Construction Wood -- Offsets & Carbon Footprints

December 21, 2021

Introduction

Coastal Douglas Firs can live for 400 or more years and achieve amazing diameters and heights in mature, healthy forest ecosystems. Much of our area's construction timber, though, comes from plantation-style, highly controlled, strands of Douglas Firs.

To call such strands "forests" is a bit misleading. They're monoculture plantings in dense uniform rows sprayed with pesticides/herbicides. They do not support a healthy habitat for a diverse ecosystem of life, from microorganisms essential for soil health, up to mammals.

Douglas Fir Age Mix

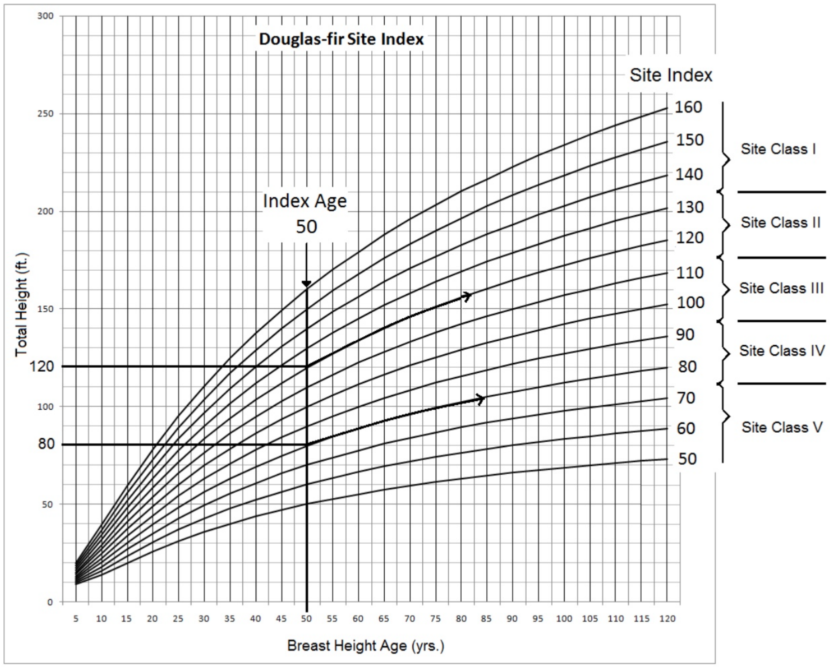
In managed timberlands, harvest cycles are driven purely by economics. What's usually clear-cut are 40 to 50 year (relatively young) Douglas Firs. Unfortunately, most of those tree's growth and carbon capture occurs *after* that point, but timber companies rarely wait longer.

Some DNR timber auctions in Washington include "legacy" trees from 70-120 years of age. These are second or third growth that have naturally-regenerated into a diverse forest habitat. (Old-growth is usually considered to be 150-years or older.) Many efforts are underway -- including some by WMTP -- to protect legacy trees in our County that are so climate and ecologically valuable as well as crucial for watershed health.

For this analysis, we believe it's fair to assume that older Douglas Firs account for 10% of the mix of logs that end up at a sawmill. On average, we'll assume they're 90 years old.

Douglas Fir Size

Timber being such a big industry in the Pacific Northwest, much research and site surveying has been done about Coastal Douglas Firs. For decades, Kings Index has served as the prime reference standard. Below is a chart from that.



The five "Site Class" levels refer to a range of soil and slope conditions, from better to worse. We'll assume the median condition, Site Class III.

As shown in the chart, 50-year old Douglas Firs in Western Washington grown in Site Class 3 conditions tend to average 80'-120' in height. We'll assume then a 100' height average.

For the 90-years old Douglas Firs, the same chart shows a ~135' height average. (Much of this later growth widens the tree trunk, not so much adds height.)

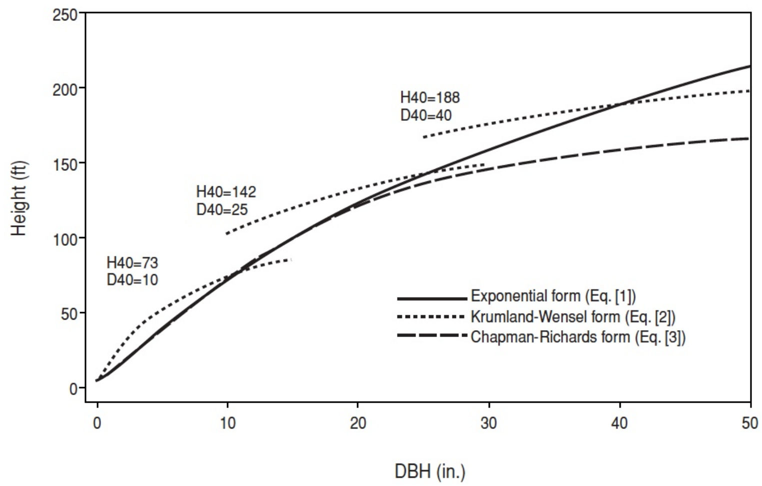
But not all of this height reaches the sawmill. Typically, the very top portion (especially of the younger Douglas Firs) is tapered too thin for a lumbermill's 4" smallest accepted diameter. And a few feet of stump are typically left in the site debris of a clear-cut.

All of the above factors result in the calculations below:

(50 years age x .90) + (90 years age x .10) = **54 year average tree age**
(100' height x .90) + (135' height x .10) = **103.5' average tree height**
103.5 - 13.5' discarded = **90' usable height** (5.6 16' logs/tree delivered to a sawmill)

Douglas Fir Diameter at Chest Height

Empirical charts also exist for PNW Coastal Douglas Firs for tree diameter. On the next page is a prime example from an Oregon State research publication.



Our average 103.5' high logged Coastal Douglas Fir would have an average chest-high diameter of **15 inches**.

Board Feet Calculations

Standard charts (some very old) are used by timber landowners, loggers, lumber mills, etc. to convert tree sizes to board feet. The chart used by most in the U.S. is called the "International Log Rule." (See below chart from the U.S. Department of Agriculture.) It represents a sound, straight tree and accounts for trunk tapering.

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TABLE 16.—*Board-foot volume table (International rule—total height) for second-growth Douglas fir*

[Western foothills of Cascade Mountains, Washington and Oregon—All site qualities, 1926]

D. b. h., inches	Total height in feet																						Basis, trees
	30	40	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220	230	240	
	Volume in board feet																						
7	12	18	24	72	40	48	56	66	78	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	58
8	16	22	32	42	52	64	76	88	102	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	68
9	20	30	42	54	66	82	96	112	128	144	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	64
10	-----	36	52	66	84	102	120	138	158	180	200	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	63
11	-----	46	62	80	102	124	146	168	194	218	242	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	50
12	-----	54	76	98	122	148	174	200	230	260	288	320	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	53
13	-----	64	90	114	144	176	206	238	270	302	336	374	416	-----	-----	-----	-----	-----	-----	-----	-----	-----	63
14	-----	-----	104	134	166	202	240	274	310	346	388	430	480	524	-----	-----	-----	-----	-----	-----	-----	-----	95
15	-----	-----	-----	154	190	232	270	312	352	392	440	486	544	592	-----	-----	-----	-----	-----	-----	-----	-----	87
16	-----	-----	-----	176	214	260	304	350	394	440	494	546	612	662	-----	-----	-----	-----	-----	-----	-----	-----	79
17	-----	-----	-----	198	238	290	338	388	438	490	548	608	678	734	814	-----	-----	-----	-----	-----	-----	-----	72
18	-----	-----	-----	-----	264	322	372	426	484	540	606	672	747	812	894	974	-----	-----	-----	-----	-----	-----	65
19	-----	-----	-----	-----	288	349	405	466	528	588	659	734	813	886	974	1,061	1,143	-----	-----	-----	-----	-----	65
20	-----	-----	-----	-----	-----	378	442	507	576	642	718	799	883	969	1,063	1,156	1,250	1,341	-----	-----	-----	-----	60
21	-----	-----	-----	-----	-----	-----	479	550	623	693	775	864	955	1,053	1,152	1,254	1,358	1,454	-----	-----	-----	-----	66
22	-----	-----	-----	-----	-----	-----	519	594	672	747	834	930	1,028	1,139	1,244	1,354	1,468	1,575	-----	-----	-----	-----	62
23	-----	-----	-----	-----	-----	-----	559	637	720	798	893	997	1,102	1,221	1,336	1,456	1,578	1,696	1,829	-----	-----	-----	59
24	-----	-----	-----	-----	-----	-----	599	682	768	852	953	1,065	1,177	1,308	1,429	1,559	1,690	1,821	1,969	2,099	-----	-----	67
25	-----	-----	-----	-----	-----	-----	640	727	817	907	1,013	1,134	1,256	1,392	1,524	1,664	1,803	1,951	2,104	2,251	-----	-----	51
26	-----	-----	-----	-----	-----	-----	683	774	868	964	1,075	1,206	1,336	1,481	1,620	1,770	1,921	2,078	2,245	2,405	-----	-----	58
27	-----	-----	-----	-----	-----	-----	728	824	922	1,023	1,141	1,280	1,420	1,571	1,719	1,879	2,043	2,211	2,389	2,564	-----	-----	53
28	-----	-----	-----	-----	-----	-----	-----	874	978	1,086	1,210	1,354	1,506	1,663	1,824	1,991	2,170	2,351	2,537	2,726	-----	-----	42
29	-----	-----	-----	-----	-----	-----	-----	-----	1,038	1,150	1,281	1,432	1,597	1,759	1,930	2,104	2,300	2,494	2,692	2,894	-----	-----	46
30	-----	-----	-----	-----	-----	-----	-----	-----	1,096	1,215	1,351	1,509	1,688	1,851	2,034	2,223	2,428	2,636	2,849	3,066	-----	-----	56
31	-----	-----	-----	-----	-----	-----	-----	-----	1,154	1,282	1,423	1,582	1,775	1,942	2,139	2,343	2,560	2,776	3,006	3,238	-----	-----	31
32	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,347	1,495	1,660	1,863	2,036	2,248	2,461	2,688	2,921	3,164	3,416	3,678	3,930	34
33	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,411	1,563	1,737	1,952	2,128	2,348	2,583	2,820	3,063	3,321	3,593	3,865	4,132	31
34	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,477	1,635	1,818	2,043	2,223	2,454	2,701	2,951	3,206	3,484	3,771	4,060	4,350	29
35	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,540	1,705	1,897	2,120	2,316	2,556	2,813	3,080	3,347	3,646	3,948	4,250	4,562	19
36	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,605	1,779	1,974	2,199	2,408	2,658	2,930	3,212	3,493	3,803	4,125	4,452	4,769	16
37	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,667	1,851	2,052	2,278	2,499	2,759	3,041	3,338	3,636	3,964	4,301	4,646	4,985	12
38	-----	-----	-----	-----	-----	-----	-----	-----	-----	1,733	1,926	2,133	2,359	2,592	2,865	3,169	3,469	3,784	4,127	4,479	4,846	5,233	10

Using the chart, our average logged Coastal Douglas Fir will hold ~320 board feet of timber. About 10% of that needs to be deducted to account for waste, imperfections, etc. **Thus, ~290 board feet per our logged Douglas Fir is produced by a sawmill, on average.**

To be clear, this means per 1,000 BF used in construction, **3.45** Douglas Firs would have to be planted now (as two-year old seedlings) and *then grow* for 52 more years. Discounting for typical 70% forest survival rates, and factoring in some waste wood created during most construction projects, **planting *five* Douglas Fir tree seedlings will offset *52-years later* 1,000 BF of construction timber.**

Translating Offsets to Real-Word Costs

Conifer tree seedlings are available for about one dollar each, depending on quantity ordered. But that's not all that is needed to have that seedling grow successfully into a healthy mature tree. Nonprofits elsewhere in the world that only fund tree planting costs have had very poor seedling success rates (less than 50% survival after a few years) and in some cases large-scale die-offs of most trees.

In Whatcom County, we therefore raise funds for *tree success* instead of just *tree planting*. Tree success costs include not only the $1/conifer seedling cost but site prep (removal of invasives like blackberry/reed canary grass, etc.), mulching for our climate, and a few years of monitoring/nurturing to ensure the trees survive and thrive. With this approach, seedling success rates can typically meet or exceed 85%, which is outstanding for reforestation.

Even with having many volunteer work parties at a site, tree success costs tend to average about $7-12/tree in Whatcom County, as verified by other nonprofits such as Nooksack Salmon Enhancement Association (NSEA) and Whatcom Land Trust who have planted trees locally for decades using the same success model. Therefore, we use **$10/tree** as our cost basis.

To offset 1,000 BF of construction lumber by planting five trees would therefore require a $50 donation to us. But let's translate that to more common terms. Buying a 2x4 pine or fir for framing that's 8' long? That's 5.33 BF of wood. **To offset it would require setting aside only $.26 more for that purchase. If that 2x4x8 costs you say $5, then you are just adding 5.2% to the lumber cost to offset the wood use successfully.**

What About Carbon Offsets?

Studies have shown that the amount of carbon sequestered by each conifer *trunk* is ~50% of the trunk's total volume. Trunk is emphasized because good data is lacking about branch and root carbon storage. Root carbon storage (especially) is substantial and may eclipse the trunk's carbon storage in some cases.

Carbon offset calculations are different than wood offset calculations because of **having to factor in energy use and CO2/methane released by the entire logging to retail store cycle.**

On-site logging roads, heavy equipment use, wood debris decay, transportation to/from sites, sawmill processing, and more all create significant releases into the atmosphere.

The timber industry touts that logged construction lumber captures carbon indefinitely by holding the carbon in the buildings, furniture etc. **The reality is different.** There's some wood waste in building construction, and contemporary residential buildings/furniture typically do not last anywhere close to 100 years. Also, a significant portion of logged timber feeds wood pulp-based energy production (even here in the PNW).

Unfortunately, no good data exists yet for the above variables. Perhaps another 50-100% of conifer growth must be added to the carbon captured in 54 years by Coastal Douglas Firs. But that unknown is no reason to lose hope if you are also interested in carbon offsets for construction.

Here's why: **Trees we plant will continue to live beyond 54 years.** Located in protected local parks and reforestation projects, they will *not* be part of a plantation-style 'working' forest that is periodically "harvested" for timber. They will instead be protected indefinitely in biologically diverse, habitat-supportive properties as they hopefully mature into (new) old-growth 150 years from now.

At some point beyond 54 years of age, those same conifers will have offset enough carbon to cover the entire logging to retail product cycle. Our hunch is that will occur around 80-90 years of age. We hope to uncover more data eventually to confirm the age point.

Bottom line: Donating to our nonprofit to plant new trees to offset construction wood use adds just a few percentage points to wood retail cost. It's an outstanding step forward to creating a more sustainable construction industry in light of the climate and biodiversity crises we all face.