Carbon Smart

Managing forests as if carbon mattered: What does science <u>really</u> tell us?

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Annual Meeting
April 26, 2012

Not so much

Agenda

Act 1: Key findings on forest-generated climate benefits from the SAF Task Force Synthesis

Act 2: How to "prove" that forest management can't provide climate benefits

Act 3: How not to manage if carbon matters– smoke signals from the Golden State

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Act 1: The SAF Carbon/Biomass Task Force

Å 2008-2009 generating Emerging Issues at FSTB

- ï How does biomass for energy play out?
- ï Are forest C offsets a scam?

Å 2010 SAF Council chartered 2 issue Task Force

- ï Synthesized best available science on these issues

Å 2011

- ï SAF publishes 50 page report as JoF supplement
  - Å Contains 8 pages of citations
- ï Findings presented at Honolulu SAF Convention

Keep forests as forests

Å … and manage appropriate forests for carbon

ï 70 years of U.S. forest cover increase and growth > mortality+removals

ï Conversion to ag or urban reduces stores & flux

ï Easy mandate for concurrence with enviros

Å But insufficient by itself

ï Unmanaged forests eventually reach C saturation

ï Stand replacing disturbance emits C with no climate benefits via product and energy substitution

Wood products C storage extends forest sequestration capacity!

Å Products can last a long time (½ life of 80 yrs)

Å Life can be extended via recycling & reuse

Å Landfills can hold wood for centuries

Å Recovery of wood and paper for energy value produces substitution benefit

Å These benefits occur outside the forest

ï They are poorly accounted for by C offset protocols

ï Analysts seeking to “prove” that any management is climate-hostile consistently understate product lifetimes, overstate unutilized residues, and ignore future potential for reuse, recycling & energy recovery

Substitution effect is real, irreversible and cumulative

- Embodied fossil energy in wood products is a tiny fraction of that in steel, aluminum, concrete and plastic
- Electricity generation via CHP of woody residue is another kind of substitution benefit
- Requires life-cycle assessment to compute
- These benefits occur outside the forest and are entirely omitted by most C offset protocols
  - Implies: biogenic C emissions = fossil C emissions

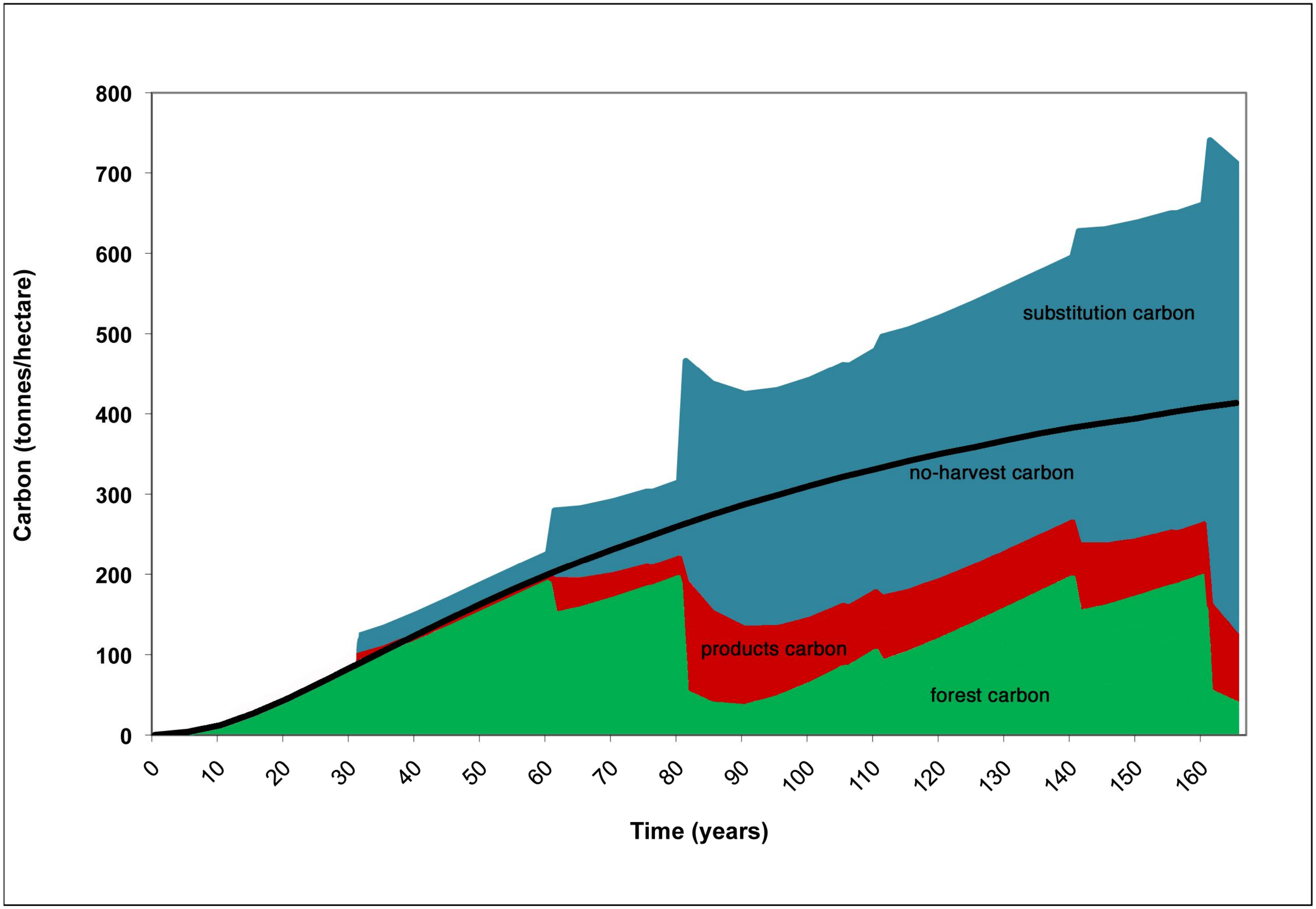
Energy from woody biomass

- Accounts for 30% of renewable energy consumed in the U.S., and 60% of this is CHP
  - CHP much more efficient when process heat usable
- Much of this is used to energize production of wood, which has large substitution benefits vs. other building materials
- Reliability/non-intermittent important
- Energy wood competes with pulp in some areas and is synergistic with wood products in others

Climate benefits of bioenergy

- Bioenergy REDUCES transfer of fossil carbon to the atmosphere and cycles contemporary C
  - Generating electricity via CHP consumes only 1 unit of fossil energy per 25 to 50 units of bioenergy produced
  - Less efficiency with transportation fuels 1:4 to 5
- Wildfires create 5% of U.S. lower 48 GHG emissions
  - Methane (25X GWP) and NOx (300X GWP)
  - Boiler combustion drops non-CO2 emissions by 98%
- Unutilized biomass that decays/burns in the woods is an emission– a net decrease in woody C stock
  - Bioenergy creates a market for small trees and residues, enabling capture of substitution benefits

Managing Forests Because Carbon Matters: Integrating Energy, Products, and Land Management Policy



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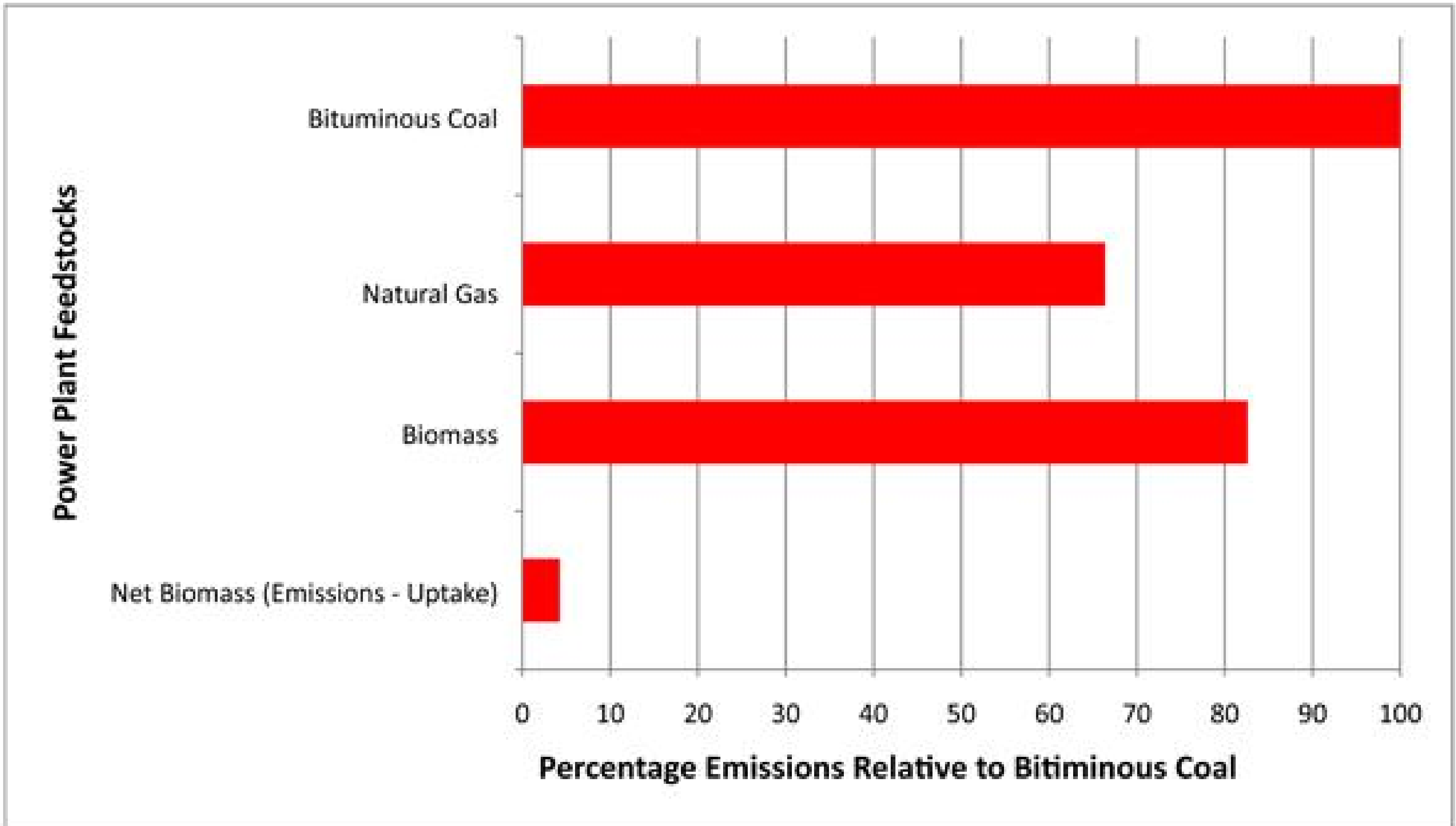
Climate benefit accounting: looking for insight beyond the forest

- Attributional Life Cycle Assessment (ALCA) helps us understand the climate impacts of producing a product
  - seedling to tree to log to 2x4 delivered to the big box store
  - The environmental cost can be attributed to the product
  - But substitution is outside the product system
- Consequential Life Cycle Analysis (CLCA) addresses the "so what", offsetting effects
  - Climate consequences of wood vs. steel wall assembly or electricity from biomass vs. coal
  - But many assumptions needed, and results always depend on them
- Bottom line: consistent carbon accounting tracks the emission AND the offset
  - But for biomass energy, carbon credit offset protocols don't

Managing Forests Because Carbon Matters: Integrating Energy, Products, and Land Management Policy



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Conditions for climate neutrality

Å If harvesting results in a stable average of carbon across forest over time, then carbon-cycle neutral

Å Climate benefit =

[avoided fossil C emissions]

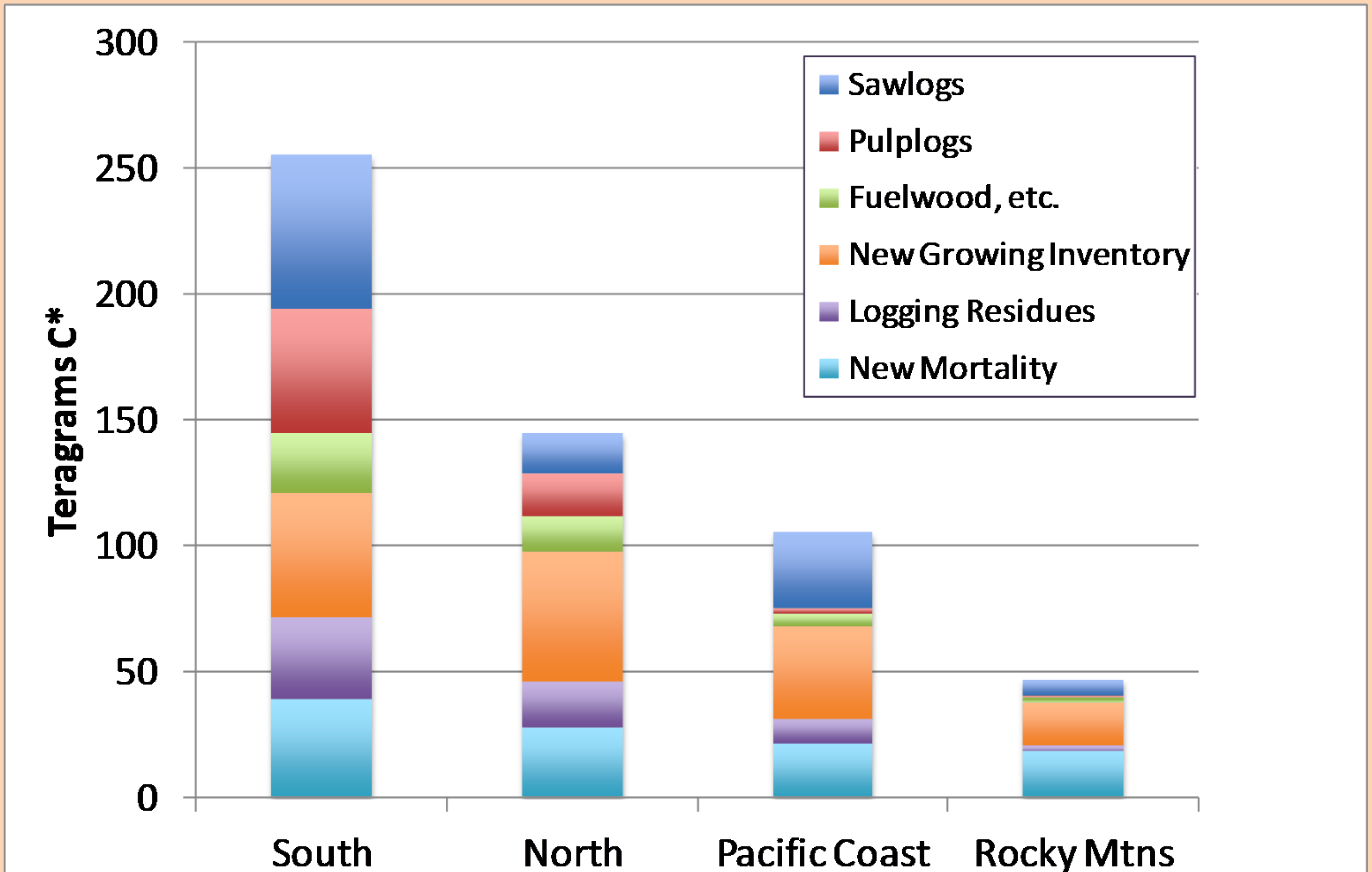
– [biomass procurement fossil C emissions]

provided that

Å Forest-wide Harvest + Mortality ≤ Net Growth

Å Soil C and forest C sequestration potential is maintained

How are we doing?
Annual woody carbon flux on timberlands



Source: Smith et al. 2009 as summarized by Bill Stewart

* approx. C based on volume converted at 40 cu. ft. per ton woody biomass, and C = 0.5 □ woody biomass

Vantage point matters

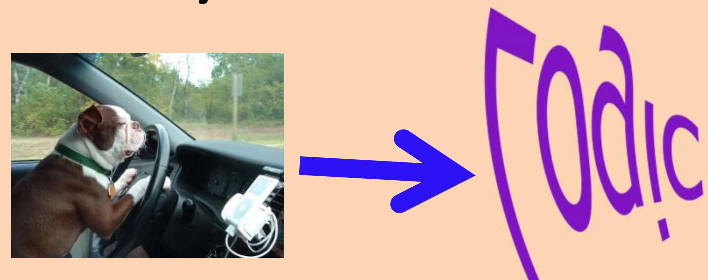
- Current sequestration an artifact of prior exploitation
- What would happen without wood utilization?
  - Buildings still built, but of different, more energy intensive materials or of wood transported from afar (Canada)
  - Electric car owners plug-in … to coal-generated juice
  - Logging residue C emits via decay or fire
- Landscape scale more relevant than stand
  - Stands have ever-changing carbon dynamics, and have increasing probability of catastrophic C loss
  - A carbon neutral forest landscape can have stable C stores, natural disturbance AND product/energy capture
    - Not an all or nothing proposition
    - Entirely unmanaged landscapes vulnerable to large emissions
    - With capture, the landscape is better than neutral

Prospects

- Carbon tank will ultimately fill, some places quicker than others
- Maintaining forests as forests is not enough
  - Deviations from C cycle neutrality likely if change in
    - Climate
    - Incidence of exotic disturbance agents
    - I&D outbreak frequency
    - Regeneration success
    - Soil productivity impairing fire frequency/intensity
- Climate benefits of active management are lo-balled if product storage and substitution effects aren’t counted

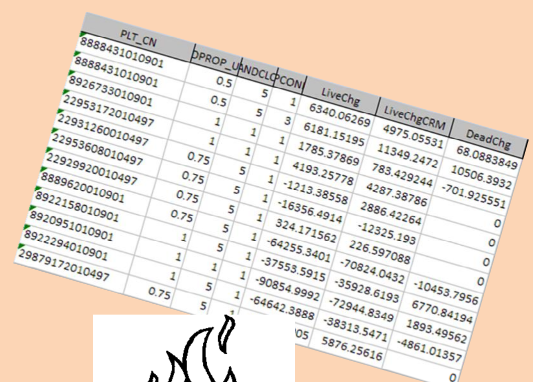
Act 2: Surprising outcomes in recently published forest C analyses

- If dogma is the driver, logic can get convoluted
- Suppose your question were:



  - How can we prove that forest harvest is bad for the climate?
  - Success would assure high profile attention to a counter-intuitive finding

  - Can unbiased data be tortured into supporting this story?
    - Lies, damn lies, and assumptions…
      - (apologies to Mark Twain)



PLT_CN	DPROP_U	ANDCL	CON	LiveChg	LiveChgCRM	DeadChg
8888431010901	0.5	5	1	6340.06269	4975.05531	68.0883849
8888431010901	0.5	5	3	6181.15195	11349.2472	10506.3932
8926733010901	1	1	1	1785.37869	783.429244	-701.925551
22953172010497	1	1	1	4193.25778	4287.38786	0
22931260010497	0.75	5	1	-1213.38558	2886.42264	0
22953608010497	0.75	5	1	-16356.4914	-12325.193	0
22929920010497	0.75	5	1	324.171562	226.597088	0
8889620010901	0.75	5	1	-64255.3401	-70824.0432	-10453.7956
8922158010901	1	5	1	-37553.5915	-35928.6193	6770.84194
8920951010901	1	1	1	-90854.9992	-72944.8349	1893.49562
8922294010901	1	5	1	-64642.3888	-38313.5471	-4861.01357
29879172010497	0.75	5	1	[illegible]	5876.25616	0

Forest carbon literature increasingly replete with

Å Rhetoric (“We all know that …”)

Å Perplexing modeling assumptions

Å Inexplicable parameter selection & sensitivity analyses (a.k.a. straw men)

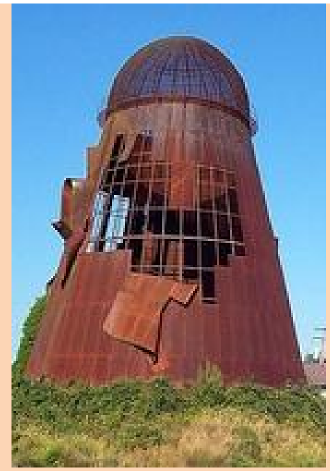
Å Strategic choices about location, spatial extent and time scale of analyses

Å Complex, difficult-to-follow logic, often buried in poorly explained technical appendices, tables, and inaccessible citations

Rhetoric/misdirection

- Reiterate, *ad nauseum*, the mantra that harvesting ***mature*** forest → huge C emissions
  - Restoring pre-harvest sequestration *can* take centuries
    - But is this really typical?
- Say post-fire emissions from decay of dead wood are offset by C accumulation in the re-growing stand
  - Don’t mention accumulation is the same if carbon had instead been captured to products and energy
- Argue that the atmosphere doesn’t “see” a difference between bio- and fossil energy emissions
  - Emphasize the lower <u>energy</u> conversion efficiency of wood to make biomass look worse than coal!
- Equate storage potential for products & dead wood
  - Products’ 7 to 70 yr half-life “not much different” than in woods

Modeling Assumptions



- Use outdated estimates of conversion efficiency
  - Assume no technical change, ever!
- Products landfilled/emitted with no energy recovery at end of life
- Call unutilized dead wood a carbon “store”
- Count only the immediate emissions of a fire
  - Surface fuels/duff are source of most emissions, so thinning yields little emissions benefit [7% emissions from live trees]
- Count emissions from wood processing no differently than if they were fossil fuel based
- Forests grow forever
  - Mortality doesn’t happen or is negligible

Straw Men

- Model ineffective hazard reduction activities
  - Reduce basal area by fixed % on every acre
  - Thin larger trees; remove only some ladder fuel
- Propose infeasible utilization assumptions
  - Remove every sapling (even on steeps!)
  - Biomass to biofuels with inefficient technology
    - Less efficiency than assuming CHP
- Compare removals with fire emissions
  - Considers only in-forest effects, no substitution effects, no accounting for fate of fire-killed wood

Strategic Location & Spatial Scale

- Model treatments in places that rarely burn (hemlock/spruce)
  - Then emphasize how low the chances are of a treated stand being hit by fire
- Confuse stand and landscape benefits of fuel treatments to show minimal acres protected
- Insist on RS/GIS, rather than sample-based analysis
  - Adds unknown model error, so can’t estimate precision
  - Adds to complexity, requires *ad-hoc* assumptions
  - Much harder to validate
- Substitute space for time (for soil carbon flux, regrowth) to fake future forest trajectories

Strategic Time Scale

- Keep time horizons short (20 years) to
  - minimize benefits of re-growth
  - maximize wood products’ end-of-life emissions
  - Justify the concept of in-forest carbon debt

Manage Uncertainties Selectively

- Cast climate change-induced increases in fire frequency as unknowable and ignore
- Account for re-growth of thinned stands by setting equal to the mean for age 1-20 yrs.
  - California NFS timberland growth:
    - 1-20 yrs: **387** lbs/ac/yr
    - 20-40 yrs: 1970 lbs/ac/yr
    - 40-60 yrs: 1041 lbs/ac/yr
    - Even at 80-100, it is 791 lbs/ac/yr

  - So when basal area is reduced by 30% (cutting the smallest, suppressed trees), assume a 50-80% drop in growth????

Act 3: NFS Region 5 Carbon Stock Change 2003-2008

U.S. in-forest C flux– virtue or artifact?

1800s: forests → farms; 1900s: farms → forests

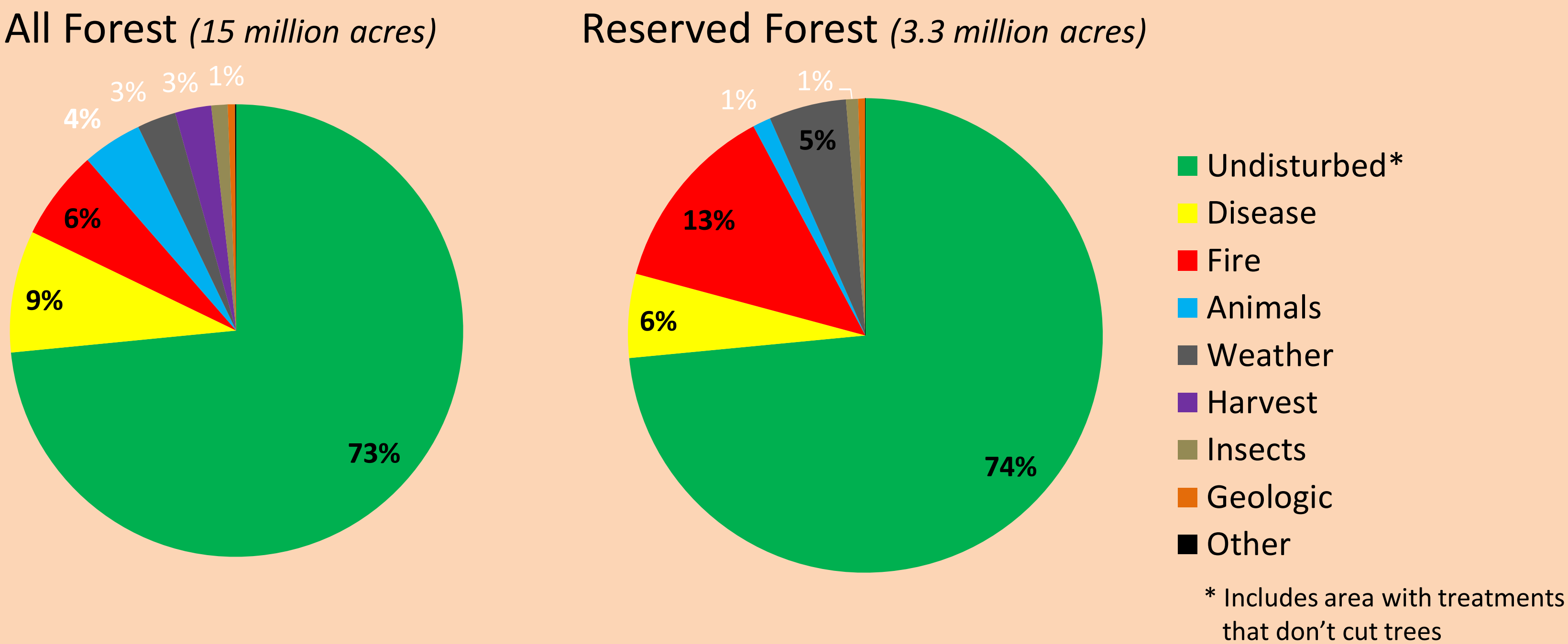
Much lumber from Canada means less harvest here

Maturing forests and large, unmanaged forest area → weakening carbon sink

Will increasing disturbance transform forests into carbon emitters?

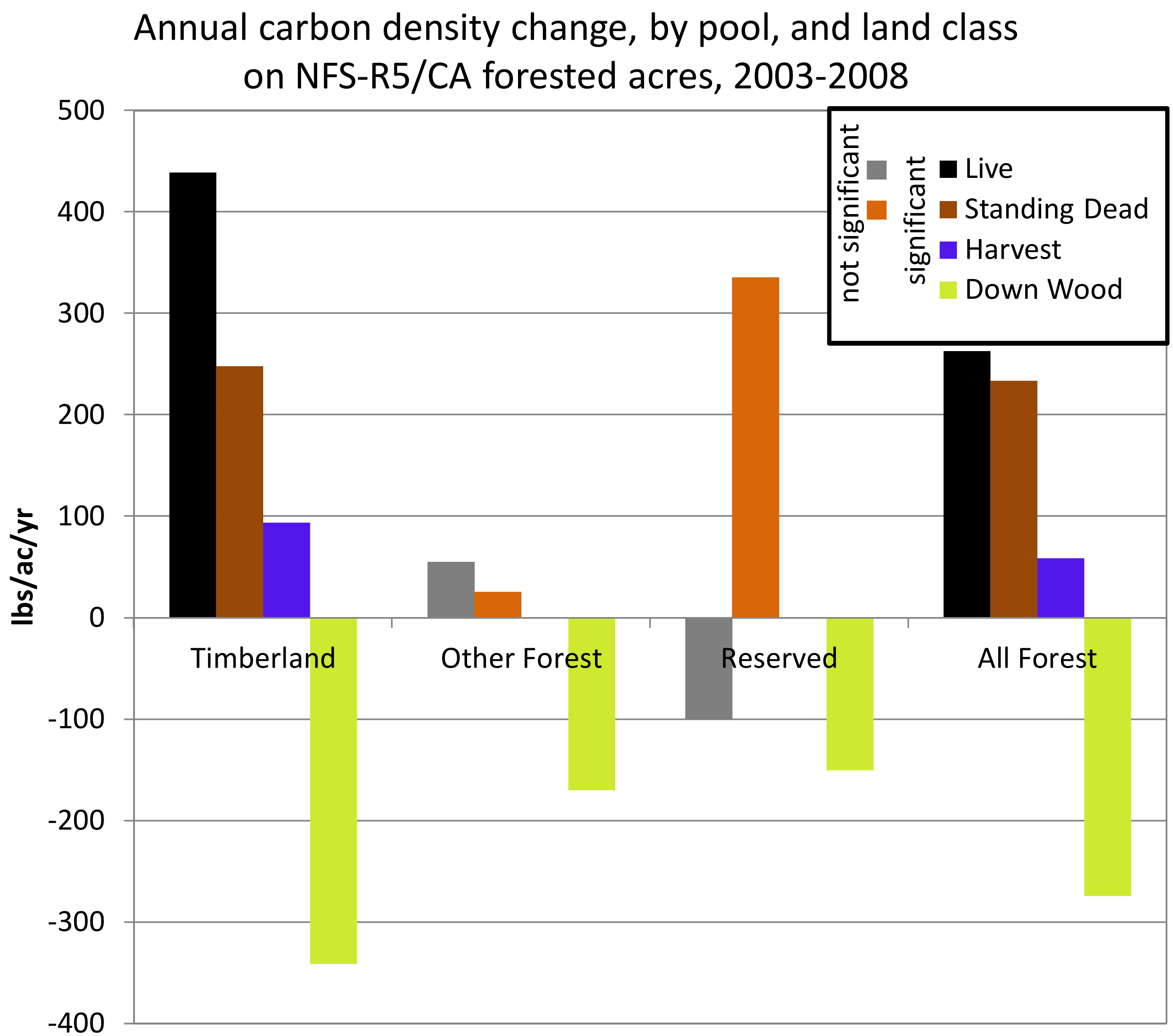
If so, would expect to see it on <u>national forests</u> first

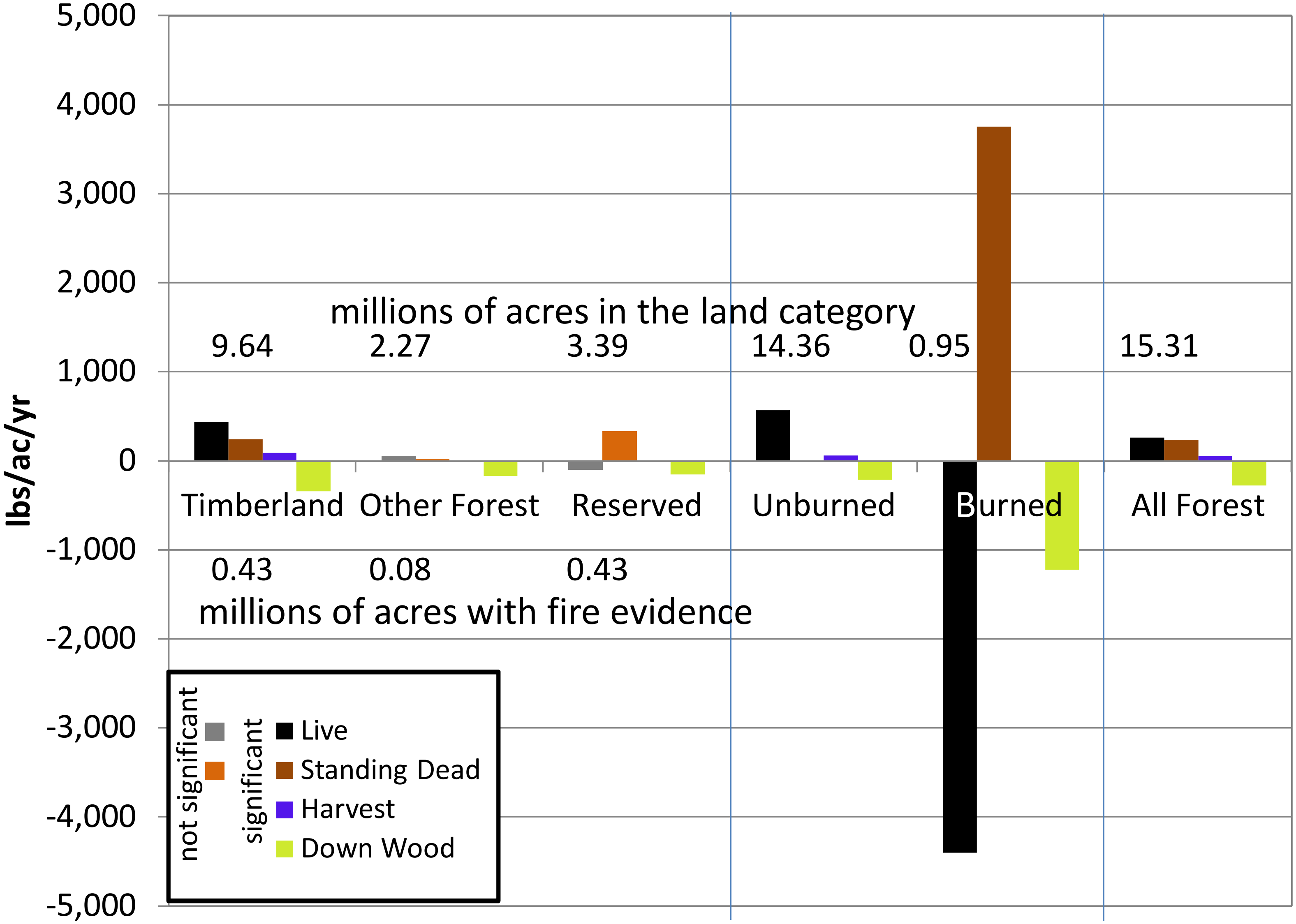
Forest Area by Disturbance Type



Å ~25% of the forest observed as harvested or disturbed in ~5 years!

Å Fire incidence in wilderness is huge (13% vs 4% for unreserved)


Annual carbon density change, by pool, and land class
on NFS-R5/CA forested acres, 2003-2008
lbs/ac/yr
500
400
300
200
100
0
-100
-200
-300
-400
Timberland
Other Forest
Reserved
All Forest
not significant
significant
Live
Standing Dead
Harvest
Down Wood



5,000
4,000
3,000
2,000
1,000
0
-1,000
-2,000
-3,000
-4,000
-5,000
lbs/ac/yr
millions of acres in the land category
9.64
2.27
3.39
14.36
0.95
15.31
Timberland
Other Forest
Reserved
Unburned
Burned
All Forest
0.43
0.08
0.43
millions of acres with fire evidence
not significant
significant
Live
Standing Dead
Harvest
Down Wood

Analysis insights

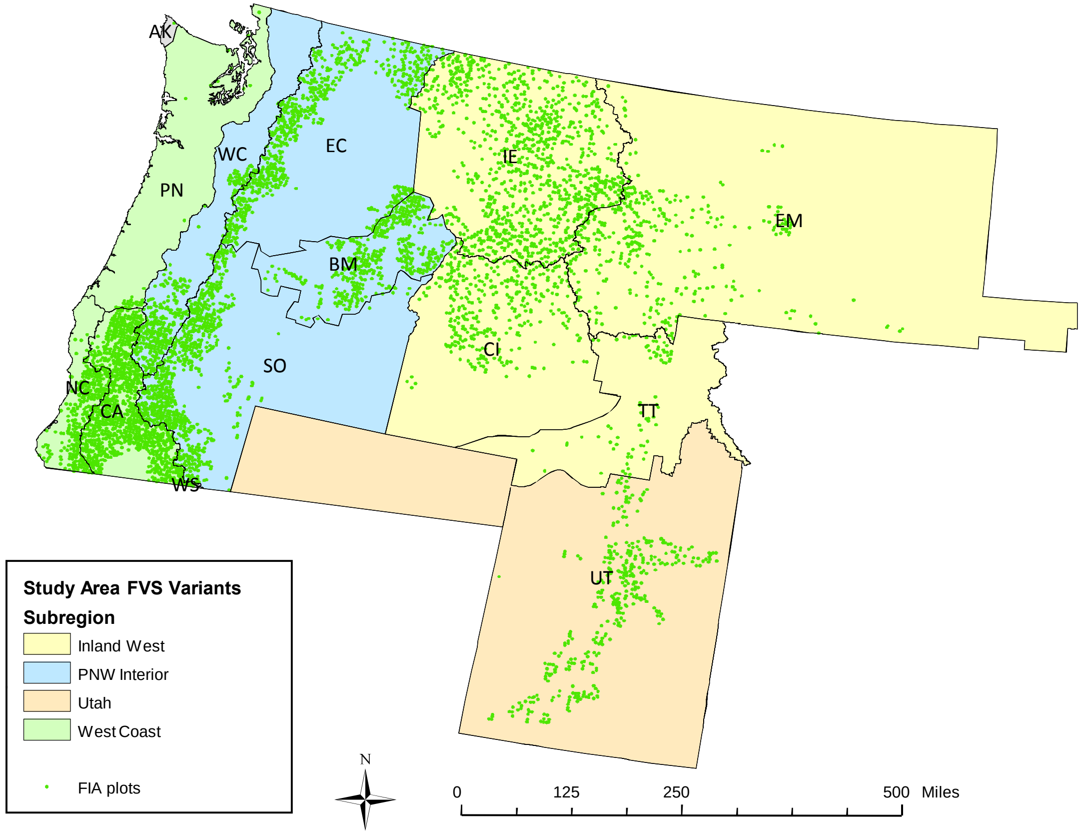
- CA national forests **can be highly productive**
- The acres (73%) **undisturbed** over 5 years definitely **accumulate** in-forest carbon
  - The other 27%, not so much
- Net carbon losses from **disturbance offset 61%** of the gains on undisturbed acres
- **Intentional harvest** is a **rare event**
- **Harvest removes 1/6th as much** carbon from the live tree pool as does disturbance-generated mortality
- Standing dead → Down dead → Atmospheric CO_2

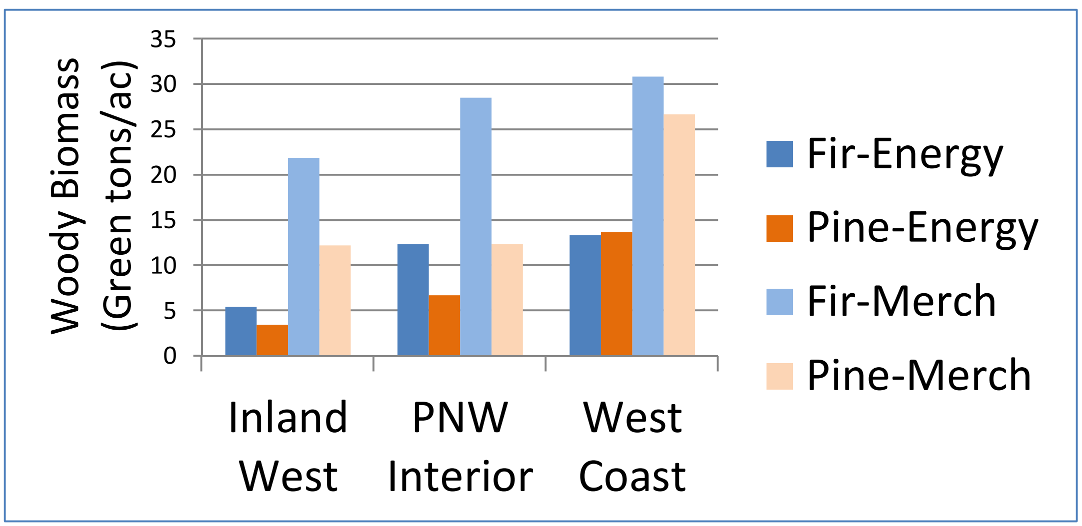
Carbon: recycled.
Without capture of energy, product storage or substitution benefits.
This is "natural", but it provides no climate benefit.

QUESTIONS NOW, OR CATCH ME L8TR

Act 4: When do fuel treatments deliver climate benefits?

A hazard-centric analysis framework





- Å A 5000 FIA plot sample of 33 million ac. of dry mixed conifer types analyzed in BioSum
- Å 4 hazard criteria
  1. Torch. Index <20mph
  2. P(torch) >20%
  3. Surface Flame Ht. >4’
  4. Mortality Volume >30%
  - ï Plot scored (0-4)
  - ï Success=score reduction
- Å About 2 million acres effectively treated
  - ï 10 billion cu ft merch
  - ï 114 million green tons energy wood

Does fuel treatment conserve carbon?

- Consider a treatment return, calculated as:

$$\text{TmtReturn} = \frac{MortVol\_pre - MortVol\_post}{TmtVol}$$

Where

MortVol_pre and MortVol_post are predicted fluxes out of live-tree bolewood carbon for untreated and treated stands, respectively, &

TmtVol is volume extracted by the fuel treatment, and destined for utilization

- If TmtReturn=1, benefit limited to capturing carbon that would leave the live tree pool
  - Average TmtReturn is 5.2 for fir, 2.4 for pine

Does fuel treatment conserve carbon?

- But what if no fire?
  - Can address as an uncertainty problem with two states of the world: fire in next 10 years or not

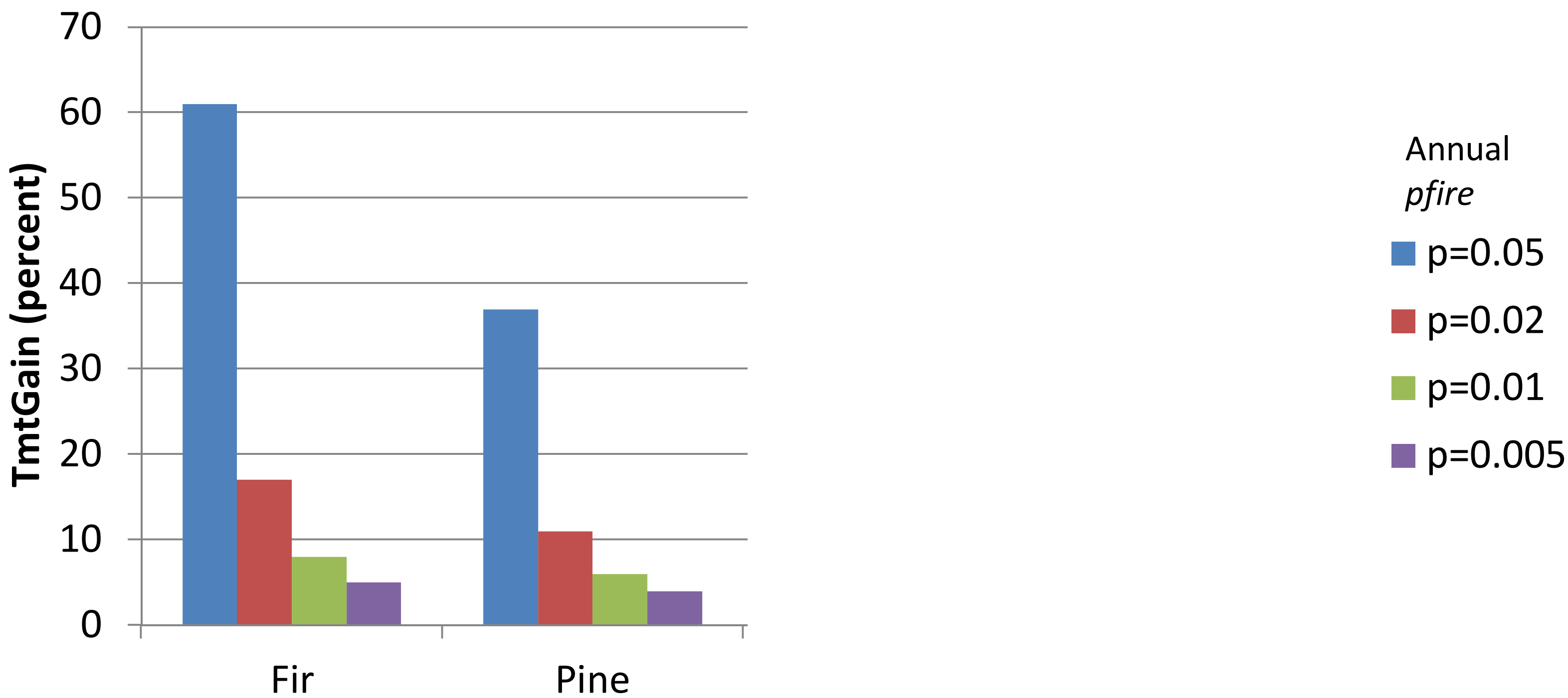
$$TmtGain = 1 - \frac{\boxed{} + \boxed{}}{\boxed{} + \boxed{}}$$

  - Where
    - *pfire*=probability of fire under severe weather, and *Vol_post* and *Vol_pre* are volume of treated and untreated stands, respectively

Simplifying, $\boxed{TmtGain = 1 - \frac{Vol\_post + TmtVol - pfire(MortVol\_post)}{Vol\_pre - pfire(MortVol\_pre)}}$

- Since *pfire* unknown, use sensitivity analysis

C conservation over 10 yrs fire exposure



Å Average TmtGain is

ï positive

ï greater for fir than pine

Å Accounts only for bole wood

Å Does not consider differences in post-tmt growth