June 5, 2018

Impact of carbon valuation on optimal rotations in Douglas-fir

Western Forest Economists Meeting

David Diaz

ecotrust

OUR CHOICES MATTER

- Forest carbon balance exerts a significant influence on our global climate.
- Pacific Northwest coastal forests are among the most productive ecosystems on the planet.
- PNW forests could make a meaningful contribution to carbon drawdown.
- But what would putting a price on carbon lead to in terms of the profitability, timber output, or carbon benefits our private forestlands deliver?

Putting a price on carbon has become a perennial policy interest in the Pacific Northwest.

The Seattle Times

Environment | Local News | Local Politics | Northwest

Washington state's carbon-tax bill dies in Legislature

Originally published March 1, 2018 at 3:36 pm | *Updated March 2, 2018 at 5:41 pm*

New Washington initiative would put fee on carbon emissions

Originally published March 2, 2018 at 6:10 pm | *Updated March 2, 2018 at 6:38 pm*

Local | Politics | News | Climate Change | Environment

Oregon Climate Policy Could Get Another Chance Next Year

by **Cassandra Profita** Follow OPB/EarthFix March 5, 2018 1:45 p.m. | Updated: March 6, 2018 6:24 a.m.

THE USUAL SUSPECTS: CARBON OFFSETS

California Environmental Protection Agency

AIR RESOURCES BOARD

Compliance Offset Protocol

U.S. Forest Projects

Adopted: June 25, 2015

… OR INCENTIVES FOR PERFORMANCE

Sierra Sun Times

Sierra National Forest Receives $5 Million as CAL FIRE Announces Forest Health Grants to Reduce Greenhouse Gases

Last Updated: Tuesday, 15 August 2017 15:47

Three of the six grants announced today fall under CAL FIRE's Forest Legacy Program. These grants enable the purchase of conservation easements on properties in Mendocino, San Bernardino and Siskiyou counties, protecting the land from being used in ways that would increase greenhouse gas emissions – such as urban or agricultural development – and harnessing the ability of trees to "sink" or sequester carbon from the atmosphere. Landowners will retain ownership of their land and will not be restricted from using it for activities such as timber harvest, hunting, fishing and hiking. These grants will protect more than 28,285 acres of forests from development.

The grants use proceeds from California's cap-and-trade program to combat climate change. Through the Greenhouse Gas Reduction Fund, CAL FIRE and other state agencies are investing in projects that directly reduce greenhouse gases while providing a wide range of additional benefits in California communities.

Incentive Models

Working Forest Carbon Incentives Model

... a State would designate revenues from power plant allowance auctions, a set-aside of allowances, or other funding sources, toward a strategic carbon investment program to offer incentives to landowners for targeted forestry practices that sequester carbon or avoid carbon emissions while generating local benefits.

-- Forest Climate Working Group (2015)

Endorsed by AFF, Green Diamond, Hancock, Oregon Small Woodlands Association, SAF, and SFI, among others.

Comparable to current Farm Bill conservation programs

RELATED WORK

Effect of Carbon Taxes and Subsidies on Optimal Forest Rotation Age and Supply of Carbon Services

G. Cornelis van Kooten, Clark S. Binkley, and Gregg Delcourt

Amer. J. Agr. Econ. 77 (May 1995): 365–374

Faustmann and the climate☆

Michael Hoel[a], Bjart Holtsmark[b,*], Katinka Holtsmark[a]

Journal of Forest Economics 20 (2014) 192–210

CARBON VALUE LENGTHENS ROTATIONS… BUT NOT MUCH

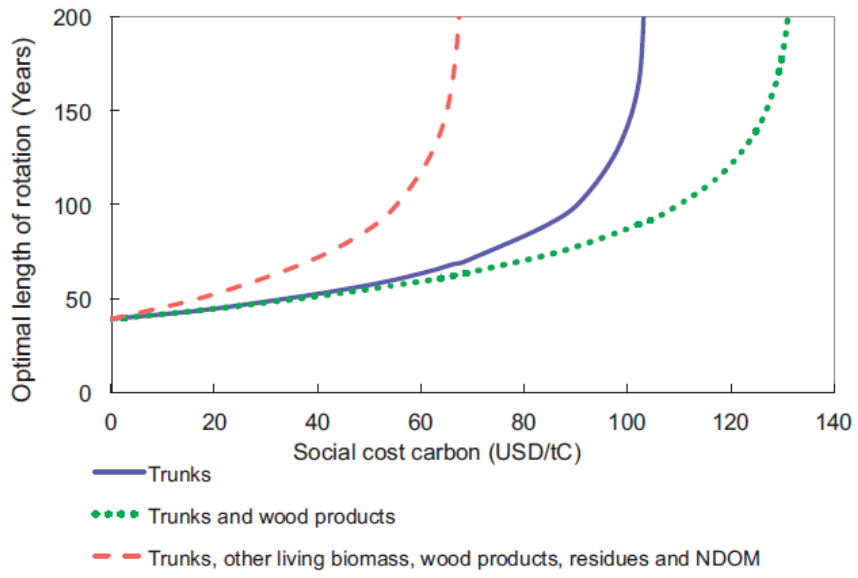


Fig. 3. The optimal length of the rotation period in the main multiple carbon pool case (the double lined curve) and cases where one or more carbon pools are not included in the analysis.

M. Hoel et al. / Journal of Forest Economics 20 (2014) 192–210

"… under some tax regimes, it may be socially optimal to never harvest the trees. In general, inclusion of the external benefits of carbon uptake results in rotations only a bit longer than the financial rotation age."

-van Kooten et al. (1995)

Research Focus

How would a carbon incentive policy affect the management calculus for west-side Douglas-fir production forestry?

More specifically, how might carbon revenue contribute to the timing of rotations, timber yield, carbon storage, and financial performance?

Growth-and-Yield Framework

- Forest Vegetation Simulator Pacific Coast (PN) Variant
- Plantations established from bare ground (435 TPA, 85% survival)
- Stochastic modeling with 10 runs for each stand
- Stands run at Site Index 75, 80, 85... 130
- 160 year simulation in 4-year cycles
- “Pretend” harvests using ECON extension

Growth-and-Yield Calibration/Validation

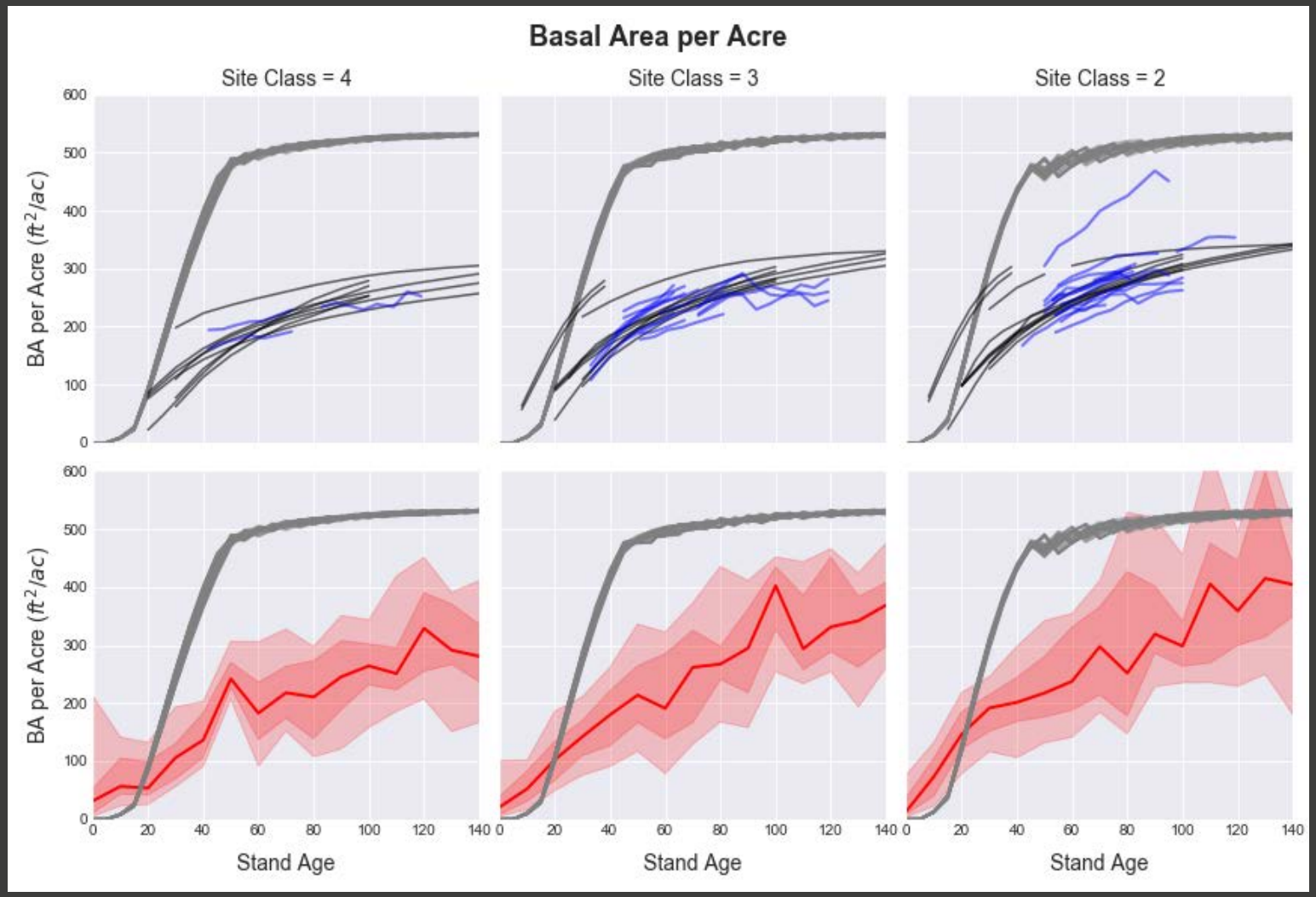
FVS projections compared to:

- **Published Douglas-fir yield tables from CA to BC**
  Schumacher, 1930; McArdle et al., 1961; Chambers, 1980; Curtis et al., 1982; Mitchell and Cameron, 1985;
  Stand Management Cooperative, 2016

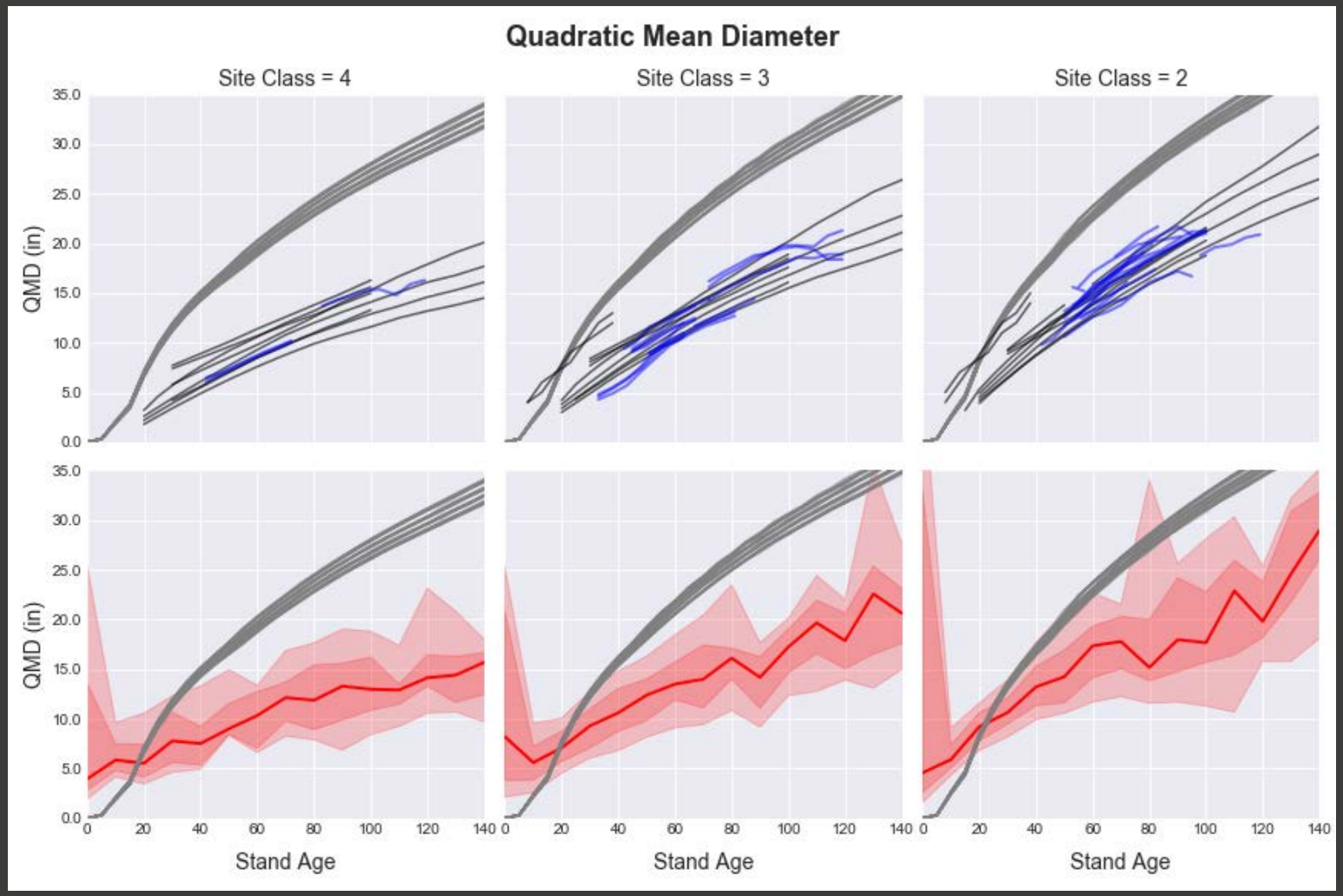
- **Published permanent plot data**
  Williamson, 1963; Curtis and Marshall, 2002

- **FIA Data from western OR & WA**

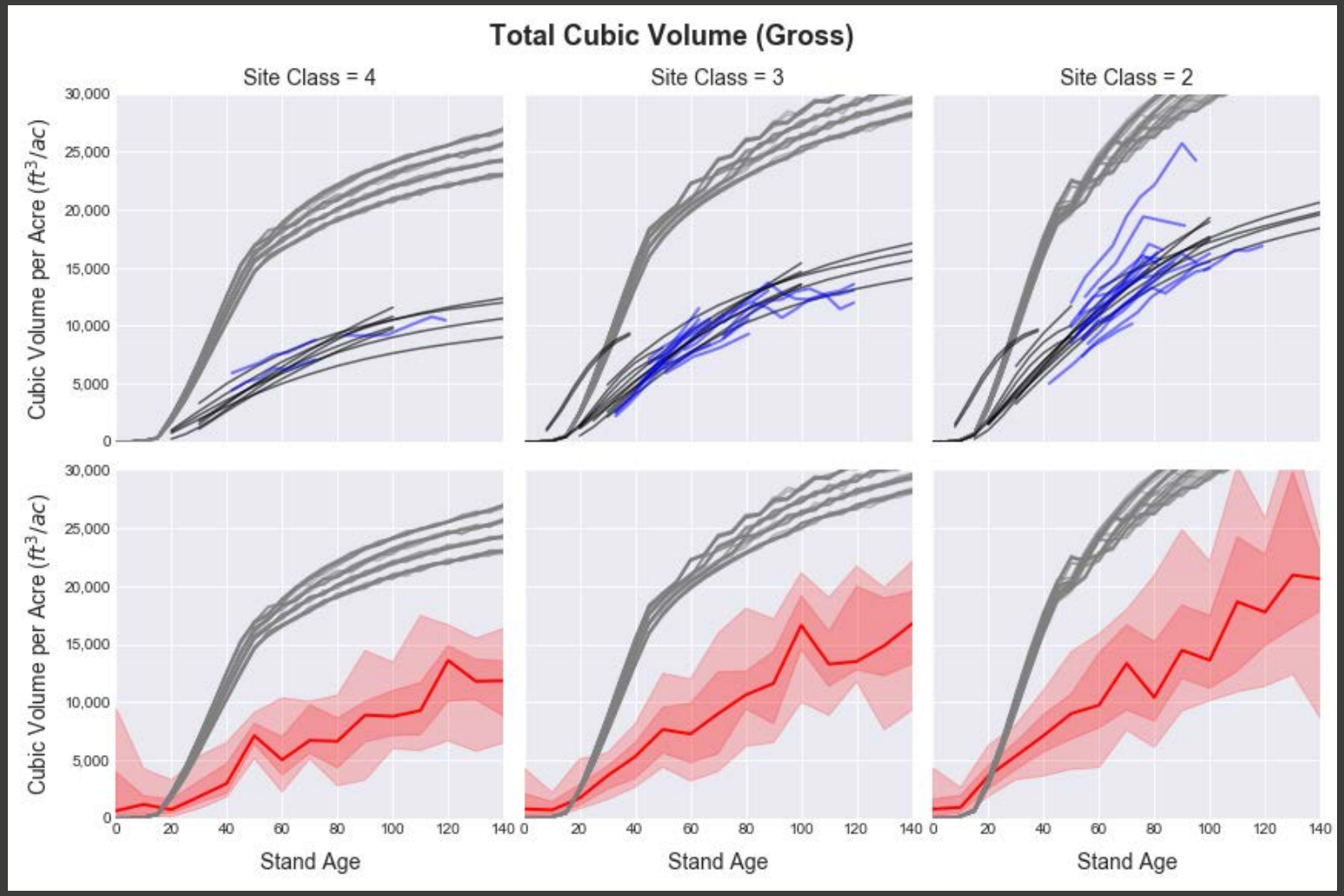
FVS Out of the Box: **Basal Area**



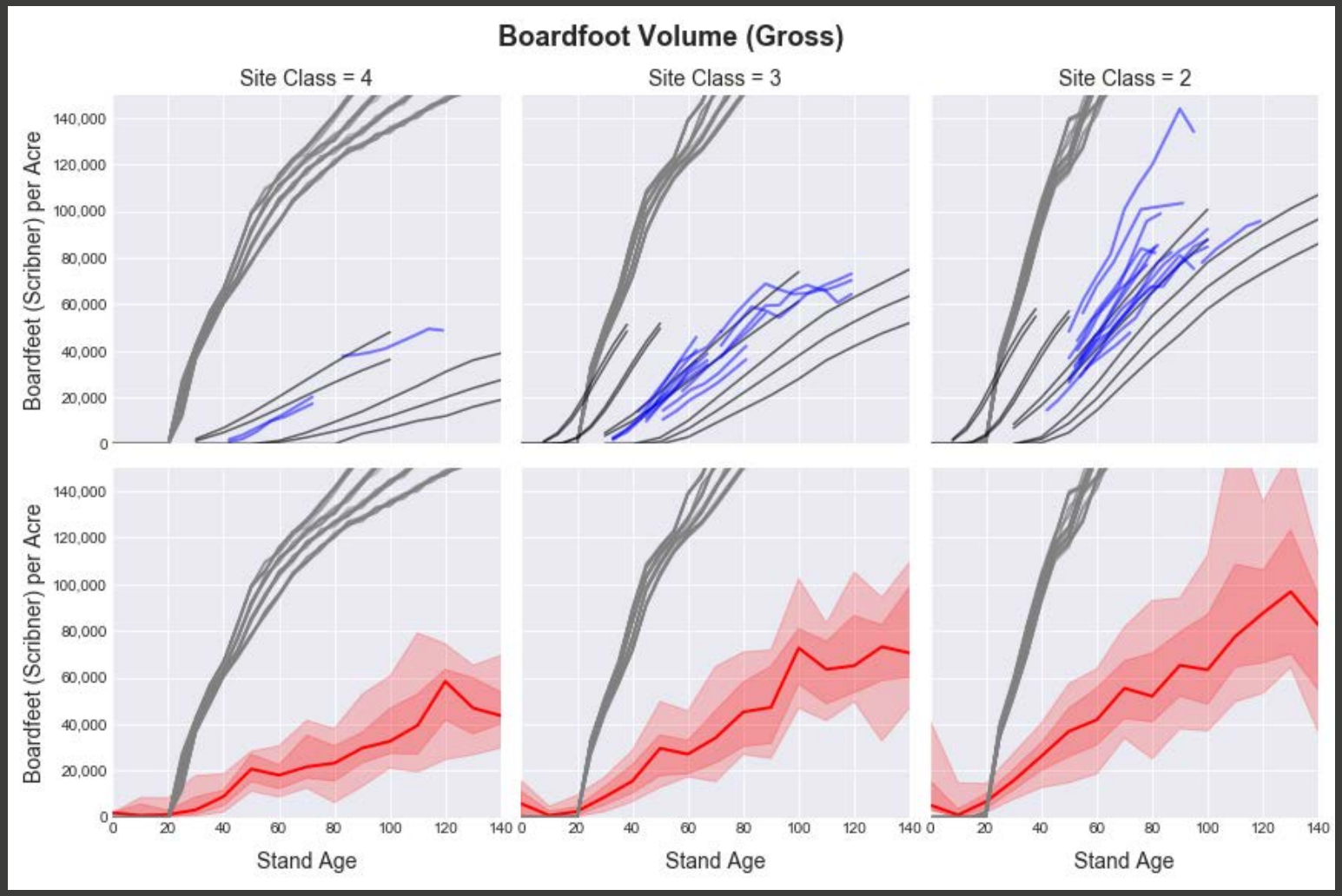
FVS Out of the Box: **QMD**



FVS Out of the Box: **Cubic Volume**



FVS Out of the Box: **BF Volume**

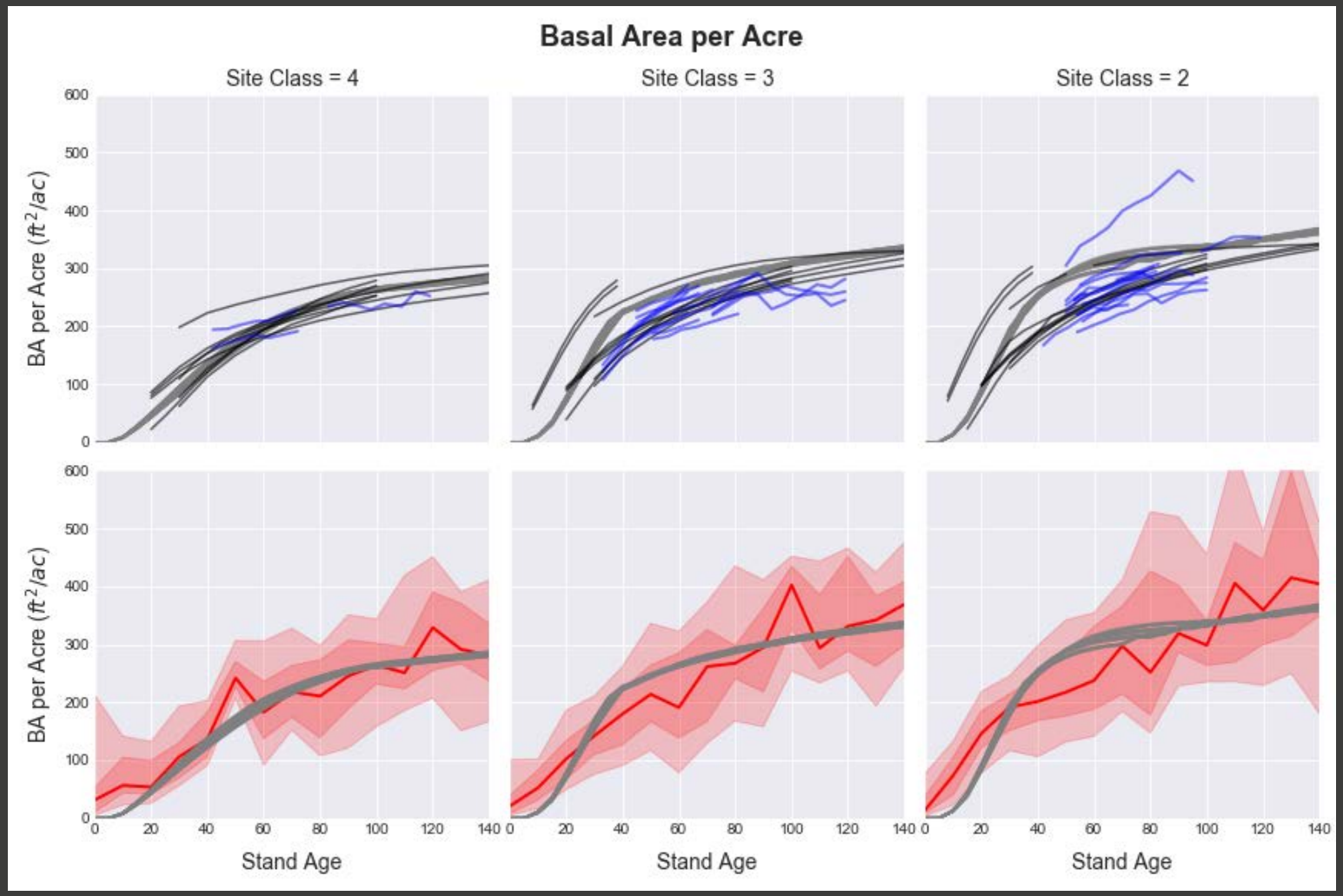


Growth-and-Yield Calibration/Validation

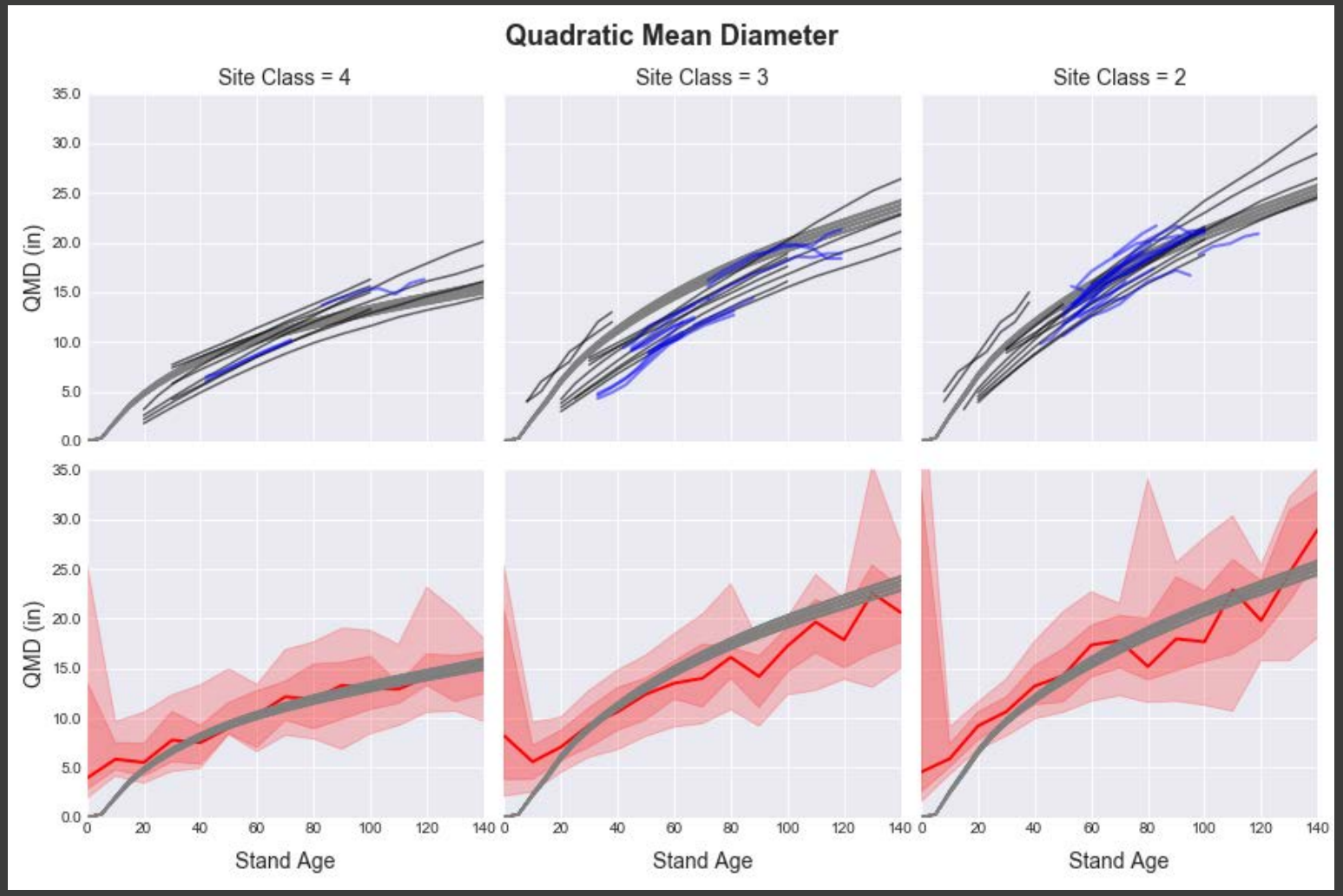
FVS projections adjusted:

- Maximum SDI set for each site class (450-550)
- Basal Area Increment @ 30-50% of default rates
- Background mortality turned off for stands < 30 yrs old
- "Defect" adjustments to FVS boardfoot volume estimates in 5" DBH classes to match FIA volume equations

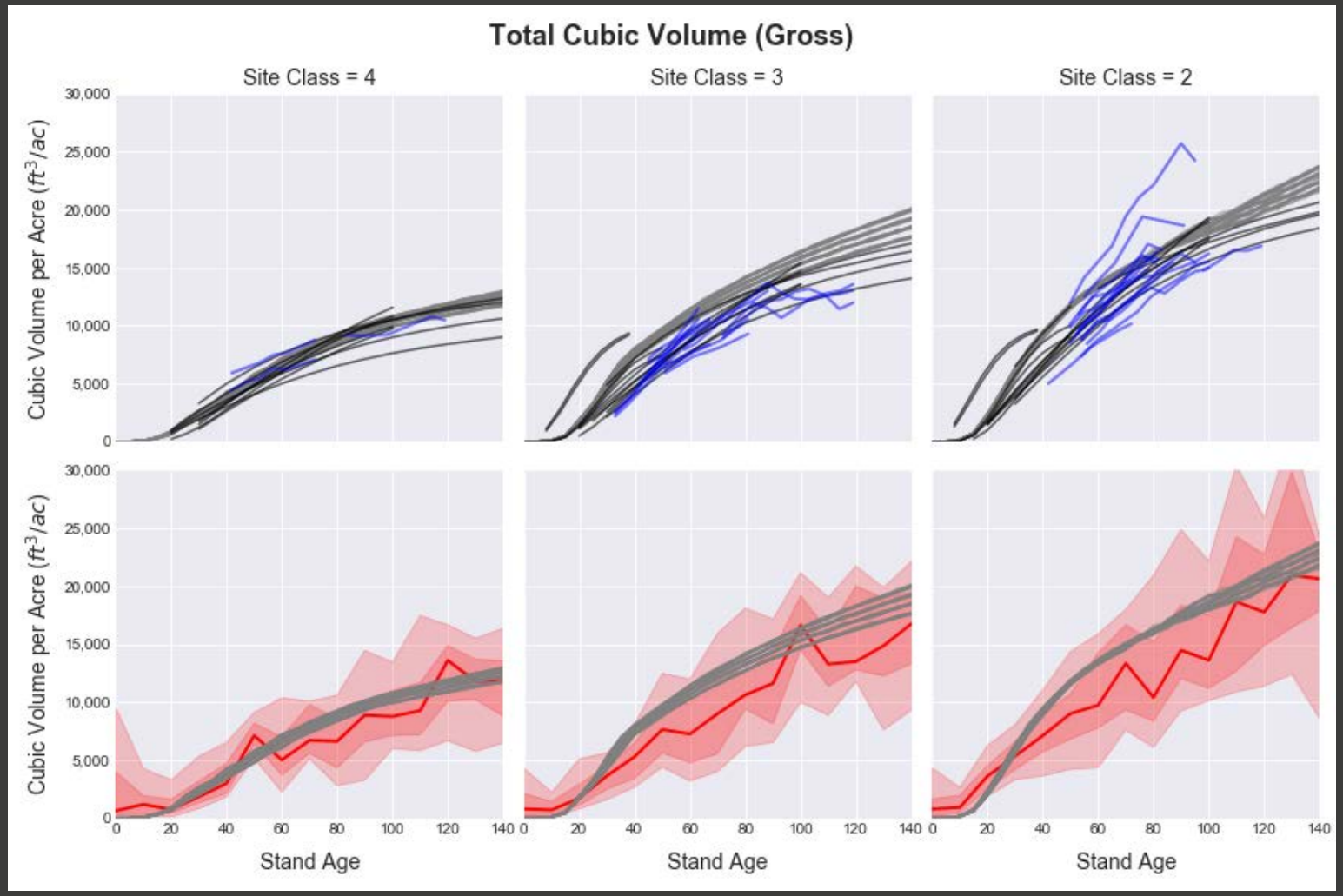
FVS Adjusted: **Basal Area**



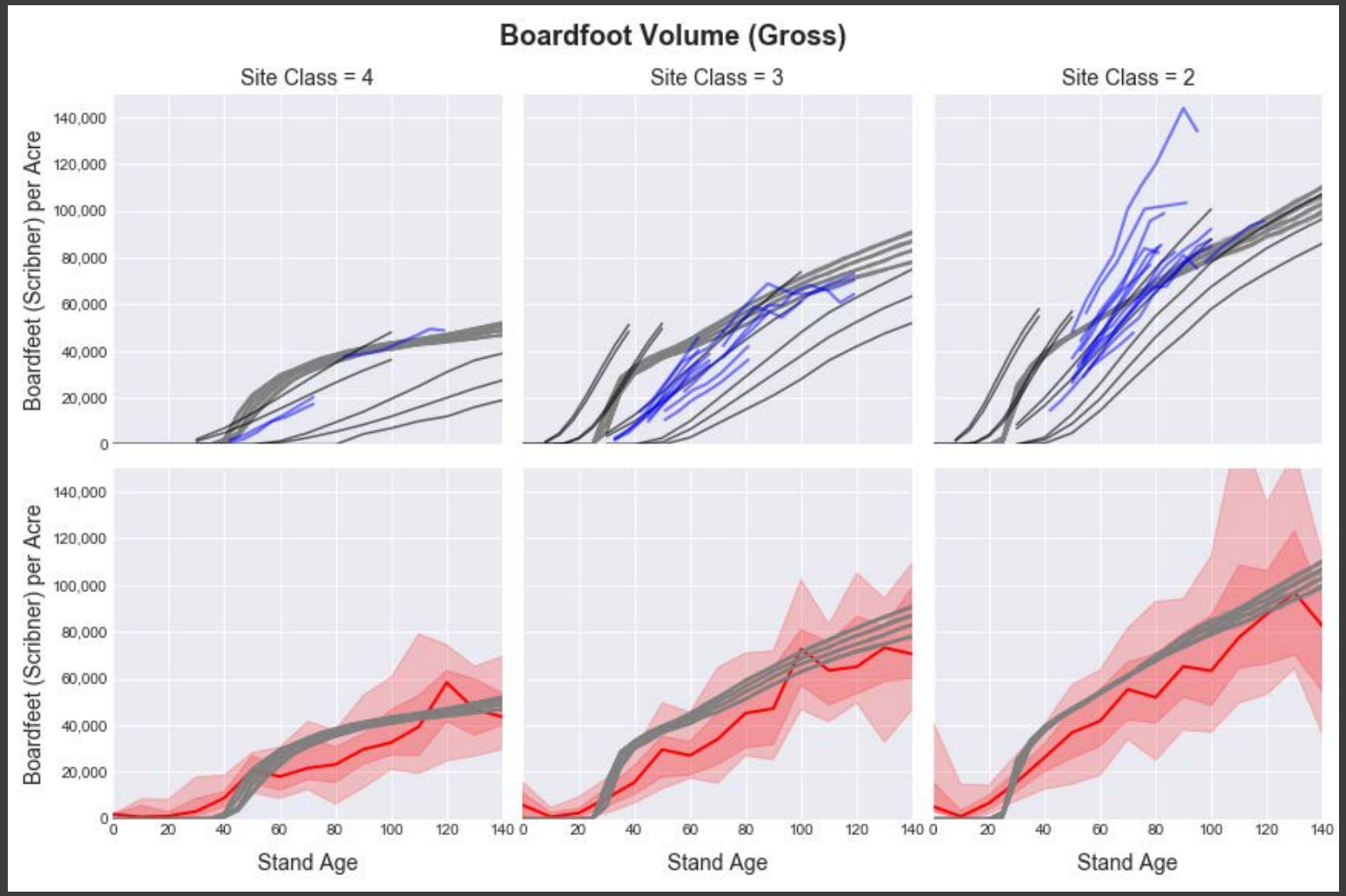
FVS Adjusted: **QMD**



FVS Adjusted: **Cubic Volume**



FVS Adjusted: **BF Volume**



Carbon policy modeled here

- Annual rental payment for carbon in live + dead trees
  Rental rate derived from carbon price following Cacho (2007):
  Rental Rate = Carbon Price * $(1 - e^{0.05})$

- Carbon rented only if stand is above "common practice."
  For high- or low-site "Northwest Coast Range Forest" values per California Air Resources Board rules (141 or 82 tCO_2e/ac; ~ 139 or 101 ft2/ac; ~ 21.5 or 11.8 MBF/ac for high-(II+) and low- (III-) site classes.

- Carbon prices evaluated at $0, 5, 10… $50 per tCO_2e. One scenario using the 2016 Federal Social Cost of Carbon.
  SCC starts at $11 in 2015 and goes up over time, even with 5% annual discounting. All other prices simulated here go down over time with 5% annual discounting. Current carbon prices in California ~ $12-13 for an offset credit.

The rest of the economic equation

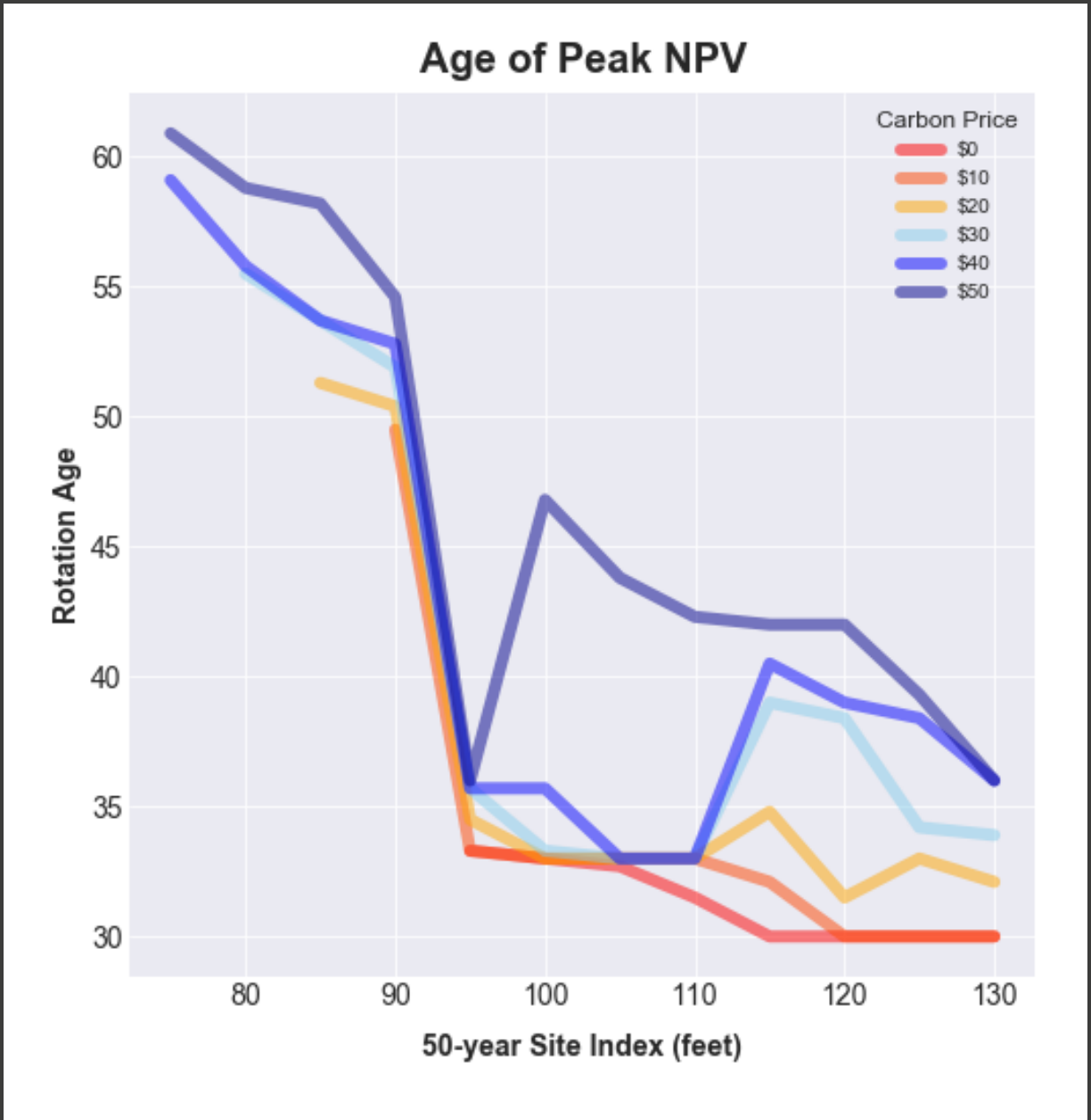
Activity	$	per
General administration	35	ac/yr
Site preparation	85	ac
Tree planting	0.73	seedling
Brush control	135	ac
Harvest administration	5	MBF
Regeneration harvest	150	MBF
Hauling	100	MBF
Road maintenance	15	MBF

drawn primarily from Arney (2016)

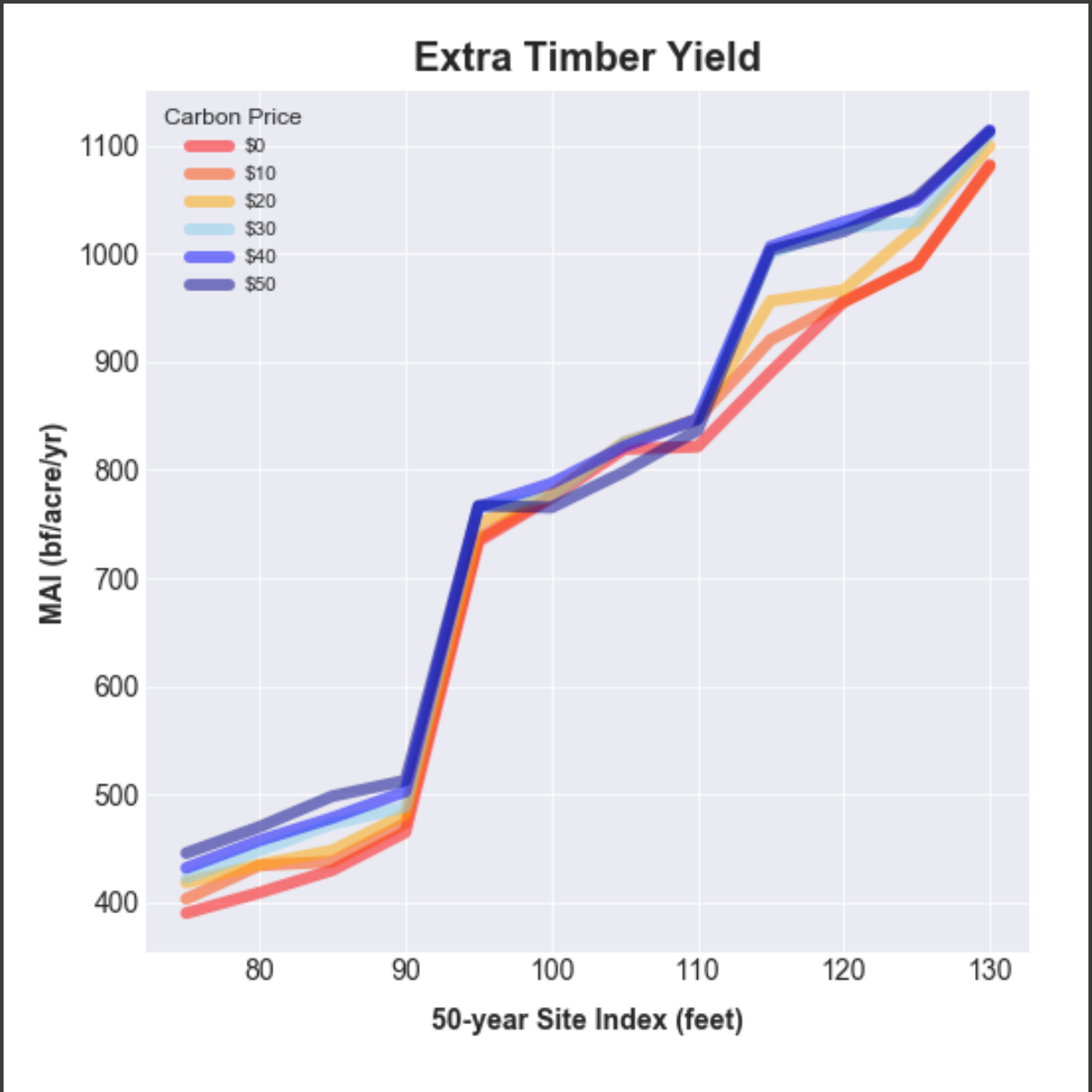
Species	$/MBF
Douglas-fir	796
Sitka spruce	450
Western hemlock	640
Noble fir	640
Grand fir	640
Pacific silver fir	640
Alaska yellow-cedar	640
Western larch	640
Western redcedar	1,263
Red alder	852
Bigleaf maple	499

Washington DNR Feb 2018 log price report

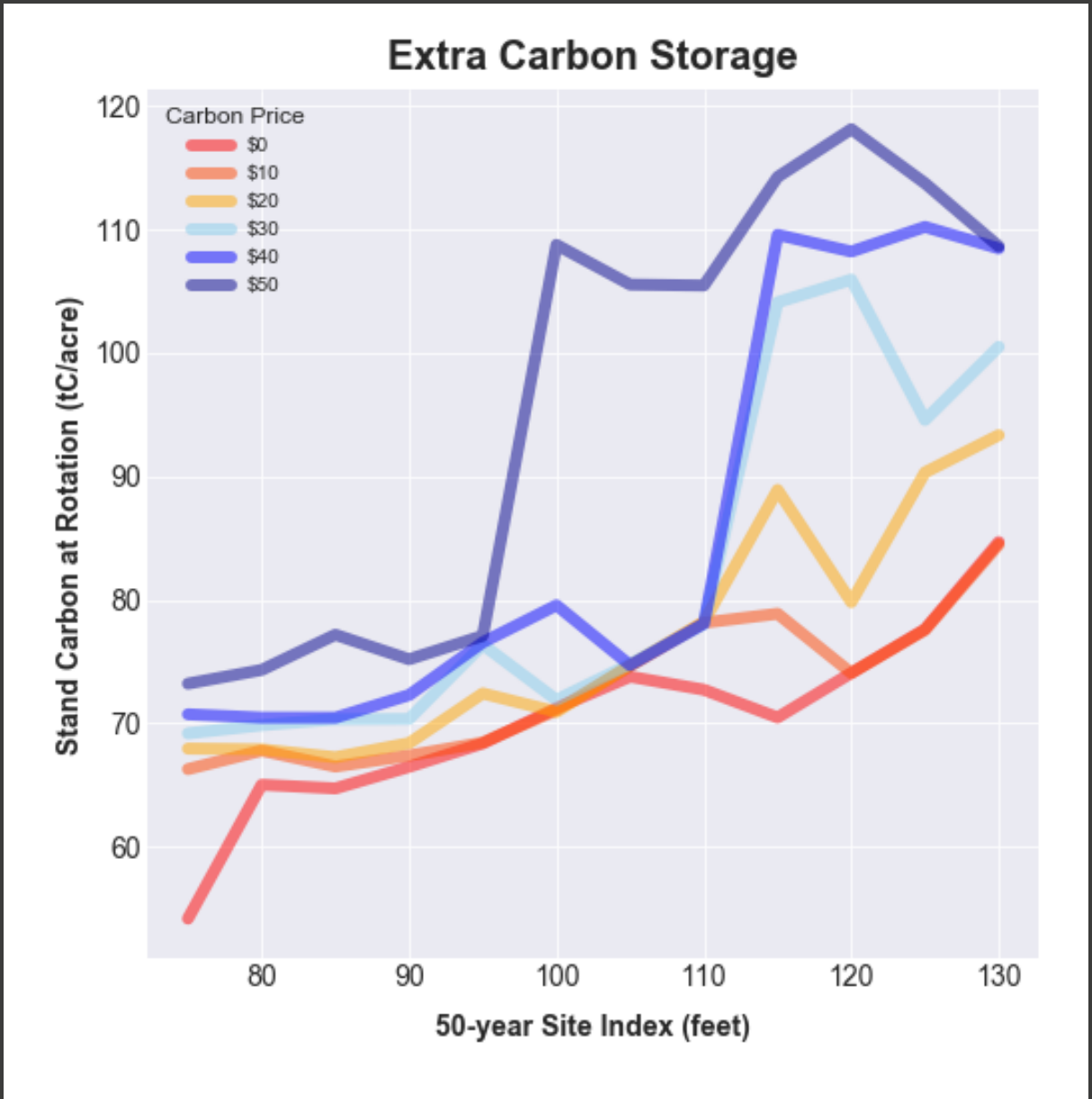
Financially-optimal rotations get extended by carbon revenue…

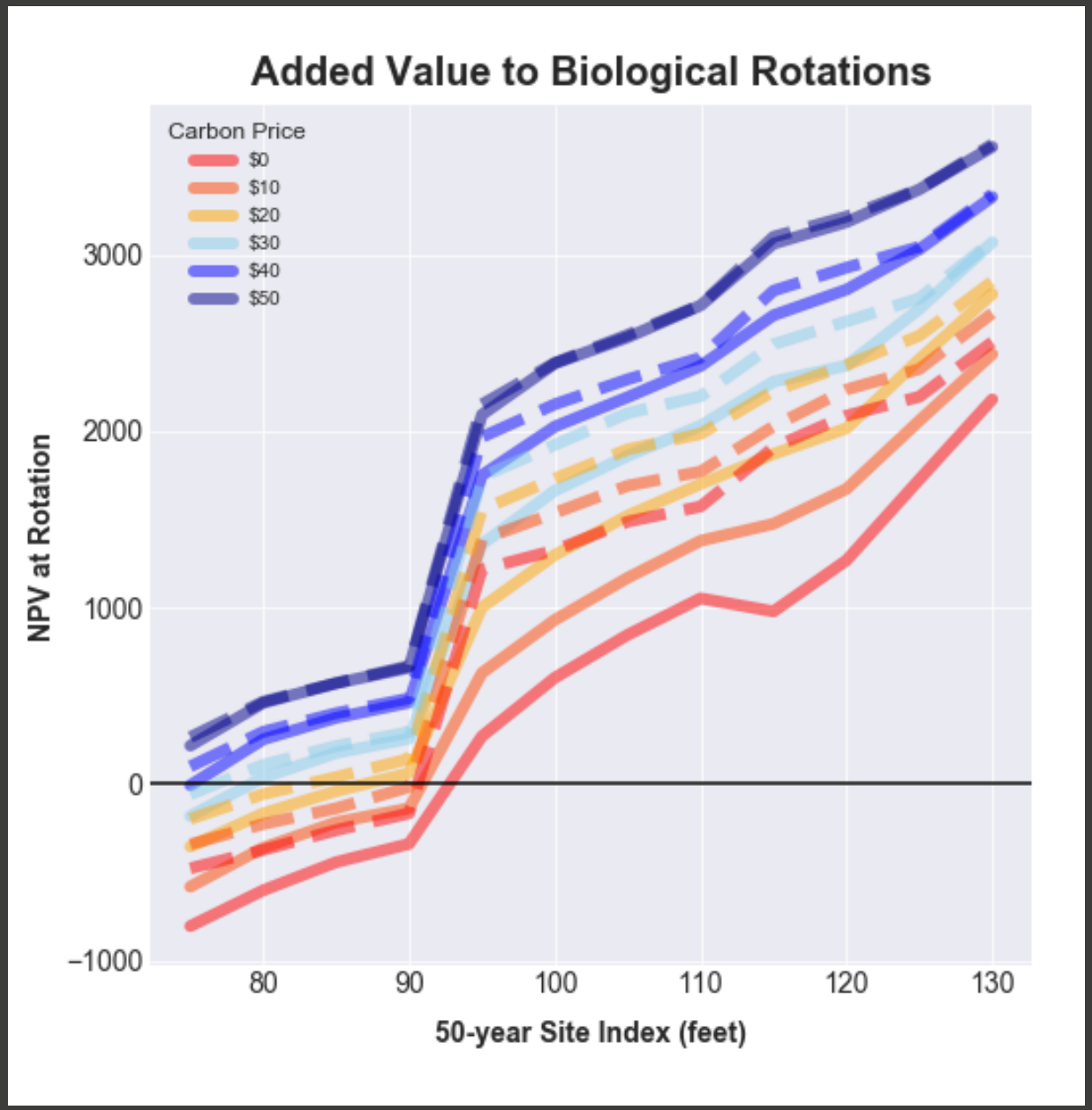


… and would yield more timber…



… as well as storing more carbon.





Longer rotations become more valuable, reducing the NPV gap between biological (solid) and financial (dashed) rotations.

Main Findings

- Renting carbon storage at the Social Cost of Carbon always led to a suspension of harvesting.
  SCC produced land values at least an order or magnitude higher than non-growing carbon prices (e.g., a stand with SI 120 was worth $49,345/ac if held to age 120 vs. $2,087 being held to age 30 without carbon value).

- Carbon revenue led to modest extension of rotation ages, which produced more timber and stored more carbon.
  Carbon prices as high as $50/t$CO_2$e led to only ~5-year extensions of rotations for current productive sites. This yields more wood, averaging 0.7-1.1 MBF/ac/yr . Carbon revenue may also enable profitable management of lower-site stands.

- $50/t$CO_2$e corresponded to adoption of biological rotation age as financially optimal scenario.

Main Findings

- Carbon prices up to $50 showed no reason to curtail timber production in favor of collecting carbon revenue.
  Consistent with findings of van Kooten (1995) and Hoel (2014), where rotations weren't suspended until > $200/t$CO_2$e.

- Changes in carbon storage and timber output were marginal, and suggest performance indicators beyond carbon may be important to guide allocation of limited carbon investment funds.
  Renting carbon for marginally extended rotations may deliver incremental gains across vast acreage, but are unlikely to deliver other substantial conservation benefits.

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Thank you.

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