

Using Virtual Reality to Empower Education, Protection and Restoration of Indigenous Waterways.

By: Brian Footen¹

Abstract

Over 100 years ago big box cameras were used to document the indigenous people and the landscapes of the Salish Sea Basin. These pictures were the first of their kind and required extreme effort to produce. The photographers needed to haul heavy equipment and glass plates, sometimes 100's of miles into the field. They then returned, and using extreme care developed the images captured on the glass. Created by using the most advanced technology of the time, these images are of extreme importance, giving us a portal into what life was like then and how the surrounding landscape appeared. Today the most advanced photographic technology uses 360- degree panoramic cameras to produce immersive virtual environments that can be accessed on desktop computers, mobile devices, or virtual reality headsets. Google "Street View" famously popularized this technology by using it to visualize and map our streets. This case explores how taking virtual reality technology beyond our streets by following in the footsteps of the first photographers that ventured into hard-to-reach places can connect indigenous people to the remote areas of the Salish Sea Basin. For the indigenous stewards of these critical places, modern virtual reality visualizations are important tools empowering waterway natural resource management, education, and cultural resource protection.

Introduction.

This case explores how imagery and Geographic Information Systems, digital data maps (GIS) can enhance our understanding of waterways without being on location. In addition, this technology called virtual reality can empower the ability to take action, learning about, protecting and conserving these places impacted by climate change.

Capturing the Past

Photography, as we know it today, began in the late 1830s in France. In the 1870s, photography took another huge leap forward. Dry gelatin plates were developed. These dry plates could be stored rather than made as needed. This allowed photographers

¹¹ Copyright 2023 by The Evergreen State College . Brian Footen is a scientist and explorer currently working as Co-Founder and Director of EarthViews Conservation Society, a non-profit using imagery and data to document endangered waterways. Prior to his work at EarthViews Brian earned a M.S. degree from The Evergreen State College Environmental Studies program and The University of Washington School of Fisheries. He worked for twenty years as a fishery research scientist for the Muckleshoot Indian Tribe Fisheries Division.

much more freedom in taking photographs. Allowing them to venture out into the field for days at a time capturing far away hard to reach places (Masoner, 2019).



Figure 1. Photographer from science expedition taking photographs of Pacific Northwest landscape.

History of Native Americans Photographed in the Pacific Northwest

During the 1850's the federal government sent photographers to the West to document the people and landscape. We can learn and gain insights about the people and landscapes from the images of this time. The University of Washington has an extensive digital collection of original photographs from this period that document the Northwest Coast indigenous cultures as well as the historical conditions of the landscapes they inhabited. These indigenous cultures are documented in the digital collection of historical imagery once occupied, and in some cases still live in parts of Alaska, British Columbia, Washington, Oregon, Idaho, and Montana that were captured by the photographers. As part of the collection maps are also available that show traditional territories or reservation boundaries.

The digital databases include over 2,300 original photographs as well as over 1,500 pages from the Annual Reports of the Commissioner of Indian Affairs to the Secretary of the Interior from 1851 to 1908 and six Indian treaties negotiated in 1855. Secondary sources include 89 articles from the Pacific Northwest Quarterly and 23 University of Washington publications in Anthropology (University of Washington Digital Library, 2022).

Modern Photography and What is Virtual Reality?

Photography was only for professionals and the very rich until George Eastman started a company called Kodak in the 1880s.

Eastman created a flexible roll film that did not require constantly changing the solid plates. The consumer would take pictures and send the camera back to the factory for the film to be developed and prints made. This was the first camera inexpensive enough for the average person to afford (Masoner, 2019).

Modern photographic technology continues to evolve with the recent development of 360-degree panoramic photography and mobile mapping systems or virtual reality. Virtual reality photography or VR is the interactive viewing of panoramic photographs. These photographs cover a 360-degree spherical view allowing the viewer to look around in all directions and feel immersed in the image. These cameras are capable of capturing a complete scene as a single image. The image can be viewed digitally by rotating it from a single central position.

VR photography is human-computer interaction and when many 360-degree photos are connected a virtual tour is created in which a real environment is digitally simulated on a computer screen and users interact with and manipulate that virtual world. This type of exploration of virtual spaces was commercialized by Google who debuted this technology in 2006 by launching "Street View". These virtual images of streets were integrated with maps to provide a new way to navigate streets enhancing location awareness. The technology used to collect the data that creates "street views" is called mobile mapping technology.

Mobile mapping refers to a means of collecting geospatial data using mapping sensors and cameras mounted on a moving platform. The platform can be a car, boat, plane or backpack. The technology used to collect the data can be seen in the picture below on top of a Google Car.



Figure 2. Google Street View car.

By adding geospatial data to the collection process each 360-degree image can be placed on a map integrating the immersive experience with the image location.

Practical VR Application in Indigenous Communities

This type of location awareness has become a very powerful way to connect people to the environment helping protect the environment through education and empathetic response to the feeling of being there. Virtual reality has therefore become an important tool for education as well.

Virtual reality is being used widely throughout indigenous communities in Australia, Africa and the United States to connect indigenous people to their traditional ecological knowledge, historical places and the environment.

One example of VR use occurred at Wind Wolves Preserve in California where two remote archaeological sites are situated in the San Emigdio Hills. Pleito, one of the most elaborately painted rock-art sites in the world, and Cache Cave hosting one of the most extensive collections of baskets ever discovered in America. The oldest of the rock paintings and baskets are over 2,000-years-old yet exploring is difficult because of the remoteness and sensitivity of the items. The paintings at Pleito on sandstone are fragile and the Cache Cave is a complex, narrow cave system. The Tejon tribes' people were unable to visit the Pleito cave site due to its inaccessibility and fragility until 2017 when the tribe partnered with a team of researchers from the University of Central Lancashire in the United Kingdom. They used mobile mapping technology to create a VR model of the sites. When the maps of the area were shown to Tejon Tribal members the

response was positive. Younger tribal members responded to a familiar environment similar to “gaming.” The VR presentation also proved effective for use by the elder members of the tribe, many who have mobility issues so visiting the preserve and its rugged terrain is not possible (Cassidy, 2017).

Mobile Mapping Technology Applied to Waterways

Waterways are environments that are difficult to access for most. Even the scientists and conservation managers who work hard to protect the rivers and shores and the fish and wildlife that depend on them often have limited access to the areas they are working in. Although VR is applied widely to streets, until recently it was not being applied to waterways. EarthViews changed that in 2015 with one of the first ever “street view” experiences of a river by using mobile mapping technology to survey the Elwha River 48 hours after the last of the Dams were removed. From there they continued surveying waterways and creating VR maps. To date over six thousand miles of rivers and lake shores have been documented creating RiverView and ShoreView experiences for anyone to go and explore. Many of these waterways have been mapped in Western Washington State in partnership with local Coast Salish Tribes.

Location

The primary location for much of the VR mapping done by EarthViews resides in the Southern portion of the Salish Sea known as the Puget Sound Basin (Figure 3).



Figure 3. The Salish Sea and Puget Sound. *Source: The Nature Conservancy in Washington.*

Here as well as along the Washington Pacific Coast the Coast Salish people have lived for thousands of years (Figure 4).



Figure 4. Distribution of Coast Salish within the Salish Sea, Puget Sound and Pacific Coast. *Source: Map drawn by Hillary Rudd.*

The arrival of Captain Vancouver to the Salish Sea in 1792 marked the start of British colonization of the Coast Salish region and the renaming of traditional Coast Salish waterway names. Puget Sound was named by Captain Vancouver after Peter Puget who the captain had sent with two paddle boats and crew to explore the Southern most areas of the of what is now the Puget Sound region of the Salish Sea. On their way South they encountered the Nisqually Reach and the present-day Billy Frank Jr.

Nisqually National Wildlife Refuge and the Nisqually Tribe. This area was described by Peter Puget. The river mouth was not explored (McBride, 1990). As Puget says:

“The water had shoaled quite across to 4 and 5 feet; that stopped our further progress toward the shore as it was falling tide and I was fearful of causing more detention, which would have been the case had we grounded. These friendly [Nisqually] Indians followed the boat a considerable distance up the west arm which we were now pursuing, though they had sold all their articles. In their persons, customs and manners, they appeared to be of the same tribe with those on Alarm Cove, the only difference a friendly disposition. Their canoes, weapons and paddles are of the same construction. They did not leave us until after we had passed the SSW Channel, and still conducted themselves in the most inoffensive and peaceable manner.”

The area where Peter Puget had the above-described encounter can now be experienced virtually via the EarthViews mapping of the area. Shown below is a screen shot from the interactive ShoreView map (Figure 5). The area can also be accessed online via this link.

<https://arcgis.earthviews.com/public/puget-sound-nisqually-delta-1021#682>



Figure 5. Screenshot of EarthViews map where Peter Puget encountered Nisqually tribal members at Nisqually Delta.

Peter Puget and crew ended up near Olympia, Washington where they encountered members of the present-day Squaxin Island Tribe as described by Peter Puget (McBride, 1990):

“An Indian village made its appearance from whence some canoes came off perfectly un-armed On our way down [to the termination of the inlet] we landed for a short time and were received by the inhabitants with all the friendship and hospitality we could have expected About sixty in number, of all ages and descriptions, they lived under a kind of shed open at the front and sides. The women appeared employed in domestic duties such as curing clams and fish, making baskets of various colors and so neatly woven that they are perfectly watertight. The occupations of the men I believe consist chiefly in fishing, constructing canoes and performing all the laborious work of the village.”

The area where Peter Puget had the above-described encounter can now be experienced virtually via the EarthViews mapping of the area. Shown below is a screen shot from the interactive map (Figure 6). The area can also be accessed via this link. <https://arcgis.earthviews.com/public/puget-sound-mud-young-1221#160>



Figure 6. Screenshot of EarthViews map where Peter Puget landed in Squaxin Tribal lands.

Methods: Data Collection, Processing and Publishing

How are EarthViews ShoreView and RiverView online maps created? Data is collected by piloting a watercraft within 10 to 15 feet parallel to the shoreline. On board the craft are data collection instruments including a 360-degree camera, a Geospatial Positioning System (GPS), and a water quality meter. These instruments are all synchronized to log collected data every ten seconds (Figure 7).

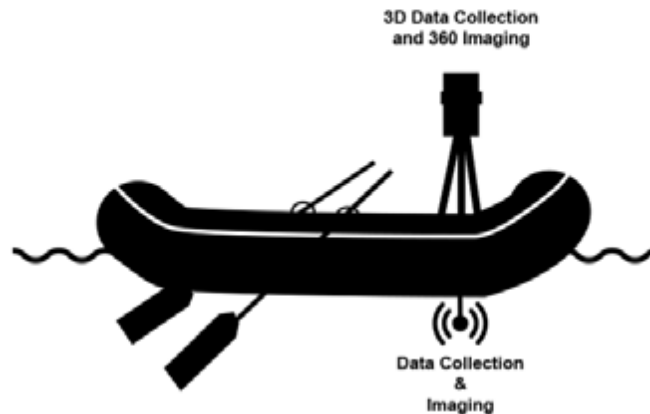


Figure 7. Representation of a data collection platform for waterways.

Once the data are collected, they are processed and published digitally via a custom online application that gives the user the ability to navigate through the imagery and data on a computer or mobile device in a manner similar to that of “street views” called RiverViews or ShoreViews. These imagery can also be viewed through a VR headset.

Results: Puget Sound Ecology

To date over 700 miles of Puget Sound Nearshore have been surveyed by EarthViews using mobile mapping technology creating a ShoreView map of the Puget Sound.

These ShoreView maps can be accessed via the Puget Sound Atlas

(<https://arcgis.earthviews.com/puget-sound-home.html>).

The primary purpose of the survey is to document nearshore conditions in an effort to help Puget Sound stewards including tribal natural resource managers better understand how the waterway is being impacted by development and climate change. Puget Sound faces many environmental and water quality challenges that are impacting the overall health of the waterway. Among those three major limiting factors exacerbated by development and climate change are bank armoring disrupting natural nearshore processes, the loss of seagrass and kelp bed habitats as well as increasing water temperature and low dissolved oxygen, especially in the southern reaches of the waterway.

Bank Armoring

One of the major impacts to Puget Sound health that can be easily observed when exploring the nearshore with the ShoreView map is the impacts of bank armoring

(Figure 8). Visit this location: <https://arcgis.earthviews.com/public/puget-sound-21-2#3864>

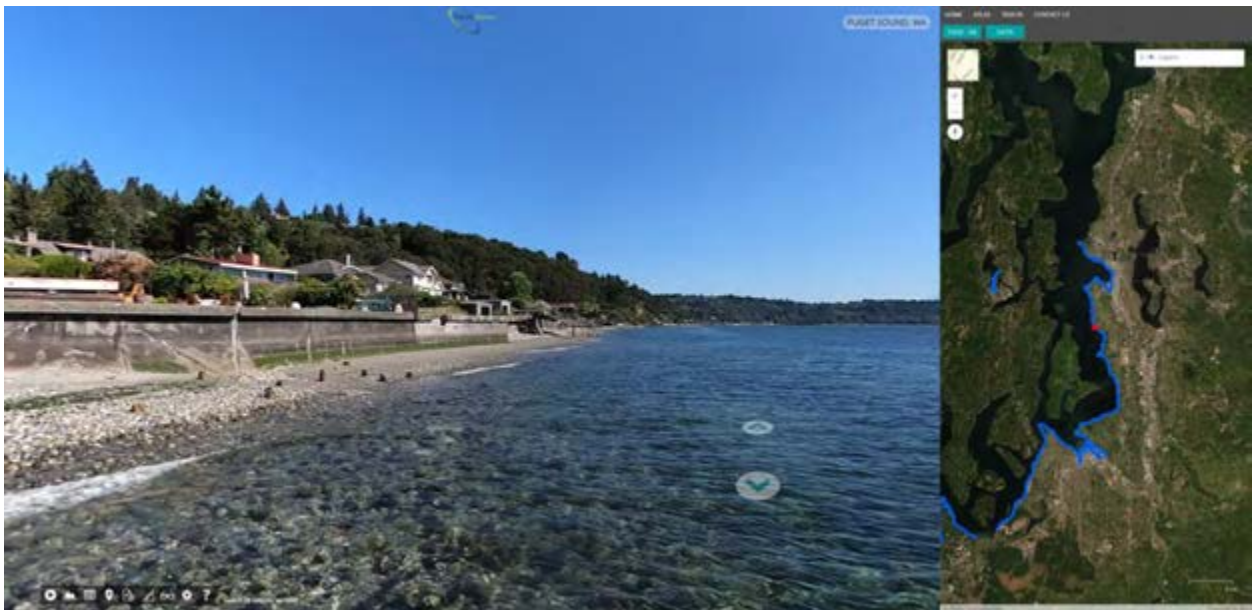


Figure 8. Screenshot of cement walls used for bank armoring along the Puget Sound nearshore.

The majority of the Puget Sound nearshore is either privately owned, used for railway passage or a municipality. All of these activities are concerned with protecting their property from tidal erosion effects. In order to stay the erosion impacts bank armoring in the form of rockery or wood and cement walls are put in place to dissect the land from the water, creating a barrier to protect the land. Because these barriers occupy so much of the Puget Sound nearshore the impacts are profound. Bank armoring disrupts the natural processes and flow of materials between the shore and the intertidal beaches. These beaches and the plants and animals that live in the intertidal areas are dependent upon the recruitment of sediment and organic materials like wood to help maintain a healthy beach. Without this exchange the intertidal habitat erodes away and becomes rocky and nutrient deficient.

Seagrass and Bull Kelp

The victims of this degraded exchange start with seagrass and bull kelp. Seagrass beds are dependent on the recruitment of sediment and other nutrients into the intertidal zone. Seagrass in turn provides rearing habitat for juvenile salmon and other fish and historically covered vast areas of the intertidal areas of the Puget Sound nearshore. Now these areas of seagrass are often limited to small patches (Figure 9). Visit the small patches of seagrass: <https://arcgis.earthviews.com/public/puget-sound-21-22#7146>



Figure 9. Looking down at a small patch of seagrass shown as a dark area under paddle and kayak.

Bull kelp is very sensitive to the nitrogen contents of the water. So any disruption to the exchange of organic material that provides nitrogen such as fallen trees and leaves into the nearshore zone can cause a reduction in nitrogen levels, reducing bull kelp productivity. However, as important as nitrogen levels are to the health of bull kelp beds, water temperature is even more so. Water temperatures have been increasing in Puget Sound exacerbated by the impacts of climate change. Here some of the few remaining bull kelp beds in Central Puget Sound can be seen in the fast-moving cooler waters of the Narrows Straight (Figure 10). Visit the bull kelp beds near the Narrows Bridge: <https://arcgis.earthviews.com/public/puget-sound-21-22#12806>



Figure 10. Bull kelp beds in the cool fast-moving waters under the Narrows Bridge.

Results: Native Areas Mapped and Tribal Use

Nisqually Tribe and the Nisqually River Delta

Less than a decade ago the Nisqually Delta was diked off and used for agricultural purposes. Now thanks to monumental habitat restoration efforts in the delta, the area must look somewhat like the way Peter Puget and Nisqually Tribal members saw it nearly 250 years ago (Figure 11). Visit the Nisqually River Delta and the Billy Frank Jr. Nisqually Wildlife Refuge: <https://arcgis.earthviews.com/public/puget-sound-nisqually-delta-1021#579>



Figure 11. Exploring deep into the Billy Frank Jr. Nisqually National River Wildlife Refuge.

The Nisqually Delta and Refuge is an incredibly difficult place to access and is off limits to boaters. Permitted access can only be obtained by shallow drafting boats like kayaks and only when tides are at the right level. Therefore, Nisqually tribal natural resource managers as well as tribal elders and school children cannot access this recently restored culturally significant area. Now with the ShoreView of the delta tribal members are able to virtually explore and learn about the habitat restoration success as well as visit important archaeological sites.

The Squaxin Island Tribe and Squaxin Island

What does an unarmored natural shoreline look like and how does it function? The unaltered shorelines experienced by Peter Puget are still present along the shores of Squaxin Island as this reservation land has been preserved and is off limits (Figure 12). Visit the Squaxin Island nearshore: <https://arcgis.earthviews.com/public/squaxin-island-0822#1607>



Figure 12. Squaxin Island nearshore with trees in water and bank eroding.

Only Squaxin Island Tribal members are allowed to access it with a permit. With the tribe's permission EarthViews scanned the Squaxin Island Nearshore and now this ShoreView is being used by the tribe for cultural, educational and scientific purposes. Just as with the Nisqually Delta ShoreView, Squaxin Island elders, school children and other tribal members are able to take virtual field trips to the island visiting sacred sites

and learning about nearshore habitat and natural function. Virtually exploring the Island nearshore allows natural resource managers to, from their desks, easily identify and plan for removal of legacy marine debris left over from commercial fishing and aquaculture before the Island was designated for tribal use only.

Conclusion

Documenting waterways is an important way to connect indigenous people to these culturally significant hard to reach areas. Recent VR mapping in Puget Sound has proven to be beneficial not only for understanding the ecology of the estuary and what some of the impacts are from climate change and other development activities but has also proven important for the original inhabitants of the Salish Sea. Now tribal natural resource managers have a tool to help better understand conservation challenges and scope potential solutions. In addition, other tribal members can virtually visit and learn about these difficult to access indigenous waterways.

References:

Masoner, L. (2019, January 3). *Explore the major advances in the history of photography*. The Spruce Crafts. Retrieved October 15, 2022, from <https://www.thesprucecrafts.com/brief-history-of-photography/>

McBride, D.J. (1990) *Viewpoints and Visions in 1792: The Vancouver Expedition encounters Indians of Western Washington*. Washington State Historical Society. Retrieved October 15, 2022, from https://www.washingtonhistory.org/wp-content/uploads/2020/04/viewpoints-visions_001.pdf

Robinson, B. C. A. D. (2017, December 12). *How virtual reality is opening up some of the world's most inaccessible archaeological sites*. Phys.org. Retrieved October 15, 2022, from <https://phys.org/news/2017-12-virtual-reality-world-inaccessible-archaeological.html>

University of Washington. (n.d.). *American Indians of the Pacific Northwest Collection*. ::: American Indians of the Pacific Northwest Collection ::: Retrieved October 15, 2022, from <https://content.lib.washington.edu/aipnw/index.html>

Sources:

Rudd, H. (n.d.). *Coast Salish territories drawn by Hillary Rudd, 2004 (thom, 2005, p. 61 ...* Retrieved October 15, 2022, from https://www.researchgate.net/figure/Coast-Salish-territories-drawn-by-Hillary-Rudd-2004-Thom-2005-p-61_fig3_322702552

The Nature Conservancy in Washington, T. N. C. (2020, April 15). *Two-minute takeaway: Where is the Salish Sea?* The Nature Conservancy in Washington. Retrieved October 15, 2022, from <https://www.washingtonnature.org/fieldnotes/two-minute-takeaway-where-is-the-salish-sea>