Lasqueti past forest conditions update from the 1875 Survey to my “CDF & Fire” blog

March 14, 2022

This series of articles were published for the general public to increase knowledge of historical forest conditions, with emphasis on Lasqueti Island (Xwe?etay/Xwe”i”tay). Most of it will also apply to the whole CDF and parts of the dryer CWH areas. The forest conditions do not only mean trees; grasses and openness were also part of the landscape condition. Research references used are available from the author. *I will attempt to Italicize all my opinions.* This is a very long report @21 pages.

As I get more information, I continue to reassess my historical forest conditions knowledge and learn. I made a spreadsheet of Carey’s 1875 legal survey information from which to do some analysis. Here are some draft results. This should allow us to understand forest conditions in 1875. Any mistakes are my fault in either the spreadsheet or my analysis. I used survey page numbers within the spreadsheet to make it easier to check; I have already found some mistakes in my fist draft. I found it hard to accurately transcribe old notes, both onto a spreadsheet and even to Carey’s closing remarks. My spreadsheet is available to anyone for use and I would appreciate any corrections if found.

Carey’s closing remarks are usually shortened. I believe condensed versions leave out information and often misrepresent information. The first thing I found out was that Elda Mason’s summary information was incomplete, so here is my complete translation:

> **Closing remarks by Carey the surveyor**
> "In describing Lasqueti Island I may State that the greater portion of the island is more suited for sheep pasturage than for actual agricultural purposes. Never the less there are many fertile belts of land extreamly (Carey’s spelling) rich in soil and fit for cultivation. The chief portion of the cultivable soil lays at the west and towards the west end of the Island. Except one belt on the east end as described on the diagram. Although the island is very hilly and rocky it is also very open and grassy and well adapted for sheep raising the native grass being sweet and intermixture of clover and pea vine.
>
> The north, N-W, SE, and South shores of the island are generally high and rocky and consist in many parts of rugged and precipitous bluffs hollowed into various forms by the constant action of the gulf. Making the shore line very indented and irregular in shape. The island is well watered by small rivulets and springs and in addition there are four small lakes.
>
> The only settlers on the island are Capt. Pearce and Albian Transfield both engaged in sheep raising. Capt. Pearse improvements are a dwelling house and out offices, 4 acres under cultivation and fencing. Say 250 sheep and six head of horned cattle. *(My comment is: cattle were needed to cultivate, in other words oxen. I can also say from reading history, Capt. Pearse did not clear this land from big trees. That it was prairie or very small trees when he moved onto his place, indicating prior occupation and use of fire by First Nations.)*
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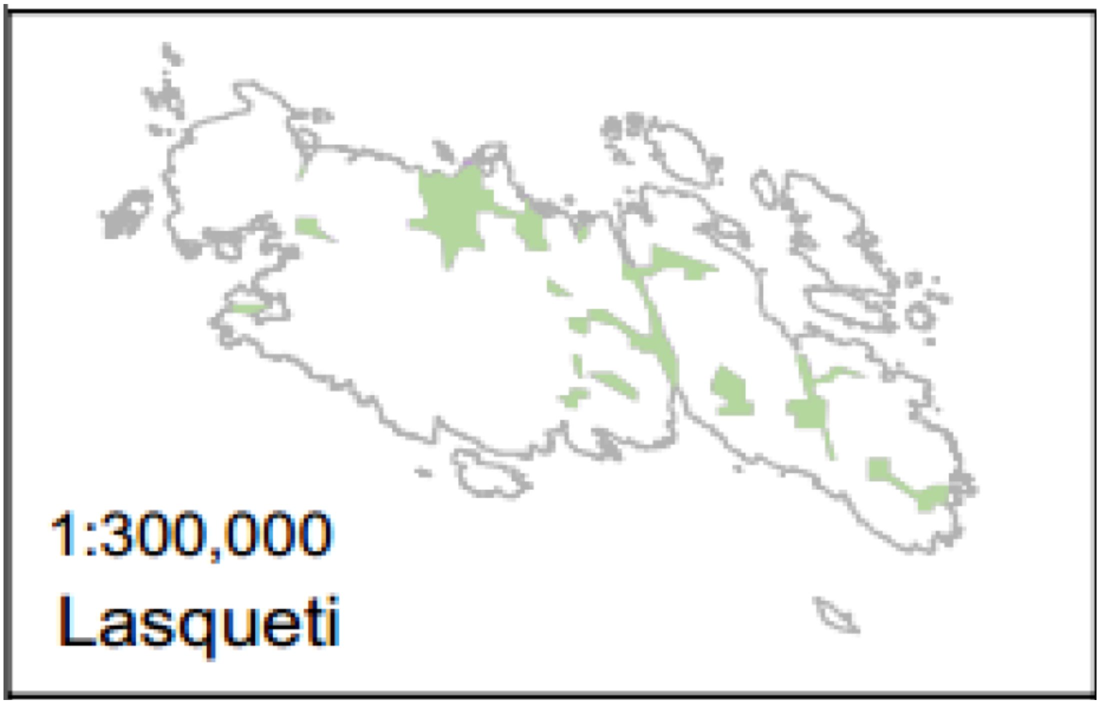
> Transfields improvements are a small cabin, sheep shed and corral, he also has about say 200 head of sheep. In conclusion I may state that Lasqueti island is capable of grazing about 10,000 sheep."



Map 1. Map of ALR (green) or best soils in 2019, is quite different than Carey's estimations of 1875. Photo clip of image. (*Much of the ALR seems to be influenced by past Farm Assessment Classification, but not all)* Map source is from State of the Islands Indicator Project 2019 Islands Trust or ALR site. (*I do not believe the ALR soil information is very accurate.)*

The first part is a summary of the notes at the ends of traverse and Carey's closing remarks

1ST ANALYSIS IS OF THE NOTES FOLLOWING EACH 80 CHAINS OR LESS:

The biggest thing I learned was that 100% of the traverses had grass and 61.5% of the traverse's had pea "native grass being sweet and intermixture of clover and pea vine" mentioned in the notes. This survey started on August the 14, 1875. This does not mean all of the grass had peas &/or clovers intermixed with the grass, but there was enough that Carey wrote it in the notes at the end of a traverse, usually 80 chains. *It was also the legumes intermixed with the grass, that indicated to Carey that 10,000 sheep might be raised on the island, at that time.* This pea was likely: Lathyrus japonicus, Lathyrus nevadennis, Vicia gigantea, possibly Lupinus sp, Trifolium dubium, Trifolium wormskjoldii, other native clovers such as Lotus micranthus, Medicago lupulina. A botanist may be of help with checking these species and/or adding species. I used "Plants of Coastal BC" as my reference. Probably these pea/clover/lupin were heavily grazed by early sheep, pigs, cattle, and horses. I would like to know how much is remaining on the island, *(I remember beach pea growing through driftwood logs somewhere?*)

- Carey also mentioned scrub and/or scattered Fir along 35.9% of the island traverse notes, but in his summary said the island was hilly and rocky, also very open. (*Openness is probably a result of cultural burning pre-1862*.)
- 20.7% of the traverses mentioned berry bushes (no species indicated) (How many berry patches were a result of cultural propagation and management practices vs non-anthropogenic*? I do not think this can be determined*.)
- Every traverse note mentions grass. (*Demonstrates the openness of at least some forest area along each traverse line*).
- 84% of traverse notes mentioned young or small trees. (These were all-natural regeneration, age unknown. *Some of the regeneration is likely from 1862 and First Nation population leaving after 1862 smallpox epidemic.)*
- Small diameter trees had wide spacing for 50% of the trees (wide spacing was >4.0 meters between trees and corner) for trees =< 7" in diameter (range was 1.4 m to >15 m [meters] between corner and tree). **This wide spacing is beyond the range that is considered good spacing for sustainable industrial forestry.** Wide spacing can lead to NSR (not sufficiently restocked if in a large area).
- Then in addition there was **very wide (>10 meters)** spacing of trees, which further means the young trees likely had large limbs down to the ground and usually then developed into "wolf" trees. Trees <11" had 20% of the

trees with 10m to 17m distance from corner to tree, again **very wide** spacing. About 20% of **all trees** were over 10 meters between corner and tree. For this **very wide** spacing (over 10 meters) there was more of these wide distances for small trees than large trees ([for points with two trees only] *this was a surprise for me)*. ***If we were to help recreate 1875 forest conditions, we need to consider widely space trees and clumps of trees, from regeneration or younger trees to big older trees. (****I find this hard to do after being trained to industrial sustainability inter-tree standards; even for trees under 25 years old. I'll expect it to be just as hard to thin older trees to wide spacing, for me, but I plan to try to do this. I also expect this will create a brush problem if periodic use of cultural burning is not allowed.)*

- Most of the alder noted on the 1875 Map was from mid-island to south end. There was also some east of False Bay just south of T-pot corner (still alder today) then farther east between section 27 & 22. The largest area of alder was in the south, though we expect the patch across section 5 was not as mapped since there are rocky hills between the traversed line that Carey did not know about (but also a valley which is much narrower than mapped), but that is mapping risk/error. Alder played an important restriction to cultural burns or a limiting factor. Why was most of the alder to south/east? *(I expect that the wide spacing of traverse lines means less alder bottoms were crossed to the western/north part of the island.) Also, any mapping symbols not across a line should be considered approximate. Eg. The 'grase flat' to west of Ogden Lake is probably to the north (Milicheap farm area).* This also shows how early settlers (Louis Vilac was the original homesteader, pre-1911, [Mason]) chose open areas to homestead as they were already cleared.
- Willow was mentioned after 67% of the traverses, often it was mentioned as: willow, mountain willow, dog brier willow, or dog brier mountain willow. *I can only think "dog brier" would be a dense thick patch of willow or brush. It also seems reasonable that this term evolved into* "dog hair" a dense thick stand that does not allow light to reach the forest floor so there is almost no undergrowth (MOF Wood Quality lesson 02) (usually a dense even-aged stand with less than 30% of live crown). How much of the willow was the result of native management is unknown, *but it seems that from such a high mention, it points to native cultural practices. I do not believe willow is as dominant today.*

> First Nations had many uses for willows: dye (red), medicine, basketry, paint brushes, and may different types of cordage. The inner bark is stripped in spring, pulled apart extracting the inner fibers, and then twisted to make rope for fishing lines, nets, and trump lines. Willow cordage is strong and flexible, and does not rot when submerged in water. Natives also recognized the food/habitat value of willow for deer and beaver.

Fire:

There is only one mention of fire and burnt trees; it is within an area north of the south end farm between section 2 & 5 with burnt Cedar and Fir. Farther to the west, Carey labeled the area with Fir & Cedar (section 5 lines), this west area was not traversed. The burnt tree traverse was 472.74 meters (1,551feet) through the burnt timber, for an estimated 22+ Ha fire area (*by me)*. It should be noted that this is the only fire/brunt area noted by Carey in 1875, *(I estimate that it might have occurred about 1870-1874, but could have been earlier).* The East and north sides of the burn was occupied by alder, which from the nature of deciduous trees are rather fire proof. The west and south sides traverses showed no indication of fire to Carey. *Burnt Cedar and Fir probably meant burnt standing trees*. The alder (unknown diameter size) to the north was 90.5 meters wide and had restricted the high-intensity part of this fire, *unknown is if the fire continued as low-intensity or ceased altogether. Also, unknown is what happened to the fire to the south and west sides and whether it continued as low-intensity into the timber or just stopped.* The 1968 Forest Cover Map (FCM) indicated the valley running NW (to the west of the burnt trees) was logged in 1958*, so was probably good-sized trees in 1958 and probably was un-burnt trees (but ground fire?) in 1875.*

> **1968 Forest Cover Map** collaboration (contains some updates from 1968 to 1972, and mixed updates across the northern part of island)
> This section 2/5 line fire area is recorded as both 41-60 and 61-80 years old (DF340-M and F430-P) on 1968's forest cover map: (DF340-M is alder (D) + fir (F), 3 = 41-60yrs, 4 = 20-37.4m in height, M = -medium soil productivity); (F430-P is fir, 61-80 yrs, 19.5-28.4m height, -poor or poorer soil productivity), *but this is mapping and another indication of difficulty of air photos analysis for typing on Lasqueti*. This also makes me rethink the 61-80 year age class (most of the island in large patches but really was a major part of the 1940 to 1970 logging)

that shows up on the 1968's forest cover map. *I used to think it was one or more low-intensity burns during the late 1800's but now I wonder if it was just delayed infilling* that happened after the First nations left following the 1862 smallpox epidemic, *of course it probably was both.* What we know is there was an abundance of 61-80 year old trees after harvests in the 1850-1960's*, or at least this area was mapped as that probably from tree* heights *in 1968.*

It is interesting how each new bit of history can lead to re-analysis of previous beliefs. It will be interesting to analyze this fire/burnt regenerated timber in the 1919 legal survey and any additional fire information that can be found.

South end farm: Continued from above. J.C. Hickson's pre-emption was the bottom land known as the south end farm. In Aug. of 1875 Hickson was not living on the island. I found a mention of him in Elda Mason 1st edition (Appendix 3). This area was reported to be small cedar and alder and contained a corner. **No bearing trees were used at this conner**; while elsewhere, Carey recorded in two different areas, 4" alder trees as a bearing trees. *I can only estimate that most of the alder and western red cedar trees on this bottom land were under 4" in diameter. Was this from First Nation management or JC Hickson's recent management?* We now know that else-where in this bottom land that there is a newly discovered archaeological site and probably the whole bottom land area was managed for a long time (estimated 3000 years) by the First Nations. *The tree data from Carey does not mean Wayne's research is wrong about the cedars & fish, just that the whole bottom land was not covered by big cedars in 1875 but by small alders. (Probably the big cedars would have been around the edges of the bottom land* (as Wayne reported). I found no mention of fish in Carey's notes. *Was Wayne reference survey the 1919 survey?)* Was the south end (farm or valley bottom) managed by First Nations by fire? If so, what were their goals? Were the plants from this wet field/wetland area used for basketry? Berries? Was some of the area used for firewood, short rotation? What do the tools found tell us? *I would expect many tools have been picked up and are now lost since this site has been occupied and worked (farmed) by settlers since 1875 off-and-on. The small diameter of alder on this site may also supports First Nation exodus in 1862-3, as there was a twelve-year period between the survey and 1862. Alder regeneration on wet soils is rather slow and spotty.*

> I would like to do some sampling of alder trees on Lasqueti that are 4" to say <8-10" diameters to obtain ages at breast height. The trouble using older trees is that it is impossible to estimate density and density affects diameter growth greatly. Alders regenerate in dense pure alder stands on bare disturbed soil, but seemed to regenerate as mixed species (in the past from early forest writing) where there is no major soil disturbance. Other old observations of young to mid aged alder stands talk about alder and cedar growing together, pre-1930 reports. (*Alder regeneration after fire may be influenced by the amount of bare soil, but this factor is unknown.) Now I think some sampling of younger alder is needed to figure out ages of under 4" diameter alder, under different conditions.* Such aging will only provide estimates, as we do not have a complete picture of conditions in 1875, only interpretations. Settlers drained this site, so we do not know how wet it was in 1875.
>
> I did a little alder testing in winter of 2022 for a mixed Douglas-fir (Fd) & alder (Dr) site planted about 20 years previously. The dominant alder was 6.25" at dbh in a sloping wet spot, surrounded by Fd. Estimate about 19 years old. Two other Dr that were topped 10 years ago, were just over 4" dbh, topping was to set them back from overtopping Fd trees yet retain their nitrogen fixing ability. Both topped 4" dbh alders were also in higher density area of trees, so this also contributed to slower diameter growth. The topping resulted in a smaller growth ring and possible false ring for part of the circumference (continued slower growth after topping was probably from density conditions).

Section 16 information at Richardson Bay: Capt. Pearse's land and cultivation: To have 4 acres in cultivation in 1875 means the cattle were most likely oxen or a mix of oxen and milking cattle. *Also, it was very likely that this area had been prairie, not cleared from big trees. The prairies would have been created by fire by First Nations.* It would be interesting to determine how much of this area is old prairie area by soils analysis, but this would take landowner permission and whomever has the say on the crown land of section 16. Also, a researcher would need to be found. In the late 1980's, I had observed infilling of pole sized trees on an open southern slope that had been historically free of trees (exception one wolf tree) within section 16. S*o, I now expect the openness of the timber, was from cultural burning.* So sometime in 1800's their started to be regeneration of this small pole sized trees (that I observed in 1989), which I now understand this regeneration was infilling. I plan to do some aging of the infill trees in 2022. *This could indicate when First Nation use of this area ceased.*

The next part is a bit more technical, but I hope is still interesting.

LOOKING AT LASQUETI TREE SIZES AND NUMBERS IN 1875:

While my calculations are only estimates of forest conditions, I used actual data Carey collected. I also analyzed the notes written by Carey. The number of line & bearing trees and their diameter's give a picture, but remember they are only a very small sample (114 total trees measured for diameter). Lasqueti is 73.56 Km2 so this is 1.52 trees per Km2 (100 Ha), a <u>very tiny sample</u>. Though I use statistics for analysis, I am the first to say the results are not definitive, just another tool for estimating.

Bearing trees:
Most research using bearing trees to recreate past forest conditions talks about potential surveyor bias. Most of the bias is around individual surveyor selection of bearing trees. Differences between bearing tree diameter and line tree diameter distribution has led some researchers to believe this was caused by surveyor bias. *Unknown is why the diameter distributions were so different on Lasqueti* (chart 3 + 4) *than Salt Spring between bearing and line trees.* The distribution between bearing and line trees was similar on Salt Spring in 1874 (Chart 5) if tree number were proportionally calculated the same as real numbers of trees.

> I have not found any detailed instructions to Surveyors in 1875, but it seems there can always be bias in surveys by surveyors. What I have found is that both the "Manual Systems of Survey adopted for public lands in Manitoba & in the Northwest Territories" 1871 and instructions from the USA were used at this time in BC. The 1871 Manual did not indicate tree selection criteria for bearing trees. The USA information about bearing tree selection was a list for different values with no priorities, so today researchers believe it was open to individual surveyor bias, as each surveyor it is believed chose their own priorities. Also in the USA, there was a distance limit to selecting a bearing tree, such a tree needed to be within 3 chains of a corner. In reexamining Cary's notes, I found one tree over one chain from a corner (1.4 chain or 140 links) otherwise all trees were under 0.89 chain or 89 links on Lasqueti. *Was this an indication of tree distances on Lasqueti, or a practice of Carey's?*

As Carey recorded only one bearing tree over 89 links (less than 1 chain) in the survey notes, I will estimate one chain was his usual cut-off for selecting a bearing tree in the 1875 survey. (Further study of other surveys done by Carey might show I am incorrect). Carey only recorded four trees at one corner on Lasqueti; mostly he used two trees but many times only one tree. I have not found a reason for this when USA instructions were for 4 trees per corner. It should also be noted that corner, sections 2, 3, 4, 5 showed no bearing trees; but was in young alder & cedar so there might have been no trees of bearing tree diameter or for some other reason. *Was it distance or another reason Carey choose different number of trees per corner?*

Taking a stab at estimating tree density from bearing trees is probably harder to do well from this 1875 survey; as there were 30 single bearing trees at corners or half section points, 24 points with two bearing trees, and only one point with four bearing trees. (The normal practice in the USA at that time was 4 trees per corner.) It usually takes >2000 points (600 points are considered minimum number) to get a reasonable estimate of density (using two trees per point) from early surveys. Carey's notes do provide 26 points with paired trees, from which inter tree distance can be calculated or accurately estimated by trigonometry. If I am correct in that Carey did not usually go beyond 100 links to select bearing trees, the distance from the corner to the bearing tree for the other 30 points meant, *inter tree distances for these corners are estimated to be more than the measured tree distance to the corner. Of course, there could have been closer trees in the same quadrant as the measured tree (behind the bearing tree from the corner), but recorded distance is still a pretty good indication of inter-tree distance.* There is no indication for why so many corners had less than 4 bearing trees selected.

dbh = diameter at breast height

BT = bearing tree
Fd = Douglas-fir
Ar = arbutus
Dr = alder
Cw western red cedar
Hw = western hemlock

From the paired trees using average dbh: (most of the pairs were very close in dbh, which is why I averaged all of them)

14 or 50% were totally Fd, average Fd dbh's of pairs ranged from 7" to 34"; (dbh's of four Fd were 19-34"; 10 Fd were 7-16" dbh)
2 were Fd & Ar with average dbh's: 18", 7"
4 were paired Cw with average dbh's: 31", 30", 11", 15"
1 was paired Dr and this was closest of any two trees at 1.4 m with average 5" dbh
1 was paired Hw with avg. 6.8" dbh
4 were mixed species with average dbh's: 12", 8", 26", 8"
Looking at average dbh's for the whole set of paired trees of all species: 8 pairs had trees with average dbh's from 18.1-34"; 18 pairs had average dbh's from 5-18"
Looking at inter tree distances for the 26 pairs of trees using trigonometry:

Mean 10.12m, median 8.55m inter tree distances
Farthest was 21m, while least distance was 1.4m, of small diameter Dr
Remove the small paired Dr and range was 4 to 21 meters between paired trees

Single bearing tree analysis of 30 BT's:

Species: 24 Fd with dbh's 6-36"; 3 Cw with dbh's 12, 14, 30"; 3 Dr with dbh's 4, 7, 8"

(10 Fd dbh's 6-16"; 8 Fd with dbh's 18-36") While the median bearing tree diameter was 12", the mean is 15.6".
For all single BT's I used the corner to tree as the minimum inter tree distance, because no other tree was chosen as a BT. I did minimal inter tree analysis, the range was 1.4 to 18 meters as minimum inter tree distances for single BT points. 6.67 meters was mean distance between corner and tree, while 5.6 meters was median distance.

Line trees = 34 trees
Line trees are trees located directly on a survey line. For line trees, only 3 were under 18" (9%) dbh, while 31 were over 18" dbh (91%) (26 of these were >30" dbh of which 9 were over 50" dbh and one was >8 feet in diameter), **so there were some documented very big trees on Lasqueti in 1875**. But again 34 trees per 61.94 Km (38.5 miles) is a very small sample or about 1 tree per 1.82 Km or (1.12miles) of survey travel. (One tree was either 9" or 119" dbh depending on interpretation of notes), median diameter was 34" dbh, while mean is 40" dbh of the line trees. If line trees are a better indication of tree sizes, this helps indicate tree diameters were large and very spread out.

Looking at all trees and considering (minimum) inter-tree distances and diameter.
There was no obvious pattern or relationship that I could observe. *There appeared to be a trend that bigger diameter trees had longer inter-tree distances (Or so it seemed until I looked at the* **very long inter-tree distances; then I realized for over 10.0 meters (corner to tree) inter-tree distances, there were actually 9 trees for both <18" diameter trees and >18" diameter trees.**

It seems line trees were larger & older, while the majority of bearing trees were smaller. *Does this represent bias by Carey or was it representative of the forest in 1875?* There also were no trends in soil rates to tree diameters. It seemed that bigger diameter trees were to the northwest end of the island, but again little real data was provided. It seems that 'alder bottoms' & big timber were 1st rate soil; 'bigger' trees on rolling terrain were 2nd rate soil; 3rd rate soil and hills had the most mix of diameters; but Carey did not provide enough information, *so this is my impression from trying to analyze soil rates to tree diameters*.

I am not a great math person, but I attempted to try some tree density calculations (Delcourt, 1976) and found they were just math calculations of density for average distances. When I looked at comparing survey points with two trees to each of the trees used for the two-tree calculation, it was just averaging (for the formula I used). The twenty-five single points had 10 points with over 200 trees/Ha. While the 24 (t/point) had only 3 points with >200t/Ha*. For me this may present an average tree number per hectare (very small sample size so a large uncertainty and not considered an adequate sample size), with better averages from 'more trees per point'.* It still does not allow for or show the variation within an area, or provide one with an image of the landscape. There is also a basal area calculation that uses four trees but on Lasqueti's 1875 survey there was only one point with four trees.

I think the actual survey data of tree diameters and distances provides a better picture of this variation, and shows that tree diameter is not related to distance or probably density. Just that single tree points that are short (point to corner), greatly increase density estimates, as would be expected*. I believe Chart 1 density calculations were from different formulas for Lasqueti vs Salt Spring, but the formula Bjorkman used is theorized to be more accurate, but does not include basal area. For the above reasons and testing done by Levine et al, 2017,* ***I question the reliability of historic densities calculations from either survey.***

Possible? Comparison of Lasqueti and Cowichan Valley densities

	# of trees	% of Lasqueti 1875	% of Cowichan Valley 1856
Forest plus undescribed	>315	20%	39%
Open Forest	151 - 315	18%	15%
Plains	35 - 150	50%	23%
Prairies	0 - 35	12%	12%
TOTAL		100%	89%

Chart 1. This is just **a rough comparison** because there was not enough information to directly compare data. Density calculations formulas were different between the two surveys. 50 % of the Lasqueti densities were based on one-tree points, one four-tree point, and the rest two-tree points; *which I do not consider accurate*. Cowichan Valley information was from Bjorkman's thesis's (figure 8 and table 4). The 'Forest plus undescribed' per centage would higher if swamp & bottom land (additional 11%) were added as their tree/Ha were over 315 line. Since I knew about Salt Spring's densities, I wanted to compare them to Lasqueti, so then learned they are not comparable.

The similarities between prairies and open forest are interesting. The differences between forest and plains may be the difference in soil types (amount of soil in the rolling Cowichan Valley vs Lasqueti which is very rocky with a lot less soil). Another factor is that cultural burning and low-intensity fires are known to create forest conditions that are very different from place to place.

The other point is that tree numbers do not represent the landscape picture as well as basal area and Chart 6. illustrates that larger diameter trees dominate one's view. Chart 6. is a three-aged stand. *This may be why most people believe "old-growth" is mainly big trees*.

Younger or small trees were noted very often:
The number of times **young or small** trees were noted at the end of traverses was 39 times (81%) in the traverse notes, ("undergrowth young fir or fir and cedar or small fir (usually with salal but not always)". Chart 2 starts at 4" diameter, since Carey recorded two 4" diameter trees and includes all the trees from Carey's 1875 survey. This young percentage from Carey's notes would go up if some other species were also added to young and small trees (eg 'dog brier mountain willow'). The distribution pattern of tree sizes (if these small trees were added onto chart #2) indicates (*to me*) an approximate all-aged/multiple aged patterns of tree sizes, which also indicates low-intensity fires.

> Isaac in 1940 believed that "Thus there may be forests of one, two. or even three distinct age classes of Douglas fir occurring more or less groupwise, but there will not be an all-age forest." Isaac was writing about CWH forests, (in the foothills & mountains) not coastal dry CDF forests. Isaac beliefs are quite different than Howe's research in 1913, where Howe recorded both younger Douglas-fir patches and younger Douglas-fir trees (=<100 year old trees [ages were: 30, 50, 70, & 100 years old]) within older stands (averaged 54.3 Fd trees/Ha remained after logging plus Cw & Hw). Bakker et al demonstrated the amount and intensities of fires in the San Juan's.

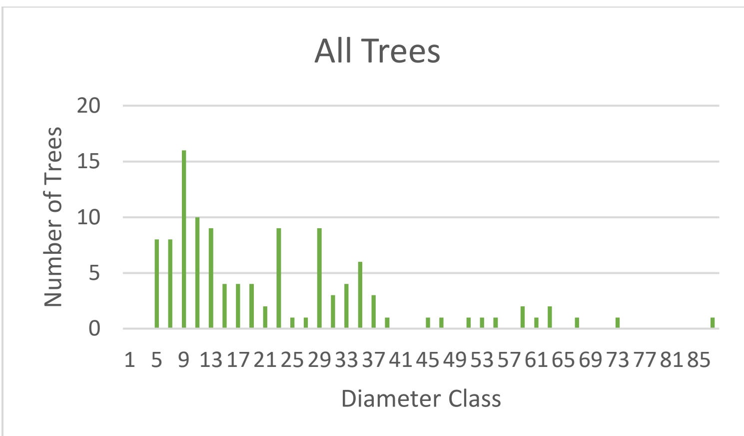


Chart 2. Tree diameters in 2 inch increments (horizonal) to number of trees (vertical axis) for both line and corner trees (114 trees) Lasqueti 1875. The difference between line trees (chart 4) and bearing trees (chart 3) on Lasqueti is quite different than line trees and bearing trees on Salt Spring (chart 5) from the 1874 survey, though the Salt Spring chart was proportion rather than tree numbers. Actual 'natural/never cut' all-aged stands rarely demonstrate an exact inverse J curve size distribution. The inverse J curve model is a balanced mathematical distribution of all aged trees at a balanced distribution. Most low-intensity fire/all aged stands deviate from the balanced model. This complexity of distribution among "fire created all aged" stands, with each area having a different size distribution, has been claimed as another indication of low to mixed-severity fires and the complexity of forests with this fire regime.

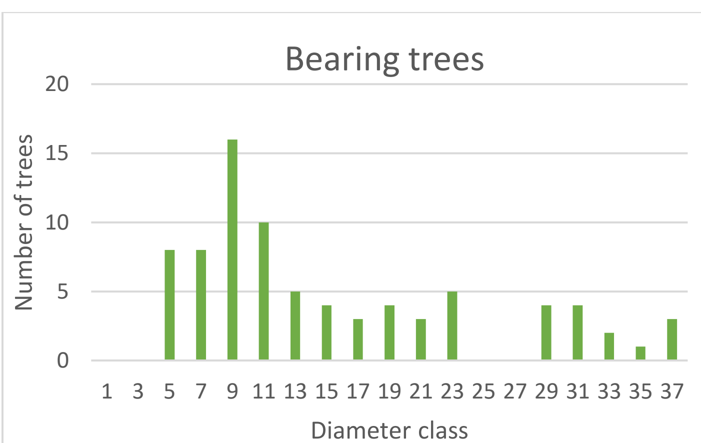


Chart 3 Just Lasqueti bearing trees. Bearing trees were recorded to locate survey points in the future.

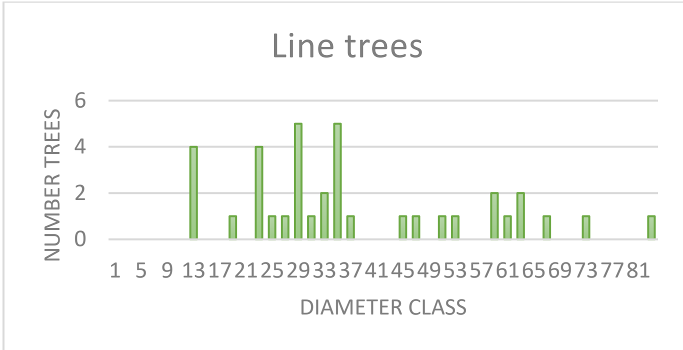


Chart 4. Line trees for Lasqueti. Line trees were trees that survey lines went through, only dbh was recorded and position along the line.

Chart 2 & 4 have the last tree in the 99" dbh class, so this tree diameter would be more to the right.
Chart 3 & 4 demonstrate that size ranges of bearing and line trees were quite different. I have not found an explanation for this within the data. Possible reasons are:

1. Bjorkman said the line tree diameters were inversely weighted by the inverse diameter, a statistical averaging technique. We also do not know how the proportional tree numbers were created. (Chart 5)
2. *One possible reason is an avoidance of taking line tree data by the surveyor.* The number of line trees per mile on Salt Spring Island in 1874 was 5.12 trees per kilometer, while Carey recorded 1.0 tree per 1.82 kilometer (0.55 trees per kilometer).
3. There were many corrections to Carey's line lengths and bearing in 1919*, which raises the question of Carey's surveying accuracy.* About 40, ½ miles lines (40 chain segments) showed corrections in 1919 by surveyor McDiarmid. From the few 1919 survey pages I have found, there were no line trees recorded, just comments on the forest conditions along the lines.

So, if want to try to compare Lasqueti to Salt Spring survey information. My diameters are inches and Salt Spring diameters are centimeters. My trees are by number of trees and Salt Springs line tree numbers are by some sort of proportion. All the Salt Spring densities (proportion of trees) were likely determined by a math calculation, so is an estimate or construct not real data. **There is no direct way to compare these charts**. I believe neither had 600 points, which are considered minimum number to get accurate density information from.

Yet I did compare them to try an understand Bjorkman's work better. Given that I do not understand the math behind Bjorkman's proportional numbers of trees and how it relates to trees/hectare. It appears the Lasqueti (chart 2) and Salt Spring (chart 5) indicate a similar pattern in distribution of tree diameters between Lasqueti 1875 and Salt Spring 1874 in the late 1800's. Both express a rough inverse J curve that indicates an almost "normal" or ideal balanced size distribution for all aged stands. Both have a unimodal bump in small to mid-sized trees. (Size is only an indication of age – no trees were aged.) (Neither legal survey was an inventory of trees.) Both do not show the youngest tree sizes in the curve as they were not recorded. I have not examined the Salt Spring survey but just used Bjorkman's information. There appears to be a major difference between "line trees and bearing trees" between the two islands by the different surveyors or by the way Bjorkman determined proportion. Neither shows the dominant trees or the landscape view or forest condition at the time, as well as does Chart 6 which expresses that size & basal area of the big trees would dominate one's view (eg. in a three aged stand).

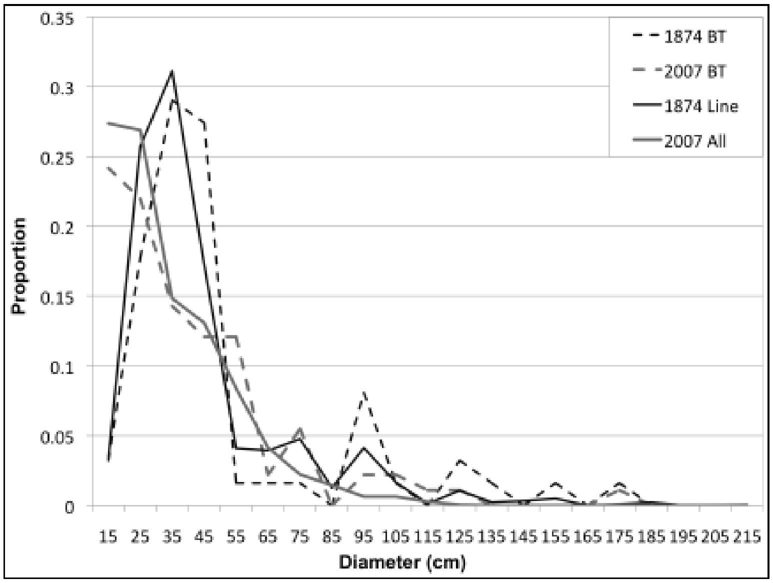


Figure 10: Tree size frequency histograms for Saltspring Island; the black, dashed line represents the bearing tree data from 1874, the grey dashed line represents the bearing tree data from 2007 (the one closest tree at each site), the black solid line represents the line tree diameters (weighted by inverse diameter) in 1874, and the solid grey line is all 2007 trees (up to 10 at each site).

Chart 5. Is Fig 10. from CHANGES IN THE LANDSCAPE AND VEGETATION OF SOUTHEASTERN VANCOUVER ISLAND AND SALT SPRING ISLAND, CANADA SINCE EUROPEAN SETTLEMENT by ANNE D. BJORKMAN, 2008, UBC Masters thesis. No changes were made, this is a photo clip.

Bjorkman did not mention anything about either smaller or around 6" (15 cm) trees (in 1874) being avoided due to expected life survival after being blazed. Bjorkman does not mention basal area relations to tree numbers as shown in chart 5. Nor that the smallest trees were not recorded and are left out of her analysis.

From a retired forester's point of view, if one added the small missing tree sizes to the Charts 2, 3, & 5, they would show a reverse J curve to tree numbers. Though I do not understand Bjorkman's tree numbers proportionality; her 2007 survey and 1874 both indicate this reverse J curve, if small trees were added in. The reverse J curve of tree sizes is well understood to represent a balanced distribution of "all aged" stands that develop from low to mixed- intensity fire regimes. Though no "natural or original" stand ever shows this exact curve, there are always deviations. *What is interesting is that Bjorkman's 2007 data (after fire suppression for over 70 years) and chart also indicates this pattern even more classically without the small diameter modality*. Again, is Bjorkman's proportionality calculations causing this or why? Or does it just indicate that within her study area, there is a balanced tree size distribution to the tree population? *This seems most likely to me.*

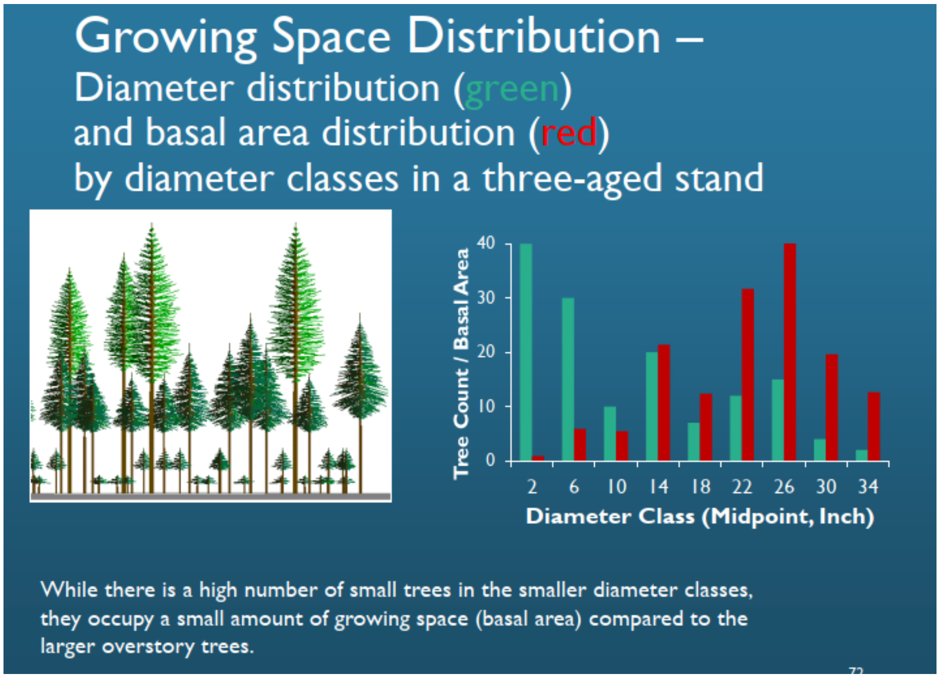


Chart 6 is slide 72 from Ecological Forest Management **–** Northwest Natural Resources Group by Rolf Gersonde, 2016. This is a photo clip of slide 72.

This Chart 6. helps explain why tree #'s by tree diameter classes does not show the landscape picture of the forest. The bigger basal area trees dominate the above image, though there are fewer of them. On the left is a simulated profile image of the three aged stand. For Chart 2. I changed the diameters (dbh) to basal area and multiplied by tree number; then I grouped the dbh's/basal area into three sizes: for trees between 5 to 23" dbh there was 16% of basal area; for trees 25 to 36" dbh there was 27% of basal area; and trees over 36" dbh have 58% of basal area. Trees over 24" dbh represented 85% of the landscape, *therefore would dominate the landscape view*. Chart 3 just "bearing trees", has 52% of basal area from trees 24 – 38" dbh, so big trees would still dominate the landscape view.

Putting both corner and inter-corner trees together:

Tree species percentages were: Fd 72%, Cw 15%, Dr 8%, Hw 3%, Ar 2%, Mb 1% from all the trees recorded in the 1875 survey. This is the mean percentages for the whole island. 17 points had trees over 18" dbh or 32%, while 36 points had trees under 18" dbh or 68%. *This using of points rather than tree number is probably a better analysis of island tree size in 1875, but is also a way to check assumptions.* But remember there could have been size bias in tree selection, also this is a very small sample size for determining tree size and was not done for forest analysis but to locate corners. Chart 1. Also shows that there were more small trees than larger trees. **This size distribution dispels the belief that CDF "old-growth" on Lasqueti were mainly big trees in 1875, but I recognize the big trees would have dominated the landscape view** (same as basal area)**.** Though I think there were a lot of areas of big trees (as indicated by the number of early logging leases [*7+ from my estimation* {Mason & other records}]). Even in the open forest there were big trees, eg the crown land task force in 1988 found an >1.3 meter diameter stump high on a ridge. One thing about low intensity fires (cultural burning) in dry ecosystems is that they are known to create wide spaced big trees and clumps of trees, *I would say especially over the 2nd & 3rd rate soils* (rocky hills, scrub fir, or scattering fir trees, and grassy conditions) as Carey indicates. They also promote grasses and forbs such as the "pea" that Carey notes. Mason also mentions a number of early pole logging operations, so there were stands of smaller diameter, relatively dense tall trees also (probably 60 to 120 years old in 1920's depending on soil conditions). (To create the pole logging conditions, there had to be a few fires or high-intensity patches within fires, from 1800-1860 that would have caused this pole regeneration so that trees could be logged => 1920.) There were 41 fires on the studied sites in the San Juans in the 1800's with 24 of the fires between 1800-1860, so the likelihood of multiple fires on Lasqueti during this period would have been high. Lasqueti's First Nation population was robust until 1862, despite the Gulf of Georgia areas epidemics from about 1760 to1862.

Comparing inter tree distances 1875 to today 2022

Looking at inter tree distances for paired trees using trigonometry there were 26 pairs. Mean distance was **10.12m**, median distance was 8.55m for inter tree distances. Farthest was 21m, while smallest was 1.4m of small diameter Dr. If one removes the small paired Dr and range was 4 to 21 meters between paired trees. The mean distance for all trees to corner was 6.54 meters but this is not really inter-tree distance, just an indication.

- I have just measured some 68 years old trees (1950's logging) for inter tree distances and found from 1.1 to 7.3 meters distances with **average (mean) 3.9m** (these were "precommercial" spaced [thinned] about 32 years ago). *An interesting observation is that though there is less forest floor fuels the ladder fuels are still high in these stands.*
- In mostly older tree areas (probably the 61-80 1968 Forest Cover Map age class) now 80-134 age class, the mostly older trees (not harvested in 1950's but mixed together with regeneration from harvesting) inter tree distances were 2.5m to 8.2m with **average 5.8m** between trees. Another older & younger mix stand of trees ranged from 3.0 to 12.1m with **average of 6.7m**. The older 80-134 year trees definitely had wider average spacing.
- In **three other** rocky shallow soil depth areas on my property, I also did some tree density counts of stumps and live harvestable size trees (considering today's off-island market or "J" quality logs), and got six live harvestable trees for every stump - in all three areas; this estimation was just a count. I believe crown closure is much denser with the six trees per stump than just the crowns from the stumps would have been. I recognize these counted trees were mostly growing in 1950's but were very small then and had much smaller crowns.
- Today's forests are producing better quality and more (industrial type) trees than the cultural/low-intensity fires produced for our pre-1862 forests. If today's forests are left to old-growth age, they will be much denser than most of the 1875 forests, *what is unknown is how future natural disturbances will affect them and even whether they will reach old-growth age.* Especially with our past and present fire protection policies*, I believe that the fire risk keeps increasing the longer time goes by without a fire.* Will they be able to reach 1875 forest conditions or 1850 forest conditions under a no-management policy and normal natural disturbances?

Tree form is often related to inter-tree distance

The range of inter tree distances also produced a lot of trees with large diameter branches (wolf trees). Some of these large branches were close to the ground and some were within the upper crowns (*personal observations on crown land and my property*). **Low down large branch** size is an indication of wide distances between trees at a young age. While the large **crown** branches (candelabra, reiterated, or crown trunks as they are sometimes described) demonstrate the crown were opened up later in the tree's life and/or the crowns were thinned internally and there were no other crowns nearby. These special large crown branches probably only develop after crown modification (loss of part of crown) later in the tree's life. (*I would expect the natural crown disturbance was from wind thinning of crowns and/or snow breakage in a healthy tree.*) After such a crown disturbance, over time the large crown branches develop and can provide the landing and nesting platforms needed by Marbled Murrelets. *I believe these character trees are disappearing from our forests and are not able or will not be able to develop from our present dense trees without some changing the densities of the trees and modifying the crowns.* How to modify crowns is another question that needs answering.

For us to create wolf trees, we would have to rethink regeneration patterns and not always seek "well stocked" areas when regenerating the forest. *I have definitely reduced my opportunities by thinning and pruning my 21-year-old stands to more normal industrial standards*, partly because I was also trying to reduce fire risk (FireSmart) practices. I did not have the knowledge I now have. Nor could I <u>safely</u> introduce cultural fire in the small patch regeneration I had.

The large crown branches (candelabra) type character trees only develop in more open conditions and probably within late mature to old-growth age classes. It is usually an epicormic branch clusters that develops the second crown trunks. It is not just old-growth, but certain types of old-growth that are needed to recreate 1875 forest conditions. To re-create these candelabra character trees, we would need to re-think our forests and old-growth management. I have seen one research project that has tried to modify crowns to recreate these crown growths, so eventually the longer term results will be known for coastal redwoods.

More open forest conditions would mimic 1875 conditions, but would also present the problem of how to maintain them (brush growth). Both re-creation and maintenance of open conditions have to be part of one's goals if one wants to mimic <1875 forest conditions.

For older trees, thinning is the way to increase inter tree distance and open up a stand. How much openness and for what per centage of the forest it is needed to recreate 1850 conditions is unknown. For marbled murrelet platforms to develop in older trees, these trees most likely would also need some crown thinning. Occasionally, winter storms dump huge amounts of snow in our area. The west coast gets winter cyclones (coming from the ocean) that meet cold fronts (coming from the interior) causing a huge dump of snow. Such dumps/loads can cause branches to break opening a crown; in addition, such storms sometimes break the tops off many trees within a young to mid-aged stand. It may be this type of topping that can also lead to candelabra tree tops forming. Broken topped cedars often form candelabra tops or branches.

> Snow data from Seattle shows that major snow years were: 1852 (on the ground for 2-3 weeks), 1861, 1880, 1884, 1894, 1896, 1916 (53" in two months), 1923, 1943, 1950, 1969 (unknown is how many of these years were cyclone meets cold front snows, which are most likely to brake crown branches).

This also highlights that **fire, snow, and wind** were and are all common natural periodic tree or crown disturbances on the Island and in the CDF.

Please watch for these character trees as you walk in the woods; they were a product of some form of disturbance. Often, they are considered poor quality for timber, unless you want special character wood. Elda Mason also reports the poor quality of some of trees harvested in the 1920's and later. (Was the poor quality from the openness and/or repeated cultural burns? *Probably both, as open grown trees are also more modified/blown by winds and have more pitch pockets.)*

Part three is a summary as per winter of 2021-2022

FIRE HISTORY SUMMARY ON LASQUETI:

Fire history pre-1862 is sketchy on the island until more research is done. There is some evidence of an high-intensity fire in the middle of the island that happened in approximately 1700. So far, older fire history can only be estimated using fire histories from around the compass points from Lasqueti and in other similar or the same biogeoclimatic ecosystems as the CDF (eg. The San Juan Island fire studies by Bakker et al, Howe around the Gulf). My blog CDF & Fire presents a good approximation of pre-settlement fires returns.

> Research has shown one is more likely to find 'fire scarred trees the closer one gets to old First Nation villages', up and down the west coast. Lasqueti was well populated so*, the fire return would have been in the most frequent range of fire return for the CDF probably in the 1 to 17 years range with a 4-6 year median interval between fires* (Varney, 2021).

The 1875 survey shows that sometime before 1875, there had been a 22-30 hector high intensity fire that killed the trees along the line between sections 2 & 5. Whether this high-intensity fire area was the only area burned or was the high-intensity area of a larger mixed-intensity fire is unknown. Aging a good representation of the trees in the area would give a good indication of fire date.

Elsewhere, we know that there were two fires in the logging slash of Rat Portage. In 1910, some of the slash of Rat Portage lease burnt for over a mile long area; then in 1919 some additional slash burnt in a fire around Hemmis swamp (along main road). Location and areas burnt are unknown for both these fires. So, the "40 acre slash" area (1919) was either post 1910 logging or had been protected from the 1910 fire. Additionally, it is doubtful that either fire continued very far into the standing timber, because Forest Cover Map 1968 shows latter logging of these areas in the early 1900's.

Additionally, much of the 1950's logging slash was burnt and these slash fires provided the conditions for good forest regeneration. For the most part this regeneration has produced our dense forest of today. The trouble with dense regeneration since 1910 has been that there has been no fires since then. Periodic fires would have thinned and opened up the stands as happened in the 1700 & 1800's. Fire protection has enabled our dense 54 to 75 year old stands to remain dense with high forest fuel & fire ladder build up.

The 1968 Forest Cover Map has a big area of indications of previous burns and/or regeneration before the logging, but after the First Nation exodus in 1862-3. These were patches of forest remaining after harvest that indicate fires or regeneration from 1860 to 1925. The age classes were from: 1908 to 1927, 1888 to 1907, and 1868 to 1887 all within different areas. (This was early photo typing so *the tree height probably was used to indicate age.* Douglas-fir also grow slower when they are shaded than out in the open, *so they may have been older than indicated*.) The (1888-1907) age class is the most predominant area and located all over much of the island. Most of the other two (plus) age classes indicate fires or regeneration areas that are less than 120 acres (>47 Ha) patches, except for one large area at the south end, around Squitty Bay (maybe a settler caused fire [1908-1927 age class disturbance {fire?}]). What was the cause of this regeneration? *Was it all delayed infilling after the First Nations left, just mapped as different heights which was interpreted as different ages?* Were these settler fires, but some occurred way inland far from where the few settlers' establishments were located in pre-1900?

> I have a larger area of the 1968 mapped area (1883-1907 age class) on my property, which I hope to thin in the near future. This will enable better age recordings since these trees need to be aged very low to obtain true ages. Only small trees can be increment cored this low and many of these trees are too large for my 16" increment corer at the germination site or just above it.
>
> > On an area so mapped on my property, a walk-through shows stumps and 'mapped 115-134' year old trees (also a few younger trees in patches) and one area of no stumps that contain the 'mapped' same size trees that had no trees harvested in the "about" 1950's. (Is this old-growth? What do we call this cohort [same aged type of stand]?)

On Lasqueti Island (Xwe?etay/Xwe"i"tay) the best history available is that the vibrant First Nation population of 1860 died or moved away probably by the end of 1863 (1862 small pox epidemic was cause). Therefore, cultural burning would have ceased about 1862. The 1875 survey's forest condition has to be viewed as 12-13 after cultural burning ceased. What is unknown is the amount of burning from 1863 to 1875, except for evidence of one patch of high-intensity burning (evidence recorded in 1875). Did any of the early settlers burn any areas of the woods? Why was there a massive amount of regeneration (Forest Cover Map as from 1860 to 1925) that was not related to early logging? What is the real age of these trees?

> *Even though cultural burning may have become a ritualistic practice, I believe each burner learned and modifieds their practices to better reach their goals.* Each site is different and different areas were held and managed to each family's goals. Some sites were more communal, especially farther away from the village sites. Then each village had different family groupings, which changed over time. Then there was trade and (Xwe?etay/Xwe"i"tay) was in the center of trading (from the wide range of obsidian points found on the island). A big part of trading was the exchange of knowledge, especially in a society that lives mostly outside. Today, cultural burning is a family affair, as it also *probably was pre-1862 on the island. So most cultural burning was a family affair with an element of continued learning.* Low-intensity fires (cultural burning) creates many variations on about the same landscape, depending on the goals of the individual burners.

How much was alder relied on to contain cultural burns is unknown. Also, if alder used for short rotation firewood production. How were the village sites protected from fire? What were the practices in the hills and what were the goals? What were the size of cultural burns? Can diameter of sticks/charcoal be determined at an anthropological/archology dig or in the lab?

Another observation (2021) is that for the old-growth trees we still have (that are rather isolated among younger trees) these old trees ***are now at risk from a wildfire***, because of existing fire ladder fuel conditions around the old-growth trees (from *observations in 2021)*. Pruning or thinning can reduce the fire ladder wildfire risk from these smaller trees, just as thinning (eg. FireSmart shaded fuel breaks) can be used to help recreate more open conditions.

There are many physical as well as biological reasons for different results to the same type of burn on the island and between islands & Vancouver Island. Schroeder presents another view of islands pre-settlement (San Juan County) is at: http://www2.rockisland.com/~tom/presettle.html from research that was done in the early 1990's. I may have some different views about Schroeder's interpretations today, but he did this work >30 years ago and a lot of both forest and anthropological research has been done since that time. (Eg. We now know the bracken fern fields were First Nation gardens and were burned to help ease the harvest of digging the roots. Also, Bakker et al (2019) now provide a multiple island image of repeated fires.) Schroeder used historical quotes about the different islands to show that they were not all in the same forest condition (part 1.) pre-1870's. Then uses summaries of the 1874 legal surveys to illustrate conditions in 1874 (part 2.). Schroeder questions the effect of cultural or natural burning, thinking the climate and soils, were mostly responsible for poor growth of trees, which does not explain the many prairies and openness, but that shows how research reveals information over time (*we should keep learning*).

Tree spacing and openness

Most of the younger trees would have been found on the 2nd & 3rd rate soils areas, or in the pockets of better soil areas between the rocky areas. These areas would have contained the even aged groups of younger trees between larger trees, tree clumps, or patches of larger trees that had been continually thinned by the by the cultural burning. Again, basal area shows the hilly areas would have visually been dominated by the larger trees on the landscape. The cultural burns would also have affected the species composition with the northern exposures showing more shade tolerant species. The 1875 survey map shows Hemlock as a species only in the section 14 & 19 area (mostly north sloping). Fire refugee areas would have been mostly north slopes and wet areas. Cultural burning would continually have been thinning different areas and enabling some new regeneration. The scrub timber would only be noticeable as one walked the hills. The 2nd & 3rd rate soils would also have contained the most open forest. Yet even the poorer soils can have old-growth conditions and bigger trees in the moist draw areas.

The forest conditions were not the same everywhere in 1875 on even Lasqueti. Some of the mapped 1888 to 1907 stands (between 1945-1970) were clear cut, some were selectively thinned, and some were not harvested (patches anyway) at all. Open Douglas-fir woodlands are now being recognized in other areas of the west, where they previously were not believed to be (Hanberry, 2020). These open Douglas-fir woodlands had much variation and historically had grass to carry low-intensity fires.

Another way to consider <1875 conditions is to review Interior Douglas-fir (IDF) and natural disturbance type (NDT) 4 conditions of the CDF.

> "For instance, stand-maintaining surface fires were common in interior Douglas-fir and ponderosa pine forests. Historically, these forests were all-aged and consisted of distinct groups (or clumps), usually of similarly aged trees, with a relatively open understory and interspersed grasslands. Such fires maintained these forests in this condition by essentially fire-proofing them: their vulnerability to crown fires was reduced, which effectively reduced the potential for succession to communities composed of later seral plant species." (From Extension Note 10 - Landscape Ecology and Natural Disturbances: Relationships to Biodiversity, 1997, by John Parminter and Patrick Daigle) The last 22 years of fire in the interior have shown what can happen to this type of landscape, after >80 years of fire suppression.

I present a challenge to the Biodiversity Guidebook 1995 about NDT types in "CDF & Fire" (Varney 2021). *In which I believe the CDF is NDT 4 (not NDT 2 [as per Biodiversity Guidebook, 1995]),* so I often refer to IDF (in BC) or other dry Douglas-fir forest information for this disturbance type information. (Interior Douglas-fir Selection Management by Ken Day 2012 is one reference I use.) The main climatic difference effecting trees between these two ecosystems (CDF & IDF) is rainfall. The IDF has lower 'yearly' rain averages but higher 'growing season' rain fall averages. Yes, the IDF is more continental (colder winter & slightly warmer summer) and CDF is maritime. Even the Douglas-fir varieties are different, Douglas-fir, menziesii (CDF) is coastal and Douglas-fir, glauca (IDF) grows in the interior of BC. But both are dry forest ecosystems that were anthropologically managed with cultural fire. The CDF is usually considered closer to the dry-CWH ecosystems, but *I believe this is from proximity not pre-contact conditions* (most original CDF old forests conditions have been harvested). *I am open to being corrected about the real NDT for the CDF, but my research, fire information, and experience indicates NDT 4.*

> The interior cedar hemlock (ICH) annual average rainfall is closer to the CDF, some of these ICH areas (dry soil conditions) have large areas of predominately Fd. Both the IDF and ICH are the areas where NDT's within the Biodiversity Guidebook have been most challenged since 1995. How much of the research from these areas might be useful in the CDF is unknown.

A major First Nations known goal was to promote forage and habitat for deer production. So, the cultural burning would have been similar to maximizing forage production, or *I would expect it mimicked the high biodiversity option for stand conditions in NDT 4* from the Biodiversity Guidebook 1995. This guide has recommendations for NDT 4 for forage production for different aged trees (as a per percentage of area on the landscape) depending on goals of timber or biodiversity (grass and openness). For the (high/grass) biodiversity option: trees 0-40 years old should be <23% of area. Trees 100->250 should be >51% of the area (with >19% of this 51% older than 250 or old-growth). The per centage of landscape with trees 40-100 years old is left open and depends on a lot of factors, including fuel loads, competition, and what's left. This also assumes that this 40-100 year old trees will progress though succession (or seral stages) for final harvest, or at least some trees. What was not provided was how to measure the per centage of area within each age class, when an area is all-aged stands. Also, the 40-100 year old trees were expected to be harvested eventually.

In the interior of BC, getting high stocking levels of the 40-100 year old trees are usually more of a challenge than regeneration success. The mid-aged group (40-100 yrs) of trees are often overly dense, especially if fires are prevented, as has happened in both the IDF and the CDF. For these dense mid aged stands to be resilient for both drought and fire they need to be thinned to maintain the tree vigor and allow them (too healthily) age into the 100+ age group and on. From a 1968 forest cover map review, Lasqueti (2022) has the largest age class is in the 40 - 95 age class (*with about 45% of the island today*). The next age class is mixture of 95-134 years old (remained after logging) that also contains 52-80 year old trees which regenerated after logging (*this mix is about 40% of the island*). So, Lasqueti has an excess of mid aged condition/trees that are overly dense (for drought & fire), according to the NDT 4 recommendations for per cent of landscape for the high conservation option.

What seems to be missing is the 0-40 trees (about 3% of the island) and the over 154 years old trees locally (also the >250 year age class). Patch harvesting and regeneration could increase 0-40 year age class. The quickest way to increase the >150 age class (or the recommended structural condition of this age class) is by thinning. This **older structural condition will be delayed if no thinning occurs**. *"*Harvest opportunities, such as commercial thinning or other non-clear-cut harvesting systems, should be sought in young, dense, homogenous stands **to hasten the development of mature structure** with an objective to maintain a CDF element occurrence over the long term*"* (Negrave and Stewart, 2010). This paper was written for crown land but is just as applicable for private land. *Most of our stands from 40 to 150 years old need thinning for fire reduction and to open up the stands if we want to better mimic 1875 conditions.* If we thin, we also need to be aware and plan for high brush conditions that follow after thinning. Cultural burning or some other way will be needed to deal with the brush response. High brush growth was not a noted or normal condition in 1875.

> It would be interesting to walk a few traverses today in Aug. to see the amount of grass observed. This would not be a direct comparison but another indication of change. The distance between paired bearing trees (BT) ranged from 4 to 21 meters with a median of 5.55 meters and a mean of 10.12 meters (exception was one pair of alders with 1.4 m between 6" dbh trees).

FOREST OF 1875, HISTORICAL REFERENCE CONDITION OR ALMOST:

Still this analysis of the 1875 survey provides a good picture of early forest and landscape conditions. *This blog tries to paint an overall picture of landscape conditions, not just trees.* I try to illustrate and explain landscape conditions, but realize that even between islands cultural burning produced different forest conditions. Landscape First Nation cultural burning was for best production of food, mostly creating habitat for deer and First Nation gardens/berry patches. It was not an attempt to maximize timber production. Prairies, plains, and even open forests meant areas taken away from tree growth, which would then provide more grass, forbs, & etc for deer forage. I need to point out that to manage for these pre-1875 values also means: a major reduction in today's industrial timber values as open patches and open forests are created and trees are thinned & let grow longer. But openness was a major part of the pre-1850 ecosystem, historical condition, or natural disturbance type before settlement.

If 1875 conditions were all aged/multi-aged or the "reverse J curve" tree distribution, this does not mean that there were not large diameter trees everywhere on the island. Or that small to medium trees dominated the landscape, though there were more 'small to medium' trees in number, but your eye view of the landscape would have been dominated by the large trees and the amount of area taken up by the large trees. This is from basal area interpretations, not tree numbers (chart 5.). The landscape image would have been mostly large trees with minor to major areas of openings.

The likely hood is that smaller to medium sized trees would have been in patches or clumps, mostly located among larger trees on the poorer soils (3rd rate) and around edges of the 2nd rate soils. Grass would have been another dominating landscape image, if you were close to the trees in the <1875 original-growth, especially on the 2nd & 3rd rate soils. We know that after the logging in the 1950-1970, most stands still had stocking of younger trees before regeneration occurred, so that the areas were not listed as "not-sufficiently-restocked" (NSR) within a large range of years after being logged (0-20 yrs), where other adjoining areas were NSR (logged from 1950 to 1969) because noticeable regeneration had not yet occurred or was not considered dense enough for good forest regeneration.

Soil depth and moisture would have had the most influence to differing tree size distribution because Douglas-firs' shade intolerance changes with soil moisture. Douglas-firs are less shade tolerant on more moisture holding soils because Douglas-fir cannot survive under the dense shade of competing understory vegetation on moister sites. Therefore, it takes a bigger "whole in the sky" or opening or disturbance for Douglas-fir to successfully regenerate and progress through life (reach large size) on moist sites. This also means that on better soil areas a natural disturbance such as fire has to be hotter/high-intensity fire to create an opening and obtain successful Douglas-fir regeneration and growth within an older age class stand*. I suggest that the better stands of timber (mostly Douglas-fir) dominated on the better soil moisture areas in 1875*. The exception would have been areas under more intense First Nation management such as alder, prairies, and wet meadows.

Even though low-intensity fires dominated the fire return, sometime high intensity patches (or whole areas) would burn during a wildfire; leading to what might be called patch or "normal Douglas-fir regeneration" following high-intensity fire. It was the stands or patches of even-aged Douglas-fir trees that lead to the belief that it took a high-intensity stand replacement fire to regenerate Douglas-fir (eg. 1700 fire and younger pole harvests (1915-1940) were created by fires demonstrate this locally). Howe, 1915 is the only discovered research that shows Douglas-fir regenerating within "old-growth" under different conditions of cultural burning, (seven different sites around the Gulf). We need to understand, both why and how Howe's reported the condition of multiple aged Douglas-fir growing among old Douglas-fir.

Also, the CDF probably needs more studies following two new studies on forest resiliency in dry forests.

1. "Operational resilience in western US frequent-fire forests" North et al, March 2022. Vigorous tree growth helps maintain a trees resiliency to drought and cultural fire. This study said tree densities had multiplied 6 to 7 times between 1911 -2011 and at the same time tree diameters had gotten smaller. (*Sounds like Lasqueti conditions.)* North et al predicted tree densities would need to be

reduced beyond 'just for fire reduction', such as below "shaded firebreak" density to restore the pre-1911 type resiliency.

2. "Crowding, climate, and the case for social distancing among trees" Furniss et al, Ecological Applications, Dec. 2021. Patchiness and longer inter tree distances helps trees to withstand drought, beetles, fire mortality and/or any combination of these mortality factors.

There is another observed fact is that infilling of Douglas-fir is periodic or in waves of regeneration (Peter & Harrington, 2014) (Eis, 1961). So far there has been no known reason or explanation for this. How much this periodic or waves of regeneration happened locally is still unknown. This helps illustrate some of the differences in stands over the larger landscape.

The picture of **forest conditions in 1875** is about what might be expected at the point in time of 12-13 years after cultural burning (post 1862 smallpox epidemic) stopped. It definitely was not like a continuous Cathedral Grove, there is a lot less soil on Lasqueti in our hills than the river floodplain of Cathedral Grove. Carey rated the hill soil third-rate or poor soil, but I have seen over 3-foot diameter stumps on this third-rate soil. Yet Lasqueti had some very big trees and tree stands of big trees on first rate, second rate, and on third rate soil (soil rates are per the 1875 survey). Overall, Lasqueti forests contained big trees and openings with lots of grass and legumes. (Repeated cultural burning can help cause both openness and large diameter trees across the landscape.) There were also young and small trees (patches) as well as medium sized trees throughout most of the forest. The number of big trees per hectare is the real question, but is relatively easily answered by counting stumps in most areas. This is the most accurate way to determine tree size and density at time of logging. Bark condition can help determine if present trees were alive at time of logging without increment coring them. This needs to be correlated to site series or soil productivity and tree size to give a good understanding of density, at different locations throughout the island or throughout the CDF.

Cultural burning had limited regeneration, provided the best conditions for periodic regeneration, and then again limiting regeneration survival or density. The openness of our hilly knolls was much greater than today. Most of the 2nd & 3rd rate soils had at least two layers of tree ages (Forest Cover Map 1968). Cultural burning was not slash burning "after harvest" and the goals were not to grow commercial trees for harvest. (*Probable First Nation goals were to grow grass/forage for deer production.)* "A Field Guide for Site Identification and Interpretation for the Vancouver Forest Region" 1994 (LMH #28) rates the hill sites as very sensitive to low sensitivity to fire "for slash burning" after harvest. The appendix 7. shows the rating depends mostly on coarse fragment content (1st) then on slope % (2nd) rather than soil depth.

> Again, I was surprised as my first forest training was the previous version, *(*1977 Guide for tree species selection & prescribed burning in the Van. Forest Region) where slash burning was to be avoided in the driest site series, which were of shallow soil depth. The practice of area slash burning (broadcast burning) had changed as I was becoming a forester, and was completely avoided, so I have never had to key out any area for slash burning in the CDF or drier CWH ecosystems from the LMH #28. *It took thinking about cultural burning and slash burning for me to research burning on Carey's 3rd rate soils.* Slash burning for timber production and cultural burning have different goals. In the prescibedfire.ca site they have limited information on both prescribed burns and cultural burning, pointing out some of the differences.

Another point might be that cultural burning *may have also increased soil carbon storage*. It has been long known that grass rotations increase soil carbon.

> Every time the grass is cut, grazed, or burned, fine roots (root-hairs) sluff off – adding carbon to the soil (as per soil science in the early 1970s). This is why prairie soils are dark. So, over the years with no cultural burning there may have been a likelihood of soil carbon depletion; with less grass and forbs adding carbon to the soil at the same time adding more carbon to the trees. "Overgrazing does not mean soil degradation; the two terms should not be confused or considered as synonyms. Overgrazing can contribute both to an increase in ecosystem carbon stocks (e.g. from wood thickening) and to a decrease in soil carbon stocks" (Livestock Grazing and Soil Carbon Sequestration, FAO website). So,

carbon storage is complicated in savanna situations with trees and grass (which was a lot of Lasqueti in 1875).

Looking at tree sizes in 1875

Tree diameter sizes can be somewhat related to age, yes, better soils allow trees to reach larger diameters quicker as does wide spacing. But to consider and help explain tree size averages within the 1875 survey: The small diameter (4-9" dbh) and young trees (in the notes) are recent regeneration, *estimated as pre-1875 to about 1845*. The medium trees 9" to 24" diameter would have been the results of regeneration from cultural burning *from 1700 – 1845 time period*, depending on soil conditions. Trees infilling from 1700-1860 would most likely have been thinned out periodically, from the subsequent cultural burns until 1862 anyway. The big diameter (>24" dbh) trees were *from pre-1700 regeneration*, after a major disturbance. Basal area theory indicates the big trees would have dominated the landscape view.

Pre-1875 cultural burning and forest gleaning would have also left an open mostly less brushy condition than we see today. A normal observation across North America forests was that early settlers could run a horse though the woods. Of course, there would have been patches of brush in places. Island trails were opened or constructed very easily in the early 1900's, then the continued trail use and upgrading turned some into "roads" by 1919. What is unknown is the condition of the roads in 1919. Probably they were pretty rough, as improvements were with pick, shovel, and dump cart. (M*y interpretation from Mason's writing)*. It was likely most roads were built before logging (before the 1919 survey) and just ran through the early forest. The roads were: Main road to Squitty Bay, Conn road to Scotty Bay, Tucker Bay road, and Lake (Centre) road to below Mount Tremberton, all other routes were still considered trails in 1919. These roads were likely formed without cutting any big trees and were wide enough for a cart or wagon. The notes from the 1919 survey might give an indication of trail/road conditions. Mason has the first car on the island arriving in 1927, but by 1929 there were six cars.

There would have been 12 years of litter fall of branches, but Carey never mentioned ground conditions under the trees or windfall patches, *so no strong windstorms probably occurred in this twelve-year period*. Elda Mason also reports the poor quality of some of trees harvested after 1920's. (Was the poor quality from the openness and/or repeated cultural burns? *Probably both, as open trees are also more modified and blown about by winds.) (The poorer quality was probably only a percentage of the trees.)*

I hope that you are open to new possibilities of what were pre-settlement forest conditions. I can only hope your (new) understanding of 1875 forest conditions is similar to what I have attempted to show. I know that 1875 forest conditions changed between different sites and soil conditions and I dough we will ever have a complete understanding of whole island or CDF conditions in 1850. I would like to see more formal and informal research and the results. I have learned a lot by doing this analysis and presenting it as well as I can.

There are a lot of contradictions that can be found about what the forests conditions were in 1875 eg:

- The amount of western cedar, western hemlock, yew compared to short fire return period.
    - These species are not very fire tolerant and repeated fires have been known to restrict these species' ability to live and regenerate. Why were they so successful here?
    - There are areas (pockets of trees) that are protected from fire within stands along the coast. (Howe 1915) What were these areas locally and why?
    - There has to be a reason for how much western red cedar was on the island in 1875. Cedar is not very fire tolerant. This seems a good point to do research on?
    - Moister micro sites, from early studies, helped provide the conditions for cedar to survive after germination in dry areas. Was this depression moisture (micro site condition) also related to survival of western hemlock? Or was fire more limiting for hemlock in the CDF?
    - Does season of burn have an affect with cedar regeneration? Ground fire was found to promote Cw regeneration if mature Cw were in a cone year.
    - When, in what season, were the majority of the cultural burns?

- Parminter and Daigle above paint a picture of results of low-intensity fire, resulting in all aged forests patches of even aged groups of trees compared to traditional images of old-growth conditions. Was the condition all-aged or just multi-aged considering both Howe and Isaac. From Bakker et al we know the fire return was very frequent.
- Though cultural burning had been widespread and surrounding areas had frequent fires, only evidence of one fire was noticed. (But it was over twelve years since the last cultural burn and before any commercial logging started on Lasqueti.)
- Wide spaced young trees develop big limbs to the ground, yet such trees also seem to survive multiple low-intensity fires, why?
- Tree density (wide spacing) was not related to tree diameters (or age). (Was it related to cultural burning? If so why and how?)
- The number of **very wide** spaced trees (over 10 meters) seems to have been about 20% of sampled trees of all diameters. *Was this from frequent fires?*
- Carey's line tree diameters were very different from his bearing tree diameters. (*Yet this appeared to not be the same on Salt Spring, where bearing and line trees were reported to have similar diameter spread, with majority of trees under 18" diameter).* Salt Spring was surveyed by Ashdown Green, he had 5.12 line trees per Km on Salt Spring compared to 1 tree per 1.82 Km for Lasqueti by Carey. But the surveyed lot size was much smaller on Salt Spring, so the sampling was denser?
- Both Lasqueti and Salt Spring (in 1875 & 1874) appeared to have more trees under 18 inches in diameter than larger than 18", so what do we call this condition: "old-growth" "original forest" "multi aged" "all-aged" "cultural burned forest" "First Nation management" "1st Nation management with cultural burning" "cultural burned/all aged and open" or something else??? (*This condition was not my picture of local old-growth before my research started.)*
- Was Lasqueti's forest condition similar to most of the CDF? Probably, according to Bjorkman, *but fire returns were probably longer the farther one traveled away from First Nation villages*. Villages were close in all areas. *Now I add that the better-quality stands were more likely on more moist and richer (nutrient) sites.*
- All tree diameter size ranges contained wide spacing. (*Probably indicates that pre-1875 there were many spots where regeneration was restricted, likely from continued fire disturbance.)*
- The 1968 Forest Cover Map has indications that fires may have continued to happen after the First Nations left?

Other factors to consider:

- Anthropogenic fire or cultural burning probably created these 1875 forest conditions, so do we continue to practice "total fire suppression"? And if we do what is the risk?
- What is a safe or less risky forest condition? If obtained, is such a condition sustainable? How? Sustainable for what values?
- What is a healthy forest in the CDF? Also why is it considered healthy?
- Does more openness mean equate to more wind damage?
- Does "shaded fire break" or "FireSmart" or "drought proofing" practices in a forest stand mimic pre-settlement CDF forest conditions? (*From the North et al, 2022 paper, about a different forest, it seems wider spacing may be needed or areas with wider spacing.)*
- What will be the stream flow conditions under a more grassy and wider tree spacing condition?
- Is one's goal or purpose to grow trees for timber, or "old-growth/original forest"," or return some area to pre-settlement conditions? All of these goals help keep forests in the CDF and seem to promote biodiversity (by different practices producing different outcomes).
- Carbon storage and its sustainability over time is another factor for some people. Does thinning accomplish less risk to carbon storage in trees?
- What do we want our future forest to look like?
- Do individual, clumps, and openings (ICO) or skips produce a more natural forest compared to evenly spaced trees? Is the ICO a way to re-establish pre-1850 forest conditions? I think this will be hard to do considering the brokenness of much of our terrain. Do we increase tree & clump spacing in the shallow soil/rocky areas?

- Without using fire, does opening the forest just mean more brush – what about the grass and grass & legumes that were a major part of 1875 conditions – how do we obtain and then maintain these grass conditions?
- Is restoring cultural burning a reconciliation practice, and if so how do we include First Nations?
- When we examine old photos of False Bay (1920, 1928) in Mason and compare this area today, we see the regenerative ability of the CDF forest is great.

1850 forest conditions

The next question is what were Lasqueti forest conditions like in pre-1850 era? Both Natural Disturbance Type and pre-contact conditions are what most conservationist consider “natural”. There also is a sustainability issue for protected areas, if a wildfire occurs on the island, what is the likely result?

I believe the fire risk on Lasqueti and the CDF is continually rising as fire protection continues. Fire protection has stopped all fires even though our fire return was in the (1 to 17) year range and 4-year mean fire return (Bakker et al), as also per NDT 4. As trees age, the lowest crown height of trees rises off the ground (lowers risk as crown rises), but nothing changes with the crown continuity or fire ladder conditions (both raise risk greatly). Most of the forest is 52 – 80 years old or a mix of this age group plus 80-134 years old with high crown connection and surrounded by fire ladders. Many of our single to small patch old-growth trees have fire ladder conditions around them. For fire risk reasons should something be done?

> “Ecological restoration is an intentional activity that initiates or accelerates recovery of an ecosystem with respect to its function (processes), integrity (species composition and community structure), and sustainability (resistance to disturbance and resilience). It enables abiotic support from the physical environment, suitable flows and exchanges of organisms and materials with the surrounding landscape, and the reestablishment of cultural interactions upon which the integrity of some ecosystems depends (Society for Ecological Restoration International Science and Policy Working Group 2004). Through intervention, the process of ecological restoration attempts to return an ecosystem to its historic trajectory – that is, to a state that resembles a known prior state or to another state that could be expected to develop naturally within the bounds of the historic trajectory (Society for Ecological Restoration International Science and Policy Working Group, 2004). However, although ecological restoration should be anchored in an understanding of the past (e.g. historical ranges of variability in ecosystem attributes), the goal is not to reproduce a static historic ecosystem state. Restored ecosystems may not necessarily recover their former states, since contemporary constraints and conditions can cause them to develop along altered trajectories. Thus, the goal of ecological restoration is to initiate, re-initiate, or accelerate processes that will lead to the evolution of an ecosystem that is characteristic of a protected area's natural region.” (Principles and Guidelines for ECOLOGICAL RESTORATION in Canada's Protected Natural Areas, 2008, Parks Canada.)

Fire needs to be considered both as a natural part of our ecosystem and **as something that will return**. Fire protection has proven that, for frequent fire ecosystems, it can be effective for a time, but the fuel buildup continues until a higher intensity fire happens. So, there is the need to lower ground and near ground forest fuels, reduce fire ladders, and obtain some crown thinning to reduce crown connectivity. There also needs to be some openings for forest renewal. Is there a need for older stands (80-150 year old trees) to be thinned to promote later successional stage conditions, without a long delay period? Will our forests be more sustainable when fire returns; *this probably will be determined by the fire intensity*?

Another question to consider is whether it matters if the forest conditions of 1850 were anthropogenically (human) or lightning created? What was the statis of young and small trees or were they also there in 1850? What are we trying to preserve and for how long? Will the “NO-management” option of present ‘preservation properties’ take us to our goal? What about the unceded/crown land? The question becomes do we want to restore, initiate, re-initiate, or accelerate processes for our forests to pre-settlement conditions and restore the CDF’s ecological integrity (especially around fire)? If we do, then how do we accomplish this goal individually and as a community?

Dick Varney, RPF (Ret)