, using community engagement processes to develop new tools for sustainability communication, dynamic composition, scientific and historical modelling and visualizations. We bring these interdisciplinary streams with the collaborative design processes to create an ethical space of cross-cultural engagement within an immersive environment. The project demonstrates how scientific, academic and practice-based approaches can work together to delve deeply into place-based concepts of water sustainability.

The discussion of the dynamics in complex systems reflects our dialogues over the four years at the Center for Culture and Technology at the UBCO. As a team, we came together in our interest in water responsibility to develop a new understanding of intertwining nature, art, science and technology. This work aims to bring opportunities for imagining and identifying shared ethical ground for sustainable living solutions. The Waterways project is an example of collaborative design that cultivates cross-cultural knowledge sharing and dialogue regarding sustainable human–water relationships. The project provides a platform for interdisciplinary research, visioning and visualizing local sensitive ecosystems across Indigenous and Western perspectives. The project synthesizes water knowledge and research to catalyze greater ecological awareness and promote more sustainable water use practices among residents. The work explores the multiple meanings of water for the many communities and interest groups in the valley, weaving stories with scientific modelling and visualizations into an immersive experience.

Supplementary Materials: The following supporting information can be downloaded at: <https://waterways.ok.ubc.ca/>.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The museum exhibit examples discussed in this section share the aim to empower creative responses to our current climate change challenges and motivate action in the context of their place. Immersive spaces designed to foster creative thinking and thoughtful multi-sensory experience can evoke participants' unique memories and associations in the cultural and environmental context, motivating personal action.

Arcadia Earth (2019–2023 <https://www.arcadia-earth.com/> (accessed on 19 October 2023)) is a large-scale immersive, interactive exhibition designed to educate visitors about climate change and inspire them to take action, currently on display in New York, USA [88]. The exhibition features 18 installation rooms, each with a unique message and purpose. Combining augmented and virtual reality technology and scenic design, the exhibition takes visitors on a multisensory journey showcasing underwater worlds, mystical forests, and underground caves. A room constructed from 44,000 discarded plastic bags symbolically represents the amount used in New York State every minute. Human consumption is highlighted by using recycled materials to construct installation spaces—plastic bottles, waste electronics and upcycled fabrics. The immersive experience is structured to motivate visitors to make small, everyday lifestyle changes that can have significant collective impacts. An actionable solution accompanies each message in the exhibition focusing on what we can do today to protect the future of our planet. The immersive exhibit intertwines physical and virtual spaces to address the climate change crisis through human needs rather than future threats, focusing on individual and collective action in an inspiring and engaging way.

Another example of an immersive exhibition space produced by the marine center in France, Nausicaá, is designed to educate visitors about the devastating effects of global warming on the ocean and marine life (2020–2023 <https://www.modulo-pi.com/showcase/immersive-room-nausicaa/> (accessed on 19 October 2023)). This digital exhibit entitled *Eye of the Climate*, which opened in 2020, depicts striking consequences of coastal erosion, marine ecosystems in changing climate, and oceans' essential role in climate regulation; 360-degree projection surrounds visitors with realistic 3D animations of marine life and underwater environments to create a lifelike experience that transports visitors to different ocean parts. This approach conveys complex ocean climate information to trigger visceral

reflexes with lasting emotional effects [89]. The exhibition is designed to raise awareness of the effects of human activities on oceans and showcase numerous solutions and best practices that can curb global warming.

Installations by Bérigny et al. [90] *Reefs on the Edge*, 2012–2017 and *InterANTARCTICA* [91], are interdisciplinary artworks that experiment with scientific data, photography, video, sound and tangible user interfaces to provide immersive educational space for reflection on climate change challenges located in Sidney, Australia. These works are examples of the interactive exhibit in the education surrounding climate change. Both installations use tangible user interfaces to shape interaction that invites viewers to engage with climate change science and its effects through embodied, visceral and aesthetic experience. These strategies allow the message of the effects of rising sea surface temperatures on young corals and melting ice in Antarctica to be translated seamlessly across multiple media platforms, creating a perceptible experience that integrates the entire body. In both works, de Bérigny works with a team of interdisciplinary professionals to bring science and art into an integrated interactive experience that engages an audience on embodied, emotional and intellectual levels. These examples highlight the importance of an interdisciplinary team approach in addressing complex problems facing humanity today.

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