Coring into the Past:
Dendrochronology on District Lot 57

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August 7th, 2019

Environmental Studies 471

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1.0 Site Introduction

1.1 Introduction

This report focuses on dendrochronology—the science of dating tree rings--conducted at the Millard Learning Centre on Galiano Island under the guidance of Spencer Bronson who is a dendrochronologist at the University of British Columbia. The characteristic patterns of growth found in Coastal Douglas fir (*Pseudotsuga menziesii),* Western redcedar (*Thuja plicata*), and Arbutus (*Arbutus menziesii*), is evidence we used to hypothesis disturbance events, chronologically date tree growth, and understand changes to the environment over the last several centuries. Our in-situ data was conducted along a linear transect of a coastal old growth Douglas fir ecosystem and within a region known to have been logged by settlers with predominant Western redcedar trees. The comparison between the two environments provided us with information which we consequently use to provide recommendations for further research and innovation around restoration projects.

The Millard Learning Centre (MLC), a 76-hectare property owned by the Galiano Conservancy Association, poses a distinctive opportunity to use dendrochronology to comprehensively understand the history of isolated tree stands, and with this information we can hypothesize larger scale changes to the Island. We conclude by discussing how we unearthed empirical evidence of the last known evidence of fire on Galiano Island, and how further dendrochronology analysis can lead us to understand patterns of fire on the landscape.

1.2 Dendrochronology and its importance

The study of tree rings provides us with information as to how old the tree is, and also how the growth elapsed each year with variations in favourable and less favourable growing conditions. To discover how these changes occurred we extracted several non-destructive core samples from different trees of the same species in a determined area, and recorded diameter at breast height (DBH). The base of the tree is where the oldest tree rings exist, and it is therefore essential to collect core samples at the same height to get a representative pattern for the region. We can then infer predictions as to the region's climatic changes. The oldest rings of a tree start at the centre (PIF) and the new growth materializes in the outermost ring, next to the cambium layer (the layer adjacent to the bark). Upon analysing the tree rings, larger and smaller rings indicate growth rate changes. Each ring represents a full calendar year, and similarities across samples are evidence to infer climatic changes (Mason, 2019). Individual growth rate changes may symbolize more isolated disturbance events to just one or two trees. The forecasts of climate scientists for unprecedented rapid climate change gives dendrochronology a strong justification: empirical data discovered in tree rings can help us understand how trees combat extreme weather and climate. By just 2050 the Pacific Climate Impacts Consortium predicts a 1.8 degrees Celsius rise in annual mean temperature and an 8% increase in winter rainfall for British Columbia as a whole (PCIC, 2013). Climate change predictions are inherently complex to model, and nearly impossible for an isolated region with inerrable micro-climates such as Galiano Island. However, trees are a living record of climate change and by hiking into the forests and methodically collecting samples, we can read the stories of the landscape and begin to understand what ecosystem integrity might look like into the future of the MLC.

1.3 Study Area and Data

The study area for this analysis is District Lot 57, now known also as the Millard Learning Centre, owned and operated under by Galiano Conservancy Association (Figure 1). The property is the Conservancy's most recent and largest piece of land, occupying 76.1 hectares of land (Galiano Conservancy Association, 2019). The Learning Centre was only recently acquired in 2012 and since then a very strong committed team have worked to establish a sustainable community within a natural environment (2019). The purpose of the property is to provide restoration, education, and nature connection opportunities for the community and students (2019). The property has a vast assortment of ecological communities that range in diversity from marsh wetlands to old growth forests and grass dominated logged land (Galiano Conservancy Association, 2013). The average temperature on Galiano Island is 10 °C, with a high average annual temperature of 24°C, and a low average annual temperature of -1°C (Custom Weather, 2019). The island receives approximately 400 millimetres of rain annually (2019). Due to the relatively recent nature of the property's acquisition, no prior dendrochronology has been undertaken. For the purpose of this analysis all information pertaining tree ring data was acquired on site, June 25th, 2019 and June 26th, 2019, by University of Victoria students in Eric Higgs' Advanced Principles and Practices of Ecological Restoration (ES 471/ER 412) field school.

2.0 Goals and Objectives

2.1 Goals and Objectives of the MLC Management Plan

The goals and objectives defined in the *2013 Galiano Learning Centre Management Plan* are an opportune platform for our project to follow; they serve the legacy of the Learning Centre and guide meaningful projects. Dendrochronology is a method to understand the history of a landscape in order to make predictions for the future. There has never been dendrochronological research done at the Millard Learning Centre, and our hope is to provide a useful synthesis of our findings to support further research. The list of goals below are drawn from the MLC management plan. The following objectives are guided by the GLC management plan; however, some are shaped to focus on pragmatic objectives of our work.

The first goal is stewardship. Stewardship can "provide foundational or preliminary research for future restoration projects to maintain, restore and conserve terrestrial systems" (Galiano Conservancy Association, 2013). The objectives under the stewardship portion of this project are to core into the history of Western redcedar and Douglas fir trees adjacent to the known clear cuts as it can inform restorationists about the health of the standing trees. This is important as they can be a reference to restoration projects replanting and reintegrating Western redcedar into the meadow. The second objective under stewardship is to discuss the implications of climate change on tree growth and health, pertaining to annual precipitation, shortened growing seasons, and even severe weather affecting the old growth Douglas fir. This discussion will aid in the education of individuals as to why only a few ancient old growth trees exist on the coast.

The second goal is: "Sustainable living and nature-based learning" (Galiano Conservancy Association, 2013). Sustainable living and nature-based learning "provide opportunities for, and facilities to accommodate single and multi-day sustainable living and nature-based learning for people of diverse age, culture, ability and background" (2013). The objectives under the sustainable living portion are to create an interactive and simple poster to educate visitors about the process of conducting dendrochronological research, utilizing the already sanded and studied core samples at the Millard Learning Centre. The second objective is to inspire people to hike into the old growth strands and conduct citizen science by documenting fire scarred Douglas fir trees using iNaturalist (Mathews & Dady, 2008).

The third and final goal is "Research and Innovation" (Galiano Conservancy Association, 2013). Research and Innovation "Provide opportunities for research and innovation on effective methods in ecological restoration, conservation biology and sustainable living as well as the relationship between human well-being and time spent in nature" (2013). The objectives under the research and innovation portion is to provide our dendrochronological research for projects around climate change mitigation and discover how Western redcedar is affected by increased drought. The second objective is to give opportunities for future dendrochronological field research to understand future climate trends on Galiano Island. Western redcedar is heavily focused on due to the large number and size of cedars throughout the properties.

3.0 Methodology

3.1 Methods

To obtain information pertaining to the age, health and disturbances that occurred on the property, the class broke into six groups comprising either two or three individuals. Each group was then tasked with extracting five cores using a standard increment borer from two different assigned plots in the southwestern portion of the property. The first plot assigned was along the Coastal bluff old growth forest, and the groups were approximately 20 meters apart. The second series of plots was in the vicinity of the classroom. Again, groups were spaced approximately 20 meters from each other (Figure 1). The sites were chosen at a distance that allowed for different types of tree stands to be evaluated and to obtain a representative sample of trees across a section of the property.

Each group was assigned a centre tree and were tasked with coring five trees closest to the centre that had a DBH greater than 12.5 centimetres. For this analysis DBH was measured at a height of 1.3 meters. The distance to the centre tree was recorded for each of the five sample trees. The largest distance from the centre tree and any of the five sampled trees provided the group with a site radius. Within the radius of the sample area, the species of the trees, general site characteristics, presence of snags and stumps, evidence of fire, and trees with a DBH less than 12.5 cm were recorded. Each group then extract cores for each of the five trees, recorded the species, canopy class, and noted whether the tree was dead or alive.

After both plots were sampled and the groups returned to the classroom, the cores were glued down to standard core mounts, and the mounts labelled with the plot number, core ID and the teams initials. The cores were then left overnight to dry. Once dried the cores were sanded down flush to the core mounts to better decipher the rings. The rings were then counted using both a magnifying glass and a low-power microscope. The rings were counted from the outermost ring inward.

Additional trees were sampled by the authors of this report on the 26th of June 2019. Four cores were extracted using the same methods, but cores were extracted from trees with a DBH less than 12.5 cm. This was conducted in order to perform a comparison analysis between the age and DBH within plot four. This comparison is helpful as it indicates the growing conditions in the area based on the size of the tree rings.

3.2 Results

The collection and analysis of the data demonstrated consistent results throughout the two different site locations. Along the ridge, 31 tree cores were extracted throughout the six sites. The estimated date of establishment for the trees in this region range from pre-1598 to 1917 (Figure 2). The mean establishment date is 1864 (Figure 2). The average diameter at breast height of these cored trees is 36.6 cm, with the largest diameter of 53.6 cm that was recorded on a 195-year-old Douglas fir (Figure 2). The smallest diameter recorded along the ridge was 14.5 cm diameter recorded on a 109-year-old Douglas fir (Figure 2). The trees in this area are predominantly Douglas fir (Figure 3). Along the ridge only one Garry Oak tree and Western redcedar were recorded, however; only the Western redcedar was cored for information (Figure 3). Near the classroom, 27 cores were extracted throughout five different sites (Figure 3). The estimated date of establishment for the trees range from 1864 to 1957 (Figure 4). The mean establishment date is 1924 (Figure 4). The largest diameter at breast height is 83.3 cm recorded from a Western redcedar which is at least 138 years, and the smallest diameter was 17 cm which was recorded on a 109-year-old Douglas fir (Figure 4). The tree species in this portion of the property are mainly Douglas fir and Western redcedar (Figure 5).

The ages of trees along the valley and ridge were plotted to analysis the difference in ages (Figure 6). The trees in the plot around the ridge have a larger range in ages and are generally older than those found near the classroom. A comparison was due prior to collection of trees with a DBH greater than 12.5cm and less than 12.5 cm (Figure 7). The trees with smaller DBH were younger (Figure 7). There is also evidence of a regeneration gap, meaning no new saplings grew for 106 years. This was observed in the establishment date of the trees with a DBH greater than 12.5 cm and less than 12.5 cm (Figure 7).

4.0 Implications and Recommendations

4.1 Implications: Helping the Conservancy Going Forward

The following implications of our dendrochronological study has provided several opportunities for restoration and conservation, which entail recommendations for further analysis. Secondary implications state the results of our research which can be paired with further research initiatives.

4.2 Western redcedar (*Thuja plicata)* Restoration

Adjacent to the Millard Learning Centre's classroom building is a clear cut of predominantly Western redcedar with other mixed coniferous trees. Western redcedar are distributed along the Coast Range-Cascade Range, which extends from south-eastern Alaska to north-western California and are found most commonly occurring on moist sites of mixed substrate (Anderson, 2019). However, the current climate change trends are believed to be causing Western redcedar to dieback from seasonal drought stress, and this is increasing significantly nearby on the east side of Vancouver Island (Pojar, p. 15, 2010). Tree growth rates as we observed are susceptible to change from many forces, and the future health of Western redcedar strands on Galiano many need protection into the future, especially for the continued growth of the "Grandmother Cedar" in the forage forest, presumed to be older than 500 years old. The "Grandmother Cedar" is presumed to be one of the oldest trees on the MLC property. This tree was saved when the conservancy bought the land as the property owner was going to cut it down for lumber. This tree now stands alone in the valley of Lot 57.

The stands of Western redcedar that were cored and analysed had an average age of 123, showed consistent growth patterns and the canopy cover did not appear to be damaged. In the clear-cut region, many non-native and native flora have regrown due to the increased sunlight and temperature with the trees removed. However, these conditions are not favoured by all species and this microclimate is challenging to return to pre disturbance conditions, because of the browsing intensity of black-tailed deer (*Odocoileus hemionus*) on young Western redcedar saplings (Anderson, 2019). Tree canopy gaps are important to forest ecology in the ways they influence nutrient cycles, preserve bio and pedo-diversity, and create the necessary temperature, soil moisture, and light to reach the forest floor; maintaining the complex environments for late-successional forests (Muscolo et al., 2014). However, in this clear cut the trees were removed and without a fire disturbance for centuries, nutrients haven't been recycled back into the soil. Climate change consequently is causing Galiano to experience more summer drought which will affect the moisture rich soil that supports the Western redcedar on Galliano. Our core samples do not show drought damage affecting Western redcedar. However the "Grandmother Cedar" has significant heart rot which may be a result of annual droughts. Climate change is already impacting integral ecosystems in British Columbia. The innumerable impacts are causing species-level changes in range, abundance, and life cycles, and globally there is evidence that some species are evolving (Pojar, p. 16, 2010). The interlocking process correlated between ecosystems and climate are inherently complex. Thereby reintroducing Western redcedar into clear cut blocks will protect and preserve species richness and ecological processes into the future.

To ensure the success of this project, dendrochronology should be conducted on the current Western redcedar trees adjacent to clear cuts, and elsewhere as to understand where replanting would fortify successful regeneration. Trees that show unhealthy growth patterns provide reason to assume soil moisture is not significant enough to support Western redcedar; these locations can be eliminated as candidate restoration sites.

4.3 Old Growth Douglas fir *(Pseudotsuga menziesii)* Conservation

Along the southern boundary of District lot 57 exists a linear stand of an old growth ecosystem. This area is atypical of a common west coast old growth forest. To the untrained eye, this stand appears to be much younger based on the diameter and height of the trees. This is due to the exposed shallow soil cliff faces and variable topography of the region. The most common and natural observed disturbance regime affecting growth here is severe weather as canopies are windswept or trees are uprooted. Douglas fir are a highly adaptable species and can be found growing from southern Mexico into Central British Columbia; virtually in all types of landscapes where fire has always been present (Douglas fir). However, as the Galiano Conservancy Association has observed, inclement winter weather paired with strong intersecting wind is causing Douglas fir mortality.

The old growth Douglas fir on Galiano Island exhibit variable growth patterns with small annual growth rings. The annual increment growth rates are small due to the harsh growing conditions associated with the location. The basal area of our increment bore samples were selected around a centre tree, and our transect follows the old growth ecosystem with 6 total plots spaced 50 meters apart. Each site exhibited unique characteristics for the basal area with variable age and growth patterns of tree strands (Appendix 5.1). There are also centuries of socio-cultural interaction with the landscape from the Coast Salish peoples which may have an effect on these strands.

Plot four along our transect contained 50 Douglas fir trees with a DBH <12.5 cm with a mean age around 30 years old based on 4 core samples from the young trees (Appendix 5.1). Thereby sometime around 1988 there was an isolated disturbance to this plot of land, followed by favourable growing seasons for a dense population of Douglas fir. Our hypothesis is that strong winds opened the canopy cover over this plot, allowing for succession of the observed young strand. However, this location was an oddity compared to the rest of the plot measurements. Further sampling along the coast would be needed to determine if there are similarities in other strands of trees if the GCA is to infer that weather was the primary disturbance to this location.

This past December an unprecedented wind storm swept across the gulf islands and Southern Vancouver Island. The storm was reported to be the most destructive storm to BC hydro's infrastructure in history, with a low central pressure measuring in at 982 millibars and winds gusts over 100km per hour (Huffman, 2019). For reference, a category one hurricane is recorded at 980 millibars (Huffman, 2019). The damage was visible along the Old Growth transect where we hiked, and we observed many fallen and broken trees. Some that were uprooted showed how shallow the soil is within this ecosystem, just one or two feet on top of solid rock. Still, many very old Douglas fir were resistant to the wind storm on Galiano Island. Around the GCA there are numerous Douglas fir that have burn scars around the base. The largest DBH recorded of all the samples was from one of these gigantic trees and was dated to the year of establishment of 1618, with still 20 plus rings off from the PIF. These trees are the last standing documentation of fire on Galiano Island and are increasingly vulnerable to mortality.

Storms that bring heavy winter precipitation and strong winds like the December 20th, 2018 windstorm are likely to become more common with Climate Change (Pojar, p 18., 2010). Old growth forests are carbon sinks of the planet and the subsequent ecosystems have been shown to positively sequester more carbon dioxide and emit oxygen from ages 15 to 800 years old (Luyssaert, et al., 2008). These trees also contribute to mitigating soil erosion where slope elevation angles are steep. However, protecting these giants on Galiano island right now requires us to first understand more about their health, age, and distribution around the property. If most of the old growth Douglas fir cannot reach a point of growth where they are resilient to wind, then we must plan to manage strands in the face of climate change, however doing so is inherently complex. We recommend additional analysis and cross-dating fire scarred trees compared to snags as to understand when old growth trees died. This may help us understand whether the oldest Douglas fir on Galiano Island are susceptible to other forms of mortality besides wind, such as stem rot, bark beetles, or the velvet top fungus *(Phaeolus schweinitzii)*, which is a slow-growing fungus that can take 250-300 years before it is distinguishable (Douglas fir).

4.4 Fire Regime Hypothesis: Last known Fire to the MLC Property

The tools that dendrochronology equip us with can inform restoration projects around the GCA in innumerable ways. One story that is seemingly lost in time can also be found within the stories of the tree rings and is critical to the succession and maintenance of native species on Galiano. The presence of fire on Galiano Island is clearly shown by the fire scars on Douglas fir, but its importance to the entire ecosystem is hard to overstate.

There was only one fire scared Douglas fir that we were able to obtain a readable core sample from, and the rest of our samples showed no signs of fire. However, this information can lead us to hypothesis the last known fire to cross the GCA property. The oldest confirmed date of establishment for a Douglas fir without any fire scar was 1821. This tree was found within plot 5 and even older trees were found here and counted to be around 200+ years old; however, the pith was missing for these samples. Based on the number of samples found with an estimated year of establishment from 1820 to 1860 and ranging across all of the plots on the old growth transect, we hypothesize the last known fire to Galiano was around 160 years ago +- 20 years. This estimate is however only true for the old growth transect, and smaller intensity fires may have crossed the adjacent cedar clear cut prior to their estimated year of establishment. To begin to understand fire regimes on Galiano Island using dendrochronology, many more samples are needed to be sampled, cross dated in a lab, and interpolated onto a map of the ecosystems. From this extensive research, and controlled burning in winter months, inferences may be made as to how fire plays a role in recycling nutrients for native plants to regrow. However, if ever a controlled experiment such as this was to take place to test weather reintegrating fire was necessary, ungulate browsing would need to be managed on the regrowth for saplings, and herbaceous plants.

4.5 Recommendations

The following recommendations of our study on District Lot 57 will provide the Conservancy an opportunity to enrich their understanding about the trees on the property. Based on our findings and the implications of the findings we have cultivated several different recommendations for the GCA. The first of these recommendations is that an analysis of trees with a DBH less than 12.5 along the ridge be conducted. As there was evidence of regeneration in several of the plots, it would be interesting to core the smaller trees within the current plots and analyse the potential similarities and differences based on the site location. The second recommendation is to continue taking tree core samples throughout the property with the eventual goal of comprehensive tree age sampling. This will provide the Conservancy with important information concerning the growing conditions throughout the property. This is both beneficial for the future of the trees and the conservation as we are better able to invest our resources in helping them succeed as well as for future restoration projects. As tree rings provide information about the general health of the soil, we could use that information to more easily determine plots on the lot with which restoration would be most successful. The third recommendation is to perform further analysis and cross-dating on fire-scarred and culturally modified trees. This analysis will further education the conservancy on the fire history and the cultural history of the land and is very important as we begin to understand more about the land that District Lot 57 resides on. The fourth and final recommendation is for the conservancy to begin searching and recording the presence of culturally modified Douglas fir and Western redcedar trees on the property. Culturally modified trees have the potential to provide us with vast amounts of knowledge pertaining precontact lives on the island and without the without the protection and knowledge about their location may result in another form of history that is lost (Mathews & Dady, 2008).

5.0 Acknowledgements

To begin, we would like to acknowledge that the land that District Lot 57 resides on is the traditional territory of the Hul'qumi'num speaking peoples. As we will be learning from the land, we believe it is especially important to acknowledge the role the Hul'qumi'num speaking peoples have played shaping the land and ecosystems. This project was inspired by the knowledge and teachings of Spencer Bronson from the Dendrochronology lab at the University of British Columbia, along with the help of Jeanine Rhemtulla. We would also like to acknowledge the help and support of Eric Higgs, Keith Erickson, and the Galiano Conservancy Association.

5.0 Appendix

5.1 Compiled Data

Introduction to Dendrochronology - Galiano Island 2019

PLOT DATA

Site Name	Plot Number	Crew Number	Slope Aspect	Slope Angle	Slope Position	Surface Shape	Latitude	Longitude	Elevation
Galiano	Plot 1	1	130	10	Upper	Convex	48.92703	-123.46851	165
Galiano	Plot 2	2	210	12	Upper	Concave	48.92721	-123.46898	201
Galiano	Plot 3	3	207	14	Middle	Concave	48.9274	-123.46959	226
Galiano	Plot 4	4	214	23	Middle	Concave	48.9276	-123.47025	189
Galiano	Plot 5	5	218	0	Middle	Level	48.92777	-123.47123	157
Galiano	Plot 6	6	199	22	Middle	Convex	48.92795	-123.47178	163
Galiano	Plot 7	1	40	12	Middle	Convex	48.9276	-123.46718	251
Galiano	Plot 8	2	187	10	Middle	Level	48.9276	-123.46677	203
Galiano	Plot 9	3	228	31	Middle	Level	48.92776	-123.46647	219
Galiano	Plot 10	4	204	16	Upper	Convex	48.9277	-123.4675	225
Galiano	Plot 11	5,6	28	22	Lower	Level	48.92796	-123.46832	216
Galiano	Plot4B	AG, RC	214	23	Middle	Concave	48.9276	-123.47025	189

Site Name	Plot Number	# snags	# stumps	# trees (<12.5cm)	Plot radius (m)	Date	Crew Member Initials	Fire Scar Evidence
Galiano	Plot 1	0	0	6	4.95	25/06/2019	K,R,E	NO
Galiano	Plot 2	0	3	0	5.5	25/06/2019	C.P., P.D., L	NO
Galiano	Plot 3	3	1	3	5.22	25/06/2019	DG, ER, MV	NO
Galiano	Plot 4	4	3	50	12.4	25/06/2019	AG, GJ	NO
Galiano	Plot 5	0	0	6	5.85	25/06/2019	AD, SG	YES
Galiano	Plot 6	0	0	0	3.5	25/06/2019	ZM, CP	YES
Galiano	Plot 7	2	1	13	7.55	25/06/2019	K, R, E	NO
Galiano	Plot 8	1	0	0	4.8	25/06/2019	C.P., P.D., L	NO
Galiano	Plot 9	1	4	5	5.45	25/06/2019	DG, ER, MV	NO
Galiano	Plot 10	1	0	0	4.4	25/06/2019	AG, GJ	NO
Galiano	Plot 11	3	0	6	6.9	25/06/2019	AD, SG	NO
Galiano	Plot4B	4	3	50	12.4	26/06/2019	AG,RC	NO

General tree information Increment cores

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan	1	1	P1-C1-T1	DF	0	Live	14.1	S	No	Gali2019-C1-01	130
GalianoIslan	1	1	P1-C1-T2	DF	1.1	Live	23.1	I	No	Gali2019-C1-02	130
GalianoIslan	1	1	P1-C1-T3	DF	3.6	Live	51.5	D	No	Gali2019-C1-03	130
GalianoIslan	1	1	P1-C1-T4	DF	3.9	Live	12.5	S	No		
GalianoIslan	1	1	P1-C1-T5	DF	4.9	Live	24.8	C	No	Gali2019-C1-05	130
GalianoIslan	1	1	P1-C1-T6	DF	5	Live	35.3	C	No	Gali2019-C1-06	130
GalianoIslan	2	2	P2-C2-T1	AR	0	Live	30.3	C	No	Gali2019-C2-01	130
GalianoIslan	2	2	P2-C2-T2	DF	2.2	Live	50.3	D	No	Gali2019-C2-02	130
GalianoIslan	2	2	P2-C2-T3	DF	2.2	Live	20.5	I	No	Gali2019-C2-03	130
GalianoIslan	2	2	P2-C2-T4	WRC	5.5	Live	22.5	S	No	Gali2019-C2-04	130
GalianoIslan	2	2	P2-C2-T5	DF	5.4	Live	40.5	D	No	Gali2019-C2-05	130

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heart wood Decay	Year of inner most ring	# Rings missing (to centre)	Establis hement Date (EST)	Crew members
GalianoIslan	1	1	14.1	Yes	Present	No	1914	7	1907	K, R, E
GalianoIslan	1	1	23.1	Yes	Present	No	1895	0	1895	K, R, E
GalianoIslan	1	1	51.5	Yes	Present	No	1883	0	1883	K, R, E
GalianoIslan	1	1								K, R, E
GalianoIslan	1	1	24.8	Yes	Present	No	1880	3	1877	K, R, E
GalianoIslan	1	1	35.3	Yes	Present	No	1918	2	1916	K, R, E
GalianoIslan	2	2	30.3	Yes	Present	No				CP, PD, LP.
GalianoIslan	2	2	50.3	Yes	Present	No	1877	3	1874	CP, PD, LP.
GalianoIslan	2	2	20.5	Yes	Present	No	1910	3	1907	CP, PD, LP.
GalianoIslan	2	2	22.5	Yes	Present	No	1894	0	1894	CP, PD, LP.
GalianoIslan	2	2	40.5	Yes	Present	No	1867	20	1847	CP, PD, LP.

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan	3	3	P3-C3-T1	DF	1.96	Live	15.3	S	No	Gali2019-C3-01	130
GalianoIslan	3	3	P3-C3-T2	AR	2.06	Live	27.4	I	No	Gali2019-C3-02	130
GalianoIslan	3	3	P3-C3-T3	DF	3.19	Live	35.2	C	No	Gali2019-C3-03	130
GalianoIslan	3	3	P3-C3-T4	DF	5	Live	23	I	Yes	Gali2019-C3-04	130
GalianoIslan	3	3	P3-C3-T5	DF	5.22	Live	45.9	D	No	Gali2019-C3-05	130
GalianoIslan	4	4	P4-C4-T1	AR	2.45	Live	25	D	No	Gali2019-C4-01	130
GalianoIslan	4	4	P4-C4-T2	DF	6.05	Live	46	D	Yes		
GalianoIslan	4	4	P4-C4-T3	DF	10.85	Live	57	D	No	Gali2019-C4-03	130
GalianoIslan	4	4	P4-C4-T4	DF	12.4	Live	49	D	No	Gali2019-C4-04	130
GalianoIslan	4	4	P4-C4-T5	DF	11.6	Live	34	C	Yes	Gali2019-C4-05	130
GalianoIslan	4	4	P4-C4-T6	DF	10.7	Live	25	C	Yes	Gali2019-C4-06	130
GalianoIslan	4	4	P4-C4-T7	DF	10	Live	45.5	C	No		
GalianoIslan	4	4	P4-C4-T8	DF	6.9	Live	61.4	D	Yes		
GalianoIslan	4	4	P4-C4-T9	DF	10.4	Live	32.6	C	No		

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heartwood Decay	Year of innermost ring	# Rings missing (to centre)	Establishment Date (EST)	Crew members
GalianoIslan	3	3	15.3	Yes	Present	No	1887	3	1884	DG, ER, MW
GalianoIslan	3	3	27.4	Yes	Absent	No	Unknown	Unknown	Unknown	DG, ER, MW
GalianoIslan	3	3	35.2	Yes	Present	No	1889	7	1882	DG, ER, MW
GalianoIslan	3	3	23	Yes	Present	No	1900	9	1891	DG, ER, MW
GalianoIslan	3	3	45.9	Yes	Present	No	1871	0		DG, ER, MW
GalianoIslan	4	4	25	Yes	Absent	No	Unknown	Unknown	Unknown	AG, GJ
GalianoIslan	4	4								AG, GJ
GalianoIslan	4	4	57	Yes	Present	No	1860	6	1854	AG, GJ
GalianoIslan	4	4	49	Yes	Absent	No	1879	Unknown	1879	AG, GJ
GalianoIslan	4	4	34	Yes	Present	No	1868	2	1866	AG, GJ
GalianoIslan	4	4	25	Yes	Present	No	1890	8	1882	AG, GJ
GalianoIslan	4	4								AG, GJ
GalianoIslan	4	4								AG, GJ

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan	4	4	P4-C4-T10	DF	12.05	Live	18.6	S	No		
GalianoIslan	4	4	P4-C4-T11	DF	10.35	Live	13	S	No		
GalianoIslan	4	4	P4-C4-T12	DF	10.6	Live	39.4	C	No		
GalianoIslan	4	4	P4-C4-T13	DF	11.9	Live	39	S	No		
GalianoIslan	4	D1	P4-C4-T14	DF	0	Live	10.8	S	No	Gali2019-D1-01	130
GalianoIslan	4	D1	P4-C4-T15	DF	2.3	Live	10.9	S	No	Gali2019-D1-02	130
GalianoIslan	4	D1	P4-C4-T16	DF	3.5	Live	6	S	No	Gali2019-D1-03	130
GalianoIslan	4	D1	P4-C4-T17	DF	5.8	Live	7.4	S	No	Gali2019-D1-04	130
GalianoIslan	5	5	P5-C5-T01	DF	0	Live	63	D	No	Gali2019-C5-01	130
GalianoIslan	5	5	P5-C5-T02	DF	4	Live	45.1	C	No	Gali2019-C5-02	130
GalianoIslan	5	5	P5-C5-T03	DF	5.5	Live	42.7	C	No	Gali2019-C5-03	130
GalianoIslan	5	5	P5-C5-T04	DF	4.1	Live	35.9	S	Yes	Gali2019-C5-04	130
GalianoIslan	5	5	P5-C5-T05	AR	5.9	Live	38.3	I	Yes	Gali2019-C5-05	130

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heart wood Decay	Year of inner ring	# Rings missing (to centre)	Establishe ment Date (EST)	Crew members
GalianoIslan	4	4								AG, GJ
GalianoIslan	4	4								AG, GJ
GalianoIslan	4	4								AG, GJ
GalianoIslan	4	4								AG, GJ
GalianoIslan	4	D1	10.8	Yes	Present	No	1988	0	1988	AG, RC
GalianoIslan	4	D1	10.9	Yes	Present	No	1981	0	1981	AG, RC
GalianoIslan	4	D1	6	Yes	Present	No	1995	0	1995	AG, RC
GalianoIslan	4	D1	7.4	Yes	Present	No	1990	0	1990	AG, RC
GalianoIslan	5	5	63	Yes	Present	No	1821	5	1816	AD, SG
GalianoIslan	5	5	45.1	Yes	Absent	Yes	1860	Unknown	Unknown	AD, SG
GalianoIslan	5	5	42.7	Yes	Present	No	1829	6	1823	AD, SG
GalianoIslan	5	5	35.9	Yes	Absent	No	1800	Unknown	Unknown	AD, SG
GalianoIslan	5	5	38.3	Yes	Absent	Yes	Unknown	Unknown	Unknown	AD, SG

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan(	5	5	P5-C5-T06	GO	1.8	Live	12.8	S	No		
GalianoIslan(	6	6	P6-C6-T01	DF	0	Live	14.5	S	Yes	Gali2019-C6-01	130
GalianoIslan(	6	6	P6-C6-T02	DF	2.4	Live	25.6	C	Yes	Gali2019-C6-02	130
GalianoIslan(	6	6	P6-C6-T03	DF	2.4	Live	53.8	C	Yes	Gali2019-C6-03	130
GalianoIslan(	6	6	P6-C6-T04	DF	3.5	Live	20.1	I	Yes	Gali2019-C6-04	130
GalianoIslan(	6	6	P6-C6-T05	DF	3.3	Live	27.7	C	No	Gali2019-C6-05	130
GalianoIslan(	Fire Tree	6	P6-C6-T06	DF	N/A	Live	84	C	Yes	Gali2019-C6-06	130
GalianoIslan(	6	6	P6-C6-T07	DF	3.4	Dead	15.9	N/A	Yes		
GalianoIslan(	6	6	P6-C6-T08	AR	2.7	Live	18.8	S	Yes		
GalianoIslan(	7	1	P7-C1-T07	DF	0	Live	47.9	C	No	Gali2019-C1-07	130
GalianoIslan(	7	1	P7-C1-T08	DF	0.9	Live	11.9	M	No		
GalianoIslan(	7	1	P7-C1-T09	WRC	4.1	Live	12.3	M	No		
GalianoIslan(	7	1	P7-C1-T10	WRC	3.1	Live	54	D	Yes	Gali2019-C1-10	130

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heart wood Decay	Year of innermost ring	# Rings missing (to centre)	Establishe ment Date (EST)	Crew members
GalianoIslan(	5	5								AD, SG
GalianoIslan(	6	6	14.5	Yes	Present	No	1917	7	1910	ZM, CP
GalianoIslan(	6	6	25.6	Yes	Present	No	1869	4	1865	ZM, CP
GalianoIslan(	6	6	53.8	Yes	Present	Yes	1833	9	1824	ZM, CP
GalianoIslan(	6	6	20.1	Yes	Present	No	1879	3	1876	ZM, CP
GalianoIslan(	6	6	27.7	Yes	Present	No	1888	11	1877	ZM, CP
GalianoIslan(	Fire Tree	6	84	No	Present	Yes	1618	20 +	pre 1598	ZM, CP
GalianoIslan(	6	6								ZM, CP
GalianoIslan(	6	6								ZM, CP
GalianoIslan(	7	1	47.9	Yes	Present	No	1886	2	1884	K, R, E
GalianoIslan(	7	1								K, R, E
GalianoIslan(	7	1								K, R, E
GalianoIslan(	7	1	54	Yes	Present	No	1897	0	1897	K, R, E

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan	7	1	P7-C1-T11	WRC	4.2	Live	57.8	D	Yes	Gali2019-C1-11	130
GalianoIslan	7	1	P7-C1-T12	WRC	3.2	Live	9	M	Yes		
GalianoIslan	7	1	P7-C1-T13	DF	4.1	Dead	14	N/A	N/A		
GalianoIslan	7	1	P7-C1-T14	DF	5.6	Live	69.2	D	No	Gali2019-C1-14	130
GalianoIslan	7	1	P7-C1-T15	DF	5.7	Live	34.6	C	No		
GalianoIslan	7	1	P7-C1-T16	WRC	7.6	Live	47.3	D	Yes		
GalianoIslan	7	1	P7-C1-T17	DF	5.7	Dead	80	M	Yes		
GalianoIslan	7	1	P7-C1-T18	Stump	5.6	Dead	70.5	M	Yes		
GalianoIslan	7	1	P7-C1-T19	WRC	6.5	Live	38.3	S	No	Gali2019-C1-19	130
GalianoIslan	8	2	P8-C2-T06	DF	0	Live	52	D	No	Gali2019-C2-T06	130
GalianoIslan	8	2	P8-C2-T07	DF	3.1	Live	27	C	No	Gali2019-C2-T07	130
GalianoIslan	8	2	P8-C2-T08	DF	3.5	Live	18.1	C	No	Gali2019-C2-T08	130
GalianoIslan	8	2	P8-C2-T09	DF	3.9	Live	48.1	D	No	Gali2019-C2-T09	130

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heart wood Decay	Year of innermo st ring	# Rings missing (to centre)	Establishe ment Date (EST)	Crew members
GalianoIslan	7	1	57.8	Yes	Present	No	1886	0	1886	K, R, E
GalianoIslan	7	1								K, R, E
GalianoIslan	7	1								K, R, E
GalianoIslan	7	1	69.2	Yes	Present	No	1917	0	1917	K, R, E
GalianoIslan	7	1								K, R, E
GalianoIslan	7	1								K, R, E
GalianoIslan	7	1								K, R, E
GalianoIslan	7	1								K, R, E
GalianoIslan	7	1	38.3	Yes	Present	No	1907	0	1907	K, R, E
GalianoIslan	8	2	52	Yes	Present	No	1950	0	1950	CP, PD, LP.
GalianoIslan	8	2	27	Yes	Present	No	1956	1	1955	CP, PD, LP.
GalianoIslan	8	2	18.1	Yes	Present	No	1955	6	1949	CP, PD, LP.
GalianoIslan	8	2	48.1	Yes	Present	No	1959	16	1943	CP, PD, LP.

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan(	8	2	P8-C2-T10	DF	4.8	Live	58.6	D	Yes	Gali2019-C2-T10	130
GalianoIslan(	9	3	P9-C3-T06	DF	0	Live	19.5	S	No	Gali2019-C3-T06	130
GalianoIslan(	9	3	P9-C3-T07A	DF	2.27	Live	67	D	No	Gali2019-C3-T07A	130
GalianoIslan(	9	3	P9-C3-T07B	DF	2.27	Live	67	D	No	Gali2019-C3-T07B	130
GalianoIslan(	9	3	P9-C3-T08	DF	5.45	Live	34.3	C	No	Gali2019-C3-T08	130
GalianoIslan(	9	3	P9-C3-T09	DF	5.1	Live	21.8	I	No	Gali2019-C3-T09	130
GalianoIslan(	9	3	P9-C3-T10	WRC	5.32	Live	23.8	S	No	Gali2019-C3-T10	130
GalianoIslan(	10	4	P10-C4-T01	DF	0	Live	38	I	Yes	Gali2019-C4-T07	130
GalianoIslan(	10	4	P10-C4-T02	DF	2.4	Live	56	C	No	Gali2019-C4-T08	130
GalianoIslan(	10	4	P10-C4-T03	DF	2.3	Live	46	C	No	Gali2019-C4-T09	130
GalianoIslan(	10	4	P10-C4-T04	DF	2.9	Live	17	I	No	Gali2019-C4-T10	130
GalianoIslan(	10	4	P10-C4-T05	DF	4.4	Live	43	C	No	Gali2019-C4-T11	130

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heart wood Decay	Year of innermost ring	# Rings missing (to centre)	Establishement Date (EST)	Crew members
GalianoIslan(	8	2	58.6	Yes	Present	Yes	1950	0	1950	CP, PD, LP.
GalianoIslan(	9	3	19.5	Yes	Present	No	1950	2	1948	DG, ER, MW
GalianoIslan(	9	3	67	No	Present	No	1943	4	1939	DG, ER, MW
GalianoIslan(	9	3	67	Yes	Present	No	1943	4	1939	DG, ER, MW
GalianoIslan(	9	3	34.3	Yes	Present	No	1950	7	1943	DG, ER, MW
GalianoIslan(	9	3	21.8	Yes	Present	No	1958	6	1952	DG, ER, MW
GalianoIslan(	9	3	23.8	Yes	Present	No	1970	13	1957	DG, ER, MW
GalianoIslan(	10	4	38	No	Present	No	1887	2	1885	AG, GJ
GalianoIslan(	10	4	56	Yes	Present	No	1890	7	1883	AG, GJ
GalianoIslan(	10	4	46	Yes	Present	No	1903	2	1901	AG, GJ
GalianoIslan(	10	4	17	No	Present	No	1910	0	1910	AG, GJ
GalianoIslan(	10	4	43	Yes	Absent	No	1920	16	Older 190¿	AG, GJ

Site Name	Plot Number	Crew ID	Tree ID	Tree Species	Distance from Centre (m)	Live or Dead	BDH (cm)	Canopy Class	Bole Damage	Core ID	Core Height (cm)
GalianoIslan	11	5	P11-C5-T07	WRC	0	Live	75.5	C	N	Gali2019-C5-T07	130
GalianoIslan	11	5	P11-C5-T08	WRC	0.7	Live	26.5	S	N	Gali2019-C5-T08	130
GalianoIslan	11	5	P11-C5-T09	DF	6.6	Live	70.4	C	N	Gali2019-C5-T09	130
GalianoIslan	11	5	P11-C5-T10	WRC	6	Live	46.5	C	N	Gali2019-C5-T10	130
GalianoIslan	11	5	P11-C5-T11	WRC	2.8	Live	83.2	C	N	Gali2019-C5-T11	130
GalianoIslan	11	5	P11-C5-T12	WRC	6.9	Live	62.7	C	N	Gali2019-C5-T12	130

Site Name	Plot Number	Crew ID	DBH (cm)	Bark	Pith /Arc	Heart wood Decay	Year of innerm ost ring	# Rings missing (to centre)	Establis hement Date (EST)	Crew members
GalianoIslan	11	5	75.5	Yes	Present	No	1880	11	1869	AD, SG
GalianoIslan	11	5	26.5	Yes	Absent	Yes	1982	Unknown	Unknown	AD, SG
GalianoIslan	11	5	70.4	Yes	Absent	Yes	Unknow	Unknown	Unknown	AD, SG
GalianoIslan	11	5	46.5	N/A	Absent	Yes	Unknow	Unknown	Unknown	AD, SG
GalianoIslan	11	5	83.2	Yes	Absent	No	1881	Unknown	Unknown	AD, SG
GalianoIslan	11	5	62.7	Yes	Present	No	1870	6	1864	AD,SG

5.2 Figures

Figure 1: Dendrochronology assessment of District Lot 57

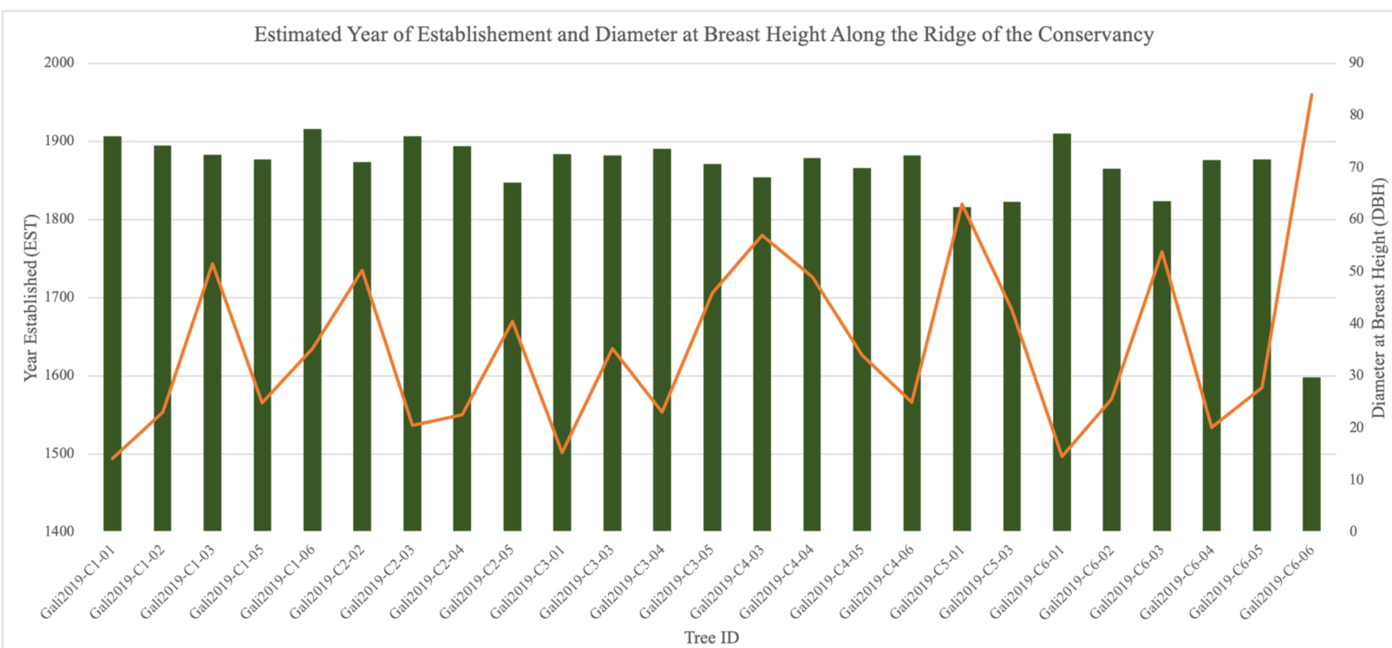


Figure 2: Estimated year of establishment and diameter at breast height comparison along the ridge of the conservancy

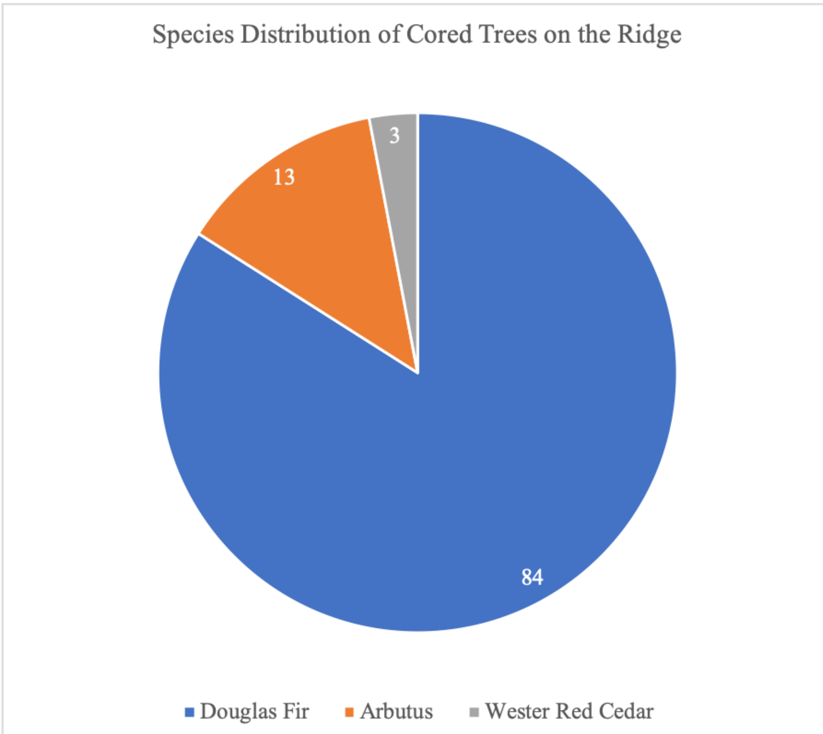


Figure 3: Species distribution of the trees cored along the ridge of the conservancy

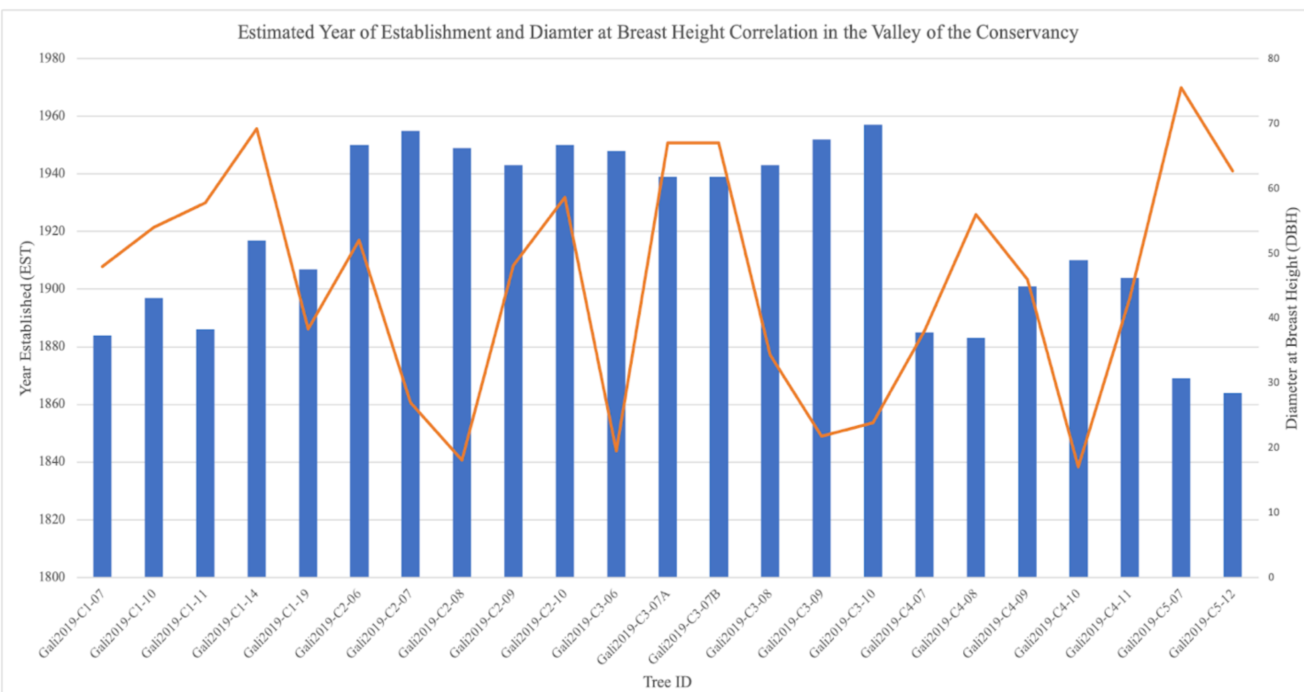


Figure 4: Diameter at breast height and estimated year of established comparison along the valley of the conservancy

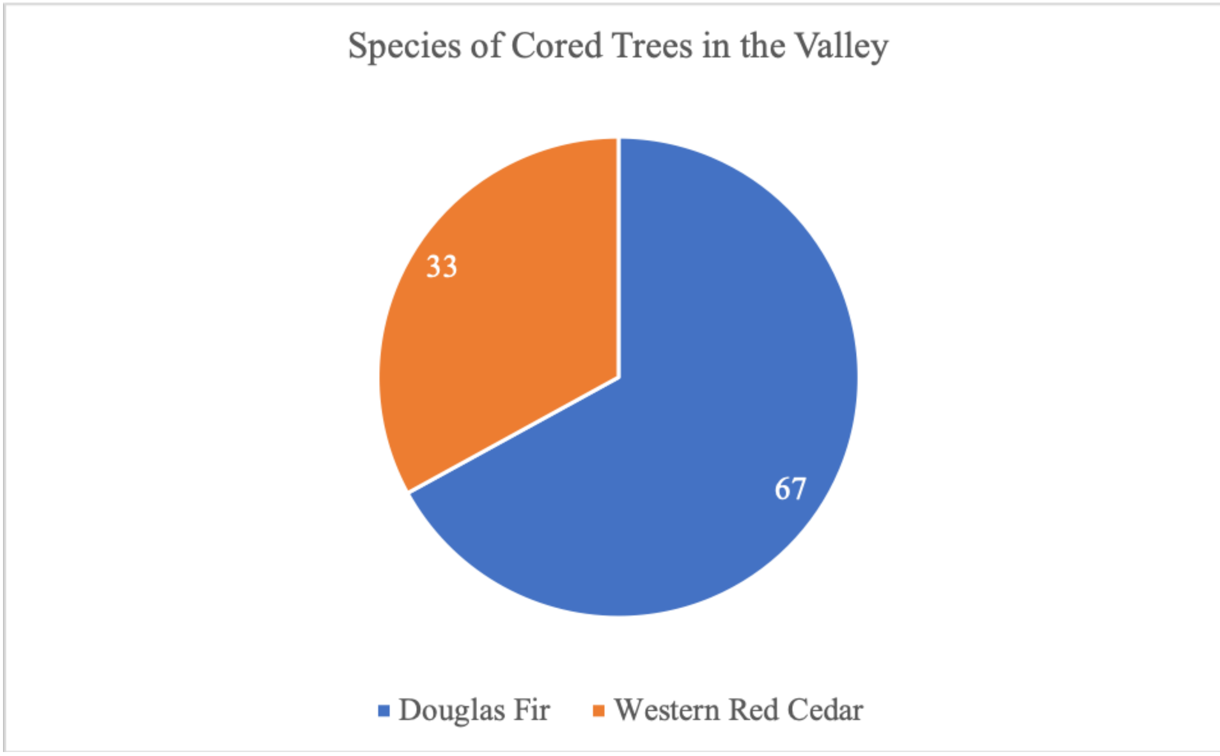


Figure 5: Species of cored trees in the Valley

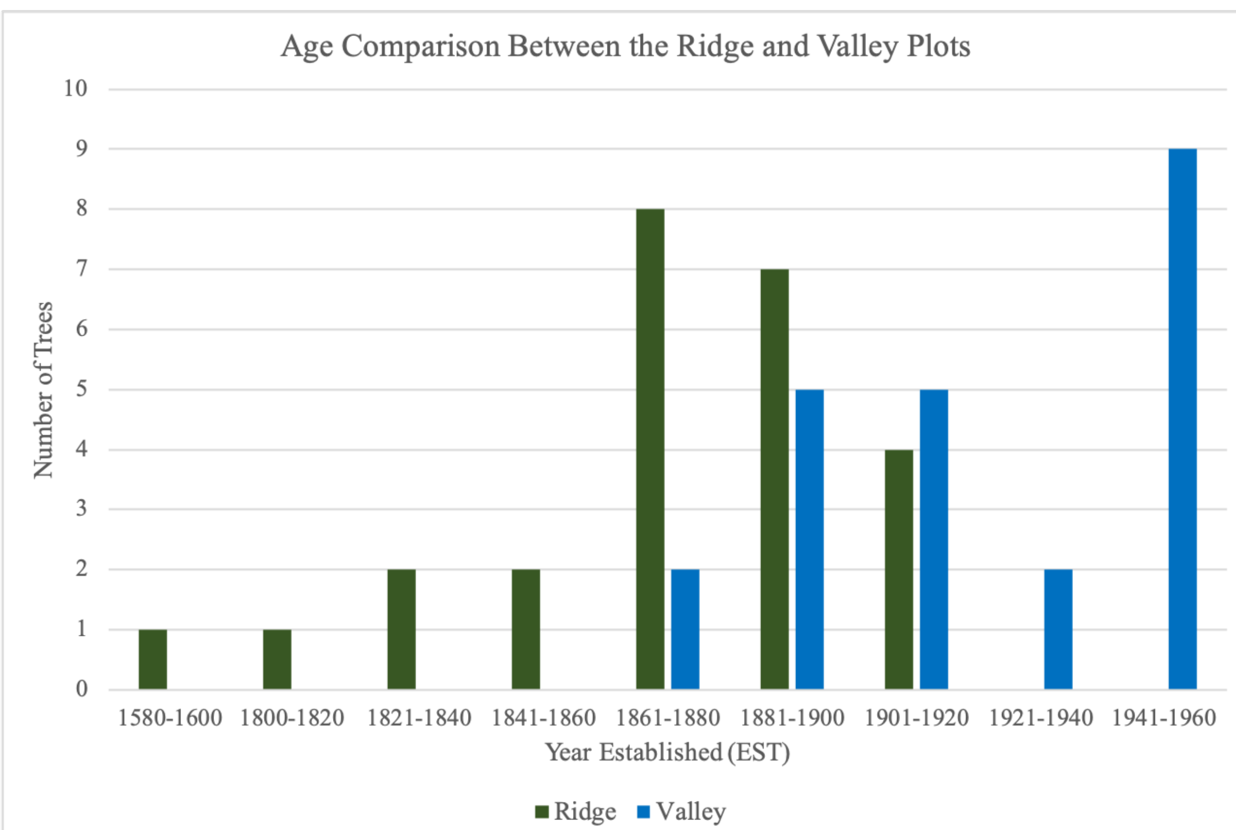


Figure 6: Age comparison between the ridge and valley

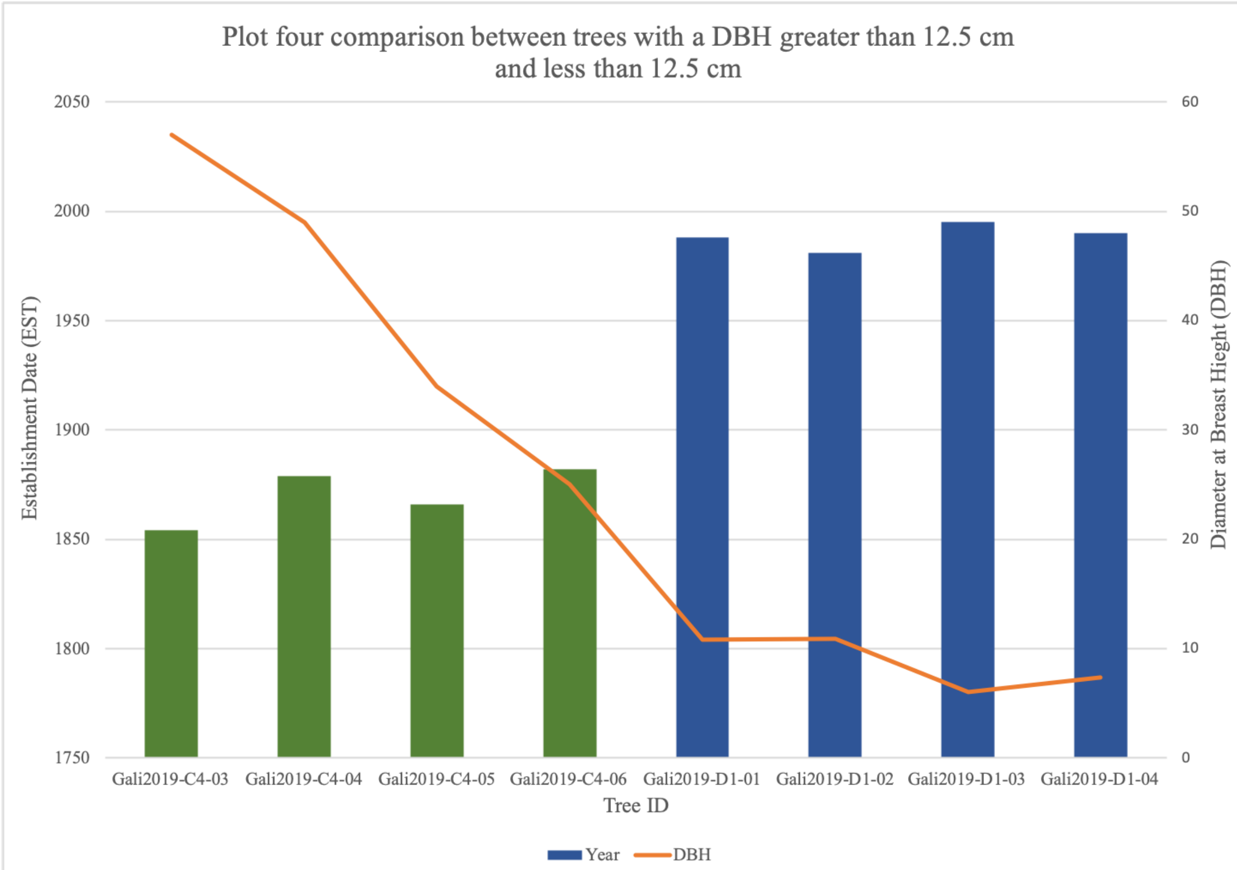


Figure 7: Comparison analysis of tree age and DBH on plot four

Introduction to Dendrochronology Assignment

Tree rings hold many secrets. We can use them to infer the age of a tree, the evolution and disturbance history of a forest stand. The climate history of a region and how landscapes have changed and been managed through time. In this assignment, we will use dendrochronology, the study of tree ring data, to begin to piece together the history of several forest stands on Galiano. By the end of this project you should be able to:

- Look for evidence of forest history such as fire scars, stumps and tree characteristics
- Use an increment borer to core a tree
- Process a tree core (munt, sand) and count the rings
- Do basic analysis of tree core data to determine tree age and general growth patterns
- Understand how more advanced analysis could be used to yield more detailed information

Part 1

Equipment:

- Increment tree borer (16-18")
- Tree coring starter kit (starter, WD-40, etc)
- DBH tape
- Reel tape measure
- Clipboard with Data sheet and pencil
- Field guide to trees

Instructions:

Working in groups of two, we will sample several different types of forest stands around the Learning Centre. Each team will sample two plots, using the n-tree sampling technique. For the purpose of this lab, we will use n=5 trees > 12.5cm diameter at breast height. In other words, you will measure the five trees >12.5cm DBH and species, and general site characteristics.

1. From the plot centre, use your tape measure to determine the distance to the closest tree >12.5cm. record the DBH of the tree (remember that DBH is measured at a height of 1.3m), the species, the canopy class, and note whether the tree is dead or alive
2. Carefully core the tree. Remember that increment borers are both fragile and expensive, so if in doubt please ask for help. Examine the core briefly and fill out core details on the data sheet. Place your core into a straw, and label the straw with the plot number, tree ID, and your initials.
3. Repeat until you complete 5 trees
4. Once all your trees are cored, take some time to record plot characteristics (slope aspect, position, etc.). also take some time to carefully observe the stand and make some notes. Do the trees seem to be the same size? Species? Or is it mixed? Is there any evidence of fire? Stumps? Record your observations.
5. Complete the same process for a second stand.

Part 2

After collecting cores, dendrochronologist allow them to dry for several days before mounting and sanding so that the cores don't crack or shrink unevenly. As we don't have time for this, we will glue and mount them right away, so that the glue can dry overnight before sanding in the morning. You will notice that some of the cores will crack and we will do our best to account for this as we count them.

Equipment:

- Core mounts & glue
- Sander
- Magnifying glass and/or low-power microscope
- Sharpe
- Lead pencil & eraser

Instructions:

1. After collecting the cores glue your cores onto the core mounts so that they have time to dry overnight. Remember to label them with the plot number, core ID, and your initials. Each team should be able to mount all ten cores onto the same wooden core mount.
2. The next day sand down your cores so that they are flush with the core mount boards.
3. Inspect your cores (notice how much easier they are to count once sanded!). are the rings all the same size? What patterns do you notice?
4. Count the rings. Start from the outermost ring (nearest the bark), this should be 2019 growth. Out 1 dot on the core mount every decade (2010, 2000,19990, etc.) to make counting easier. Place 3 dots for every century (2000,1900,1800, etc.) and 2 dots for every half century (1950,1850,1750, etc.). for narrow rings, you may need to use the magnifying glass or microscope.
5. Discuss your findings with your partner. Are all the trees the same age? How do your two plots differ? Do the patterns in rings width size suggest anything? Do different species exhibit different growth patterns?
6. As a class, we will construct histograms of tree age by species for each of the tree stands and together piece together the history of the stands.

Deliverable (one report per team): Write a one-page consultant's report, describing your findings. The audience for a consultant's report is generally a busy upper-level manager, so your report should be short and snappy. Use good headers to summarize the main message of each section. The report should briefly describe what you did, the results, and your interpretation. What is the history of each of the stands you sampled? Do you have any recommendations for how the stand could be managed or restored based on your finds?

Format: Consultant's report, max 1 page of text plus 1 page of graphs or other supporting evidence.

Deadline: Thursday June 2t, 6pm. Submit either a printed version or by email to mariapcatanzaro@gmail.com. This assignment is worth 15% of the total course evaluation.

5.4 Dendrochronology Field Notes

Introduction to Dendrochronoly - Galiano Island 2019

Site Name: ______

Plot 1 Notes:	Latitude: ______	# of Snags P1 P2	Date:
Slope Aspect (degrees) of Plot 1:	Longitude: ______	# of Stumps P1 P2	Crew:
Slope Angle (degrees) of Plot 1:	Elvation: ______		
Slope Position Plot 1: upper slope - middle slope - lower slope Surface Shape Plot 1: convex - level - concave		# of trees <12.5cm P1 P2	Fire Scar Evidence:
Plot 2 Notes:	Latitude: ______		
Slope Aspect (degrees) of Plot 2:	Longitude: ______		
Slope Angle (degrees) of Plot 2:	Elvation: ______		
Slope Position Plot 2: upper slope - middle slope - lower slope Surface Shape Plot 2: convex - level - concave			

General Tree Information

Site Name	Plot Number	Tree ID	Tree Species	Distance From Centre (m)	Live or Dead	DBH (cm)	Canopy Class D,C,I,S	Bole Damage Y/N

Increment Cores

Core ID	Core Height (cm)	Dia at Core HT (cm)	Bark (Y/N)	Pith / Arcs (P/A)	Heartwood Decay (Y/N)	Notes

Translating Tree Rings: Introduction to Dendrochronology

Galiano Island Field Study

Spencer Bronson
Jeanine Rhemtulla

June 25th 2019

TREE RING LAB at UBC

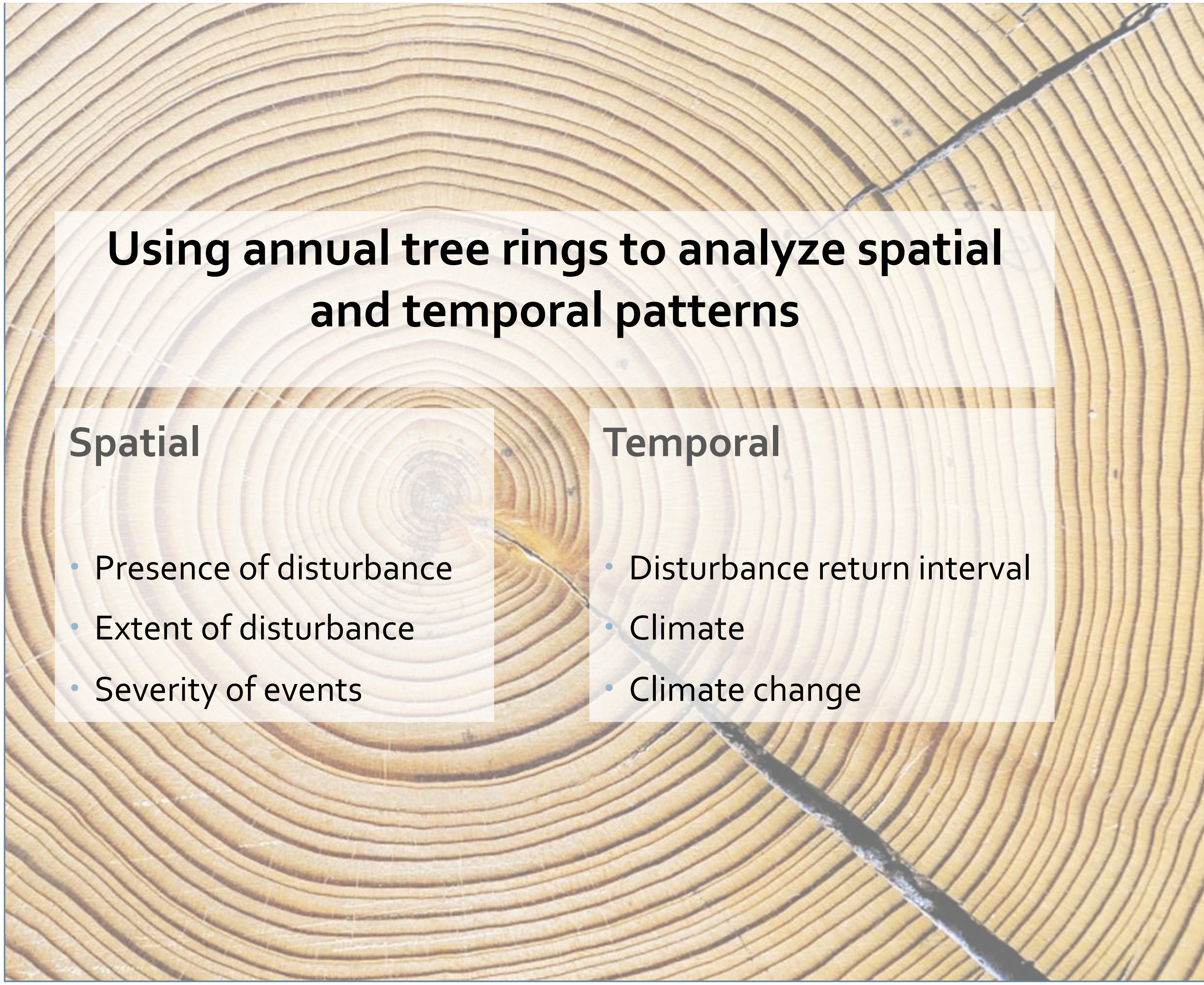
forestry university of british columbia

Why Core Trees?

- Trees provide information about the past
  - Long lifespan (generally)
- Growth is distinctly separated
  - Where seasons are unique
- We can use this information to quantify changes
- We can make predictions for what the future holds

Courtesy of Ashley Dobko and Wayne Point

Dendrochronology



Using annual tree rings to analyze spatial and temporal patterns

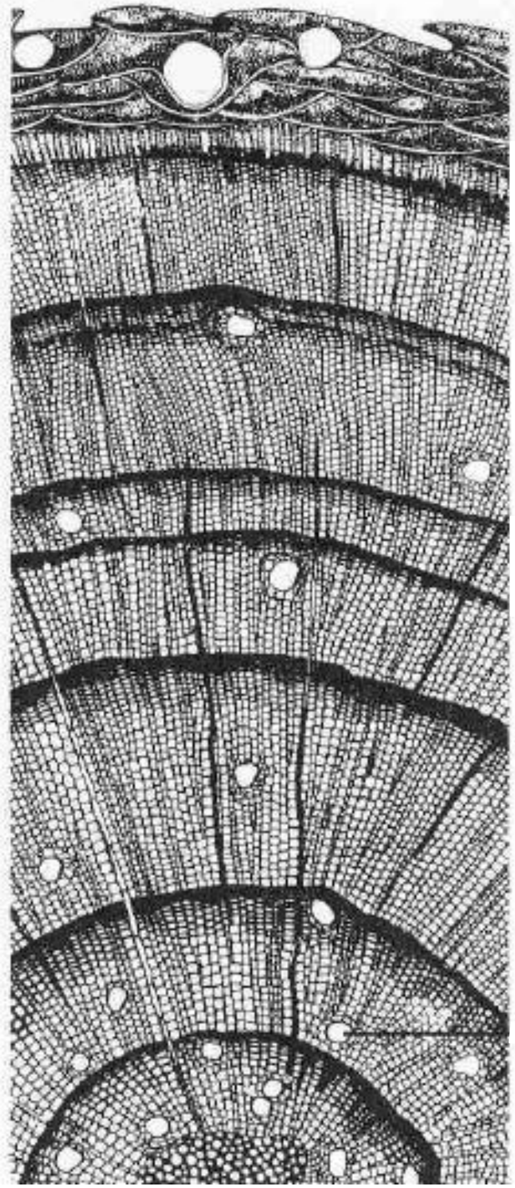
Spatial

- Presence of disturbance
- Extent of disturbance
- Severity of events

Temporal

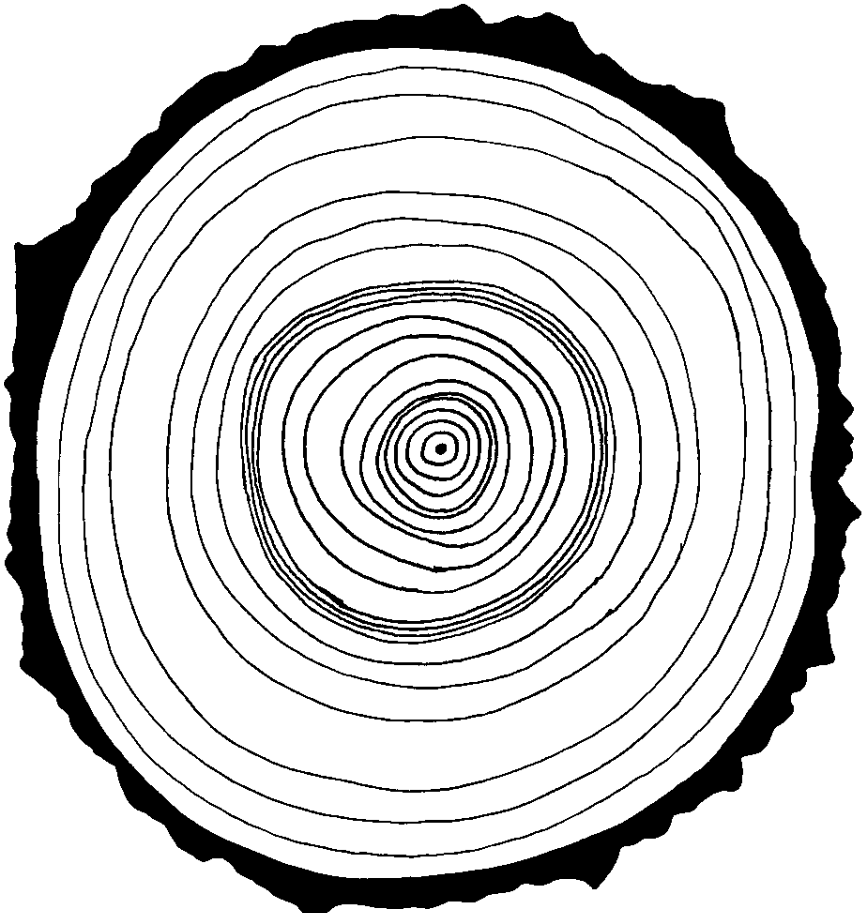
- Disturbance return interval
- Climate
- Climate change

Tree Rings



Tree Growth

- Trees respond to variability in growing conditions by producing larger or smaller annual rings



Reasons for Difference in Ring Size

Larger Rings

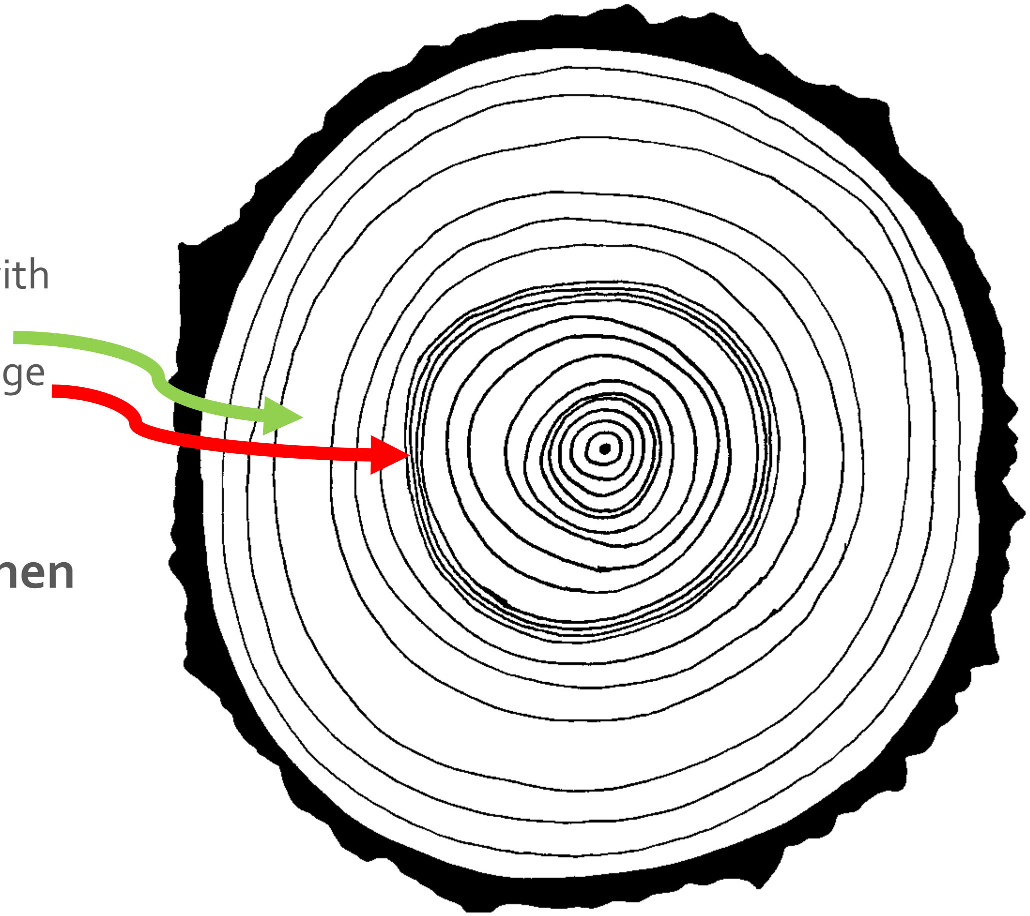
- Extended growing season
- Early snowmelt
- High nutrient availability
- Enough precipitation
- Death of competing trees

Smaller Rings

- Drought
- Damage to foliage
- Colder growing season
- Volcanic activity
- Infection or pest activity

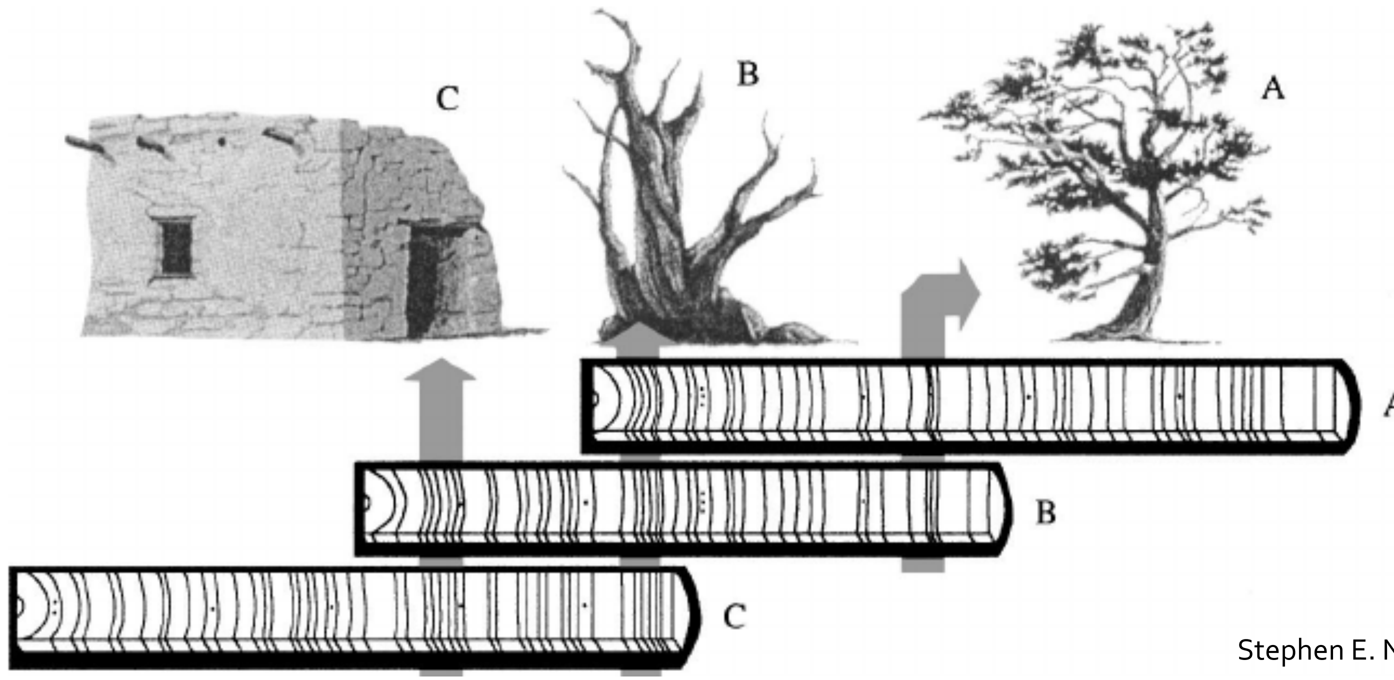
Marker Rings

- Annual rings with above average or below average growth
- **Essential when crossdating**



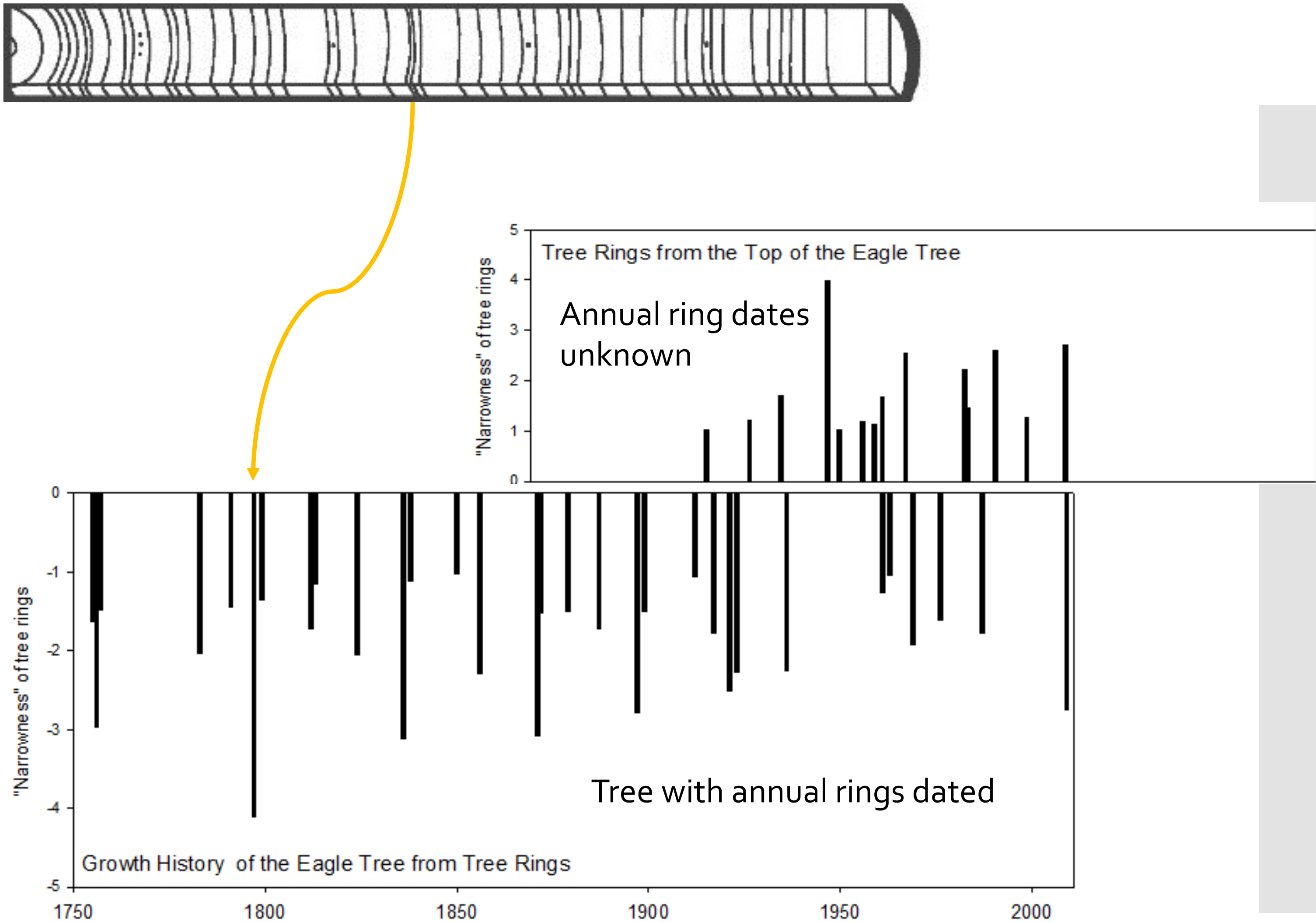
Crossdating

- Essential in Dendrochronology
- Pattern matching of annual ring from sample to sample
  - Or against many hundreds of samples in a chronology

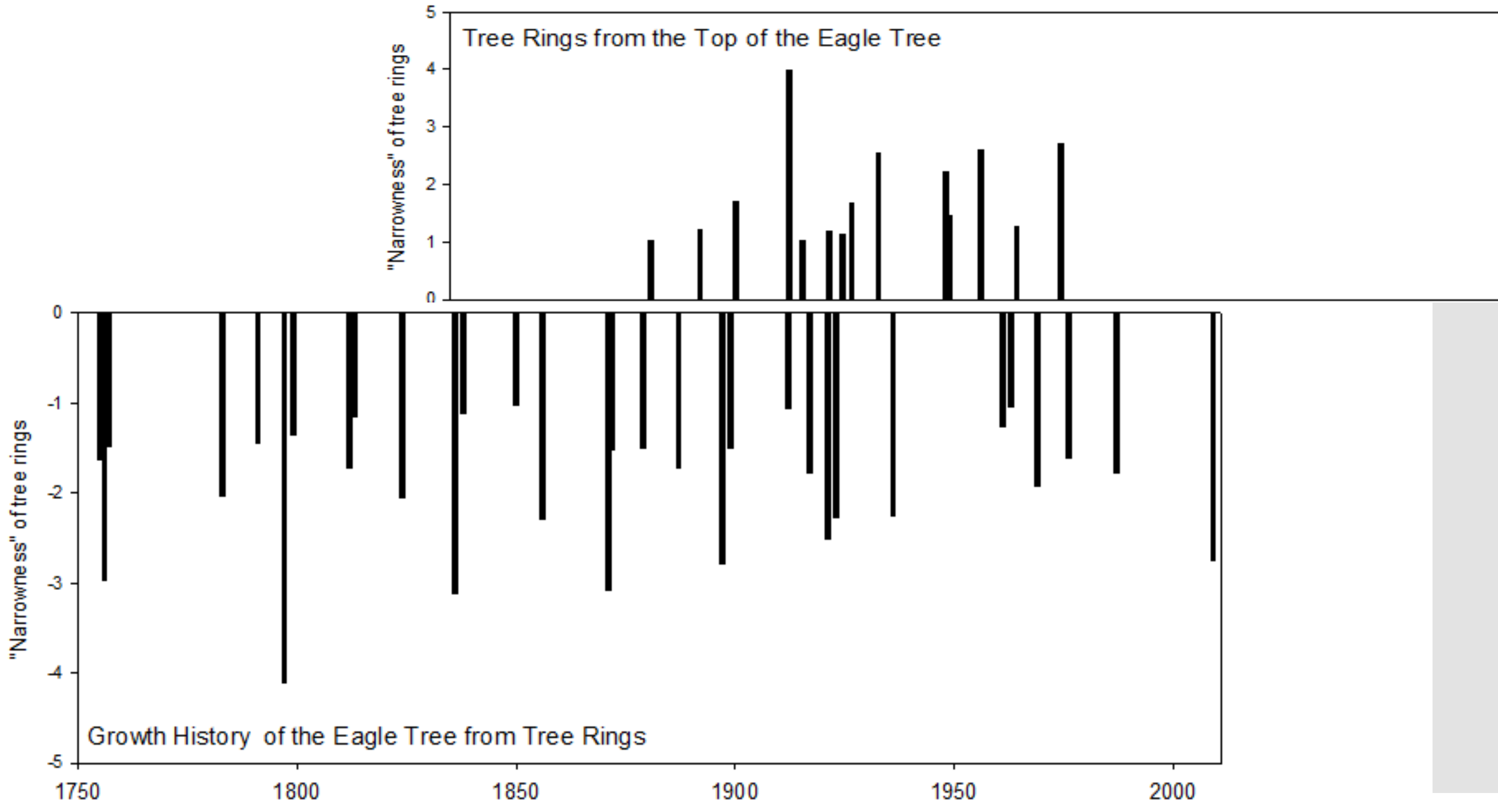


Stephen E. Nash

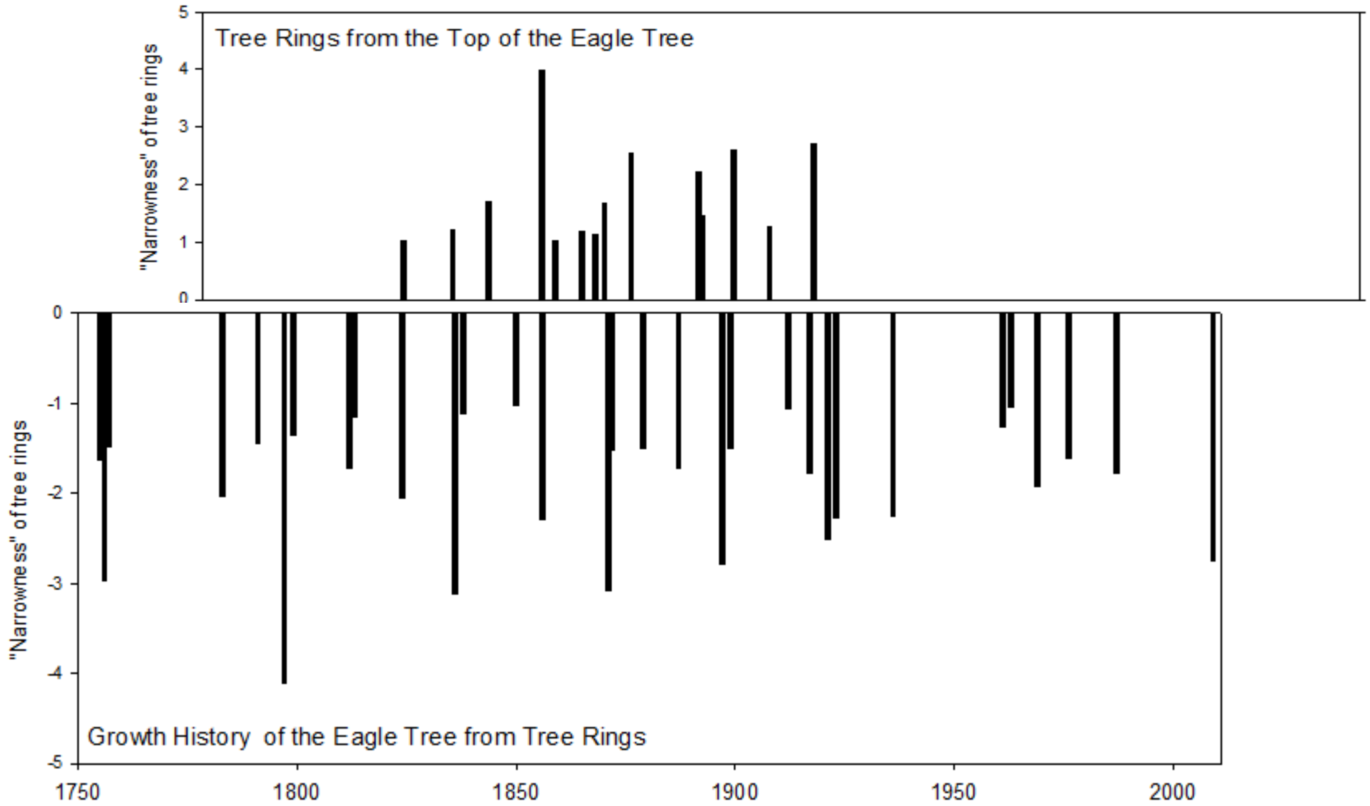
Crossdating



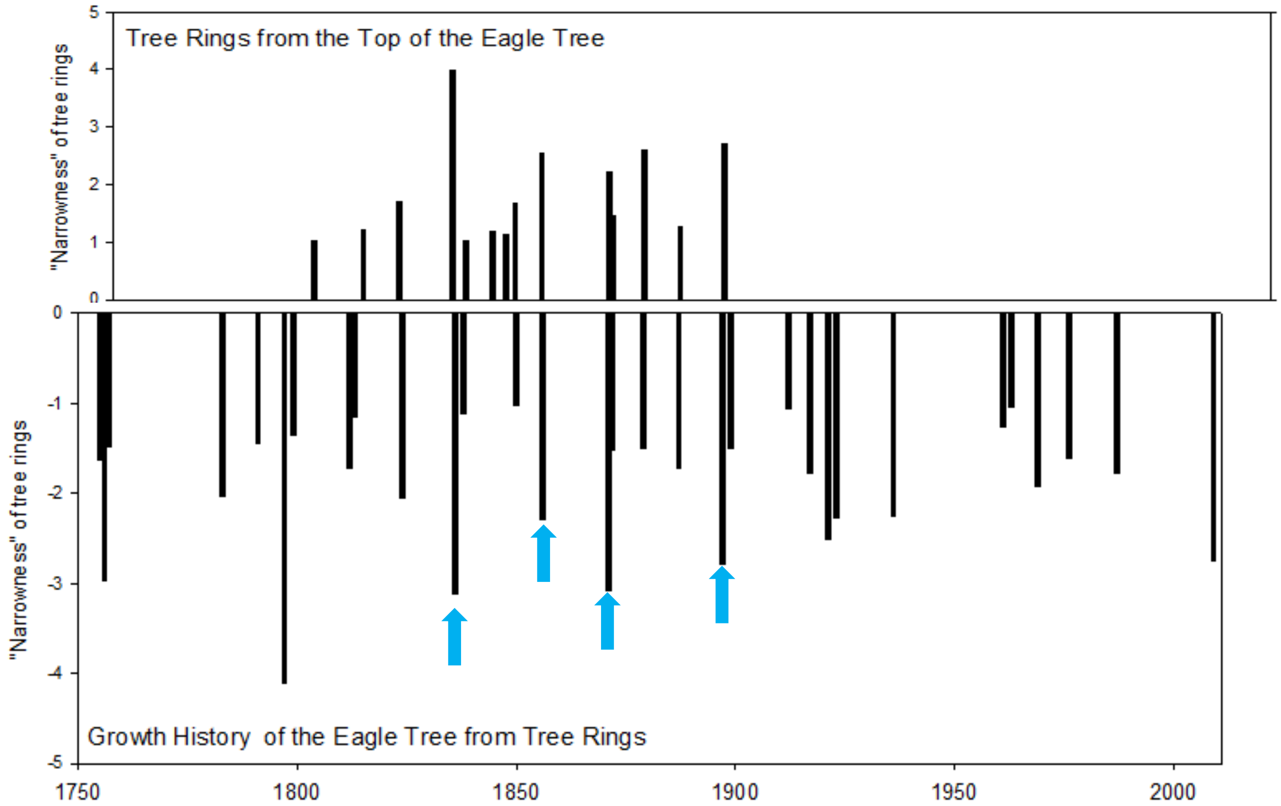
Crossdating



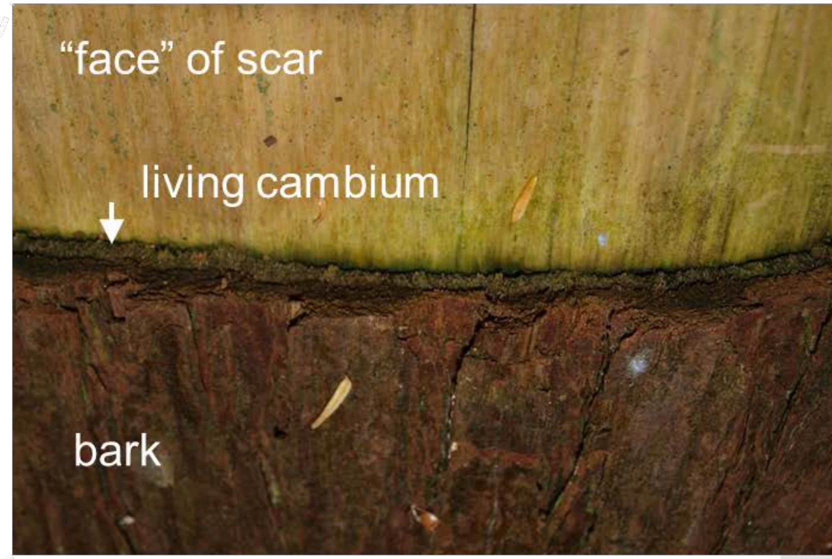
Crossdating



Crossdating



Culturally Modified Tree



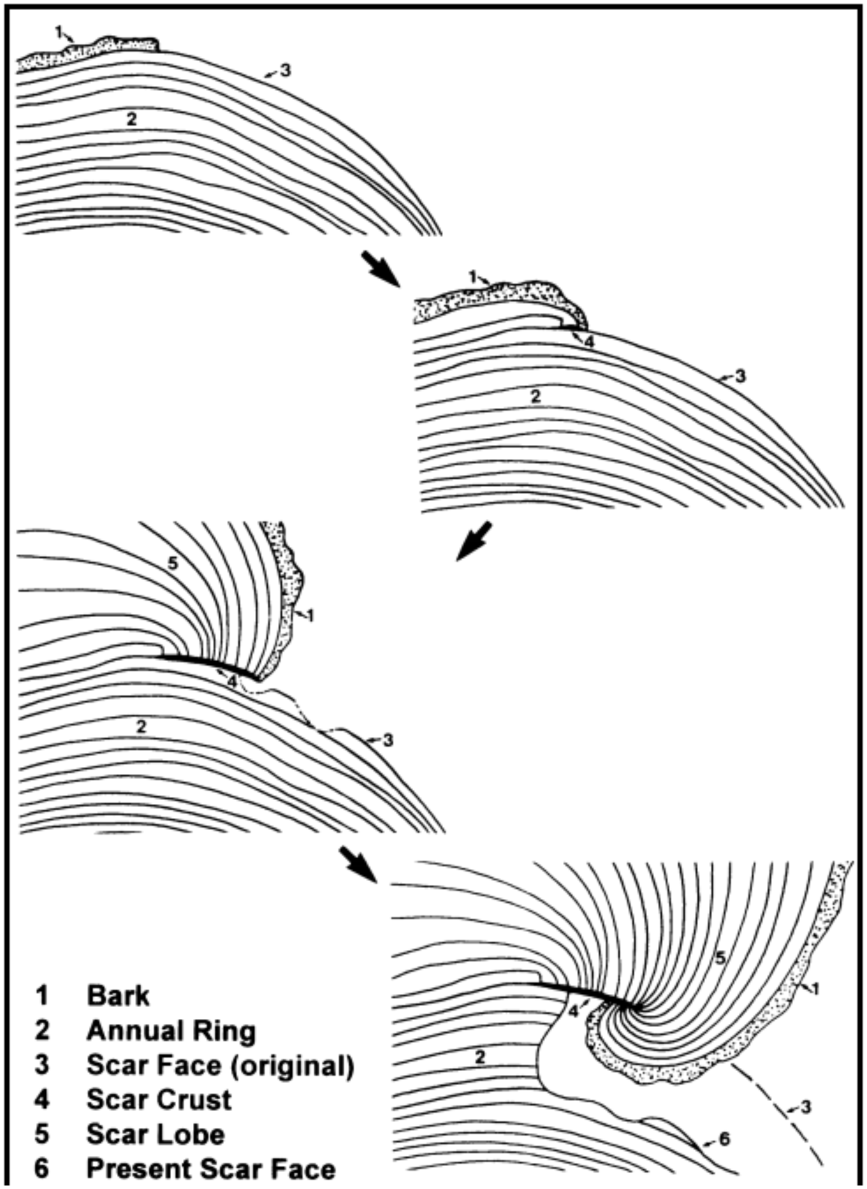
Culturally Modified Tree

Immediately Following Bark Stripping

2 Years After Bark Stripping

12 Years After Bark Stripping

22 Years After Bark Stripping



Revised from the *Culturally Modified Trees of British Columbia* Handbook

Coring and Culturally Modified Trees

From the *Culturally Modified Trees of British Columbia* Handbook

Dendroarcheology

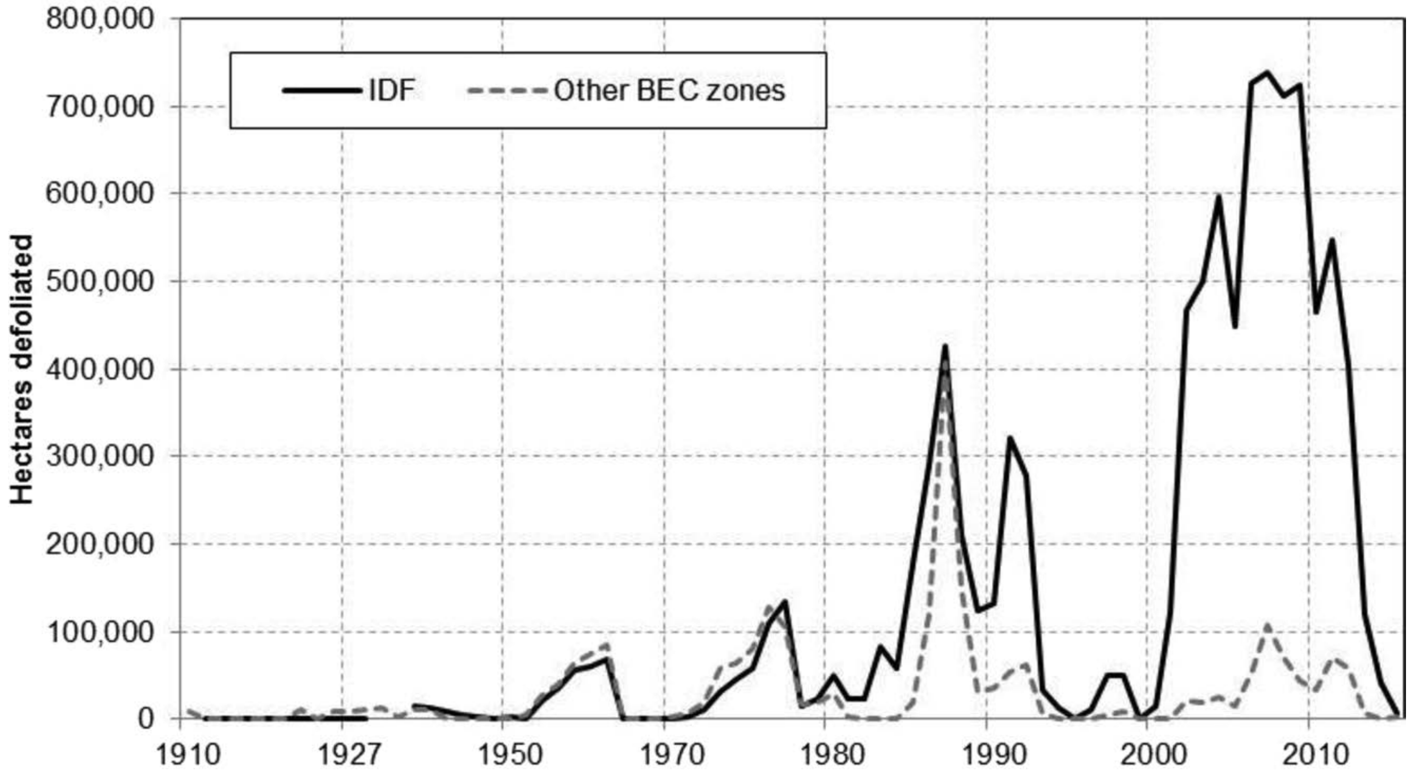
Big house posts + beams
Kiix?in World Heritage Site
Vancouver Island, BC

Thanks to the University of Victoria Tree Ring Lab for sharing these results

Insect Outbreaks

- Defoliation injures trees
  - Recorded within tree rings
- Can reconstruct return intervals
- Can determine if current outbreaks are unprecedented

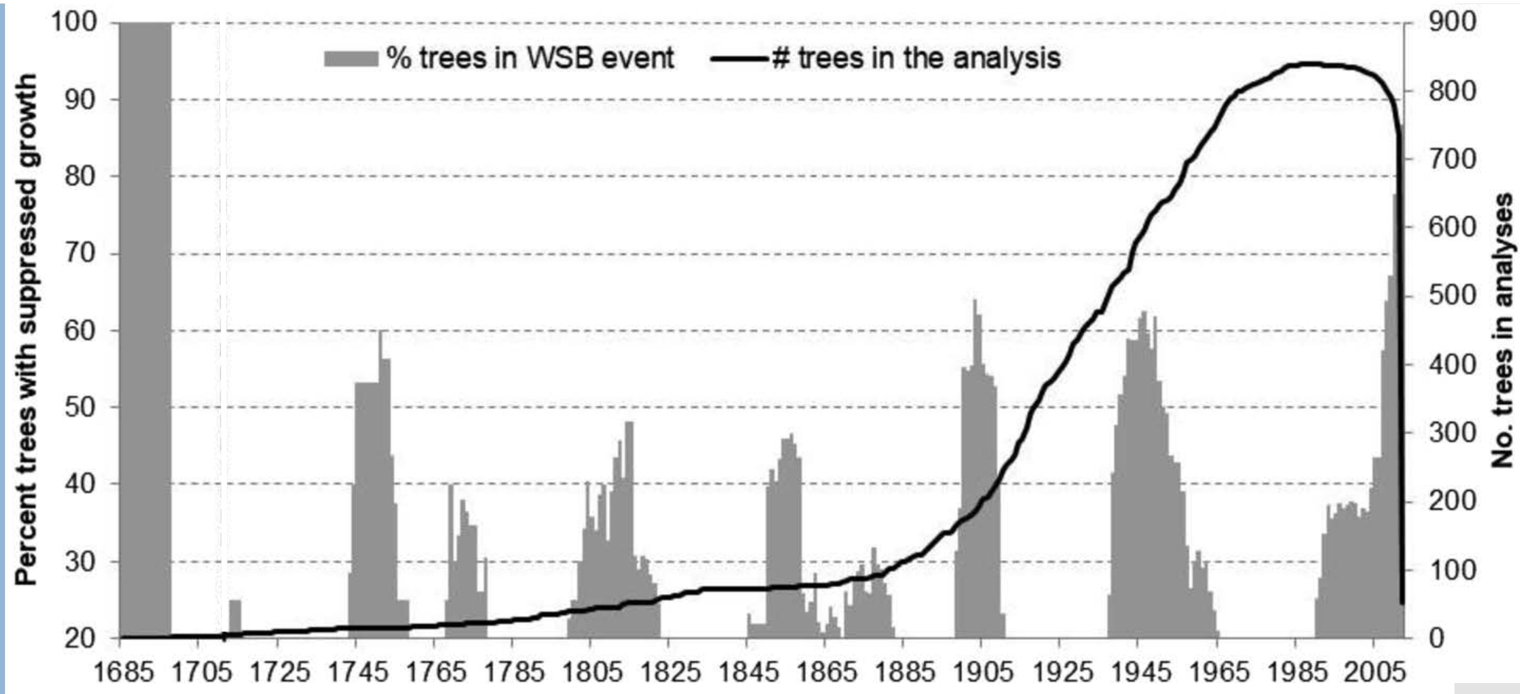
Outbreaks Through Aerial Photography



Hectares defoliated by WSB in British Columbia as recorded in the annual aerial overview. Comparing Interior Douglas-fir (IDF) biogeoclimatic ecosystem classification (BEC) zone with all other BEC zones combined.

Maclauchlan et al. 2018
Published in Can. J. For. Res. 48:783-802.
DOI: 10.1139/cjfr-2017-0278

Outbreaks Through Tree Rings



Consolidated outbreak chronology for southern B.C., with percent trees recording growth suppression from a WSB outbreak.

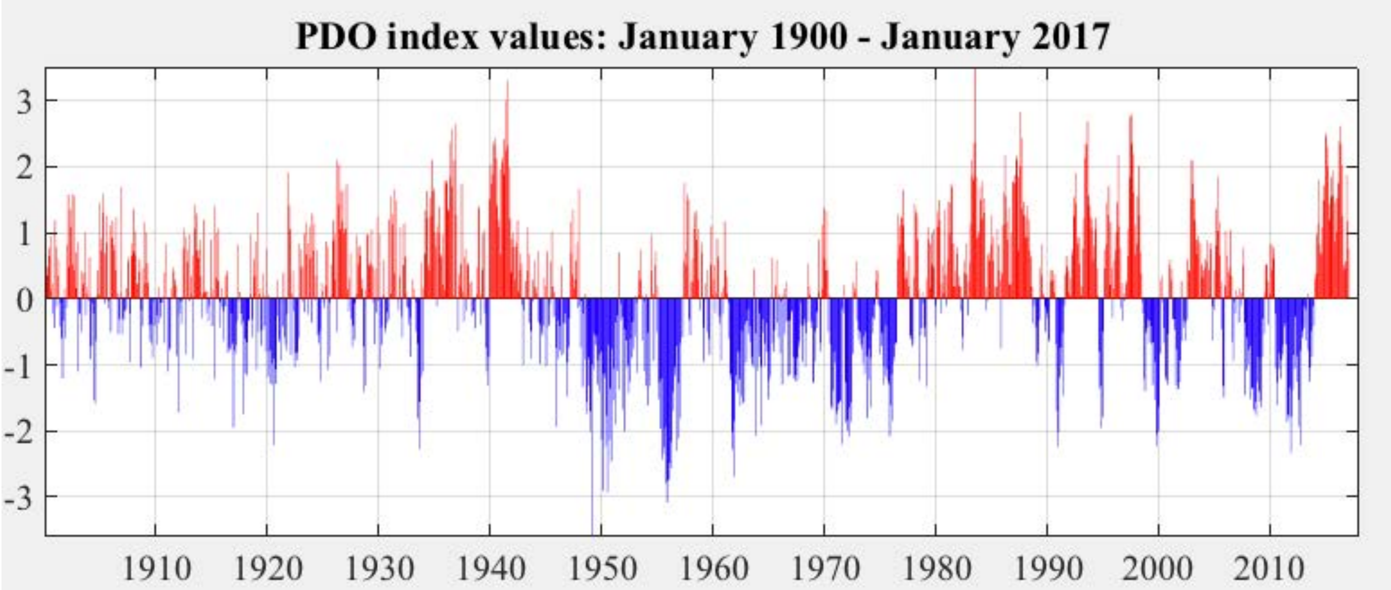
Maclauchlan et al. 2018
Published in Can. J. For. Res. 48:783-802.
DOI: 10.1139/cjfr-2017-0278

Climate and Tree Growth – Haida Gwaii Yellow Cedar

Climate and Tree Growth – Haida Gwaii Yellow Cedar

Annual growth response to shifts sea surface temperatures

- Pacific Decadal Oscillation
- Warm wet phase = larger rings
- cold dry phases = smaller rings



Nate Mantua, Joint Institute for the Study of the Atmosphere and Ocean

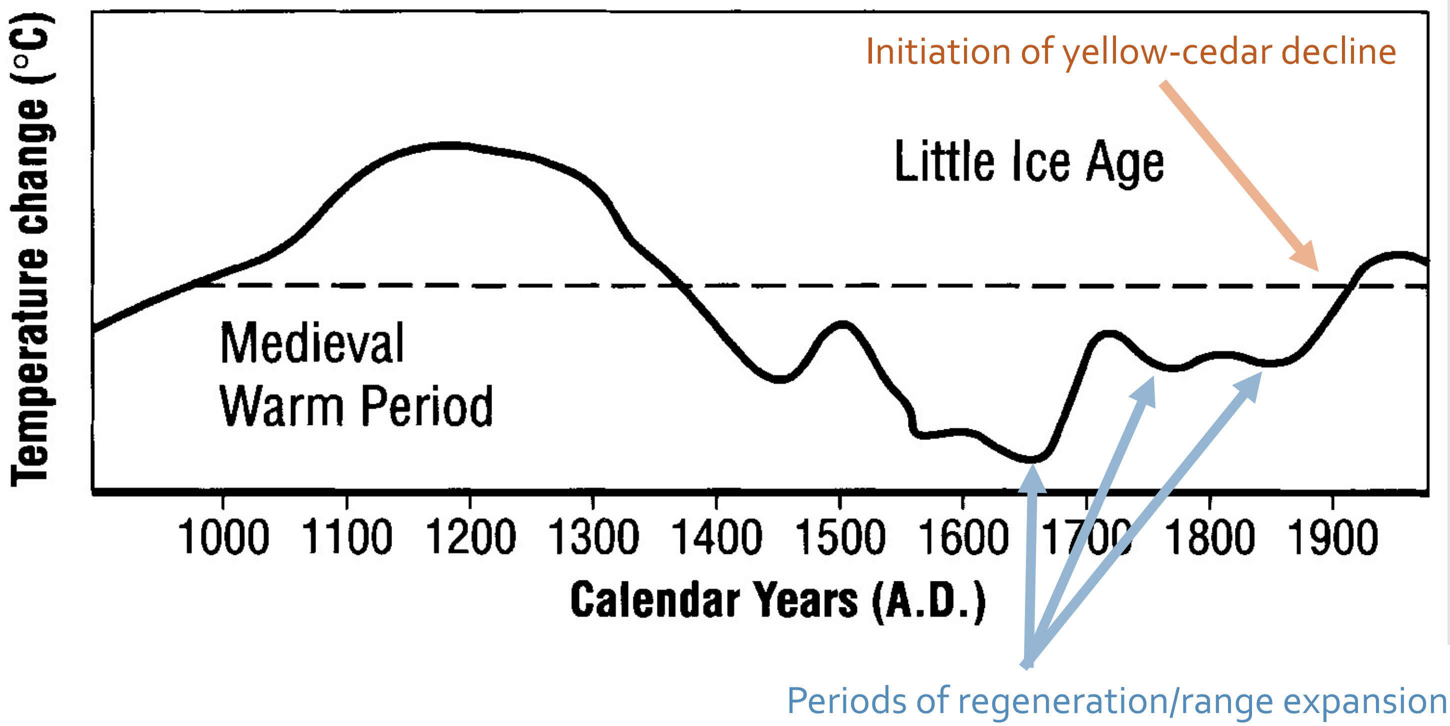
Climate and Tree Growth – Haida Gwaii Yellow Cedar

Many trees have a similar date of initiation

- Cold periods of the Little Ice Age

Large number of trees have similar date of death

- End of the little ice age



Modified from USDA Forest Service, Alaska Region

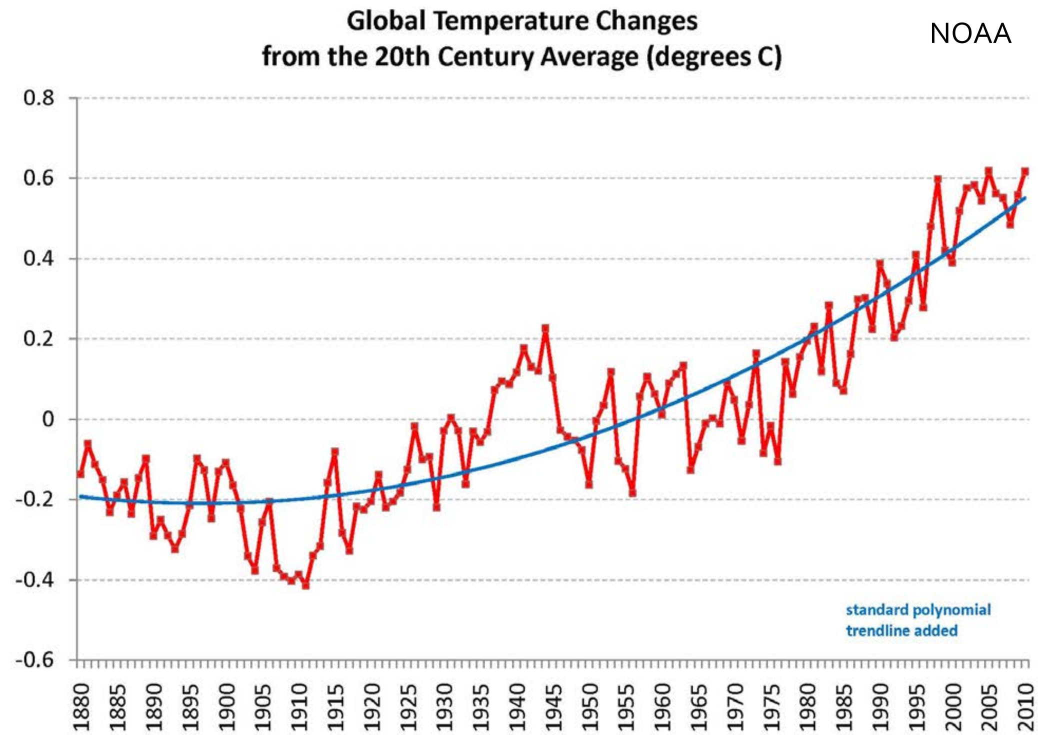
Climate and Tree Growth – Haida Gwaii Yellow Cedar

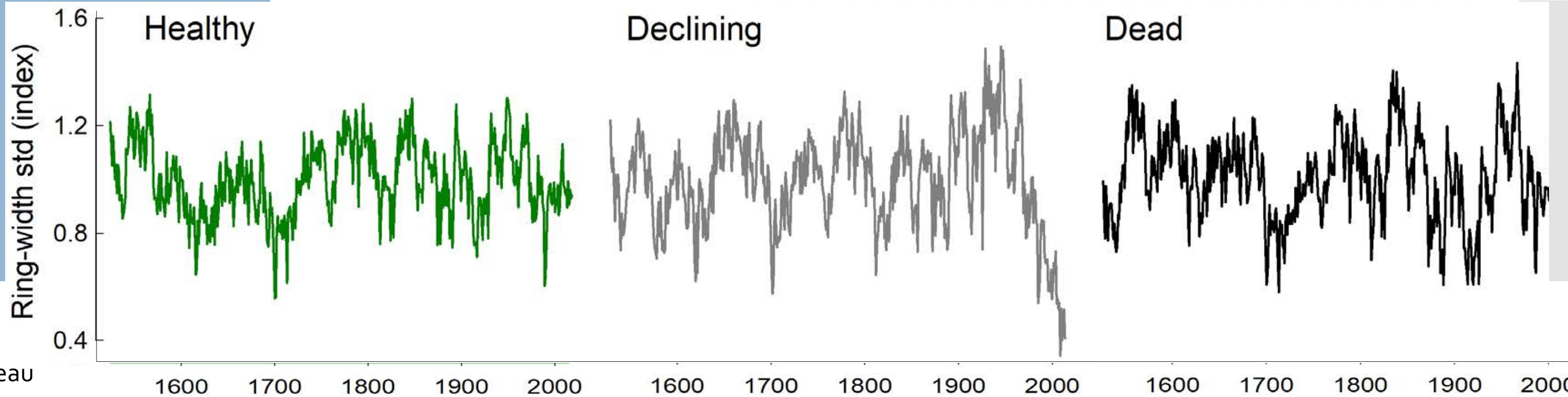
Climate and Tree Growth – Haida Gwaii Yellow Cedar

Mortality has been increasing
- Anthropogenic climate change

- **Change in annual growth precedes death**

NOAA





Vanessa Comeau

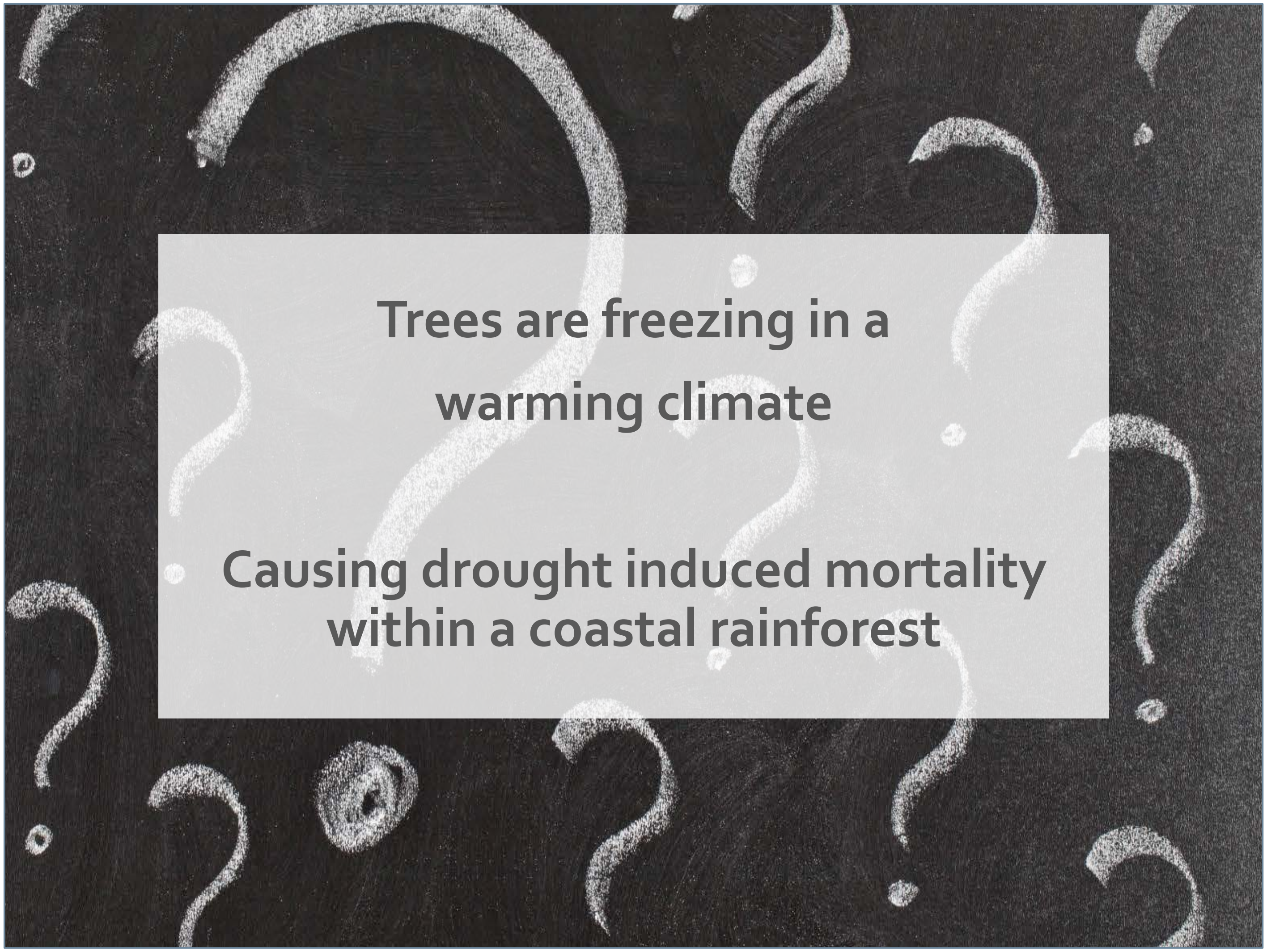
Climate and Tree Growth – Haida Gwaii Yellow Cedar

Knowing this, what are the series of events leading to decline?

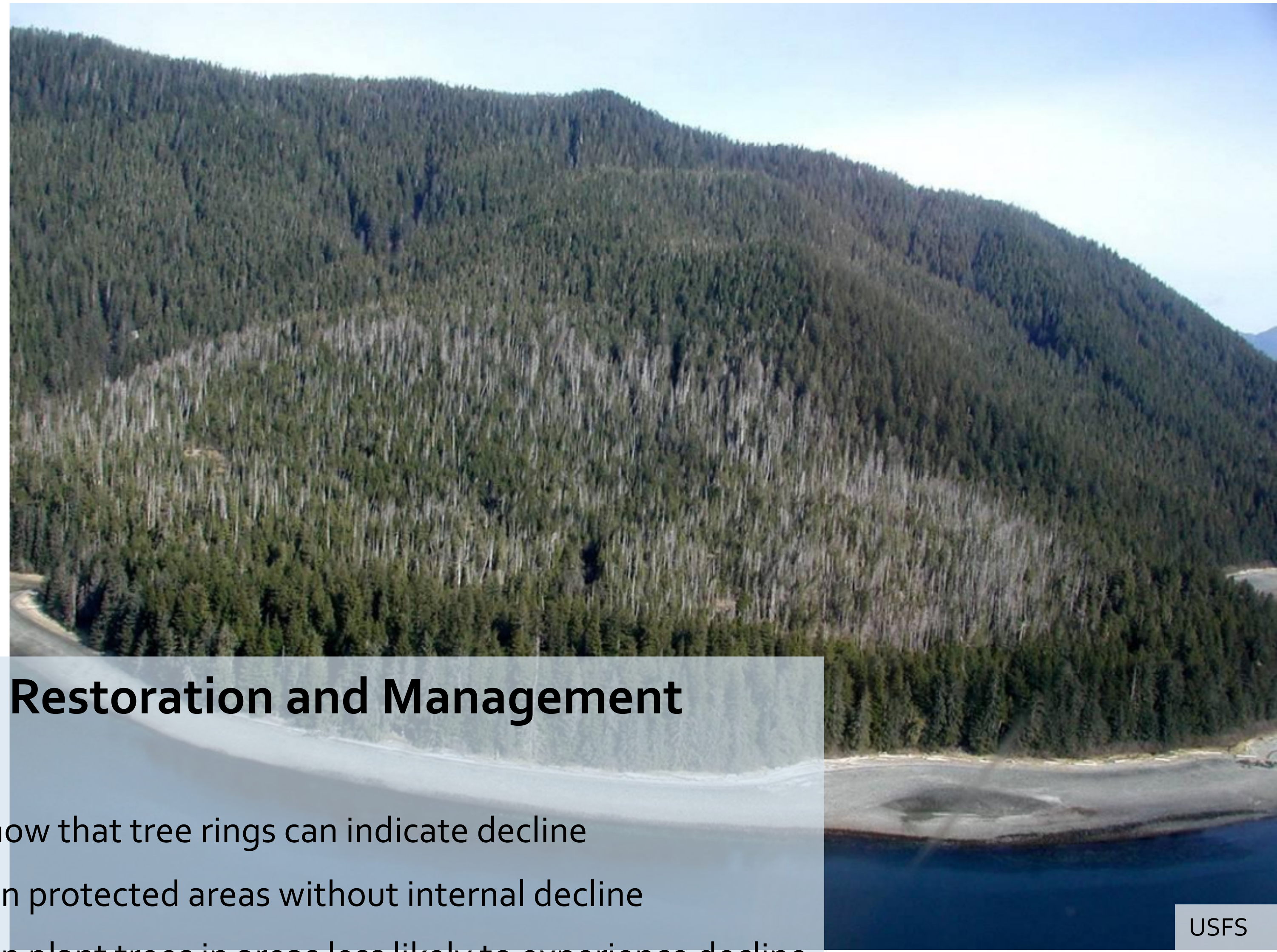
- Warmer temperatures = less snow
- Less snow = earlier root activity
- Active roots = susceptible to freezing
- Damaged roots = reduced water intake
- Trees suffer from drought

- Internal symptom of decline

Climate and Tree Growth – Haida Gwaii Yellow Cedar



Climate and Tree Growth – Haida Gwaii Yellow Cedar



Restoration and Management

- We know that tree rings can indicate decline
- We can protected areas without internal decline
- We can plant trees in areas less likely to experience decline

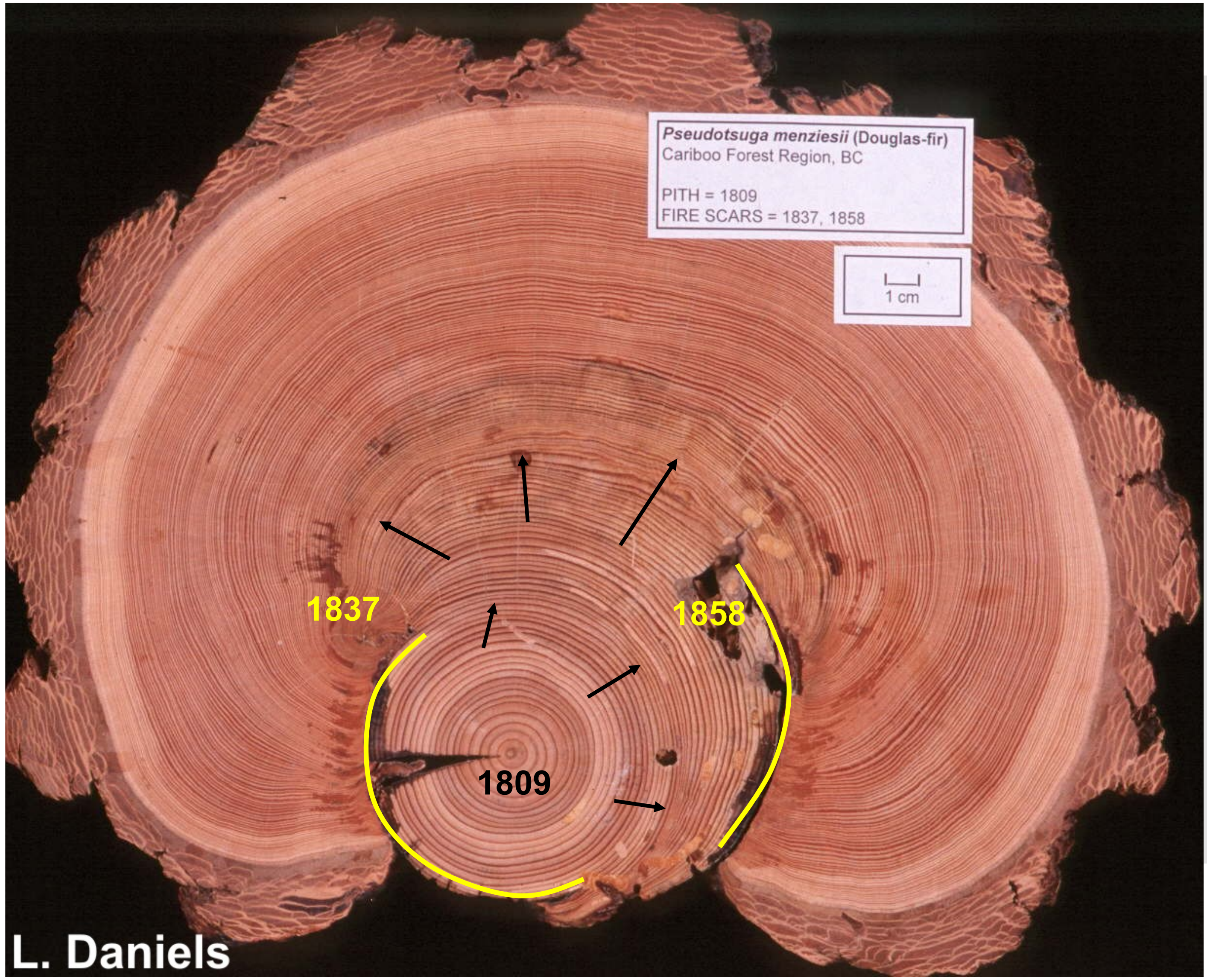
Wildfires


Variable in intensity,
extent, reoccurrence
Washington Department of Natural Resources

Dendropyrochronology

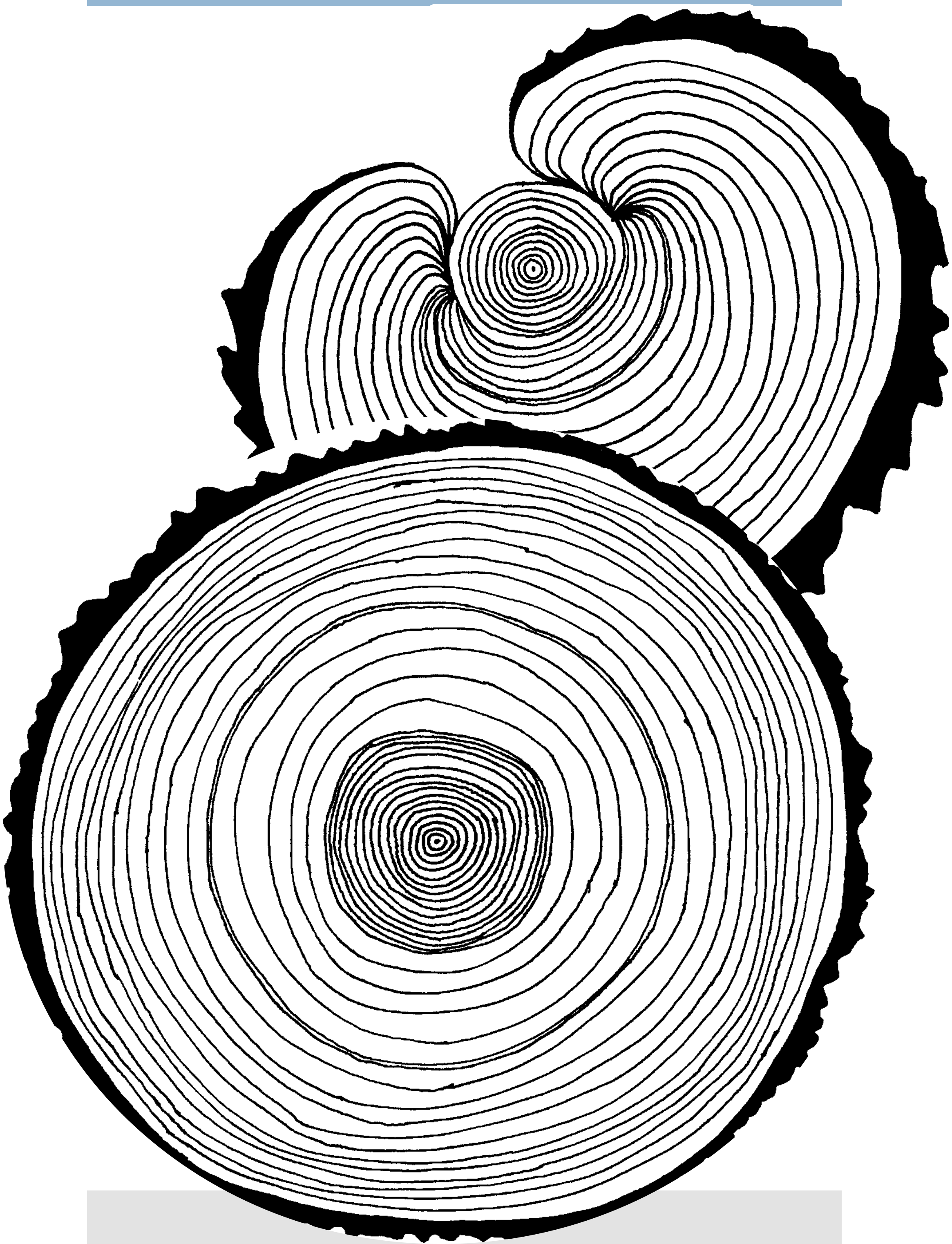
Photo: L. Daniels

Dendropyrochronology
Fire Scars

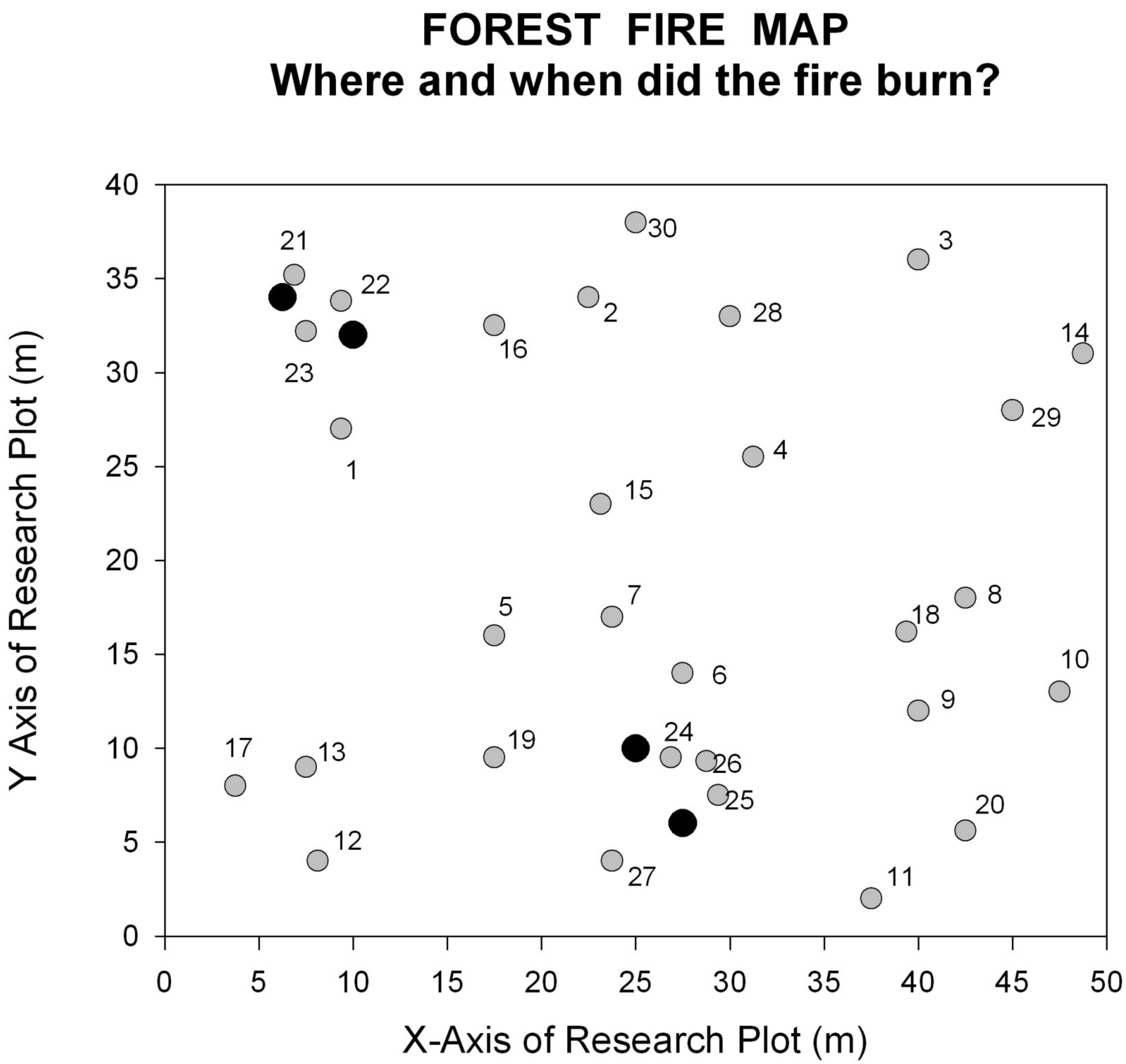


Dendropyrochronology Regeneration and Cohorts

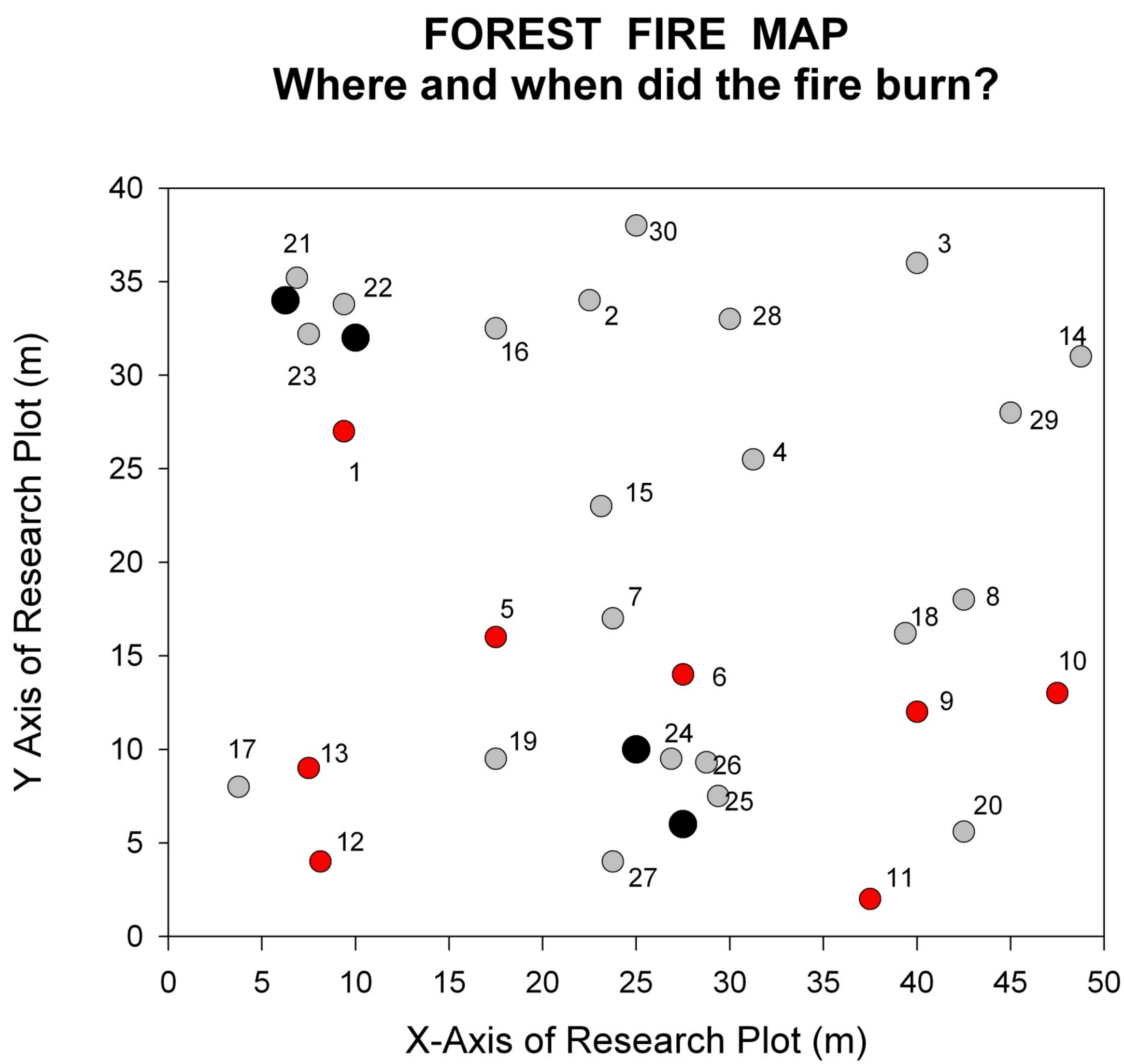
Dendropyrochronology Releases



Mapping Fire

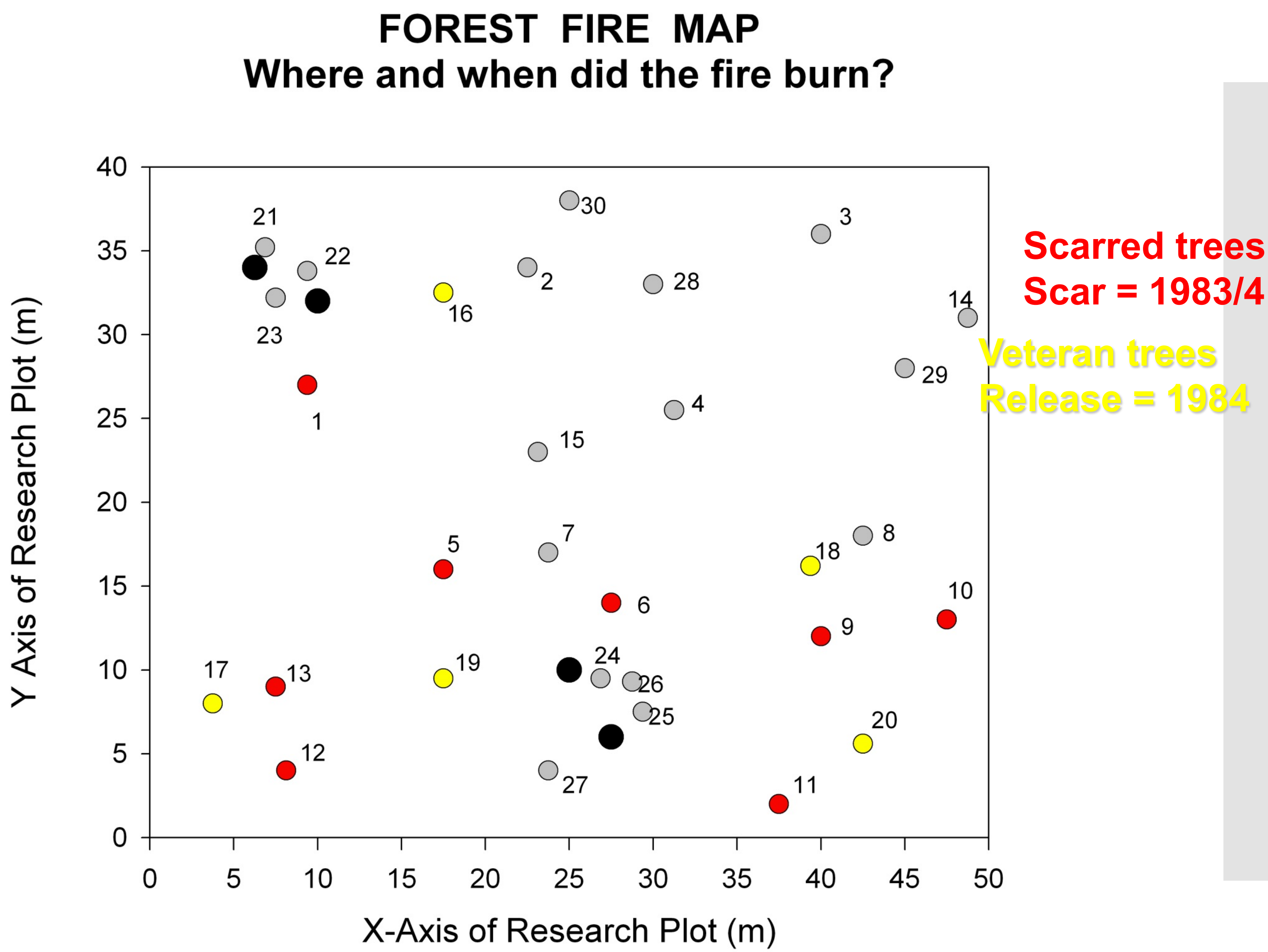


Mapping Fire

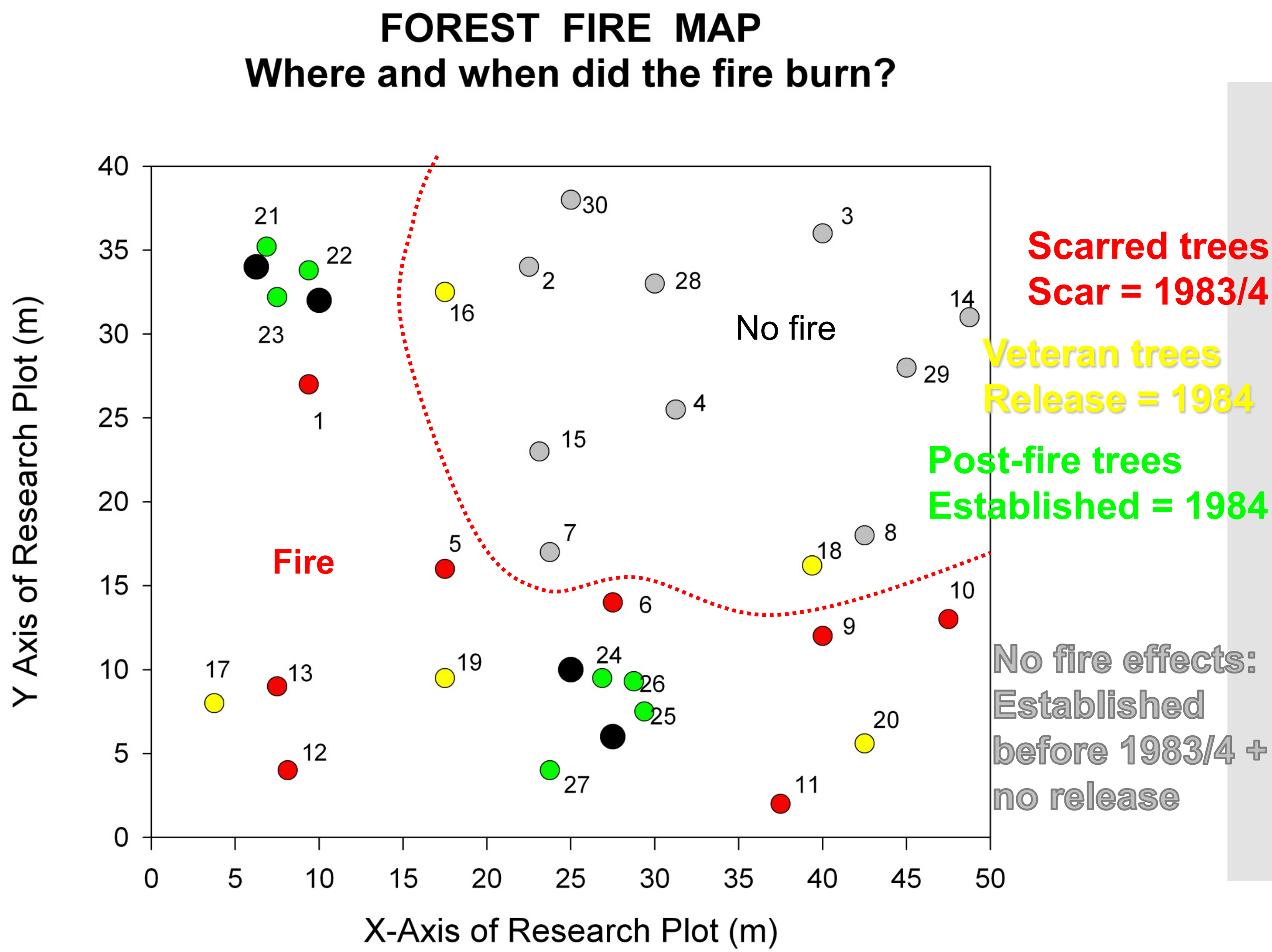


Scarred trees
Scar = 1983/4

Mapping Fire



Mapping Fire



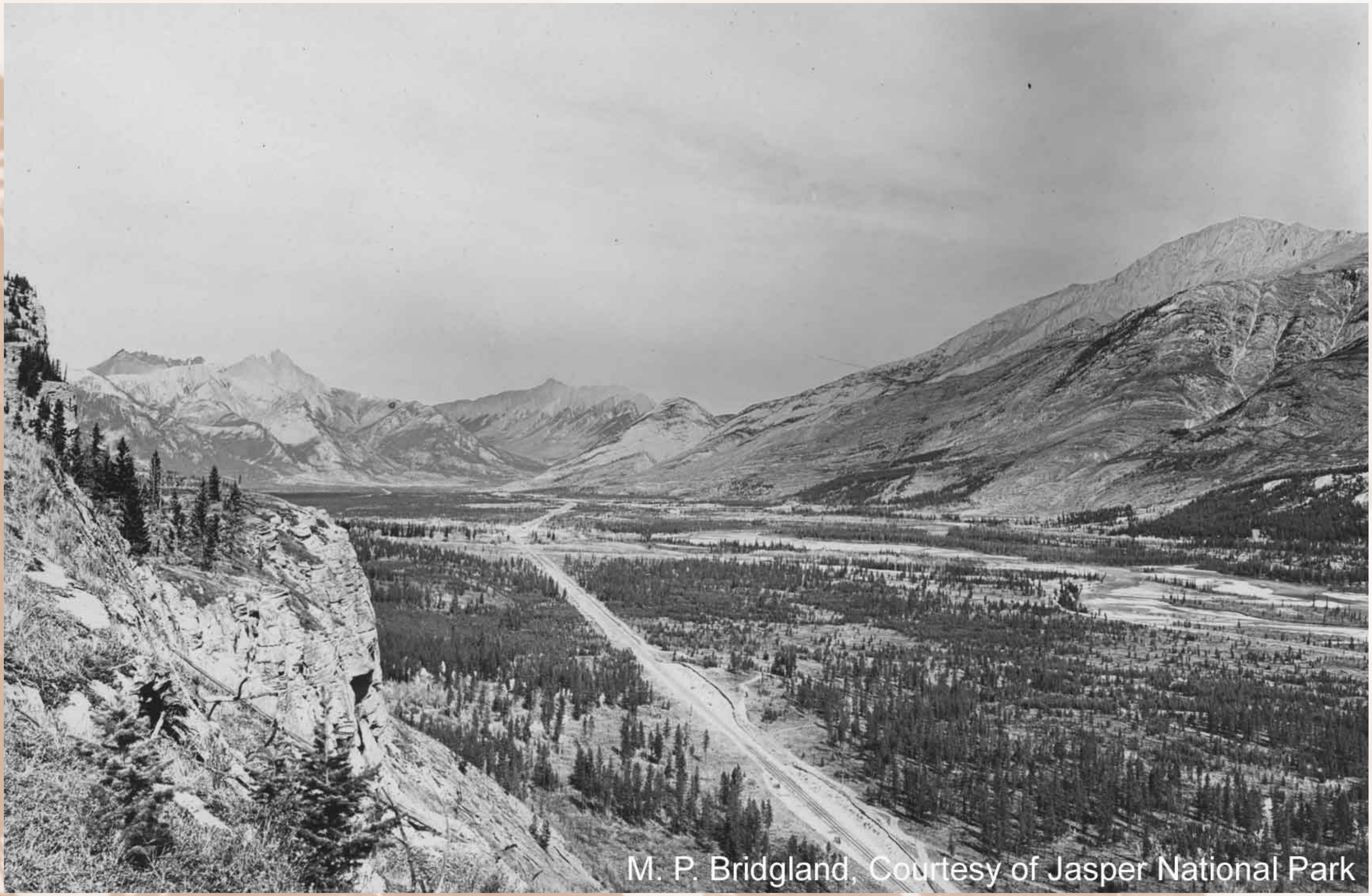
Jasper National Park

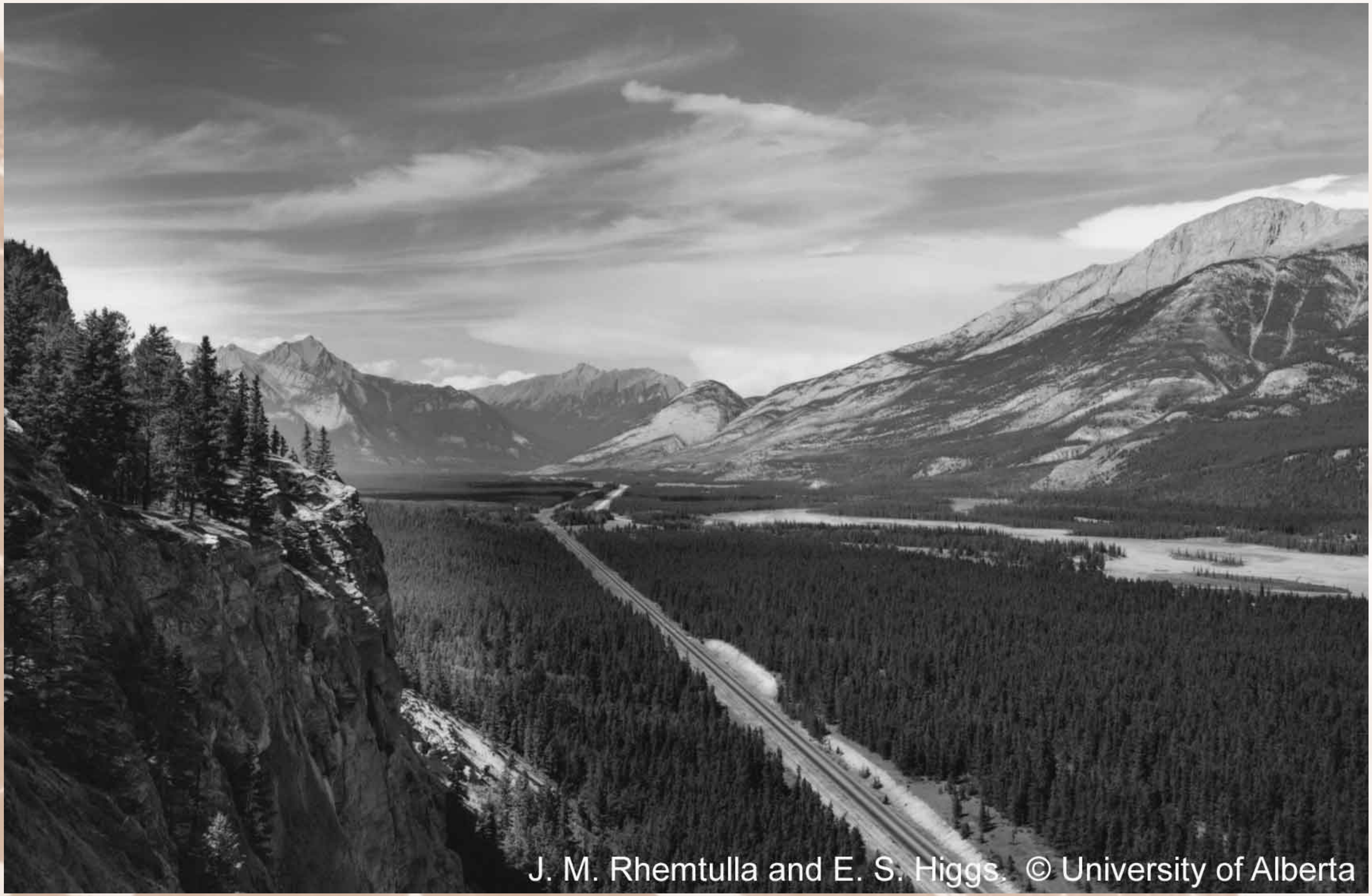
- Founded in 1907
- 10 900 km^2
- Largest of the Rocky Mountain Parks
- UNESCO World Heritage Site

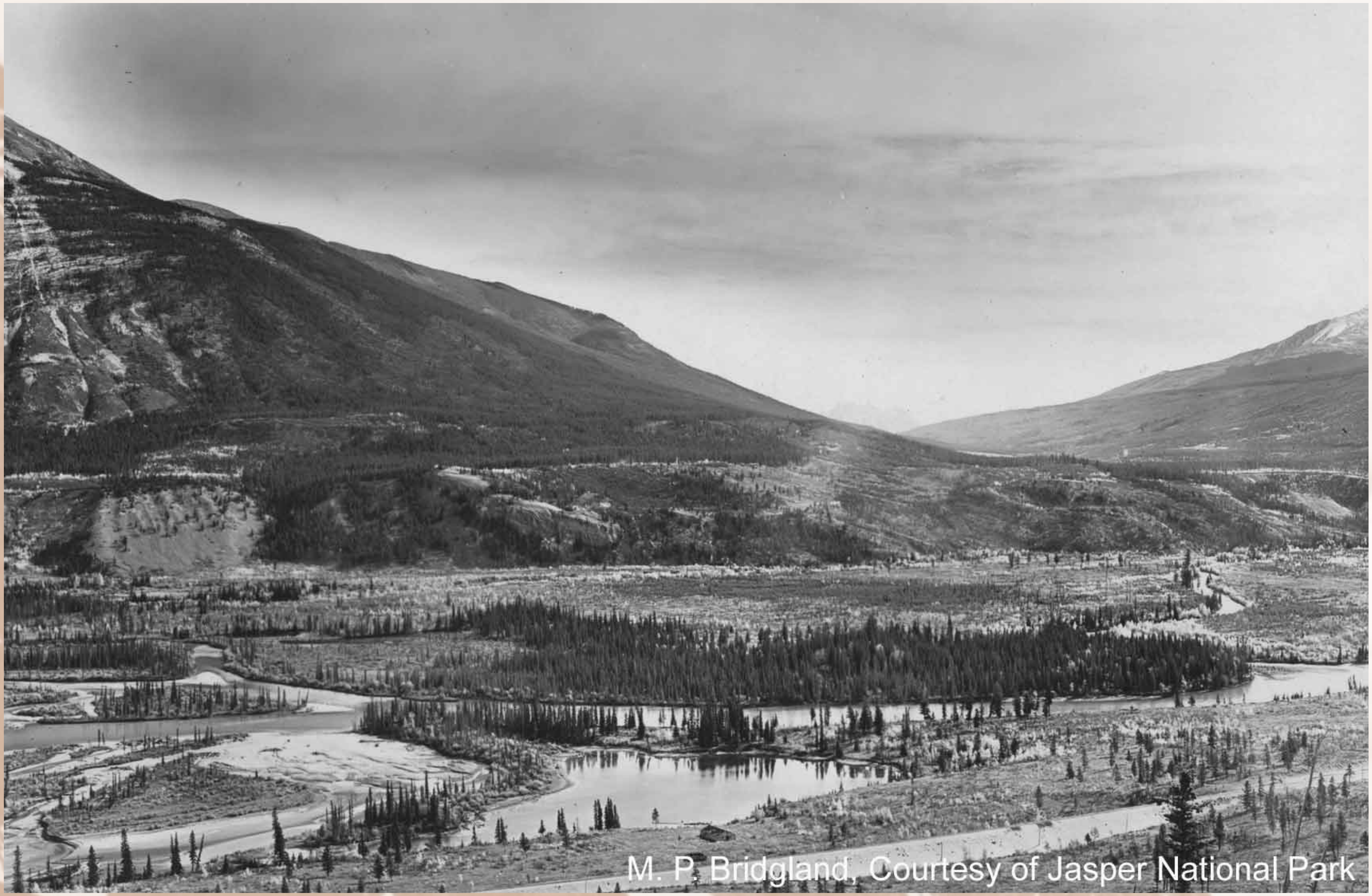
Two views of the park. Which is 1915? Why?

A.

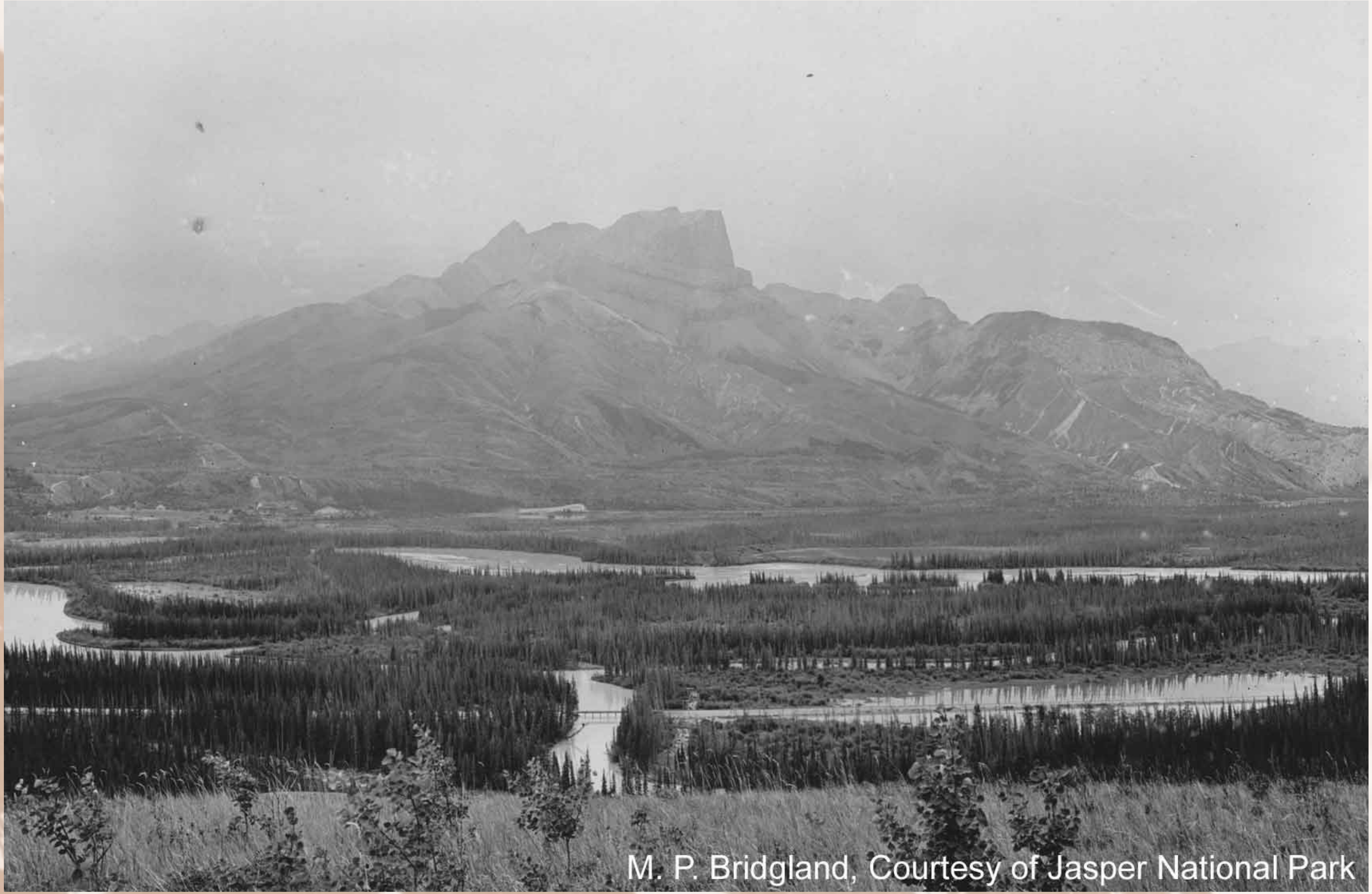
B.

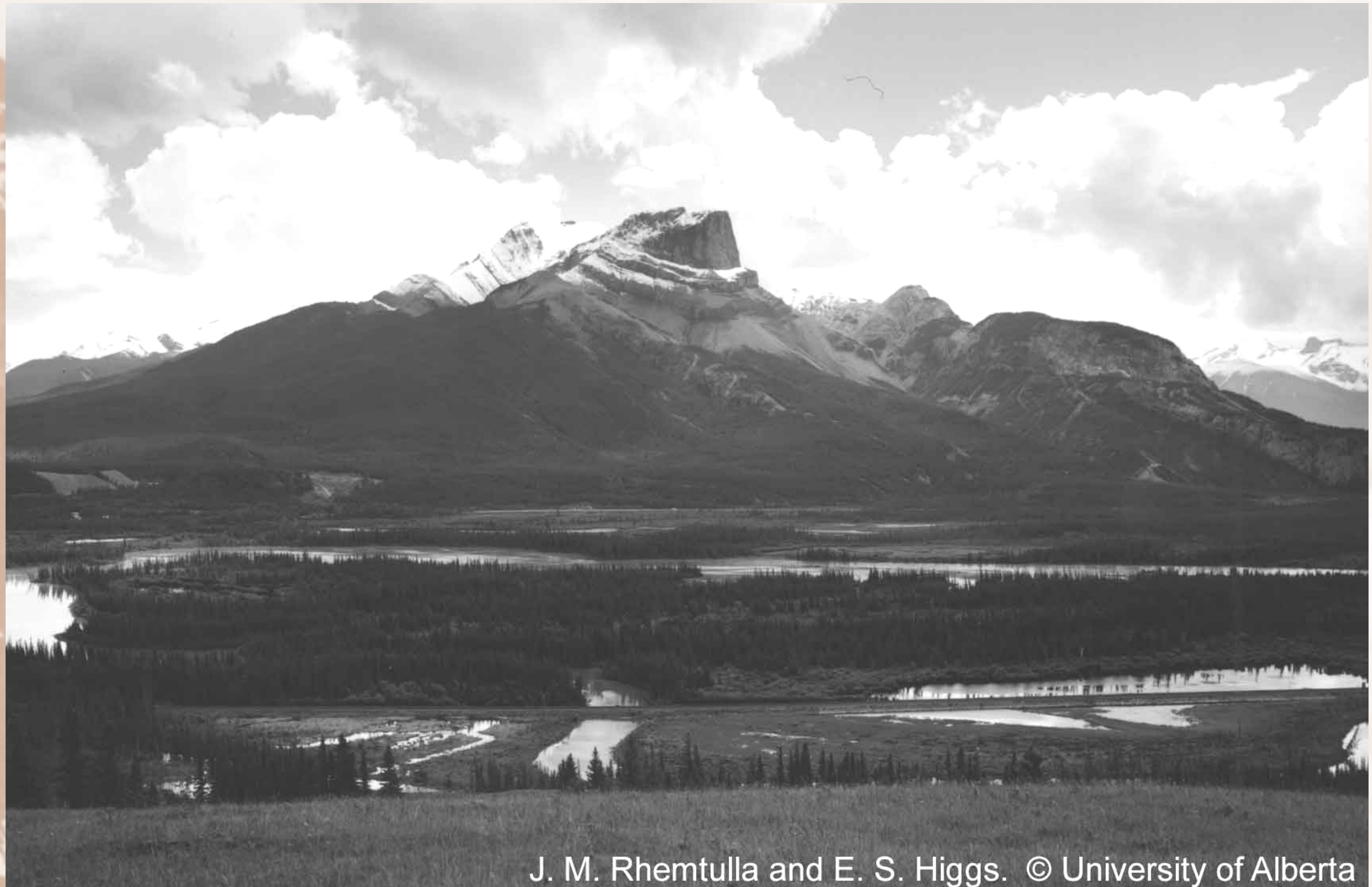

M. P. Bridgland, Courtesy of Jasper National Park

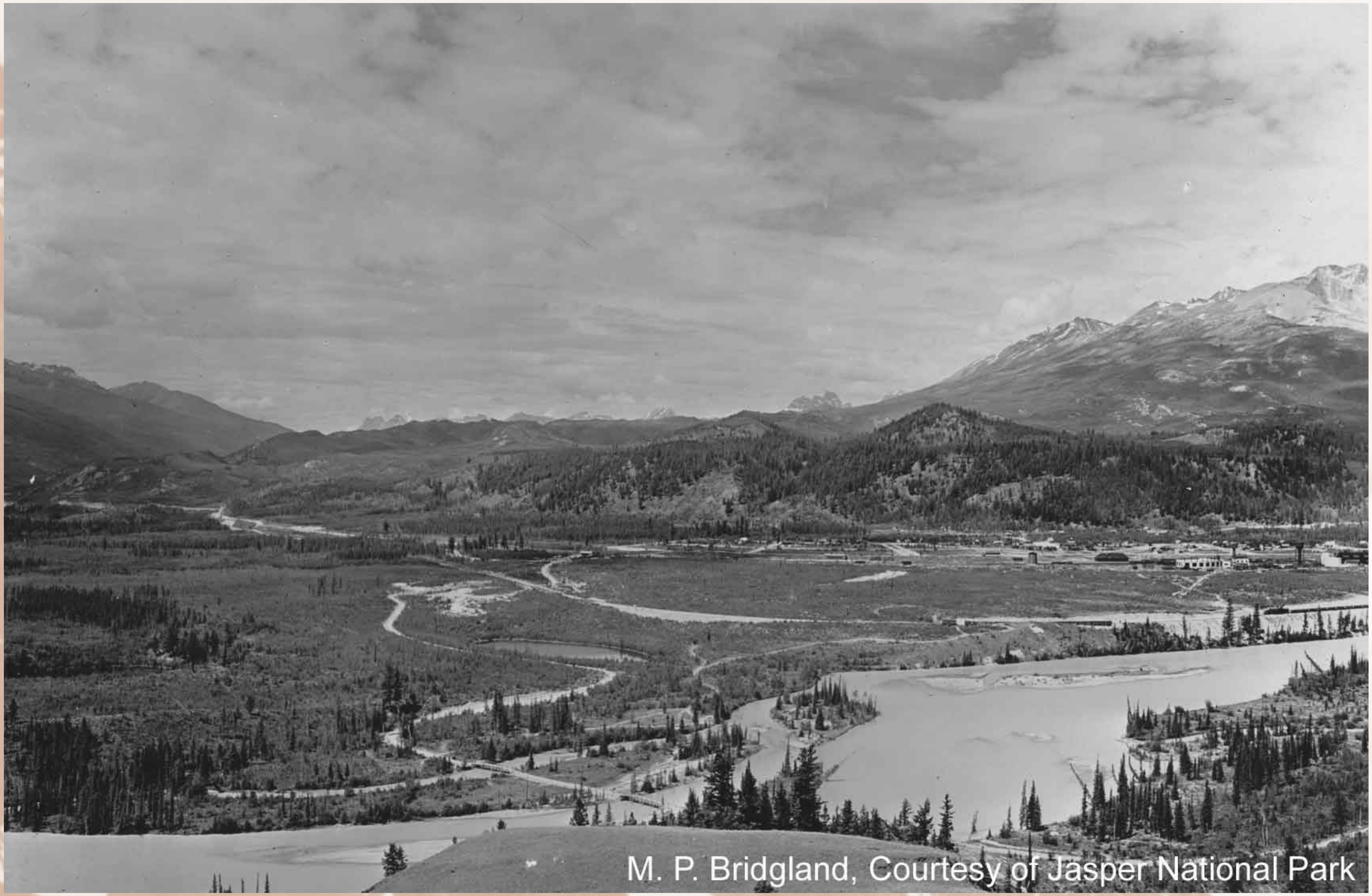

J. M. Rhemtulla and E. S. Higgs. © University of Alberta

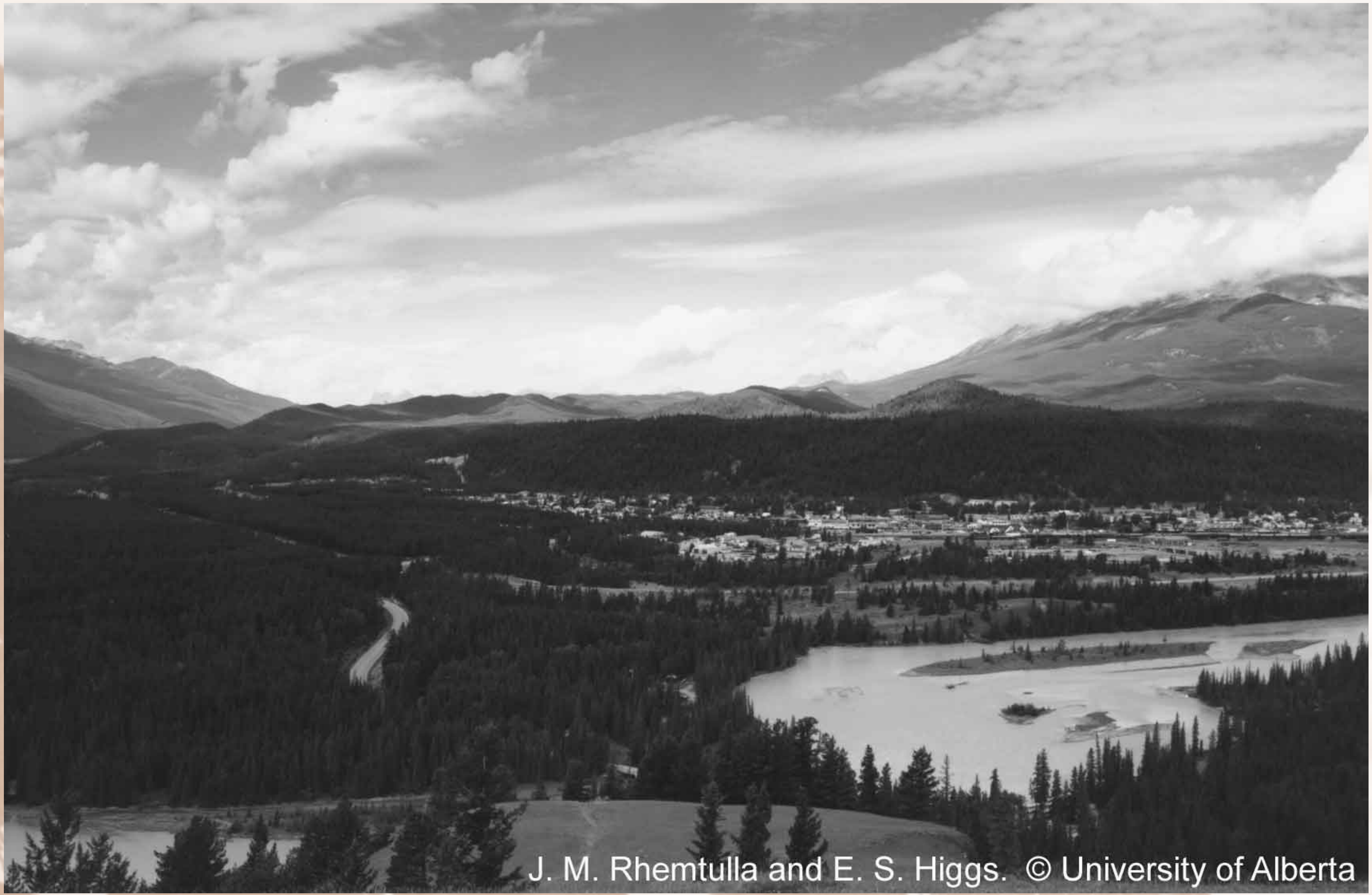

M. P. Bridgland, Courtesy of Jasper National Park


J. M. Rhemtulla and E. S. Higgs. © University of Alberta


M. P. Bridgland, Courtesy of Jasper National Park




M. P. Bridgland, Courtesy of Jasper National Park


J. M. Rhemtulla and E. S. Higgs. © University of Alberta


M. P. Bridgland, Courtesy of Jasper National Park


J. M. Rhemtulla and E. S. Higgs. © University of Alberta

Huge changes over the past century of management

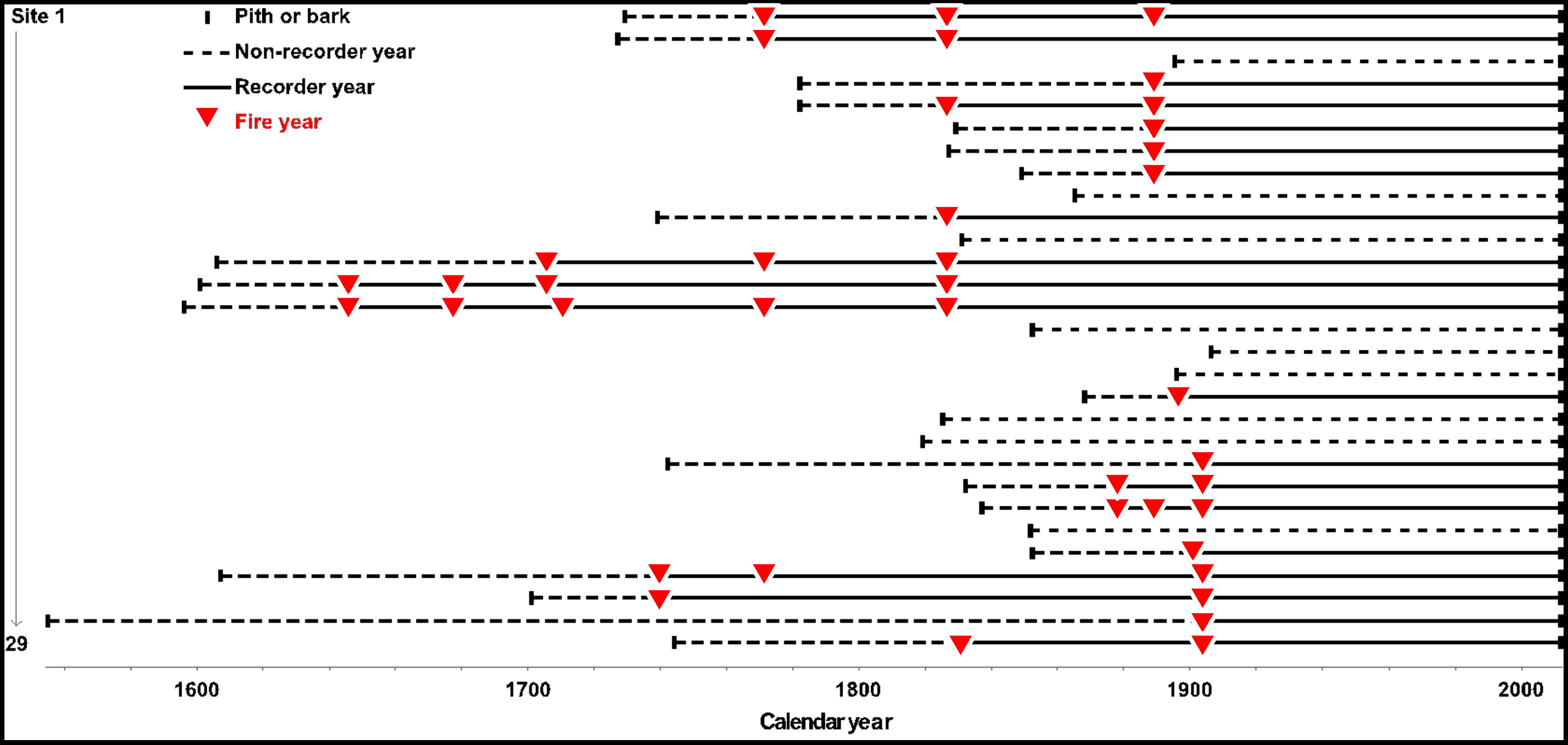
- More forest, more homogeneous landscapes
- Fewer open grassland areas
- Increased human infrastructure
- Reduction in glaciers

Is this natural?

Fire-scar record showing low-severity fire

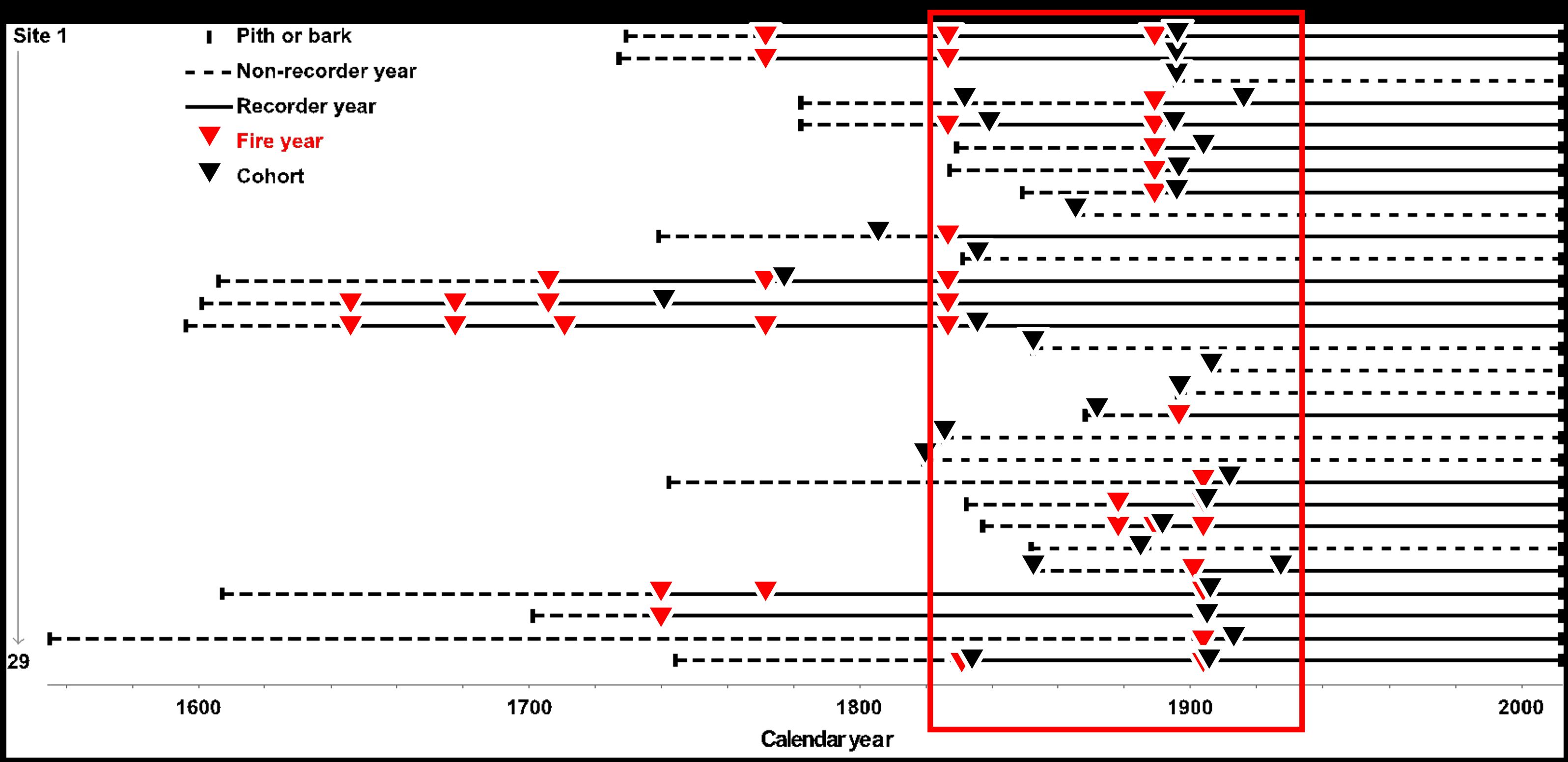
Fire intervals = 11-165 yrs

Mean return interval = 60 yrs



Moderate- to high-severity fires: Cohorts

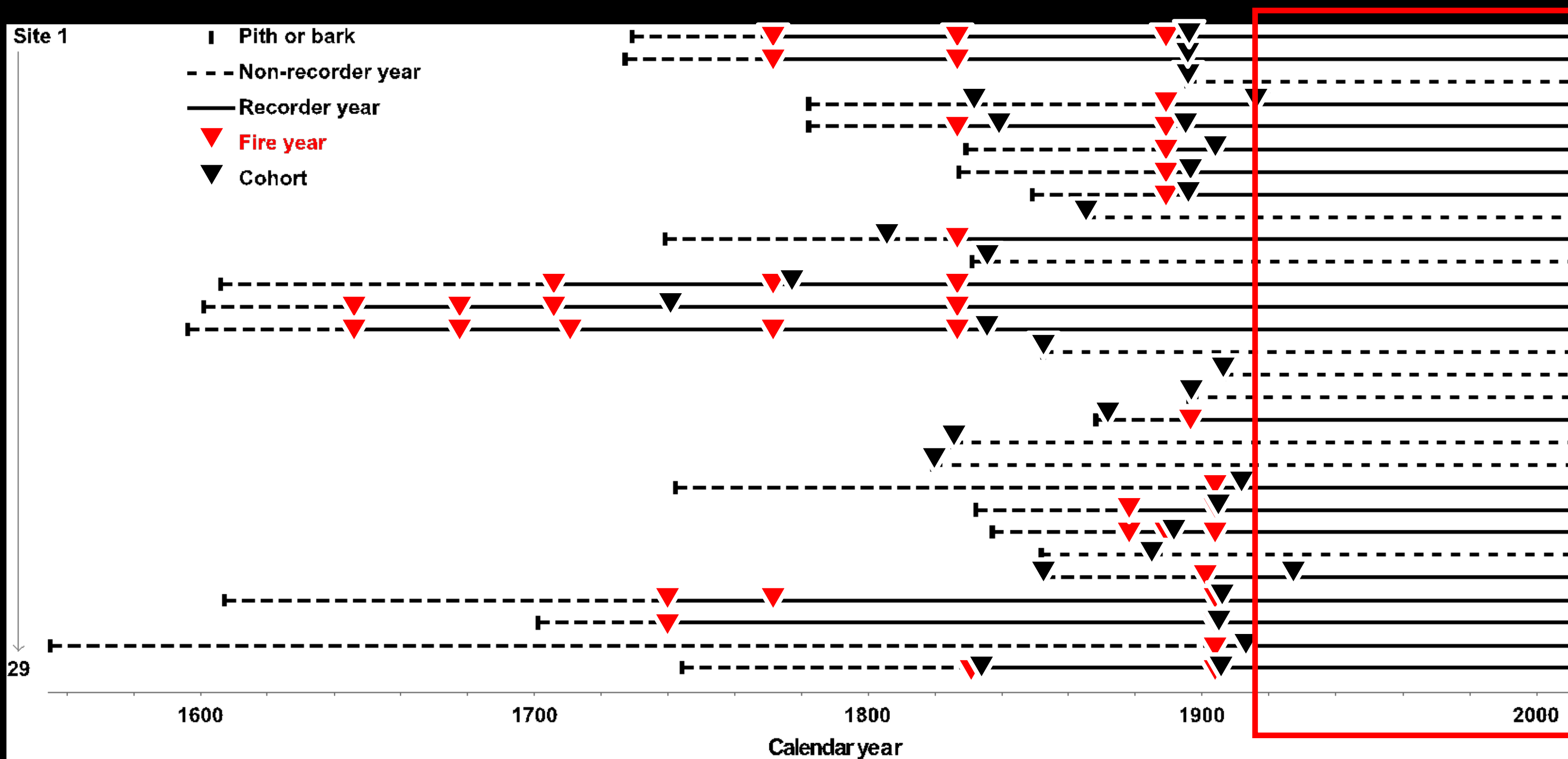
Cohorts at 17 sites after fires in 1827, 1889 and 1905



Historic mixed-severity fire regime

Lack of fire after 1905 is unprecedented

Why?



Smokey Bear


DEATH RIDES
THE FOREST
WHEN
MAN IS
CARELESS


YOU CAN STOP THIS
SHAMEFUL WASTE!
Remember—Only you can
PREVENT FOREST FIRES!


Remember:
there are babes
in the woods.

But that’s not all!

Long history of occupation

- A 'place of historical & cultural significance'
- 9000 years of human occupation
- Important staging post during fur trade – Jasper House founded in 1813

"No person shall ... locate, settle upon, use or occupy any portion of the said public park"

Management of the park would require "[t]he removal and exclusion of trespassers." (MacLaren 1999)

- ½ dozen Metis homesteads in 1907
- All kicked out except Lewis Swift

Aboriginal Fire

"It has been a long time since my father and my uncles used to burn each spring. But we were told to stop. The country has changed from what it used to be ...brush and trees where there used to be lots of meadows and not so many animals as there were before..." (76 year old Cree elder)

First Nations Burning

- Clear brush to make travel easier
- Create firebreaks
- Renew growth
- Encourage berries and grasses
- Purify the land
- Prevent high intensity blazes

Annie Kruger, Firekeeper

https://www.cbc.ca/news/canada/british-columbia/fire-fighting-first-nations-firekeepers-annie-kruger-penticton-bc-wildfire-mega-fire-1.4205506

Fire Exclusion & Suppression

Phenomenally successful:
Almost no fire in Jasper over last 70 years!

Fire Based Restoration

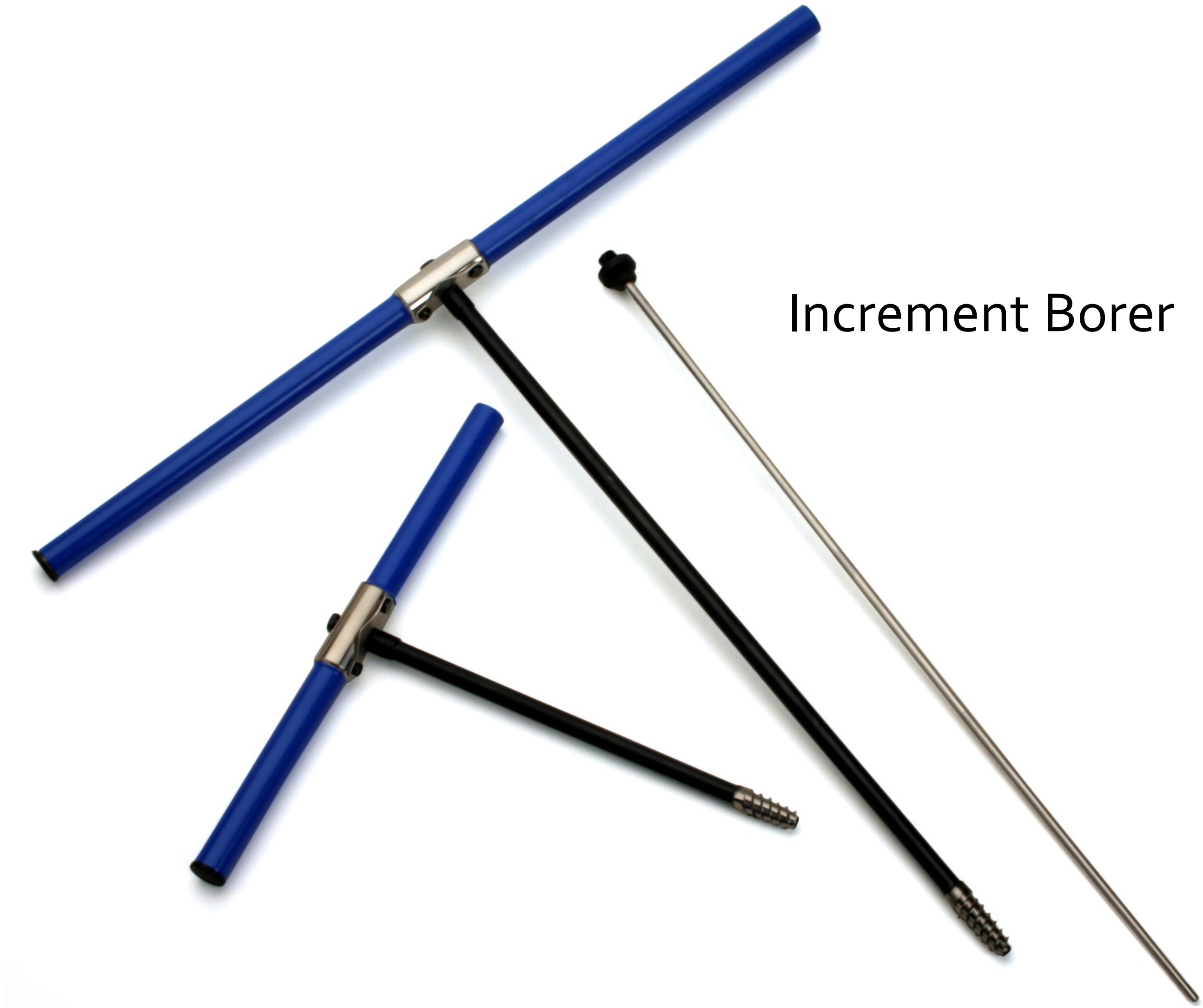
What can burning do for the landscape?

Kelsey Copes-Gerbitz

Tree Coring on Galiano

Erik Frankson

Tools of the Trade

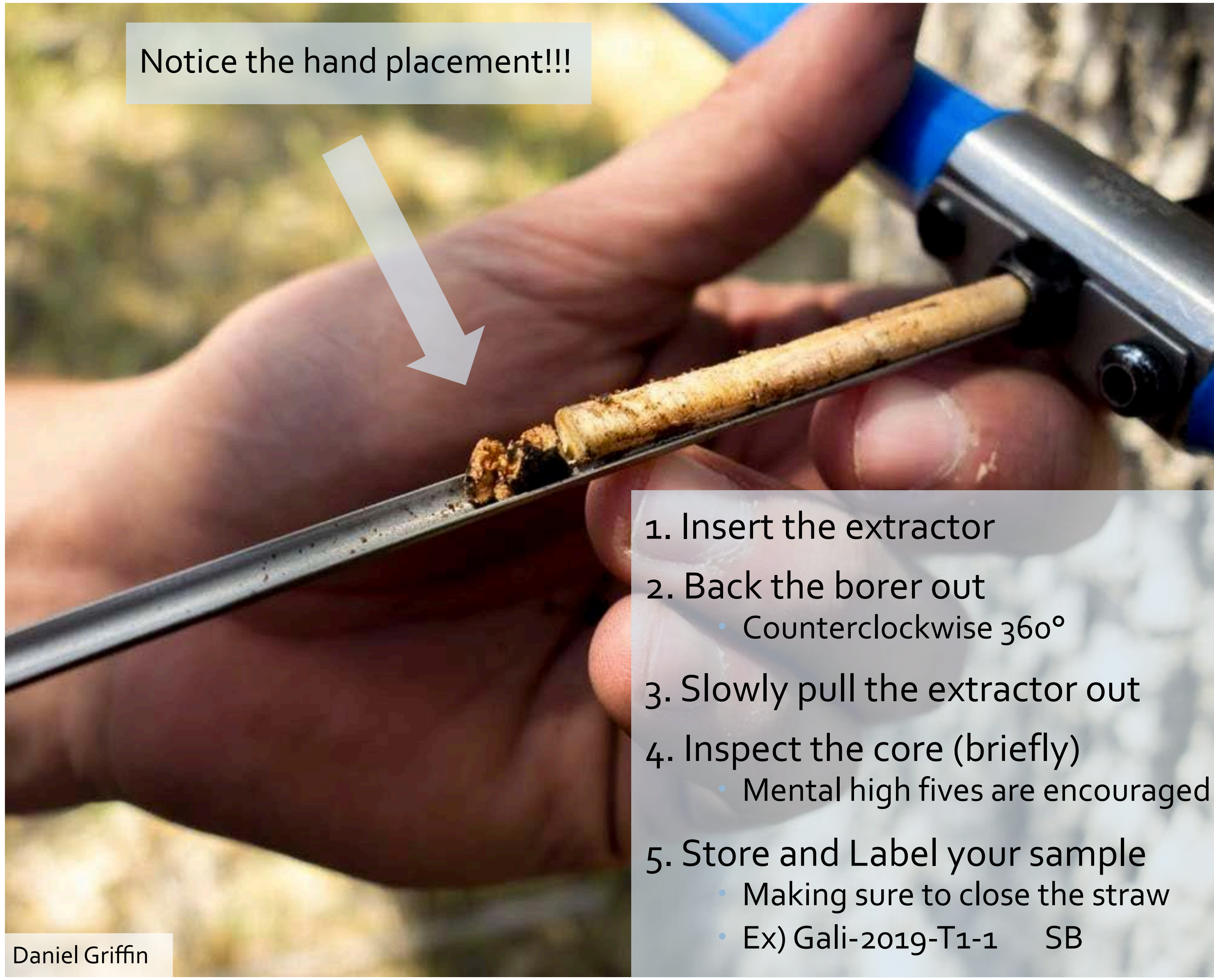


Increment Borer

Starting to Core

- Apply pressure when starting
  - reduces chance of core breaking
- Righty tighty, lefty loosey
- Maintain one path, do not try to angle the borer once started
  - runs the risk of breaking the bit

Removing your Sample



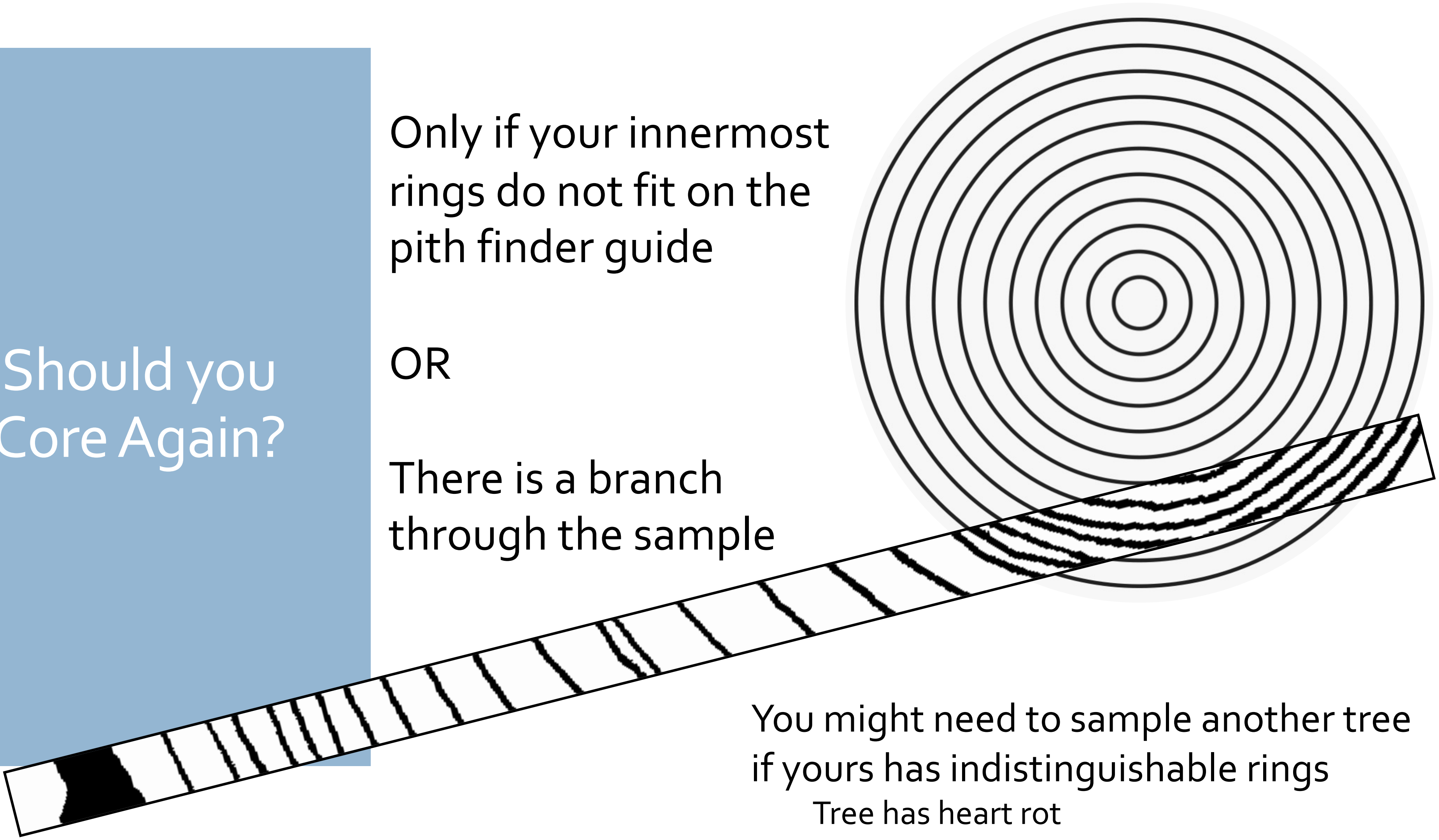
1. Insert the extractor
2. Back the borer out
   - Counterclockwise 360°
3. Slowly pull the extractor out
4. Inspect the core (briefly)
   - Mental high fives are encouraged
5. Store and Label your sample
   - Making sure to close the straw
   - Ex) Gali-2019-T1-1 SB

Should you Core Again?

Only if your innermost rings do not fit on the pith finder guide

OR

There is a branch through the sample



You might need to sample another tree if yours has indistinguishable rings

Tree has heart rot

Safety in the Field

- When walking with the borer, always have it within the sheath
  - They are very sharp!
  - They are very fragile
  - They are also very expensive ($300 each)
- Never place the borer with the cutting head down
  - Dulls the edge, could chip it
- Keep track of the extractor
  - Always lean it against the tree

Sample Prep

- Label core mount
- Remove sample from straw
- Identify correct orientation of sample
- Glue core into the mount
  - Not drowning the sample
- Apply tape to secure sample
  - Minimal tape to allow drying
- Stack core mounts to maintain pressure

Nicole Davi

What we are Working Towards

- Determine when tree established
- Determine tree age
- Identify any trends/patterns in growth

- Produce a histogram of tree age
- Interpret histogram in relation to Galiano's history

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