Resilient Forestry, LLC
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Vashon Forest Carbon Methods

I. Forest Type Calculations

I started with inventory data, much of which I have personally collected, for a number of King County parks on Vashon and Maury. These parks include

- Island Center Forest
- Dockton Forest
- Maury Island Marine Park
- Maury Island Natural Area
- Frog Holler Forest

I then classified all the plot data into conifer, mix, or broadleaf, and combined into a single workbook for analysis.

I added other protected forest parcels on Vashon which includes Vashon Parks Districts, Vashon Land Trust, and King County conservation easements. Since not field data is available for these parcels, classifying these into forest types was done using visual inspection of high-resolution aerial imagery. I excluded all parcels that were non-forest or very sparsely forested. To designate forest type I used the below thresholds as general guidelines.

- Conifer: 75% or greater conifer canopy
- Mix: Conifer canopy between 25% and 75%
- Broadleaf: Conifer canopy less than 25%

I then calculated total acres of each forest type based on the forest type designation of each parcel using GIS.

II. Carbon Modelling

I used Forest Vegetation Simulator (FVS) to model out the grown for 100 years in 5-year intervals for each of the 3 forest types. (5 years is the smallest time interval recommended for accurate growth modeling). FVS calculates carbon and produces a report with the carbon storage at each time interval, broken down by different storage vectors.

- Aboveground Live
- Belowground Live
- Belowground Dead
- Standing Dead
- Downed and Dead wood
- Forest Floor (duff and litter)
- Shrubs

I set FVS to report the carbon in metric tonnes per acre. To convert this carbon number to carbon dioxide equivalent ($MTCO_2E$), the FVS carbon number is multiplied by 3.667 or (44/12). This results in the $MTCO_2E$ stored at each 5-year interval per acre of each forest type.

Annual carbon sequestration of each forest type was calculated by finding the average change in carbon over the first 20 years. I used 20 since it is a realistic and relatable number for people, as

opposed to using the full 100-year average. Carbon equations also tend to break down as the modeled trees grow and age, so a shorter timeframe renders a more grounded carbon value.

I did some checks against publications on forest carbon storage. Although carbon storage and sequestration rates are highly localized, the numbers I calculated for Vashon are within 10% difference to Pacific Northwest regional average for our forest types.

The total acres for each forest type was multiplied by the current forest carbon estimate, the 20-year carbon estimate and the 20-year annual average sequestration rate to get total storage and sequestration.

III. Afforestation

Modeling the Afforestation was done at just the per acre level. I could not find any discernable comprehensive spatial data on pastureland on Vashon. In an effort to promote a diverse forest structure I modeled the afforestation with a large variety of species with a planting density of 400 seedlings per acre. This is a very standard planting density. There are a few minor species I would have liked to include (such as Pacific crabapple), but FVS does not have them. To accommodate the crabapple and others, I increased the percent of the other minor broadleaf species. I also excluded madrone since it is very unlikely that pastureland would have the appropriate soil texture required for it to survive.

Species	TPA	Percent
Douglas-fir	150	37.5%
Grand fir	50	12.5%
Western white pine	50	12.5%
Bitter cherry	45	11.3%
Paper birch	45	11.3%
Sitka spruce	25	6.3%
Western Redcedar	25	6.3%
Pacific yew	10	2.5%
Total:	**400**	**100%**

One important note with the afforestation modelling is that FVS simply interprets the model as a forest with no trees; so FVS is showing a lot of downed wood, shrubs, and duff / litter, which do contribute a lot of carbon, but would not actually be present for a long time in an afforested pasture.

The carbon calculated for afforestation assumes that the seedlings will be well maintained to ensure a high rate of survival. Low seedling survival would significantly reduce the carbon stored in restored pastureland.

Storage and Sequestration						
Forest Type	**Current Storage**	**20y Storage**	**20y Mean Sequestration**	**Acres**	**Total Stored**	**Sequestration / Year**
Conifer	371	466	4.3	417	154,755	1,807
Mix	425	496	3.2	1,123	477,195	3,637
Broadleaf	242	358	5.3	620	150,019	3,275
		Total:		**2,160**	**781,969**	**8,718**

Afforestation Summary			
Year	**Storage / acre**	**Sequestration / year**	**Annual Offset Acres**
Planting:	0	0	
Year 5:	2.2	0.4	119
Year 10:	9.0	1.4	38
Year 15:	29.8	4.2	13
Year 20:	85.8	11.2	5
Yearly Average:	**25.4**	**3.4**	**44**

Use per year:	52.3
Vashon Population:	11,000
Total Carbon Use:	575,300
Average Offset Acres:	**167,628**

Summary				
	Acres	Total	Per Acre	Annual Offset Acres
Current Forest Stored:	**2,160**	**781,969**	**362**	
Conifer:	417	154,755	371	
Mix:	1,123	477,195	425	
Broadleaf:	620	150,019	242	
Forest Sequestration:	**2,160**	**8,718**	**4.0**	**13.0**
Conifer:	417	1,807	4.3	12.1
Mix:	1,123	3,637	3.2	16.1
Broadleaf:	620	3,275	5.3	9.9

Use per year:	52.3
Vashon Population:	11,000
Total Carbon Use:	575,300
Average Offset Acres:	**142,517**