Succession at the Eugene Millrace Pond:

2017, 1963, and Analogs for the Older Pond

Introduction:

I did this study after walking the length of the Eugene Millrace and noting the primary stages of succession along all of its parts. The millrace is rewilding, it appears to be in an overgrown state of chaos. How long has it been this way? Is its current state indicative of its past states? I needed to study succession. Before this project, I tended to see trees as relatively permanent things, so I initially hypothesized that the current state of the millrace was about the same as it had always been. My question essentially boiled down to two parts:

1. How does today's millrace pond compare with what it was 50 years ago?

2. How does today's millrace pond compare with what it was 500 years ago?

In order to explore my question, a basic understanding of succession was necessary. Succession is the mechanism by which forests (and other ecosystems) develop.[1] The first question ended up addressing the speed at which succession occurs, and the second addressed the plants involved.

Materials and Methods:

I addressed Part 1 with a historical study, initially scouring the internet and online databases from local organizations, eventually finding a series of pictures in the Lane County Historical Society's online collection of photographs by Don Hunter. Hunter (1914-2016) founded the Audio-Visual Department at the University of Oregon. He was also an amateur photographer who took pictures of campus life.[2] The pictures of interest for me were a series of photographs taken on the North bank of the millrace pond. The subjects of the pictures were mostly floats participating in a canoe fête in 1963, but the pictures all included the banks of the pond, and provided enough information for me to assess the vegetation in the area. I chose four pictures that gave a good perspective on the area, and revisited the site of each. I did my best to replicate the position and angle of each picture, and took pictures to format in a "before and after" style.

I addressed Part 2 by finding analogous ponds. Two ponds were recommended to me: the first was the Mount Pisgah Watergarden, the second was a small slough located on the North Bank of the Willamette River just East of the Autzen footbridge. The second site will henceforth be referred to as the Willamette slough. At each site, I performed a 30-meter belt transect along the water's edge, maintaining a distance of about 2 meters from the bank. This belt transect gave me a fair representation of what was present in each area. I also wanted to see if there was any change in vegetation from the water's edge back, so I ran 5-meter belt transects perpendicular to the bank in intervals of 5 meters along the initial 30-meter belt transect (Figure 1).

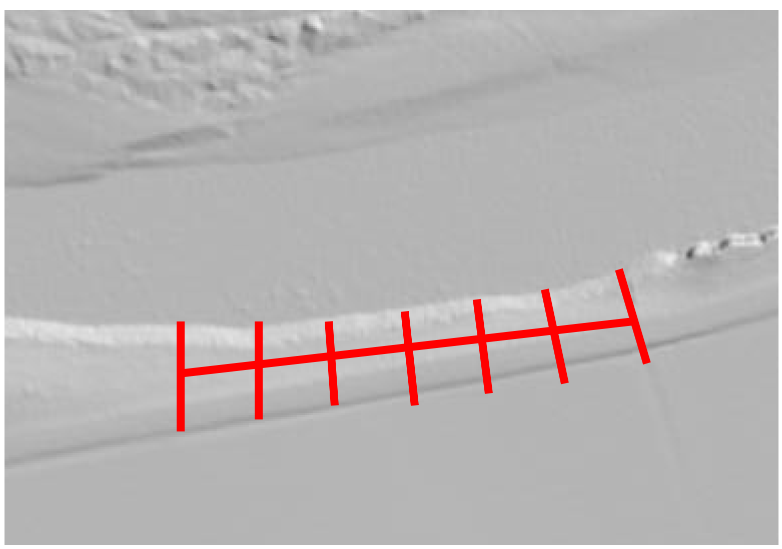

Figure 1: Belt transect layout

At each site, I recorded all woody species along the transect line. This reduction in complexity was necessary because of the time constraints of the term. At the millrace pond (Figure 2), I decided to choose a belt transect location that had been photographed by Don Hunter, so I would have an area that had been documented around 50 years ago. The Mt. Pisgah Watergarden (Figure 3) was the largest of the two analogs, so I just decided to do a transect where I could. The Willamette slough (Figure 4) was the smallest analog, and the initial 30-meter belt transect nearly covered its entire length.

Figure 2: Millrace pond belt transect location

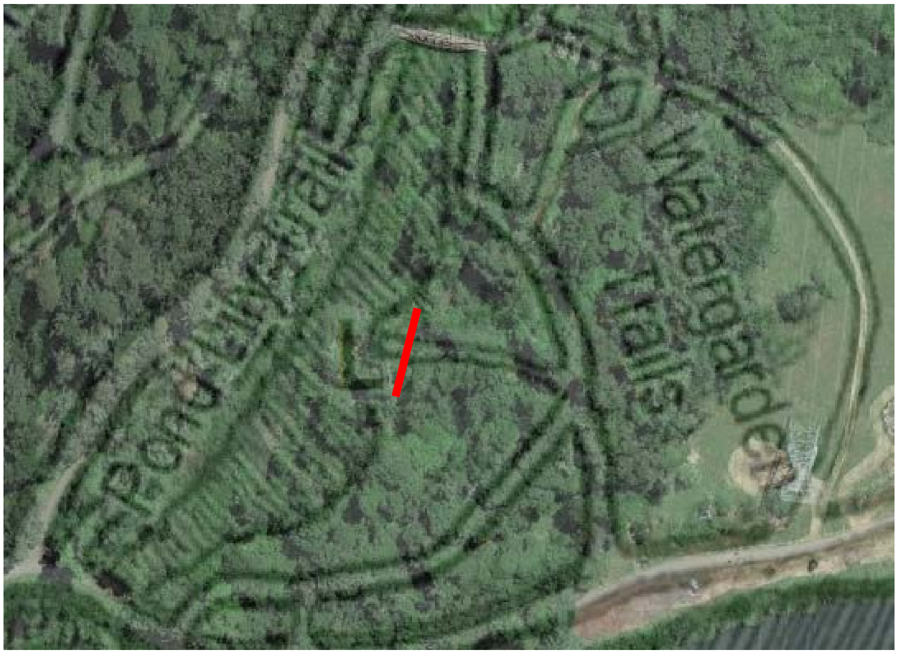

Figure 3: Mt. Pisgah Watergarden belt transect location

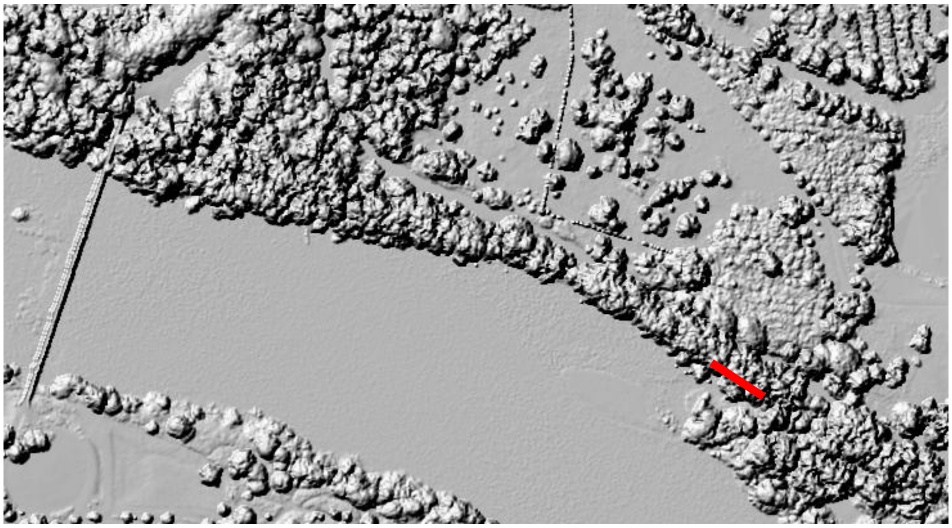

Figure 4: Willamette slough belt transect location

I took the average percent cover of each species found at the belt transect locations and the sum of the number of times each species was recorded as "present" along each transect location.

Results:

Initial examination of the data showed no evident trend in vegetation change from the water's edge back. 5 meters is apparently too small a belt transect length to see vegetation change from the bank back, so I decided to abandon that area of study and focus on presence and percent cover of each transect. After initial analysis of the data, we (Bitty Roy and I) found that I didn't have enough 5-meter belt transects, and the initial 30-meter belt transect was going to be difficult to fit into the dataset seamlessly, so I broke up the 30-meter transect into six 5-meter belt transects and lumped them together with the rest of the 5-meter transect data. Thus, my study ignores the species distribution of the areas. The millrace pond had a species richness of 7, with 3 native species. The Mt. Pisgah Watergarden also had a species richness of 7, but had 6 native species. The Willamette slough had a species richness of 12, with 7 native species. Dominant species at the millrace pond included a non-native *Quercus sp.* and *Rubus bifrons*. Dominants at the Mt. Pisgah Watergarden included *Symphoricarpos albus*, *Rubus bifrons, Acer macrophyllum*, and *Fraxinus latifolia*. The dominant species at the Willamette slough were *Fraxinus latifolia*, *Populus balsamifera ssp. trichocarpa*, and *Symphoricarpos albus*. After adding error bars of one standard deviation, most species that I recorded were not significant. Dominant species were found by removing these non-significant results.

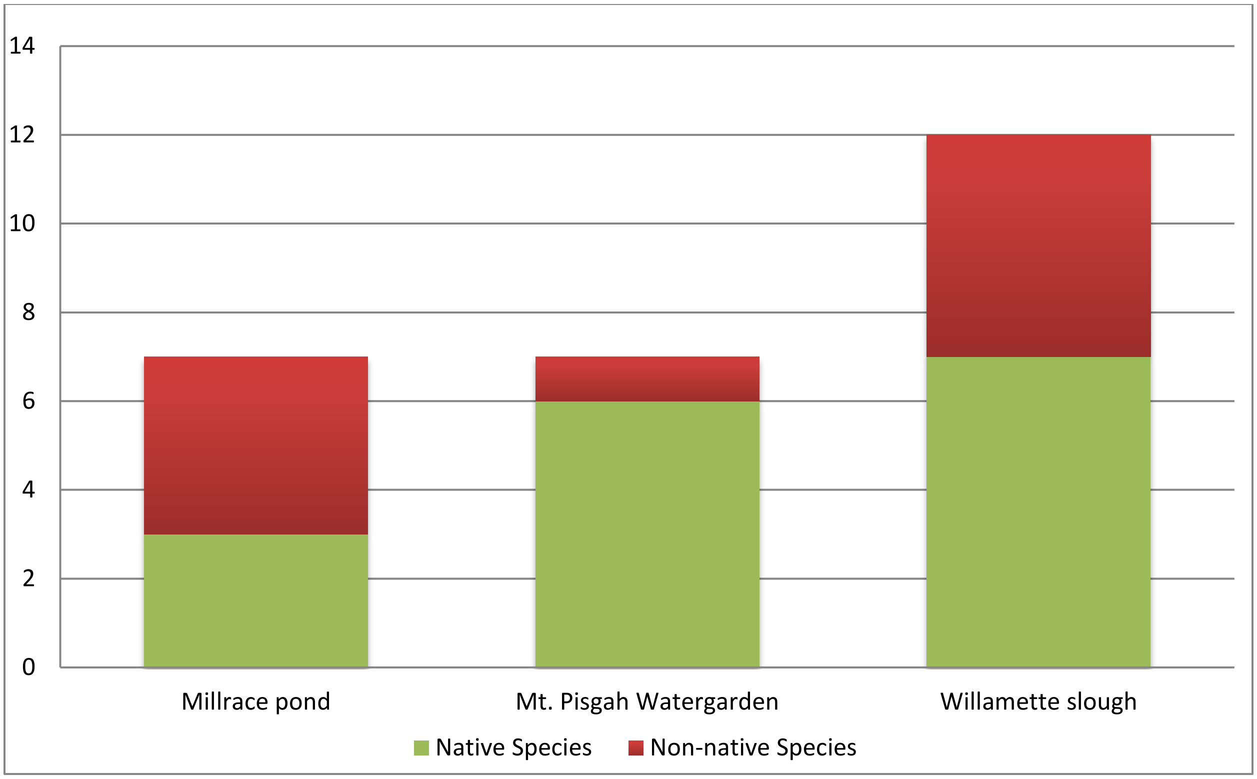

Figure 5: Species count for each site

Key for Figure 6 (below):

MP: millrace pond

WG: Mt. Pisgah Watergarden

WS: Willamette Slough

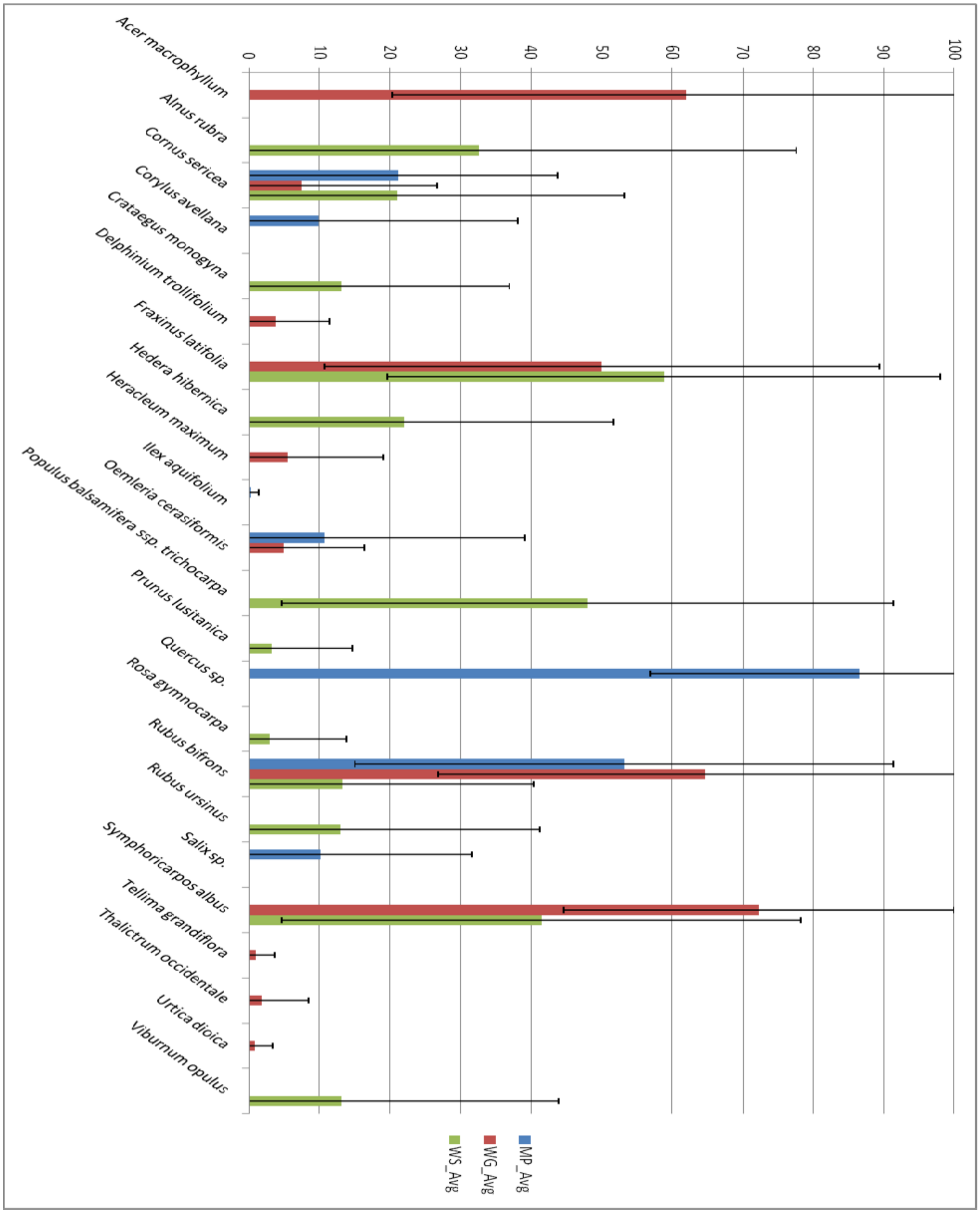

Figure 6: Average percent cover of each species

Discussion:

Only a few of my percent cover results are significant, even with error based on one standard deviation. The results that are significant at that level are of more use for indicating the presence of certain species at the sites and the absence of those species at other sites. From this information and the origin of species present, we can assume that the dominant plants at the millrace pond were planted. In one sense, this study is a first step in quantifying the extent of dominant non-native species around the millrace pond. From the data gathered, we can make inferences about the history of each site. A few native species have crept in to the millrace pond, but, as much of the area I surveyed was shaded by non-native *Quercus sp.* and *Rubus bifrons*, not many early successional native species have been able to find a hold. The shrub layer of *Symphoricarpos albus* is absent here, but is present in both analog sites. The Mt. Pisgah Watergarden is probably the best analog for the millrace pond, because it isn't right on the riverbank like the Willamette slough. Also, the Watergarden is likely managed, as there was only one non-native species found in all of the transects. The similarities between the Watergarden and the Willamette slough were encouraging, but it was interesting that the Willamette slough had more native and non-native species than the Watergarden or the millrace pond. This is most likely a result of the proximity of the Willamette slough to the river and the bike path, as well as the likelihood that the site was neither planted nor recently managed. Today, the Eugene millrace pond is mostly covered by non-native canopy (*Quercus sp.*) and non-native understory (*Rubus bifrons*), but 50 years ago, the woody vegetation around the pond was non-existent. At that time the area around the pond consisted of manicured lawn grass on the South side and fine-grained sediments along the North bank. Pictures that I took 54 years later showed the dramatic successional change (Figures 7-10). The analogous ponds that I studied indicated that 500 years ago, the millrace pond would have looked quite different. The *Rubus bifrons* understory would have been replaced by *Symphoricarpos albus*, instead of *Quercus sp.* shading the water, it would likely have been a mixture of *Fraxinus latifolia* and *Acer macrophyllum*, possibly even some *Populus balsamifera ssp. trichocarpa*. I speculate that some of the native species currently present at the millrace pond would have been present, such as a few members of the *Salix* species, as well as *Oemleria cerasiformis* and *Cornus sericea*. My initial hypothesis about the millrace pond was entirely wrong, but I was delighted to discover the radical change that can occur in succession. Future research in this area should look at the successional trajectory of the millrace pond. Will it be taken over by *Rubus bifrons*? Is it progressing toward a native climax community (regular Markov chain[3])? The presence of non-native, invasive species can also alter successional pathways[4]. Is that occuring at the millrace pond? Is the presence of non-native species effecting succession downstream? Quantifying more of the plant coverage around the pond would also be helpful. The North bank (along the South wall of the Central Power Station) has a number of conifers, and it would be interesting to see how that side compares to the analogous ponds. Different transect styles would be useful as well, especially if the desire is to assess the difference in vegetation as you go back perpendicular to the water's edge. A consideration that occurred to me was the absence of dams upstream (or downstream) of the millrace pond 500 years ago, and how the fluctuating water level back then would have affected the pond differently than our current dammed situation. Water level fluctuation effects the succession of ecosystems along riverbanks[5], but would it have had a large effect on the pond? There are a lot of places that this study can go, and doing the preliminary work was truly fun and interesting.

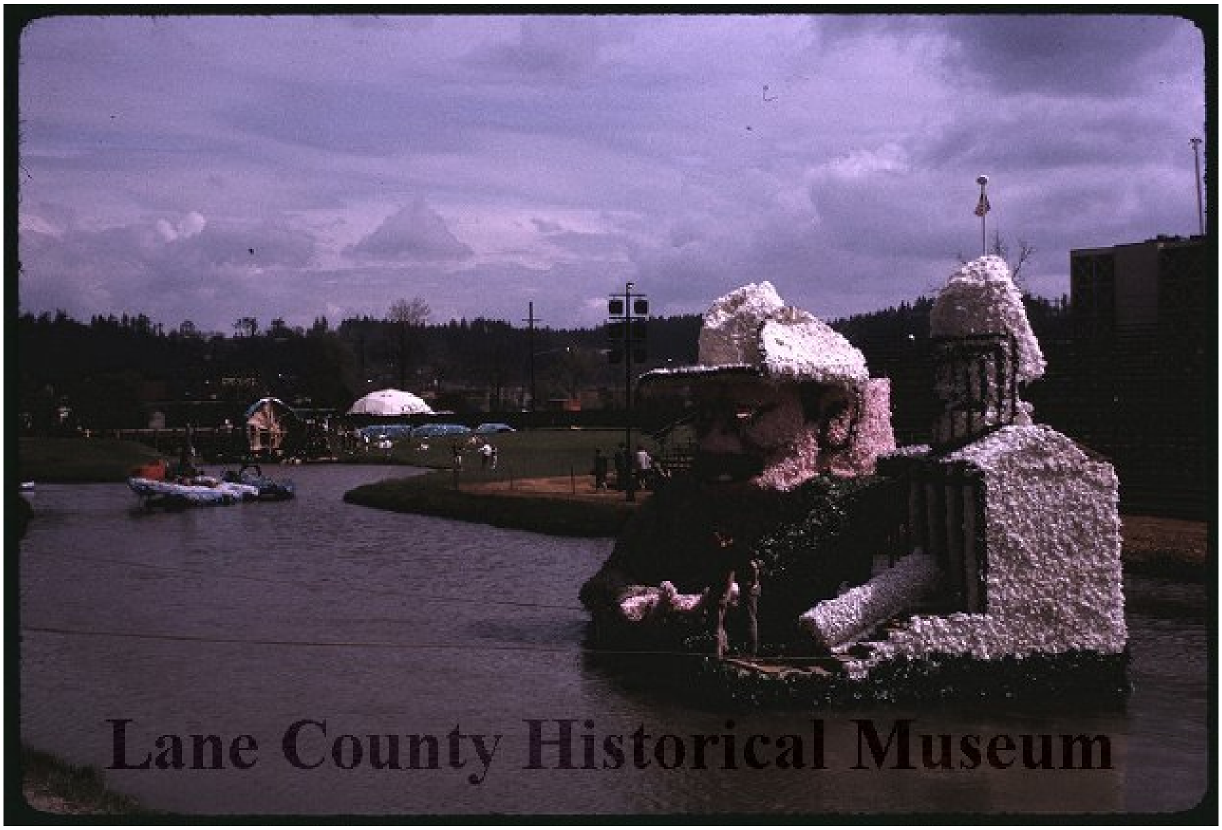

Figure 7: S. Bank 1963-Don Hunter

Figure 8: S. Bank 2017

Figure 9: N. Bank 1963-Don Hunter

Figure 10: N. Bank 2017

References:

[1] Connell, J. and Slatyer, R. (1977). Mechanisms of Succession in Natural Communities and Their Role in Community Stability and Organization. *The American Naturalist*, 111(982), 1119-1144.

[2] *The Don Hunter Collection*. (n.d.). Retrieved from http://lchm.org/digital-collection/

[3] Horn, H. et al. (1975). Markovian properties of forest succession. *Ecology and Evolution of Communities*, 196-211.

[4] Sullivan, J. et al. (2007). Secondary forest succession differs through naturalised gorse and native kānuka near Wellington and Nelson. *New Zealand Journal of Ecology*, 31(1): 22-38.

[5] Nilsson, C. and Berggren, K. (2000). Alterations of Riparian Ecosystems Caused by River Regulation: Dam operations have caused global-scale ecological changes in riparian ecosystems. *BioScience*, 50 (9): 783-792.