Forestry in Ireland

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Introduction

One of the greatest crisis humanity faces is Global Warming. Recent reports suggest rising sea levels could within three decades push chronic floods higher than land currently home to 300 million people (Kulp & Strauss, 2019) and that ice losses have increased from roughly 760 billion tons per year in the 1990s to more than 1.2 trillion tons per year in the past decade (Slater et al., 2021).

These alarming reports combined with my personal interest in climate change have borne this report – an analysis of Forestry in Ireland. Forests are natural carbon sinks and can directly help fight global warming by storing carbon dioxide. While Ireland has seen massive historical deforestation up until the turn of the 20th century (Everett, 2014), in recent times the government has been encouraging the growth of new forests and re-growth of old forests via the Afforestation Grant and Premium Scheme which was renewed in 2014 for a six year term (Irish Government, 2020). This report directly ties in with this by analysing Ireland's:

- forestry rates
- ownership levels of forests
- tree types
- tree species and;
- afforestation over time

Design Process

All data analysed comes from the National Forest Inventory Results Data of 2017 and Teagasc's Forest Statistics Ireland report of 2020 which contained a large volume of data with which to analyse and interpret forestry statistics in Ireland as of 2017 and 2019, respectively.

From review of the data contained in the downloaded excel spreadsheet (link in Appendix), it became apparent that the data would need to be reshaped as the data was in wide format and thus intelligible in Tableau. Further to this, the measures contained in the datasets were mostly limited to categorical variables (e.g. - county, tree type, tree species) and two attributes, % and Area (hectares 000's).

Given this, the visualisations that could be completed were not as comprehensive as they may have been where there to be consistent date measures to use as an axis against which measures can be graphed. With this said, I set out to use the Teagasc Report of 2020 to analyse yearly afforestation from 2000-2019. I also realised aggregate measures would also need to be manually developed to manipulate the data to provide the desired results – for example, the sum of total percentage, creation of 'regions' and ranked hierarchical measures.

Objectives

From review of the data contained within the datasets selected and downloaded, I set out to answer the following questions:

- Which counties have the highest percentage of forestry for their area size and how does this vary throughout Ireland?

- What types of trees (Conifer/Broadleaf) are most commonplace in Ireland, and where can they be found?
- What are the demographics of Forest Ownership in Ireland?
- Does a relationship exist between altitude and tree type? If so, where and what patterns can be observed?
- How has Afforestation changed over time?
- What tree species are Ireland's forests composed of?

Pre-processing

Two datasets were selected that addressed my objectives and held the possibility of providing answers. They were subsequently cleaned by changing from wide to long format in Excel and then merged into one excel workbook. When read into Tableau, the 'tables' (being excel sheets) were linked by creating relationships on common fields. I manually entered in statistics reflecting total forestation in Ireland from 2000-2019 from page 28 of the aforementioned Teagasc report of 2020.

Regions were created manually by using the following code:

```
IF [County] = "Mayo" or [County] = "Sligo" or
[County] = "Roscommon" or [County] = "Galway" or
[County] = "Leitrim" THEN "Connaught"
ELSEIF [County] = "Dublin" or [County] = "Kildare" or
[County] = "Meath" or [County] = "Carlow" or [County]= "Louth" or [County]= "Westmeath" or
[County] = "Wicklow" or [County] = "Longford" or [County] = "Wexford" or [County]= "Offaly" or [County]=
"Laois" or [County]= "Kilkenny" THEN "Leinster"
ELSEIF
[County] = "Donegal" or [County] = "Monaghan" or [County] = "Cavan" THEN "Ulster"
ELSE
"Munster" END
```

In order to illustrate the % of Forested land across Ireland by county as an aggregate (Sum of % and hectare size 000's), I created the following calculated field (measure) where '*LUTPercent'* refers to the % of Forested Land by County. This created three categories that represented a range of the %.

```
IF ([LUTPercent]) <= 8.2 THEN "2.9 - 8.2" ELSEIF [LUTPercent]>8.2 AND [LUTPercent]<= 13.6 THEN "8.3 - 13.6"
ELSE "13.7 - 18.90" END
```

So as to identify which counties had a dominant tree type of either Conifer or Broadleaf, the following calculated fields were created:

Ratio: *SUM([% (Species & Area County)])*
Species Highlighter: *IF [Ratio] <50 THEN "Broadleaf" ELSE "Conifer" END*

Design Choices

Land Use Type

Forest	11% 770
Non-forest	89% 6,206

As outlined by Sharon Lin and Jeffrey Heer in the Harvard Business Review Insight Center Report of 2014, where data is numerical or rank ordered;

'a diverging or sequential colour scheme may be preferred, in which a single colour becomes darker or lighter depending on the relative order of the values' (Harvard Business Review, 2014)

Building on this, I used three shades of green to reflect low, moderate, and high forestry rates with each shade getting darker once the % fell into the next range of values with the intention of illustrating this via a map of the Republic of Ireland.

I also decided to display the top 5 counties that were Forested and Non Forested (by %) as an ad hoc visualisation. The reason for using this measure (top 5) was to limit the axis size as otherwise the graph would be more difficult to interpret and contain *too much data*. Two axes were used on the rows shelf in Tableau and merged thus creating a dual axis. One row mark was a bar chart reduced to the lowest bin width and the other a circle resulting in the generation of these graphs. This was so as to present the data in a *clean* fashion.

Ownership Type

Region	Private (grant aided)	Private (other)	Public	**Grand Total**
Connaught	69.1	21.6	100.6	191.3
Leinster	60.6	36.5	94.3	191.4
Munster	115.4	43.6	148.8	307.8
Ulster	23.0	8.9	47.7	79.5
Grand Total	268.1	110.5	391.4	770.0

Given there are only three categorical variables for Ownership Type, a pie chart sprung to mind as it is quite effective in conveying data when there are only a small number of categories being compared. Building on this, I deduced that it would be insightful to generate pie charts for each region, and each county based on their respective ownership levels to see how these differ across Ireland. As the data is not continuous, it cannot be used in the same vein as in where a rank ordered measure of % of land forested was created as touched upon earlier. As such, an interactive pie chart was required to help highlight how each ownership type compares to the other by way of the total for each region (hectares 000's).

Further to this, I decided to illustrate the top 5 counties by % of Ownership Type as an ad hoc visualisation using the same method previously outlined under Land Type Use however this is not included in this report, but rather my interactive dashboard.

Tree Types by Region

	Region				
Species	Connaught	Leinster	Munster	Ulster	**Grand Total**
Broadleaf	38.0 23.06%	67.4 40.87%	71.0 27.18%	17.2 34.47%	193.6 33.55%
Confier	135.3 76.94%	104.3 59.13%	187.2 72.82%	52.7 65.53%	479.5 66.45%
Grand Total	173.3 100.00%	171.7 100.00%	258.2 100.00%	69.9 100.00%	673.1 100.00%

Given the level of variability that was observed between most regions where tree types were concerned, I thought it would be interesting to identify which tree type was dominant in each county and group the county into it's respective region to see how this changed across each region. I decided to create a graph resembling a dot chart, except using a custom shape (tree) instead to denote which tree type was most dominant via the use of two colours.

Tree Species - Distribution by Altitude

% of total for each Tree Species

	Species Group														
Altitude	alder	ash	beech	birch spp.	Douglas fir	larch spp.	Norway spruce	OLL broadl eaves	OSL broad leaves	other conifers	other pines	Scots pine	ses. & ped. oak	Sitka spruce	sycamore
0 - 49	24.00%	35.60%	28.50%	21.30%	1.00%	7.80%	9.80%	36.50%	23.40%	4.20%	9.60%	18.80%	21.20%	6.30%	32.40%
50 - 99	28.60%	41.35%	37.60%	54.34%	41.50%	23.00%	60.20%	33.70%	40.90%	22.10%	21.80%	50.90%	38.00%	22.10%	47.93%
100 - 149	28.80%	16.50%	18.10%	14.10%	28.70%	26.68%	18.20%	18.00%	17.20%	33.30%	19.90%	20.50%	23.80%	15.10%	8.80%
150 - 199	16.10%	4.10%	14.50%	5.70%	18.60%	15.40%	6.20%	6.60%	10.10%	26.70%	14.20%	4.80%	13.90%	16.70%	10.40%
200 - 249	0.50%	2.40%	1.30%	1.90%	6.40%	10.50%	4.00%	4.30%	4.10%	6.10%	12.20%	3.00%	2.30%	14.50%	0.07%
250 - 299	1.70%	0.05%	0.00%	2.60%	3.80%	9.30%	1.60%	0.20%	1.50%	7.60%	7.10%	0.00%	0.40%	11.30%	0.40%
300 - 349	0.30%	0.00%	0.00%	0.06%	0.00%	5.80%	0.00%	0.70%	1.90%	0.00%	7.30%	2.00%	0.30%	8.00%	0.00%
350 - 399	0.00%	0.00%	0.00%	0.00%	0.00%	1.50%	0.00%	0.00%	0.90%	0.00%	5.30%	0.00%	0.10%	2.80%	0.00%
400 - 449	0.00%	0.00%	0.00%	0.00%	0.00%	0.02%	0.00%	0.00%	0.00%	0.00%	1.40%	0.00%	0.00%	2.30%	0.00%
450 - 499	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.20%	0.00%	0.00%	0.70%	0.00%
500 +	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.20%	0.00%

% of Total % (Specie..
0.00% 60.20%

Given the types of data being used and building on the above results, I elected to create a clustered column chart based where each Tree Species was measured as a % of its total distribution across each altitude range. Using a colour palette in a clustered column can enable a person to browse from column to column following the observable pattern to draw their conclusion. As such, I decided to incorporate a colour palette in the visualisation.

Tree Species – Composition of Forests

Species group	% of Total	Area Hectares (000's)
Sitka spruce	40	871475
OSL broadleaves	15	323819
birch spp.	10	225394
other pines	7	162694
ash	7	153288
OLL broadleaves	5	104513
Norway spruce	3	62480
alder	3	60246
larch spp.	3	53952
sycamore	2	45526
ses. & ped. oak	2	44164
beech	2	38224
Scots pine	1	17706
Douglas fir	1	17952
other conifers	0	5692

When reviewing the types of tree species as a percentage of total trees and ranking them from highest to lowest and, taking into consideration there are a large number of tree species, I decided to use a Treemap to illustrate the composition of forests by tree species.

The reason I chose to use a Tree Map to illustrate this data is that it can handle a large number of categorical variables and allows a combination of size and colouring to clearly illustrate a hierarchical ranking of tree types. This is in contrast to the likes of a Pie Chart which does not handle a large number of categorical variables well and can subsequently make it difficult to identify how each group ranks to another. In this case, the colour was chosen to reflect how large, or small, each type of tree species is in the composition of forestry by way of tree species. Finally, I decided to embolden the labels for tree species to help the viewer identify what each 'block' related to and chose to display the above summary statistics for each tree species.

Afforestation

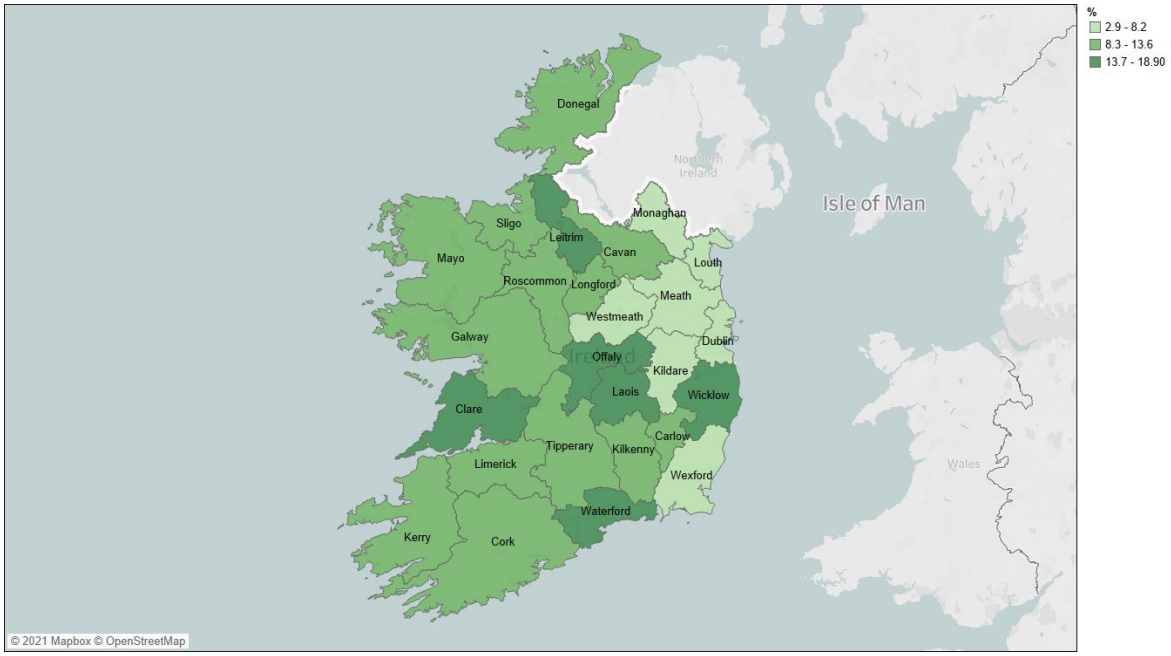
Afforestation, 2000 - 2019

Year	Hectares				Running Sum of Hectares along Year				Hectares	Running Sum of Hectares a..
	Connaught	Leinster	Munster	Ulster	Connaught	Leinster	Munster	Ulster	**Total**	**Total**
2000	3,245	3,542	7,528	1,380	3,245	3,542	7,528	1,380	15,695	15,695
2001	2,943	3,165	7,738	1,619	6,188	6,707	15,266	2,999	15,465	31,160
2002	2,874	3,038	7,481	1,663	9,062	9,745	22,747	4,662	15,056	46,216
2003	2,037	2,147	4,246	667	11,099	11,892	26,993	5,329	9,097	55,313
2004	2,216	1,923	4,780	819	13,315	13,815	31,773	6,148	9,738	65,051
2005	1,810	2,317	5,263	707	15,125	16,132	37,036	6,855	10,097	75,148
2006	1,418	1,759	4,295	563	16,543	17,891	41,331	7,418	8,035	83,183
2007	1,510	1,277	3,471	691	18,053	19,168	44,802	8,109	6,949	90,132
2008	1,258	1,298	3,241	450	19,311	20,466	48,043	8,559	6,247	96,379
2009	1,602	1,577	2,948	520	20,913	22,043	50,991	9,079	6,647	103,026
2010	1,727	2,436	3,621	530	22,640	24,479	54,612	9,609	8,314	111,340
2011	1,312	1,769	3,239	333	23,952	26,248	57,851	9,942	6,653	117,993
2012	1,339	2,155	2,782	374	25,291	28,403	60,633	10,316	6,650	124,643
2013	1,906	1,703	2,300	343	27,197	30,106	62,933	10,659	6,252	130,895
2014	1,943	1,551	2,258	406	29,140	31,657	65,191	11,065	6,158	137,053
2015	2,011	1,589	2,304	387	31,151	33,246	67,495	11,452	6,291	143,344
2016	1,931	1,580	2,439	550	33,082	34,826	69,934	12,002	6,500	149,844
2017	2,089	1,275	1,740	432	35,171	36,101	71,674	12,434	5,536	155,380
2018	1,380	1,031	1,143	473	36,551	37,132	72,817	12,907	4,027	159,407
2019	1,241	595	1,439	271	37,792	37,727	74,256	13,178	3,546	162,953

Based on the above results, I decided I would create a graph with a dual axis, one denoting the number of new trees planted by region, and the other the running sum of afforestation by region. I elected to not use a synchronised graph as to do so would result in the former being very small given the significant numerical difference in the running sum total and afforestation in 2019. With year on the x axis to illustrate how this changed over time, I thought to use an annotation mark to pinpoint the exact values for new trees planted at two different points in time. New trees by year were illustrated by area under the total, and the running sum of afforestation by lines (one for each region).

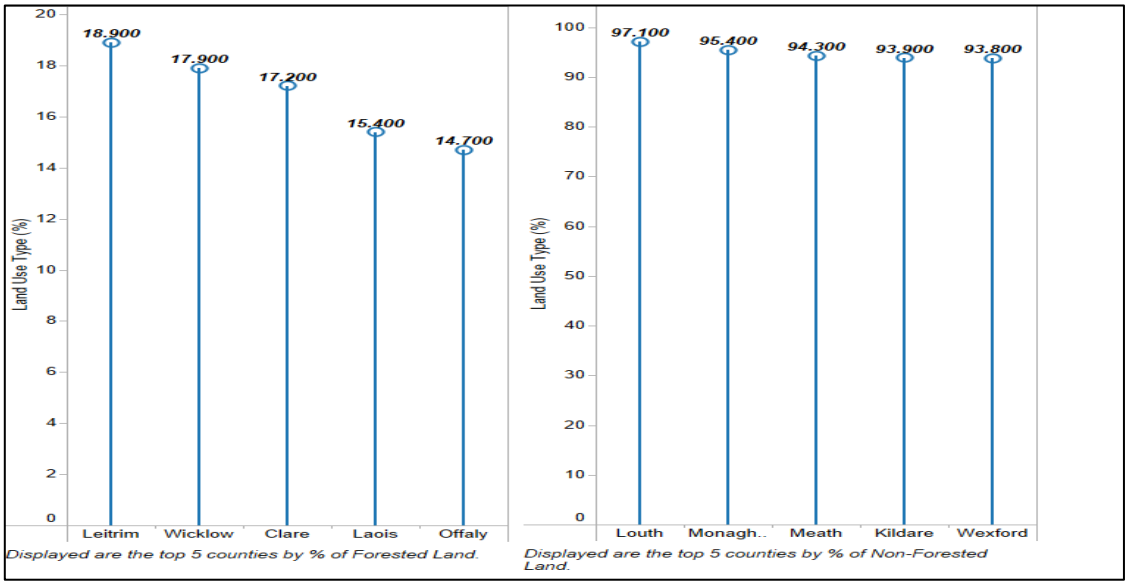
Design Solution

Land Use Type – Forested Land in Ireland

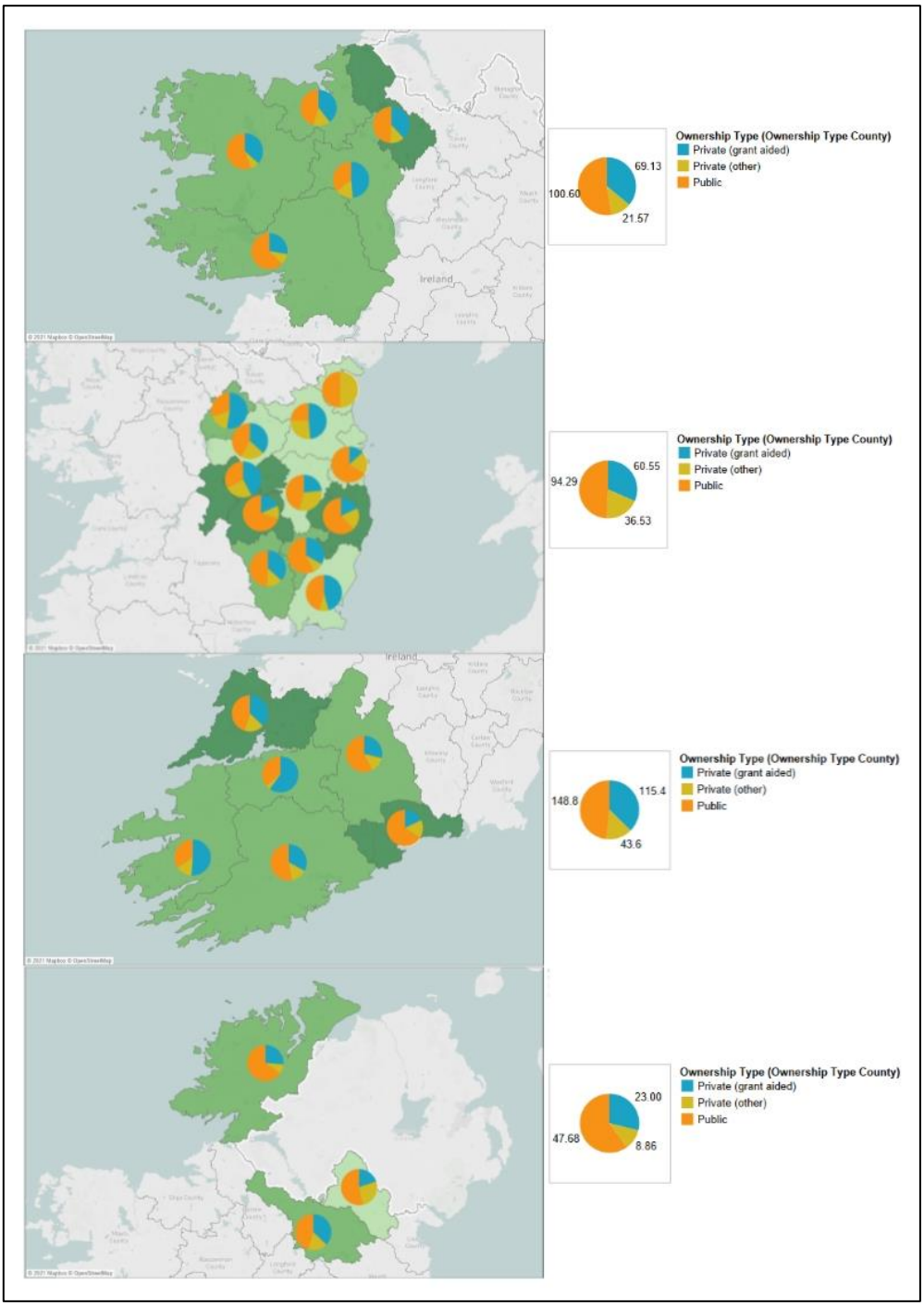


With the exception of Monaghan, all counties that have a % of forest cover between 2.9% and 8.2% are in Leinster. Of the other's, 33% of Munster's counties (6) have a % of forest cover between 13.7% and 18.9% with 20% for Connaught (5 counties). It is interesting to note the east of the country is where the low forested counties reside. This may relate to population statistics however this would need to be investigated and compared in order to confirm same. 27% of Ireland's counties have a % of forest cover between 2.9% - 8.2% with this figure increasing to 50% for the 8.3% -13.6% range and decreasing to 23% for the 13.7 – 18.90% range.

Below, we can see the top 5 Forested counties and top 5 Non-Forested counties by way of % of total hectares (000's).

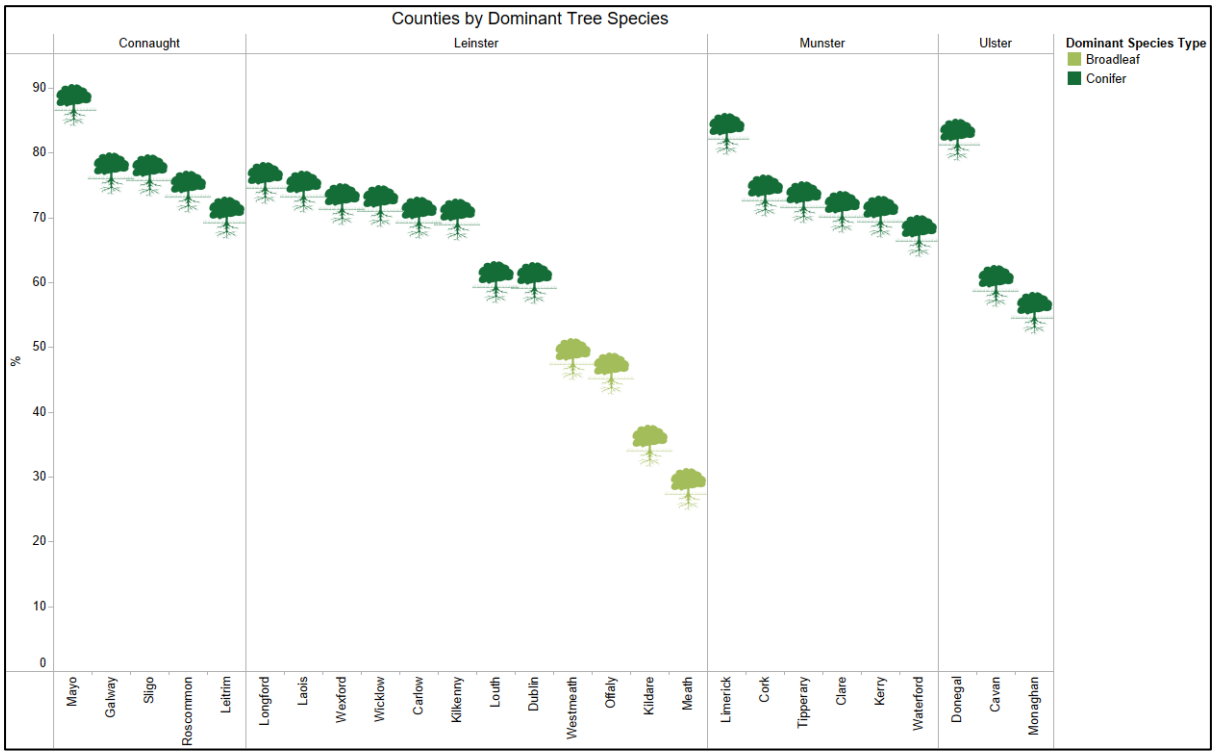


Ownership Type by Region



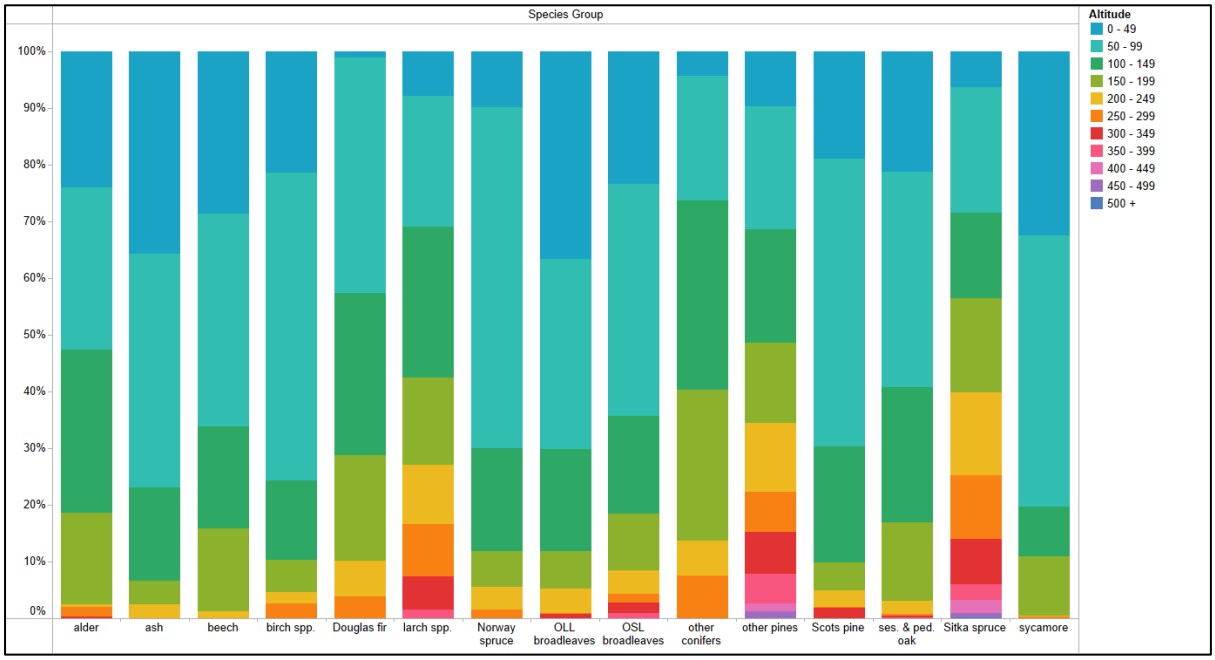
Ownership levels vary by county with no general trend for any ownership group in any one region. The highest level of public ownership is observed in the Ulster Region, followed by Munster. Private grant aided land is fairly consistent throughout the four regions, as is Public land. Connaught and Ulster have the lowest levels of Private (other) land in Ireland. Louth has no grant aided land of any kind which is notable considering the Afforestation Grant and Premium Scheme essentially pays landowners to plant sponsored tree species. Laois has the highest proportion of public forestry in Leinster, with the same holding true for Donegal, Waterford and Galway in the Ulster, Munster, and Connaught regions, respectively.

Tree Types by Region



As can be seen above, Conifer is only dominant in four counties all of which are located in Leinster. Mayo, Limerick, and Donegal had the greatest % of Conifer trees by total of tree type. It is interesting to note that with the exception of Wicklow, all counties adjoining Dublin had a demonstrably more equal breakdown of Broadleaf to Conifer trees.

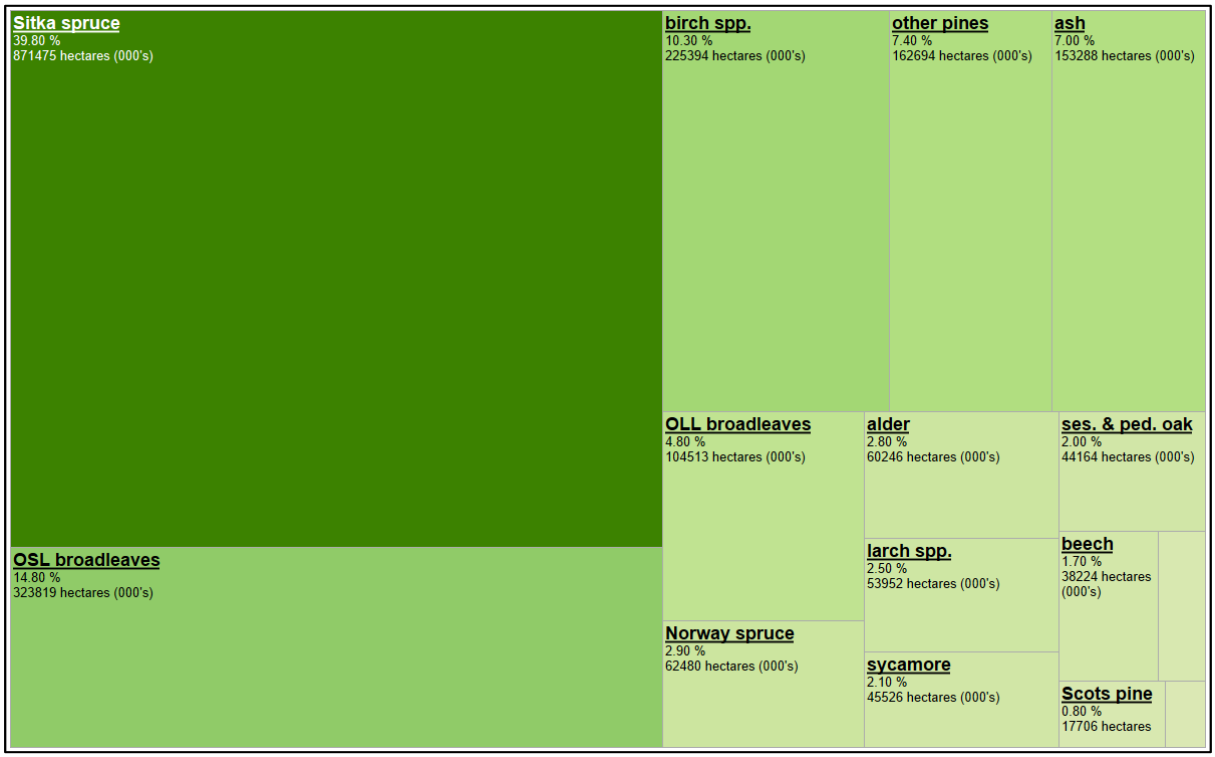
Tree Species - Distribution by Altitude



Most tree species are dispersed over three altitude ranges, 0-49, 50-99 and 100-149. Sitka Spruce has the largest dispersion followed by other pines and Larch spp. It is interesting to see that on the whole, tree species are predominantly found in one or two Altitude Ranges.

It is interesting to note that native Irish trees such as Birch and Alder, both of which can be considered 'hardy' trees, are not present at high altitude in Ireland. Sitka Spruce – a non-native 'hardy' tree however is. This could be related to use of the government Afforestation Grant and Premium Scheme which encourages planting of Sitka Spruce. Non arable or non-Grazing land is more prevalent at higher altitudes, and so landowners of such land may be afforesting their land with Sitka Spruce as a commercial crop in lieu of sheep farming.

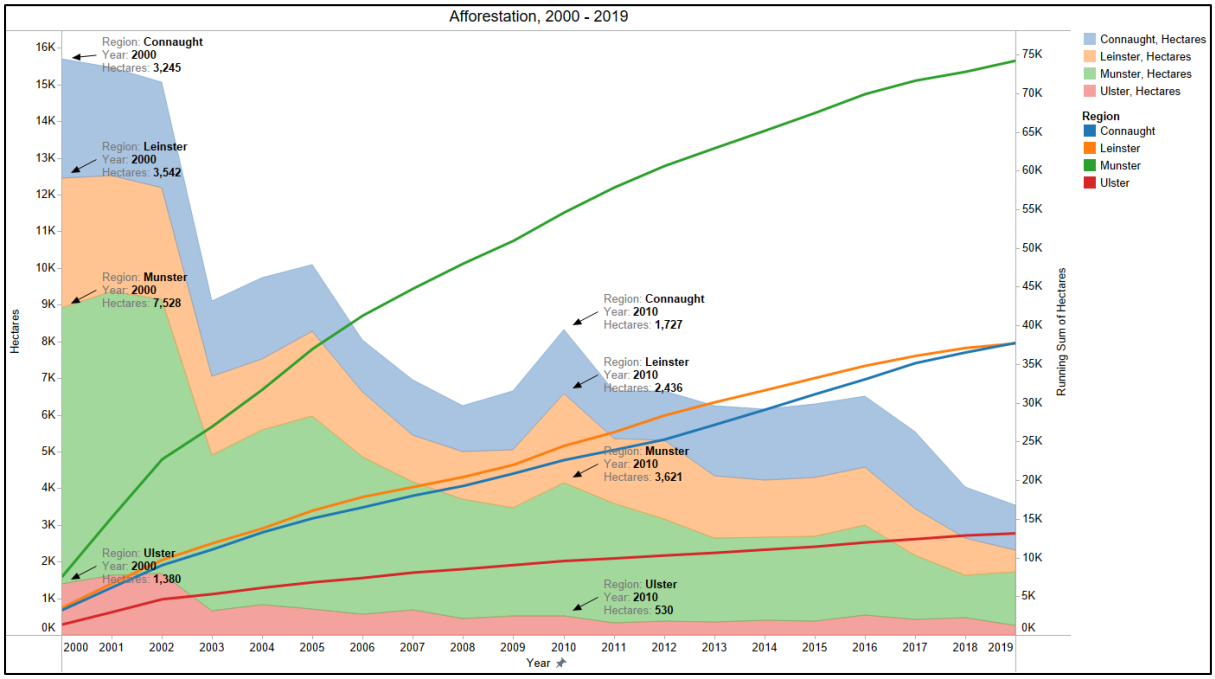
Tree Species – Composition of Forests



Sitka Spruce makes up 39.8% of all trees in Ireland, followed by OSL Broadleaves (14.8%) and Birch Spp. (10.3%). Sitka Spruce is a poor carbon sink compared to species such as Oak meaning it is not as efficient at storing carbon dioxide in its soil. While a good source of timber accounting for 90% of timber forested in Ireland (Teagasc, 2020) due to its relatively fast growth rate and tolerance of poor weather, it does not provide sufficient protection for native bird species who are unable to nest in the tree due to its lack of branches.

Native trees to Ireland - Alder, Ash, Birch Scots Pine, Oak; compose 22.9% of all Irish trees. A potentially negative implication of this is that Native Irish Animal and Plant species which depend upon this type of vegetation (native trees) could suffer or be suffering due to the loss of their natural environment to non-native trees.

Afforestation



As can be seen above, the rate with which tree's have been planted has slowed down in recent years. Munster has continuously seen the largest numbers of trees planted each year and was the key driver for afforestation when compared to other regions as illustrated in it's running sum which significantly increased year on year from 2000 – 2009. Afforestation was highest in 2000 (15696 ha.) and is at it's lowest as of 2019 (3550 ha.).

Conclusion

In conclusion, public Forests account for 51% of all trees, followed by grant aided private forests at 35% and non-grant aided private forests at 14%. The ownership levels of Forests do not vary much by region. Forestry is at its lowest in Leinster, and highest in Munster. Leitrim has the greatest percentage of Forestry in Ireland, and Louth the smallest.

Ireland has experienced massive growth in Afforestation since 2000, however this has been slowing down in recent years. Sitka Spruce is the most prominent tree species in Ireland despite being a non-native tree. Most trees can be found between 0 and 150m altitude. Trees found after this height are almost all Sitka Spruce with minor amounts of Larch ssp. and other types of pine trees found, all of which are non-native trees. Native trees compose 22.9% of all trees, with Birch and Ash accounting for 75% of native trees. Four counties, all of which are located in Leinster have a greater number of Broadleaf trees than Conifer trees. Connaught and Munster are dominated by Conifer trees with Leinster having the most equal distribution of tree types.

Interactive graphs of my results can be located at https://public.tableau.com/profile/ross.currid#!/vizhome/ForestryinIreland2017/Dashboard.

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Appendix

Sources

1. https://wayback.archive-it.org/org-1444/20201125172921/https://www.agriculture.gov.ie/nfi/nfithirdcycle2017/nationalforestinventoryresultsdata2017/ (Chapter 2 and Chapter 4)
2. https://www.teagasc.ie/media/website/crops/forestry/advice/Forest-Statistics-Ireland-2020.pdf (page 28)