

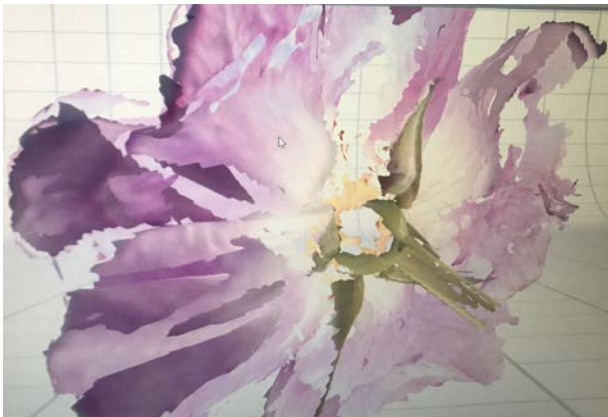
# **Librarian Study Leave Report**

## ***The DIF Edge: Explorations in Digital Information Fluency***

### ***Selected Data Visualization Topics***

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**Study Leave [6 months]:** Taken between May 15, 2017 & December 10, 2017  
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# Study Leave Report Outline: May 15 Manuscript Updated May 24-25, 2018

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## **Executive Overview & Acknowledgements**

### **Inspiration & Goals for Study Leave Topics:**

Three topics were the focus of my study leave activities: 3D modelling of specimen collections, citizen science in the sciences, and science data visualization by artists.

The 3D modeling topic was inspired by my 4 year participation in the UVic Libraries' McTaggart Cowan digitization projects which included 3D modeling of a number of specimens collected by Cowan that were held by the Royal BC Museum and the Beaty Biodiversity Museum. <https://exhibits.library.uvic.ca/spotlight/ian-mctaggart-cowan/browse/3-d-scans>

The citizen science topic was inspired by some preliminary work I had done to propose a Citizen Science Panel of UVic scientists for IdeaFest 2016. The proposal was not accepted, but my interest was engaged.

The science data visualization by artists was inspired by an article I came across in the online Hakai Magazine, titled "*Amplifying Data Through Art*", and by 2016 Earth Day "Climate Clock" project that was a collaboration between a Concordia University climate scientist and a multi-media artist. <https://www.hakaimagazine.com/article-short/amplifying-data-through-art/> <https://www.concordia.ca/news/climateclock.html>

All three topics are interconnected by the overarching framework of science data. My first goal was to experience the research data life cycle by creating a 3D data set of botanical specimens and thus explore issues around data creation, metadata, data description, data deposit, data sharing & access. A second goal was to explore the role citizen scientists play in collecting and working with scientific data. A third goal was to explore how artists are engaged in artistic visualizations of science data and knowledge mobilization.

It is important to characterize my study leave activities as exploration. Prior to my study leave I met with Dr. Shailoo Bedi, to determine if my proposed study leave activities would require an ethics application. It was determined that my activities were really exploratory in nature, and, thus an ethics application was not be required.

### **Learning Opportunities and Reflections:**

Reflecting upon my study leave activities and explorations, I have come to understand that my 6 month study leave time was really a first step in a journey of learning about three interrelated science data topics that continue to deeply interest and engage me. Since the formal conclusion of my study leave, I continue to learn about exciting new developments in all three topics. For example, one of the sessions at the IASSIST Conference [May 2018] is titled: *Introduction to the community standards for 3D data preservation (CS3DP) project*. [https://www.openconf.org/IASSIST2018/modules/request.php?module=oc\\_program&action=summary.php&id=88](https://www.openconf.org/IASSIST2018/modules/request.php?module=oc_program&action=summary.php&id=88)

Another example is the recent call for an Artist-in-Resident-Ocean Program, a collaboration between Ocean Networks Canada and UVic's Department of Fine Arts. <https://finearts.uvic.ca/research/blog/2018/04/>.

Recent news at UVic celebrates citizen science and the integration of science data and art:

- *Grad blends passion for conservation with community-based citizen science* <https://www.uvic.ca/news/topics/2017+convocation-fall-science-korolyk+ring>
- *When Art Meets Science* <https://www.uvic.ca/news/topics/2018+knowledge-art-meets-science-hash+news?ticket=ST-92670-R6yh-pRTk56PBE52avDE2urWT6Y-tchagra>

Challenges, leading to learning opportunities, during the study leave, included trying to learn 3D modeling without the help of a mentor or experienced people to work with, and in the absence of an in depth instruction manual. Dr. Kurki did give me a brief demo but then I was on my own. As a consequence my learning was of a trial and error nature and I spent a lot of time doing and redoing.

Another challenge was the solo nature of my study leave. I experienced a huge cultural shift from my day to day work as an academic librarian, and although I was motivated and interested, I was "homesick" for my regular work, for the first while. However, I was fortunate to have the opportunity to attend research conferences and to visit London's Natural History Museum and Kew and this offered wonderful opportunities to tap into the research data expertise of many and, especially, at the NHM, to share 3D experiences.

Also, in March 2017, I was selected for participation in the David Suzuki Citizen Science Victoria Butterflyway Program that was active April – October 2017, so this offered a cohort of new people to engage with, mostly on weekends and evenings, when we pursued our citizen science activities. More about this in the body of my Study Leave Report, as this citizen science project became a co-located hands-on activity that enriched my more academic exploration of the citizen science topic.

I hope to continue exploring all of the topics I was engaged with during my study leave. A complex issue pertains to the long term curation of 3D datasets. In my small 3D scanning project, each 3D scan generated a large number of proprietary file types. To be able to deposit and publish these models (on Sketchfab, for example), different file types are exported. The volume and complexity of 3D data files types poses metadata challenges, especially for botanical 3D files, where metadata schema are still evolving as part of the DarwinCore metadata initiatives.

I am also interested in continuing to follow the 3D specimen collection projects in Natural History Museums around the world, specifically the DiSSCo initiative in Europe with a vision of digitizing all European natural science collections to position these collections "at the centre of data-driven scientific excellence and innovation" <http://dissco.eu/>.

Also, I hope to do more in depth exploration of the research based in 3D modeling in both archaeology and biological anthropology. The UVic Anthropology Department has just hired a new biological anthropologist whose research involves 3D scanning of bones with a micro CT scanner. And of course, Dr. Kurki's research is focused on 3D modelling of paleo-skeletal specimens. Thus the availability of an older desk top NextEngine scanner that Dr. Kurki so generously entrusted to me for my Study Leave 3D project.

My 3D scan project focused on botanical specimens and this is an area where much innovative technical and software development is underway by crop scientists, so I hope to keep in touch with those developments. My 3D botanical models would perhaps have been better [with fewer missing data points] had I chosen photogrammetry for my hands-on project in 3D modelling, or, if I had had access to a CT scanner.

Most of my assigned science subject liaison disciplines conduct their research involving a range of 3D modeling techniques so I hope to be able to explore these disciplines and other 3D modeling technologies in more depth, as time permits.

As for citizen science, there are an overwhelming number of opportunities and projects all around the world for citizen scientists. When I visited Kew Gardens, I was invited to help transcribe the correspondence of Joseph Hooker, and was provided the protocols for transcribers. So this may be a future opportunity. <https://www.kew.org/explore-our-collections/correspondence-collections/joseph-hooker-collections>

And last but not least, I am totally interested in the intersection of art and science, often characterized as the "collision" of art and science. I will continue to explore this topic, as time permits. This topic was the most difficult to figure out how to explore. Everywhere I looked I was seeing artists' visualizations of science data: online in social media posts and platforms; in journals and magazines [often with no identification of the artist], and in the museums I visited in person and toured online.

### **Acknowledgements and Sincere Thank You's :**

- To Dr. Heken Kurki, UVic Anthropology, for the generous loan of her NextEngine Desktop Laser Scanner and her PC hosting the ScanStudio Software.
- To Oak Bay Parks, for giving me permission to collect Garry Oak Meadow plant specimens for the purposes of 3D scanning.
- To staff at the Natural History Museum and Kew Gardens, for tours of their specimen collection digitization programs, and for sharing their Citizen Science initiatives and their approaches in engaging artists with knowledge mobilization of their collections through art.
- To the UVic Libraries for approving my Study Leave Proposal, for agreeing to reschedule my 2017 Scholarly Days until 2018, and for granting an extension until May 15, 2018, for the submission of my Study Leave Report.
- To the UVic Libraries who provided funding for DHSI, and funding towards participation in the RDA Plenary in Montreal, visits to the NHM and Kew, and attending the CoData Conference in St. Petersburg.

## **Afterthoughts and Ongoing Challenges**

There was no question that my study leave topics were, and continue to be, fascinating but they were also very challenging. As predicted by colleagues, I had taken on a lot. Too much perhaps, in retrospect, given the ongoing challenges, and the associated learning opportunities in response to the challenges.

An ongoing challenge has been trying to figure out to manage all the various data sets I created: hundreds of 3D files, hundreds of screen shots and photos that document the 3D processes, hundreds of photos documenting my visits to Kew, the NHM, and the Dublin Science Gallery to capture examples of the intersection of art and science, and, a few photos of my own watercolour efforts to visualize data.

In my 3D project, I learned a lot about the complexity of living blossoms and challenges associated with 3D modeling plants with a laser scanner. Blossoms reflect light and are curved so there are many occlusion areas and thus point and mesh data is not fully captured. Blossoms, once picked, are still breathing so they move and like a cake trying to rise in an oven, people walking around the house introduce vibrations. I love the 3D images I generated, but they are far from perfect, as I knew they would be before I even ventured into this experiment. The point clouds and meshes are works of art in my mind. Rotating these blossoms in 3D is visually engaging. My goal was never 3D printing. My goal was to explore plant structures, to zoom in and 360 rotate, in a 3D environment.

Also, I have learned that the original colours of the blossoms scanned are truest in the NextEngine's ScanStudio representation of the models. Colour is important to botany. As the 3D models resolve on different software platforms [MeshLab, Sketchfab, Flickr], the colours change to varying degrees. Colours also resolve differently on the PC laptop Helen Kurki loaned me, on my home iMac, and on the Libraries PC Laptop where the original ScanStudio files now reside. In truth, my home scanning environment was not a controlled light environment, so scanning the same blossom, at different times of the day, resulted in different colours for the same blossom. Subtle differences but significant.

A major ongoing challenge is associated with the visual nature of my study leave topics. I chose to document my 3D exploration activities with photos and screenshots. These digital files are now posted/published in a distributed fashion across a number of platforms. My 63 3D models are posted on Sketchfab. A selection 3D documentation images [photos, ScanStudio screenshots, MeshLab snapshots] are posted Flickr, but the full set of these image files reside on my home iMac and on hard drives. The 3D .ply files I chose for "deposit" in a data repository are on FRDR Demo [a temporary deposit, likely secure until September 2018]. Other image files are on a UVic laptop and hard drives. Examples of Sci-Art from visits to the NHM, Kew, and Dublin Science Gallery, are on Flickr.

My "research" readings are in the process of being posted to Zotero. I learned Zotero post study leave, as I discovered that Zotero makes it easy to capture social media websites,

journal article metadata and PDFs. During my study leave, I was searching for articles and resources via my iPhone and on my home Mac. As a consequence, I was sending links and PDFs to myself via email. I still have readings to retrieve from my email folders to add to Zotero. As of this writing, I also realized I did not yet know how to print a Reference List from Zotero. I had focused all my previous Citation Management Tool energies on EndNote Web, not an easy tool for social media and website capture. So Zotero presented yet another new learning challenge “opportunity” that took a while to resolve.

All of this complexity and digital output also poses technical challenges for preparing this Study Leave Report in both print and digital formats. Mostly I have added links to the various platforms where my image files can be accessed, but I also hoped to be able to include a few photos in the body of my Study Leave Report. This generated WORD and PDF documents that are too big to attach to email, so I am uploading my Study Leave report via Google Drive.

I also realize, that I have created many data sets, not just the 3D data set I had set myself as a goal as a way to experience the Research Data Life Cycle. During my 2017 DHSI “Visualization of Information” Workshop, I learned that a data set can be any collection of things that can be analysed and interpreted and used to tell a story about something.

In conclusion, it occurs to me that my Study Leave experience can be likened to the *lifecycle of the butterflies* that I learned about in my Citizen Science Butterflyway Project.

Ideas were created throughout 2016 and led to a Study Leave proposal. I call this the “*Egg Stage*”. The 6 month Study Leave was the “*Caterpillar Stage*” where I was seeking out and consuming information and experience and intellectual nourishment. I am currently in what seems to be the “*Chrysalis Stage*” where I try to transform/morph all the Study Leave learning, information and experience into a Study Leave Report, a report I have actually been drafting in my head since May 15, 2017, asking myself: How will I put this into a Study Leave Report? I now ask myself when the “*Butterfly Stage*” will manifest. Hopefully in time for the LIBCNCL presentation in September 2018?

## Study Leave – Exploration Strategies & Methodologies

My study leave focused on exploring 3 intersecting "research data" visualization topics. Exploration of these topics involved a variety of strategies:

- **Scholarly articles & books:** The Web of Science and Google Scholar were used to discover scholarly literature. Cited articles were also tracked and reviewed. Reference Lists are included in Appendices.
- **Social Media resources:** Posts on Facebook and Tweets on Twitter were amazingly fruitful for my three study leave topics. This methodology was characterized by some very fortuitous serendipity. I had "liked" a number of relevant Facebook pages and followed a number of Twitter feeds, such as: iDigBio, various NHM pages [National History Museum, London], Mark My Bird, iNaturalist, Zooniverse, Kew; SciArt, BioArt, BHL, Citizen Science, CitSci, Australian Citizen Science, Smithsonian Transcription, Smithsonian NMNH, American MNH, GBIF, CoData, RDA, and others. These posts often referenced scholarly articles and lead to informative blog posts and conference presentations that were relevant to my study leave topics. Reference Lists are included in the Appendices.
- **Hands-on projects:** A major focus of my study leave revolved around a 3D hands-on project, and a second, less major Citizen Science hands-on project. A minor post Study Leave SciArt project is also noted. These hands-on projects, integrated to some degree, all three research topics and brought a sense of reality and engagement to the literature/resource searching and associated reading. The hands on projects also provided me opportunities to share my experiences with research data visualization and the research data life cycle, at the conferences I attended, at a DHSI Workshop, and, especially during my visits to the Natural History Museum and Kew Gardens.
  - **3D Project:** I was fortunate to borrow a NextEngine laser scanner for the first 4 months of my Study Leave. This enabled me to conduct 3D scanning of local Garry Oak Meadow plants and I also scanned a number of other garden plant specimens, including those considered nectar or host plants for local butterflies. A selection of photos, MeshLab snapshots and ScanStudio screenshots, are included in the *3D section* of this report.
  - **Citizen Science Project:** Prior to starting my Study Leave, I was selected as a participant in a Victoria based David Suzuki Foundation Citizen Science project focusing on the education and creation of native plant corridors for local butterflies. The project started in March 2017 and continued until the Fall of 2017. Most events and activities happened on weekends and evenings. Preparation was especially intense during April and early May, before my Study Leave started, as we had to learn about butterflies and their native host plants. My group committed to building an educational Butterflyway Booth to take to community events. I add this as a hands-on

Study Leave Project because it provided an opportunity to participate in Citizen Science activities, such as the 150 Canada-wide BioBlitz where I learned to use iNaturalist, an important Citizen Science app. A selection of photos are presented in the *Citizen Science* section of this report.

- **Science Data Visualization Project:** I add this, as a post Study Leave SciArt hands-on activity, as I had optimistically noted, in my Study Leave Proposal, that I might attempt a watercolour to visualize a data set. It seems I need to be taking a course to actually get down to doing watercolours so I signed up for a WaterMedia evening credit course in January 2018. By April, I had done a number of WaterMedia assignments and eventually, realized I had two watercolours that may qualify, vaguely, as an amateur artistic visualization of a citizen science data set, focusing on the local butterflies I had been learning about during the spring and summer of 2017. A section of photos are presented in the *Science Data Visualization by Artists* section of this Report.

➤ **Two Conferences, a Workshop & one On-Site Visit/Tours**

- In support of each of these research topics, I was able to visit the Natural History Museum, and Kew Gardens, in London, where I learned about their specimen collection imaging programs and technologies, their citizen science and crowd sourcing initiatives, and the long engagement of museums with artists who make visible, with engaging creativity, the vast assemblage of scientific specimen collections.
- I also attended two conferences focusing on all aspects of Research Data: 1) 2017 Research Data Alliance Plenary in Montreal and 2) International 2017 CoData Conference in St. Petersburg, Russia.
- In June 2017, I attended the DHSI workshop: “*Visualization of Information: Where Data Meets Design*” where I was introduced to a vast array of visualization tools and strategies. It would take a year to visit each tool and explore their features and potential. I had an opportunity to present a PPT of my emerging 3D dataset to workshop participants. I was also required to create a new dataset to be represented both physically and in 2D. I based this new dataset on the geo-distribution of my family members.
- Each of these activities informed each of my study leave topics and led to deeper reflection regarding the long term preservation and curation of digital outputs associated with 3D imaging of specimen collections, the challenges of developing protocols for working with citizen scientists and curating their research data set contributions, and the critical role of art in the visualization and knowledge mobilization of science research.
- A selection of photos from the visits to Kew, the NHM, and Dublin’s Science Gallery are in Appendix C.

- 3D – Modelling of Specimen Collections
  - Overview: 3D Modelling – Specimen Collections
  - Hands-On Project: 3D Scanning– Garry Oak Meadow & Garden Plants
  - Outcomes & Reflections
  - Photos and Screenshots

## Overview: 3D Modelling – Specimen Collections

The first study leave topic focused on the 3D imaging of scientific natural history specimen collections. In addition to preliminary research and readings, I experimented with 3D scanning, using a desktop NextEngine laser scanner. Over the spring and summer, I scanned a selection of Garry Oak Meadow plants and selected garden plants. While the scanning technology available for my study leave was not ideal for the 3D imaging of complex objects such as the flower and leaf parts of live plants, I was able to experience the challenges of 3D imaging, especially relating to the scanning of botanical collections, and the downstream challenges associated with 3D image file management and data curation.

In the process of generating a 3D data set, I also experienced many of the components of the Research Data Life Cycle. I created a Data Management Plan using the Portage DMPAssistant tool. I uploaded some of my 3D files, [those associated with the Garry Oak Meadow plants that I had scanned], to the FRDR Demo repository. In preparation for the FRDR Demo upload, I created a data dictionary for the 3D specimen models selected for upload, with data elements chosen based on selected elements from the DarwinCore metadata schema. As part of the deposit to FRDRs Demo repository, I provided the required DublinCore collection level metadata. FRDR Demo is a temporary instance but it is anticipated that my 3D data set, and the associated collection level metadata, will be secure via FRDR Demo, until September 2018. I will explore uploading my dataset to UVic's Dataverse, if my 3D dataset appears to be of interest, given this dataset is the outcome of my Study Leave and the Study Leave Report may be uploaded to UVicSpace.

I chose the FRDR as my repository because it is a demo instance, and I am not convinced that 3D data set is of enough enduring enough value to be hosted on UVic's Dataverse. I also did not want to encumber my UVic colleagues with helping me through a Dataverse deposit activity. As a new member of the Portage FRDR User Experience Working Group, uploading my 3D data set to FRDR Demo provided an opportunity to experience FRDR data deposit, and thus prepared me for the working group tasks of editing FRDR web site documentation related to data deposit.

I also “published” many of my 3D models on Sketchfab. I am shy to share my 3D models too widely, given the limitations I experienced in getting a complete botanical 3D image. My 3D models, as captured and created during the doing and re-doing, are published on Sketchfab at <https://sketchfab.com/KathleenUVic/collections>  
The Garry Oak Meadow collection, associated with the data set deposited in FRDR Demo, is at <https://sketchfab.com/KathleenUVic/collections/garry-oak-meadow-plants-oak-bay-bc-canada>

I also read articles and explored social media posts referencing 3D imaging of specimen collections. The reading I did, specifically some pre-reading in preparation for my study leave, revealed that desktop and handheld laser scanners are not yet an effective approach for imaging plants. Prior to my study leave, I found some papers on the complexities and challenges of 3D modelling plants. Crop scientists are interested in

phenotyping and using 3D as a way to generate measurements automatically from the generated 3D plant geometries. An interesting new plant scanner developed in Germany called PlantEye. Info at <https://phenospex.com/products/plant-phenotyping/science-planteye-3d-laser-scanner/planteye-f500-multispectral-3d-laser-scanner/>

I decided to carry on with imaging plants with my borrowed NextEngine, as my intent was to learn about 3D imaging [meshes, point clouds, fusing, volume merging]. I really wanted to explore whatever I could explore with living plants material. The NextEngine software manual was basic, as was the training video. Learning proceeded via a great deal of trial and error.

My subsequent reading of the literature and my exploration of 3D botanical images on Sketchfab, suggested that photogrammetry may be a better imaging strategy for plant material. However, the quality of digital cameras required, the lighting set up, and the computer storage required to store and process the hundreds of images captured for good photogrammetry outcomes, far exceeded my technical set up.

During my visit to the NHM, I saw a perfectly scanned 3D lily, captured by a rather expensive CT scanner. See: <https://www.sciencephoto.com/set/2823/micro-ct-creates-virtual-replicas> and <https://www.sciencephoto.com/media/621552/view>

Neither the NHM, nor Kew, have focused their 3D imaging programs on botanical specimens. Kew is engaged with a massive 2D imaging project of their herbarium collections <http://www.nhm.ac.uk/our-science/our-work/digital-museum/digital-collections-programme/digitising-botanical-collections.html> .

The NHM is 3D imaging many of their natural history collections. See: <https://blog.sketchfab.com/nhm-london-building-custom-3d-interactives-sketchfab-api/> and <http://www.nhm.ac.uk/our-science/departments-and-staff/core-research-labs/imaging-and-analysis-centre/techniques.html> and <https://sketchfab.com/KathleenUVic/collections/nhm-favourites>.

The 3D and 2D imaging of natural history collections is receiving massive funding support, especially in Europe for their DiSSCo project described at <http://dissco.eu/> “*a new pan-European Research Infrastructure initiative of 21 European countries with a **vision** to position European natural science collections at the centre of data-driven **scientific excellence and innovation** in environmental research, climate change, food security, one health and the bioeconomy*”

A Digitization Fair, held in 2017, at the Smithsonian, highlights the importance of 3D imaging in the museum world. <https://dpo.si.edu/2017-smithsonian-digitization-fair-welcome-0>. All sessions have been webcast and published on YouTube at <https://youtu.be/Bnb54UdSU9Y>. Of great interest to me was the key note by Dr. Ian Owens, Science Director of the NHM, London, who summarized the imaging projects underway at the NHM. His talk is on You Tube at [https://www.youtube.com/watch?v=8DT0W\\_9Aqo0&feature=share](https://www.youtube.com/watch?v=8DT0W_9Aqo0&feature=share)

As mentioned earlier, in September 2017, I had the opportunity to visit the Imaging and Analysis Unit at the NHM and was given a tour of their imaging activities. I learned about both 3D and 2D digitization projects and was shown the many technical innovations that enable the NHM to digitize entire trays of pinned butterflies, for example, and also capture the labels. Thus my excitement of discovering Dr. Owens' key-note talk on YouTube. Dr. Owens' talk and PPT slides capture so well what I was honoured to have been shown during my visit.

Having visited the NHM in September 2017, a special treat, on returning home, was going to Victoria's IMAX *Museum Alive* show, <https://imaxvictoria.com/movie/museum-alive/> where "*David Attenborough takes us on a nocturnal adventure through London's famous Natural History Museum. When the last visitor leaves, the doors are locked and night falls, and the world's favourite naturalist roams the museum halls and corridors, encountering extinct creatures that, through the wonder of cutting edge 3D CGI are brought to life right in front of our eyes.*" How special to revisit the NHM via this amazing 3D IMAX show.

Researching the wider topic of visualization in the sciences, and even focusing primarily on 3D technologies, was really too big a research topic for my 6 month study leave. I did read a few classic books on visualization, specifically Edward Tufte's *Envisioning Information* and *Beautiful Evidence*, as well as *The Visual Miscellaneum* by David McCandless, and, *The Infographic Guide to Science* by Tom Cabot.

And last, but not least, was my participation in the DHSI workshop "*Visualization Information: Where Data Meets Design*" in June 2017, where I was exposed to a vast array of visualization tools, techniques and applications. I prepared a PPT of my 3D imaging work as of June 5<sup>th</sup>, and shared this experience and the challenges, with the workshop participants.

I also attended a DHSI weekend session that focusing "*3D Visualization for the Humanities*, offered by Computer Canada. This session featured sophisticated visualization tools available to research scientists ParaView, Miniconda, and Python.

A Reference List of selected readings and resources is found in Appendix D3.

## Hands-On Project: 3D Scanning–Garry Oak Meadow & Garden Plants

### ➤ Activities:

- Set-up & initial learning use of laser scanner [May 15–25, 2017]
- Used a NextEngine with ScanStudio Software on a PC laptop
- Thanks to Dr. Helen Kurki for the generous loan of the scanner, software, and PC laptop [running Vista]
- Harvested plant material specimens [May 25 – Aug. 31, 2017]
- Learning, relearning & redoing ongoing [May 15 – Dec 15, 2017]
- 3D scans performed [May 15 – August 31, 2017 ]
- 3D data capture & endless cleaning [May 15 – Dec 15, 2017]
- Took many photographs and screenshots as scan images were captured and manipulated to document process [May – Dec 2017]
- Prepared of a PPT for 3D presentation at DHSI [June 2017]
- Multiple backups to external hard drives [Sept – Dec 2017]
- Published selected scan files via MeshLab [on home iMac] to Sketchfab at <https://sketchfab.com/KathleenUVic/collections>
- Created Data Dictionary Metadata - selected scans [Dec. 2018]
- Uploaded selected scan files to Portage FRDR Demo [Dec. 2017] <https://demo.frdr.ca/repo/handle/doi:10.5072/106.090>
- Backed up all scan files to UVic PC [January –Feb 2018]
- Installed ScanStudio Software on UVic Laptop [6 month trial]
- Organized all photos & screenshots as a potential visual images dataset for a future printed photo album [Jan – February 2018]
- Loaded selected photos and screenshots to Flickr [May 2018]

### ➤ Specimens scanned [May 25, 2017 – August 31, 2017]

- Garry Oak Meadow Plants [several scans of each plant type]
  - Nootka Rose Blossom
  - Nootka Rose Leaf
  - Camas Blossom
  - Camas Seed Pod
  - Buttercup Blossom
  - Mountain Sneezeweed Blossom
  - Oak Leaf
  - Wild Garlic Umbel
  - Yarrow Umbel
  - Woolly Sunflower Blossom
  - Blackberries [invasive]
- Garden Plants [several scans of each plant type]
  - Pansy Flower
  - Wallflower blossoms
  - Pink blossom
  - Lily Flower
  - Honeysuckle Leaf & Flower

- Buttercup Flower
- Nasturtium Flower [several]
- Rose Flower
- Sweet Pea Flower
- Rhododendron Flower
- Cedar branch

➤ **NextEngine ScanStudio File Types Created**

- .scn
- .jpg
- .obj [Originally uploaded to MeshLab]
- .ply [Used for final upload to MeshLab & Sketchfab]

➤ **MeshLab File Types Created en route to Sketchfab upload**

- .mlp
- .png

➤ **Sketchfab Collections**

<https://sketchfab.com/KathleenUVic/collections> [63 models uploaded]

- Garry Oak Meadow Plants – Oak Bay, B.C., Canada [18 models]  
<https://sketchfab.com/KathleenUVic/collections/garry-oak-meadow-plants-oak-bay-bc-canada>
- Garden Plants – Oak Bay, B.C. Canada [17 models ]  
<https://sketchfab.com/KathleenUVic/collections/garden-plants-oak-bay-bc-canada>
- Rogue Flower Fusion Sculptures [15 models]  
<https://sketchfab.com/KathleenUVic/collections/rogue-flower-fusion-sculptures>  
NOTE: These models happened because I was using a Fuse function in the software rather than a Volume Merge function. I reprocessed all the original scans once I figured out the problem. I rather like these “fused” models as a form of botanical 3D folk art.
- Temporary Collection [of very fragmented scans] [17 models]  
<https://sketchfab.com/KathleenUVic/collections/rogue-flower-fusion-sculptures>

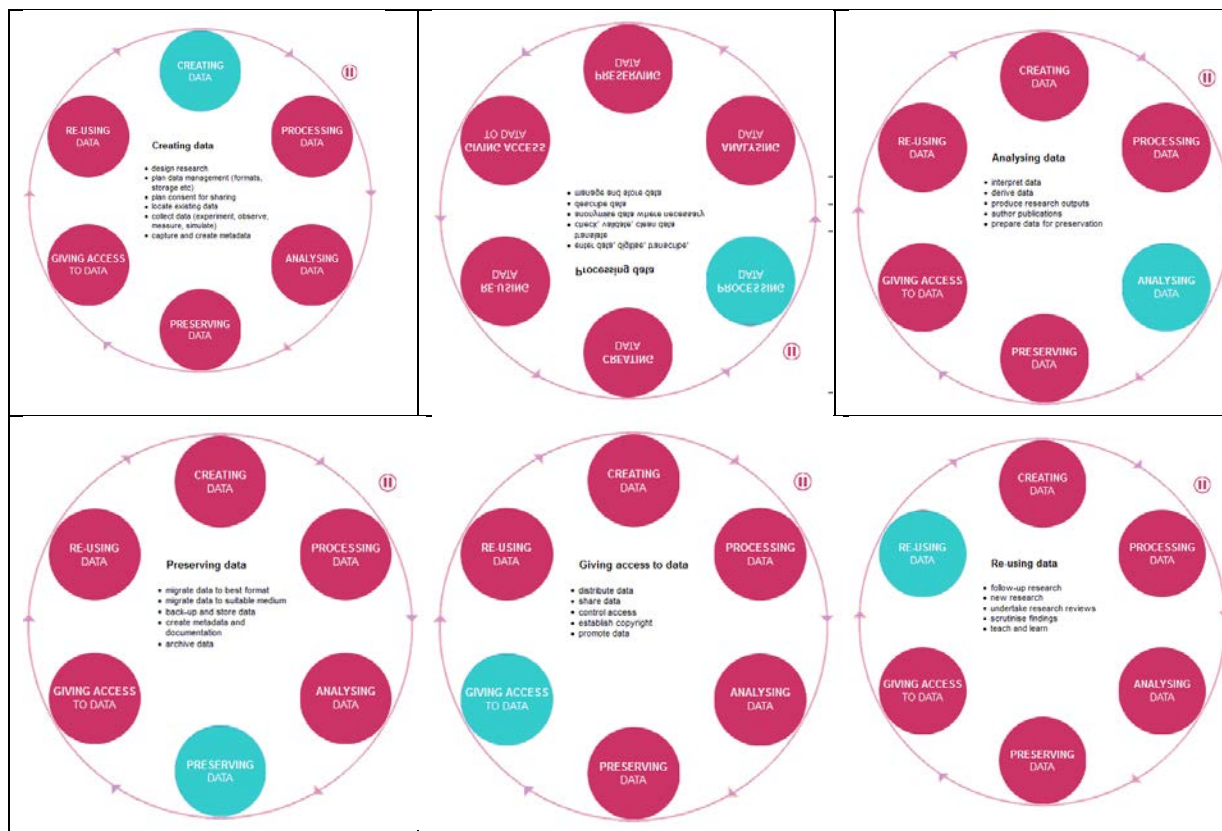
➤ **Downloaded Models from other creators:**

- Natural History Museum favourites [9 models downloaded]  
<https://sketchfab.com/KathleenUVic/collections/nhm-favourites>
- Favourites from other 3D creators [65 models downloaded]  
<https://sketchfab.com/KathleenUVic/collections/favourites-from-other-3d-creators?cursor=48>

- **Dataset file locations and some file counts:**
  - Next Engine Files [on UVic laptop and two hard drives; ]
    - 36,349 Files, 978 folders [includes screenshots]
  - Screenshots of ScanStudio image progressing [on UVic laptop and two hard drives] [3375 screenshots]
  - MeshLab Files [on home iMac and iMac backup]
  - Photographs documenting scan specimens & processing [on home iMac & iMac backup]
  - Sketchfab models on the internet [63 models uploaded]
  - Next Engine .ply files uploaded via Globus as FRDR Demo dataset [search FRDR demo for 3D and Garry Oak]
  
- **Permissions**
  - Permission was granted by Oak Bay Parks allowing me to collect flower specimens of non-rare Garry Oak Meadow plants

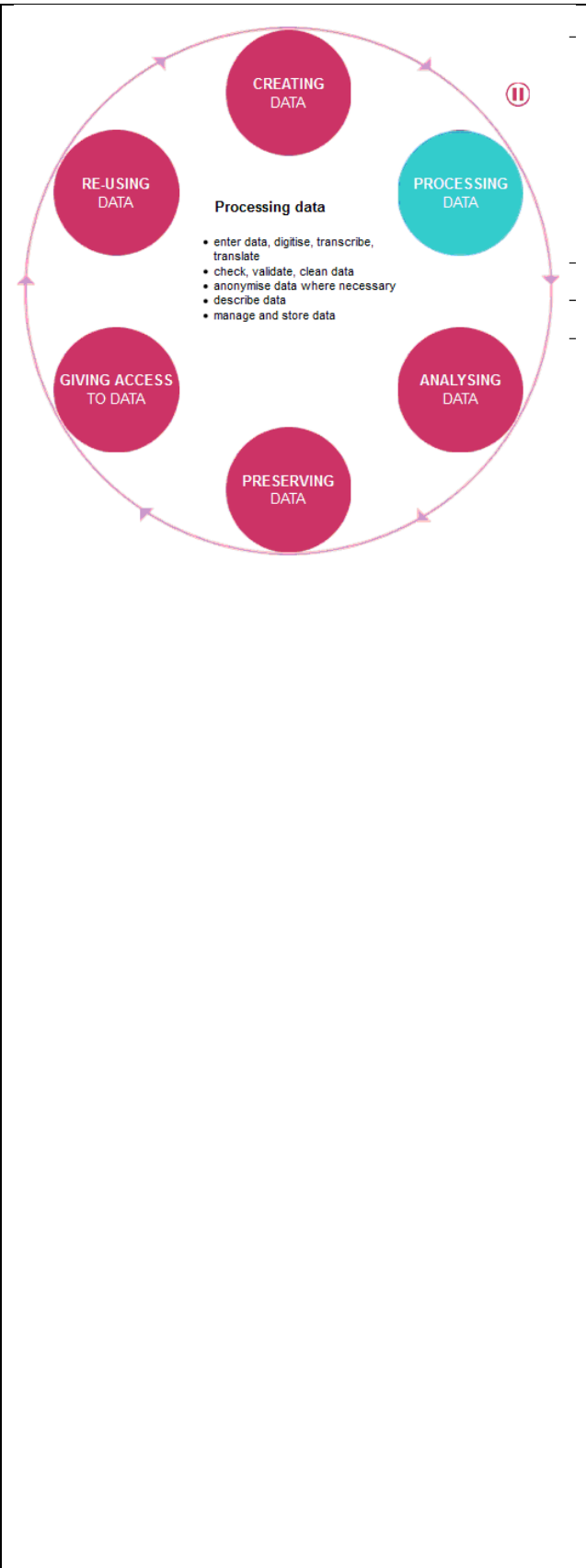
## 3D Scanning Project – Outcomes & Reflections

One goal of the 3D scanning project was to create a dataset with which I could experience the Research Data Life Cycle. Therefore the goals were: To create data. To process data. To analyse data. To preserve data. To give access to data. To re-use data.



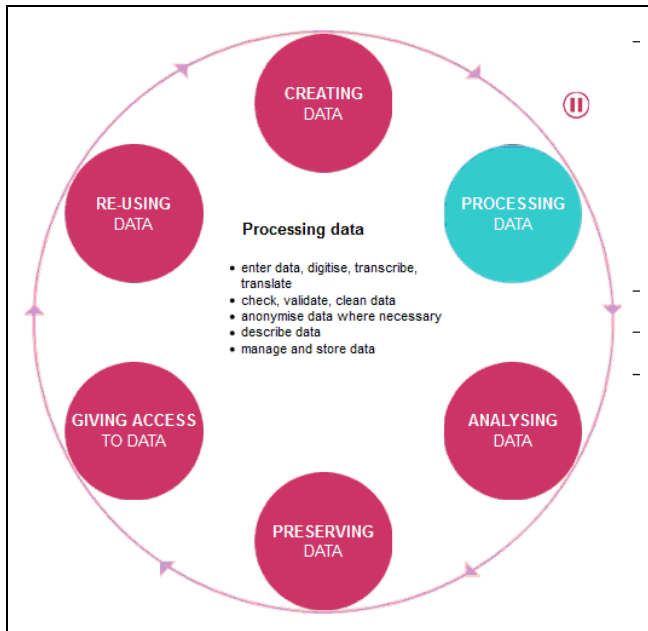
As a reflection, I have to say that I totally enjoyed this Study Leave opportunity to 3D image botanical specimens. I loved watching the images emerging as they were being scanned and then exploring them [rotating and zooming] from many 360 perspectives on the ScanStudio software, and again, exploring them on MeshLab and Sketchfab. However, only the ScanStudio images remained true colour-wise. I loved looking at the meshes and point clouds, from many 360 orientations. I took many photos and screen shots, not only to document the process, but because I was also captivated by the potential of these 3D images as a form of digital botanical art.

Here is my 3D experience, in more detail, with the Research Data Life Cycle.

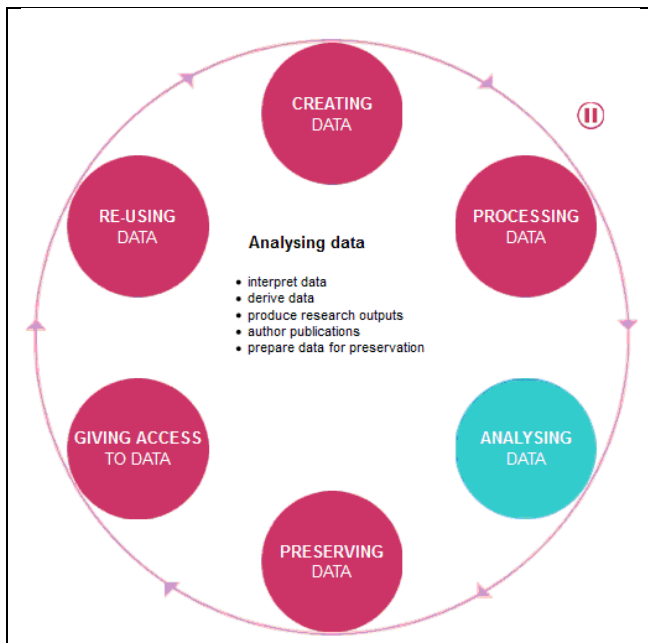


**Creating data:**

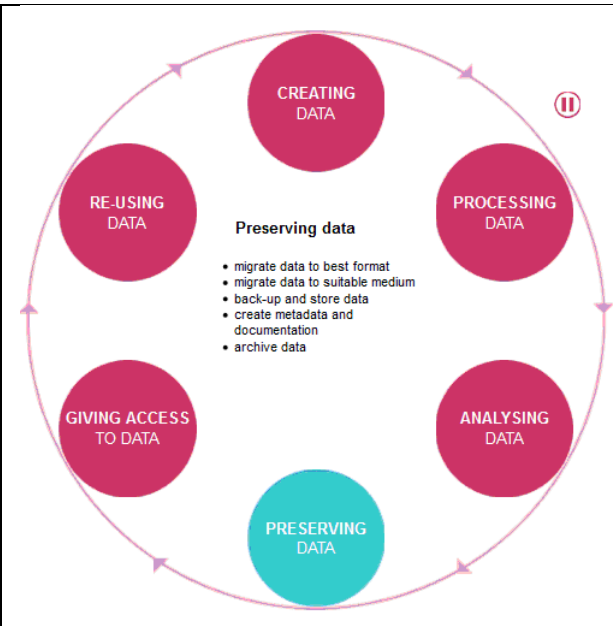
- A Data Management Plan was drafted using DMP Assistant.
- Permission was obtained from Oak Bay Parks to collect plant specimens.
- The NextEngine scanner was set up and the ScanStudio software explored and learned to a basic functional level.
- A number of data sets (7) were created: 1) The .scn files and associated .jpegs generated by the ScanStudio software along with saved intermediate files. 2) A set of photographs documenting the specimens and each scan as it progressed. A set of screen captures documenting each scan as it progressed. 3) A set of .ply [and .obj/.jpg] files exported from ScanStudio and imported into MeshLab. 5) A set of .png files of the MeshLab version of the models from many of the potential 360 views. 6) A set of models loaded onto Sketchfab. 7) A dataset .ply file corresponding to the Sketchfab models, along with a spreadsheet of metadata that was uploaded to FRDR Demo.
- Photos and screenshots were taken to track the process of each scan. A file naming scheme was developed to clearly identify the specimens and the dates of harvesting and scanning as a preliminary practice of capturing metadata.
- Data was initially stored on the laptop and eventually backed up regularly on two external hard drives.



**Processing data.** The scan data was captured, processed, and reprocessed many times, at many stages along the route to publication of models in Sketchfab and uploading a dataset to FRDR demo. This was part of learning and re-learning the ScanStudio software functionality, and trying and retrying various techniques to get better images. And it was reprocessed again, [a form of data cleaning?] once I realized that .ply files would work better in MeshLab and Sketchfab than the .obj/.jpeg files I had originally exported from ScanStudio.



**Analysing data :** This phase of the project involved reviewing all the scans and selecting a subset for loading into Sketchfab. The selected .ply files were loaded into MeshLab and the models explored and .pgn files captured for many of the potential 360 degree views. Ultimately the MeshLab files were exported to Sketchfab. In some cases the .ply files were imported directly into Sketchfab in those cases where MeshLab did not want to accept the .ply file for some reason. Descriptive data was provided for each model uploaded to Sketchfab. The creation of the .ply files set the stage for creating a dataset for preservation and sharing purposes.



**Preserving data:** All 7 data sets noted in the creating data phase were backed up on hard drives. The .ply corresponding to the Gary Oak Meadow 3D models that had been loaded to Sketchfab files were prepared as a data set and a spreadsheet of metadata created describing each 3D model in the dataset . This dataset was uploaded to FRDR Demo, and Dublin core metadata was created to describe the dataset. A DOI was generated and an Orcid ID included in the metadata.

<https://demo.frdr.ca/repo/handle/doi:10.5072/106.090>



**Giving access to data:**

Sixty three (63) of my 3D models can be viewed & downloaded from Sketchfab, an open access 3D publishing platform.

<https://sketchfab.com/KathleenUVic/collections>

A subset of my 3D .ply files can be downloaded from FRDR Demo at

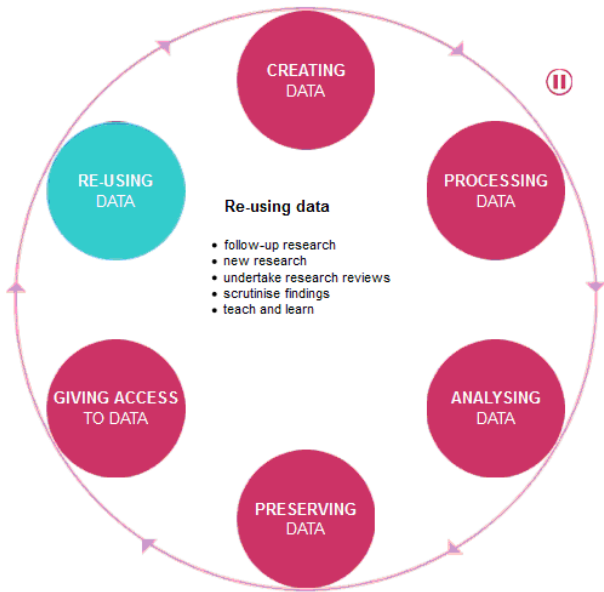
<https://demo.frdr.ca/repo/handle/doi:10.5072/106.090> .

The .ply files uploaded to FRDR Demo are those files used to transfer 3D models from the NextEngine ScanStudio software [via MeshLab] for publication on Sketchfab, specifically, for the *Garry Oak Meadow 3D Collection* at

<https://sketchfab.com/KathleenUVic/collections/garry-oak-meadow-plants-oak-bay-bc-canada>

Citation: Matthews, Kathleen, "Garry Oak Meadow 3D Collection - Selected Flowering Plants," 2017,

<http://dx.doi.org/10.5072/106.090>



**Reusing data:**

Data sets uploaded to FRDR would be discoverable by Google searches. Data sets uploaded to FRDR Demo can be discovered by searching FRDR Demo [search term 3D] at <https://demo.frdr.ca/repo/>

FRDR Demo is a temporary instance of FRDR , but my 3D dataset is anticipated to be secure until September 2018.

FRDR provides a citation and DOI to facilitate tracking reuse.

Citation: Matthews, Kathleen, "Garry Oak Meadow 3D Collection - Selected Flowering Plants," 2017, <http://dx.doi.org/10.5072/106.090>

An ORCID is associated with dataset to also facilitate discovery for the purposes of reuse.

<https://orcid.org/0000-0003-0561-5728>

All my Sketchfab 3D models are discoverable on via Google or direct searching of Sketchfab at <https://sketchfab.com/KathleenUVic/collections>.

To my surprise 4 people have liked two of my 3D Models: the Nootka Rose and the Woolley Sunflower as seen on May 9-2018 at <https://sketchfab.com/feed/activity?feed=activities>

As my Study Leave Report will hopefully be uploaded to UVicSpace, I will explore uploading my 3D Study Leave Dataset to UVic's Dataverse repository.

## 3D – Modelling of Specimen Collections : Photos and Screenshots

KathFusion3D Sketchfab Models:

<https://sketchfab.com/KathleenUVic/collections/rogue-flower-fusion-sculptures>

Nootka Rose 3D May 25-2017 - Photos Documenting original scan and ScanStudio "Fuse" functionality

<https://www.flickr.com/photos/imagerambling/albums/72157696611561655>

Nootka Rose 3D Sept 8-2017 - Screenshots Documenting Reprocessing May 25th Scan with ScanStudio "Volume Merge" functionality

<https://www.flickr.com/photos/imagerambling/albums/72157690840916800>

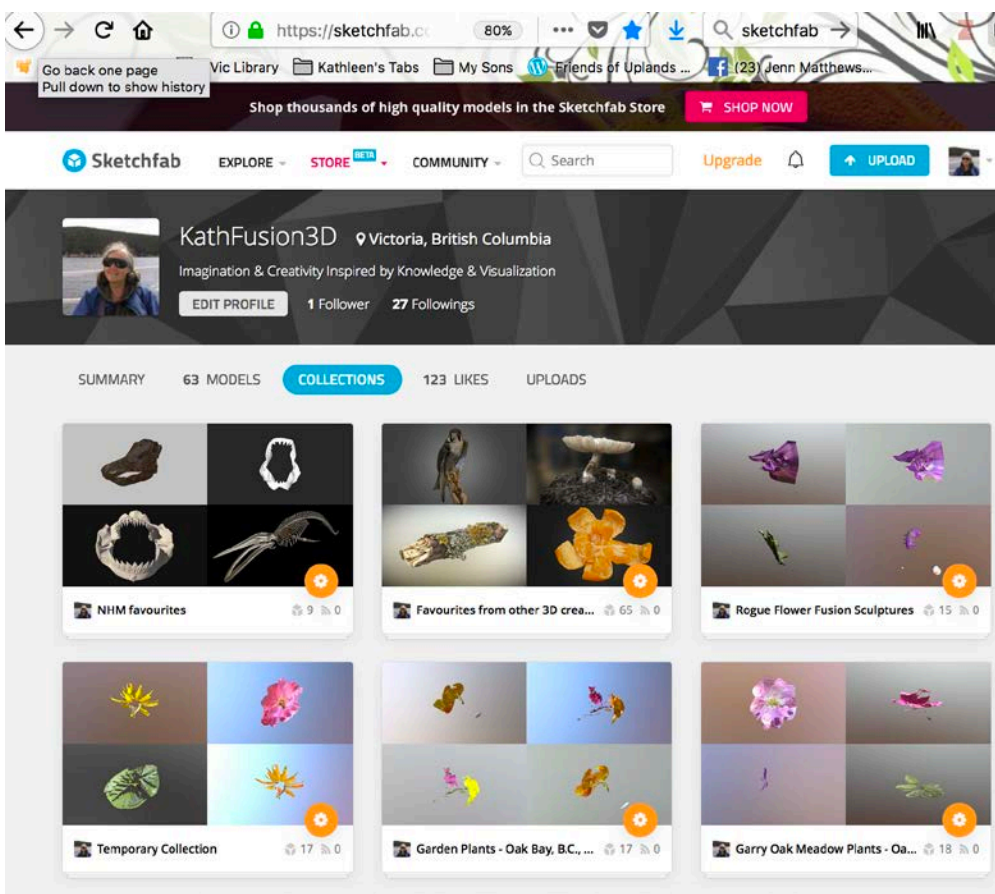
Rogue Flower 3D Fusion Sculptures 3D Botanical Folk Art

<https://www.flickr.com/photos/imagerambling/albums/72157690973488440>

FRDR Dataset - Collection Level Metadata:

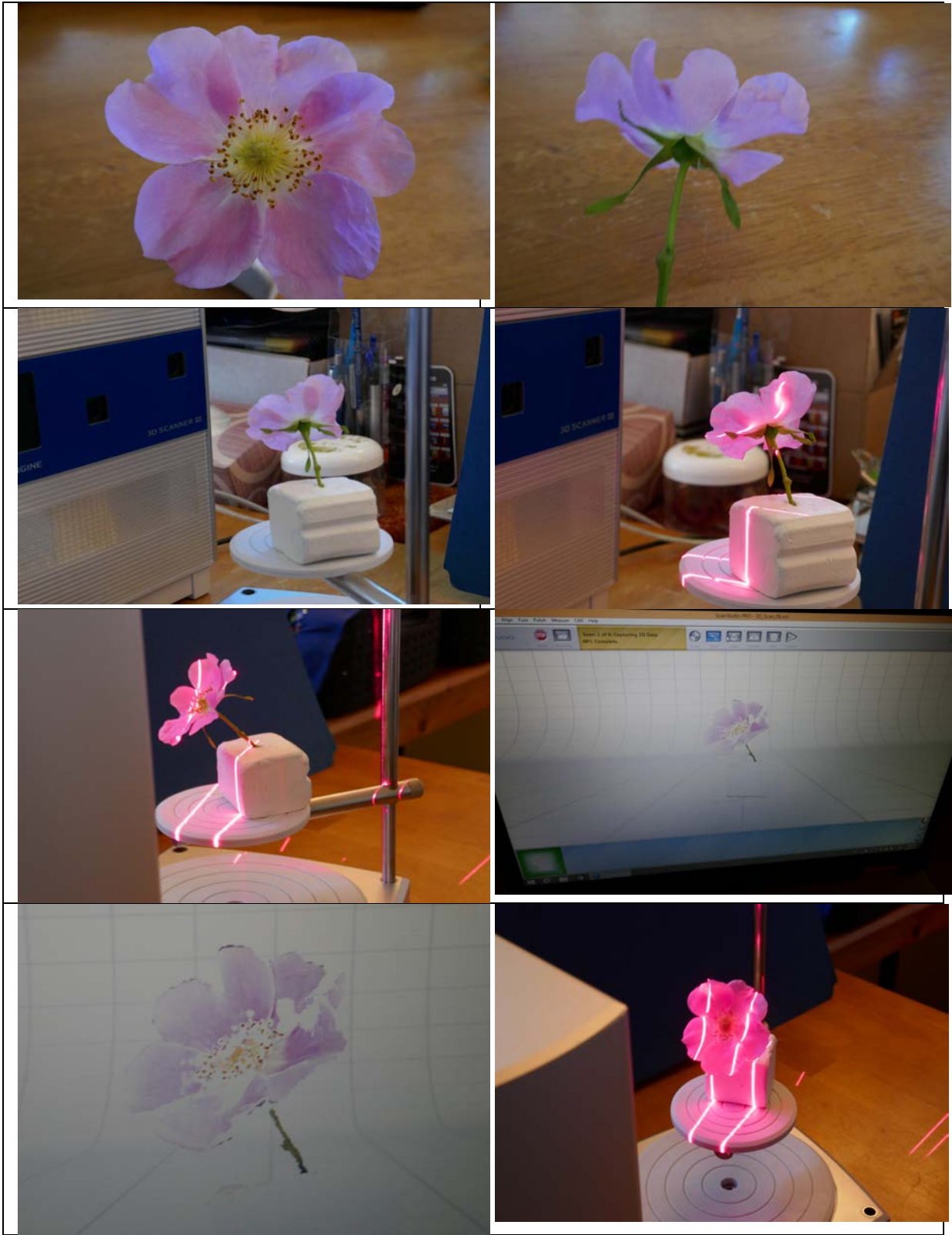
Garry Oak Meadow 3D Collection - Selected Flowering Plants

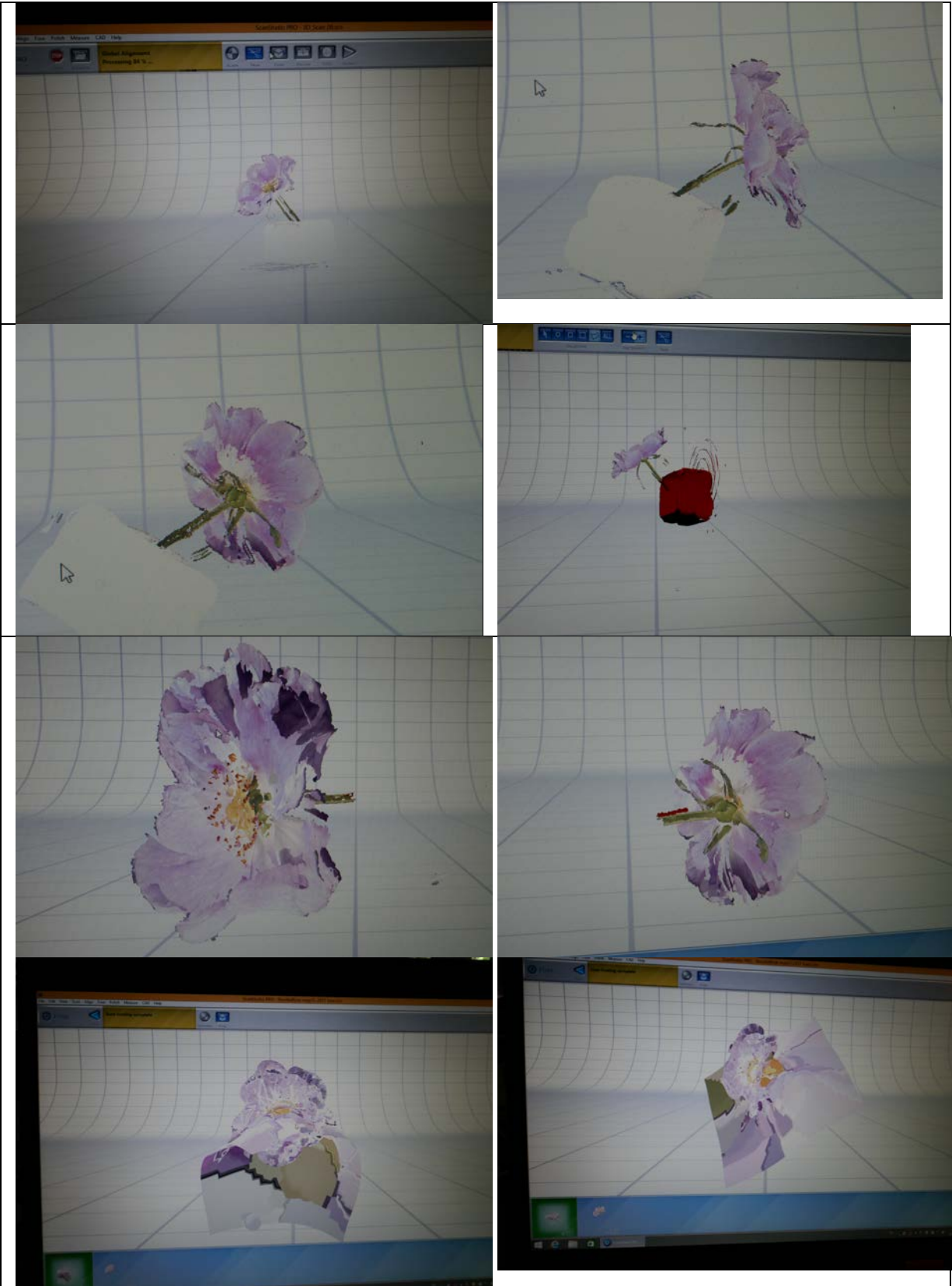
<https://demo.frdr.ca/repo/handle/doi:10.5072/106.090>



**3D Photos Nootka Rose – Blossom Harvested May 25-2017**

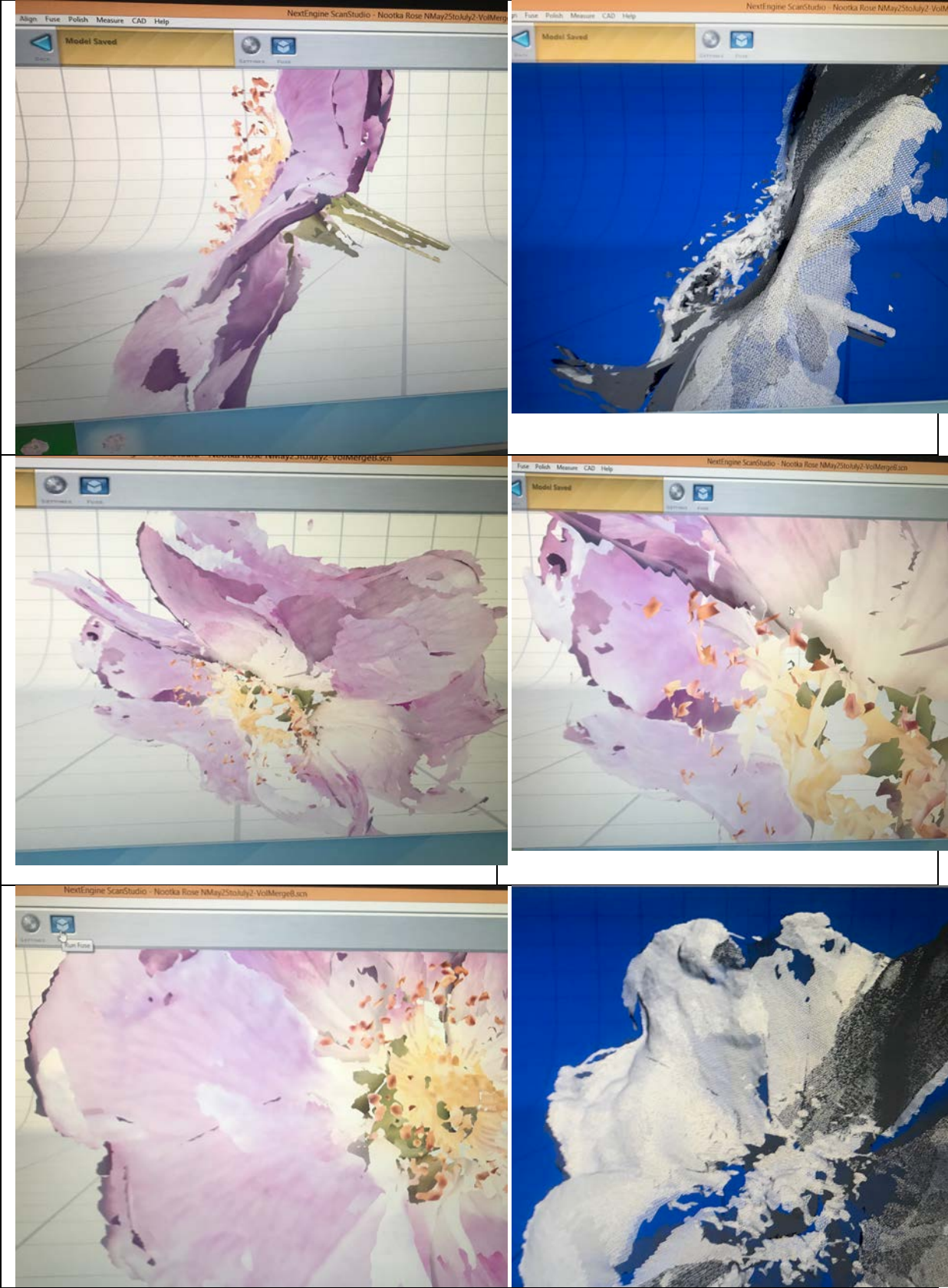
Original scan May 25, 2017. First trial. Fuse problems. [Rogue Flower Fusion Sculptures Created.](#)

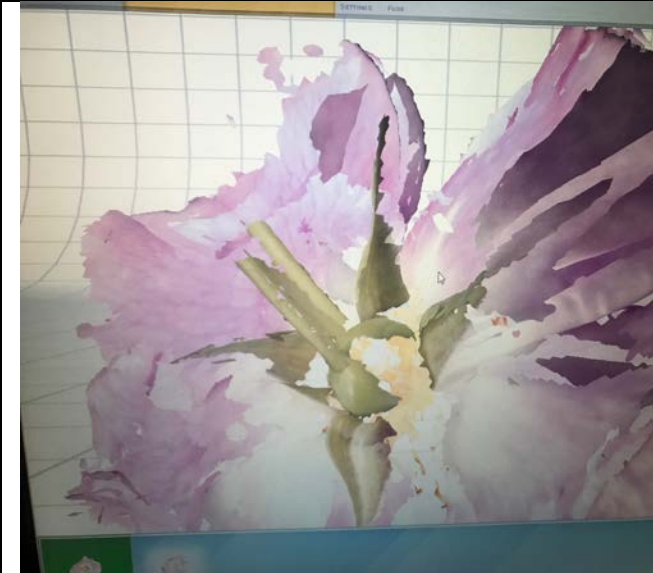
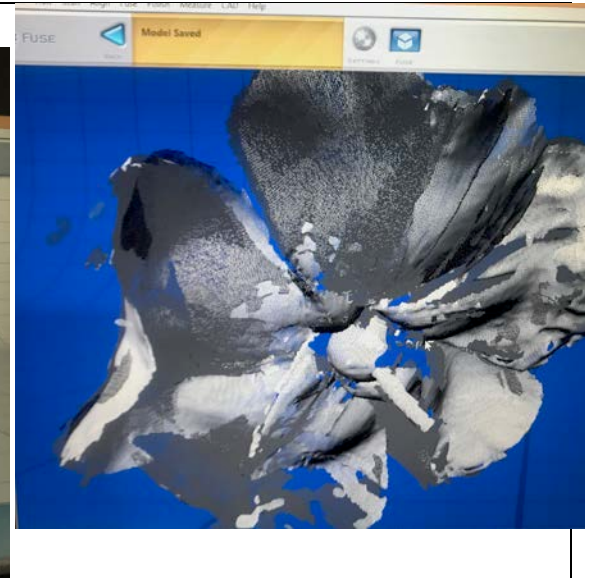
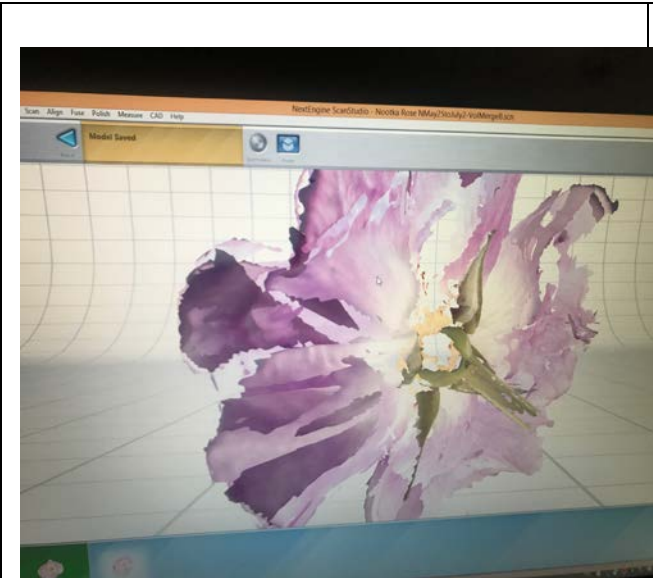




The original scan created a point cloud that extended beyond the blossom, resulting in a fuse that extended beyond the blossom. Eventually discovered Volume Merging as another way to fuse.

3D Screenshots Nootka Rose – May25th Scan VolMerged Sept8-2017





## **Citizen Science in Selected Science Disciplines**

- Overview and Examples
- Hands-On Project: David Suzuki Foundations - Butterflyway Project
- Outcomes & Reflections
- Photos

## Citizen Science – Overview and Examples

My second study leave topic focused on Citizen Scientists and their contribution to research data creation and visualization. A great deal of scholarly literature describes citizen science activities and the documents the research by scientists to ascertain the robustness and validity of the research data collected by citizen scientists. For example:

Caitlin McDonough MacKenzie, Georgia Murray, Richard Primack, Doug Weihrauch, Lessons from citizen science: Assessing volunteer-collected plant phenology data with Mountain Watch, *Biological Conservation*, Volume 208, 2017, Pages 121-126,

<https://doi.org/10.1016/j.biocon.2016.07.027>.

(<http://www.sciencedirect.com/science/article/pii/S0006320716302920>)

*Abstract: Citizen science has the potential to expand the scope of data collection, engage the public in research, and answer big scientific questions. But, the quality of volunteer-collected data is often called into question, and citizen science programs must find ways to assess the validity of this concern. Here, we review five years of volunteer-collected data from an alpine flower monitoring citizen science project and present our efforts to investigate the quality of the volunteer-collected data.*

The web also abounds with Citizen Science news and opportunities. My exploration activity led to a huge number of examples of Citizen Science initiatives, and, as it turned out, based on what I was liking on Facebook and following on Twitter, I found myself focusing most of my exploration on Citizen Science activities in the natural sciences.

In fact, it was via a Facebook post by iDigBio, and subsequently via Twitter, that I learned about the Mark My Bird Citizen Science project at <https://www.markmybird.org/>. This Citizen Science project, is the result of a 3D collaboration of the University of Sheffield and the NHM, London, featuring 3D bird beaks and skulls. This inspired me to contact the NHM to see if I might visit them and learn more about their 3D imaging program, their Citizen Science initiatives, and also their Artists in Residence activities.

On my return, from my visit to the NHM, I signed on to the Project Plumage project at <https://www.zooniverse.org/projects/ghthomas/project-plumage> and tried my hand at measuring the diversity of bird colouration.

<https://www.zooniverse.org/projects/ghthomas/project-plumage/about/research>

Not a day went by during my Study Leave, when Facebook and Twitter did not keep me tuned into Citizen Science events, new projects, new apps for Citizen Scientist, and even news of new scholarly articles. Here are some examples from my explorations:

There are number of Citizen Science Associations around the world:

- **US:** <http://citizenscience.org>
- **Europe:** <https://ecsa.citizen-science.net/>
- **Australia:** <https://csna.gaiaresources.com.au/>

There is a Citizen Science journal and Special Issues :

- *Citizen Science: Theory and Practice*  
<https://theoryandpractice.citizenscienceassociation.org/>
- PLOS One, is one of many publishers highlighting Citizen Science research  
[http://journals.plos.org.ezproxy.library.uvic.ca/plosone/browse/citizen\\_science](http://journals.plos.org.ezproxy.library.uvic.ca/plosone/browse/citizen_science)

Citizen Science Conferences are held.

- CitSci2017  
<http://citizenscience.org/association/conferences/citsci2017/>
- In 2016, Arizona State University hosted a Citizen Science Maker Summit .  
“*designed to explore the crossroads of citizen science and the maker movement*”.  
<https://makersummit.asu.edu/>. Videos of the sessions are posted and A report recently published at  
<https://www.dropbox.com/s/2icsb1pd5eqf7os/ASU%20Citizen%20Science%20Maker%20Summit%20report.pdf?dl=0>

A number of web site sites announce Citizen Science events and activities:

- Citizen Science Events are posted on SciStarter  
<https://scistarter.com/events>
- The European Citizen Science Association posts events at  
<https://ecsa.citizen-science.net/events>
- A Citizen Science Day is promoted and celebrated  
<http://citizenscience.org/events/citizen-science-day/>..  
This year Citizen Science Day coincided with March for Science Day April 14, 2018.
- Citizen Science Projects are featured on Zooniverse at  
<https://www.zooniverse.org/projects>
- eBird, a project of the Cornell Lab of ornithology, has long engaged volunteers, now called Citizen Scientists, in bird monitoring projects. <https://ebird.org/home>
- NASA has many Citizen Science projects related to the Eclipse  
<https://eclipse2017.nasa.gov/citizen-science>

Tweets & Facebook posts engage Citizen Scientists & attract new Citizen Scientists:

- Citizen Science at the Natural Museum @NHM CitSci  
[https://twitter.com/NHM\\_CitSci](https://twitter.com/NHM_CitSci)  
“*Tweets from the #CitizenScience team at @NHM London, help you explore nature & get involved in real science!*”
- Phytoplankton - Citizen Science Program [Strait of Georgia]  
<https://www.facebook.com/CitizenSciencePhytoplankton/>
- European Citizen Science Association  
<https://www.facebook.com/ECSAcommunity/>
- iDigBio  
<https://www.facebook.com/iDigBio/>
- Kew Gardens and the Open Air Laboratories [OPAL]  
<https://www.opalexplorenature.org/OPALconference2016>  
<https://www.kew.org/blogs/kew-science/the-lost-and-found-fungi-project>

Apps are also available for Citizen Scientists, for example:

- My iNaturalists observations are posted at [https://www.inaturalist.org/observations/kath\\_uplandspark](https://www.inaturalist.org/observations/kath_uplandspark)
- Library and Archives Canada Co-Lab Initiative
  - <http://co-lab.bac-lac.gc.ca/eng>

Victoria BC initiatives in Citizen Science

- Habitat Acquisition Trust ‘volunteer/citizen science’ opportunities <https://www.hat.bc.ca/>. A recent call for help with local Western Screech Owls announced via a TC article on February 11, 2018
- UVic Celebrates Citizen Science Initiatives: <https://www.uvic.ca/ideafest/>
- Whither plastic? Nurdles and plastics on Victoria beaches
- <https://www.uvic.ca/ideafest/events/events/librchemgeog.html>
- Dr. Jay Cullen invites Citizen Scientists to help collect data on contamination levels from Fukushima
  - <https://www.uvic.ca/communicationsmarketing/about/news/2017+fukushima-inform-update+media-release>
- RBCM Works with Citizen Scientists
  - <http://staff.royalbcmuseum.bc.ca/2013/08/01/citizen-science/>
- Victoria Butterflyway Citizen Science Project hosted by the David Suzuki Foundation
  - <https://david Suzuki.org/take-action/act-locally/butterflyway/> [scroll down]
- Jackson, M. M., Gergel, S. E., and Martin, K. (2015). Citizen science and field survey observations provide comparable results for mapping Vancouver Island white-tailed Ptarmigan distributions. *Biological Conservation* **181**, 162–172. <https://www-sciencedirect-com.ezproxy.library.uvic.ca/science/article/pii/S0006320714004352?via%3Dihub>
- Grad blends passion for conservation with community-based citizen science <https://www.uvic.ca/news/topics/2017+convocation-fall-science-korolyk+ring>

A Citizen Science List of References and Resources is found in Appendix E.

As noted above, in September 2017, I had the opportunity to meet with staff at the NHM and learn about their Citizen Science initiatives. <http://www.nhm.ac.uk/take-part/citizen-science.html>

In September 2017, I also visited Kew Gardens and learned about the Citizen Science Project to digitize and transcribe the correspondence of founder Joseph Dalton Hooker. The staff shared with me their transcription protocol which is also found on the project website. <https://www.kew.org/explore-our-collections/correspondence-collections/joseph-hooker-collections/about-the-project/scope-and-content>

In addition to researching and exploring the topic of Citizen Science, I had an opportunity to participate in the David Suzuki Foundation's Canada 150 ButterflyWay Citizen Science Project. This hands-on provided an opportunity to be a "Citizen Scientist", which involved learning about our local butterflies and their native host and nectar plants, learning about citizen science BioBlitzes and use one of the many apps available to support Citizen Scientists, such as iNaturalist, and, sharing my new found knowledge within my local community. As a member of the Butterflyway "Oak Bay" group, a Butterflyway Booth exhibit was created with the goal of encouraging the planting of native plant "Butterfly Corridors". We took our exhibit [handouts, photographs, butterfly puppets] to local events over the spring and summer, and participated in the 2017 Oak Bay Tea Party Parade, for which our group won 2nd prize. The Victoria Butterflyway Project is featured at

<https://davidsuzuki.org/take-action/act-locally/butterflyway/> [scroll down]

**To conclude this “overview”, perhaps it is appropriate to offer some definitions of Citizen Science as a way of tracking the evolution of Citizen Science over time.**

**From 2009:**

Bonney, R., Cooper, C. B., Dickinson, J., Kelling, S., Phillips, T., Rosenberg, K. V., and Shirk, J. (2009). Citizen science: a developing tool for expanding science knowledge and scientific literacy. *Bioscience* 59, 977–984. <https://doi-org.ezproxy.library.uvic.ca/10.1525/bio.2009.59.11.9>

*Citizen science enlists the public in collecting large quantities of data across an array of habitats and locations over long spans of time. Citizen science projects have been remarkably successful in advancing scientific knowledge, and contributions from citizen scientists now provide a vast quantity of data about species occurrence and distribution around the world. Most citizen science projects also strive to help participants learn about the organisms they are observing and to experience the process by which scientific investigations are conducted. Developing and implementing public data-collection projects that yield both scientific and educational outcomes requires significant effort. This article describes the model for building and operating citizen science projects that has evolved at the Cornell Lab of Ornithology over the past two decades. We hope that our model will inform the fields of biodiversity monitoring, biological research, and science education while providing a window into the culture of citizen science.*

**From 2015:**

Jordan, R., Crall, A., Gray, S., Phillips, T., and Mellor, D. (2015). Citizen science as a distinct field of inquiry. *Bioscience* 65, 208–211. <https://academic-oup-com.ezproxy.library.uvic.ca/bioscience/article/65/2/208/243853>

*Citizen science has generated enthusiasm among environmental and conservation biologists. Although citizen science-generated data have enabled a number of research questions to be addressed, there is a growing interest in studying the process and outcomes of citizen science. The unifying focus of research on citizen science is the discovery of the socioscientific outcomes of expert–nonexpert partnerships that involve collecting authentic*

scientific data. Example areas of study include the modes of participant involvement, how identity in the context of authentic data may differ from that of informal science education, and factors of individual and community learning in the project context. On the basis of the unique development of theoretical ideas, we propose that research on citizen science should be acknowledged as a distinct discipline.

**From 2017:**

Eitzel, M.V. et al. , (2017). Citizen Science Terminology Matters: Exploring Key Terms . Citizen Science: Theory and Practice . 2 ( 1 ) , p . 1 . DOI: <http://doi.org/10.5334/cstp.96>

*Much can be at stake depending on the choice of words used to describe citizen science, because terminology impacts how knowledge is developed. Citizen science is a quickly evolving field that is mobilizing people's involvement in information development, social action and justice, and large-scale information gathering. Currently, a wide variety of terms and expressions are being used to refer to the concept of 'citizen science' and its practitioners. Here, we explore these terms to help provide guidance for the future growth of this field. We do this by reviewing the theoretical, historical, geopolitical, and disciplinary context of citizen science terminology; discussing what citizen science is and reviewing related terms; and providing a collection of potential terms and definitions for 'citizen science' and people participating in citizen science projects.*

**SciStarter: What is Citizen Science:** <https://scistarter.com/citizenscience.html>

*Science is our most reliable system of gaining new knowledge and **citizen science** is the public involvement in inquiry and discovery of new scientific knowledge. A citizen science project can involve one person or millions of people collaborating towards a common goal. Typically, public involvement is in data collection, analysis, or reporting. Here are four common features of citizen science practice: (a) anyone can participate, (b) participants use the same protocol so data can be combined and be high quality, (c) data can help real scientists come to real conclusions, and (d) a wide community of scientists and volunteers work together and share data to which the public, as well as scientists, have access. The fields that citizen science advances are diverse: ecology, astronomy, medicine, computer science, statistics, psychology, genetics, engineering and many more. The massive collaborations that can occur through citizen science allow investigations at continental and global scales and across decades—leading to discovery that a single scientist could never achieve on their own. "Amateur science," "crowdsourced science," "volunteer monitoring," and "public participation in scientific research" are also common aliases for citizen science.*

**From Wikipedia: Citizen Science**

[https://en.wikipedia.org/wiki/Citizen\\_science](https://en.wikipedia.org/wiki/Citizen_science)

*Citizen science (CS; also known as community science, crowd science, crowd-sourced science, civic science, volunteer monitoring, or networked science) is [scientific research](#) conducted, in whole or in part, by [amateur](#) (or nonprofessional) [scientists](#).<sup>[1]</sup> Citizen science*

is sometimes described as "public participation in scientific research," [participatory monitoring](#), and [participatory action research](#).<sup>[2]</sup>

### Citizen Science Center: Citizen Science Definition:

<http://www.citizensciencecenter.com/citizen-science-definition/>

One of the most common questions I get when I tell people that I write about citizen science is: can you give me a citizen science definition?

For many years, that wasn't an easy question to answer. For one thing, no one had really settled on a name for the concept. Terms used to refer to the subject have included participatory science, participatory action research, participatory monitoring, civic science, civic scientists, citizen scientists, and even crowdsourced science. Phew! ... [definitions over the years are offered]...

Fast forward to last year, and the concept had become a movement, and the definition had been polished and simplified... at least, outside of academia and according to the Oxford dictionary. In it's June 2014 update, the term citizen science was officially added to the [Oxford Dictionary](#) and defined as:

"scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions."

### Citizen Science: Definition

**WHAT IS CITIZEN SCIENCE?**

Citizen science occurs when ordinary people like you help to conduct real scientific research. By participating in citizen science projects, you can contribute to our understanding of our world and make it a much better place.

You don't have to have an advanced degree to contribute, and it's something you can do in your spare time. Check out a few of the amazing results of citizen science projects below, and learn how you can join in the fun!

**DATA**  
50 million classifications were received by the GalaxyZoo project in its first year, contributed by more than 150,000 people!

**PAPERS**  
More than 60 scientific papers have used Cornell Lab citizen science data collected by bird watchers since 1997.

**DISCOVERIES**  
Foldit players discovered the structure of a protein-cutting enzyme produced by an AIDS-like virus in monkeys...in just three weeks.

**A FEW WAYS YOU CAN PARTICIPATE:**

- Donating money: The easiest way to contribute to a project is to give money via a crowdfunding site like Microzryza or directly to a project, like Monarch Watch.
- Set and forget: Another easy way to be a citizen scientist is to install a program called BGCNC on your computer and let it crunch data while you write your emails.
- Web-based: Way more fun is actually doing the science yourself: you can listen to bat calls at Bat Detective, or sift through ocean images at Seabird Observers.

**WHAT DO I GET OUT OF IT?**

- An education! Learn about your favorite topics in depth while contributing.
- Fun! You never know what you might find.
- A sense of purpose. Online games and reality TV are great for winding down; citizen science projects provide a way to put your spare time to use in a meaningful way.

"There are a lot of smart, educated, thinking people who are not in the tenure track who have a lot to contribute to the world."  
- Jessica Richman, uBiome

FIND OUT MORE AT:  
**WWW.CITIZENSCIENCECENTER.COM**

## Hands-On Project: David Suzuki Foundation - Butterflyway Project

- Citizen Science Participant in the David Suzuki Victoria ButterflyWay Project (Spring 2017)  
<https://davidsuzuki.org/take-action/act-locally/butterflyway/>  
<https://davidsuzuki.org/take-action/act-locally/butterflyway/victoria/>

*The Butterflyway Project is a citizen-led movement that is growing highways of habitat for bees and butterflies through neighbourhoods in communities across Canada. Butterflyway Rangers in Victoria, B.C., planted more than 10 pollinator gardens in the city, at private residences, public parks, and schools and hospitals. The Victoria Rangers built a bicycle-propelled flower buggy as a mobile pollinator classroom. This garnered much interest from young and old alike, inspiring many to plant their own pollinator gardens! The Victoria Rangers also employed art and creativity, building giant butterfly puppets and a butterflyway float to help teach people what they can do to support pollinators. They joined the Oak Bay Tea Party Parade and won second prize! Pollinator education and habitat restoration continues in Victoria, as one of our Rangers was awarded a municipal grant to build pollinator gardens throughout the Fernwood area, and to run pollinator education programs for local elementary students.*

- Integrating the Citizen Science Butterflyway Project with my Study Leave:
  - A call for participants went out from the David Suzuki Foundation in February, 2017.
    - Time Colonist article: February 15, 2017  
*Butterfly rangers to wing it in effort to boost insects*  
<http://www.timescolonist.com/news/local/butterfly-rangers-to-wing-it-in-effort-to-boost-insects-1.9978635>
  - I submitted my expression interest, given that one of my Study Leave topics focused on Citizen Science and this offered an opportunity to participate in a Citizen Science Project.
  - Thirty [30] volunteers were selected from more than 100+ interested citizens. Training in Victoria took place in March 2017 on a weekend.
  - The Victoria Butterflyway “Citizen Scientist” Rangers were organized into community/neighbourhood based sub-groups.
  - I was part of the Oak Bay/Fairfield sub-group and we had a joint interest in educating our communities about local butterflies. In addition to helping create Butterflyway corridors in our neighbourhoods, the idea of a Butterflyway Booth that could be taken to community events emerged.
  - My neighbourhood Butterflyway corridor garden was planted in my front yard and in pots on my back deck, by May 11, 2017. By now I had learned quite a lot about local butterflies and their native host and nectar plants and felt better prepared to delve deeper into my Citizen Science Study Leave “research” explorations.

- Developing the Butterflyway booth took place on weekends and evenings throughout April 2017. Several in person meetings and many emails.
  - Events where we took our Butterflyway Booth took place on evenings and weekends, around Oak Bay, Fernwood, and Oaklands, starting the end of April through to mid-August
  - Researching the Citizen Science literature [via social media postings and academic literature searches] took place during my study leave weekdays and continues to this day.
  - Learning about and exploring the various online tools and apps available for Citizen Scientists took place during my study leave work days and continues to this day.
  - I took many photos of our Butterflyway booth at various events and posted many photos to the Butterflyway Facebook pages.
  - I arranged meetings with staff members at the NHM in London and at Kew Gardens to learn about their Citizen Science Initiatives. [September 2018]
  - I contributed my photos of butterflies I had seen in Oak Bay, Montreal, and Oslo, Norway, to iNaturalist, an app used by Citizen Scientists, to document observations. <https://www.inaturalist.org/home> at kath\_uplandspark
- Butterflyway Booth Design & Construction:
- Photos are on the Victoria Butterflyway Facebook pages at Victoria Butterfly Rangers 2017  
<https://www.facebook.com/groups/1774825862835534/>
  - Photos also on Butterflyway Victoria [Open to the Public]  
<https://www.facebook.com/groups/1671155883178345/>
  - Butterflyway Booth Objectives:
    - To function as a transportable display/exhibit that could be taken to events around Victoria to educate Victoria about local native butterflies, their native host and nectar plants.
    - The first step was for the “Rangers” to learn about local butterflies and their local host and nectar plants
  - Butterflyway Booth components contributed by group members:
    - Paper handouts listing local butterflies and their host and nectar plants [a document provided by Kristen Miskelly]
    - Eventually, after much lobbying by Butterflyway Booth members, about the cost of photocopying hundreds of handouts, the DSF designed a printed new professional style colour handout.
    - Two large fly-able butterfly puppets were created [Pat Reeve]
    - Vancouver Island Butterfly books were on display [KathleenM]
    - A digital PPT was created featuring photos of local butterflies and used for indoor events on a laptop [Kathleen Matthews]
    - Butterfly shaped bubble wands were provided [Kathleen Matthews]
    - Native host and nectar plants were purchased from the Saanich Native Plants and the Swan Lake Native Plant Sale. These plants were displayed at events in April and May and then planted in KM’s garden to help create a Butterflyway Corridor in my neighbourhood.

- A matching type butterfly game was created featuring local butterflies. {Marie}
  - Plugs of Native Plants and “Butterfly” seed packets to give away. [Pam Stonehouse]
  - Framed Art photos of local butterflies. [Pam Stonehouse]
  - A portable backdrop for our Butterflyway Booth. [Pat Reeve]
  - Handouts on pollinators and native plants collected local organizations [Pam Stonehouse]
- Chronology of events featuring the Butterflyway Booth:
- 2017 Victoria BioBlitz [Parks Canada initiative: Canada 150 Bioblitz Program] hosted by GOERT and Friends of Uplands Park Saturday April 22, 2017.
    - <https://friendsofuplandspark.org/2017/04/08/2017-victoria-earth-day-bioblitz-uplands-park-beacon-hill-park-uvic-campus-saturday-april-22-2017/>
    - Photos of ButterflyWay Booth at Uplands Park BioBlitz on April 22 2017 at <https://www.flickr.com/.../imageramb.../albums/72157679698345034>
  - Oak Bay Artists’ Studio Tour Sunday April 23, Noon – 4:30
    - Photos of ButterflyWay Booth at Oak Bay Artist's Studio Tour <https://www.flickr.com/.../imageramb.../albums/72157680909905461>
  - Camas Day Celebration – Uplands Park – Sunday April 30-2017
  - VicWest Fest – Saturday May 6, 2017
  - Spring Fair at Hillcrest Elementary – Friday ,May 12, 5:30 PM
  - Oaklands Street Party, Saturday, May 13, 2017
  - ButterflyWay Seed Capsules taken to Victoria Musical Garden Tour at 10 Mile Point, Saturday May 13, 2018.
  - Oaklands Community Dinner – Sunday May 28, 2017
  - Oak Bay Tea Party Parade – Saturday June 3, 2017. Butterflyway group wins 2<sup>nd</sup> prize!
    - Here is a link to the full parade, start watching for The Butterflyway Project around 20:42 <https://www.youtube.com/watch?v=IM4CPopj6ll>
    - Victoria Butterflyway group photo from the Oak Bay Tea Party is featured as Cover-photo on the national Butterflyway Project Facebook page. [https://www.facebook.com/ButterflywayProject/?ref=br\\_rs](https://www.facebook.com/ButterflywayProject/?ref=br_rs)
  - Elk Lake Breezy Breathtaking Butterflies – Guided Walk – Sunday June 18, 2017.
  - Oaklands Community Market – July 5, 2017.
    - <https://www.facebook.com/media/set/?set=oa.1850191881965598&type=3>
  - Bowker Creek Brush Up – Art Show – Sunday August 13-2017

- I participated in one VNHS monthly butterfly walk (Sunday, Sept 3). Camosun Association Community Fall Fair September 15-2018 [I was en route to Montreal on Sept 15.]
- Cedar Hill Park's 50<sup>th</sup> Anniversary – Saturday Sept 23-2018 [I was in Montreal]
- Victoria Butterflyway Wrap up event – October 22, 2017 [I was still away until Oct 24<sup>th</sup>]

## **Citizen Science Outcomes & Reflections**

As noted earlier regarding my participation in the Butterflyway Project: This project was not explicitly identified in my Study Leave Proposal back in November 2016, as I did not know anything about this project at the time. I put my name in for consideration, to the David Suzuki Foundation, early in 2017 and was one of 30 people selected for training. The training was over a weekend in March. The Butterflyway Booth exhibit was actually put together in April and our first three events took place on weekends at the end of April and early in May. It was only after I started researching Citizen Science that I realized I was actually participating in a Citizen Science project. And the David Suzuki Foundation also had started to characterize this project, on its web site, as a Citizen Science activity. Most of the Butterflyway Booth exhibit events took place on weekends and evenings off and on through to mid-August. I missed the Fall exhibit events as I was away by then. It was an interesting project and exposed me to the iNaturalist app and BioBlitzes and the various protocols, and social media based communication strategies, and best practices that are emerging in the maturing Citizen Science culture.

Being able to be actively "doing" provided invaluable context that both informed and guided the research exploration. Although the time commitment on the ButterflyWay Project was not as intense after the April-May time period, when we were building the exhibit and fine tuning and enhancing, I wanted to include this in my Study Leave reporting because it did provide me an opportunity to actually experience and participate in a local Victoria based Citizen Science Project. And, when I talked with the staff and the NHM and at Kew Gardens, about their Citizen Science initiatives, because of my active participation in the Butterflyway Project, their descriptions resonated with my experience. I also experienced Citizen Science as an effective way of learning for myself, and as a form of knowledge mobilization in the sciences. I was very pleased to be engaged in Community as a Citizen Scientist. I shared my new found local butterfly knowledge with hundreds of local citizens and enjoyed working with the other Butterflyway "Rangers".

This hands-on project also ensured my Study Leave was not an isolating experience of home based internet research.

## Citizen Science Photos

Study Leave Report Butterflyway Photos: Photos Documenting Citizen Science Activities  
March 2017 - October 2017

<https://www.flickr.com/photos/imagerambling/albums/72157690840330730>

ButterflyWay Booth Launch - Earth Day BioBlitz - Uplands Park - April 22-2017

<https://www.flickr.com/photos/imagerambling/albums/72157679698345034>

ButterflyWay Booth - Oak Bay Art Studio Tour - April 23-2017.

<https://www.flickr.com/photos/imagerambling/albums/72157680909905461>

[Butterflyway Victoria](#) Facebook page [public group]

<https://www.facebook.com/groups/1671155883178345/>

Victoria Butterfly Rangers Facebook page [closed group]

<https://www.facebook.com/groups/1774825862835534/>

David Suzuki Butterflyway Project

<https://davidsuzuki.org/take-action/act-locally/butterflyway/>

<https://davidsuzuki.org/take-action/act-locally/butterflyway/victoria/>

# PHOTOS : Butterflyway Citizen Science Project : Knowledge Mobilization via Art

## Photos on David Suzuki Foundation Web pages



### About the Victoria Butterflyway

In March 2017, two dozen Victoria residents were recruited and trained as Butterflyway Rangers. Since then, these keen volunteers have planted pollinator patches across the city and have participated in numerous community events, including the Oak Day Tea Party Parade, where their butterfly-themed costumes and bag-trailer garden won second prize!



### CHECK OUT THE BUTTERFLYWAYS



In March 2017, two dozen Victoria residents were recruited and trained as Butterflyway Rangers. Since then, these keen volunteers have planted pollinator patches across the city and have participated in numerous community events, including the Oak Day Tea Party Parade, where their butterfly-themed costumes and bag-trailer garden won second prize!



**Butterflyway Booth at Uplands Park BioBlitz – April 2017**



**Butterflyway Puppets at Oaklands Night Market – July 2017**



**Butterflyway Booth at Bowker Creek Brush Up – August 2017**  
[note 2<sup>nd</sup> prize ribbon from Oak Bay Tea Party parade]



**Butterflyway Citizen Scientists at Oak Bay Tea Party Parade – June 2017**  
[aka Butterflyway “Rangers”, winning 2<sup>d</sup> prize for parade entry]



**“Big Blue” flyable puppet – modeled after Western Spring Azure Butterfly**



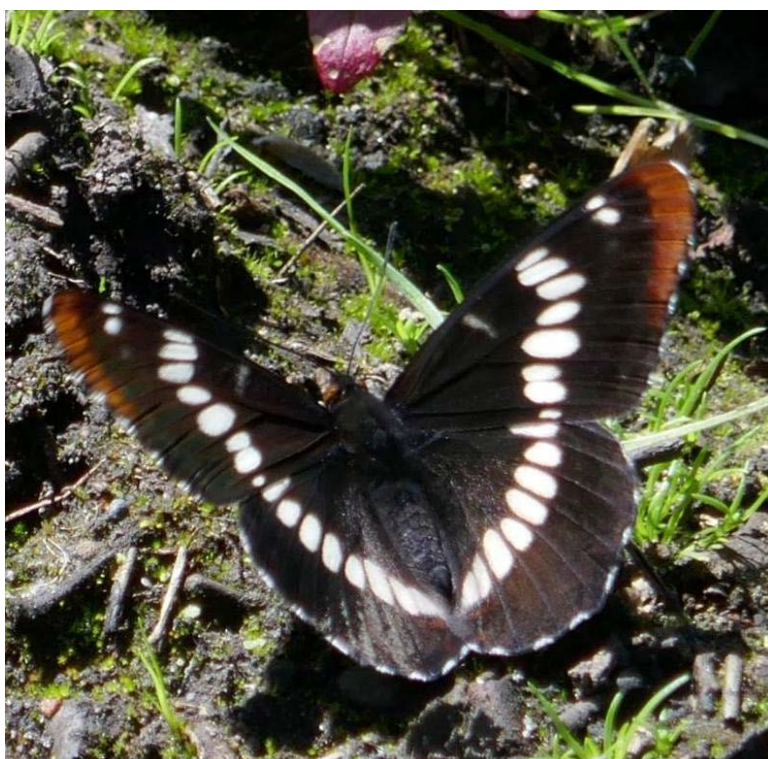
**Photo Western Spring [echo] Azure Butterfly in Uplands Park – Kathleen’s photo**



**“Dude” flyable puppet - modeled after Lorquins’ Admiral Butterfly**



**Lorquin’s Admiral in Uplands Park - Kathleen’s Photo**



## **Science Data Visualization by Artists**

- Overview and Highlights
- Hands-On Projects:
  - Art Visualization - Local Butterflies - WaterMedia by Kathleen
  - 3D Rogue Flower 3D Fusion Sculptures
- Outcomes & Reflections
- Photos

## Science Data Visualization by Artists – Overview and Highlights

The third study leave topic focused on the intersection of art and science, specifically art created to present scientific research data to the public, as a form of knowledge mobilization. This topic was the most challenging topic to explore and to narrow down. A visit to any Natural History Museum will reveal the long and vast history of the intersection between art and science: scientists as artists [Leonardo da Vinci, for example]. In addition to all the print based and physical artistic representations inspired by science data, the new digital and virtual reality representations and exhibits, present an exploding creative environment for science data visualizations.

My initial idea was to focus on artistic collaborations between research scientists and visual artists for the purpose of communicating their research data findings to the general public. An article in the online Hakai Magazine, published August 22, 2016, inspired this Study Leave Topic. Raina Delise’s article, *Amplifying Data Through Art*, presents 5 artists who “make meaning out of science by translating hard data from the world’s oceans” and are “turning on lights, helping us look at scientific data differently”. Here are the opening paragraphs from this article:

*For the armchair scientist, looking at histograms, scatter plots, and probability distributions is like trying to read Beowulf in Old English. You know it’s important and you desperately want to understand, but it isn’t easy. With challenges such as overfishing, ocean acidification, and sea level rise rapidly changing our marine environments, it’s more important than ever to help people understand—and care about—what’s going on. To this end, artists are working with scientific data and translating complex concepts and new findings into visually stimulating, thought-provoking works—similar to what director Robert Zemeckis did with his cinematic spin on Beowulf.*

*The idea that art can be the catalyst to spur curiosity in science and promote greater awareness is gaining traction—some research and exploration vessels are taking on “artists-at-sea,” while academic and arts initiatives are pairing the right-brained with the left-brained for cross-pollination. When Philadelphia-based artist [Rebecca Rutstein](#) was aboard the exploration vessel [Nautilus](#) last year, expedition leader [Robert Ballard](#) made an apt analogy she won’t soon forget: exploring the deep ocean is like standing on the edge of the Grand Canyon in the dark. The artist can turn the light on. “I see art making the invisible visible and communicating scientific ideas in a visceral way that can reach a broader audience,” says Rutstein, adding that her data-driven work seeks to evoke wonder and excitement about ocean exploration.*

*The full article, with beautiful images of the art, can be accessed at [https://www.hakaimagazine.com/article-short/amplifying-data-through-art/?utm\\_source=Hakai+Magazine+Weekly&utm\\_campaign=3ec5e83ca9-Newsletter+Aug+26+2016&utm\\_medium=email&utm\\_term=0\\_0fc1967411-3ec5e83ca9-89419917](https://www.hakaimagazine.com/article-short/amplifying-data-through-art/?utm_source=Hakai+Magazine+Weekly&utm_campaign=3ec5e83ca9-Newsletter+Aug+26+2016&utm_medium=email&utm_term=0_0fc1967411-3ec5e83ca9-89419917)*

As I explored this topic, I was introduced to a new word: “Artivism” where art has often played a central role in activism. I was introduced to this concept at the *Robert Bateman Lecture with Dr. Briony Penn*, held at Royal Rhodes on August 8, 2017. The title of the lecture was “*Artivism: Imagination and Intuition on the Front Lines.*” Briony is both a Scientist and an Artist, who has effectively and beautifully translated scientific concepts derived from ecology and environmental “data” into art. As stated on the web page announcing this lecture:

*“Penn is a tireless and passionate advocate for and protector of the natural world. Through words, illustrations and maps, lectures and mentorship, she expresses her deep aesthetic sensibility and belief that there is a more just, sane, biodiverse and possible world by pushing the edges of culture as an art-ivist – informing and inspiring action through creativity and art.”*

The work of the five artists described in Delise’s article can also be said to be engaged in “artivism”.

An example of artivism, that is closer to home, is a Climate Clock, as seen at <https://climateclock.net/>. My son, Damon Matthews, is a climate scientist at Concordia University. He was approached by a David Usher, a multimedia artist, and together they created a multimedia Climate Clock, a musical/graphical creation presenting a climate data countdown. Whereas the original presentation was projected outside, on Earth Day 2016, on the side of the clock tower at Concordia University, this digital multimedia visualization is now hosted online by David Usher at the Human Impact Lab. The “artivism” role of this Lab is explained at <http://www.humanimpactlab.com/> :

*Founded by [David Usher](#), the Human Impact Lab at Concordia University is a creative studio focused on exploring and developing projects and platforms that reimagine how we tell the most important and urgent stories of our time. The Lab works at the intersection of art, technology and data and engages artists, designers, game developers and interactive programmers to visualize solutions to big data social impact problems.*

Posters featuring the Climate Clock graphic, now hang in the Montreal Metro, inviting students to attend Concordia.

A recent March 29-2018 article in the Times Colonist, titled “*When Art Meets Science*” features a work of art by UVic art student Colton Hash: “*an interactive orca sculpture fuses art, ocean data and climate change concerns*”. The article, reposted by UVic Fine Arts explains the art-science integration: from <https://finearts.uvic.ca/research/blog/category/undergrad/>

*While visually appealing, Hash’s sculpture is firmly rooted in science—entirely appropriate, given that he’s also working toward a minor degree in environmental studies. The project data is gathered from the [Canadian Centre for Climate Modelling and Analysis](#), located on the UVic campus. It includes variables such as precipitation,*

*ocean temperatures and ground surface temperatures, all of which impact the health of different aquatic systems. The audio recordings are taken from UVic's [Ocean Networks Canada](#) hydrophone stations in the Salish Sea.*

In reflecting further on this topic of the intersection of art and science and the idea of “artivism”, I will venture to propose that artists, through “artivism”, are also Citizen Scientists. As such, artists are inspired and informed by science, to use art forms to visualize and communicate the findings of scientists. It was through this topic, while exploring examples of the artistic visualizations of research data, that my three study leave topics intersected most fully, and confirmed, in my mind, the role of art as a key contributor to the knowledge mobilization of scientific research.

To illustrate the intersection of art and science data and citizen science, I came across a recent example of the intersection of art and citizen science. In the 2018, March 10-16 print issue of *New Scientist* [page 26-27], to which I subscribe, there is a feature image titled “Eye of the storms”. It is an image of the ammonia, hydrogen and helium storm cloud formations swirling on Jupiter. The original data was captured by the JunoCam from NASA’s Juno spacecraft on December 16, 2017. The image caption reads:

*“To create this image, citizen scientist Kevin Gill processed the camera’s raw data, combining three images representing red, green, and blue, and enhancing the colour.”*

This image, as published in *New Scientist*, [[https://doi.org/10.1016/S0262-4079\(18\)30439-1](https://doi.org/10.1016/S0262-4079(18)30439-1)] will eventually be able to be seen online at UVic, via an EbscoHost database, once the one year embargo has passed. This image is also hosted on Science Direct at <https://www.sciencedirect.com.ezproxy.library.uvic.ca/science/article/pii/S0262407918304391> but behind a pay wall as UVic does not have a current online subscription.

However, after a bit of searching, similar images, rendered by Kevin Gill can be seen at Cal Tech’s Jet Propulsion Laboratory web page, published Jan 12-2018, under the title Jupiter’s Colourful Cloud Belts, at <https://www.jpl.nasa.gov/spaceimages/details.php?id=pia21974>. And also at <https://www.jpl.nasa.gov/spaceimages/details.php?id=pia21984>, published April, 6, 2018, under the title *Intricate Clouds of Jupiter*. And the actual image published in *New Scientist*, is found at <https://www.nasa.gov/image-feature/jpl/pia21978/jupiter-s-swirling-cloud-formations> under the title “*Jupiter’s Swirling Cloud Formations*” .

Well that was a bit of an online diversion as I write this study leave report. I am experiencing my Study Leave to actually have been the first step along a path of exploration. Also, to clarify that this example of citizen science art, came to my attention by serendipity, and to confess, that serendipity brought me to many of the examples of the intersection of art and science that I contemplated.

Other NASA Images of the Day, rendered for publication by NASA artists can be found at <https://www.nasa.gov/multimedia/imagegallery/iotd.html>. A search of the NASA website for “artists” brings up many examples of artists at work on NASA data. A web page at <https://www.nasa.gov/topics/history/features/nasaartfeature.html> from 05.15.09 titled “Artists Give NASA a Different Light”, offers this perspective:

*James Webb garnered tremendous praise for his management acumen as NASA’s administrator during the race to space and the moon. But along with setting a course for a clearly left-brained organization focused on engineering and inventing technology, Webb also gave NASA room for the right-brain to breathe a bit.*

*Photographs show us how human eyes see a space launch, but it takes an artist to show us the different ways the mind sees, feels and reacts to such an event, Dean said in giving Webb credit for recognizing a need for different eyes to chronicle the agency’s exploits.*

*“That’s the beauty of art,” said Bert Ulrich, curator of NASA’s art program. “That it reaches people in different ways. The idea is that art is another way to inspire people.”*

*An artist also could bring something that engineers and managers loathe to admit to: emotion.*

*“Artists are really emotional types who can project themselves into it and really get a lot out of the experience,” Dean said.*

And, another two “personal” examples of Citizen Science Art?

- David Suzuki 2017 Victoria Butterflyway flyable puppets  
<https://davidsuzuki.org/take-action/act-locally/butterflyway/victoria/?nabe=6104812080070656:1>
- Rogue Flower Fusion Sculptures  
Kathleen’s 3D botanical folk art, forged by my initial ignorance of what ScanStudio function to use to “fuse” my 3D scan images  
<https://sketchfab.com/KathleenUVic/collections/rogue-flower-fusion-sculptures>

Having made the point, that my three study leave topics all intersected, I will list some other Art-Science resources demonstrating the intersections of Science and Art that I encountered. In truth, it was clear, early on in my Study Leave, that visualization in the sciences, and specifically the intersection of science and art [digital & non-digital] is a vast topic. I barely scratched the surface. Here are some findings:

- Sci-Art Journals and blogs and a few articles
  - Art and Science Journal, *Where fields collide*  
<http://www.artandsciencejournal.com/>  
*Established in December 2011, Art & Science Journal is a publication based in*

Toronto, Canada. *Art & Science Journal* focuses on artworks concerned with science, nature, and technology. Our mission is to promote, explore, and inspire the wonder that occurs when art and science collide. We strive to be an informative and engaging resource for educators, students, and artscience enthusiasts alike.

- SciArt Magazine

<https://www.sciartmagazine.com/team.html>

*Art and science have long shared a common ground; the ground of boundless inquiry about the nature of our existence. It has only been for the past few decades, however, that artists have turned their creative gaze towards the sciences as their sole source of artistic information, inspiration, and conceptualization. SciArt, or science-based art, is the avant-garde of the art world, with an increasing number of artists who hold doctorate degrees in the sciences, who are funded by the NSF, and who hold artistic residencies in scientific institutions such as CERN*

- CLOT Magazine: A magazine dedicated to Art explorations into Science and Technology

<http://www.clotmag.com/>

***CLOT Magazine** is an online publishing and curational platform dedicated to art and science explorations. We aim to collect, display, broadcast and promote the crossover of Art, Science and Technology.*

- Articles tagged as Art Meets Science/Smithsonian

<https://www.smithsonianmag.com/tag/art-meets-science/>

- Art–science collaborations: Change of perspective, 2016, by Sheila Mulrooney Eldred, *Nature* 537, 125-126. doi:10.1038/nj7618-125a

- Interalia Magazine: An online magazine dedicated to the interactions between the arts, sciences and consciousness.

<https://www.interaliomag.org/about/>

- Artist in Residence in the Sciences & Natural History Museums [as funding permits]:

- Arts at CERN : When Art Meets Science

<https://arts.cern/>

- How Art and Science Collide at the CERN Physics Laboratory

<http://bigthink.com/Picture-This/how-art-and-science-collide-at-the-cern-physics-laboratory>

*“Knowledge is limited,” [Albert Einstein](#) once said, “imagination encircles the world.” A new program at the [CERN](#) physics laboratory, home to the [Large Hadron Collider](#), takes Einstein’s words as their mantra. [Collide@CERN](#) hopes to invite artists of all disciplines to work as artists in residence at the laboratory, where they can both be inspired by the science and inspire the scientists to make new discoveries. While protons collide in the machinery at unimaginable speeds and perhaps reveal some of the secrets of the universe, the artists and scientists will collide in ways that may help make some of those secrets more intelligible to the human imagination. With this initiative, the chasm between the arts and the sciences may finally be bridged.*

- Call for Artist-in-Residence Ocean Program | Fine Arts Research  
<https://finearts.uvic.ca/research/blog/2018/04/04/call-for-artist-in-residence-ocean-program/>  
*The Faculty of Fine Arts and Ocean Networks Canada at the University of Victoria in British Columbia, are sponsoring an Artist in Residence program. The concept strengthens connections between Art and Science to broaden and cross-fertilize perspectives and critical discourse on today's major issues such as the environment, technology, oceans, cultural and biodiversity and healthy communities.*
  - San Diego Natural History Museum Artist in Residence  
<https://www.sdnhm.org/calendar/artist-in-residence/>
  - Carnegie Museum of Natural History  
<http://carnegiemuseumnaturalhistory.tumblr.com/post/148646284477/museum-artist-in-residence>
  - Natural History Museum: An Artist in Residence at Tring  
[https://www.facebook.com/pg/naturalhistorymuseum/photos/?tab=album&album\\_id=10151382687651537](https://www.facebook.com/pg/naturalhistorymuseum/photos/?tab=album&album_id=10151382687651537)
- Twitter abounds with SciArt Tweets
- #SciArt
  - @HistSciArt
  - #BHLib
  - #medicalillustration
  - #paleoart
  - #spaceart
  - #medart
  - #anatomicalart
  - #PhysicsArt
  - #ChemArt
  - #botanicalart
  - #botanical images
  - etc...
- Pinterest - A Social Media Repository for Art Inspired by Science  
<https://www.pinterest.ca>.

In the Spring of 2016, I took an Credit Course at the Vancouver Island School of Art called *Watercolour: Art & Science*. Each week we were assigned homework projects that to be informed by a difference science discipline: Botany; Zoology; Geology; Astronomy; Cell Biology; Mathematics. We were encouraged to look for examples of art inspired by science on Pinterest. The quality of the art was astonishing. One has to only sign up and search.

To wrap up, my visit in September 2016, to the Natural History Museum [NHM], in London, and Kew Gardens, impressed upon me that Natural History Museums are places where Art and Science have always collided. The NHM has a wonderful exhibit called the

“Art of Nature”. See <http://www.nhm.ac.uk/business-services/touring-exhibitions/art-of-nature.html>

*This new exhibition explores the crucial role art has played in building our understanding of the natural world. Inspired by the stories of pioneering artists and naturalists, Art of Nature is a unique opportunity to host fascinating stories of scientific investigation through selected works from the Museum's art collection. Visitors will see drawings, paintings and sketches of nature, spanning from 1700 to the present day. The works expertly combine aesthetic beauty with scientific accuracy. Visitors will discover the importance of illustration in documenting species, gaining an appreciation of how natural history artists' techniques, and how their pieces became increasingly scientifically accurate. As well as finding out how artworks were distributed to the public, visitors will discover how new digital techniques have revolutionised the way we observe and record species, and how despite all this, illustration remains an important means of recording the natural world.*

But, in addition to this specific exhibit, many of the natural science exhibits in the NHM are simply works of art. The grounds at Kew Gardens feature amazing sculptures informed by botanical specimens and Kew's botanical art collections document contemporary and historical botanical art “data sets” from around the world.

The Science Gallery in Dublin has this to say about itself at <https://dublin.sciencegallery.com/about>

#### **WHERE SCIENCE AND ART COLLIDE**

*"It may have 'science' in the title, but each exhibition at the gallery proves it to be the most creative, innovative and artistic venue in Ireland." — The Irish Times*

*Science Gallery Dublin is a world first - a venue where today's white-hot scientific issues are thrashed out and you can have your say. A place where science and art collide.*

In addition to the opportunity during my study leave to meet with staff at both Kew Gardens and the Natural History Museum, to chat about artists who have worked with their scientific collections, from time to time, as funding permits, I also had the opportunity to visit the Hermitage in St. Petersburg, a tour arranged for delegates to the 2017 CoData Conference. The art collections in the Hermitage are a testament to the intersection of art and science.

As I noted at the outset of this section of my study leave report, I barely scratched the surface of the intersection of science and visual art. Everywhere I looked I found art and science colliding: in science journal articles and books, on the covers of science books, in iMAX 3D, in the virtual reality headsets experiences offered at the Natural History Museum and the Hermitage, on Twitter, on Facebook, in an Indigenous Art Exhibit at the Victoria Art Gallery. I tried to capture/document what I could, but, as engaging and exciting as this topic is, it simply has been overwhelming. Artists have always been inspired and informed by science. Selected readings and resources in Appendix F.

## Science Data Visualization by Artists - Hands-On Projects & Photos

In my Study Leave Proposal, I suggested I might attempt a watercolour of a science dataset. I never did do any watercolours during my Study Leave, so I took a course early in 2018 to hopefully fulfil that “deliverable”. Also, I remembered a 2016 watercolour course that actually inspired my interest in the intersection of art and science.

### ➤ **Art Visualization - Local Butterflies - WaterMedia Works by Kathleen**

Perhaps I am going too much on a limb here. In my WaterMedia course [January – April 2018] we were set an assignment of “Deconstruction and Reconstruction”. The idea was to make a watercolour collage by exacto-knifing out watercolour images we had painted in earlier assignments and create new works. The works I chose had featured some of the local butterflies I had learned about in my Butterflyway Citizen Science Project. I offer my newly reconstructed works, as an example of “citizen science” folk art – an artistic representation of selected local butterflies.

For photos documenting this “deconstruction and reconstruction” process, see the Flickr photo album at

<https://www.flickr.com/photos/imagerambling/albums/72157695007981911>

Also included in the above Flickr album are a few watercolour works that I created in 2016, at a watercolour course on Art & Science. Each week we created a watercolour inspired by a science discipline: Geometry, Astronomy, Botany....etc.

### ➤ **3D Rogue Flower 3D Fusion Sculptures**

And perhaps, going out on another limb of offering my work as an example of citizen science folk art, my initial floundering with learning how to use the NextEngine ScanStudio software, generated images that I found beautiful. I have called these Rogue Flower 3D Fusion Sculptures and they can be viewed on Flickr and Sketchfab.

Sketchfab Collection at <https://sketchfab.com/KathleenUVic/collections/rogue-flower-fusion-sculptures>

Flickr collection [with screenshots from ScanStudio & Snapshots from MeshLab] at <https://www.flickr.com/photos/imagerambling/albums/with/72157690973488440>

### ○ Art-Sci Collisions – Visiting NHM, Kew, Dublin’s Science Gallery

#### ○ Natural History Museum – SciArt Exhibits

<https://www.flickr.com/photos/imagerambling/albums/72157693544792972>

#### ○ Kew – Historical Botanical Art & Contemporary Sculpture

<https://www.flickr.com/photos/imagerambling/albums/72157693546653742>

#### ○ Science Gallery Dublin – Contemporary SciArt

<https://www.flickr.com/photos/imagerambling/albums/7215769494688734>

**WaterMedia Art - by Kathleen A Local Victoria Butterfly dataset?**

**Margined White; Western Spring Azure; Mourning Cloak; Western Sulphur; Painted Lady**



**Western Spring Azure in Uplands Park - Photo by Kathleen**



**Lorquin's Admiral -WaterMedia Art Assignment - by Kathleen**



**Lorquin's Admiral in Uplands Park - Photo by Kathleen**



**Butterfly dataset as WaterMedia Art? – Deconstructed & Reconstructed**



## **Science Data Visualizations by Artists: Outcomes & Reflections**

Science is a data driven enterprise. With reference to the research data life cycle, data is created, processed, analyzed, and hopefully will be preserved, accessed and reused.

Scientific data is ultimately used to tell stories. Knowledge mobilization is a priority in academic communities, to engage and inform citizens of research findings.

Given the explosion of scientific research, visualization becomes an essential method by which to communicate, to educate, and to learn. I can argue that visualization has always been central to human knowledge transmission from generation to generation. I have always believed, from my own encounters with Indigenous Art, that within this art, Indigenous Science is encoded and communicated. In Western Science, and long before Leonardo da Vinci, a long tradition of visual art and illustration in the natural sciences, attests to the importance of artists as scientific communicators. For me, based on my visits to NHM and Kew Gardens, I now consider natural history exhibits as works of art. And, every image presented to the public by NASA, of a galaxy or some other celestial phenomena, has been processed by an artist.

Not only are artists inspired and informed by science, but scientists also are encouraged to present their data visualizations, whether in print, or digitally, with good design practices. Digital data visualization tools and apps and courses abound. DataCamp.com, a commercial offering, is one example. Libraries are offering Visualization Workshops. To effectively visualize their data and the knowledge gleaned from their data, I reflect that scientists are engaging in artist-like processes.

The catchwords of “colliding” and “artivism”, as discussed earlier, powerfully convey the compelling and powerful intersection of art and science.

I barely scratched the surface of this proposed study leave topic.

## **Two Conferences, a Workshop & On-Site Visit/Tours - Reflections**

- DHSI - Data Visualization: participation & activities [June 2017]
- RDA Plenary - Sessions on specimen collections [September 2017]
- NHM – Imaging & Analysis Unit Visit [September 2017]
- Kew – Library & Digitization Centre Visit [September 2017]
- CoData Conference – Ocean Sciences Research Data [October 2017]

In support of each of my 3 research topics, I was able to visit the Natural History Museum, and Kew Gardens, in London, where I learned about a number of specimen collection imaging programs and technologies, their citizen scientist and crowd sourcing initiatives, and the long engagement of museums and artists to make visible their research specimen collections. I also attended two conferences focusing on all aspects of Research Data: the Research Data Alliance Plenary and the International CoData conference.

Each of these activities led to deeper reflection regarding the long term preservation and curation of the digital outputs associated with 3D imaging of specimen collections, the challenges of developing protocols for working with citizen scientists and curating their research data set contributions, and the critical role of art in the visualization and knowledge mobilization of science.

### **Here is a list of my activities at the NHM and at Kew Gardens: Sept 25 – 29, 2017**

#### **September 25-2017:**

Meeting with *Helen M. Hardy - Digital Collections Programme Manager*, Natural History Museum, Cromwell Road, London SW7 5BD [2D digital initiatives]

<http://www.nhm.ac.uk/our-science/departments-and-staff/staff-directory/helen-hardy.html>

<http://www.nhm.ac.uk/our-science/our-work/digital-museum/digital-collections-programme.html>

#### **September 26-2017:**

Meeting with *Dr. Amy Scott-Murray, Manager 3D Visualisation Laboratory, Imaging and Analysis Centre*, Natural History Museum, Cromwell Road, London SW7 5BD [Not yet on the NHM Staff profile page.]

<http://www.nhm.ac.uk/discover/the-spectacled-porpoise-a-scientific-debut.html>

<http://www.nhm.ac.uk/our-science/departments-and-staff/core-research-labs/imaging-and-analysis-centre.html>

Meeting with *Lucy Robinson, Citizen Science Programme Manager*, Angela Marmont Centre for UK Biodiversity, Natural History Museum, Cromwell Road| London, SW7 5BD

<http://www.nhm.ac.uk/our-science/departments-and-staff/staff-directory/lucy-robinson.html>

Meeting with *Dr. Gavin Broad, Acting Principal Curator in Charge (Insects)*, Department of Life Sciences, Natural History Museum, Cromwell Road, London SW7 5BD (*Art-Science Interest Group at the Museum & Artist-in-Residence Initiatives*)

<http://www.nhm.ac.uk/our-science/departments-and-staff/staff-directory/gavin-broad.html>

<http://www.nhm.ac.uk/search.html?q=art+and+science>  
<http://www.nhm.ac.uk/visit/exhibitions/colour-and-vision-exhibition.html>

<http://www.nhm.ac.uk/discover/nature-on-our-doorstep-the-art-of-british-natural-history.html>

<http://www.nhm.ac.uk/visit/galleries-and-museum-map/images-of-nature.html>

### **September 27, 2017:**

Meeting with *Dr. Sarah Phillips, Research Leader Digital Collections*, Herbarium, Kew Gardens. Initiative: [Initiative: Large scale digitisation of Herbarium specimens]  
<https://www.kew.org/science/projects/large-scale-digitisation-of-herbarium-specimens>

Meeting with *Cam Sharp Jones, Project Officer Joseph Hooker Correspondence Project*, Library, Art & Archives, Royal Botanic Gardens, Kew. [Coordination of volunteer transcribers, a Citizen Science initiative. ]

[http://jdhooker.kew.org/p/jdh?\\_ga=2.24206138.1877713612.1510083307-547626506.1504048691](http://jdhooker.kew.org/p/jdh?_ga=2.24206138.1877713612.1510083307-547626506.1504048691)

<https://www.kew.org/blogs/library-art-and-archives/sir-joseph-dalton-hooker-at-200>

<https://www.kew.org/explore-our-collections/correspondence-collections/joseph-hooker-collections/about-the-project/joseph-hooker-project-team-and-partners>

### **September 28, 2017:**

Spent the day at the NHM visiting the exhibits with a particular interest in the Images in Nature exhibit. In truth, the entire museum is a work of art, a triumph of beautifully constructed visualizations featuring selections of their vast specimen collections.

<http://www.nhm.ac.uk/visit/galleries-and-museum-map.html>

**September 29, 2017:**

Continued visiting the exhibits and attended the NHM's annual public science exhibition - Science Uncovered, where the NHM brings a huge range of scientific equipment up into the public galleries for the purpose of discussing their science informally with members of the public.

<http://www.nhm.ac.uk/events/science-uncovered.html>

I also had an opportunity to meet and thank *Dr. Alex Ball, Head of Division, Imaging and Analysis*, for arranging for me to meet with so many of the NHM staff.

<http://www.nhm.ac.uk/our-science/departments-and-staff/staff-directory/alex-ball.html>

<http://www.nhm.ac.uk/our-science/departments-and-staff/core-research-labs/imaging-and-analysis-centre.html>

## **Study Leave Appendices**

- Appendix A - Study Leave Proposal
- Appendix B - Collective Agreement Article - Study Leave Report –
- Appendix C - Photos: Natural History Museum; KEW Gardens; Science Gallery
- Appendix D1 - 3D Scanning Project: Data Management Plan – September 2017
- Appendix D2 - 3D Dataset Uploaded to FRDR Demo – December 2017
- Appendix D3 - 3D Scanning of Natural Specimens: Selected Reference List
- Appendix E - Citizen Science in Selected Sciences: Selected Reference List
- Appendix F – Science Data Visualizations by Artists: Selected Reference List

## Appendix A: Study Leave Proposal

This is the text that I submitted to Jonathan in my Study Leave Application on Nov 15, 2017:

Focusing on the disciplines\* where I am currently assigned subject librarian and research data responsibilities, and evolving from "research & development" projects and assignments I have had an opportunity to be engaged with, I am interested in exploring and researching the following 3 intersecting "research data" topics and doing a "Project" that integrates, in some measure, the three research topics.

\* Subject Librarian (Physics & Astronomy, Chemistry, Earth & Ocean Sciences, Biology & Forest Biology, Anthropology); Research Data Librarian – Sciences; Research & Development Librarian  
Research Topics:

1) The emerging practice of using 3D technologies to scan artefacts in specimen collections and how such digital scans are being used in research & learning: As a background to a focus on the 3D scanning practices and activities, pertaining to specimen collections, I am also interested in learning more about the range of current specimen collection digitization practices, in academic and research institutions around the world. Digitization of specimen collections creates questions about the long term curation of an assortment of potential digital research data sets associated with specimen collections. Potential long term curation leads to questions about the emerging technical infrastructures and metadata schemas necessary to facilitate discoverability and citation of digitized specimen collections and associated digital research data sets.

2) The visualization of scientific research data: Specifically, I am interested in learning more about how artists work with scientists to help present scientific concepts and research data, as a form of knowledge mobilization. I am also interested in learning more about digital visualization tools and technologies, beyond GIS, spreadsheets, tables and graphs that are being used by scientists to share their research findings.

3) The intersection of research data collection [and analysis] and Citizen Scientists: This topic follows from some initial research I started in order to develop a proposal for IdeaFest 2017. I am interested in discovering the kinds of Citizen Science projects happening around the world in my assigned subject areas and the nature of the research data sets that have emerged from these initiatives.

Hands-On Project Proposal:

Whereas the above research topics are primarily based on reading the literature, exploring websites, and attending conferences or workshops, as part of my Study Leave, I would like to do a small hands on research data project that ties together, to some degree, the above three research topics and provides some practical experience in working with research data. I have permission from the Head of Oak Bay Parks and Recreation to work

with specimens of plants (flowers and bushes) representative of the Garry Oak Meadow Ecosystems and permission to create 3D scans of these specimens, either in situ, or collected. The idea is to create a visual dataset of 3D images, probably on Shetchfab, and attach metadata based on Darwin Core, with the idea this data set could be properly described and loaded, by me, onto UVic's Dataverse instance. I have experience using photogrammetry software, [thanks to a DHSI 2015 Workshop], as one option for generating 3D images. The UVic Libraires' Music and Media Unit is ordering a portable 3D scanner so this is another option.

This project would:

- provide some hands on experience with 3D imaging of specimens,
- provide a context for learning the Darwin Core metadata schema,
- provide some real experience collecting research data and preparing a data set for submission to Dataverse,
- provide an opportunity to use the DMPAssistant research data management planning tool,
- provide an opportunity to engage in a Citizen Science kind of activity,
- contribute some community based research into Garry Oak Meadow Ecosystems.
- possibly this might result in some watercolours (by me) as a form of artist engaged knowledge mobilization (?)

The collection of 3D images would have to take place in the Spring of 2017. Whereas there are many 2D photograph collections Garry Oak Meadow ecosystem plants, I think a collection of 3D images of these Garry Oak Ecosystem plants would be a new contribution, and of local interest, given the plants imaged would be from Uplands Park.

## **Appendix B - Study Leave Report – Collective Agreement Provisions**

### Study leave report

44.21 Within ninety days following the completion of a study leave, a Librarian must submit a study leave report to the University Librarian that provides an account of:

1. 44.21.1 the research, scholarly activity, or professional project undertaken during the study leave; and
2. 44.21.2 how the Librarian expects the research, scholarly activity, or professional project undertaken during the study leave will contribute to or enhance the Librarian's ability to meet changing needs in the Libraries

NOTE: Due to workload constraints on return to work [January 2, 2018], an extension was granted by the University Librarian and the Study Leave Report clock was reset to start March 1, 2018 with the due date set for May 15, 2018.

## **Appendix C – Photos: Natural History Museum; KEW Gardens; Science Gallery**

*Photos include 3D, Citizen Science and Sci-Art visualizations*

*Access to these photos is via Flickr. Most photos were taken by Kathleen Matthews. A few are photos taken by Wayne Matthews.*

- Natural History Museum, London: September 25, 26 & 28, 2018  
Photos of 3D Imaging activities, Citizen Science Programs, and Historic and Contemporary SciArt Works & Exhibits.  
<https://www.flickr.com/photos/imagerambling/albums/72157693544792972>
- Kew Gardens, London: September 27, 2017  
Photos of Herbarium 2D Imaging and Contemporary SciArt Garden Structures.  
<https://www.flickr.com/photos/imagerambling/albums/72157693546653742>
- Dublin Science Gallery, October 17, 2017. Contemporary SciArt Works  
<https://www.flickr.com/photos/imagerambling/albums/72157694946887341>

## **Appendix D1 – 3D Scanning Project – Data Management Plan**

**Project Name:** Kathleen's 2017 Study Leave

**Principal Investigator / Researcher:** Kathleen Matthews

**Institution:** Portage

<https://assistant.portagenetwork.ca/en/projects/kathleen-s-2017-study-leave>

### **Data Collection**

#### **What types of data will you collect, create, link to, acquire and/or record?**

Creating 3D scans of about 50 plant parts using NextEngine laser/lidar scanner and proprietary NextEngine ScanStudio software. Scans are exported to .PLY and .OBJ formats (The .OBJ export also generates and .MTL file and multiple associated .JPG files). The .PLY files will be further manipulated in MeshLab, and OpenSource application for editing and processing 3D meshes. The MeshLab output files will then be loaded to Sketchfab. The work is taking place between May 2017 and December 2017.

#### **What file formats will your data be collected in? Will these formats allow for data re-use, sharing and long-term access to the data?**

NextEngine ScanStudio files are proprietary but the 3D images are exported as .PLY and .OBJ formats (The .OBJ export also generates and .MTL file and multiple associated .JPG files). The .PLY files will be further manipulated in MeshLab, and OpenSource application for editing and processing 3D meshes. The MeshLab output files will then be loaded to Sketchfab. Only the export files are in formats available for sharing and re-use. For each scan, multiple screen shots have been taken and these are saved as .JPEG files. IN some cases, photographs of the screen has been take, and these are stored as .jpeg's

#### **What conventions and procedures will you use to structure, name and version-control your files to help you and others better understand how your data are organized?**

All file names include the common name of the plant, the date scanned, and usually include some additional descriptive info to indicate stages along the scanning file save process. For example: Camas360-May27-2017 FamilyA VolMerged Sept7-2017.ply.

### **Documentation and Metadata**

#### **What documentation will be needed for the data to be read and interpreted correctly in the future?**

If the NextEngine proprietary files are to be opened, then access to the NextEngine User Guide will help guide access to these 3D images. If the exported .PLY and/or .OBJ suite of files are to be accessed in MeshLab or Sketchfab, then documentation for these Open Source applications is available on the internet. There will be a Dictionary listing the plant parts scanned, the date scanned, and whether files were exported to .OBJ and .PLY

formats. The Dictionary will also note those files edited in MeshLab and loaded to Sketchfab.

**How will you make sure that documentation is created or captured consistently throughout your project?**

A spreadsheet will be used to track the path of the exported .OBJ and .PLY files for each plant. At present, this information is visible in named folders on a PC and on an external hard drive backup.

**If you are using a metadata standard and/or tools to document and describe your data, please list here.**

The DarwinCore Metadata standard is being considered and a subset will be adapted and applied when (and if) the 3D images are uploaded to Sketchfab.

**Storage and Backup**

What are the anticipated storage requirements for your project, in terms of storage space (in megabytes, gigabytes, terabytes, etc.) and the length of time you will be storing it?

As of September 6-2017, 60 gigabytes of data is backed up on a Transcend external hard drive and also backed up on Desktop PC at my office. As more export files are generated and more screenshots captured, possibly as much as 100 gigabytes is anticipated.

**How and where will your data be stored and backed up during your research project?**

At present, all the data files are stored on a PC that is set up with the licensed proprietary NextEngine Software, in a folder named Kathleen Matthews/Documents/My3D. These files are also backed up on a Transcend external hard drive, as of September 8-2017. Also backed, as of Sept, 2017 on PC workstation in office, but this backup is no longer up to date given the ongoing work, since Sept 7-2017, to generate the .PLY and .OBJ export files and additional screenshots.

**How will the research team and other collaborators access, modify, and contribute data throughout the project?**

There are no other members of the research team.

**Preservation**

**Where will you deposit your data for long-term preservation and access at the end of your research project?**

A subset of the files associated with 5-10 scanned plants may be uploaded to the UVic

instance of Dataverse. This is a preliminary goal and will depend on the perceived usefulness of the dataset and the perceived value in my personal professional development.

Indicate how you will ensure your data is preservation ready. Consider preservation-friendly file formats, ensuring file integrity, anonymization and de-identification, inclusion of supporting documentation.

The .PLY and .JPEG and .OBJ file formats are non-proprietary. The NextEngine formats are proprietary.

## **Sharing and Reuse**

**What data will you be sharing and in what form? (e.g. raw, processed, analyzed, final).**

Not yet known. A subset of 5 - 10 3D scans will be shared via Sketchfab.

**Have you considered what type of end-user license to include with your data?**

The end user license can be an Open Data Commons form of license.

**What steps will be taken to help the research community know that your data exists?**

If the images are added to Sketchfab, then it will be discoverable via Google and other search engines. It will be announced among colleagues via email.

## **Responsibilities and Resources**

**Identify who will be responsible for managing this project's data during and after the project and the major data management tasks for which they will be responsible.**

All data will be managed by me.

**How will responsibilities for managing data activities be handled if substantive changes happen in the personnel overseeing the project's data, including a change of Principal Investigator?**

The project is the focus of a professional development study leave and not intended to be more than an opportunity to learn about 3D imaging, specifically the 3D imaging of plant material. So there is no intention to assign responsibilities to others.

**What resources will you require to implement your data management plan? What do you estimate the overall cost for data management to be?**

Time as afforded by the 6 month Study Leave and possibly an additional 14 additional Scholarly Days in both 2017 and 2018. The NextEngine scanner and software has been on loan courtesy of Dr Helen Kurki, UVic Anthropology. Scanner has been available May 15, 2017 - Sept 7, 2017. The laptop with ScanStudio software is available from May 15, 2017, and hopefully until December 2017. Access to MeshLab and Sketchfab will be from my office PC at UVic and possibly from my home Mac. The overall cost is covered by my salary during my Study Leave time period.

**Ethics and Legal Compliance**

**If your research project includes sensitive data, how will you ensure that it is securely managed and accessible only to approved members of the project?**

No sensitive data.

**If applicable, what strategies will you undertake to address secondary uses of sensitive data?**

Not applicable.

**How will you manage legal, ethical, and intellectual property issues?**

Not applicable.

**How will you manage legal, ethical, and intellectual property issues?**

Not applicable.

## **Appendix D2 - 3D Dataset Uploaded to FRDR Demo - December 2017**

The metadata for my 3D data set uploaded to FRDR Demo. Is found at <https://demo.frdr.ca/repo/handle/doi:10.5072/106.090?mode=full>

FRDR Demo is a temporary repository, but I can anticipate that my 3D dataset is secure until September 2018, and hopefully the metadata will persist beyond that date.

## **Appendix D3 - 3D Scanning of Natural Specimens: Selected References and Resources**

Reference List from Zotero attached May 24, 2018.

## **Appendix E - Citizen Science: Selected References and Resources**

Reference List from Zotero attached May 24, 2018.

➤ **Appendix F – Science Data Visualizations by Artists: Selected References and Resources**

Reference List from Zotero attached May 24, 2018.