Repeat Photography Project for the Galiano Conservancy Association

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Eric Higgs
ES 471/ER 412
September 5th, 2018

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1.0 Background Information

Photographs are frozen moments of time that allow us to capture small pieces of a particular place (Lemmons, Brannstrom, & Hurd, 2014). Repeat photography is like replaying the natural and historical drama of a particular place. It is the practice of taking multiple photographs of the same thing in the same location at different times (McManus, 2011). Repeat photography has been used as a scientific tool since the late 1800s (Webb, Boyer, & Turner, 2010). Initially used for glaciology studies, repeat photography has now become an important tool for documenting plant populations, weathering, bedrock erosion, landscape-level changes and can be used to communicate complicated issues of change (Webb, Boyer & Turner, 2010). In essence, repeat photography is an inexpensive time machine that documents long-term ecological and geological changes in landscapes over a long period of time. The methods for repeat photography have not changed significantly from the early 1900s however, paired with archival research, Geographic Information Systems (GIS), Google earth and traditional field methods provide meaningful and useful information about that landscape and allow for other users to precisely determine the photographs location (Meyer & Youngs, 2018; Pezzoni, 2017).

2.0 Objectives

1. To provide the Galiano Conservancy with baseline photographs at a time of rapid ecological change + structures;
2. To choose sites that include ongoing, future and past projects on the property and provide a diversity of landscapes;
3. To leave a precise and rigorous methodology for future students to continue this project.

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3.0 Methodology

3.1 Study Area and Data

Galiano Island is located just off the east coast of Vancouver Island, British Columbia (Appendix. 1, Map 1). It is a part of the Southern Gulf Islands which are a collection of small islands that make up a distinctive area in the Salish Sea (CRD, 2013). The long narrow island is a part of the Coastal Douglas-Fir (CDF) biogeoclimatic zone, which has recently been classified as at risk both provincially and globally (Erickson & Simon, 2012). A Coastal Douglas-fir biogeoclimatic zone undergoes warm, dry summers and mild, wet winters (Egan, 1999). Galiano Island's climate is highly influenced by the rainshadow effect of the Olympic and Vancouver Island mountains as well as its proximity to the ocean (Erikson & Simon, 2012). The island's annual rainfall ranges from 597.3 mm to 1152.6 mm, 75% of which falls during the winter months (Erikson & Simon, 2012). Low precipitation and warm temperatures result in an annual moisture deficit in the summer months from the middle of June to early October (Erikson & Simon, 2012).

The study area for this report is District Lot 57 (Appendix 1, Map 2 & 3). This lot is 76 hectares that was acquired for conservation and is the site for the Millard Learning Centre (Erikson & Simon, 2012). While District lot 57 includes areas of healthy old growth and second growth forests and wetlands it has undergone extensive anthropogenic disturbances including a long history of agricultural use, grazing and small-scale forestry up until 2012, when the land was purchased by the Galiano Conservancy from William and Lennis Campbell (Erikson &

Simon, 2012). This lot is suitable for repeat photography because it has had a long history of disturbance and only in a couple of years since DL57 has been under the Galiano Conservancy Association, there has been significant changes to the landscape. It will be interesting to see how the landscape will continue to evolve in the next 50 to 100 years in the face of climate change.

Selection of the monitoring areas required a great deal of thought. The purpose for repeat photographic monitoring is a critical factor when considering where to monitor (Hall, 2001). The sites selected for the baseline photographs were chosen based on past, present and future projects within the District Lot 57. These sites included the future backcountry campsite location, the mill-site and program centre building, the forage forest and valley, the classroom building (vantage of the ridge), and the upper section of the cove (Appendix 1, Map 4).

Equipment for primary data collection included: Fujifilm X-T1 camera, Nikon D3200 camera, a tripod, a kestrel weather measuring device, a compass, a Garmin eTrex Vista GPS (NAD 83 UTM 10U), measuring tape (30m), flagging tape, a field notebook, and a laptop. Photographs were collected during the dry mid-late summer month, from August 23rd to August 26th, 2018. Weather conditions were taken down in field notebooks in order to understand the context of when these photographs were taken. A total of 49 photographs on 6 different location throughout District Lot 57 where taken and where uploaded onto a website (Result section & Appendix 5). Data for each site are described below (Tables 1- 6). Site locations are shown on the map titled ‘Baseline Photographs Locations on District Lot 57, Galiano Island, 2018’ and are included as part of this document (Appendix 1, Map 4).

3.2 Procedure

The first step was to choose a prominent camera location at each site that could be used as a permanent benchmark that can be easily repeated. Information recorded in the field notebook at each site included: date, time, camera location, model, lens setting, GPS location, compass bearing of the view for each photograph, camera vertical tilt, and names of photographer and crew. A description of the scene including the weather, dominant plant species, and evidence of human use or disturbances was recorded.

The tripod was set up so that from the base of the camera supported on the tripod to the ground measured 1.5m (Appendix 2, Fig. 1). A waypoint was taken from the centre of the tripod on the ground. At each location, a photograph of the photographer posing with the camera setup was taken in order to document the camera position and relative height (Appendix 4). Ideally, a similar camera and tripod would be used for future repeat photographs. Using flagging tape, a triangulation of the tripod was set up for future students to be able to find the locations more efficiently. In areas where it was not suitable for flagger, more photographs of the surroundings were taken.

Once the camera and tripod were set up, the first photograph taken at each site started at a prominent feature (i.e. rock feature, dominant tree, building). There was approximately 30° increments recorded between each photograph to allow for approximately 30% photograph overlap. For each site, 5 to 8 photographs were taken. For some sites, a full 360 degrees was taken in order to observe larger landscape change.

The photographs were uploaded to iphoto on a Macbook Air in order to create panoramic photographs (Appendix 3, Fig. 1-6). The software Hugin was downloaded. Hugin is a panorama

photograph stitcher. The individual photographs in an overlapping series were uploaded the panoramic software (Result section). Each series of photographs were dragged and dropped into order, aligned, and then saved as a panoramic tiff file.

Drag and Drop Tool

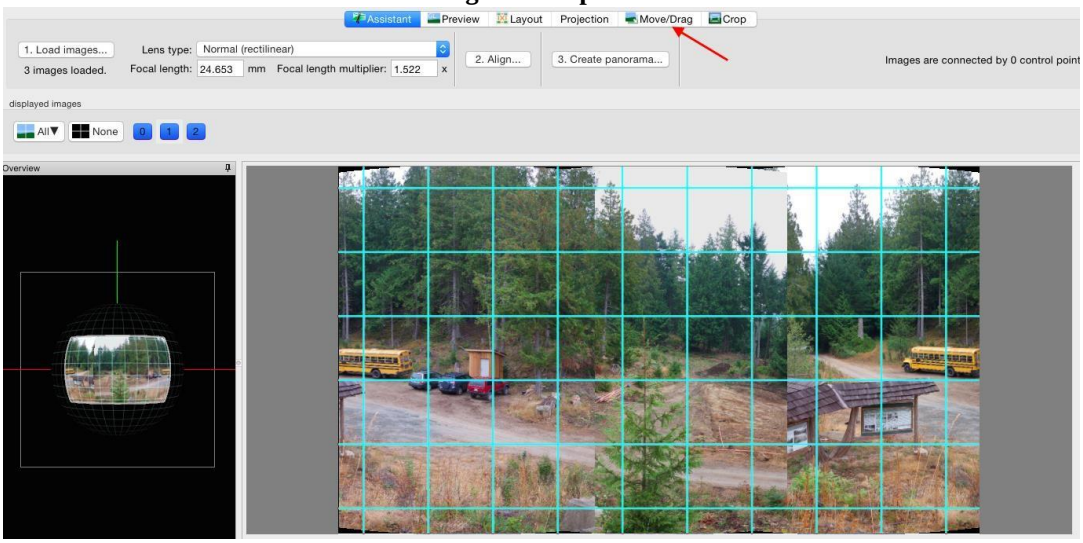

Figure 1: Figure illustrating the drag and drop tool within Hugin.

Align Tool

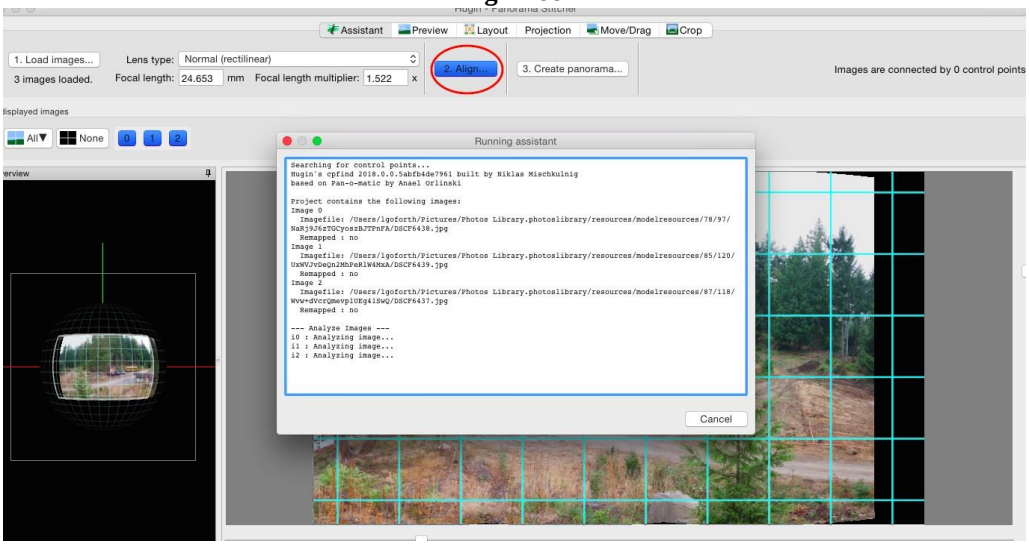

Figure 2: Figure illustrating the align tool in Hugin.

Create Panorama Tool

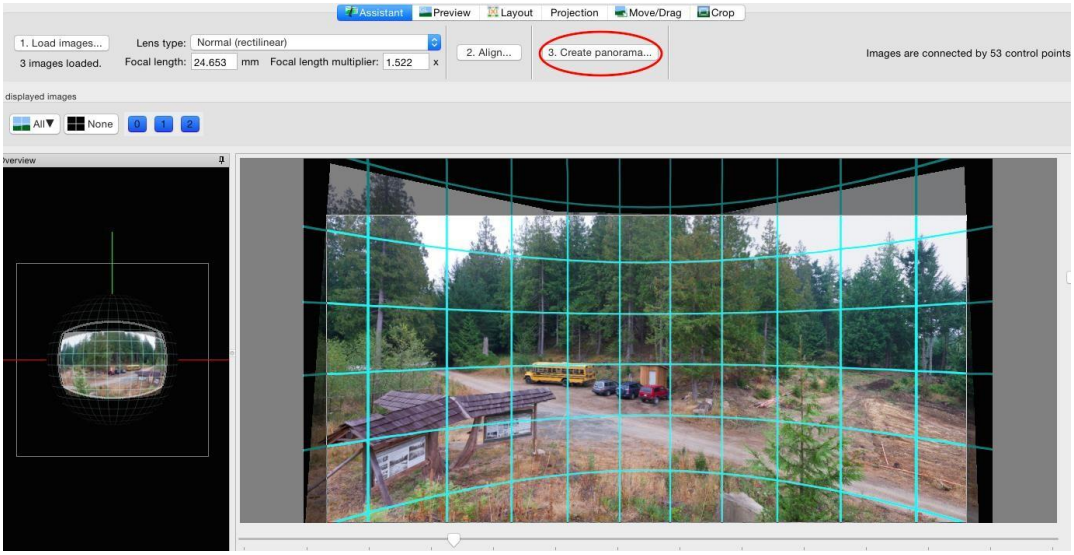

Figure 3: Figure illustrating the create panorama tool in Hugin.

4.0 Summary of Results

The baseline photographs of each location are included in Appendix 3 of this document. A website was created in order to upload the individual photographs of each site (Appendix 4). The photographs were also uploaded to a dropbox folder that will be sent to Eric Higgs as a backup strategy to safeguard the photos in the event that the website is no longer available. Tables for each individual site can be found in Appendix 5. These tables indicate the location, camera parameters, photograph number and azimuth for each individual photograph at each individual site. These tables are also accompanied by descriptions of each photograph and a section named "questions looking forward" (Appendix 5).

We chose to take a different number of photographs depending on the characteristics of each site. At the mill-site (site 2) and at the ridge above classroom building (site 3) we took a 360-degree photo to encapsulate the maximum possible area from that location. We decided that the entire area would be valuable data and of interest for future observations. At the campsite (site 1), kitchen deck (site 4), upper cove (site 5) and food forest (site 6), we chose to take photographs within a certain range, or angle. Some decisions were more obvious than others. On the kitchen deck, the angle directly behind us was constrained by the walls of the classroom building. At the food forest, we chose to focus our photographs on the food forest area and the area immediately in front of us from the vantage of the hillside. At the campsite, we were looking down a slope, and decided to focus our attention on the clearing that may soon become a new backcountry campsite. At the upper cove, the angle directly behind us was impeded by *Rubus armeniacus.* These photographs are not a bible, and future groups may decide they want to focus on other locations. Or, perhaps they will add new locations to our newly formed database.

All of our photographs were taken with a shutter speed of 1/60 second. We found this to provide us with the best possible picture given the calm conditions and ample light during the daytime hours when we completed the project. If the sun were brighter, perhaps if there were less smoke, then the next group may choose a faster shutter speed. Also, if there had been more intense wind, swaying branches or trees may have negatively affected the image quality. In this case, we recommend that the next group go with a faster shutter speed as well. All of our photos were taken with an aperture of F9 or F11. We found this to be a good middle ground that gives the photographer ample flexibility when editing the photographs at a later time.

Please see appendix 5 for more details on each individual location and a discussion concerning questions going forward.

5.0 Recommendations

We would like to see this project continue next year during Eric Higgs' ER 411 class at the Millard Learning centre. We propose two different options for the continuation of this project:

Note: these are 2 suggestions that may be combined or altered in different combinations

1. Next year's repeat photography group would choose 4-6 new sites to create new baseline photographs. This would create two sets of baseline photographs, one for even years (2018-2020 etc..) and one for odd years (2019-2021 etc..). We propose that next year's group could focus their energy on the western part of property as well as along different parts of the 2km coastline of the Millard Learning centre property. Stretches of coastline that are made up of the threatened Coastal Douglas fir-Arbutus vegetation associations will be interesting to track over time. The wetland at the west side of the property may be an important site going forward as well.
2. Next year's repeat photography group would choose 2-3 new sites to create their own baseline photography (see recommendations of new sites above). In addition, they would

also replicate 2-3 of Lauren and Christophe's photos from 2018. This way, the new group would become familiar with the protocol, the materials and the methodology in taking repeat photographs. Their work would serve to continue the work begun by Christophe and Lauren. This way, the new group would have the agency to choose which photographs they wished to re-take. This may enticing for the new groups so as to convince them that they can also make their own decision as to their site selection. In subsequent years, the new groups would have a number of different repeat photography sites to choose from. As well as the opportunity to start their own baseline photographs.

We would also recommend that, if possible, permanent bolts of small structures be installed to mark the locations of each individual repeat photography site. This, along with the UTM coordinates would eliminate any confusion as to the exact location of the sites. Rebar stakes or permanent structures should not be used if it poses a risk to the ecological integrity of the area. Groups in subsequent years should also continue to take waypoints and add to the map that is included in the section below. This is a useful visual aid when presenting to the class or the community and for the Galiano conservancy to keep on record.

The lecture by Eric Higgs about the Mountain Legacy project (mountainlegacy.ca) was inspiring and provided a spark for the students. This lecture should continue next year as to encourage new students to become interested in continuing this project. This project is extremely time sensitive. It is important that students get on this project right away and make quick decisions when out in the field as to the sites they want to choose. Eric Higgs was instrumental in helping us learn how to properly go about taking repeat photography shots. If possible, it would

be best for the next group to get the help of Eric Higgs (at least in completing the first photograph).

6.0 Expected Value of Research

We were originally drawn to this project after hearing of Eric Higgs' mountain legacy project. The Millard learning centre has only recently come under the stewardship of the Galiano Island Conservancy. We believe that it is important to document the 'early days' of the property in order to track the ecological succession of the individual sites over time. The goal is to track landscape level changes over time on: 1) previously disturbed sites 2) previously disturbed sites undergoing restoration 3) changes to man-made structures and roadsides 4) changes to landscapes that have compacted soils vs soils that have been de-compacted or aerated. 5) changes in the regeneration of forest understory and establishment of new seedlings.

The other potentially important part of this project, which deserves to be highlighted is the focus on Thuja plicata (western red cedar). Some of our photographs (whenever possible) have included one or multiple red cedar's that are in different age classes. The idea is to see how climate change and increased drought will affect western red cedar. Over a 20-year period (or more) we may begin to see major changes in the health and composition of cedar within the property of the Millard learning centre. These changes we will be able to see with our Repeat photographs. This may be an important project in documenting the migration and exodus of western red cedar within the southern Gulf Islands and the CDF biogeoclimatic zone as a whole.

We may also capture details that will be important to restoration that we cannot foresee at this point. These photographs may provide clues to future scientists and teachers as to the species composition and changes over large time periods. The photographs may be also used as educational tools for school children or university classes, or for the benefit of the general public that are visiting the site. They may be used at the new program centre to show corners of the property that the majority of the general public may not be able to visit. This project may also spur interest for students to complete long term projects on the Millard learning centre property. Students in the RNS diploma program may be interested in completing a longer term project on the property, which would be an added advantage for the conservancy. Integrating repeat photography into the field course will allow students to conduct collaborative research that provides meaningful and situated-learning experiences (Meyer & Youngs, 2018).

7.0 Acknowledgements

We would like to acknowledge that the land of District Lot 57 lies within the traditional territories of the Hul'qumi'num speaking people. We would also like to acknowledge the help and support we have received from Eric Higgs, Jeanine Rhemtulla, Keith Erickson, as well as the community members that came to our presentation.

8.0 Literature Cited

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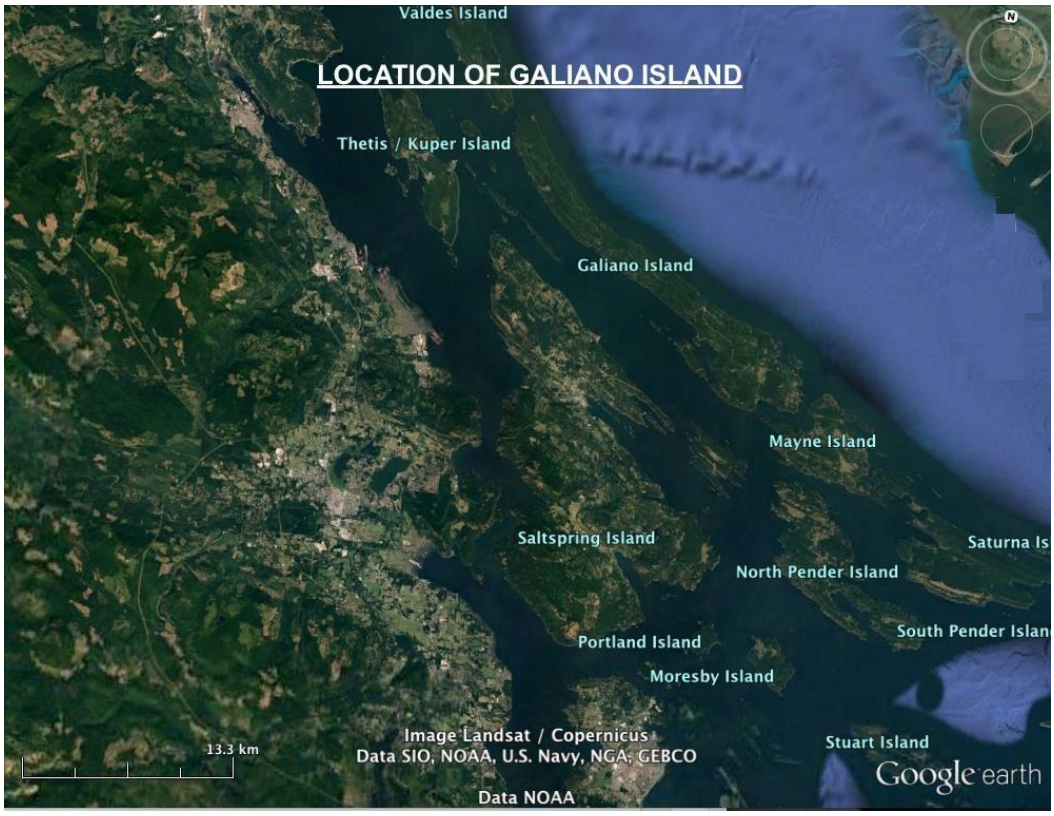
9.0 Appendices

Appendix 1: Maps



Map 1: Google Earth image of Galiano Island.

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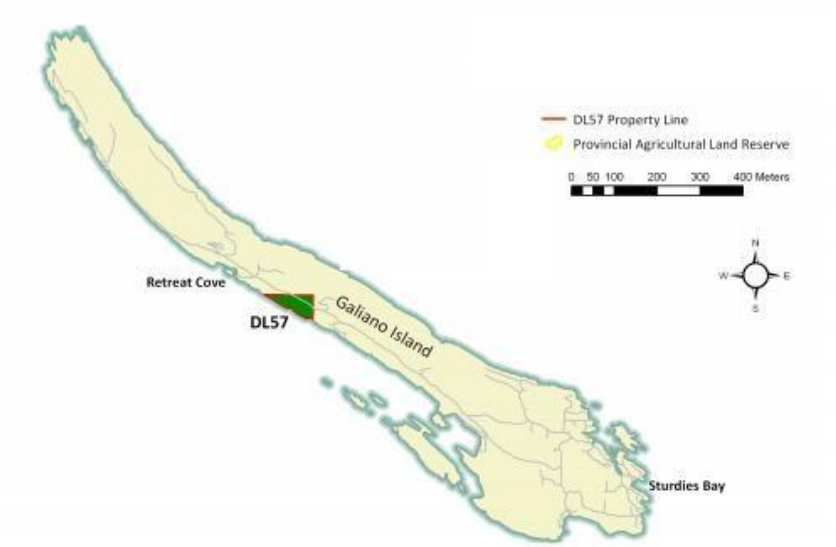
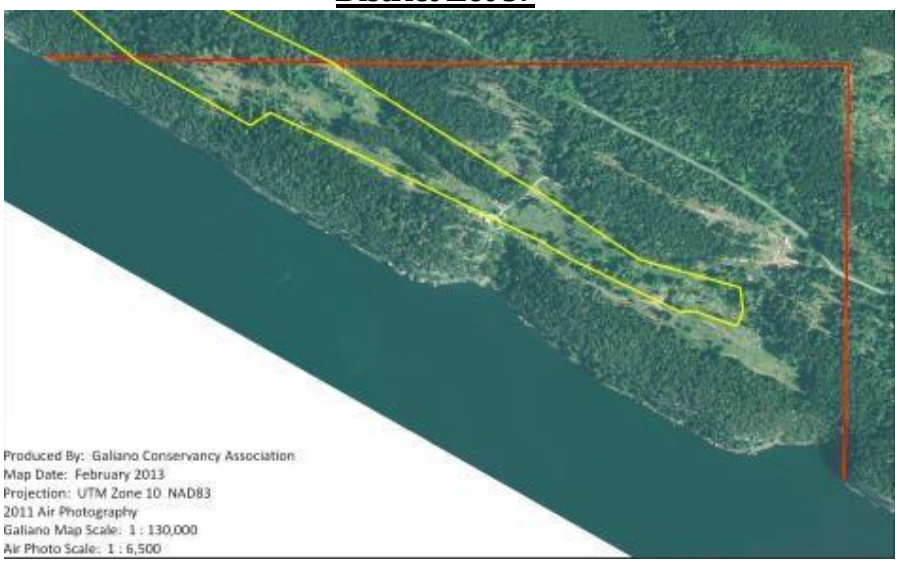
Galiano Island



Map 2: Map of Galiano Island and DL57 property line. Retrieved from (Erickson & Simon, 2012)

District Lot 57



Map 3: Map of the District Lot 57. Retrieved from (Erickson & Simon, 2012)

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Baseline Photograph Locations on District Lot 57, Galiano Island, 2018

Map 4 : The locations of the 6 baseline photographs within District Lot 57.

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Appendix 2: Figures

Figure 1: Measuring the height of the camera from the ground to the base on camera. Aimed from 1.5m at each location.

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Appendix 3: Panorama Results

Backcountry Campground

Pano 1: Pano of backcountry campsite location (10U mN mE) was taken on August 23rd, 2018 around 5PM.

Ridge

Pano 2: 360 degree pano of the Millsite and new location for the office spaces (10U 0465743 mN 5419794 mE) looking down onto the Millard Learning Centre. Photos taken on August 24th, 2018 around 12PM.

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Millsite and New Office Spaces

Pano 3: 360 degree pano of the Ridge (10U 5419607 mN 465773 mE) looking down onto the Millard Learning Centre. Photos taken on August 24th, 2018 around 2AM.

Kitchen Deck

Pano 4: Pano from the kitchen deck (10U mN mE) looking down onto the forage forest. Photos taken on August 25th, 2018 around 4PM.

Upper Cove

Pano 5: Pano of the Upper Cove (10U 0465207 m N 5419829 mE) area. Photos taken on August 26th, 2018 around 2PM.

Food Forest

Pano 6: Pano of food forest (10U 0464924 mN 5420137 mE). Photos taken on August 26th, 2018 around 3:30PM

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Appendix 4

Website address:
https://lgoforth14.wixsite.com/repeatphotography

These Photographs will also be sent to Eric Higgs via dropbox. Or, contact christophe.boyer@mail.mcgill.ca (Christophe) or lgoforth14@gmail.com (Lauren) if photos are unavailable.

Appendix 5

Table 1: Campsite Location (10U 0465209 mN 5420061 mE)

Location	Camera Parameters	Photo number	Azimuth
RP_Campsite1A _08/18	XF23mm F1.4 R ISO: 400 Aperture : F11 Shutter speed: 1/60s Vertical tilt	DSCF6410	126.5 ° E
RP_Campsite1B_08/18	XF23mm F1.4 R ISO: 400 Aperture: F11 Shutter speed: 1/60s Vertical tilt	DSCF6411	156 ° SE
RP_Campsite1C_08/18	XF23mm F1.4 R ISO: 400 Aperture: F11 Shutter speed: 1/60s Vertical tilt	DSCF6412	192.3 ° S
RP_Campsite1D_08/18	XF23mm F1.4 R ISO: 400 Aperture: F11 Shutter speed: 1/60s Vertical tilt	DSCF6413	234.5 ° SW

RP_Campsite1E_08/18	XF23mm F1.4 R ISO: 400 Aperture: F11	DSCF6415	280 ° W
	Shutter speed: 1/60s Vertical tilt		

Site description:

Date: August 23rd, 2018
Time: 15:00
Weather: 17 degrees celsius, partly cloudy
Dominant Vegetation: *Pseudotsuga menziesii, Thuja plicata, Mahonia nervosa*
Disturbances: Evidence of past selective logging and clearing in the flat area below the photograph (now intended for the establishment of new campsite). - Intensive dear browsing **Questions looking forward:**

1) Will the forest understory under the *Pseudotsuga menziesii* canopy continue to regenerate? Or will it continue to dwindle because of the effects of intense Dear browse 2) How will the new campsite change the field (clearing) in the centre of the photo?

Table 2: Millsite (10U 0465743 m N 5419794 m E)

Location	Camera Parameters	Photo number	Azimuth
RP_Millsite_2A_08/18	XF23mmF1.4 R ISO: 400 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6437	101.5 °
RP_Millsite_2B_08/18	XF23mmF1.4 R ISO: 500 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6438	138 °
RP_Millsite_2C_08/18	XF23mmF1.4 R ISO: 640 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6439	169 °

RP_Millsite_2D_08/18	XF23mmF1.4 R ISO: 1000 Aperture : F9 Shutter speed: 1/60s	DSCF6440	208 °
	Vertical tilt		
RP_Millsite_2E_08/18	XF23mmF1.4 R ISO: 320 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6441	233 °
RP_Millsite_2F_08/18	XF23mmF1.4 R ISO: 640 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6442	260.5°
RP_Millsite_2G_08/18	XF23mmF1.4 R ISO: 640 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6443	290°
RP_Millsite_2H_08/18	XF23mmF1.4 R ISO: 400 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6444	314°
RP_Millsite_2I_08/18	XF23mmF1.4 R ISO: 500 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6445	340°
RP_Millsite_2J_08/18	XF23mmF1.4 R ISO: 400 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6446	10°
RP_Millsite_2K_08/18	XF23mmF1.4 R ISO: 200 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6447	32°

RP_Millsite_2L_08/18	XF23mmF1.4 R ISO: 250 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6448	62°
RP_Millsite_2M_08/18	XF23mmF1.4 R ISO: 320 Aperture : F9 Shutter speed: 1/60s	DSCF6449	82°
	Vertical tilt		

Site description:

Date: August 24th, 2018
Time: 14:00
Weather: 16 degrees, Partly cloudy, light rain showers
Dominant Vegetation: *Cesium vulgare, Mahonia nervosa, Pteridium aquilinum* (see restoration planting below)
Disturbances: Area was previously a Mill site and was heavily disturbed. It is likely that Sulphur and Hydrocarbons were used on site and may have seeped into the soil. The area north of the Road is being actively restored by a previous student in the Restoration of Natural Systems Diploma program at the University of Victoria. New plantings (protected by metal cages) include: *Abies grandis, Rosa gymnocarpa, Rosa nutkana, Pseudotsuga menziesii, Arbutus menziesii, Thuja plicata* and *Malus fusca*. There is also intensive dear browsing that affects the ability of small shrubs and seedlings to become established **Questions looking forward:**

1) What will the new program centre look like? To what degree will ecological design be included in the planning process?
2) How will the solar panels look once they are installed? Will there be other plantings and shrubs that might exist in conjunction or adjacent to the solar panels? Will they attract invasive species?
3) Will the already completed Millsite restoration project be a success? What trees will thrive? What shrubs will thrive? And Why?
4) How will the fenced off *Alnus rubra* restoration zone differ from the non-fenced area?
5) Will the *Thuja plicata* trees be able to withstand the drought and intense summer temperatures that accompany climate change?

Table 3: Ridge (10U 5419607 m N 465773 m E)

Location	Camera Parameters	Photo number	Azimuth
RP_Ridge_3A_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6421	124 °
RP_Ridge_3B_08/18	XF23mmF1.4 R ISO: 200	DSCF6422	144 °
	Aperture: F9 Shutter speed: 1/60s Vertical tilt		
RP_Ridge_3C_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6423	175 °
RP_Ridge_3D_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6424	190 °
RP_Ridge_3E_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6425	220 °
RP_Ridge_3F_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6426	250 °

RP_Ridge_3G_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6427	278 °
RP_Ridge_3H_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6428	292 °
RP_Ridge_3I_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6429	309 °
RP_Ridge_3J_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6430	334 °
RP_Ridge_3K_08/18	XF23mmF1.4 R ISO: 200	DSCF6431	361 °
	Aperture: F9 Shutter speed: 1/60s Vertical tilt		
RP_Ridge_3L_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6432	19 °
RP_Ridge_3M_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6433	55 °

RP_Ridge_3N_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6434	86 °

Site description:

Date: August 24th, 2018
Time: 12:00 PM
Weather: 21 degrees celcius, mix of sun and cloud. Partly smoky.
Dominant Vegetation: *Pseudotsuga menziesii, Gaultheria shallon, Mahonia nervosa*
Disturbances: This site is immediately east of the Millard learning centre classroom. It has been selectively logged for *Thuja plicata* by the former owner of the property, Bill Campbell. There are large cedar stumps and the area is south-west facing and thus receives ample sunlight. The vegetation is sparse as a result. The area is rocky and hummocky and the slope immediately west of our camera location is at an approximate slope of 30 degrees. The slope is prone to mud and rockslides. The area is also affected by intensive dear browsing.
Questions looking forward:

1) Will the forest understory recovers given the intensity of the sun?
2) Will new conifer saplings will be able to establish themselves?
3) How will the Millard learning centre classroom area transform over time?
4) Will the compacted (grassy areas) on the photograph be revegetated or restored in the future?
5) Will the *Thuja plicata* trees be able to withstand the drought and intense summer temperatures that accompany climate change?

Table 4: Kitchen Deck (10U 5419580mN 0465727mE)

Location	Camera Parameters	Photo number	Azimuth
RP_Kitchen_4A _08/18	XF23mm F1.4 R ISO: 320 Aperture : F9 Shutter speed: 1/60s horizontal tilt	DSCF6451	331.5 °

RP_Kitchen_4B_08/18	XF23mm F1.4 R ISO: 320 Aperture: F9 Shutter speed: 1/60s horizontal tilt	DSCF6452	301.5 °
RP_Kitchen_4C_08/18	XF23mm F1.4 R ISO: 640 Aperture: F9 Shutter speed: 1/60s horizontal tilt	DSCF6453	258 °
RP_Kitchen_4D_08/18	XF23mm F1.4 R ISO: 500 Aperture: F9 Shutter speed: 1/60s Horizontal Tilt	DSCF6454	211 °
RP_Kitchen_4E_08/18	XF23mm F1.4 R ISO: 640 Aperture: F9 Shutter speed: 1/60s horizontal tilt	DSCF6455	184 °

Site description:

Date: August 25th, 2018
Time: 16:00
Weather: 19 degrees, Partly cloudy. Partly Smoky.
Dominant Vegetation: Dominant vegetation in the area surrounding the learning centre includes: *Cesium vulgare, Mahonia nervosa, Pteridium aquilinum, Gaultheria shallon, Digitalis, Polystichum munitum, Achlys, Alnus rubra* (seedlings), *Thuja plicata* (seedlings). The photograph also encompasses the native forage forest (4A and 4B), that is currently being cared for and nurtured by Adam.
Disturbances:
Area immediately adjacent to the learning centre classroom has been heavily disturbed due to past and ongoing construction (most recently the construction of the washroom facilities). Bill Campbell has had a profound impact on the compaction of the soil (driving his vehicles around) surrounding the learning centre. The dirt road leading down to the learning centre from the Porlier pass road will be an ongoing disturbance on site.
Questions going forward:

1) How will the native forage forest change transform over time? Will new seedlings create a canopy? How long will this take and what species will do best on site?
2) How will the native forage forest (de-compacted soils) differ from the area immediately surrounding the learning centre classroom (compacted soils). Will any seedlings be able to establish themselves in the compacted soils? Will the presence of *Cesium vulgare* change over time
3) How will the area immediately surrounding the Millard learning centre classroom transform over time? Will a grey water pond or rain garden be installed?

Table 5: Upper Cove (10U 0465207 m N 5419829 m E)

Location	Camera Parameters	Photo number	Azimuth
RP_Cove5A_08/18	XF23mmF1.4 R ISO: 400 Aperture : F9 Shutter speed: 1/60s Vertical tilt	DSCF6461	215.5 °
RP_Cove5B_08/18	XF23mmF1.4 R ISO: 400 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6462	240 °
RP_Cove5C_08/18	XF23mmF1.4 R ISO: 250 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6463	264.5 °
RP_Cove5D_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6464	296 °
RP_Cove5E_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6465	319 °

RP_Cove5F_08/18	XF23mmF1.4 R	DSCF6467	347.5 °
	ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt		
RP_Cove5G_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6468	16 °
RP_Cove5H_08/18	XF23mmF1.4 R ISO: 200 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6469	42 °

Site description:

Date: August 26th, 2018
Time: 14:00
Weather: 18 degrees, Partly cloudy
Dominant Vegetation: The site is sparsely vegetated and is mostly clear of any larger trees. There are invasive grasses interspersed with clusters of *Cirsium vulgare, Digitalis, Phalaris arundinacea*, *Iris pseudacorus* and *Ilex aquifolium.* There is also some *Holodiscus discolor* directly adjacent to the site. There is one particularly large quince tree as well as some apple trees and plum trees that are relics of the former settlement around the cove. The other vegetation (wrapped in metal coverings) was planted during a cove restoration project completed by a student of Eric Higgs.
Disturbances: The area was cleared for roads and structures, some of which still stand today. There is evidence of past farming in the cove area. The soils have been heavily compacted by Bill Campbell and his heavy machinery.
Questions going forward:

1) Will the structures on site remain into the future? How will the landscape change after they are gone?
2) Will the ongoing restoration project that was done by the former student of Eric Higgs prove successful? How will the seedlings and shrubs grow over a longer period of time?
3) Will intensive dear browse continue to stunt the recovery of the vegetation in the Cove?

Table 6: Food Forest (10U 0464924 mN 5420137 mE)

Location	Camera Parameters	Photo number	Azimuth
RP_Foodforest_6A_08/18	ISO: 640	DSCF6472	174 °
	Aperture: F9 Shutter speed: 1/60s Vertical tilt		
RP_Foodforest_6B_08/18	ISO: 640 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6473	205 °
RP_Foodforest_6C_08/18	ISO: 320 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6474	248 °
RP_Foodforest_6D_08/18	ISO: 500 Aperture: F9 Shutter speed: 1/60s Vertical tilt	DSCF6475	276 °

Site description:

Date: August 26th, 2018
Time: 3:30 PM
Weather: 21 degrees, partly cloudy, partly smoky
Dominant Vegetation: The food forest is comprised of a variety of exotic plants. It is fenced off to protect it from the Dear. The Chinese chestnut trees are intended to provide the primary canopy cover going into the future. The foreground of the photo (the hill immediately east of the site) is composed primarily of medium *Pseudotsuga menziesii* trees, *Mahonia nervosa* and invasive grasses.
Disturbances: The area has been previously cleared. The soil was heavily compacted and thus a Heidelburg permaculture technique has been employed by the Galiano Island conservancy.
Questions going forward:

1) How will the chinese chestnut trees grow over time ? Will they provide adequate canopy for the sun-averse plants in the garden to thrive?
2) How will the composition of plant species change over time as the food forest evolves?
3) Will new seedlings establish themselves on the hillside immediately east of the food forest? What about new shrubs and a forest understory?

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ES 471/ER 412- Field Course 2018
Repeat Photography
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Submitted to: Eric Higgs