Timberland's Financial Optimization

FINANCIAL OPTIMIZATION USING THE DATA YOU ALREADY HAVE

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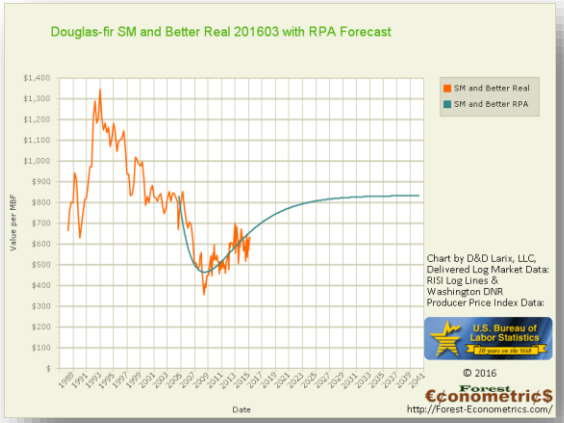
LEWIS-CLARK STATE COLLEGE
BUSINESS DIVISION

D&D Larix, LLC

FRASS Action Team

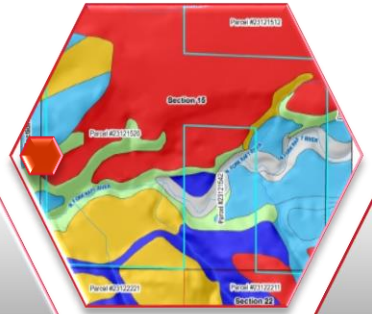
Critical Asset Management Data



FRASS Action Team

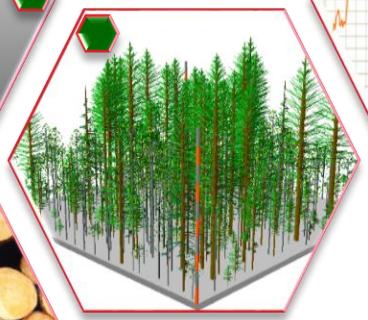
Critical Members of Your Asset Management Team

Geospatial Analyst – GIS –



Forest Biometrician – G&Y –

Forest €¢onometri¢$ – FRASS –



Chief Financial Officer

Forest Resource Manager

FOREST RESOURCE ANALYSIS SYSTEM SOFTWARE

Actionable Decision Data

Getting Value from your data

- **Spatial (GIS)**
  - Stand Boundaries
  - Stream Networks
  - Road Networks
    - Non-Op & Distance
  - Soil Types
    - Site Index

- **Biometric**
  - Growth & Yield
  - Volume articulated by Years
  - Merchandized Volume:
    - Stand
    - Sort & Grade

- **Economic**
  - Real Price Appreciation
    - Delivered Log Market Value
    - Logging Costs
    - Trucking Costs
    - Road Construction
  - Inflation Rate
  - Discount Rate

Analysis Architecture

Database Records

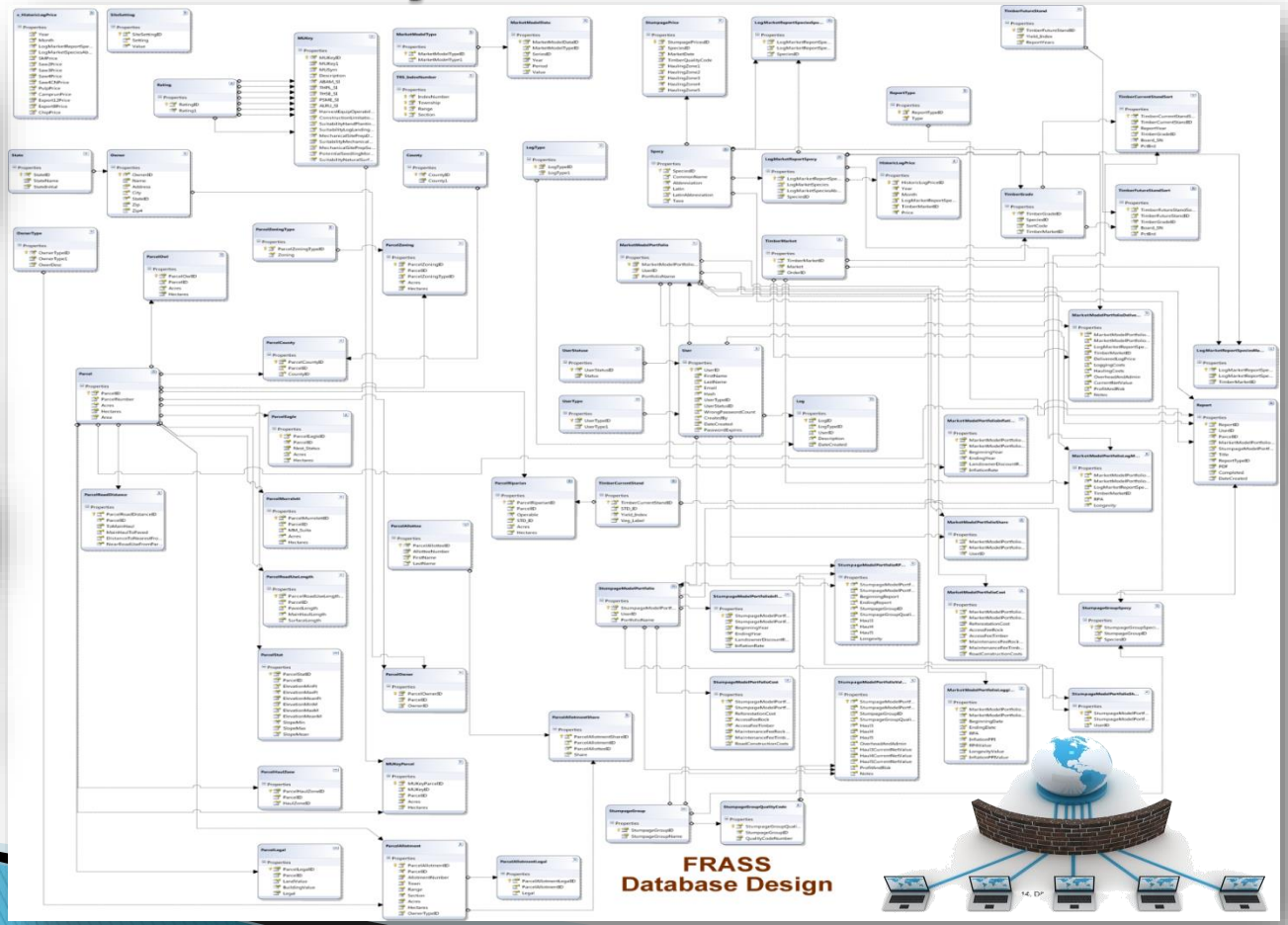
Microsoft SQL Server

MySQL

Sun ORACLE

Microsoft Office Access

SQLite python



Forest €¢onometri¢$

Spatial Analyses

Arc GIS ESRI

MapWindow GIS

Growth & Yield

Forest Biometrics Research Institute

FVS

Organon

Forest Growth Modeller

GYPSY
FORESEEING THE GROWING FUTURE

Sequential Quadratic Programming

Why use this approach?

- SQP builds from basic Linear Programming –
  - *It includes Nonlinear and Linear Optimization*
- Linear Programming is for optimization of a linear objective function, subject to linear equality and inequality constraints.
  - What is the lowest cost?
- SQP methods are used on mathematical problems for which the objective function and the constraints are twice continuously differentiable: constrained nonlinear optimization.
  - What is the optimal combination of 200 factors at each evaluation point, each moving independently through perpetuity?

Sequential Quadratic Programming

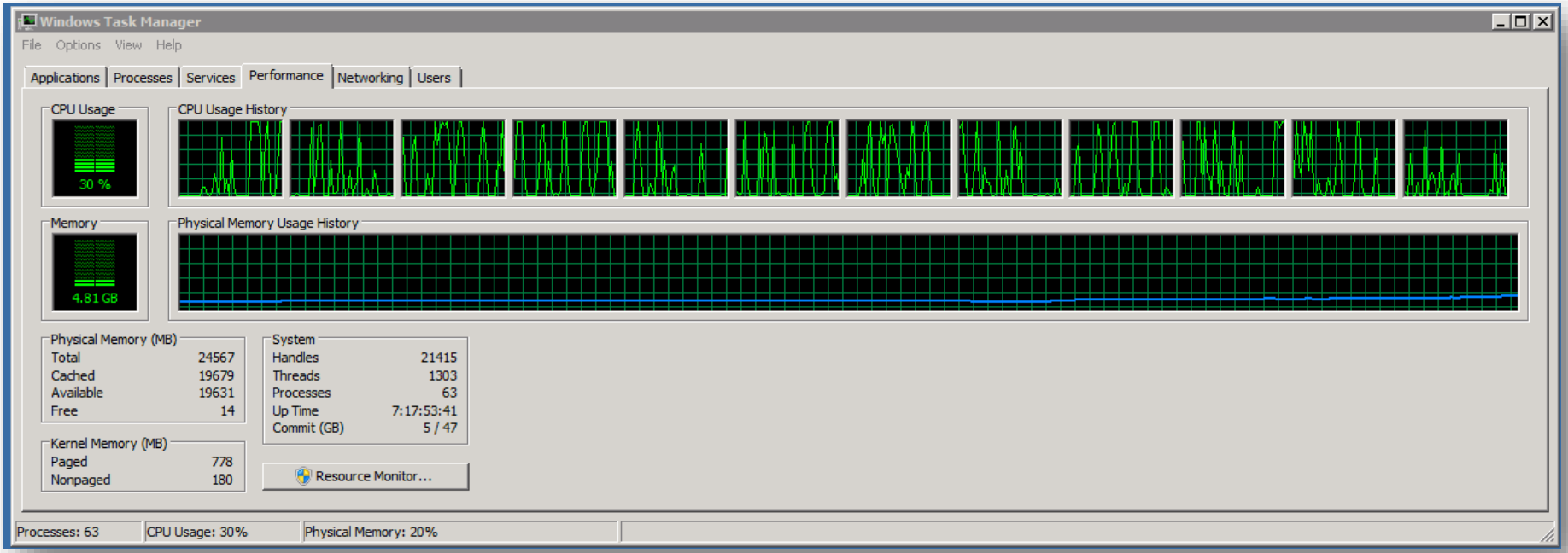
Mechanics of Evaluation

- Information Reduced to Database Collections
  - GIS Data
  - Stand Boundary Area
  - Road Network distances & class
  - Stream Network reach & extent (riparian)
  - G&Y Volume by Sort & Grade
  - Historic Log Sort Values (Nominal)
  - Historic Economic data

- Programming: ASP.NET foundation
  - SQL data retrieval
  - Linear & Non-Linear optimization protocols
  - Sequentially continuous optimization analyses
    - 1,600 simultaneous optimizations, per timber stand, per rotation

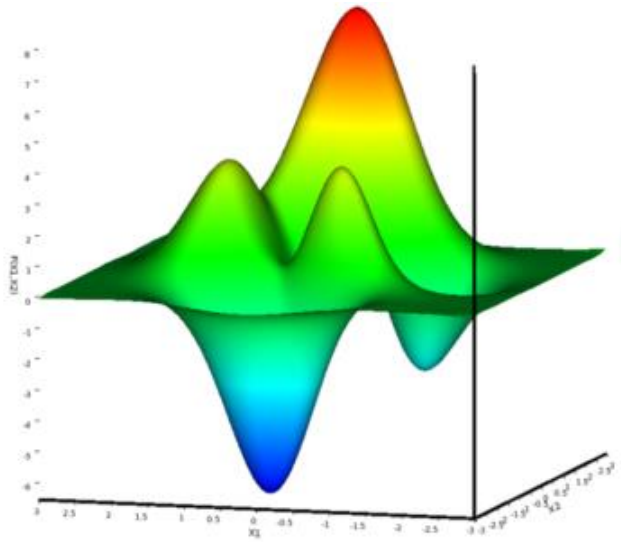
Sequential Quadratic Programming

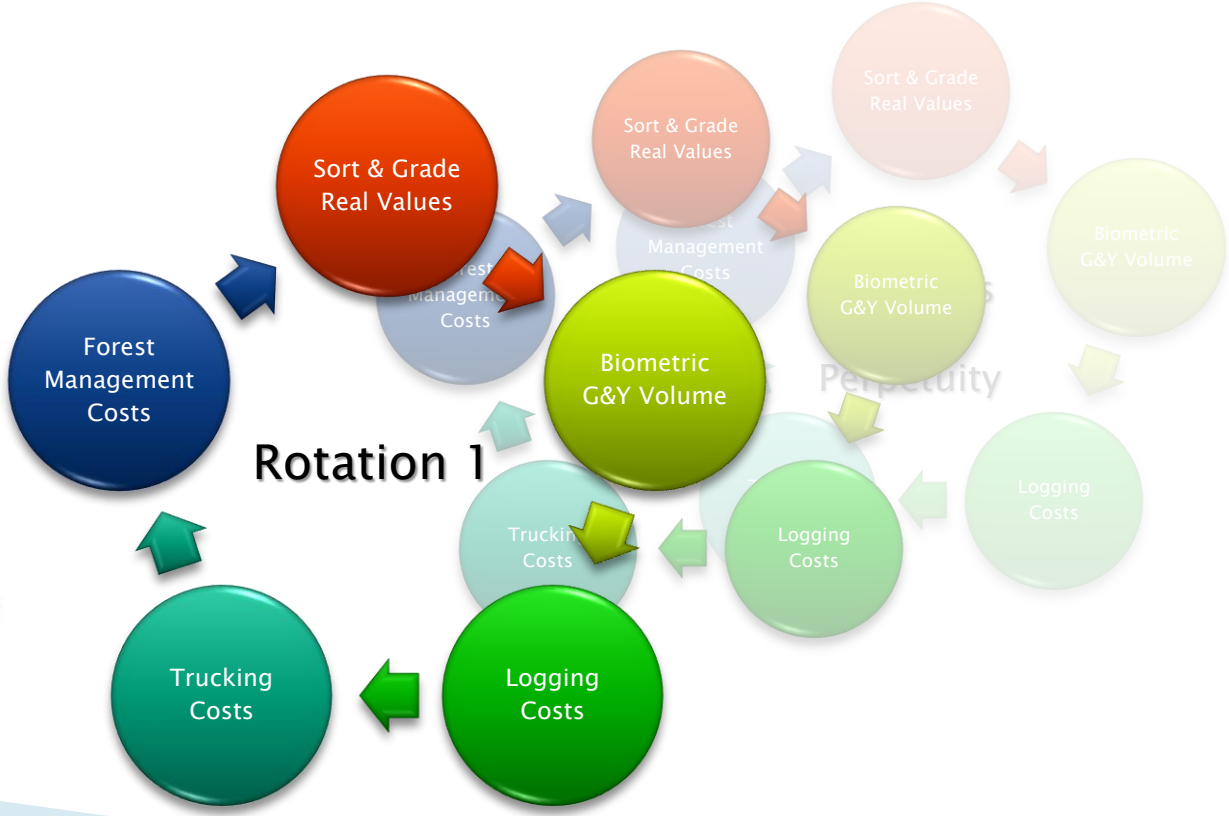
Tools of Evaluation



Sequential Quadratic Programming

The most successful method for solving nonlinearly constrained optimization problems

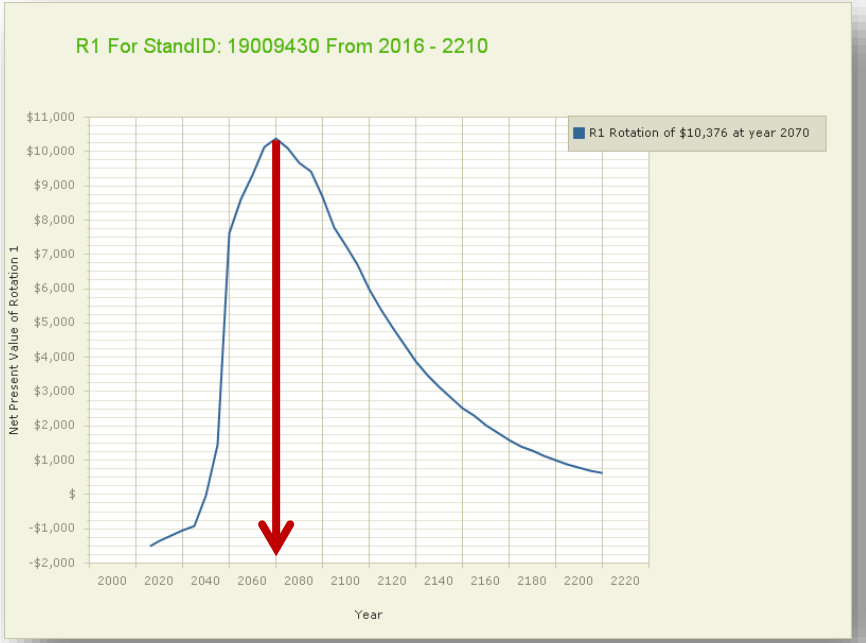




Extend Your Economic View

Not about a single rotation's optimum

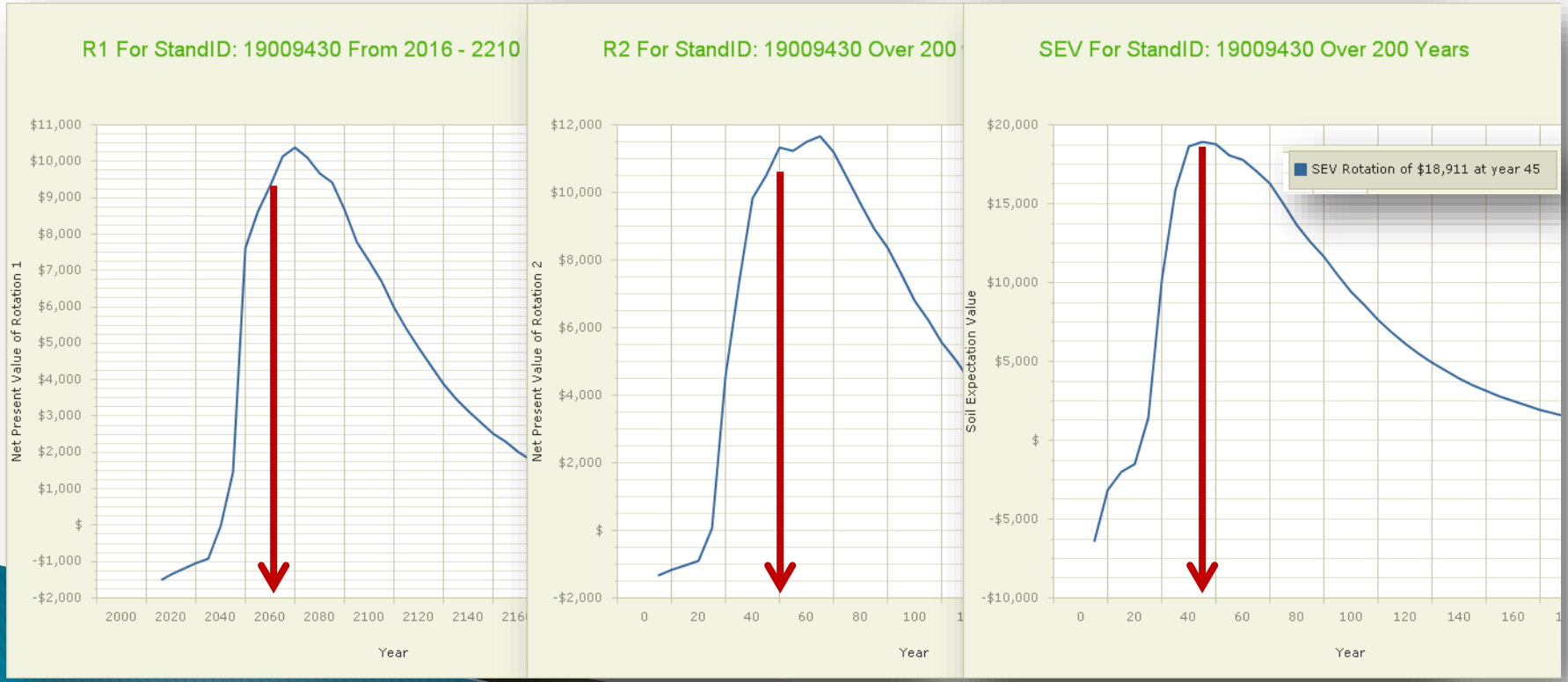
- Traditionally, the single rotation's biological optimum has been the target.
- Financially optimum became the next target – but only for the current rotation.



Extend Your Economic View

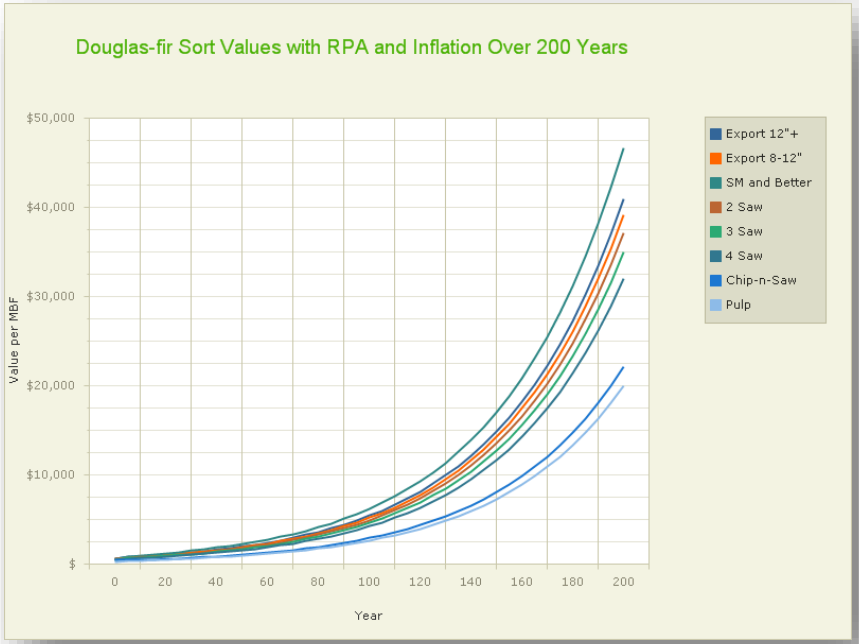
Not about a single rotation's optimum

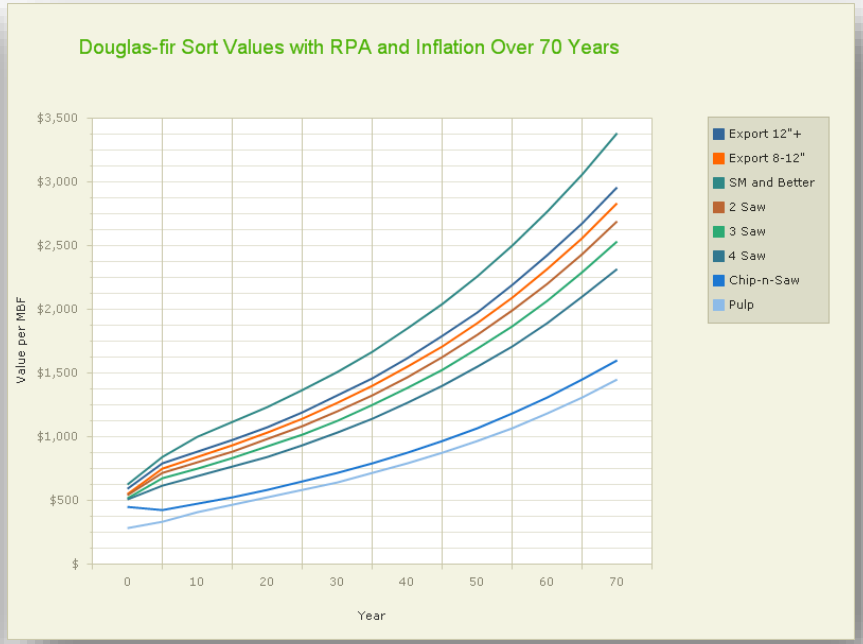
- Link Rotations 1 → 2 → Perpetuity



Extended Economic View

Revenues & Costs independently considered with RPA Forecast Tool

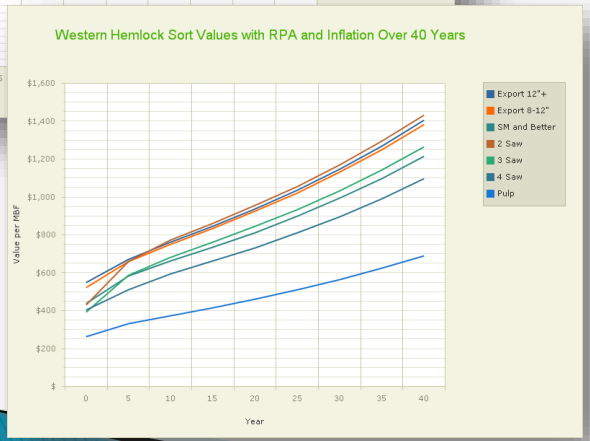




Forest €¢onometri¢$

In the Long-Run, everything is Variable

A Look into the Proof of Concept



View Market Value Report | PSLMA 20160329 | Cascadia 20160329 | Apply Market Model with RPA Portfolio

View Stand Report | 19009430

Export to PDF | Generate Full Parcel Report

Market Model Name	RPA Portfolio Name	Rate of Inflation	Landowner Discount Rate	Reforestation Cost	Access Fee (Timber)	Maintenance Fee	New Logging Road Construction
PSLMA 20160329	Cascadia 20160329	2.04%	2.71%	$375/Acre	$0.50/MBF/Mile	$1.33/MBF/Mile	$19,500/Mile

Sort	Market Value	RPA	Longevity Term	Profit & Risk	Overhead & Administration	Logging Cost	Hauling Cost	Projected Delivered Log Value 2016	2020	2030	2040	2050
Western Red Alder												
2 Saw	$711	0.0869	10.91	0.04	$30	$90	$60	$711	$662	$707	$789	$917
3 Saw	$657	0.0676	10.91	0.04	$30	$90	$60	$657	$608	$665	$756	$888
4 Saw	$514	0.0797	10.91	0.04	$30	$90	$60	$514	$519	$558	$628	$732
Pulp	$251	-0.0705	8.75	0.04	$30	$30	$60	$251	$242	$338	$437	$548
Black Cottonwood												
2 Saw	$438	-0.0946	1.75	0.04	$30	$90	$60	$438	$465	$573	$701	$858
3 Saw	$415	-0.0512	2.91	0.04	$30	$90	$60	$415	$429	$542	$665	$814
4 Saw/CNS	$378	-0.0665	2.16	0.04	$30	$90	$60	$378	$388	$481	$589	$721
Pulp	$226	-0.0509	11.25	0.04	$30	$30	$60	$226	$176	$248	$328	$419
Douglas-fir												
Export 12"+	$590	-0.1697	2.16	0.04	$30	$90	$60	$590	$783	$969	$1,186	$1,451
Export 8-12"	$548	-0.2574	2.16	0.04	$30	$90	$60	$548	$745	$927	$1,134	$1,388
SM and Better	$629	-0.1570	3.83	0.04	$30	$90	$60	$629	$819	$1,094	$1,352	$1,657
2 Saw	$545	-0.2193	2.16	0.04	$30	$90	$60	$545	$709	$880	$1,077	$1,318
3 Saw	$515	-0.2099	2.16	0.04	$30	$90	$60	$515	$668	$828	$1,013	$1,240
4 Saw	$512	-0.2069	2.16	0.04	$30	$90	$60	$512	$611	$758	$928	$1,135
Chip-n-Saw	$449	-0.2304	2.16	0.04	$30	$90	$60	$449	$422	$524	$641	$785
Pulp	$281	-0.1167	7.00	0.04	$30	$30	$60	$281	$323	$447	$569	$705
Western Redcedar												
Camprun	$1,437	0.1692	3.16	0.04	$30	$90	$60	$1,437	$1,097	$1,338	$1,638	$2,004
Western Hemlock												
Export 12"+	$547	-0.1360	4.08	0.04	$30	$90	$60	$547	$651	$826	$1,015	$1,243
Export 8-12"	$523	-0.1412	4.08	0.04	$30	$90	$60	$523	$641	$814	$1,001	$1,226
SM and Better	$438	-0.1657	2.91	0.04	$30	$90	$60	$438	$566	$718	$880	$1,077
2 Saw	$429	-0.1500	4.58	0.04	$30	$90	$60	$429	$639	$836	$1,034	$1,267
3 Saw	$391	-0.1446	4.58	0.04	$30	$90	$60	$391	$567	$739	$914	$1,121
4 Saw	$403	-0.1300	4.58	0.04	$30	$90	$60	$403	$495	$641	$793	$971
Pulp	$262	-0.2118	3.50	0.04	$30	$30	$60	$262	$324	$406	$499	$610

Sequential Quadratic Programming

Rotation 1	Rotation 2	Perpetuity	Optimal Combination

Total	R1	R2 Year	R2	SEV (45)
This harvests R1 in 2016				
$105,378.72	$78,395.35	30 (2046)	$6,473.66	$20,509.71
$112,912.68	$78,395.35	35 (2051)	$16,574.30	$17,943.03
$116,514.03	$78,395.35	40 (2056)	$22,421.12	$15,697.56
$119,050.19	$78,395.35	45 (2061)	$26,921.74	$13,733.10
$118,689.62	$78,395.35	50 (2066)	$28,279.79	$12,014.48
$118,399.28	$78,395.35	55 (2071)	$29,493.00	$10,510.93
$118,272.66	$78,395.35	60 (2076)	$30,681.76	$9,195.55
$116,568.78	$78,395.35	65 (2081)	$30,128.66	$8,044.78
$114,765.11	$78,395.35	70 (2086)	$29,331.74	$7,038.02
$112,701.32	$78,395.35	75 (2091)	$28,148.72	$6,157.25
$110,379.47	$78,395.35	80 (2096)	$26,597.42	$5,386.70
$107,620.94	$78,395.35	85 (2101)	$24,513.00	$4,712.59
$105,823.29	$78,395.35	90 (2106)	$23,305.11	$4,122.83
$103,365.88	$78,395.35	95 (2111)	$21,363.65	$3,606.88
$100,956.16	$78,395.35	100 (2116)	$19,405.31	$3,155.50
$98,940.75	$78,395.35	105 (2121)	$17,784.79	$2,760.61

Sequential Quadratic Programming

Rotation 1 | Rotation 2 | Perpetuity | Optimal Combination

This harvests R1 in 2025

Total	R1	R2 Year	R2	SEV (45)
$107,494.52	$86,858.56	30 (2055)	$4,938.40	$15,697.56
$113,266.17	$86,858.56	35 (2060)	$12,674.50	$13,733.10
$116,028.52	$86,858.56	40 (2065)	$17,155.48	$12,014.48
$117,972.70	$86,858.56	45 (2070)	$20,603.21	$10,510.93
$117,697.96	$86,858.56	50 (2075)	$21,643.85	$9,195.55
$117,476.19	$86,858.56	55 (2080)	$22,572.85	$8,044.78
$117,379.43	$86,858.56	60 (2085)	$23,482.85	$7,038.02
$116,075.40	$86,858.56	65 (2090)	$23,059.58	$6,157.25
$114,694.95	$86,858.56	70 (2095)	$22,449.68	$5,386.70
$113,115.39	$86,858.56	75 (2100)	$21,544.24	$4,712.59
$111,338.32	$86,858.56	80 (2105)	$20,356.92	$4,122.83
$109,227.02	$86,858.56	85 (2110)	$18,761.57	$3,606.88
$107,851.15	$86,858.56	90 (2115)	$17,837.08	$3,155.50
$105,970.31	$86,858.56	95 (2120)	$16,351.14	$2,760.61
$104,125.98	$86,858.56	100 (2125)	$14,852.29	$2,415.13
$102,583.44	$86,858.56	105 (2130)	$13,611.99	$2,112.89

Sequential Quadratic Programming

Rotation 1	Rotation 2	Perpetuity	Optimal Combination

Total	R1	R2 Year	R2	SEV (45)
This harvests R1 in 2020				
$109,422.13	$85,828.79	30 (2050)	$5,650.31	$17,943.03
$116,017.55	$85,828.79	35 (2055)	$14,491.20	$15,697.56
$119,173.05	$85,828.79	40 (2060)	$19,611.17	$13,733.10
$121,394.32	$85,828.79	45 (2065)	$23,551.06	$12,014.48
$121,079.87	$85,828.79	50 (2070)	$24,740.16	$10,510.93
$120,826.23	$85,828.79	55 (2075)	$25,801.90	$9,195.55
$120,715.58	$85,828.79	60 (2080)	$26,842.02	$8,044.78
$119,224.98	$85,828.79	65 (2085)	$26,358.18	$7,038.02
$117,647.06	$85,828.79	70 (2090)	$25,661.02	$6,157.25
$115,841.55	$85,828.79	75 (2095)	$24,626.06	$5,386.70
$113,810.27	$85,828.79	80 (2100)	$23,268.89	$4,712.59

3.3% Value increase +$4,015
5 year shortening of current Rotation
15 year shortening of next Rotation

Financial Optimization

Hundreds of variables, thousands of possible outcomes, one Optimum

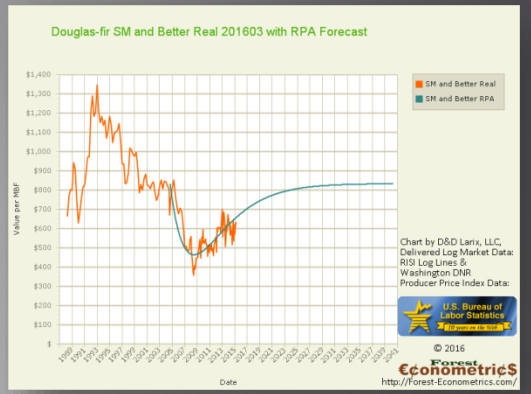
Harvest Volumes & Value Summary

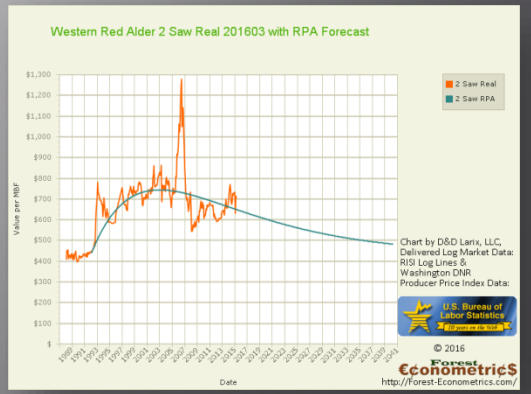
Stand Info		Current Rotation		Next Rotation		Third Rotation Into Perpetuity		Total Present Value	
Stand ID Number	Operable Commercial Timber Land Acres	Harvest Year	Net Present Value	Rotation Length (years)	Net Present Value	Rotation Length	Soil Expectation Value (Present Value)	Stand	Per Acre
19009430	4.08	2065	$10,343	50	$3,080	45	$1,165	$14,588	$3,577
19359150	12.85	2020	$85,829	45	$23,551	45	$12,014	$121,394	$9,447
19918010	8.60	2045	$52,332	50	$11,081	45	$4,192	$67,605	$7,864
		Scheduled In		Current Cost		Future Cost		Discounted Road Cost	
New Road Construction		--		--		--		--	
Total Value based on Operable Commercial Timber Land Acres:							25.5 Acres	$203,588	$7,976/Acre
Value per Acre (Forested Acres):							36.6 Acres		$5,567/Acre
Value per Acre (Entire Parcel):							39.2 Acres		$5,189/Acre
Bare Land Value (Entire Parcel):							39.2 Acres	$112,286	$2,862/Acre

Forest Resource Analysis System Software

Forest €¢onometri¢$

- Repeatable, with sensitivity analysis made possible for thousands of variables.
- Uniform Asset Value
  - Appraisers
  - CFO
  - Forest Managers





$$\iiint_1^{250} e^x = 1 + \frac{x}{1!} + \frac{x^2}{2!} + \frac{x^3}{3!} + \cdots,$$
$$-\infty < x < \infty \rightarrow \max_{0 \le x \le 1} xe^{-x^2}$$

Timberland's Financial Optimization

FINANCIAL OPTIMIZATION USING THE DATA YOU ALREADY HAVE

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