

Wisconsin Forests – Sources and Sinks for Carbon

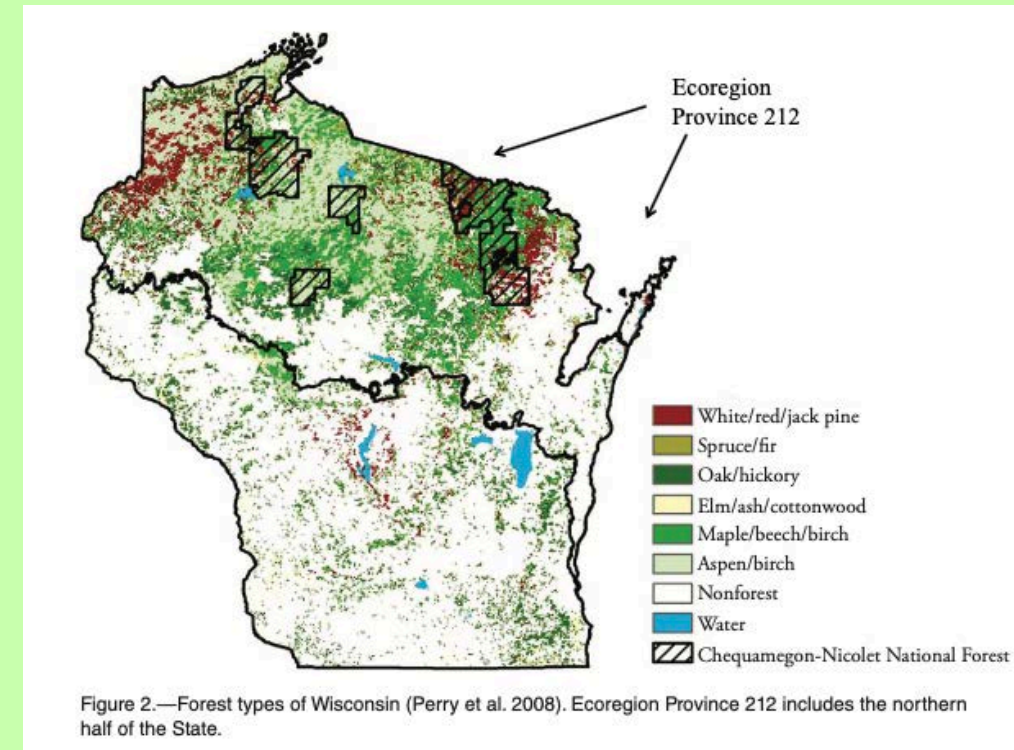


Don Waller
Forest ecologist &
conservation biologist
28 April, 2021

Chequamegon-Nicolet NF

Forest Carbon - Big topic, limited time . .

- The Big Picture
- Forests and carbon (biology)
- Corollaries of these
- How will Carbon markets affect forest management?
- Hopes, risks and opportunities



The Big Picture

- Forests are major sources and sinks for CO₂
- Trees **release** CO₂ when harvested and **absorb** CO₂ as they grow

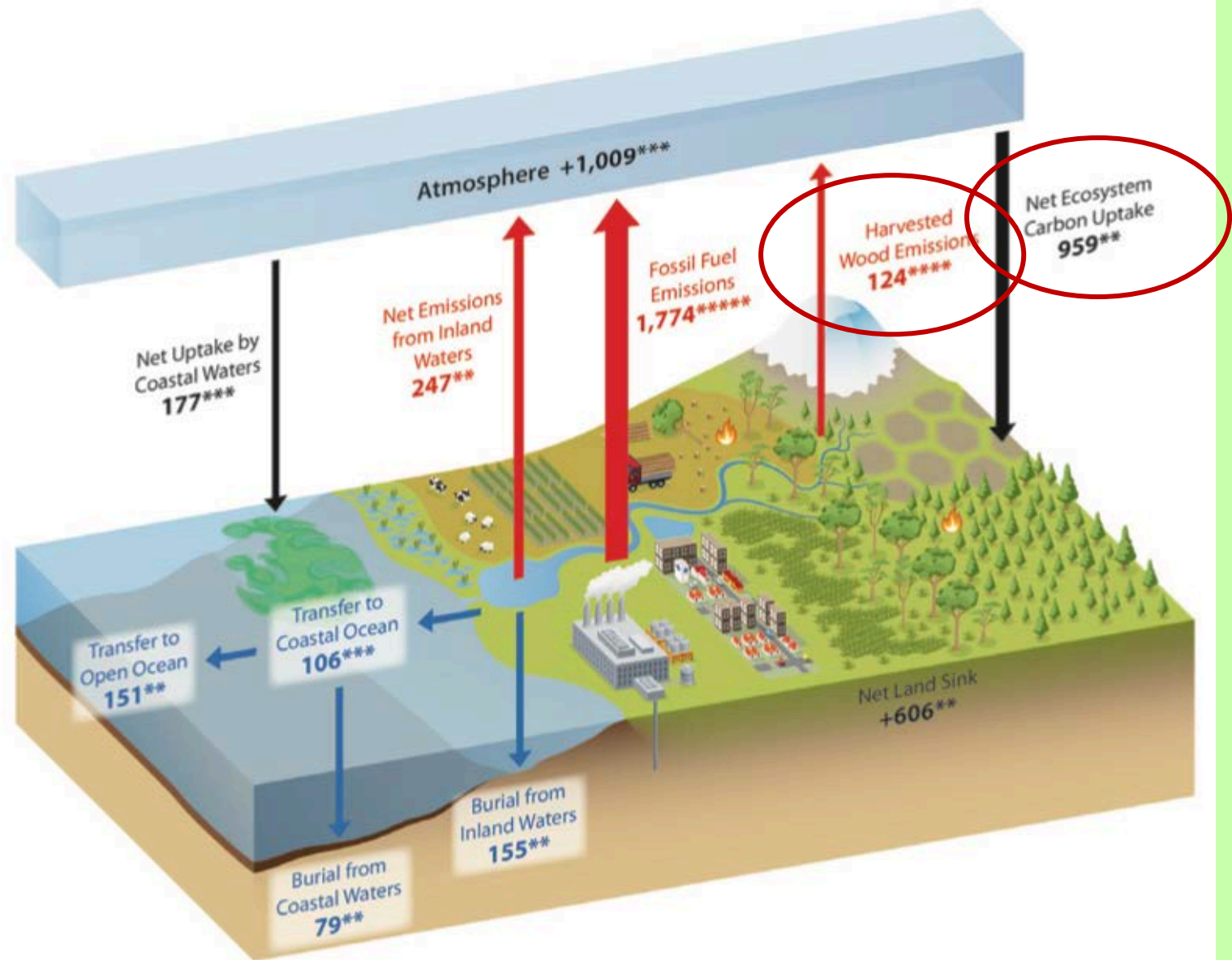
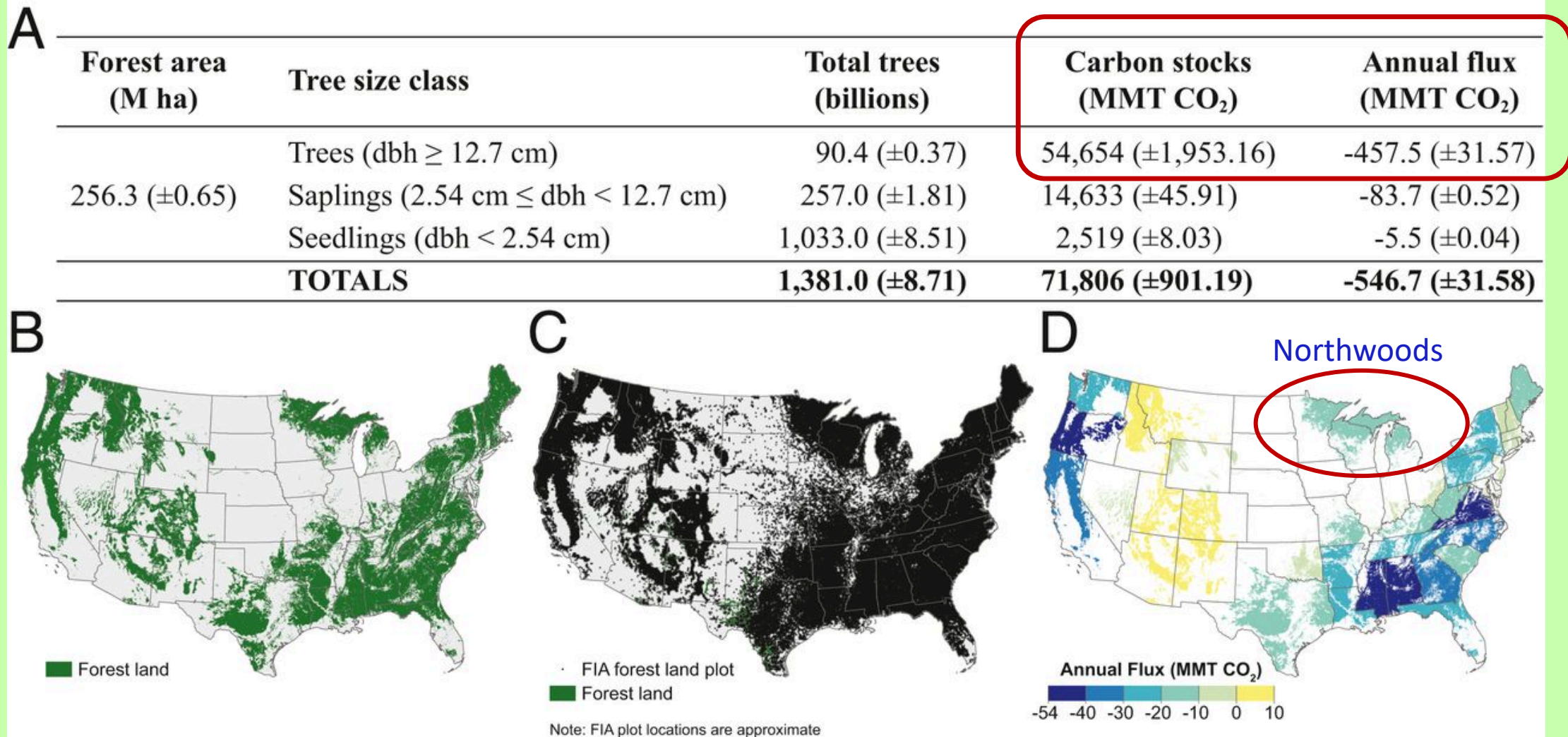


Figure ES.2. Major Carbon Fluxes of North America. Net fluxes and transfers of carbon among the atmosphere, land, and water are depicted in this simplified representation of the North American carbon cycle. The diagram includes fluxes of carbon dioxide but not methane or other carbon-containing greenhouse gases. These carbon



Grant M. Domke et al. PNAS 2020;117:40:24649-24651

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Above-ground forest C within the continental US:
51.4 Gt = 684M acres * 75.2 MT CO₂e per acre

<https://apps.fs.usda.gov/Evalidator/evaluator.jsp>

Key points on forests and carbon

Wonderful technology!

1. **Trees absorb massive quantities of CO₂** from the air

- They are very good at this – they have been doing it for a long time
 - On their own, they cool the climate
 - Almost froze Earth at the end of the Carboniferous (360 Mya)
- They do this for free and for their own reasons
 - No patent / design / test / build / scale-up issues



Key points on forests and carbon

1. Trees absorb massive quantities of CO₂ from the air
2. Bigger trees and older forests absorb and store the most C

NATURE COMMUNICATIONS | <https://doi.org/10.1038/s41467-020-14369-y>

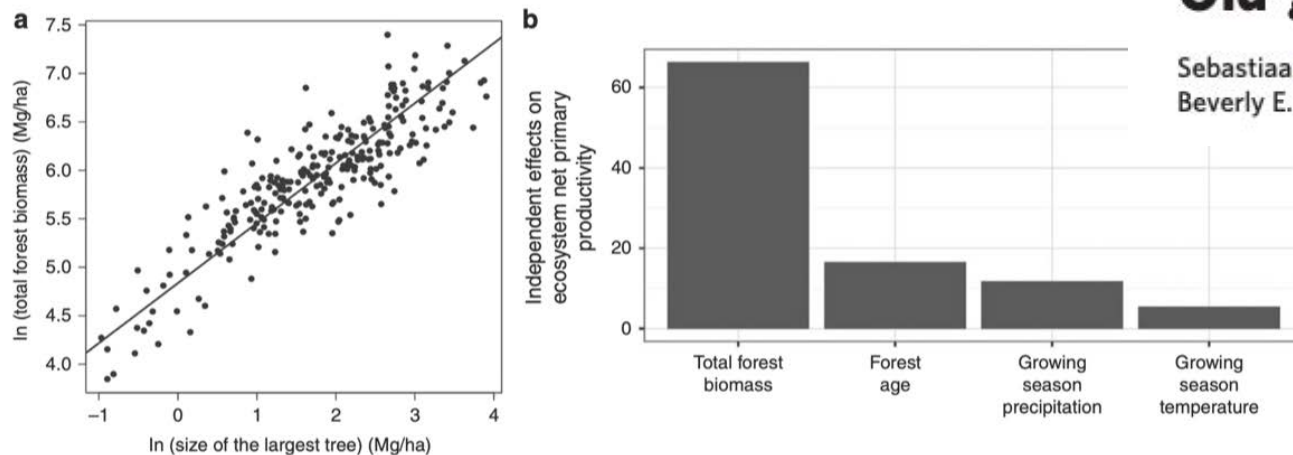


Fig. 3 Forests with larger trees disproportionately store more biomass (carbon) and are more productive. In (a) the total above ground forest biomass is best predicted by the size of the largest tree. Analysis of biomass calculated from $n = 267$ independent forest plots distributed across the Americas from 40.7° S to 54.6° N latitude. The best single predictor of variation in forest biomass is the size of the largest tree in that forest. The fitted slope of the relationship (the scaling exponent) is 0.62, which is indistinguishable from the predicted scaling function from metabolic scaling theory where the total biomass should scale as maximum tree size to the 5/8 or 0.625 power. Data from ref. ⁴⁸. In (b) global analyses of the relative importance of several drivers of variation in forest ecosystem net primary productivity (data from ref. ⁵¹). The most important driver of variation in terrestrial net primary productivity is the total forest biomass. Variation in forest biomass has a larger effect than precipitation, temperature, and forest age. As the best predictor of total forest biomass is the size of the largest individual (a) these results indicate that forests with large megaflores are more productive. Vegetation with megaflores collectively dominate the biomass and carbon stored in vegetation and the productivity of land vegetation.

Old-growth forests as global carbon sinks

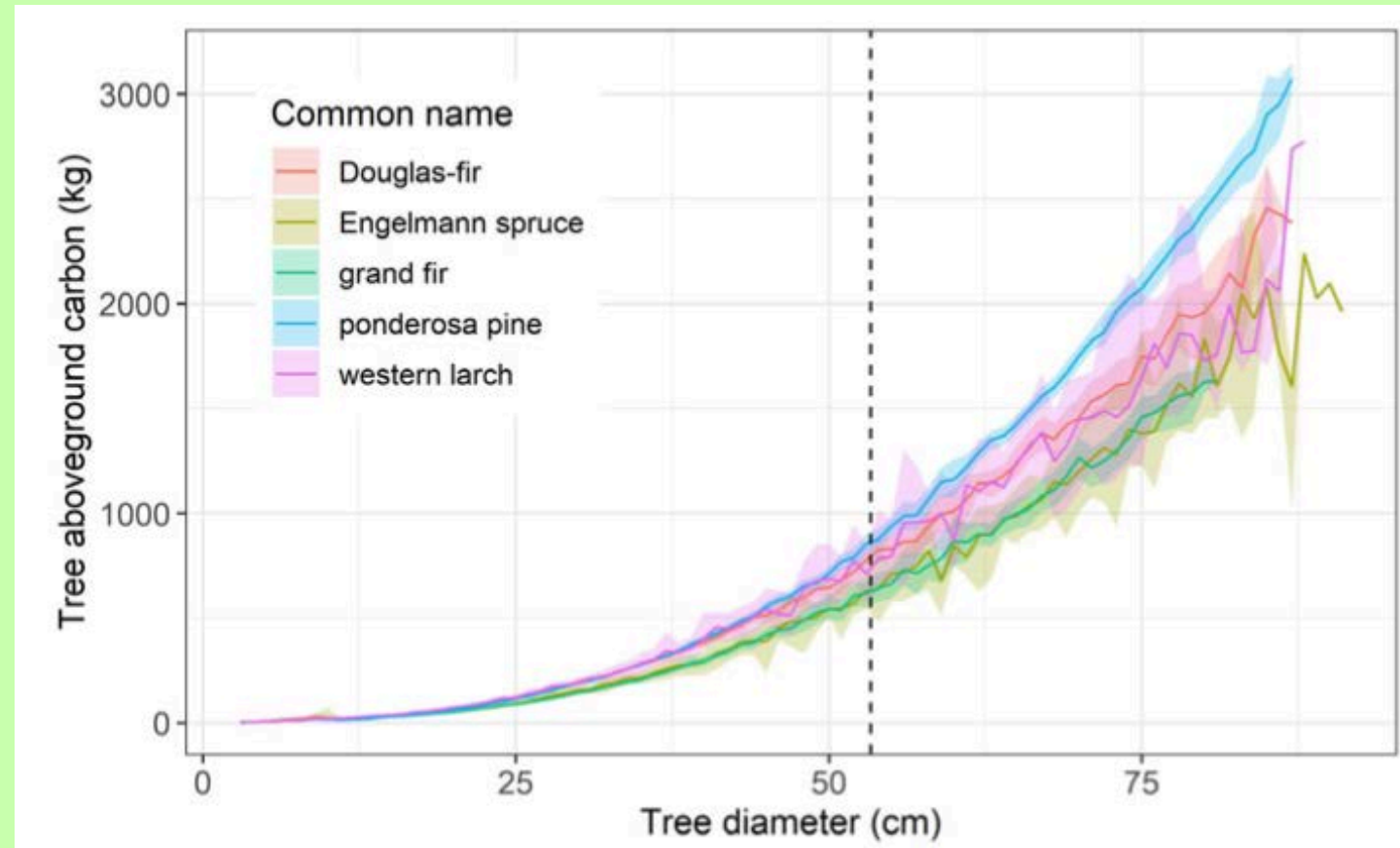
Sebastiaan Luyssaert^{1,2}, E. -Detlef Schulze³, Annett Börner³, Alexander Knohl⁴, Dominik Hessenmöller³, Beverly E. Law², Philippe Ciais⁵ & John Grace⁶

“old-growth forests continue to accumulate carbon, contrary to the long-standing view that they are carbon neutral. . . much of this carbon, even soil carbon, will move back to the atmosphere if these forests are disturbed.” Nature 2008

Enquist et al. 2020. *Nature Communications*

Big trees / old forests

- Used to think mid-sized trees and middle-aged forests fix the most C
- Actually. Older forests with the biggest trees do
- Older, bigger trees invest more C in **soils**



Mildrexler et al. 2020. Frontiers in Forests and Global Change

“Allowing forest biomass to fully recover in secondary forests [in] the Northeast has the potential to increase *in situ* C storage in those stands by a factor of 2.3 to 4.2”

Keeton 2018; Keeton et al. 2011

More C goes to **soils** as forests mature

- It is much easier to measure C in trees than in soils
 - Hence many programs focus on above-ground C
- But soil C is just as important
- Deciduous forests may store more C in trees while coniferous forests may store more in soils



Authority on Wisconsin Forest C dynamics

- Birdsey et al. 2014 – recommended!

Past and Prospective Carbon Stocks in Forests of Northern Wisconsin

A Report from the Chequamegon-Nicolet National Forest Climate Change Response Framework

Richard Birdsey, Yude Pan, Maria Janowiak, Susan Stewart, Sarah Hines,
Linda Parker, Stith Gower, Jeremy Lichstein, Kevin McCullough,
Fangmin Zhang, Jing Chen, David Mladenoff, Craig Wayson, and Chris Swanston

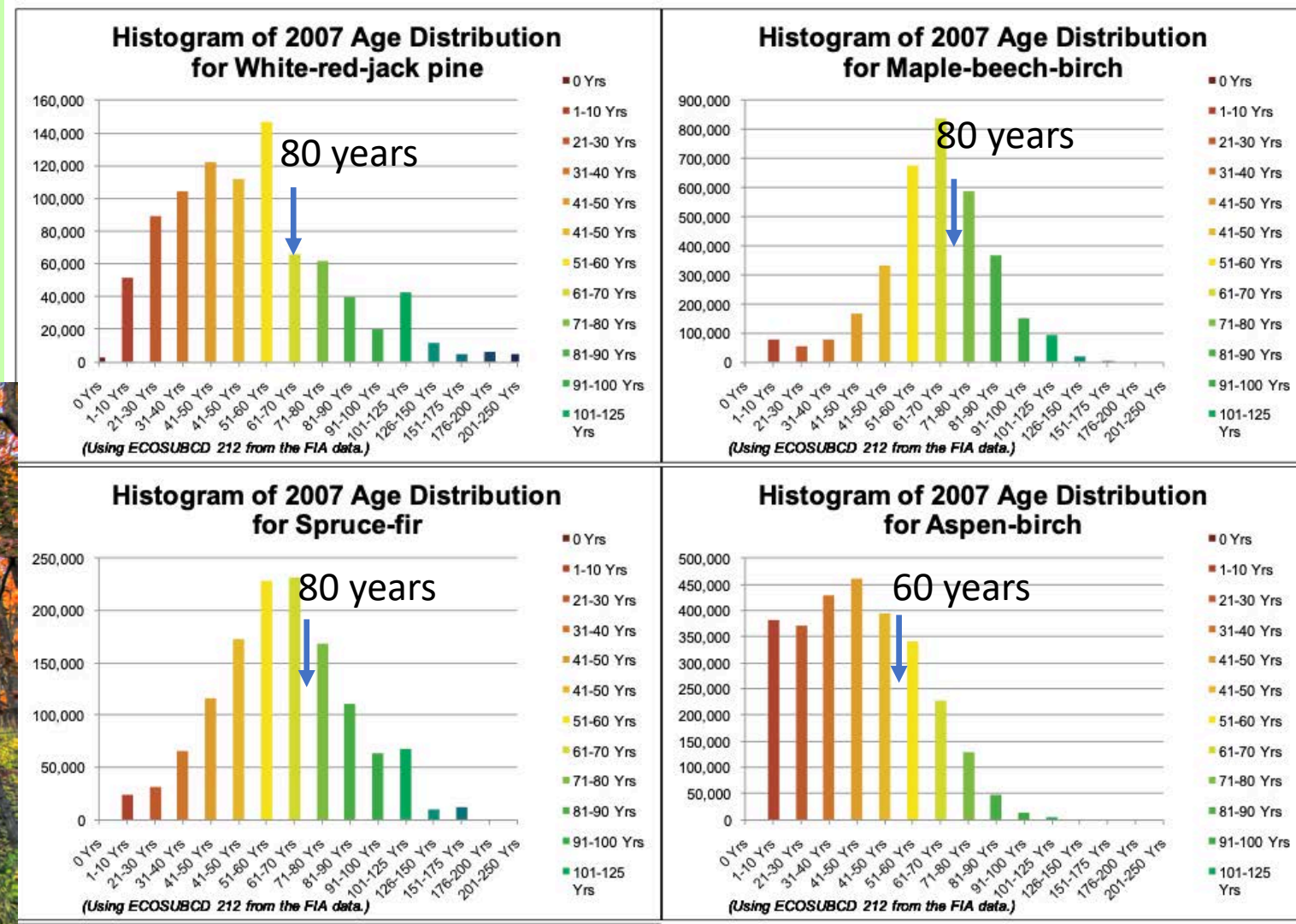
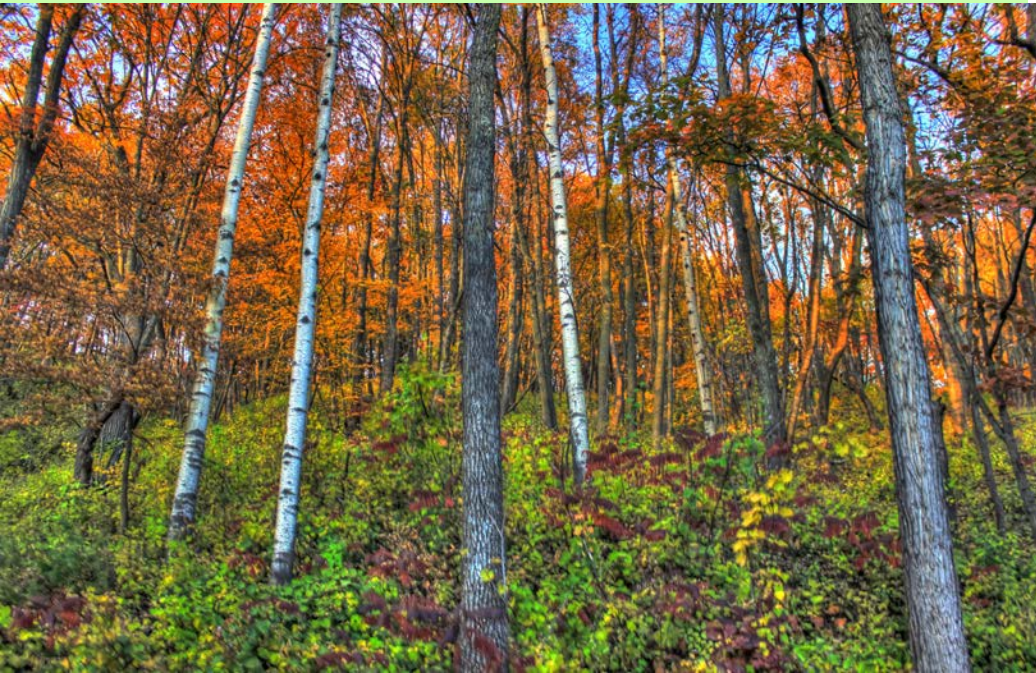
Carbon stocks — “Carbon density (amount of carbon stock per unit area) averages 237 megagrams (Mg or metric ton) per ha”

Changes in carbon — “Over the last decade, carbon stocks of northern Wisconsin forests have been increasing by ~one teragram (Tg) per year or 0.22 Mg (tons) per ha per year”

Conventional forest management truncates tree growth

Birdsey et al. 2014

- Most forest types are logged at 40-80 years, short of their C fixation & storage potential



Birdsey et al. 2014 Key conclusions

- in northern Wisconsin ecosystem carbon could increase at an annual rate of **4.3 million Tg** per year over the next 50 years in the absence of harvest, compared with the current rate of **1.5 million Tg** per year (p. 2)
 - When forests are clearcut, C is removed for wood products, and residual . . . woody debris and litter, decompose. It typically takes several decades for the ecosystem carbon stocks to recover to the preharvest level. (p. 12)
- Increasing the interval between harvests . . . can increase overall C storage. The no-management scenario had significantly higher mean C stocks than all other scenarios.
 - Among active management scenarios, individual tree selection with high structural retention sequestered the greatest C. (p. 25)

= Menominee style forestry

Key points on forests and carbon

1. Forests absorb massive quantities of CO₂ from the air
2. Bigger trees and older forests absorb more C
3. **Letting forests mature to absorb more C brings co-benefits**
 - Biodiversity** – many species thrive in mature forests
 - Soils** – gaining C, structure, and complexity over time
 - Hydrology** – moderate water flows, reduce flooding

Logging releases both tree and soil C

- Logging forests releases CO₂
- This takes decades to repay via new tree growth

Soil carbon fails to recover in cleared forests

Feature by [Miles Grant](#) • May 21, 2019



Biogeochemistry (2019) 144:1–14
<https://doi.org/10.1007/s10533-019-00568-3>

New Hampshire study

Losses of mineral soil carbon largely offset biomass accumulation 15 years after whole-tree harvest in a northern hardwood forest

Steven P. Hamburg • Matthew A. Vadeboncoeur • Chris E. Johnson • Jonathan Sanderman



Could Wisconsin forests fix more C?

- **YES:** “In N Wisconsin, ecosystem carbon could increase . . . **4.3 M Tg** per year over the next 50 years in the absence of harvest, compared with the current rate of **1.5 million Tg** per year, for a potential net additional increase of **2.8 million Tg** per year.”
- “Harvest activities have a profound influence on regional forest carbon dynamics”
- Not by expanding forests: “Afforestation options are limited across the northern Wisconsin landscape”
- Or making more wood: “changes in ecosystem carbon stocks are about twice as large as changes in carbon stocks of harvested wood products”

Birdsey et al. 2014

Corollary 1 – older & bigger are better

- Letting forests & trees grow older and bigger brings benefits
 - Let the trees grow more = “Pro-forestation”
 - Mimics historical forest conditions
 - Example: The Menominee forest = ‘light touch’ selective logging

“growing existing forests intact to their ecological potential—termed *proforestation*—is a more effective, immediate, and low-cost approach that could be mobilized across suitable forests of all types. Proforestation serves the greatest public good by maximizing co-benefits”

Moomaw et al. 2019



Corollary 2 – favor immediate over long-term

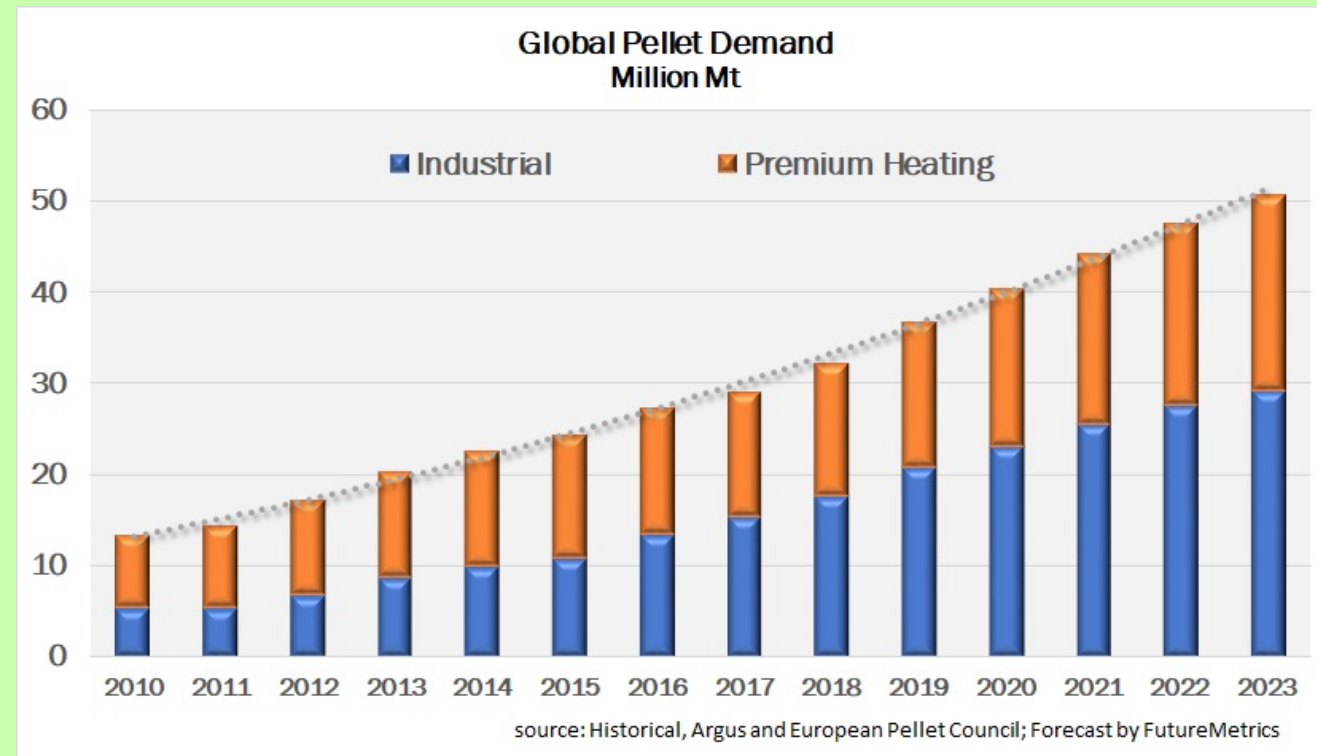
- Reforestation and afforestation are fine long-term ideas, but do not expect them to do much to reduce GHG's for *decades*
 - A slow process . .

"The only perspective that matters now is long-term – the future of the planet is at stake – and so the only actions that matter are short-term."

Bill McKibben 2021 The Guardian

Corollary 3 – Biofuels

- Promise: reduce C emissions
 - More C-neutral
- Biofuels **problematic** . .
 - Forests take time to regrow
 - Harvesting, processing, transporting, & burning all cost CO₂
 - “Accounting error” – must account for releases of CO₂ upon harvest and early regrowth from soils & slash



Key things about C markets and forestry

1. Forest carbon markets are new and in flux

Approaches vary . . .

Long or short term?

Large or small scale?

Allow direct substitution, e.g. with biofuels?


Mandatory or voluntary?

e.g., California Air Resources Board ('CARB')

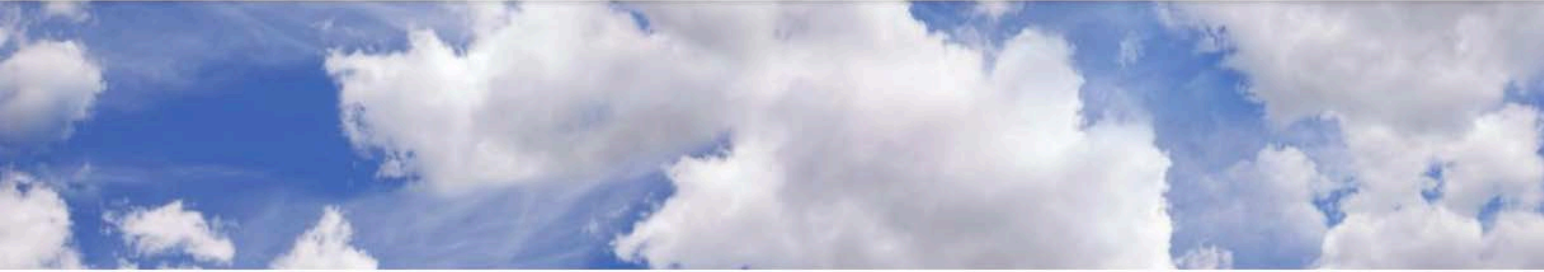
California Air Resources Board

- Cap-and-Trade system
 - Mandated . .
 - Expensive!

Technical!

CALIFORNIA
AIR RESOURCES BOARD

ABOUTOUR WORKRESOURCESSERVICESRULEMAKINGNEWS



Cap-and-Trade Program

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Cap-and-Trade Program
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The Cap-and-Trade Program is a key element of California's strategy to reduce greenhouse gas emissions. It complements other measures to ensure that California cost-effectively meets its goals for greenhouse gas emissions reductions.

[MORE ABOUT THIS PROGRAM >](#)

This page last reviewed April 6, 2021

Cap-and-Trade Program Recent Market Information

This webpage provides access to the most recently posted market information from the Cap-and-Trade Program. CARB posts information about auctions, Compliance Instrument Tracking Systems Service (CITSS) registrants, compliance instrument holdings in CITSS, compliance, offsets issuance, and other market information to ensure that market participants and the public are provided with simultaneous access to market information.

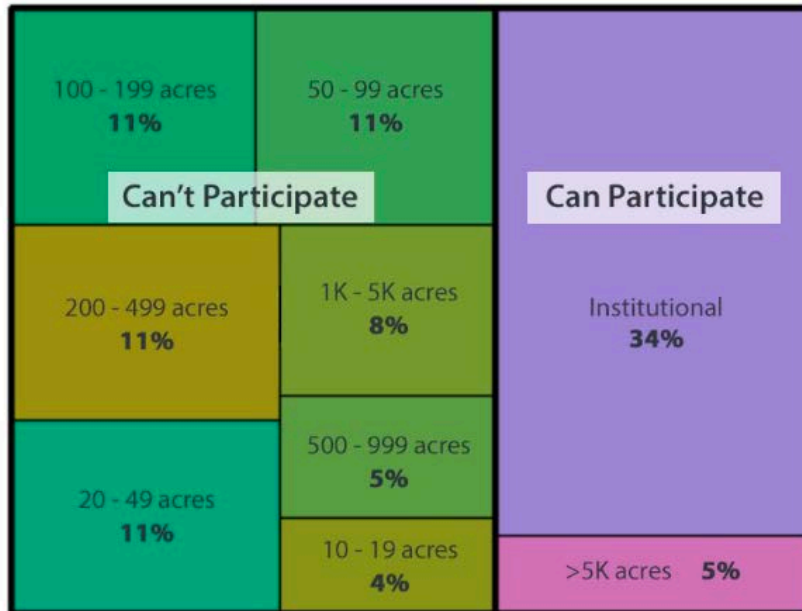
All publicly available Cap-and-Trade Program data is available on the [Cap-and-Trade Program Data webpage](#).

- [Compliance Instrument Report](#)
- [Notice of Offset Investigation - Dairyland Farm](#)
- [Dairyland Farm Offset Investigation FAQ](#)
- [CITSS Registrants Report](#)
- [May 2021 Joint Auction #27 Notice](#)
- [Carbon Allowance Prices](#)
- [California Post Joint Auction Proceeds Report](#)
- [Summary of Market Transfers Completed in 2020](#)
- [Summary of Market Transfers Completed in Q4 2020](#)
- [Vintage 2021 Allowance Allocation](#)
- [2019 Compliance Report](#)
- [2018 Compliance Report](#) (Updated on December 1, 2020)
- [2015-2017 Compliance Report](#) (Updated on December 1, 2020)
- [2016 Compliance Report](#) (Updated on December 1, 2020)
- [Summary of Market Transfers Completed in Q3 2020](#)
- [Final Determination Central Sands Dairy Offset Investigation](#)
- [Notice of Offset Investigation - Central Sands Dairy](#)
- [Central Sands Dairy Offset Investigation FAQ](#)
- [Updated Allowance Allocation Forms](#)
- [Resource Shuffling FAQ](#)
- [EDU and NG Supplier Use of Allocated Allowance Value Reports](#)
- [ARB Offset Credit Issuance](#)
The ARB offset credit issuance table is updated at 12:00 p.m. (noon) Pacific Time on the Wednesday of every month.

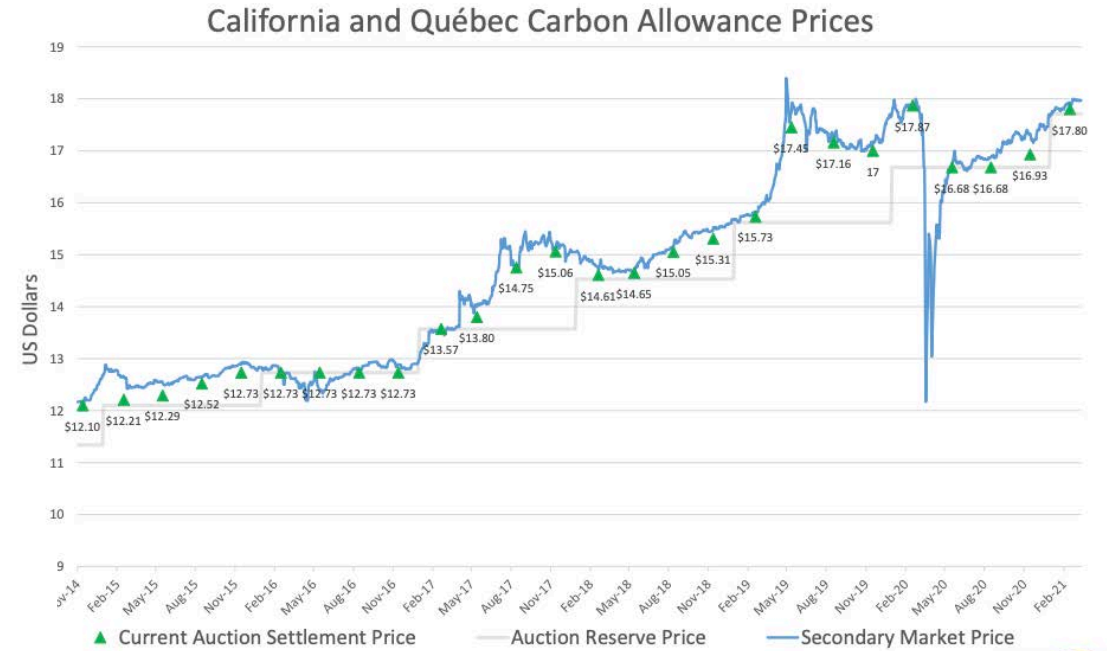
Carbon market: Price increases

- C markets are here to stay
 - Concerns growing
 - Demand is increasing

Figure 2: Proportion of private forest acreage by landowner size and ability to participate in CARB



Posted March 19, 2021



California and Québec held their first joint auction in November 2014.
Current Auction Settlement Price is the price at which current vintage allowances sold at auction.



But smaller forestland
owners have been excluded

Uncertainty about C markets and forestry

1. Forest carbon markets are new
2. Carbon prices are going up
3. **Who audits and certifies?**
 1. Key issues: Additivity
 2. Permanence – how long is the C stored?
 3. Timeline? Discount rate?

Verra:



<https://verra.org/project/vcs-program/>

VCS Standard: The VCS Standard lays out the rules and requirements which all projects must follow in order to be certified.

Independent Auditing: All VCS projects are subject to desk and field audits by both qualified **independent third parties** and Verra staff to ensure that standards are met and methodologies are properly applied.

Accounting Methodologies: Projects are assessed using a technically sound GHG emission reduction **quantification methodology** specific to that project type.



Key things about C markets and forestry

1. Forest carbon markets are new and in flux
2. Carbon prices are going up
3. Who audits and certifies projects?
4. Potentially very large and important market – matching large potential of forests to sequester & store C

New kid on the block - SilviaTerra



<https://www.silviaterra.com/>

- Voluntary market focus
 - Corporate support – Microsoft, etc.
 - Short-term contracts (1-year)
 - Any scale, including small
 - Automates & scales-up audits
 - Remote sensing + FIA + big data
 - Focus: Pay landowners to increase forest C by deferring harvest (forecast for each individual property) for 1 year
- } Lowers the bar to enter forest C markets

SilviaTerra's 'immediate' criterion

Takeaways: Forest carbon strategies and the 'Immediate' criterion

Requirements	<ul style="list-style-type: none">• Little delay between action and impact• Climate impact during this critical decade• Flexibility to adapt to changing circumstances• Attainment of "permanent" impact
---------------------	---

Strategy	Adherence to Immediate criterion
Afforestation	<ul style="list-style-type: none">• Poor. Newly established trees take years or decades to accumulate significant carbon.
Coarse long-term IFM Improved forest practices	<ul style="list-style-type: none">• Poor. Impact is spread over years or decades. 100 year "lock in" limits adaptability to changing circumstances.

Real

Immediate

Scalable

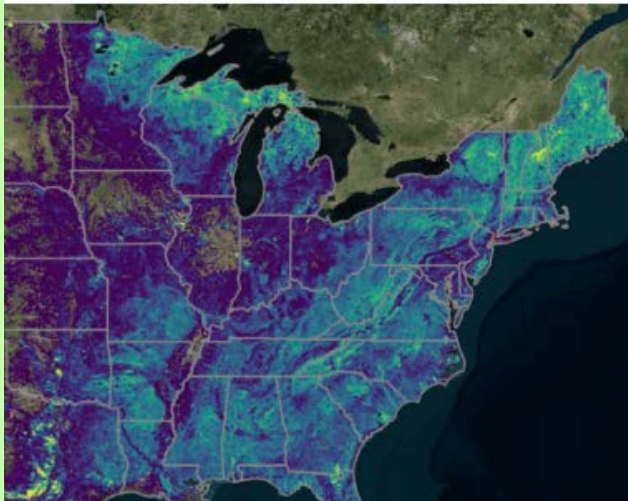
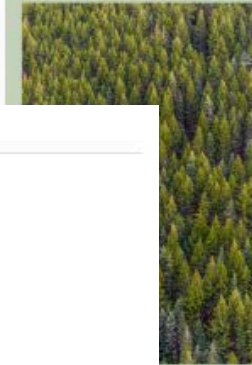
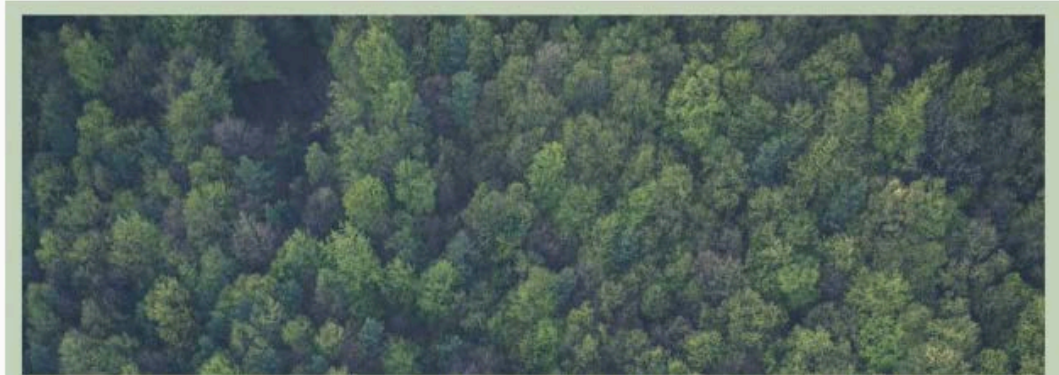
Efficient

SilviaTerra building . .

- Spring 2021: Contracts on 1M acres of SE Pinelands
- Fall/Winter: Upper Midwest

Forests and Carbon

A Guide for Buyers and Policymakers



NCAPX IS BUILT ON BASEMAP

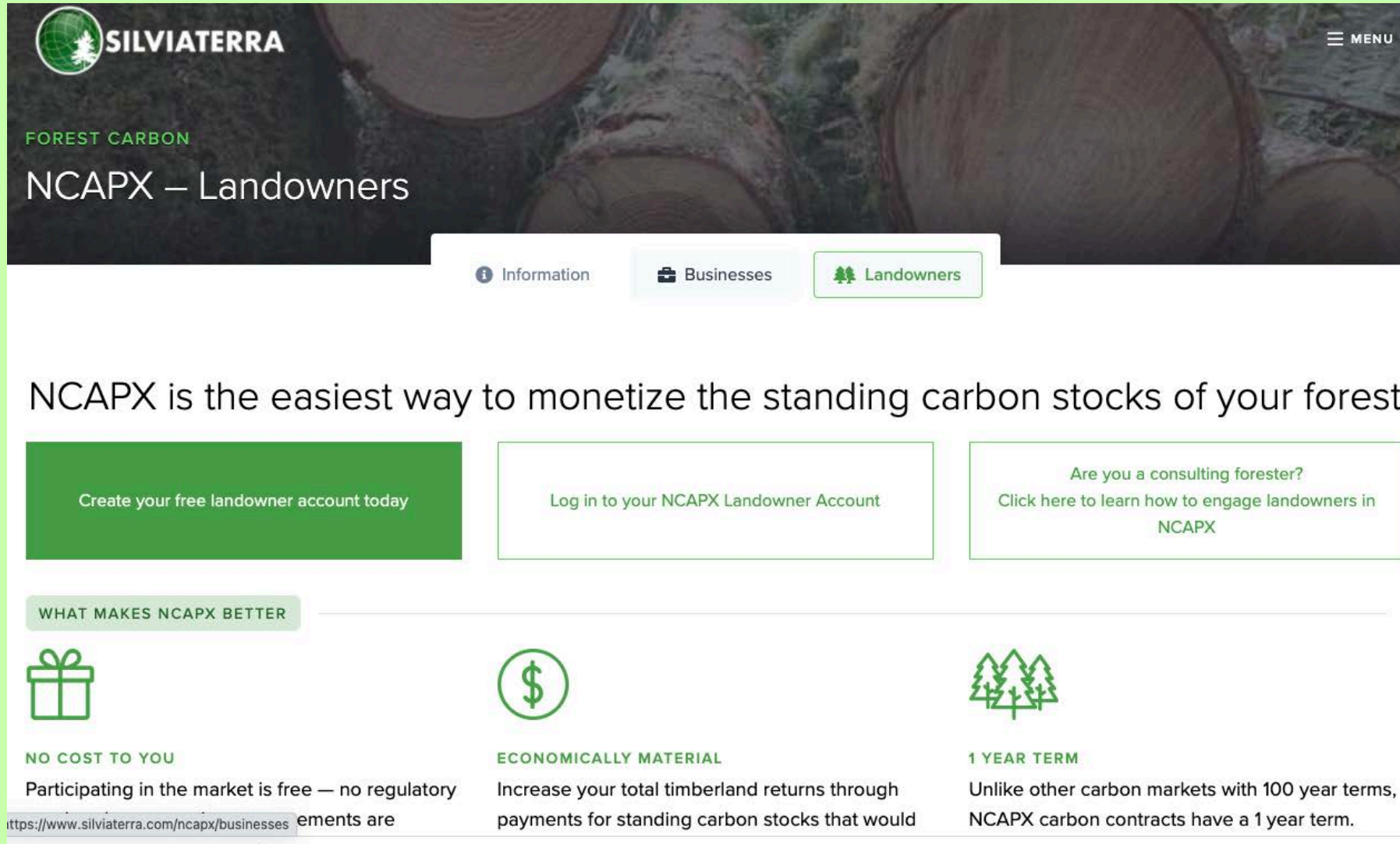
SilviaTerra measures every acre every year.

Basemap, our high-resolution map of every forested acre in the US, brings transparency and accountability to forest carbon credits.

[Learn more →](#)

LVIA TERRA

SilviaTerra's "Natural Capital Exchange"



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FOREST CARBON

NCAPX – Landowners

Information Businesses **Landowners**

NCAPX is the easiest way to monetize the standing carbon stocks of your forest

Create your free landowner account today

Log in to your NCAPX Landowner Account

Are you a consulting forester?
Click here to learn how to engage landowners in NCAPX

WHAT MAKES NCAPX BETTER

NO COST TO YOU
Participating in the market is free — no regulatory requirements are

ECONOMICALLY MATERIAL
Increase your total timberland returns through payments for standing carbon stocks that would

1 YEAR TERM
Unlike other carbon markets with 100 year terms, NCAPX carbon contracts have a 1 year term.

<https://www.silviaterra.com/ncapx/businesses>

Lowers the bar to enter forest C markets
→ scalable

Meets need for 'additionality' by estimating forgone logging

Immediate \$\$ and C rewards

Flexible to changing markets

Uncertainty about C markets and forestry

1. Forest carbon markets are new and in flux
2. Carbon prices are going UP
3. **Who audits and certifies projects?**
4. **Technical issues continue to evolve**
 1. e.g. measuring tree growth, soil C, CO₂ and CH₄ fluxes

Recap - Key points on forests and carbon

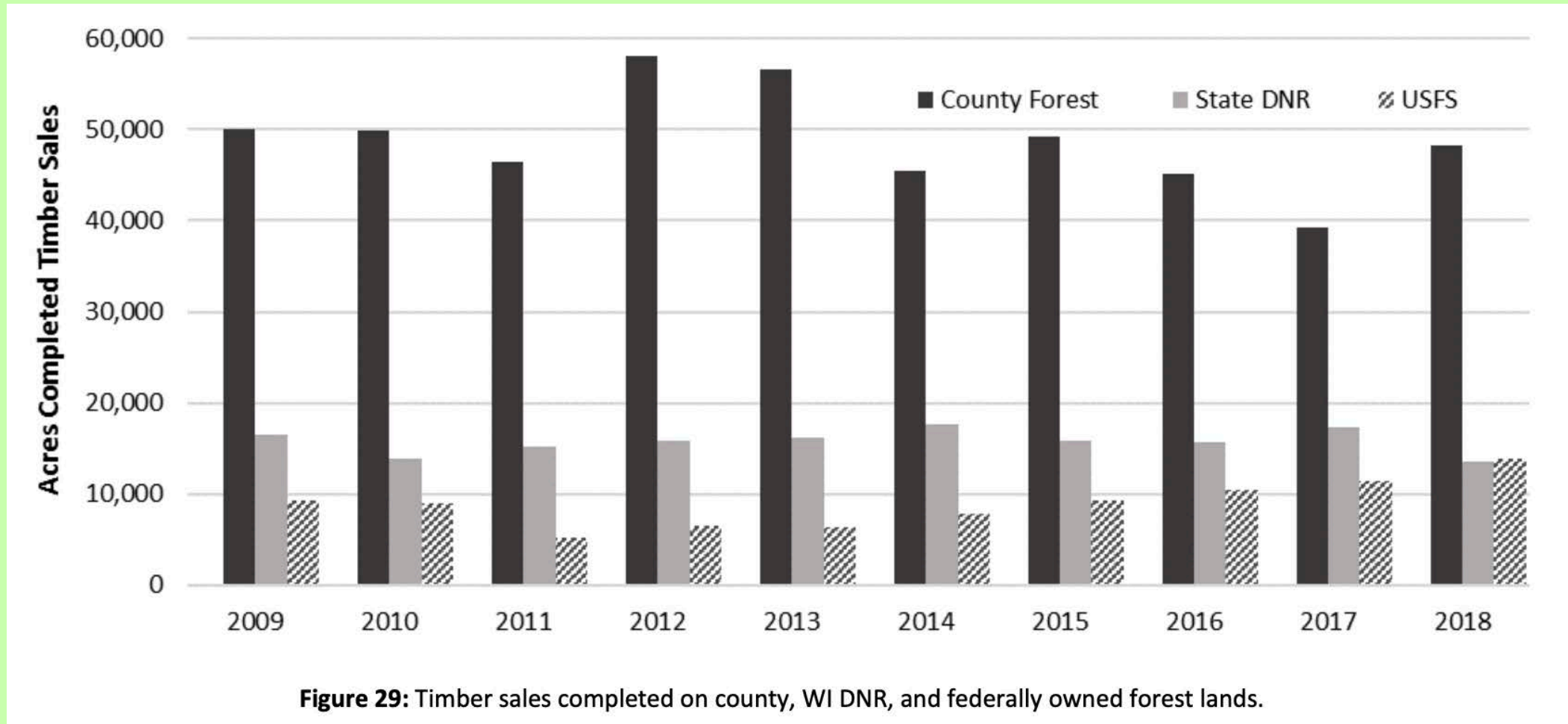
1. Forests absorb massive quantities of CO₂ from the air
2. Bigger trees and older forests absorb more C
3. Letting forests absorb more C brings other benefits
Biodiversity, soils, hydrology, . .
4. Opportunities for Wisc forests to fix far more C
5. For this to happen, markets need to expand and forest policies need to favor longer rotations
6. Science, markets, and policy continue to evolve

Q & A

Reduce logging and extend rotations on public lands?

Big industry in Wisconsin

Recent logging trends:



Risks and opportunities

- Market uncertainties – Demand? Supply? Prices?
- Political uncertainties
 - Price supports?
 - Public forestland policies to favor C management?
 - Modify MFL here in Wisconsin?

Risks and opportunities

- Market uncertainties – Demand? Supply? Prices?
- Political uncertainties
 - Price supports?
 - Public forestland policies to favor C management?
 - Modify MFL here in Wisconsin?
- Ecological uncertainties – disturbance!
 - Forests flood, burn, and get blown down, releasing CO₂
 - Insect & disease outbreaks
 - How to incorporate these?

Uncertainties may lead to conflict

- Ecological uncertainties
 - Effects of climate change? N deposition?
 - Disturbance, pests, & disease can release forest C
 - How to include these in certification and audits?
 - Are C goals congruent with biodiversity / hydrology goals?
- Trade-offs?
 - E.g., Pine barrens need to burn to support their diversity, but burning releases CO₂
 - But fire-managed Moquah pine barrens have lower respiration than regenerating hardwood & red pine stands (Noormets et al. 2007)

Ecological naïveté?

- This looks like an even-aged plantation of fast-growing *Eucalyptus* grown for biofuel . .

Caption:

Apple partnered with Conservation International and Komaza, a sustainable “micro-forestry” company in Kenya, to support its positive impacts on carbon, **biodiversity conservation**, and socioeconomic development. Photo: Will Swanson for Komaza.



April 15, 2021

Apple and partners launch first-ever \$200 million Restore Fund to accelerate natural solutions to climate change

Investment builds on the company's forestry and responsible packaging innovations to deliver new financial and climate returns

Controversy – how to manage forests?

- Scientist's Letter on the climate & diversity impacts of logging
 - “No evidence to support logging to store more C in wood products”
 - Wood biofuels not a climate solution
 - Well referenced . .

Furthermore, the **scientific evidence does not support the burning of wood in place of fossil fuels as a climate solution**. Current science finds that burning trees for energy produces even more CO₂ than burning coal, for equal electricity produced (Sterman et al. 2018), and the considerable accumulated carbon debt from the delay in growing a replacement forest is



To: Rep. Kathy Castor, Chair, House Select Committee on the Climate Crisis
Rep. Frank Pallone, Chair, House Energy and Commerce Committee
Rep. Raúl Grijalva, Chair, House Natural Resources Committee
Rep. Collin Peterson, Chair, House Agriculture Committee
Sen. Lisa Murkowski, Chair, Senate Committee on Energy and Natural Resources
Sen. John Barrasso, Chair, Senate Committee on Environment and Public Works

From: Scientists concerned about climate and biodiversity impacts of logging

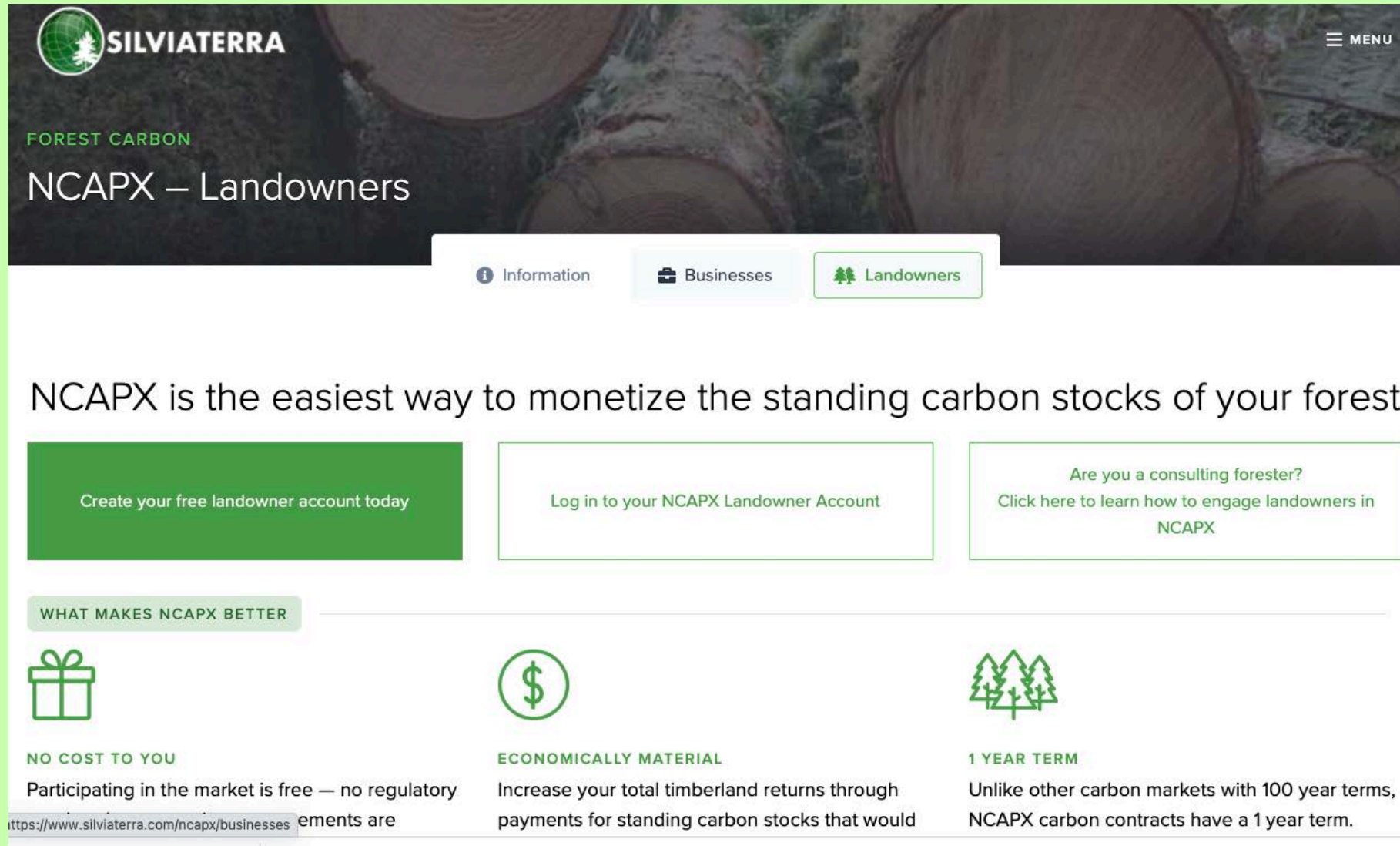
Date: 23 April 2020

Dear Members of Congress,

As forest and climate change scientists and experts, we are writing to urge you to oppose legislative proposals that would promote logging and wood consumption, ostensibly as a natural climate change solution, based on claims that these represent an effective carbon storage approach, or claims that biomass logging, and incinerating trees for energy, represents renewable, carbon-neutral energy.

We find **no scientific evidence to support increased logging to store more carbon in wood products**, such as dimensional lumber or cross-laminated timber (CLT) for tall buildings, as a natural climate solution. The

'Amazon' approach to forest C?



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