SONGS OF THE OTTAWA: A SONIFIED ENVIRONMENTAL HISTORY OF THE CHANGING RIVERSCAPE FROM THE CHAUDIÈRE FALLS TO KETTLE AND DUCK ISLANDS, 1880 to 1980

by

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Abstract

"Songs of the Ottawa" is an experiment in the digital data sonification of the Ottawa River's pasts. This study examines a stretch of river extending from below the Chaudière, Akikodjiwan, or Kana:tso Falls, past the points of confluence with three important waterways – the man-made locks at the Rideau Canal, the tumbling Rideau River falls and the low-lying delta of the Gatineau – to the sandy Kettle and Duck Islands. "Sonifying" the history of the river means to express history to achieve a particular sensual engagement with the past. Sonification is the "visualization" of historical data auditorially, to achieve a particular sensory affect. This project asks readers and listeners to *hear* uncanny, affective pasts and consider the ways in which storytellers can "de-form" and "re-form" data and sources. The three "songs of the Ottawa" offer a way into the stories of the river's flows, of commerce and industry extending up and downstream, and of recreation on the water and shores.

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Introduction

Stretching more than 1,200 kilometres, the Ottawa River drains a watershed as immense in its geography as its role in the natural and human history of the land we know as Canada. This digital project sonifies the history of a small but historically significant section of the river between 1880-1980. Sonification denotes the "visualization" of historical data auditorially, to achieve a particular sensory affect.[1] My area of interest extends downriver from below the Chaudière, Akikodjiwan, or Kana:tso Falls, past the points of confluence with three important waterways – the man-made locks at the Rideau Canal, the tumbling Rideau River falls and the low-lying delta of the Gatineau – to the sandy Kettle and Duck Islands. Fundamental to my research project is the fluidity and movement of the river, its shores, and its riverbed. The river's water level rises and falls with changing weather and the rhythm of the seasons, and its "boundaries" shift accordingly. This is particularly important in the consideration of these islands and their edges. The theme of socio-nature is also central to my studies – especially of boat traffic and industry – where natural and human ecosystems develop together over time and cannot be separated from one another.[2]

An experiment in digital history, this project sonifies several elements of the river's past to hear the patterns of the seasons, its materiality, and the waxing and waning of human settlement and boat traffic. The first song, "Hearing the River's Flows," uses

[1] Note: affect, rather than effect, to represent the experience of feeling an emotion.
[2] Edward MacDonald, Joshua MacFadyen, and Irené Novaczek, "Promise and Premise: An Environmental History for Prince Edward Island" in *Time and a Place: An Environmental History of Prince Edward Island* edited by Edward MacDonald, Joshua MacFadyen and Irené Novaczek, 3-15 (London; Kingston; Montreal; Chicago: McGill-Queen's University Press, 2016), 10.

monthly mean water level data collected at the foot of Rideau Locks over 98 years to tune into the hydrology and regulation of the Ottawa. The second, "Sounds of Industry," uses the physical data of a pulp paper sample to tell the story of evolving industry on its shores. The final song, "On the Water," sonifies the trips of three boats crisscrossing the river in a single week of July 1912. In the following pages, I survey a number of different experiments with data sonification and explain my choice to explore the technique for this environmental history. "Sonifying" the history of the river is a way to achieve a particular sensual engagement with the past. Sonification is different from what R. Murray Schafer called 'the soundscape.'[3] Whereas soundscapes paint with 'found' sounds – the auditory snapshot of a location at a given time, at a given place – sonification is an act of *translation*, or *re-mediation* and so is the aural equivalent of mapping, graphing, or charting to tell a story. I propose that sonification can also be an act of de-formance, or the deliberate re-interpretation of a text, and that this is a reminder of the constructed nature of data.[4] Music and sound help to capture the complex changes in the history of the riverscape and are highly effective in their ability to represent *place* and change. This project uses data in several forms as the basis for each "song of the Ottawa" and employs computer algorithms to create these compositions. In each case, I have chosen to represent facets of place and seasons with musical keys, notes and tempo. This reflection will introduce the Ottawa River, explain the selection of sources, describe the methodology used in the sonifications, show the ways in which the songs reveal

[3] R. Murray Schafer, *The Soundscape: Our Sonic Environment and the Tuning of the World*, (Rochester, Vermont: Destiny Books, 1994.)

[4] For the average listener, this act may not be evident. I propose that simply engaging with data through sound can challenge its perceived objectivity and is a worthy end.

patterns and interruptions, like dams or changes in human activity, and explore some other possible interpretations.

While the riverscape has always been defined by its movement, the period selected is a particularly dynamic one. Its temporal frame begins in 1880 and is established by debates about sawdust pollution and the dredging of sand, moving and changing the riverbed and shape of Duck and Kettle Islands. It extends to 1980, the year that the final cottage was removed from Duck Island. The river's temperature, water levels, island profiles, and shorelines changed enormously over the century, and this information is more easily accessed as humans document their interactions with it. Although its scope considers a recent, and particularly human, history, this project is situated in the deep time of Canadian environmental history and the long history of the Ottawa River watershed as a place of transit and exchange for traditional peoples and colonisers.[5] Human activity between 1880 and 1980 can be identified in approaches to the river and its islands as places for both possibility and risk; its potential explored for development, resource extraction, commercial activity, leisure (steamboat tourism, an amusement park and vaudeville theatre on Kettle Island, and a variety of sports), and at the same time as feared, with drownings, shipwrecks, crime, pollution, and floods.

The spatial frame of this research reaches from the Chaudière Falls downstream to the point of Lower Duck Island and encompasses the river's shores on either side. It

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[5] I am cognizant of critiques in Colin Coates', Jason Hall's and Anya Zilberstein's discussion of the tendency in Canadian environmental history to deal with more recent human history, as opposed to addressing the broader "deep time" chronology. This project, by its nature, cannot be as extensive as they suggest, but will situate its stories in the broader history of the river and land. See Colin Coates, Jason Hall, Anya Zilberstein and Alan MacEachern, "Early Canadian Environmental History: A Forum," *The Otter – La Loutre* (blog), May 25, 2016.

includes the points of confluence with tributary waterways, including where the Gatineau meets the Ottawa and the low-lying Gatineau Point, as well as the Rideau Canal and the Rideau River's rushing falls as they change and are changed through time. Kettle Island and Upper and Lower Duck Islands are also central to this sensory environmental history. I am also interested in the Ottawa's riverbed, and life and activity below the surface. I consider the water's borders and trace changes its water levels over nearly one hundred years. This project's reach has inevitably had to extend upstream and downstream to consider the implications of human activity on the river, especially in its attention to technological megaprojects like the 1962 Carillon Dam, and their effects on the riverscape. To capture the materiality of the river in examining the pulp and paper industry on its shores, and to consider boat traffic for trade and tourism, my discussion extends beyond the project's spatial scope.

On Sources

In getting a preliminary sense of the Ottawa on both shores, I accessed English primary sources held in both Library and Archives Canada and the City of Ottawa Archives, as well as French sources at the Bibliothèque et Archives nationales du Québec. The City of Ottawa Archives' collection of city directories were invaluable in tracing business interests on the river, and identifying the government departments charged with riverworks as their names and roles changed. I used both the *Ottawa Journal* and the *Ottawa Citizen* to explore the broader history of the river – recorded thaws and floods for example – and then to trace more subtle changes and activities along the riverscape. These newspapers record the impacts of the lumber trade, which sent vast sawdust pollution from upstream lumber mills.[6] These stories pushed me to consider the history of the riverbed, and I was captivated by the business of dredging and selling sand and clay from the river-bottom, which boomed throughout the 19th century and made changes to the riverscape and the islands' profiles.[7] I also found both the *Ottawa Journal* and the *Ottawa Citizen* to contain interesting anecdotes about the river's fish and their presences and absences.[8] While I had to set these angles aside for this project, to focus on data sonification, I employed advertised schedules in the newspapers for evidence of the heavy ferry and steamboat traffic for tourism and trade, as well as to understand the role of the river and the islands as a playground for people settled around its shores throughout the 19th and 20th centuries. Over the years, rowboats and ferries shuttled city-dwellers to camping sites, walking trails and amusement parks. I also accessed the rich material culture, archival, and library collections at the Canada Museum of Science and Technology to uncover stories from the lumber and pulp and paper industries on the river and the technologies mediating human interactions with it. Through historical images and maps of the city in the museum's collection and that of the city and national archives, I was able to glean material changes in the riverscape in corporate documentation of

[6] "The Sawdust Nuisance," *Ottawa Journal* (Ottawa, Ontario), January 20, 1890. See also, "As to the Sawdust, The Latest Remarks in the Marine Blue Book." 24 August, 1893, "Will Not Speak, Board of Trade Silent on the Sewer Question." 28 October 1896, "The Western Sewage, Finding of the Provincial Health Board." 27 October, 1897, "A Local Invention. A Sand Pump That Raises 2 ½ Cubic Yards of Sand per Minute." 15 August, 1898, "A Demand for Sand. How it Will be Supplied from the Ottawa River." 21 March, 1899.

[7] "Sand in Demand," *Ottawa Journal* (Ottawa, Ontario), 22 October, 1898.

[8] One such example is that of the brown bullhead, also known as a mud pout or *louche*, commonly fished for subsistence by francophone populations on either shore of the river in winter. Several columns in the *Ottawa Journal* in 1949 and 1957 reveal that the river's warmer temperature and weaker ice made mud pout harder to catch.

industrial development to the high and low water levels on fire insurance maps. Maps of the former townships along its shores also offer insight into the Lower Ottawa, including an 1860 map showing a lighthouse at Green Shoal near Duck Island, the base of which still stands.[9] I considered consulting aerial photographs but they are not available for the entire scope of my sensory environmental history. I decided instead to capture the river's changing shape and flow through other means.

Setting out to sonify data led me to understand traditional sources differently and pushed me to listen for non-traditional historical sources and uncover surprising stories. The first song sonifies the Canadian Water Survey's hydrologic data to capture its changing flows. The second, "Sounds of Industry," is a case study in re-forming the data of the river's material culture in the Canada Science and Technology Museum collection. I would not have investigated these angles of the river's history without the impetus to sonify data.

Sonification to empower and enchant publics

In each case, I present the historical methods I have used in selecting the stories and data to be sonified, as well as the digital methods I apply in my approach. This reflection should be read alongside the "songs of the Ottawa" themselves. These are available through links to Soundcloud and Youtube in each chapter discussion and also introduced on the project's website.[10] The code and tools used to create them are also linked throughout. My aim in making this process available in its entirety is to encourage

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[9] *Map of Gloucester Township* [map], 70 chains per inch, "The Canadian County Atlas Digital Project: McGill University," 1880.

[10] The project is available online at www.songsoftheottawa.ca. This online home is a work-in-progress.

readers and listeners to experiment with the method. Remixing these "songs of the Ottawa" or reproducing the outcomes with their own data is highly encouraged. This experiment is a work of digital, environmental, and public history that considers and seeks to empower publics to play with the past.

Sensory and affective approaches have long been used to explore non-human agency, and this has informed both my research and my digital history outcome.[11] Vinciane Despret's study of non-human agency suggests that "one may be an agent without being a subject."[12] Julie Cruikshank's *Do Glaciers Listen?* has especially helped me to conceive of the river acting, speaking, and shaping the stories told about it.[13] My aim in experimenting with sound is to build a sensuous engagement with the past and explore the ways in which an experience with the past in audio might elicit a feeling of 'enchantment.' Often employed in archaeological, anthropological and heritage spheres, the notion of 'enchantment' describes the power of art and artifacts of the past "to exercise non-human agency and produce enchanting effects."[14] Political theorist Jane Bennett describes it as follows:

> The mood I'm calling enchantment involves, in the first instance, a surprising encounter, a meeting with something that you did not expect and are not fully prepared to engage. Contained within this surprise state are (1) a pleasurable feeling

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[11] See Gilles Deleuze and Felix Guattari, *A Thousand Plateaus: Capitalism and Schizophrenia,* transl. Brian Massoumi (Minneapolis: Minnesota University Press, 1987), whose notion of *agencements* explores perception to capture the agency of the non-human. Bruno Latour and Vinciane Despret also explore the sensory in networks to account for non-human agency in animals and non-sentient things.

[12] Vinciane Despret, "From Secret Agents to Interagency," *History and Theory, Theme Issue* 52 (2013), 39.

[13] Julie Cruikshank, *Do Glaciers Listen? Local Knowledge, Colonial Encounters, and Social Imagination* (Vancouver: UBC Press, 2005).

[14] Christina Fredengren, "Unexpected Encounters with Deep Time Enchantment. Bog Bodies, Crannogs and 'Otherworldly' sites. The materializing powers of disjunctures in time," *World Archaeology* 48 no. 4, (2016), 485, DOI: 10.1080/00438243.2016.1220327.

> of being charmed by the novel and as yet unprocessed encounter and (2) a more *unheimlich* (uncanny) feeling of being disrupted or torn out of one's default sensory-psychic-intellectual disposition.[15]

This uncanniness is what I seek to evoke through the "Songs of the Ottawa." In a world where the primacy of sight is deeply entrenched and denotes objectivity and truth, hearing information is confronting and *other*. The notion of "songs" of the Ottawa – even if they are not what a listener typically expects of a musical piece – also reminds the listener that this can be an affective experience. In exploring affect, I hope that the songs offer a way into broader stories about the river's history.

Why Data Sonification

Data sonification is generally understood as the transmission or translation of data into audio signals. Sometimes, scholars draw a distinction between sonification, a mapping of more complex data to elements of music, and audification, a more direct translation of data waveforms into sound waves.[16] Without naming it as such, most people encounter forms of data sonification on a daily basis. A clock whose ticks are audibly signalling the seconds passing, or whose chimes ring every quarter hour, is conveying information through sound. Like this form of sound information, my project makes data "sing" through parameter mapping and algorithmic composition.

A brief history of the approach

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[15] Jane Bennett, *The Enchantment of Modern Life: Attachments, Crossings, and Ethics* (Princeton, New Jersey: Princeton University Press, 2001), 5.
[16] David Worrall, "Introduction to Data Sonification" in *The Oxford Handbook of Computer Music*, ed. Roger T. Dean (New York; Oxford: Oxford University Press, 2009), 321.

Though it can be broadly defined as "the use of nonspeech audio to convey information," data sonification is ever-changing.[17] In the same way that many approaches to graphical representation fall under the umbrella term of visualization, there are many ways to render data as sound and produce sonifications.[18] In a 2015 article summarizing the history of the method, Alexandra Supper identifies the common presence of "an element of transformation through which sound is generated out of (previously silent) data.[19] Data sonification has been employed in the past by researchers in the fields of medicine and science. In the nineteenth century, physiologists made "nonaudible phenomena audible for the purposes of listening for information" by attaching muscle tissue to telephone speakers to understand the paths of electrical currents running through the tissue.[20] While these experiments had a limited scope, Supper (and others) cite the Geiger-Müller counter tube – known to most as the Geiger counter to detect radiation – as a longer-lasting and better-known example of data sonification.[21] The Geiger counter makes radiation audible.

These developments in "making informative sounds" led to research in sound communication in the 1980s and 1990s. Seismologist Sheridan Speeth, for example,

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[17] Gregory Kramer et. al., "Sonification Report: Status of the Field and Research Agenda. Report prepared for the National Science Foundation by members of the International Community for Auditory Display," International Community for Auditory Display, 1997.
[18] Alexandra Supper, "Sound Information: Sonification in the Age of Complex Data and Digital Audio," *Information & Culture* 50, no. 4 (2015): 442.
[19] Ibid.
[20] Supper identifies this, based on historian Axel Volmar's work, as an early instance of data sonification in which external information is made audible to answer specific research questions. Ibid., 445-446.
[21] Supper also cites Kramer, who calls this "perhaps the most successful example of sonification," in Supper, "Sound Information," 446.

audified earthquake data to better understand it.[22] Supper cites researchers in human-computer interaction as among the first to explore how sound might be added to enhance graphical user interfaces.[23] The origins of this method are deeply intertwined with the development of the systems using sound in computing that helped shape our multisensory interactions with digital tools today.[24] Growing interest in this research after a 1985 conference session on "Communicating with Sound" led to the organization of a 1992 "International Conference on Auditory Display" by the composer of computer music Gregory Kramer.[25] This moment is cited by many as the genesis of a community of researchers interested in auditory display and data sonification.[26] This interdisciplinary group was made up of many scientists. Sonification grew as more scholars recognized its potential as a tool to help researchers and the public understand large and multivariate datasets.

This method faced criticism as well. Sonification's potential for enhancing interest and communication has proved to be a double-edged sword. The notion that sonification – and *listening* – could be a valuable scientific method struggled to take hold beyond the community of researchers directly engaged in it. Supper cites a 2010 interview with an astrophysicist using sonifications in his work who does not use them for research but

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[22] Supper, "Sound Information," 448.
[23] Ibid., 447.
[24] At the same time that Bill Gaver was developing the SonicFinder interface for Macintosh computers, Supper shows that researcher Sarah A. Bly was exploring the ways in which sonification might help to "understand multivariate datasets." These experiments came together in 1985 in a panel session on Human Factors in Computing Systems. Supper, "Sound Information," 462.
[25] Ibid., 447.
[26] Supper, Luca A. Ludovico and Giorgio Presti, Sandra Pauletto and Andy Hunt all cite Kramer's early work as a starting point.

"frames [the sounds] as a gimmick to create public interest."[27] Another physicist believes the sonifications of particle collisions she creates to be useful, but suggests that her scholarship would be immediately dismissed as not serious or objective if she did not "sell the project as a public outreach activity."[28] Supper's 2015 review of the history of sonification cites the lack of a systematic interpretive framework for the sound outputs as a weak spot in the field. Because researchers experimenting with auditory display are scattered across disciplines and emphasize the tools and techniques, she suggests that "the underlying data often slips into the background."[29]

Supper's critique, among others, has paved the way for more recent scholarship that sets out to emphasize rigorous interpretation of data sonifications. Italian scholars of music and information studies Luca A. Ludovico and Giorgio Presti propose a "sonification space" – a "reference system for sonification tasks" in a 2015 article.[30] A 2018 study tracking northern elephant seals separates the insights derived from the sonification created from the extensive data visualization (using the same data to digitally map networks of seal movement) also produced. Its authors affirm that humans possess an "innate musical predisposition" and that this produces a sensitivity to anomalies or irregularities in data less easily detected by visual analysis.[31] While this piece

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[27] Supper, "Sound Information," 449.
[28] Supper, "Sound Information," 450.
[29] Ibid., 448.
[30] Luca A. Ludovico and Giorgio Presti, "The Sonification Space: A Reference System for Sonification Tasks," *International Journal of Human-Computer Studies* 85, (2016): 72-77.
[31] Carlos M. Duarte, Paul Riker, Madhusudhanan Srinivasan, Patrick W. Robinson, Juan P. Gallo-Reynoso and Daniel P. Costa, "Sonification of Animal Tracks as an Alternative Representation of Multi-Dimensional Data: A Northern Elephant Seal Example," *Frontiers in Marine Science* 5 no. 128 (April 2018), 7. doi:10.3389/fmars.2018.00128.

acknowledges the need for more formal testing of the method as a scientifically legitimate one, the authors assert that the heuristic value of sonification for pattern detection in large datasets is invaluable for future research.[32] Many other scholars embrace the method for the same end, sonifying large-scale data to hear anomalies in patterns of hurricanes and global warming.[33]

Importantly, recent discussions of the usefulness of this method have stressed its value for the visually impaired. Astronomer Wanda Diaz Merced lost her sight as an undergraduate, and developed a sonification technique to study space datasets and "hear the stars."[34] Diaz Merced's work has been vital in asserting the legitimacy and rigour of the method as an analytical tool in the scientific community, pushing researchers and publics to recognize sonification as more than a gimmick.

Why data sonification for history & the humanities?

Since its inception, data sonification has mostly been explored for its potential as a tool for scientific research. The method is clearly valuable to detect patterns in data sets and display scientific and medical information. In the humanities, sonification is relatively underexplored. Some scholars have employed sonification for textual analysis to identify patterns and variations. In a 2016 issue of the *Journal of the Text Encoding Initiative*, Iain Emsley and David De Roure report the process and outcomes of an

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[32] Duarte et al., "Sonification of Animal Tracks," 8.

[33] See Mark Ballora and Matthew Kenney's sonification of polar ice data, Ballora and Jenni Evans, "Turning Hurricane Data into Music," Smithsonian.com, accessed March 20, 2019, https://www.smithsonianmag.com/innovation/turning-hurricane-data-into-music-180967414/.

[34] Wanda L. Diaz Merced, "Sound for the exploration of space physics data" (PhD diss., University of Glasgow, 2013.)

experimental sonification of XML variants of Shakespeare's *Hamlet*.[35] Their work cites the challenges of work in such a novel area and acknowledges the compositional choices to be made when practitioners assign "sound, tone, pitch, or volume" to data parameters.[36] Emsley and De Roure explore the possibility of sound in tandem with visualizations – generated by the same data to produce symbols representing events in the famous tragedy – as well.[37] Shawn Graham's "Listening to Watling Street" is an experiment in the sonification of historical data, sonifying space and travel in the Roman world using the numbers of epigraphs inscribed in Roman Britain.[38] Graham's project is directly inspired by the work of Brian Foo (also known as the Data-Driven DJ) who experiments with data sonification to reveal scientific, sociological and economic patterns.[39] His sonification of coastal land loss in Louisiana over time, called *Too Blue,* was an inspiration for my "Songs of the Ottawa."

I contend that data sonification is useful for historians in large part because the dimension of time is inherent to sound and music. History, and the humanities more broadly, have been complicit in upholding the "privileged position of sight" as the predominant of human senses.[40] Such visualizations as charts and graphs are

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[35] See Glossary for definitions of Text Encoding Initiative and XML.
[36] Iain Emsley and David De Roure, "'It will discourse most eloquent music': Sonifying Variants of Hamlet," *Journal of the Text Encoding Initiative* 10 (2016): 11.
[37] Ibid., 10.
[38] "Listening to Watling Street – Dr. Shawn Graham," The Heritage Jam, posted September 18, 2015, accessed March 30, 2019. http://www.heritagejam.org/2015exhibitionentries/2015/9/18/listening-to-watling-street-dr-shawn-graham.
[39] Brian Foo, "Data-Driven DJ," accessed May 27, 2018. https://datadrivendj.com.
[40] Shawn Graham, Stuart Eve, Colleen Morgan, and Alexis Pantos, "Hearing the Past" in *Seeing the Past with Computers: Experiments with Augmented Reality and Computer Vision for History*, ed. Kevin Kee and Timothy J. Compeau, (Ann Arbor, Michigan: University of Michigan Press, 2019): 226.

unquestioned as excellent sources for historical information, but these mostly display time to the viewer all-at-once. While there is usually a logical and chronological organization – from left to right or from top to bottom – these visual media are intended to be understood at a glance. Sound and music, in contrast, can naturally present a flow of information to the listener one day after the other or one year after the other.

Shawn Graham also explores data sonification for the digital humanities with a comprehensive lesson and thoughtful reflection on *The Programming Historian.*[41] This work emerges from an impulse to hear *a meaning* of the past, performed through data sonification in the present.[42] Graham is driven to "deform" data, "to make it unfamiliar again" and to investigate what can be gleaned from this process.[43] Like Graham, I am inspired by the arguments proposed by Mark Sample for a "deformed humanities," and intrigued by what may be learned in the act of "deformance." Sample cites Lisa Samuels and Jerry McGann, who first developed the portmanteau for this "interpretive concept premised upon deliberately misreading a text, for example, reading a poem backwards line-by-line."[44] Through this process, we are reminded what texts really are – constructed, with "seams, edges, and working parts."[45] Trevor Owens' article on "data for humanists" also contributes to the foundation for this work in helping me to conceive of data as

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[41] Shawn Graham, "The Sound of Data (A gentle introduction to data sonification for historians)," *The Programming Historian* (June 2016), https://programminghistorian.org/en/lessons/sonification#miditime.
[42] Ibid.
[43] Ibid.
[44] Mark Sample, "Notes towards a Deformed Humanities," posted May 2, 2012, accessed January 4, 2019, http://www.samplereality.com/2012/05/02/notes-towards-a-deformed-humanities/.
[45] Ibid.

"computer-processable information to be computed in a whole host of ways to generate novel artifacts and texts which are then open to subsequent interpretation and analysis."[46]

Where this project differs so significantly from data sonifications for scientific research or textual exegesis is in its objective. Like Sample, Graham and others, I am identifying the *deformed* work – the sonifications of environmental history data – as the end itself. I am interested in how my creation of a new artifact affects the past it presents. These sonifications are an intervention in the river's history in the same vein as my project "Picturing Lebreton Flats," which seeks to re-place light, colour, and play in the place of a formerly vibrant neighbourhood in Ottawa.[47] In both of these projects, I emphasize the importance of affective storytelling to communicate and engage publics and reflect on the role of a storyteller in shaping the emotional response of viewers and listeners. In the subsequent chapters describing each "song of the Ottawa," I explain my trajectory through the historical research and the methodological choices shaping each *affective* outcome.

Hearing the River's Flows

The following pages trace the historical research leading to the "song of the Ottawa" called "Hearing the River's Flows." The reader may choose to listen alongside the stories it tells.

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[46] Trevor Owens, "Defining Data for Humanists: Text, Artifact, Information or Evidence?" *Journal of Digital Humanities* 1, no. 1 (Winter 2011), 6 http://journalofdigitalhumanities.org/1-1/defining-data-for-humanists-by-trevor-owens/.
[47] Details about "Picturing Lebreton Flats" can be found on the project's webpage, www.picturinglebretonflats.ca.

It is not clear whether the hydrometric data on the Ottawa was used for research purposes in the early years of its collection, but the fields of hydrometry and hydrology developed considerably through the nineteenth and twentieth centuries. The number of data collection stations multiplied, especially since the establishment of the Geodetic Survey of Canada in 1909.[48] For a remarkable period spanning 128 years, the water level of the Ottawa River was measured and recorded at the foot of the Rideau Locks.[49] These figures were obviously invaluable for navigation at the junction between the waterways, as well as for flood prediction as urban development intensified. Starting in 1850, surveyors used a manual gauge to collect data for navigation and mapping purposes.

Figure 1. A manual gauge on the Ottawa River, at La Passe, ON. Credit: Y. Déguise, 1942. E6, S7, SS1, P7008, Bibliothèque et Archives nationales du Québec.

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48 "100 Years of Geodetic Surveys in Canada," Natural Resources Canada, accessed December 15 2018, https://www.nrcan.gc.ca/earth-sciences/geomatics/geodetic-reference-systems/canadian-spatial-reference-system/9110.

49 The first site on the Ottawa River to be measured was at Grenville/Besserer's Grove.

Until 1883, these data consisted of monthly mean water levels in metres. From 1884 to 1977, data exist for almost each day of the month at the same location. While it is now made available through the National Hydrological Service of Canada, the river's water level data is contributed by Transport Canada and the Geodetic Survey of Canada Datum, who managed the collection at different points in time. The first "song of the Ottawa" sonifies these data.

The 1964 *Handbook of Applied Hydrology*, written for practicing scientists, engineers, planners, and students, describes the field's technological and intellectual evolution.[50] Ven Te Chow writes that while "hydrology refers to the general science of water…hydrometry is the science of the measurement of water." Chow describes the scope of hydrology as broad and interdisciplinary, relying on such supporting sciences as "physics, chemistry, biology, geology, fluid mechanics, mathematics, statistics and operations research."[51] Its applied uses range from the domains of limnology and glaciology to agriculture, political science and sociology.[52] In planning cities and infrastructure for human activities – water supply, drainage, hydropower, and navigation – hydrometric data and hydrological science is crucial. It is important to note that the traditional ecological knowledge of Indigenous peoples mediated human interactions with the riverscape long before settlers and hydrological science, although this is not the story this chapter tells.

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[50] Ven Te Chow ed., *Handbook of Applied Hydrology: A Compendium of Water-resources Technology*, (New York: McGraw-Hill Book Company, 1964).
[51] Ibid., 1-5.
[52] Ibid., 1-5.

In his *History of Hydrology,* Asit K. Biswas writes that while "records of high flood levels of the Nile can be traced back to the dawn of civilization, global river flow records prior to the seventeenth century, were, in general, qualitative rather than quantitative."[53] In the eighteenth and nineteenth centuries, interest was aroused in collecting regular stage records about such European rivers as the Elbe, Rhine, and Oder.[54] Chow calls the nineteenth century the "period of modernization" in hydrological science. The development of new flow formulas and measuring instruments facilitate the beginning of systematic stream gauging in rivers across North America, and government hydrologic agencies are established at this time.[55] Hydrology developed in the first decades of the twentieth century with what Chow identifies as "the period of empiricism."[56] Over these years, hundreds of empirical formulas were developed, and international organizations were founded to strengthen work and cooperation related to hydrology.[57] The following period, from 1930-1950, marked increased "rationalization" and analysis to solve hydrological problems and better understand fluctuations.[58] Chow identifies the study of hydrology after 1950 as the "period of theorization," in which scientists had increased access to more precise tools for measurement and increased international research on water resources.[59]

[53] Asit K. Biswas, *History of Hydrology* (Amsterdam: North-Holland Publishing Company, 1970), 299.
[54] Ibid., 300.
[55] Chow, *Handbook of Applied Hydrology,* 1-8.
[56] Ibid., 1-9.
[57] Ibid.
[58] Ibid.
[59] Ibid., 1-10.

The history of this science tells in broad strokes the story of the hydrological data set I selected as part of this project. Hydrometric data is important in determining and harnessing the power of a waterway, as the Ottawa River Engineering Board – and others – demonstrate. These measurements have also helped to record the impacts of dam and reservoir construction on the river's main stem and its tributary waters.

When considering the river and the technologies mediating the ways humans know it, it is vital to examine this section of the Ottawa as it has existed between urban places. In *Urban Rivers*, Stéphane Castonguay and Matthew Evenden introduce a series of cases in Western Europe and North America, and consider the broad technological and institutional patterns shared. While they do not attempt to present a comprehensive global history of urban rivers, Castonguay and Evenden suggest that the cases "are linked by the fact that they engaged collectively in the diffusion of water technologies in the nineteenth century."[60] The Ottawa is not one of the studies in their text, but it can readily be placed in this larger context of engagement with water technologies and structures of regulation from the seventeenth to twentieth centuries. Today, the dams and reservoirs in the Ottawa River basin have made it "one of the most highly regulated catchments in Canada."[61] The regulation process began in earnest in the late nineteenth century and intensified through the twentieth.

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[60] Stéphane Castonguay and Matthew Evenden, "Introduction" in *Urban Rivers: Remaking Rivers, Cities, and Space in Europe and North America*, (Pittsburgh, Pennsylvania: University of Pittsburgh Press, 2012), 8.
[61] Tim Haxton and Don Chubbuck, "Review of the historical and existing natural environment and resource uses on the Ottawa River," Ontario Ministry of Natural Resources, Science and Information Branch, Southcentral Science and Information Section Technical Report #119 (Ontario: Queen's Printer for Ontario, 2002), 1.

Until the first decade of the twentieth century, the only storage and regulating structures on the Ottawa River itself were low dams and weirs.[62] These existed to facilitate logging operations, navigation, and to produce power for small mills along the shores.[63] While these were crucial developments for industry and urban expansion, "the effect of these structures on the overall regime of flows was generally negligible."[64] Lumbermen also managed the water on a small scale – damming tributary rivers while they accumulated logs in advance of the spring drive, and then harnessing freshet floods to release and transport them downstream. Generating units for AC hydroelectric power were installed at Chaudière Falls in 1889, and throughout this decade, there were many negotiations between private owners of hydraulic lots and the companies commissioned to electrify Ottawa and Hull.[65]

Anna Adamek recounts the growing interest in transforming Canada's capital city from the "provincial and uninfluential" town its inhabitants perceived it to be to a hub of water power production.[66] The river, upstream and downstream from its urbanizing shores, would soon come to be harnessed for its power on a larger scale.

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[62] The Rideau Canal, completed in 1832, was a feat of engineering and water management for defense, navigation, and trade.
[63] T.M. Patterson, F.W. Beatty and Raymond Latreille, *Report on Hydrology and Regulation of the Ottawa River*, Ottawa River Engineering Board (N.p.: Government of Canada, 1965), 17.
[64] Ibid.
[65] Anna Adamek's "Incorporating Power and Assimilating Nature: Electric Power Generation and Distribution in Ottawa, 1882-1905" (M.A. Thesis, University of Ottawa, 2003) offers an in-depth examination of these struggles for riparian privilege and their urban interplays.
[66] Adamek, "Incorporating Power and Assimilating Nature: Electric Power Generation and Distribution in Ottawa, 1882-1905," 20.

In 1909, engineers from the Department of Public Works submitted a report that encouraged the government to consider the "advantages that [extensive] regulation would have for the Ottawa River, notably (at that time) for the early water-power plants at the Chaudière Falls."[67] 1910 saw the construction of the ring dam at the Falls to divert water to recently constructed power stations. Then, between 1911 and 1914, three of the Ottawa's main regulating dams were constructed by the government of Canada.[68] The first, beyond Lake Temiskaming above the Quinze Rapids, "[raised] the level of Quinze Lake and Lac Simard."[69] Robert Legget, in his 1975 history of the Ottawa waterway, cites the second dam across the outlet from Lake Temiskaming as the most important of the three since it controls the level of the lake. Another small dam on the Kipawa River also controlled "an unusually large body of water" before it meets the Ottawa.[70] These projects, Legget writes, allowed for the water level in each reservoir to drop before spring melt and floods, so that these would not disrupt a "normal" flow of the river. Major storage reservoirs were also built in in 1927 and 1929 in the headwaters of the Gatineau River, forming enormous human-made storage lakes – the Dozois and Grand Lake Victoria reservoirs.[71] Today, over fifty major dams and hydroelectric systems dot the Ottawa's mainstem and tributaries, and all but one were built between 1868 and 1976, with intensive bursts in the years before and following the Second World War.[72]

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[67] Robert Legget, *Ottawa Waterway: Gateway to a Continent* (Toronto: University of Toronto Press, 1975), 15.
[68] Ibid., 15.
[69] Ibid.
[70] Ibid.
[71] Ibid.
[72] "Ottawa Riverkeeper's River Report. Issue no. 1: Ecology and Impacts," (Ottawa: Ottawa Riverkeeper/Sentinelle Outaouais, 2006), 27-28.

In a 1959 government publication by the Water Resources Branch of the Department of Northern Affairs and Natural Resources, the authors identify "the only major undeveloped site [for power generation] on the mainstem of the Ottawa River" at Carillion, downstream from Hawkesbury and Grenville, Québec. Citing the long-term "hydraulic investigations" on the Ottawa between the gauge at the foot of the Rideau Locks and Besserer's Grove – just downstream from Duck Island on the Lower Ottawa – the authors demonstrate the importance of this data in justifying hydroelectric development projects.[73] From 1959-1963, the Québec Hydro Commission built a major generating station at Carillion. This project proved to have significant effects on the Ottawa River upstream, and rising water levels brought changes to the profiles of Duck and Kettle Islands. The river's shores were also affected by the Carillion project, with marked flooding of lowlands. Operated by Hydro Québec, this final major development on the Ottawa's mainstem has the highest maximum generating capacity on the waterway due to its opportune geography and high flow of water.[74]

The hydrologic cycle of the Ottawa River is driven in large part by the snowmelt, and the biggest flows occur in two freshet flood peaks.[75] April usually brings a first, smaller peak as snow melts in the southern portion of the watershed; early May brings a second peak as the northern watershed melt occurs.[76] Flows decrease during the summer and early fall, and are "usually moderate during the fall and winter," with the exception of

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[73] Water Resources Branch: Department of Northern Affairs and National Resources, *Hydrological Investigations of the Ottawa River* (Ottawa: Government of Canada, 1969), 7.
[74] "Ottawa Riverkeeper's River Report. Issue no. 1: Ecology and Impacts," 28.
[75] Ibid., 16.
[76] Ibid.

occasional fall flooding as cyclonic storms contribute to excessive rainfall in the watershed.[77] The lowest flows usually occur in the month of September, and the flow rises thereafter.[78] In their report on the river's hydrology, the Ottawa Riverkeeper organization suggests that while its flows are regulated by the large reservoirs and dams in the upper watershed, "the general monthly trends in flow remain similar to natural conditions."[79]

Many texts written about the Ottawa – including *The Ottawa Waterway* by Robert Legget, a major contribution to its historiography – lament the loss of a wild and wonderful river.[80] In its place is a modern river, whose flows are tamed and controlled for human navigation, power generation, and flood control. This notion of an ideal river or environment, prior to human and technological intervention, is a common theme addressed by environmental historians. While a fruitful intellectual history of this notion on the Ottawa might yield fascinating connections with ideas of imagined communities and national character, my project sets this angle aside. Instead, inspired by Joy Parr's *Sensing Changes: Technologies, Environments, and the Everyday, 1953-2003*, I was attentive to the ways in which changes to the riverine environment through regulation impacted peoples' embodied experiences with water and land. The sources leading me to explore the river's water levels through data sonification emphasized changes to the island profiles with the construction of the Carillion dam, a technological megaproject like those cited in Parr's sensuous history. The dam caused the water level to rise

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[77] "Ottawa Riverkeeper's River Report. Issue no. 1: Ecology and Impacts," 16.
[78] Ibid.
[79] Ibid.
[80] Legget, *Ottawa Waterway*, 21.

upstream, and flood lowlands. Laments in the *Ottawa Journal* describe the loss of property along the river in advance of the construction project, including at Jacques Cartier and Lac Leamy parks in Hull.[81] Gloucester's town council also met to discuss the losses faced by the township, which owned the 100 acres of real estate on Upper Duck Island and rented them for summer camps and cottages.[82]

Composing "Hearing the River's Flows"

This "song of the Ottawa" uses the hydrometric data collected at the foot of Rideau locks from 1880-1977. While daily measurements are available for much of this period, I chose to use monthly mean data to limit the size of my dataset, and to foreground the river's seasonal shifts. On nineteenth-century fire insurance maps of Ottawa, Hull, and the river's islands at Chaudière, there are small reminders that the borders and boundaries between water and land were and remain in flux. These maps depict the river's "high water" and "low water" levels, but do not offer much else about the impact its changing flows have on city life.[83]

I encountered discussions in Ottawa newspapers about negotiations for a "Duck Island easement" to be paid by Hydro Ontario to Gloucester Township in 1964 after the flooding of the island. The township requested payment for the land after the construction of the downstream hydroelectric generating station at Carillion caused the Ottawa River's water levels to rise.[84] Although reports like that of the Ottawa Riverkeeper suggest that

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[81] "Carillon dam will affect Hull Parks," *Ottawa Journal* (Ottawa, Ontario), 25 May, 1961.
[82] "Carillon Dam will flood Gloucester Playground," *Ottawa Journal* (Ottawa, Ontario), 23 February, 1962.
[83] *Ottawa Lumber District, May. 1885* [map], 100 feet to an inch. Ottawa: Charles E. Goad Company, 1885.
[84] "Duck Island Easement. Township, Hydro Stumble on Price." *Ottawa Journal*

the regulated river's flow patterns resemble its natural rhythms, the Carillion development, and regulation on the Ottawa more broadly, has had its impacts.

Though it is possible to use historical hydrometric data to visualize the river's flows through charts and graphs, I set out to sonify it instead. In the same ways that changes to the riverscape affected those whose everyday lives were entangled with it, I want this sonification to evoke and *affect* contemporary listeners. Music notes are played sequentially, according to a time signature and tone. For this reason, time series data is particularly conducive to data sonification, and this sample is no exception.

This song of the Ottawa is intended to capture the large-scale changes to the riverscape over a period of 98 years. I wanted to highlight the seasonal shifts in flows and ensure that these would be the main, repetitive structure of the song. To do this, I selected monthly average water measurements in metres [See Appendix A]. These twelve data points per calendar year over 98 years meant a total data set of more than 1100 points.

My songs are algorithmically generated, meaning that while the author of the code can determine the inputs and parameters of the outcome, the computer is the actual composer. I used "MIDITime," a library for Python developed by Reveal News for a radio story about earthquake frequency in Oklahoma, to translate the numerical data into "Musical Instrument Digital Interface."[85] This interface, MIDI hereafter, is not an audio file but rather "a list of notes to be played at a certain time, sort of like electronic sheet

(Ottawa, Ontario), 21 July, 1964.

[85] Michael Corey, "Turn your data into sound using our new MIDITime library," Reveal from The Center for Investigative Reporting, posted July 9, 2015, https://www.revealnews.org/blog/turn-your-data-into-sound-using-our-new-miditime-library/.

music."[86] Notes in MIDI are represented by pitch numbers corresponding to keys on a piano. The lowest key - A0 - is the note A in octave 0, and is MIDI pitch 21, and the next note Bb0, is pitch 22.[87] Middle C, or C4 is pitch 60, and the keyboard ranges to C8, or pitch 108.[88]

The sonification is created through a specific code script in a text editor, and then run through the computer's terminal. I formatted the project to set the beats per minute to 108, or 1 beat for approximately every half second. MIDITime is built for time series data over multiple years and requires the author to set the number of seconds in the music to represent a year in the data. Since I wanted to explore the shift of the seasons over a year, I set this parameter to 4 seconds per year. Running this code results in a song that is nearly seven minutes in length. Finally, two further parameters determine the key in which the notes will be set and the number of octaves over which they are played. I chose the key of C major for this song, since it is one of the most common (and thus familiar to listeners) in western music. I indicated for the notes to be played over 4 octaves because I speculated that this might make variations in water levels more apparent. The measurements range between a low level of 38.801 and 44.64 metres, and I concluded that a wider range of notes would make seasonal shifts and flood years audible as the pitch of the music changed.[89] Corey suggests that these choices are analogous to those

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[86] Michael Corey, "Turn your data into sound using our new MIDITime library."
[87] Ibid.
[88] Ibid.
[89] I followed Michael Corey's instructions, as well as Shawn Graham's Programming Historian tutorial to understand and construct the code.

made when graphing data for a visual chart - “we use a musical scale instead of an X or Y scale.”[90]

MIDITime was developed for earthquake data and as a result, it is formatted by date of a seismic event, followed by its magnitude. Since I am not a trained programmer, I decided to leave the terms of the interface intact and assert that in this case, “magnitude” is equivalent to “water level.” Because I selected monthly averages, and the date format required an input for year, month and day, I made the decision to assign the water level average to the first day of each month. After these parameters were set and the data were inserted into the code, I ran the Python script to produce MIDI file and quickly received an error message which required a change. The data points – water levels in tens of metres – were too large for the code to process. To resolve this issue, I chose to shift the decimal point of each figure by one digit, turning 39.849 into 3.9849, and so on. I determined that this scaling down would not impact the integrity of the data, as long as this choice was made clear with a note in the code.

Following this change, the script successfully produced a MIDI file to be played by electronic instruments. I opened the file in Garageband, the digital music studio for Mac computers. Here, I was able to select an instrument to play the notes generated by the river data. This step represents the end of a simple transposing of data and parameter mapping for the sake of clarity, and asks the author to make more subjective, compositional choices. As mentioned, though this project is inspired by R. Murray Schafer’s *soundscapes* and the process of creating with “found sounds,” my data sonification endeavours to create a new artifact. To draw this distinction, I deliberately

[90] Michael Corey, “Turn your data into sound using our new MIDITime library.”

avoided organic sound samples that evoked water and nature when instrumenting the MIDI file. I also chose to avoid the digital tools that play music notes like physical orchestral instruments. My rationale in avoiding these was to emphasize the nature of this music as written by a machine through algorithmic processes, and choosing a distinctly electronic instrument could hopefully remind the listener of this fact. The synthesizer I selected, Evolving Currents, achieves this, and evokes an amorphous, fluid sensibility.

The reverb of this instrument means that each note fades into the other like drops into a larger body of water. Low water levels are audible as the pitch and volume of the music decreases, and freshet floods are distinctly present in crescendos year after year. Listening through the full length of the song reveals a gradual narrowing of the range in the data's peaks and valleys as the river becomes increasingly regulated. This is a subtle shift, but is particularly evident when the first and last 16 seconds (or 4 years) are heard side by side.

There are no silences or pauses throughout the song, which emphasize the continuity of flowing water. It does not matter which note is January or September, because the seasons flow into one another. The calendar is a human imposition, and the river – as we can understand it through the data – refuses this structure.

Sounds of Commerce and Industry

The following discussion serves as the backdrop for the sonification titled "Sounds of Industry." The reader may choose to listen as they are introduced to the river's broader stories of commerce and industry.[91]

[91] The full song produced was 5 hours and 56 minutes in length. I have uploaded a 15 minute sample to Youtube.

The story most often told about the Ottawa River is that of a major thoroughfare for trade and connection. From time immemorial, Indigenous Peoples have travelled on the waterway by canoe; gathering at the Akikodjiwan or Kana:tso Falls, hunting, fishing, and living on this stretch of river and its islands. This project, as a result of its temporal scope, does not endeavour to tell the story of the Algonquin Anishinaabe for whom this is traditional, unceded territory.[92] Instead, it places settler trade and commerce into this larger historical context.

Throughout the nineteenth century, lumbering was the story of the Ottawa River. Legget explains that the abrupt end of timber supply after the American Revolution in 1783 shifted demand in small part to Canada, but mainly prompted an increased emphasis on trade with Baltic countries.[93] When the geopolitical context shifted again with the 1806 Berlin Decree of Napoleon, "a rapid and very great increase in exports of Canadian timber to England followed."[94] Legget describes the square timber trade on the Ottawa River as follows:

> Large timbers could be trimmed from logs in the woods, skidded or hauled to the nearest watercourse, and then floated downstream. This was done in the great days of Ottawa Valley lumbering on most of the tributaries to the main river and even on many of the tributaries of the tributaries. The great logs were floated down until they reached the main river, where they were assembled and lashed together in rafts.[95]

Timber rafts contained living quarters for their crews as well as deck loads of other products and stores of provisions for the lumbermen. Throughout the nineteenth century, many made their fortunes in this trade, harvesting the old growth white and red pine in

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[92] The river is also a traditional route for travel and trade for many other First Nations.
[93] Legget, *Ottawa Waterway*, 101.
[94] Ibid. 101.
[95] Ibid., 101-102.

enormous volumes. Legget writes that the average raft contained “up to one hundred separate cribs and thus from 2,000 to 2,400 timbers, a total volume of 80,000 to 120,000 cubic feet of first-class [pine].”[96]

As well as technological innovation in the processing of lumber and its byproducts for export, new tools and techniques were devised in harvesting as well. To help loose timbers down tributaries to the river’s mainstem, lumbermen danced from log to log and used hooked staffs called “picaroons” or “pike poles” to manipulate them. The trade also prompted the mid-century development of a low-profile and sturdy boat by Ottawa area John Cockburn and family. The “Cockburn Pointer Boat” was commissioned for lumber baron J.R. Booth with a pointed bow and stern to make fast changes of direction possible in rough waters.[97] The pointer was also designed with a flat-bottomed draft so that “a pointer carrying eight men was once made to float in five inches of water.”[98] Though developed for Booth, the pointer boat was widely used by other companies in the lumber trade.

While the initial trade in Ottawa Valley timber was for square logs in Britain, market demands shifted in the mid-nineteenth century. American companies had “virtually completed the process of stripping the forest cover of southern New England and New York State…[and] had begun to look northward.”[99] Instead of square timber, the Ottawa Valley shifted its focus to sawn lumber, building saw mills to process logs into boards and other products. Some of the largest saw mills “not only in Canada but in all North

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[96] Legget, *Ottawa Waterway*, 103.
[97] Donald MacKay, *The Lumberjacks* (Toronto: Natural Heritage/Natural History Inc., 1998), 129.
[98] Ibid.
[99] W.E. Greening, *The Ottawa* (Toronto: McLelland & Stewart, 1961), 111.

America" were operated around the Chaudière Falls by such firms as James Rochester, J.R. Booth, E.B. Eddy, Perley and Pattee, Bronson and Weston, A.L.A. Baldwin, the Walsh Brothers, and Joseph Shears.[100] From its outset, the industry relied the water power at the falls to operate machinery and process exports.

Towards the 1890s, historian of the industry and the Ottawa W.E. Greening writes, competition in the American market led lumber operators to question the future profitability and sustainability of the sawn lumber industry.[101] The exploitation of hardwood harvesting also meant the proliferation of smaller, softwood trees. E.B. Eddy had realized by the mid-1880s the possibilities for growth into a new industry - pulp and paper. In 1888, Eddy constructed a ground-wood pulp mill on the shore of the Ottawa River at Hull, and in 1893, converted it into a paper mill with the installation of machines for book paper, tissue paper and newsprint.[102] Through the early twentieth century, the mills at the Chaudière became the heart of pulp and paper manufacturing in eastern Canada, exporting products to the United States and beyond.[103] Greening also suggests that "pulp-and-paper manufacturing was the first industry in the Ottawa Valley to make large-scale use of its vast water-power resources" and that its lobby played a role in the continued development of the river for power.[104]

Composing "Sounds of Industry"

This "song of the Ottawa" is a distinct from the others in several ways, and is the most experimental and compositional of the methods I tried. "Sounds of Industry" is the

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[100] Greening, *The Ottawa*, 114.
[101] Ibid., 148.
[102] Ibid., 150.
[103] Ibid., 153.
[104] Ibid., 154.

audification of the physical data of a 1932 pulp sample from the E.B. Eddy factory site. The sample is one of a series of five blocks of pulp paper pressed flat and dried, and is part of the Canada Science and Technology Museum's collection. It is a result of the Eddy company's testing to improve the quality of their product, though it is not quite clear why this example was collected. Now yellowed with age, it is a few millimetres thick, 18.8 by 17 centimetres square, and corrugated from the press used to remove excess water from the pulp. It is hand-marked with ".73" in blue ink, which stands out on a yellow-white backdrop. Its texture is apparent to the touch and eye – its bumps and ridges and rough edges immediately evident.

I set out to tell a story of commerce and industry on the river, either from lumbering in the nineteenth century to pulp-and-paper through the twentieth, or from the extraction and trade of other goods above and below the water's surface.[105] The stories of industry on the Ottawa are interwoven with stories of technology and innovation; the development of durable flat-bottomed boats and novel methods for pulp-and-paper processing are two examples of this overlap. Inspired by an assignment of Shawn Graham's in his winter 2018 course titled "Critical Making in Digital History" to play with the physical data created by 3D scans, I stopped searching for river-related data in the E.B. Eddy Company business ledgers and turned to the artifact collection at the Canadian Museum of Science and Technology. I was the 2018-2019 Garth Wilson Fellow for Public History at

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[105] I attempted to find data about the dredging of sand from the river's bed over many years to tell a story of changes effected underwater, but could not pursue it for this project.

Ingenium: Canada's Museums of Science and Innovation and had access to archival and artifact collections over the course of my time there.[106]

To come to find "data" in a physical object demands separating it from its context in situ and setting aside the information or understanding that makes it an artifact with a history. In essence, the data is the physical object and where it exists in space. For the purposes of sonification and to find data that can be computed in a physical object, it must be made available or legible in another form. A three-dimensional scan gathers and re-forms this data as a digital object. It exists as a collection of the points in space occupied by the object, and when viewed on online platforms like Sketchfab or in virtual reality environments, this collection is constructed to appear in three dimensions. In contrast, when it is opened in a text editor, the scan appears as a series of vertices, edges and faces - numerical coordinates.

To sonify this pulp sample, I first made a three-dimensional scan of it using an app called Trnio. The app takes many photographs as the user moves it 360 degrees around the subject. It then constructs a 3D rendering of the object that can be manipulated and viewed in different ways, appearing as a model in the app interface, but is also under the surface an "object" text file. From the app, I exported the scan to Sketchfab – a web platform to share 3D, virtual reality and augmented reality content – where I could examine it in more detail.

I then downloaded the file to my own computer to work with it in Meshlab, an open-source program for editing 3D files. This platform enables more detailed edits for users

[106] The museum received the extensive Domtar collection in 2012, including the materials the company had inherited from the E.B. Eddy Company when they acquired it in 1998.

wanting to perfect their scans. I only made a few minor changes to the scan to trim the edges depicting the table on which the sample sat. If the main focus of this project had been to produce a polished 3D rendering of the sample, this step would have been more important. Since for this project, the scan is a means to access data for the purposes of sonification, I chose not to perfect it and leave it mostly intact as a product of the tools I could access and the "first impression" of the pulp sample in space.

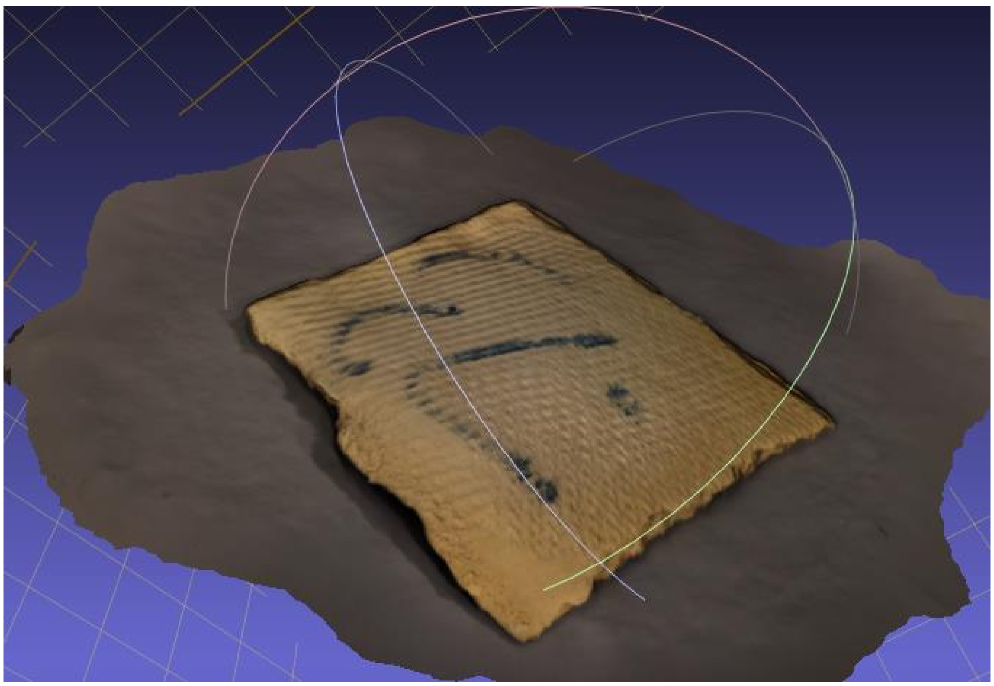

Figure 2. A 3-D scan of the E.B. Eddy pulp sample (Artifact 2012.0091.004) rendered in Meshlab. Screen capture by author.

The same file seen in Figure 2 appears as a series of vertices, edges and faces – numerical coordinates when opened in a text editor. This file is enormous, with 418,055 lines of code defining 86,246 vertices and 159,619 faces. I quickly determined that it would be impossible the "hear" the entirety of this object. I chose a section (5000 lines) of the pulp sample's data to experiment with and removed any letters from the file that would prevent the algorithm from computing it. I then used a program called MusicAlgorithms to map a selection of data to the 88 keys on a piano keyboard.[107] MusicAlgorithms uses the American Standard Code for Information Exchange to translate the input numbers into a format to be computed and assigned to piano keys, and then prompts the user to limit or assign certain parameters such as musical key and octave range. I chose the key of E minor, simply because I hoped that the resulting sound would be very different from the other songs. The program then produced an MP3 file for download, which I could import to Garageband to manipulate.

While 5000 lines seemed like a small sample size of the larger scan, the number of data points produced a song 44,080 notes in length. In a 4/4 time signature, the "song" of the pulp sample is nearly six hours long. It has a recognizable pattern of the *x* and *y* coordinates in the rendering but does not have a discernible rhythm or beat. The song can sound random and dissonant to a listener if notes are played simultaneously, and I used Garageband's "Arpeggiator" tool to play chords one at a time. This compositional choice adds a level of musicality to the song, but by virtue of the fact that it is a sample of the object's data, it does not capture much variation. In continued experiments with this method, I propose to select smaller samples from intervals in the larger dataset in hopes to explore an object's different edges. Perhaps the sounds of its rough edges would be in stark contrast with the corrugated, but relatively flat surface. Since all of these points exist at the same time in space, layering these tracks one on top of the other could mean "hearing the object" all at once – in the same way the eye observes it.

[107] This is a web-based platform developed by Jonathan N. Middleton to experiment with algorithmic music and is a very user-friendly tool for anyone who would like to sonify data without coding.

These experiments are preliminary, but I contend that sonifying such historical artifacts as the Eddy pulp sample offers a meaningful way for researchers to engage auditorially with material culture. This can be executed without the physical, tactile contact with museum collections that is inaccessible to most, and risks damage even by professional handlers.[108]

Beyond their interest for researchers, digital data sonifications of artifacts can also add an interpretive layer to exhibitions for visitors. Modern museological practice counters the former "silent museum" with a multisensory approach.[109] Sound – and other senses – have an invaluable place in today's museums. Nikos Bubaris' study of sound in museums suggests that "[it] can energize and orient the visitors, offering them a sense of vitality and immediacy" not present in static exhibits with textual interpretive labels.[110] Like Bubaris, I believe that sound contributes to deeper interactions between visitors and exhibitions and can "generate knowledge through embodied and affective experiences."[111] With minor interpretation – whether a narrated introduction before the "song" begins to play in the ambient space or present through a panel at the exhibition's entrance – this sound story adds another meaningful layer to the broader narrative of an exhibit. The song might also exist in tandem with the artifact on display, for visitors to tune in with headphones or with the push of a button and a speaker. Placed alongside the

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[108] The supervisor of my fellowship at Ingenium, Curator of Communication, Tom Everrett, is working to develop a methodology for the study of material culture through sound for fellow curators and researchers.

[109] Nina Sobol Levent and Alvaro Pascual-Leone eds., *The Multisensory Museum: Cross-Disciplinary Perspectives on Touch, Sound, Smell, Memory, and Space* (Lanham, Maryland: Rowman & Littlefield, 2014).

[110] Nikos Bubaris, "Sound in Museums - Museums in Sound," *Museum Management and Curatorship* 29, no. 4 (2014): 395.

[111] Ibid., 397.

physical object, the sonification can be as an accessible way for visually-impaired visitors to experience artifacts. The data sonification of artifacts is one of several potential avenues for this technique in the museum setting but is a novel way to "re-form" and make accessible the physical data of objects on display for listeners.

On the Water and the Islands

The historical background in the following pages introduces the stories of boat traffic told in the final sonification, "On the Water." Readers may choose to listen to this "song of the Ottawa" in tandem with the written discussion.

Through the late nineteenth and early twentieth centuries, the stretch of the Ottawa River downstream from the Chaudière Falls was a distinct place for recreation, beyond its uses for trade and navigation. Settlements on both shores and few bridges meant that in the nineteenth century, many crossed between the river's shores by boat. Both official, licensed ferries and competing, under-the-table services shuttled the inhabitants of Ottawa and Gatineau between their homes, workplaces, and play-places.

Leggett mentions that the first bridge across the river, built in 1828 from wooden trusses, was well-maintained but still not sufficiently engineered to support the demands of growing cities on either shore.[112] The Union Bridge, so called because it was the first land connection between Upper and Lower Canada, was replaced with an iron suspension bridge after the collapse of the wooden structure in 1836.[113] A toll of one penny per pedestrian and "for each head of cattle, horses sheep and pigs, but two-pence for every

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[112] Legget, *Ottawa Waterway,* 193.
[113] Ibid., 193-194.

cart, waggon [sic], carriage, or sleigh" was charged, angering its users.[114] In 1889, a steel truss bridge replaced the Union Bridge, and continued in use until it too was replaced in 1919 with larger steel truss spans. Legget writes that in 1880, "the Prince of Wales Bridge was built upstream of the Chaudière at Lemieux Island, and the Alexandra Bridge followed in 1901."[115] Two further crossings were built later into the first half of the twentieth century – the Champlain Bridge in 1928 and the MacDonald-Cartier Bridge in 1965.[116] The settlements on either shore, Wrightsville and Bytown (later called Hull and Ottawa respectively) expanded to become urban industrial centres connected by industry at the Chaudière.

Throughout this time, ferry boats continued to shuttle people and goods from one shore to the other. Of particular importance to my project is the ferry between Rockcliffe and Gatineau Point. Legget identifies this as the most famous, having been in operation since 1843.[117] Until 1870, he writes, the ferry was operated by James O'Hagan – a settler on Gatineau Point.[118] From then until at least 1971, the Seguin family ran ferry service on the route.

As well as a route for commuters, the stretch of river downstream of the Chaudière was a recreational place for clubs and camps. The general public also experienced the river as a place to picnic and socialize. These groups were entangled with the river through its seasons, with ice fishers on the river in winter and paddlers and rowers in the fair weather. In the late 1880s, local athletic clubs coordinated snowshoe tramps to camps

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[114] Legget, *Ottawa Waterway,* 194.
[115] Ibid.
[116] Ibid.
[117] Ibid., 195.
[118] Ibid.

and entertainment on Kettle Island.[119] Social groups announced excursions in the newspapers for their members and organized weekly trips in the winter.[120] In summer, the Ottawa Rowing Club's members participated in and were spectators to canoe and rowboat races, as well as social events held at the organization's boathouse.[121] Swimmers also enjoyed the river in summer, from the beaches on its islands as well as directly from the city.[122]

Before the turn of the century, formal businesses were also beginning to emerge to sell an experience of leisure on the river and its islands. Ottawa's E.G. Laverdure purchased a steamboat and property on Kettle Island, and began to operate "Kettle Island Park," advertising "amusements, games, swings, aerial railway" and "refreshments of all sorts on the Grounds."[123] The Steamer *E.G. Laverdure* in 1892, and *Ida* in 1893 travelled between Queen's Wharf, at the foot of Sussex Avenue in Ottawa, the island's wharf, and Hull to bring visitors to its shores. Although Laverdure's business venture could not be sustained, the same site would welcome visitors at another park a decade later.[124]

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[119] "Notes of Sport" *Ottawa Journal* (Ottawa, Ontario), 17 January, 1887, and "Notes of Sport" *Ottawa Journal* (Ottawa, Ontario) 16 February, 1888 report snowshoe tramps to Kettle Island.

[120] "Snowshoe Notes" *Ottawa Journal* (Ottawa, Ontario), 18 February 1887 reports on the activities of eight separate snowshoe clubs whose tramps explored the river and its islands.

[121] "Sports and Pastimes. The Entries for the Amateur Regatta on Aug. 6th. General News and Notes of Popular Athletics and Aquation." *Ottawa Journal* (Ottawa, Ontario) 23 July, 1887.

[122] In August of 1893, a pair of young swimmers set out from the ORC boathouse at the foot of Parliament Hill and made it to Rockcliffe. "Swam a Mile and a Half in the Ottawa," *Ottawa Journal* (Ottawa, Ontario) 26 August, 1893.

[123] "Amusements. Kettle Island Park. 3 ½ miles from the City. The Prettiest Picnic Grounds in Canada." *Ottawa Journal* (Ottawa, Ontario) 7 June, 1892.

[124] Karine Maisonneuve's "Vivre sur l'Ile Kettle : Un siècle de dynamisme revisité (1839-1962)" (MA Thesis, University of Ottawa, 2006) traces its transition from settler colony to a site of recreation between 1839-1962.

On June 15, 1912, Belle Isle Park opened on Kettle Island. The steamboat *Quinte Queen* brought Ottawans from Queen's Wharf to the amusement park, which featured the "Gaiety Theatre" for moving pictures, a restaurant, acrobatic performances, slides, and a merry-go-round.[125] Though it existed for several years, its inaugural year was particularly exciting. On August 19, "local fistic fans" were invited to the island to see a boxing match between Bobby Pittsley and Charlie Goldberg, "two of the fastest lightweights on the continent."[126] Other events included baseball matches and picnics at the park.[127]

Downstream, the history of Duck Island is less well-known but was a more contested in-between space. In September of 1901, the Inspector of the Ottawa Humane Society reported that he knew of frequent cock fights held on Sundays on Duck Island but "because there is a doubt as to which province these islands belong to, there have been no arrests."[128] Several clubs also had camps on the Duck Islands, and some private summer homes remained there until 1980 when flooding forced their removal.

Other city-dwellers vacationed further afield in the late nineteenth and early twentieth century, taking steamboats to resorts upstream at Aylmer's Hotel Victoria or downstream to Besserer's Grove, Montebello, or Caledonia Springs.[129] The Jubilee House hotel at Besserer's Grove – just past the eastern tip of Lower Duck Island – was advertised for its "cool shades and breezes along the river bank; excellent fishing and boating, and

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[125] "Extra Free Attractions at Belle Isle Park," *Ottawa Citizen* (Ottawa, Ontario) 3 August, 1912.
[126] "To Fight Here. Pittsley and Goldberg Will Meet on August 19," *Ottawa Citizen* (Ottawa, Ontario) 9 August, 1912.
[127] "Belle Isle Park Grand Opening," *Ottawa Journal* (Ottawa, Ontario) 15 June, 1912.
[128] "Cock Fighting," *Ottawa Journal* (Ottawa, Ontario) 7 September, 1901.
[129] The Ottawa River Navigation Company, *Snap Shots on the Ottawa River and Rideau Lakes* (Montreal: Debarats & Co. Engravers and Printers, 1898) 8-12.

perfectly safe agreeable bathing on the fine beach."[130] The Jubilee House would later be renamed the Hiawatha Park Hotel in the early twentieth century, and continued to welcome vacationers escaping the city life.

Figure 3. A family poses beside the Steamer Wanakewan at the wharf, Besserer's Grove. CA 026042. City of Ottawa Archives.

While recreation did thrive in this stretch of the river and beyond in these years, the environmental realities of industrial pollution had major impacts. Randy Boswell writes about the extensive sawdust pollution clogging the waterway, and Jamie Benedickson reports on the sometimes fatal effects it had for humans.[131] Sawdust and other waste

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[130] Ottawa River Navigation Company, *Snap Shots on the Ottawa River and Rideau Lakes*, 8.

[131] See Randy Boswell, "Cholera, the "Sawdust Menace," and the River Doctor: How Fear of an Epidemic Triggered Canada's First "Pollution" Controversy," *Histoire Sociale. Social History* 49, no. 100 (2016): 503-542 and Jamie Benedickson, *The Culture of Flushing: A Social and Legal History of Sewage* (Vancouver: University of British Columbia Press, 2007.) There is still research to be done on the impacts of this pollution

products of the lumber industry formed shoals on the river bed, affecting navigation and prompting legal action as early as 1867. The mill operators mostly refused to comply with new laws preventing the disposal of their "grindings" in the river, and continued to behave as usual. Benedickson notes, citing a legal complaint, that "not only was water fouled and rendered offensive both offensive taste and smell" but the sawdust deposits also produced explosive methane gas under the surface.[132] In 1897, John Kemp, a Montebello-area farmer, was killed by one such explosion as he crossed the river in his boat.[133]

Sawdust pollution and shoals persisted for many years, even as lumbering declined on the Ottawa. In 1912, motorboat owners banded together to demand action on the issue of lumbering pollution, calling attention to dangerous deadheads and the sawdust clogging their engines.[134] When the *Quinte Queen* struck a sawdust shoal while towing the steamboat *Wanakewan* from Besserer's Grove in 1913, several tugboats were required to free it.[135]

The river was a place for transit and recreation for humans who engaged with it through the late nineteenth and early twentieth centuries. Their entanglements with the riparian and island environments were often social in nature, and this was an emphasis in the "song of the Ottawa" described in the following pages.

Composing "On the Water"

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on non-human animal life.

[132] Jamie Benedickson, *The Culture of Flushing: A Social and Legal History of Sewage* (Vancouver: University of British Columbia Press, 2007), 45.

[133] Ibid.

[134] "Boat Owners Make Protest. Department to take Action Re Deadheads," *Ottawa Journal* (Ottawa, Ontario), 16 July, 1912.

[135] "Steamer Released," *Ottawa Citizen* (Ottawa, Ontario), 29 August, 1913.

"On the Water," this song of the Ottawa, tells the story of boat traffic from the urban Ottawa river downstream past Kettle and the Duck Islands to Besserer's Grove. I elected to sonify the trips back and forth of three boats whose schedules I could determine over the course of a single week in July of 1912.

I selected this data in large part because of the very existence of information about scheduled passenger boat trips in this time. There had long been informal ferry traffic criss-crossing the river, as well as commercial traffic. The passenger boats advertising their trips for the public were easier to trace and spoke to an experience of the river that I wanted to highlight. This period represents a moment in the river's history where recreational experiences were more accessible to city dwellers, and this project's emphasis is on the affective, sensuous experiences of place – often accessed in documentary sources about leisure and sport.

Between July 22nd and 29th, the steamer *Quinte Queen* made daily trips to Belle Isle Park on Kettle Island. Every day, the first trip left Queen's Wharf at 8:30 in the morning, and returned every half hour from the park's wharf.[136] The advertised schedule shows that boat service operated until 10:30 p.m. daily. Queen's Wharf, at the foot of Sussex Avenue, was the departure point for many steamers on the lower Ottawa, as well as for commercial boats travelling west to the Rideau Canal system.

[136] "Belle Isle Park Ferry. Steamer *Quinte Queen*." *Ottawa Journal* (Ottawa, Ontario), July 11, 1912.

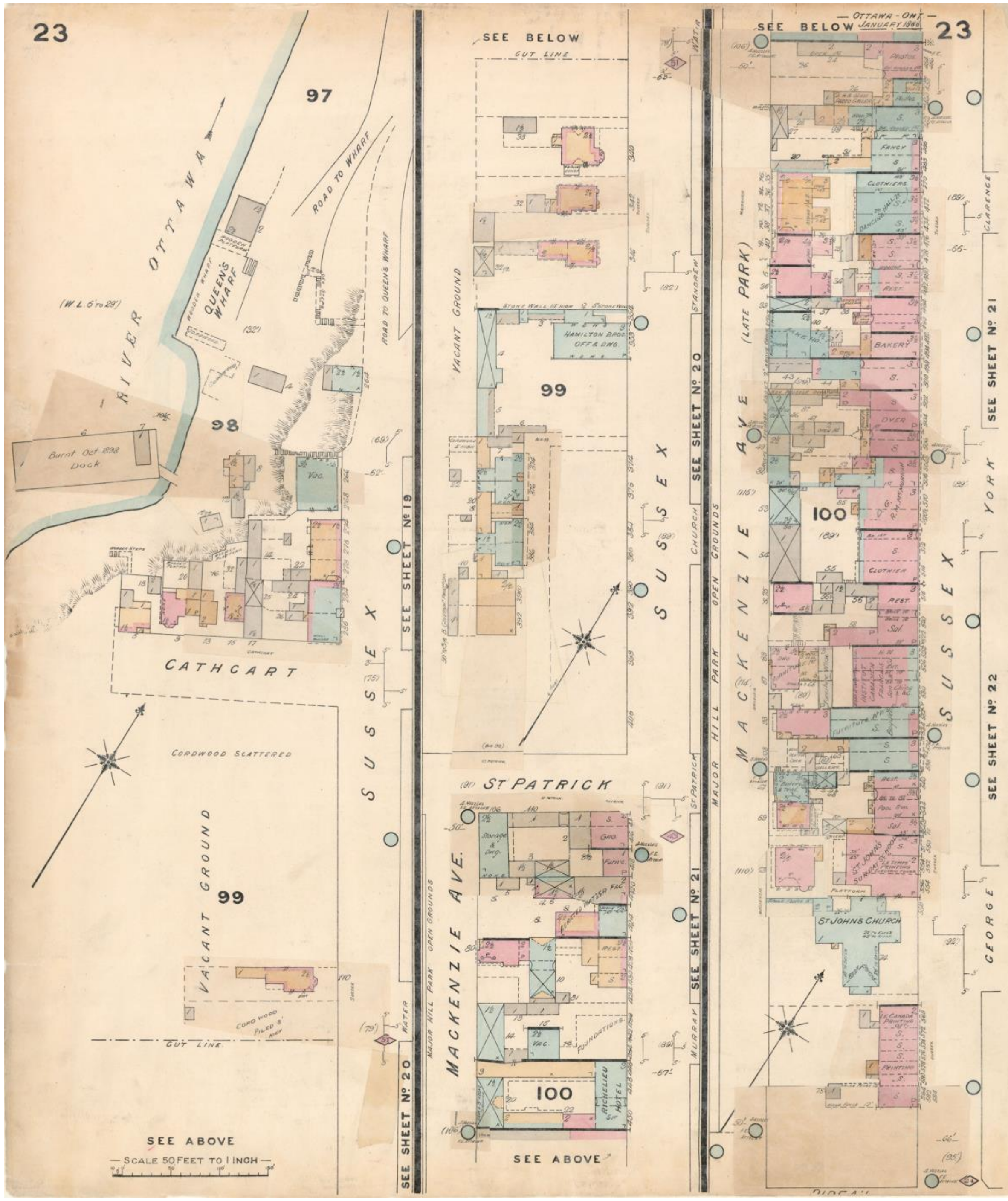

Figure 4. Queen's Wharf, as depicted in an 1888 fire insurance plan. *Sheet 23, Ottawa Fire Insurance plan* [map]. 1888. 50 feet to an inch. Ottawa: Charles E. Goad Company, 1888, revised 1901. *Library and Archives Canada*.

The steamer *Wanakewan* was also regularly travelling between Queen's Wharf and Hiawatha Park, downstream at Besserer's Grove, beginning for the season on July 1, 1912.[137] These two schedules appear clearly in the *Ottawa Journal* for the selected dates, but I also wanted to highlight more informal ferry traffic in this song.

A request for tenders by the federal government appears on March 2, 1912, to "[lease] the privilege of ferrying across the Ottawa River between Rockcliffe, in the province of Ontario, and the old ferry landing on the Gatineau Point in the province of Quebec." I could not find a schedule for the ferry during the week of July 22nd to 29th 1912 but drew on several interviews in the *Ottawa Journal* with two Seguin ferrymen, to extrapolate the potential frequency of trips during that time. In a 1964 interview with 27 year-old Dave Seguin, who inherited the ferry business from his father, he tells the *Journal* that "a good summer Sunday can bring between 200 and 300 customers for the ferry."[138] The family's license also extended slightly upstream and down, and for an extra fee, the ferry could be commissioned to take picnickers to Kettle or the Duck Islands.[139] His father, also Dave Seguin, recalls that his family ran the ferry daily from his earliest memories, including through the winter of 1914-1915 for all but three days of the season.[140] The stretch of river between Gatineau Point and the Rockcliffe landing is very narrow, and trips are thus

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[137] "Hurrah for Hiawatha Park," *Ottawa Journal* (Ottawa, Ontario), 29 June, 1912.
[138] Art Mantell, "Seguin Ferry Service: An Ottawa Institution for 90 Years," *Ottawa Journal* (Ottawa, Ontario) 22 August, 1964.
[139] Ibid.
[140] "What, no Mud Pout! Open Water Cutting Calories Of Ottawa Riverfront Residents," *Ottawa Journal* (Ottawa, Ontario) 17 January, 1949.

very short. To account for this traffic on the river without a formal schedule, I estimated the minimum number of trips that the Seguin ferry might have taken per day.

Initially inspired to adapt Cassandra Marsillo's "Ottawa Love Stories" project, I wanted to sonify the paths taken by each boat using latitude and longitude.[141] I hoped that I would be able to represent the data of each journey where it overlapped in time with another and identify when boats might cross paths or follow after one another in the water. I drew on the schedules of each boat published in newspapers, and while I could identify the time and place of departure from schedules and historical maps, it was not possible to determine the speed or the route navigated of each boat to accurately represent their spatial journeys and I set this approach aside.

Instead, I focused on representing each boat's journey over the course of a day through the number of trips it took per hour. I used the same interface as for the first "song of the Ottawa," MIDITime, to turn the data into sound. With more coding confidence, I changed the term "magnitude" to "trips," so that the file's language would more accurately reflect the data's meaning. I built a separate Python script for the *Quinte Queen*, *Wanakewan*, and the Seguin Ferry, and ensured that each contained a dataset the same length. Since MIDITime requires year, month, and day inputs to sonify long-term data, I decided to represent days of the week as the numbered months of the year. The "day" column then, could represent the hours of the day. For example, eleven o'clock on

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[141] Cassandra Marsillo's project takes sites of memory for the individuals or couples who submit them - the spot where their first meeting took place, the first apartment they shared - and sonifies the distance between them using latitudinal and longitudinal coordinates.

Monday, July 22nd became “1912,1,11” and midnight on Thursday, July 25th became “1912,4,24” in the script.[142]

I then incorporated the number of trips each boat made per hour – a simple digit between zero and two. I determined that in order to hear the different rhythms each day, the music should represent one year (in this case, more than the entire dataset) in 240 seconds. Running each script resulted in three separate files, or sets of electronic sheet music. This stage, Shawn Graham writes in his tutorial on data sonification for digital humanists, is where “having unique midifiles to arrange…moves you from ‘sonifying’ to composition and sound art.”[143]

This song experiments with composition, sonifying each simultaneous boat schedule separately to bring them together after the fact. Like instruments in an ensemble, the boats overlapped in space and time. I represented each boat with an instrument, making choices about the tone that best suited it. The *Quinte Queen* track is played by a strings ensemble, chosen in part to echo the grand dreams and plans developers and investors had for this island resort. For its grand opening and other major events, the *Quinte Queen* featured a band on board. I chose an ensemble instrumentation to evoke these multiple voices as well. The *Wanakewan* track is played by the oboe, whose deeper tone evokes longer journeys. Finally, the Seguin ferry track is played by a drum kit, and the repetition forms a beat and familiar baseline, asserting a near-constant presence on the river.

The resulting track begins as night turns to morning and the Gatineau Point Ferry starts its shuttling back and forth. The *Quinte Queen*, whose regular trips took summer

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[142] The year “1912,” represents the framing for a week in time.
[143] Graham, “The Sound of Data.”

cottage owners back and forth from the city, joins in shortly thereafter. In the mid-afternoon on Monday, the *Wanakewan* departs for Hiawatha Park. Its schedule, in contrast with the others, changes drastically depending on the day of the week. It is also travelling a greater distance – approximately fourteen kilometres between wharves – and not making more than a single trip per hour. The *Quinte Queen* makes its last trip of the day at 10:30 p.m., and I hypothesize that the Seguin ferry also stopped running before midnight. The busy river evoked by the musical notes then sounds silent overnight, though this does not prompt me to conclude from that there was no activity there. Only a few years earlier, the Duck Islands had again been confirmed the site of an illegal cockfighting ring, and other sources reinforce that this in-between space - the islands and the river - continued to be a site of some illicit activity as night fell.[144] The silences in the music overnight are hours of the day where interaction with the river is unaccounted for. They inspire the listener to imagine disappointed customers who missed the last trip back to town, illegal ferries offering their services, clandestine meetings of secret societies, or young swimmers crossing the river to return home.[145]

The repetition as each day begins for the constant variable – the Seguin Ferry – and the *Quinte Queen* following thereafter, evokes a steady rhythm of life and business on the Ottawa. The *Wanakewan*'s occasional interjections increase on the weekend as demand soars.

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[144] "Sunday Cock Fights. A Dead Bird Found Inside a Pit at Duck Island," *Ottawa Journal* (Ottawa, Ontario) 26 July, 1900.

[145] These are all examples of things that happened over the years, not during this week, but that might fill these spaces.

I selected this period of time to engage with this stretch of river as a recreational place, before many city dwellers had increased access to cars and funds to vacation further afield. In high summer, these boats took city-dwellers to beaches and resorts within half an hour of their city homes. Saturday and Sunday, in the final seconds of the song, are especially evocative of a joyous, summer day on the water. Even if a listener does not know the sites on the Ottawa, or cannot see the accompanying images, this sense and *affect* is clear.

Conclusion

In their chapter of the edited volume *Seeing the Past with Computers*, Shawn Graham, Stuart Eve, Colleen Morgan, and Alexis Pantos explore hearing the past and suggest that "sound can give us access to that which is hidden. Sound waves permeate, transgress, and transcend surfaces; they cause surfaces to vibrate, to amplify, and to muffle."[146] "Songs of the Ottawa" has shown some success in demonstrating the power of sound and digital data sonification to transcend the visual in historical storytelling. I set out to build a sensuous engagement with the past and explore the ways in which these "songs" can inform and *enchant* publics. Fundamental to this work has been the act of "de-formance" and the notion that data is not static or immutable, that it can be shaped and re-formed through different means.

This project is an exploration of several potential avenues for data sonification in the humanities. In each case, I used computer algorithms to compose the songs and made choices to represent facets of each story with musical keys, instruments, and tempo.

[146] Graham et. al. "Hearing the Past," 226.

“Hearing the River’s Flows” sonifies the hydrometric data collected at the foot of the Rideau locks from 1880-1977. I used monthly mean data to foreground the river’s seasonal shifts and maintain a narrow dataset, and each year of data plays over 4 seconds. This song helped me to consider the ways researchers can tune in to the agency of rivers and the non-human and *hear* their voices.

“Sounds of Industry” is the audification of a sample of pulp from the E.B. Eddy pulp mill, collected in 1932 as the industry experienced significant growth. I made a three-dimensional scan of the sample to collect the data of its physical matter in space. This song was a preliminary experiment with the sonification of in the history of commerce and industry on the Ottawa. In this case study, the size of the dataset pushed against the limits of the program to sonify it and my own abilities to share and transmit the file size. The sonification of artifacts is a method with enormous potential for museums and researchers of material culture but would require development in the computer algorithms to process large-scale data.

The third song, “On the Water,” sonifies boat traffic on the stretch of the river to tune into the social and recreational ways inhabitants interact with it over a week in July 1912. At the height of summer, the Steamers *Quinte Queen* and *Wanakewan* travelled back and forth between Queen’s Wharf in downtown Ottawa and Kettle Island and Besserer’s Grove, respectively. A commuter ferry also shuttled between Rockcliffe Park and Gatineau Point at regular intervals year-round. This case study evokes a *sense* of the river and prompts questions about the silences overnight when no boat trips are scheduled.

I propose this new methodology for sonification, and experiment with its potential for three stories, and datasets, with different spatial and temporal scopes. At least with this sample, it tended to confirm the hypothesis that the auditory may be especially well attuned to movement, in the changing water levels and the boat traffic. The audio outcome of this endeavour also shaped the trajectory of my research about the environmental history of this stretch of the Ottawa, demanding attentiveness to its sensory and affective histories. These approaches have often been used in environmental histories to explore non-human agency, and helped me to do the same. “Hearing the River’s Flows” tells the river’s life story over 98 years and invites the listener to hear the pattern of its hydrologic cycle from freshet floods to periods of low water. “Sounds of Industry” and “On the Water” more directly explore the entanglements of human activity with the riverscape through time and offer a way into discussions of commerce, industry and recreation in this *place*.

In this telling of river stories, I sought to evoke a sense of the uncanny and *enchanting*. To “hear the past” is confronting and *other* and encourages listeners and readers to consider the myriad ways to encounter history.

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Glossary

Garageband is a music and audio production software made for Mac computers. I use this program to listen to the sonifications generated by the computer scripts and assign the instruments to each "song."

Github is a web-based hosting service mostly used for computer code. Users can share and collaborate on code with its built-in tools for version-control and bug-fixes. I use it to create repositories to store the data and scripts for each sonification, and also to research the ways in which others have remixed data in various ways.

Hypothes.is is an open-source software project enabling commenting on web-based text. The program adds an open layer of annotation over published content. I use Hypothes.is on the "Songs of the Ottawa" website to encourage comments, questions, and feedback on the work.

Meshlab is a free and open-source software for three-dimensional mesh processing. In this program, users can employ tools to edit and manipulate polygon meshes. A polygon mesh is a collection of vertices, edges and faces defining the shape of an object.

Sketchfab is a platform used to view and share virtual reality objects and three-dimensional scans. Virtual reality is a computer-generated experience in which users interact with virtual auditory and visual cues.

Soundcloud is an online audio and music sharing platform. Users can upload content and annotate specific parts of tracks as "timed comments." The website also depicts audio tracks as waveforms.

Sublime Text is a source code editing program, or a text editor. It is not open-source and can be purchased for continued use, but a free version is available for download. I use this program to create and edit the codes for sonification, as well as modify the scripts to build the “Songs of the Ottawa” online home.

Terminal is the command-line interface app for Mac computers. In it, the user issues commands in successive lines of text. I use Terminal to run the Python (a coding language) scripts that generate sonifications.

Text Encoding Initiative is an academic consortium maintaining a set of standards for the representation of texts online. Its Guidelines define methods for encoding machine-readable texts in the humanities, social sciences, and linguistics.

Trnio is a photogrammetry app for smartphones that guides users through the process of scanning three-dimensional objects. It connects with Sketchfab to facilitate the exporting and sharing of 3-D renderings.

XML, or Extensible Markup Languague, is a kind of markup language widely used in computer processing. It uses “tags” and a standardized format to structure and annotate documents.

Appendix A: Historical Hydrometric Data collected on the Ottawa, at the foot of Rideau Locks. Monthly mean water level. (Government of Canada)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1977	41.97	42.18	42.39	42.43	41.97	41.44	41.46	41.41	41.38	41.29	-	-	-
1976	41.75	42.04	42.58	43.19	42.66	41.8	41.63	41.57	41.57	41.55	41.51	41.77	41.97
1975	42.05	41.8	41.79	41.92	42.21	41.8	41.4	41.42	41.4	41.48	41.54	41.23	41.67
1974	41.81	41.88	42.11	42.65	43.43	42.96	41.76	41.44	41.43	41.58	41.86	41.98	42.07
1973	42.05	42.25	42.88	42.82	42.69	42.15	41.84	41.52	41.44	41.57	41.55	41.77	42.04
1972	41.56	41.54	41.63	42.07	42.92	41.98	41.86	41.72	41.63	41.62	41.94	42.06	41.88
1971	41.69	41.89	41.99	42.29	42.31	41.58	41.34	41.32	41.31	41.3	41.33	41.43	41.65
1970	41.84	41.82	41.86	41.9	42.12	41.99	41.89	41.63	41.45	41.51	41.56	41.68	41.77
1969	41.7	41.78	41.76	41.96	42.17	41.9	41.58	41.42	41.4	41.45	41.85	41.92	41.74
1968	42.22	42.2	42.22	42.07	41.56	41.47	41.53	41.43	41.42	41.39	41.43	41.55	41.71
1967	42.48	42.32	41.99	42.53	42.5	42.16	41.75	41.43	41.41	41.67	42.19	42.02	42.03
1966	42.14	42.13	42.29	42.17	41.94	41.81	41.38	41.48	41.38	41.44	41.67	42.74	41.88
1965	41.5	41.51	41.62	41.68	42.05	41.63	41.3	41.41	41.57	42.27	42	42.05	41.72
1964	41.54	41.68	41.76	41.83	41.68	41.51	41.48	41.41	41.22	41.28	41.3	41.36	41.5
1963	40.4	40.39	40.59	41.4	40.89	40.66	40.72	40.85	41.22	41.24	41.2	41.45	40.92
1962	40.51	40.95	40.83	41.43	41.5	40.3	39.63	39.61	39.65	39.79	40.07	40.28	40.38
1961	40.41	40.24	40.43	40.7	40.94	40.4	40.25	40.11	40.18	40.23	40.04	40.49	40.37
1960	41.24	41.29	41.22	42.79	43.77	41.11	41.46	40.79	40.2	40.13	40.16	40.31	41.21
1959	40.8	40.83	40.84	41.75	41.39	40.38	39.82	39.73	39.91	40.23	41.09	41.29	40.67
1958	41.58	41.49	41.64	41.67	40.53	40.37	40.26	39.95	40.11	40.42	40.73	40.9	40.8
1957	40.91	40.95	41.08	40.78	40.83	40.42	41.73	40.14	40.27	40.64	41.13	41.43	40.86
1956	40.75	40.75	40.7	41.59	41.8	41.25	40.58	40.46	40.98	41.14	40.54	40.73	40.94
1955	41.37	41.28	41.43	43.03	41.09	40.21	39.84	39.56	39.56	39.93	40.9	40.85	40.75
1954	39.98	40.29	40.98	42.11	41.35	41.38	40.63	40.16	40.26	41.47	41.46	41.29	40.95
1953	40.83	41.03	41.59	42.65	41.17	40.18	39.98	39.73	39.64	39.76	39.71	39.82	40.5
1952	41.68	41.54	41.46	42.41	42.33	41.4	40.46	40.43	40.1	40.17	40.14	40.58	41.06
1951	40.74	40.74	41.22	43.89	42.13	40.52	40.64	40.05	40.08	40.83	41.89	41.58	41.19
1950	40.22	40.2	40.18	41.63	41.62	40.8	40.23	39.95	39.92	39.87	40.16	40.48	40.44
1949	39.94	40.13	40.42	42.09	41.97	40.65	40.54	39.42	39.4	39.77	39.86	40.07	40.36
1948	39.98	40.15	40.73	41.67	41.41	40.69	40.01	39.87	39.72	39.64	39.62	39.77	40.27
1947	40.72	40.86	40.92	42.72	44.54	44.47	41.58	40.23	39.94	40.03	39.92	40.05	41.33
1946	40.53	40.6	41.32	41.3	40.87	41.01	39.93	39.73	39.7	39.84	40.1	40.55	40.46
1945	40.21	40.18	40.97	41.76	41.7	41.79	40.14	39.7	39.79	40.08	40.23	40.22	40.56
1944	40.38	40.28	40.5	40.5	41.32	40.23	39.8	39.71	39.72	39.84	39.89	40.13	40.19
1943	40.34	40.48	40.89	41.77	43.58	42.37	40.8	40.09	40.26	40.06	40.29	40.34	40.94
1942	40.93	40.92	41.35	42.17	42	41.43	40.14	39.92	39.8	39.76	39.93	40.04	40.69
1941	40.47	40.51	40.6	42.02	41.52	40.3	40.2	40.02	40.12	40.75	41.46	41.25	40.77
1940	39.8	39.79	39.93	41.31	41.79	42.42	41.03	40.09	40.09	39.88	40.06	40.47	40.56

1939	40.12	40.08	40.13	41.03	42.71	41.29	40.05	40.21	39.69	39.63	39.89	39.88	40.39
1938	40.57	40.71	41.68	43.67	42.79	41.14	40.03	39.85	39.87	40.06	39.94	39.98	40.85
1937	41.1	41.27	41.35	41.91	42.69	41.04	40.12	39.97	39.77	40.09	41.16	40.91	40.95
1936	40.21	40.23	41.22	41.9	43.88	42.27	40.36	39.81	39.76	40.29	40.78	40.39	40.93
1935	40.49	40.38	40.94	41.39	41.25	40.53	40.69	40.14	39.85	39.8	40.07	40.15	40.47
1934	39.93	39.92	39.98	42.16	43.34	41.56	40.64	39.76	39.75	40.08	39.98	40.51	40.64
1933	41.03	40.72	40.58	42.89	43.08	41.37	40.31	40.03	39.61	39.42	39.62	39.8	40.7
1932	40.6	40.62	40.5	41.81	41.59	40.67	40.33	40.28	41.22	41.65	42.46	41.53	41.1
1931	40.05	40.01	40	40.7	41.01	40.53	39.82	39.79	39.47	39.51	39.63	40.2	40.06
1930	40.36	40.26	40.39	40.93	41.71	41.72	41.82	40.47	40.01	39.98	39.83	39.98	40.62
1929	41.3	41.02	41.63	42.87	44.17	42.17	41.12	40.15	39.88	39.86	40.33	40.28	41.23
1928	40.95	40.87	40.87	43.1	44.64	42.94	41.75	40.92	40.98	42.16	42.35	41.58	41.92
1927	40.56	40.52	41.47	41.22	41.49	41.68	41.22	40.85	40.11	40.24	41.02	41.56	41
1926	40.15	40.01	40.07	40.83	42.92	42.35	41.3	40.34	39.79	39.67	40.8	41.32	40.8
1925	39.8	40	40.94	42.38	42.33	41.98	41.17	40.43	39.67	39.68	40.15	40.55	40.76
1924	40.29	40.13	40.46	41.83	43.49	42.29	40.66	40.05	39.96	40.11	39.99	40.35	40.8
1923	39.5	39.48	39.56	40.81	43.76	41.99	40.6	39.87	39.98	39.64	39.7	40.21	40.43
1922	40.06	39.85	40.42	42.98	43.42	41.18	40.3	39.74	39.64	39.47	39.5	39.59	40.51
1921	39.83	39.56	40.91	42.46	42.52	40.59	39.77	39.47	39.12	39.44	39.78	40.1	40.3
1920	40.57	40.33	40.91	41.79	42.06	40.81	40.37	39.89	39.54	39.31	39.62	39.87	40.42
1919	40.88	40.48	40.98	42.48	44.13	42.87	40.52	39.74	39.84	40.52	40.98	41.29	41.23
1918	39.82	39.81	40.17	41.81	42.13	41.38	40.98	39.99	39.93	40.7	41.56	41.34	40.8
1917	40.27	40.13	40.4	41.91	42.82	42.64	41.74	40.85	40.05	39.8	40.08	39.98	40.89
1916	40.09	40.35	40.26	42.91	44.09	42.6	40.82	39.77	39.29	39.58	40.28	40.63	40.89
1915	39.39	39.38	39.4	40.4	41.54	40.94	40.3	39.98	39.76	39.95	39.77	40.03	40.07
1914	40.3	40.09	40.12	40.77	41.67	40.61	40.14	39.24	38.99	38.86	39.15	39.45	39.95
1913	40.78	40.54	41.36	42.86	42.9	41.22	40.01	39.55	39.41	39.66	40.61	40.8	40.81
1912	40.25	39.79	39.78	41.47	42.93	42.89	40.94	40.09	39.87	39.98	41.15	40.99	40.84
1911	39.66	39.48	39.3	40.9	43.02	42.13	40.46	39.75	39.28	39.07	39.49	40.14	40.23
1910	40.13	39.93	40.42	42.2	42.06	41.56	40.19	39.68	39.66	39.91	40.15	40.04	40.49
1909	39.65	39.77	39.89	42.13	44.32	43.34	41.3	40.89	40.33	40.17	40.14	40.38	41.03
1908	40.41	40.22	40.24	41.75	44.41	43.13	41.03	39.83	39.15	38.84	38.88	39.43	40.61
1907	39.11	39.08	39.43	41.21	42.47	42.53	41.3	40.21	39.92	40.38	40.8	40.66	40.6
1906	40.05	40.36	40.03	40.77	42.43	42.22	40.76	39.63	39.06	39.19	39.21	39.48	40.26
1905	40.05	40.01	39.93	41.26	42.14	41.56	40.46	39.93	39.59	39.65	39.84	39.83	40.36
1904	39.82	39.81	40.01	42.13	43.99	43.71	41.5	40.2	39.9	40.77	40.6	40.09	41.04
1903	40.39	40.18	41.76	41.92	42.34	41.67	41.17	40.33	40.02	40.4	40.09	39.9	40.85
1902	40.41	40.38	41.35	42.43	42.57	42.12	41.2	40.35	39.78	39.93	40.8	40.95	41.02
1901	40.06	39.86	39.84	42.54	43.08	42	40.3	39.67	39.26	39.19	39.52	40.08	40.45
1900	40.57	40.22	39.93	41.83	42.53	41.55	41.4	40.97	40.15	40.5	40.46	40.44	40.88
1899	40.18	40.14	40.17	41.86	44.02	42.6	41.28	40.19	39.59	40.29	40.05	40.47	40.91
1898	39.79	39.88	41.47	41.98	42.03	41.69	41.04	40.12	39.83	40.19	40.84	40.43	40.78
1897	40.62	40.41	40.58	41.54	43.91	42.66	40.94	40.33	39.85	39.55	39.91	40.1	40.87
1896	41.18	40.38	40.15	42.3	42.99	41.78	40.64	39.84	39.55	39.92	40.88	41.19	40.9

1895	40.27	39.78	39.58	41.47	42.94	42.14	40.48	39.98	39.7	39.38	39.48	40.09	40.44
1894	39.83	39.77	41.11	41.83	43.4	42.26	41.21	39.9	39.36	39.98	40.58	40.54	40.82
1893	39.91	39.57	39.55	41.16	43.88	43.31	41.47	40.29	39.77	39.84	39.98	39.88	40.72
1892	40.79	40.2	39.83	41.11	41.46	41.6	40.9	40.2	39.72	39.84	40.21	40.44	40.53
1891	39.55	39.52	40.45	42.32	43.42	41.42	40.55	40.54	40.17	39.63	39.84	41.09	40.72
1890	40.89	40.51	40.76	41.93	43.42	43.73	41.89	40.69	40.48	40.04	39.83	39.69	41.16
1889	40.12	39.98	39.94	40.81	42.3	42.85	41.76	40.58	39.8	39.51	39.47	40.13	40.61
1888	39.26	39.22	39.23	40.27	43.22	43.29	41.32	39.92	39.56	39.39	40.19	40.16	40.42
1887	39.84	39.96	39.91	41.5	43.85	41.84	40.43	39.6	38.99	38.8	38.9	39.26	40.24
1886	40.86	40.41	40.13	42.69	43.32	41.76	40.91	40.11	39.75	40.03	40.02	40.05	40.84
1885	40.82	40.33	40.05	41.26	43.53	42.69	41.68	40.5	39.83	39.65	39.95	40.23	40.88
1884	40.79	40.37	40.43	41.92	43.28	41.9	40.41	40.21	39.51	39.89	40.4	41.09	40.85
1883	39.72	39.6	39.56	40.75	42.46	42.73	42.35	40.74	39.99	40.09	40.75	41.37	40.85
1882	39.72	39.72	40.07	40.94	42.54	43.04	41.59	40.62	40.58	40.17	40.26	40.09	40.78
1881	39.72	39.74	40.01	40.46	42.82	41.67	40.12	39.41	38.9	38.97	39.43	39.72	40.08
1880	40.18	40.07	40.23	41.5	43.79	43.01	41.21	40.23	39.57	39.74	40.77	40.53	40.9