Understanding Forest Carbon and Relevance for Managing NFS lands

Intermountain Region – Climate Assessment Workshop

May 24, 2018

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Outline

- What's motivating us to look at carbon?
- Basics of forest carbon cycling
- Making sense of different perspectives on carbon
- Putting management actions in context: policy and ecology
- A path towards addressing and communicating effectively on carbon
- Some resources to help and what's coming

Goals of this talk

- Come to shared understanding of carbon as it relates to decision-making on NFS lands
- Prime a discussion about how we might approach carbon internally and externally

Carbon timeline – an evolving *vision* for federal forests

- **2005-2009: focus on "markets for ecosystem services"**
  - Voluntary carbon markets
    - Offset credits
    - Carbon reserves
    - Carbon insurance

- **2010 FS CC Roadmap:**
  - Actively managing carbon stocks
    - Reforestation after disturbance
    - Conserve working forests
    - Tech assistance to increase carbon thru afforestation, reforestation, and forest health
    - Retain greenspace and plant trees in cities
  - Demo projects for development of markets for carbon (private lands)

- **2014 -2018 USDA Strategic Plan (GHG 17% below 2005 level by 2020):**
  - "help maintain forests as a carbon sink"
    - Plant trees
    - Minimize deforestation
    - Land acquisitions
    - Conservation easements

- **2015 USDA Building Blocks (GHG 26-28% below 2005 level by 2025):**
  - "… Stewardship of federal forests Building Blocks are designed to recover, maintain, and enhance resilience of the carbon sink… through restoration/reforestation"
    - Reforest post-disturbance NFS lands (320,000 acres)
    - Fuel treatments in WUI
    - Sustain or restore watershed function and resilience

?

Forest Service Handbook (Implementation of the 2012 Planning Rule)

FS Direction (FSH 1909.12.4) related to carbon for planning:

- Assessment of carbon stocks to understand how:
  - The plan area plays a role in sequestering and storing carbon
  - Disturbances, projects, and activities influenced carbon stocks in the past and may affect them in the future
  - Where carbon is stored, how the storage is changing, and how storage might be influenced by management
- Responsible official <u>may</u> consider:
  - Whether existing conditions and trends of vegetation (aboveground carbon pool) indicate that the plan area is a carbon sink or carbon source; and
  - The future trend of the plan area in sequestering and storing carbon under existing plan guidance

Forest Service NEPA guidance on Climate Change Considerations

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, D.C. 20503

Climate Change Considerations in Project Level NEPA Analysis
January 13, 2009

Introduction

Forest Service Chief Abigail R. Kimbell characterized the Agency's response to the challenges presented by climate change as "one of the most urgent tasks facing the Forest Service" and stressed that "as a science-based organization, we need to be aware of this information and to consider it any time we make a decision regarding resource management, technical assistance, business operations, or any other aspect of our mission."[1] The Forest Service mission is to "sustain the health, diversity, and productivity of the Nation's forest and grasslands to meet the needs of present and future generations."[2]

Ongoing climate change research was summarized in reports by the United Nations Intergovernmental Panel on Climate Change (IPCC) (www.ipcc.ch), US Climate Change Science Program's Science Synthesis and Assessment Products and the US Global Change Research Program. These reports concluded that climate is already changing; that the change will accelerate, and that human greenhouse gas (GHG) emissions, primarily carbon dioxide emissions (CO_2), are the main source of accelerated climate change.

Projected climate change impacts include air temperature increases; sea level rise; changes in the timing, location, and quantity of precipitation; and increased frequency of extreme weather events such as heat waves, droughts, and floods. These changes will vary regionally and affect renewable resources, aquatic and terrestrial ecosystems, and agriculture. While uncertainties will remain regarding the timing and extent magnitude of climate change impacts, the scientific evidence predicts that continued increases in GHG emissions will lead to increased climate change.

This document provides initial Forest Service guidance on how to consider climate change in project-level National Environmental Policy Act (NEPA) analysis and documentation. The following are the basic concepts outlined in this paper:

1. Climate change effects include the effects of agency action on global climate change and the effects of climate change on a proposed project.
2. The Agency may propose projects to increase the adaptive capacity of ecosystems it manages, mitigate climate change effects on those ecosystems, or to sequester carbon.
3. It is not currently feasible to quantify the indirect effects of individual or multiple projects on global climate change and therefore determining significant effects of those projects or project alternatives on global climate change cannot be made at any scale.
4. Some project proposals may present choices based on quantifiable differences in carbon storage and GHG emissions between alternatives.

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[1] Abigail R. Kimbell, Chief, USDA Forest Service, February 15, 2008, letter to Forest Service National Leadership Team
[2] USDA Forest Service Strategic Plan, FY 2007 - 2012

"As GHG emissions are integrated across the global atmosphere, it is not possible to determine the cumulative impact on global climate from emissions associated with any number of particular projects. Nor is it expected that such disclosure would provide a practical or meaningful effects analysis for project decisions.

Where a proposed project would be anticipated to emit relatively large amounts of greenhouse gases (e.g., large-scale oil and gas development project), the following may be appropriate.

1. Quantify the expected annual and total emissions from the project, where possible, using already generated data from air quality analyses;
2. Provide context for these numbers by comparing to other emission sources (e.g., individual, regional, national, global); and
3. Qualitatively describe the effects of GHG emissions on climate change."

Case law…

FILED
United States Court of Appeals
Tenth Circuit

September 15, 2017

Elisabeth A. Shumaker
Clerk of Court

PUBLISH

UNITED STATES COURT OF APPEALS

TENTH CIRCUIT

WILDEARTH GUARDIANS; SIERRA CLUB,

Petitioners - Appellants,

v.

UNITED STATES BUREAU OF LAND MANAGEMENT,

Respondent - Appellee,

and

WYOMING MINING ASSOCIATION; BTU WESTERN RESOURCES, INC.; STATE OF WYOMING; NATIONAL MINING ASSOCIATION,

Respondents - Intervenors - Appellees.

THE INSTITUTE FOR POLICY INTEGRITY AT NEW YORK UNIVERSITY SCHOOL OF LAW,

Amicus Curiae.

No. 15-8109

APPEAL FROM THE UNITED STATES DISTRICT COURT FOR THE DISTRICT OF WYOMING
(D.C. No. 2:13-CV-00042-ABJ)

- Focused on emissions from fossil fuels, less so on biogenic emissions
- Very large project emissions (typically thousands of times larger than all emissions w/forest plan)
    - FS has never lost a case related to carbon and vegetation management
- Evolving… Past USG defense on not considering GHG emissions on large projects has been:
    - Rationale that emissions are trivial with respect to global emissions (global problem)
    - If this project is not done here it will be done somewhere else, thus emissions would happen anyways (i.e. Leakage effect) (this argument failed in 10th circuit…)

CLIMATE CHANGE UNDER NEPA: AVOIDING CURSORY CONSIDERATION OF GREENHOUSE GASES

AMY L. STEIN*

Neither the National Environmental Policy Act ("NEPA") nor its implementing regulations require consideration of climate change in NEPA documentation. Yet an ever-growing body of NEPA case law related to climate change is making it increasingly difficult for a federal agency to avoid discussing the impacts of those emissions under NEPA in its Environmental Impact Statements ("EISs").

Although consideration of climate change in NEPA documents sounds right in theory, within the current legal framework, the NEPA documents provide only lip service to the goals of NEPA without any meaningful consideration of climate change. An empirical evaluation of two years of selected EISs demonstrates that the degree of "consideration" is far from meaningful, an outcome that fails to reflect the purposes behind NEPA. As a result, the nation is left with more paperwork and more greenhouse gas emissions.

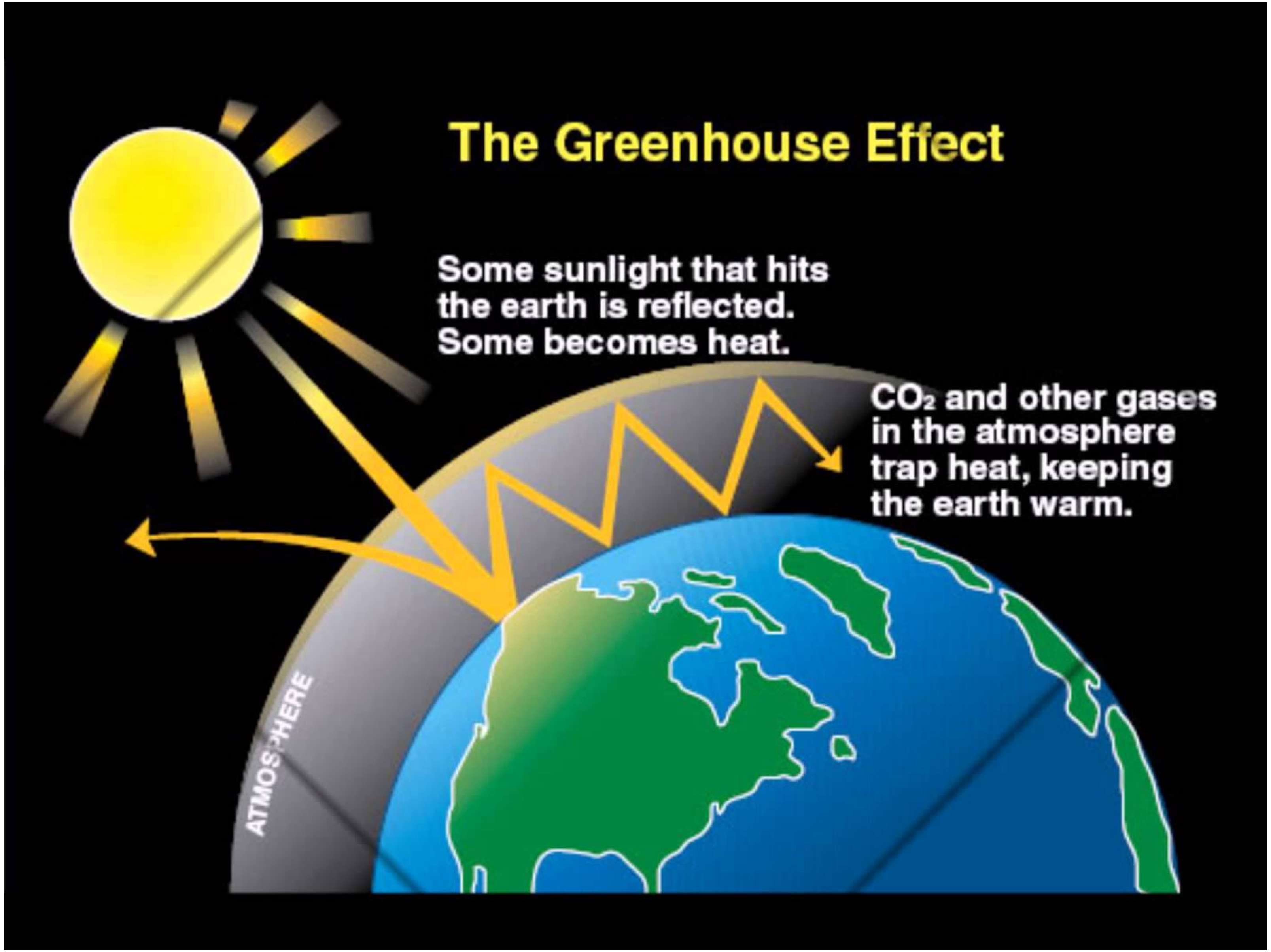
This Article concludes that inclusion of climate change in NEPA documentation is inevitable, but that within the current judicial interpretations of NEPA and the Administrative Procedure Act, litigation has reached its maximum effectiveness to elicit meaningful consideration of climate change. It makes recommendations for fortifying NEPA with concrete requirements to address this new challenge, including a recommendation that all but de minimis greenhouse gas emissions be considered significant under a NEPA analysis.

INTRODUCTION

The United States has no comprehensive federal law limiting the human sources of greenhouse gas ("GHG") emissions

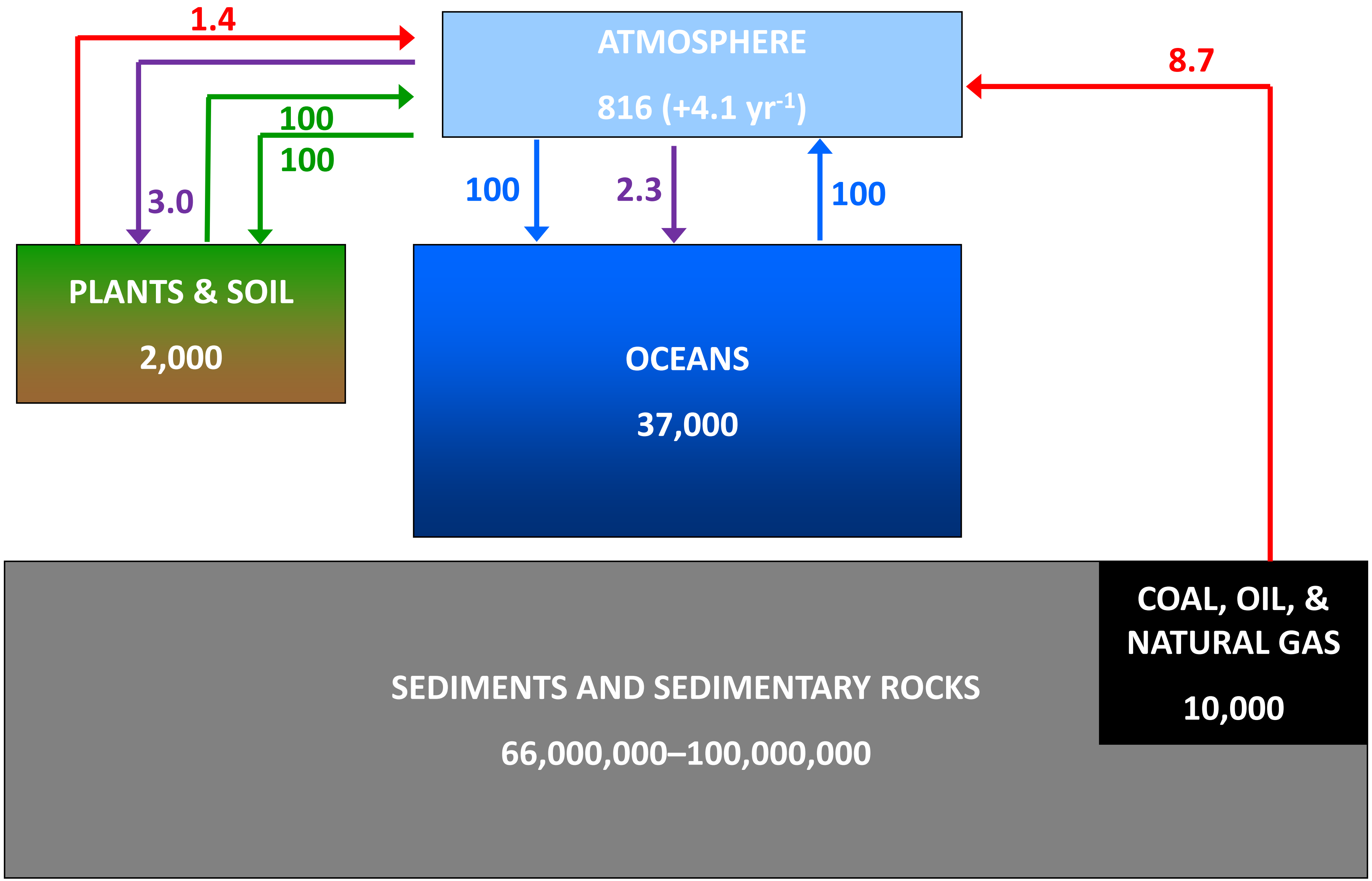
* Visiting Associate Professor of Legal Research and Writing, The George Washington University Law School. Thanks to John Bessler, Ursula Ehretsman, Jamie Grodsky, Lee Paddock, William Stein IV, and Michael P. Vandenbergh for their thoughtful input and to my research assistants, Jessica Katz and Sara Vink.

How greenhouse gases act in the atmosphere



Petagrams (Pg) C
1 Pg = 1 billion tonnes

Global Stocks and Flows of Carbon

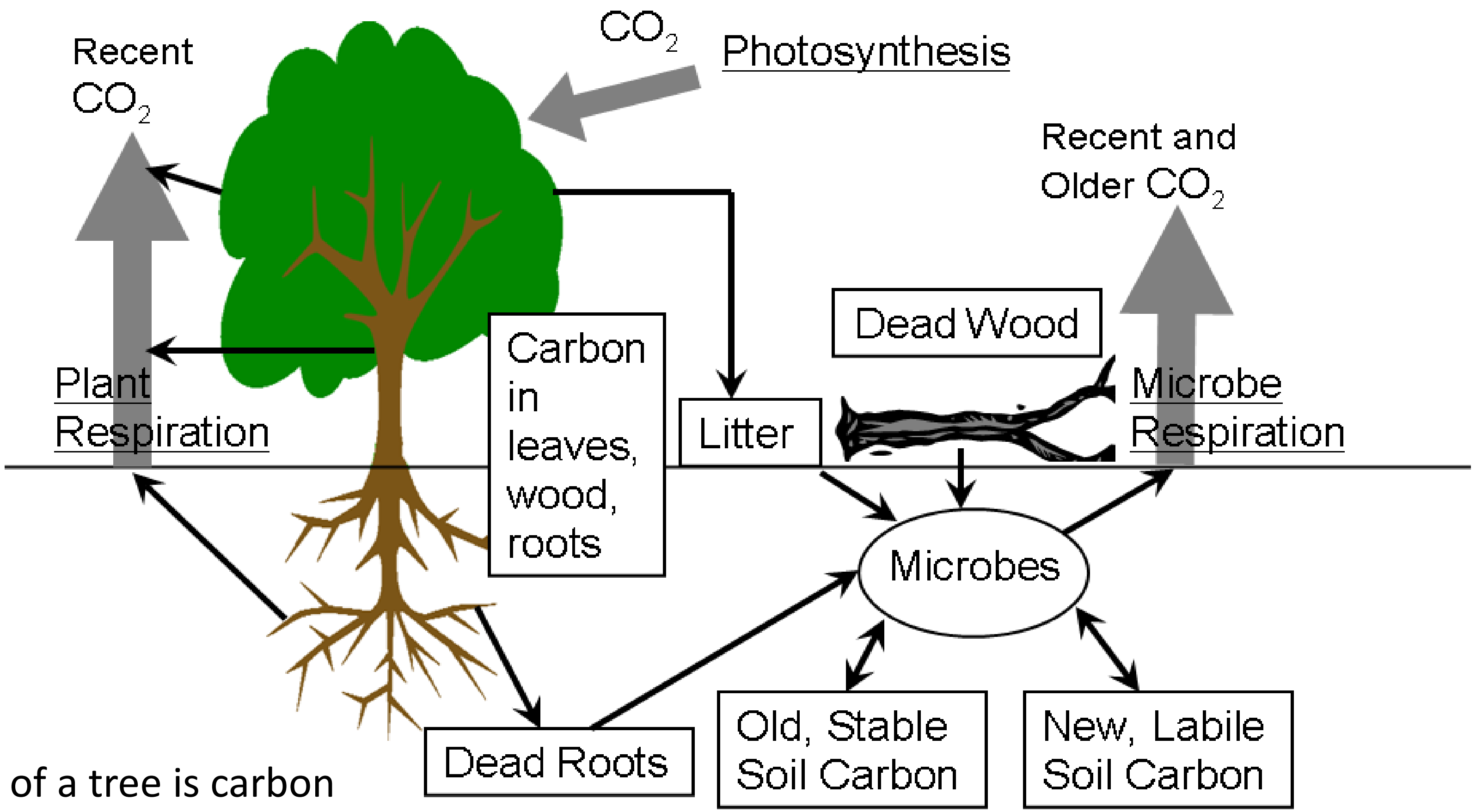


McKinley et al. 2011

The Role of Forests in Carbon Cycling

$6CO_2 + 6H_2O$ ------> $C_6H_{12}O_6 + 6O_2$

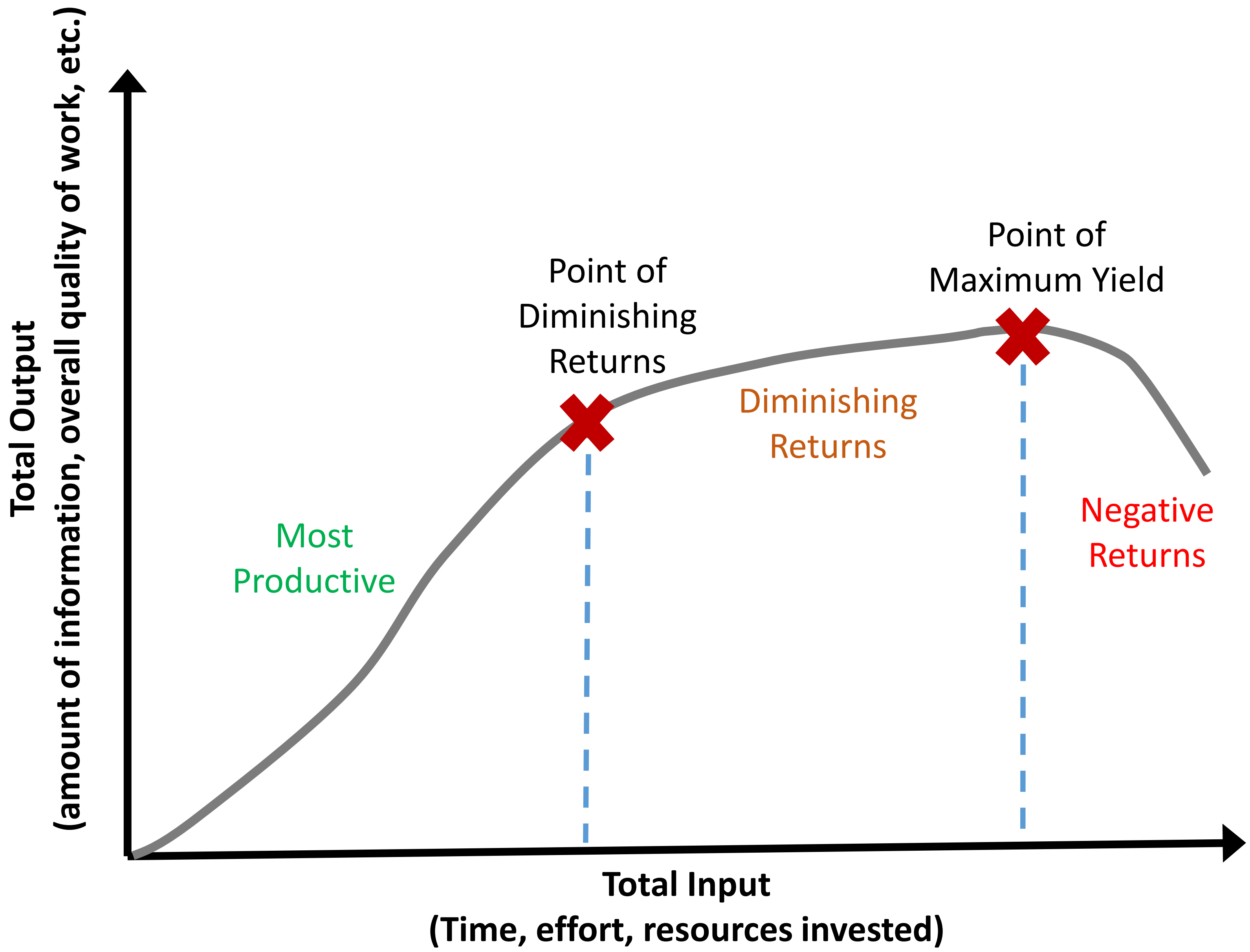
Sunlight energy



*About ½ of the mass of a tree is carbon

McKinley et al. 2011

Diminishing Returns – Carbon Analysis



The ***sweet spot*** depends on:

- **Policy**: what's driving our need to know?
- **Biology**: What makes sense to measure?
  - Context
  - Ability to measure carbon with accuracy and precision.

Why a Shared View of the System is Helpful?

- Can develop a common approach (e.g., template, framework, generic language, etc.) for reporting.
- Focus on what’s really meaningful and deemphasizing what’s not, to increase efficiency and reduce vulnerabilities to litigation
- Reduce inconsistencies
- Provide agreement on what activities will have a desirable or undesirable effect on carbon
- Produce clear and concise documents or responses

Some big questions that we struggle with that's related to how we view the forest system…

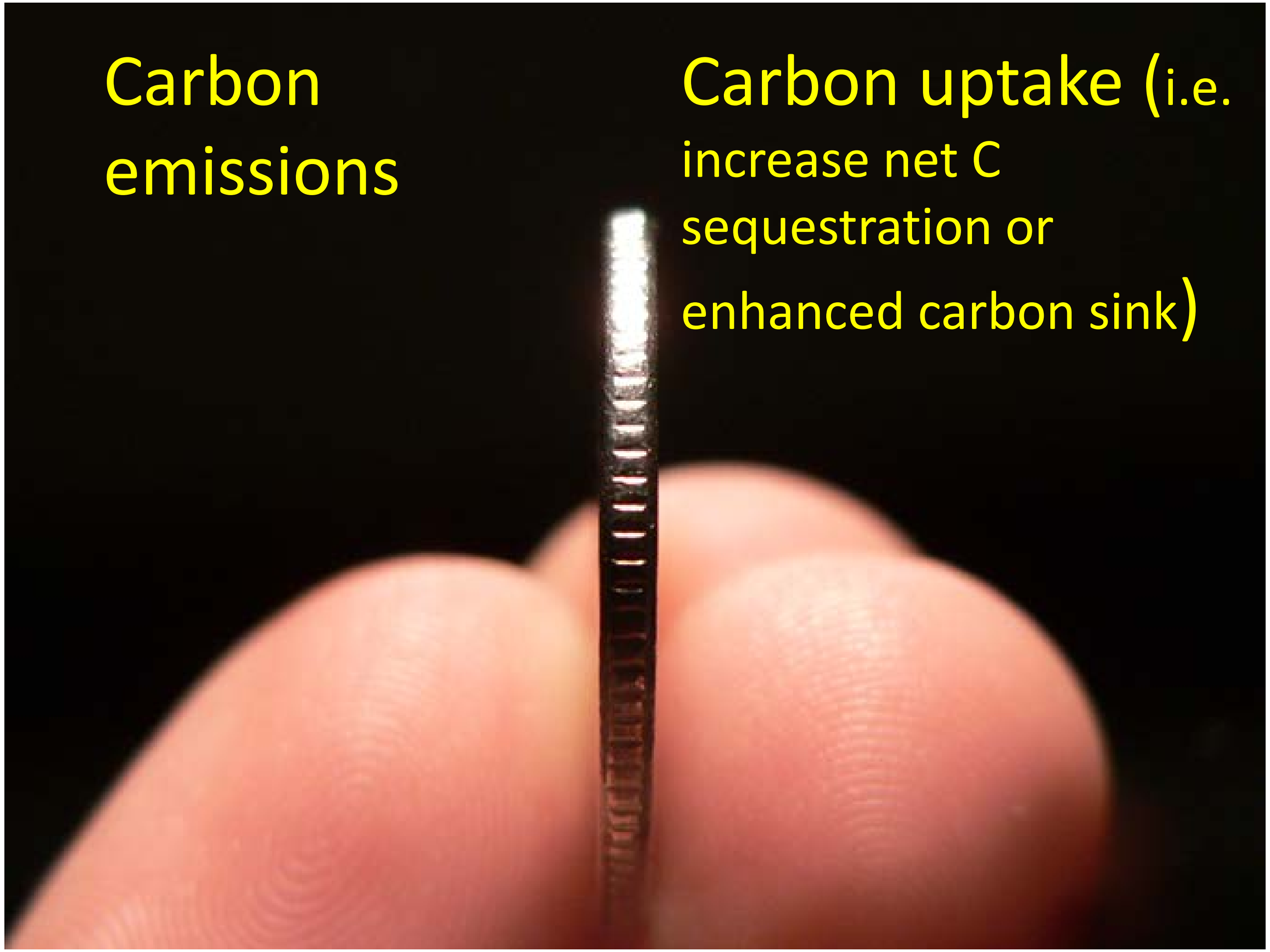
- How to reconcile the scale of decision making (i.e. project or forest level) with best **spatial scale** to evaluate patterns and trends in carbon dynamics?

- How to reconcile the **temporal scale** of decision making with the long-term dynamics of carbon?

- How much detail on carbon is necessary to fully inform decision making?

Problem/Solution to the carbon problem

We tend to look at carbon with entirely different perspectives, but how…and… why?



:em

Mountain pine beetle and forest carbon feedback to climate change

W. A. Kurz[1], C. C. Dymond[1], G. Stinson[1], G. J. Rampley[1], E. T. Neilson[1], A. L. Carroll[1], T. Ebata[2] & L. Safranyik[1]

The mountain … Coleoptera: C… pine forests of… odically erupt… resulting wide… and increases… impacts of ins… rally ignored i… break in Briti… larger in area… Here we estim… break in the a… tonnes (Mt) c… 374,000 km² o… small net carb… immediately a… resulting from… valent to ~75%… from all of Ca… net primary p… observed durin… Climate chang… severity of this… an important… mine the abili… spheric carbo… large-scale mo…

Forest insect… dynamics by ca… of trees over ex… affect both m… impacts are the… supply to mills)… effects[4]. The in… climate are not…

The current… an order of ma… to the increase… favourable clim… climatically sui… reduced minim… tures and redu… facilitated exp… elevation forest… in the extent o… dented scale ar… break area was… years), with tr…

[1]Natural Resources… British Columbia, V…

CONCEPTS AND QUESTIONS

protect…
a full ac…

…, George W Koch, …

…f forests for carbon … global warming. H… CO₂ release and p… …ment that reduces … …ed to be a CO₂ sour… …ally increase long-… …l that, for forest lan… …O₂ release from live… …ve historically exp… …duce the risk of cat…

…8; 6(9): 493–498, doi…

…ntury, fire suppressi… …ment tool in many … …ncreased tree density… …ased risk of stand-r… 1988; Covington et … 2006; Wang et al. … fire suppression, ha… … carbon (C) storag… …s (Hurtt et al. 2002)… …now more vulnerabl… forests of pre-settl… …2002). …stern US, fire frequ… …om high-frequency, … and Sierran mixe… …ore 1994; McKelve… …severity fires in fore… …ce–fir and northern … Schoennagel et al.

In a nutshell:

…counting, forest manag… …ic disturbances are typ… …uppression has caused… …treatments can diminis… …y promoting carbon stor… …hould recognize the val… the risk of carbon lo…

… Sciences and Merriam … Northern Arizona U… …nau.edu)

… America

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ISSUES IN ECOLOGY

TECHNICAL REPORT

Ecological Applications, 21(6), 2011, pp. 1902–1924

A synthesis of current knowledge on forests and carbon storage in the United States

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Abstract. Using forests to mitigate climate change has gained much interest in science and policy discussions. We examine the evidence for carbon benefits, environmental and monetary costs, risks and trade-offs for a variety of activities in three general strategies: (1) land use change to increase forest area (afforestation) and avoid deforestation; (2) carbon management in existing forests; and (3) the use of wood as biomass energy, in place of other building materials, or in wood products for carbon storage.

We found that many strategies can increase forest sector carbon mitigation above the current 162–256 Tg C/yr, and that many strategies have co-benefits such as biodiversity, water, and economic opportunities. Each strategy also has trade-offs, risks, and uncertainties including possible leakage, permanence, disturbances, and climate change effects. Because ~60% of the carbon lost through deforestation and harvesting from 1700 to 1935 has not yet been recovered and because some strategies store carbon in forest products or use biomass energy, the biological potential for forest sector carbon mitigation is large. Several studies suggest that using these strategies could offset as much as 10–20% of current U.S. fossil fuel emissions. To obtain such large offsets in the United States would require a combination of afforesting up to one-third of cropland or pastureland, using the equivalent of about one-half of the gross annual forest growth for biomass energy, or implementing more intensive management to increase forest growth on one-third of forestland. Such large offsets would require substantial trade-offs, such as lower agricultural production and non-carbon ecosystem services from forests. The effectiveness of activities could be diluted by negative leakage effects and increasing disturbance regimes.

Because forest carbon loss contributes to increasing climate risk and because climate change may impede regeneration following disturbance, avoiding deforestation and promoting regeneration after disturbance should receive high priority as policy considerations. Policies to encourage programs or projects that influence forest carbon sequestration and offset fossil fuel emissions should also consider major items such as leakage, the cyclical nature of forest growth and regrowth, and the extensive demand for and movement of forest products globally, and other greenhouse gas effects, such as

Manuscript received 7 April 2010; revised 23 December 2010; accepted 7 January 2011. Corresponding Editor: D. McKenzie. This paper complements *Issues in Ecology* 13. Reprints of the 23-page report are available for $10.00 each, either as a PDF or as hard copy. Prepayment is required. Order reprints from the Ecological Society of America, Attention: Reprint Department, 1990 M Street, N.W. Suite 700, Washington, D.C. 20036 (esaHQ@esa.org).
[15] E-mail: dcmckinley@fs.fed.us

McKinley et al. 2011

May 2014

Managing Carbon

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… on short

JUNE 2010 NCI-2010-03

MANOMET REPORT

Biomass Sustainability and Carbon Policy Study

Prepared for:
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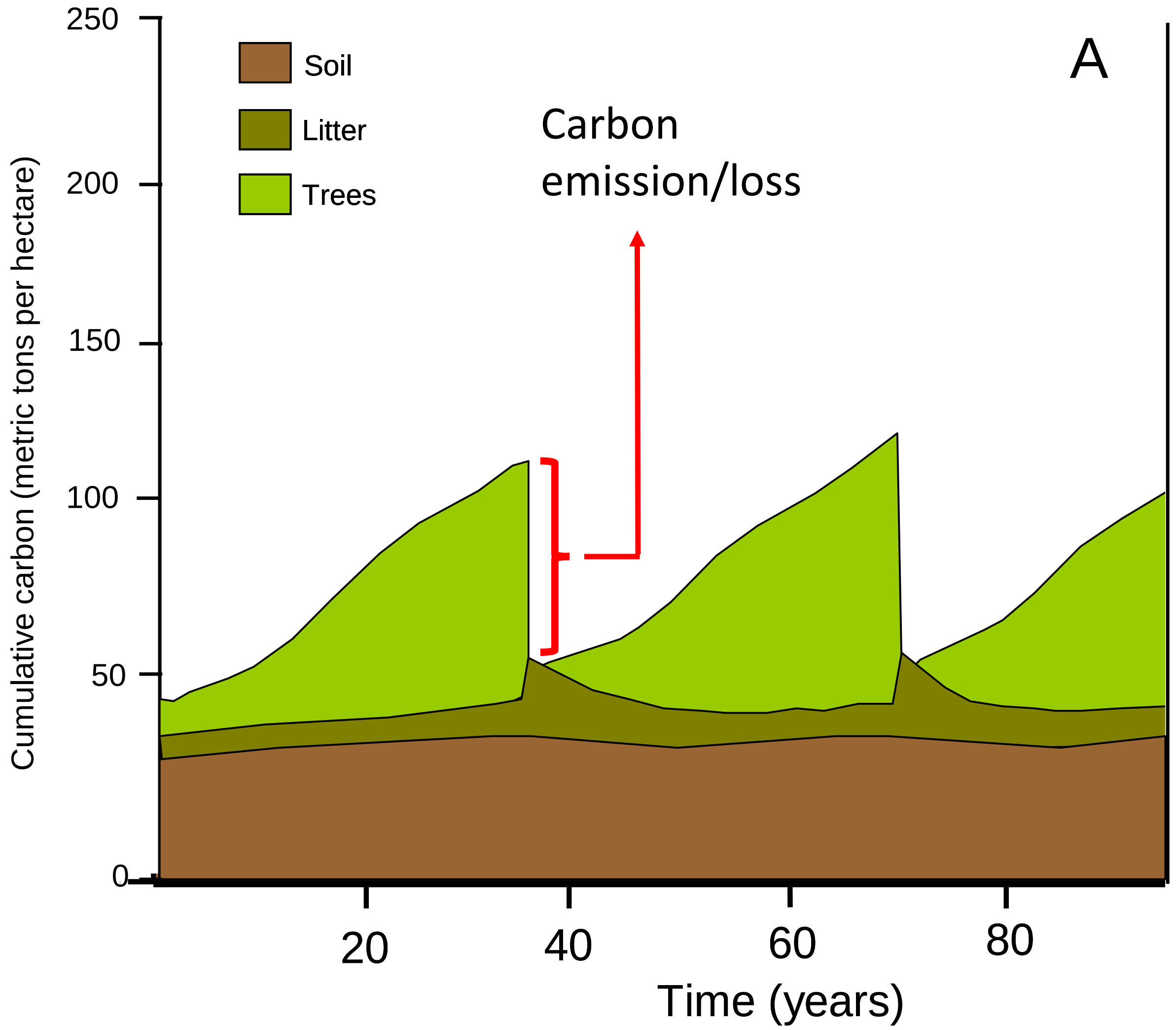
Forest Carbon Cycle: narrow view

Photo by National Park Service

Narrow view of the forest system

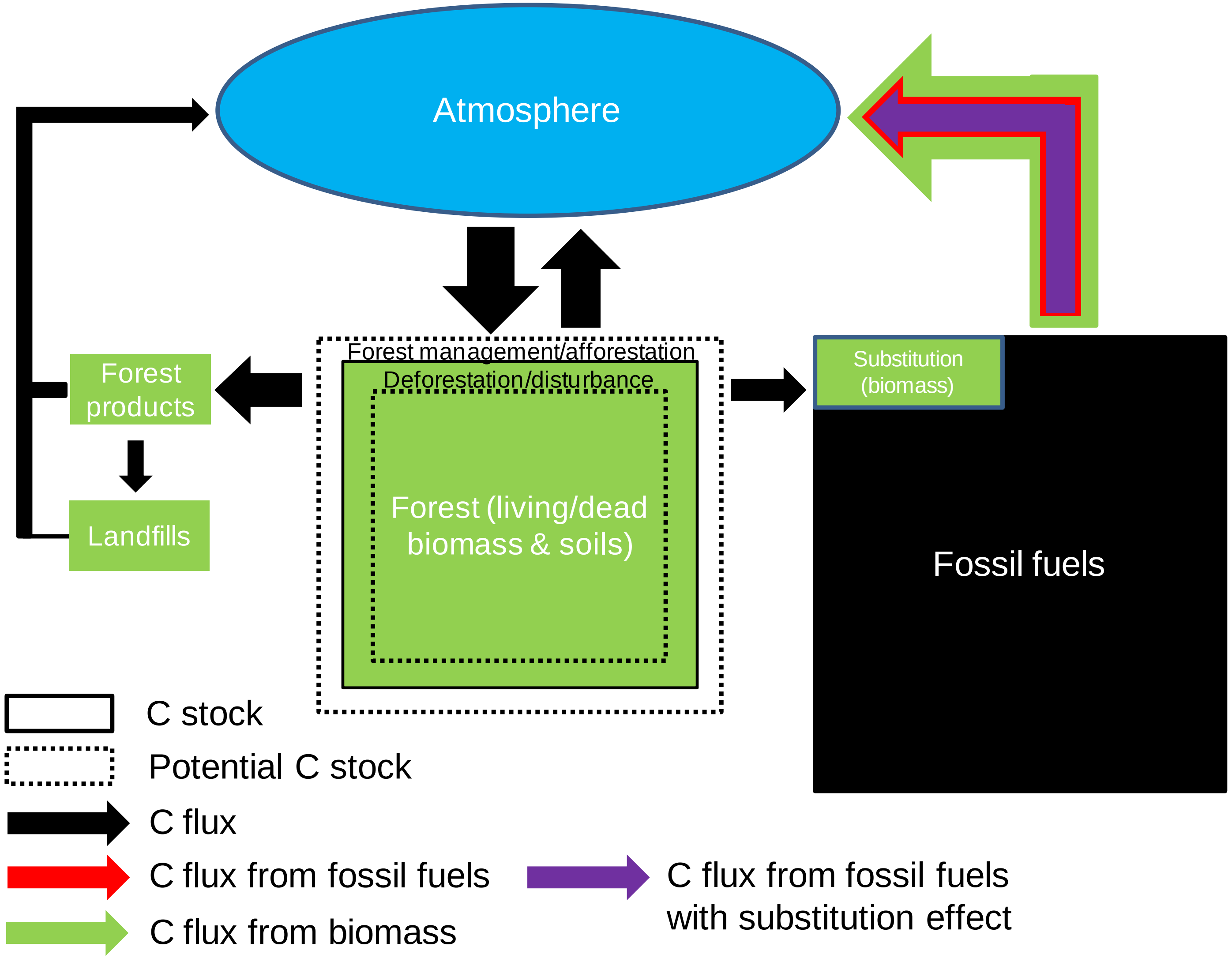


- Concerned with emissions/carbon loss on shorter time scales and limited geographical extent
- Source/sink trends main way to view impacts of management activates
- Considers narrower range of activities that influence carbon positively

E.g., timber harvesting would have an immediate negative impact.

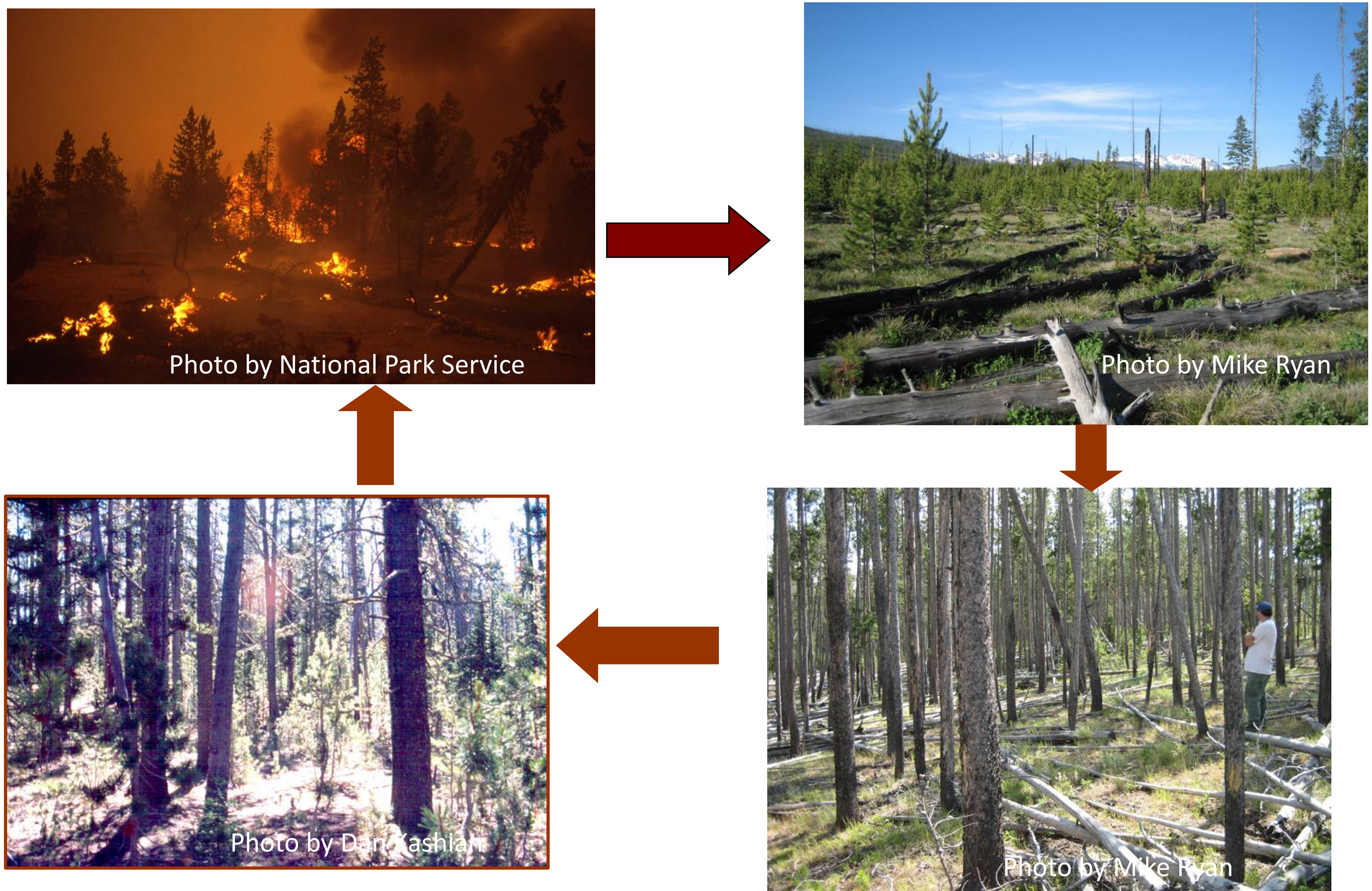
McKinley et al. 2011

Broad view of the Forest System



McKinley et al. 2011

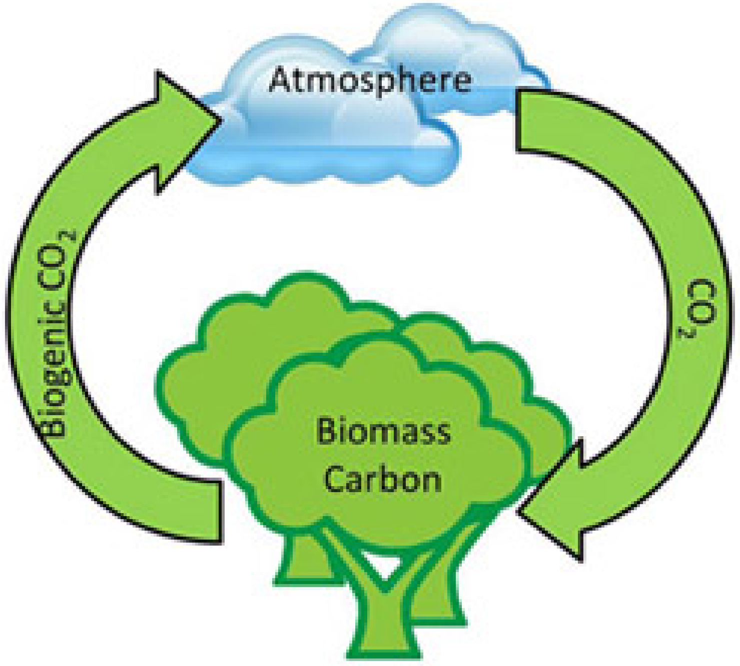
Forest Carbon Cycle



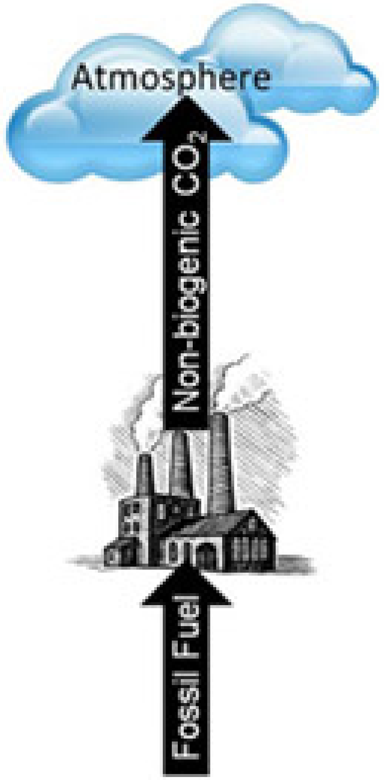
A forest may have all these stages happening at the same time.

Biogenic vs. Fossil Fuel Emissions

"Closed loop"



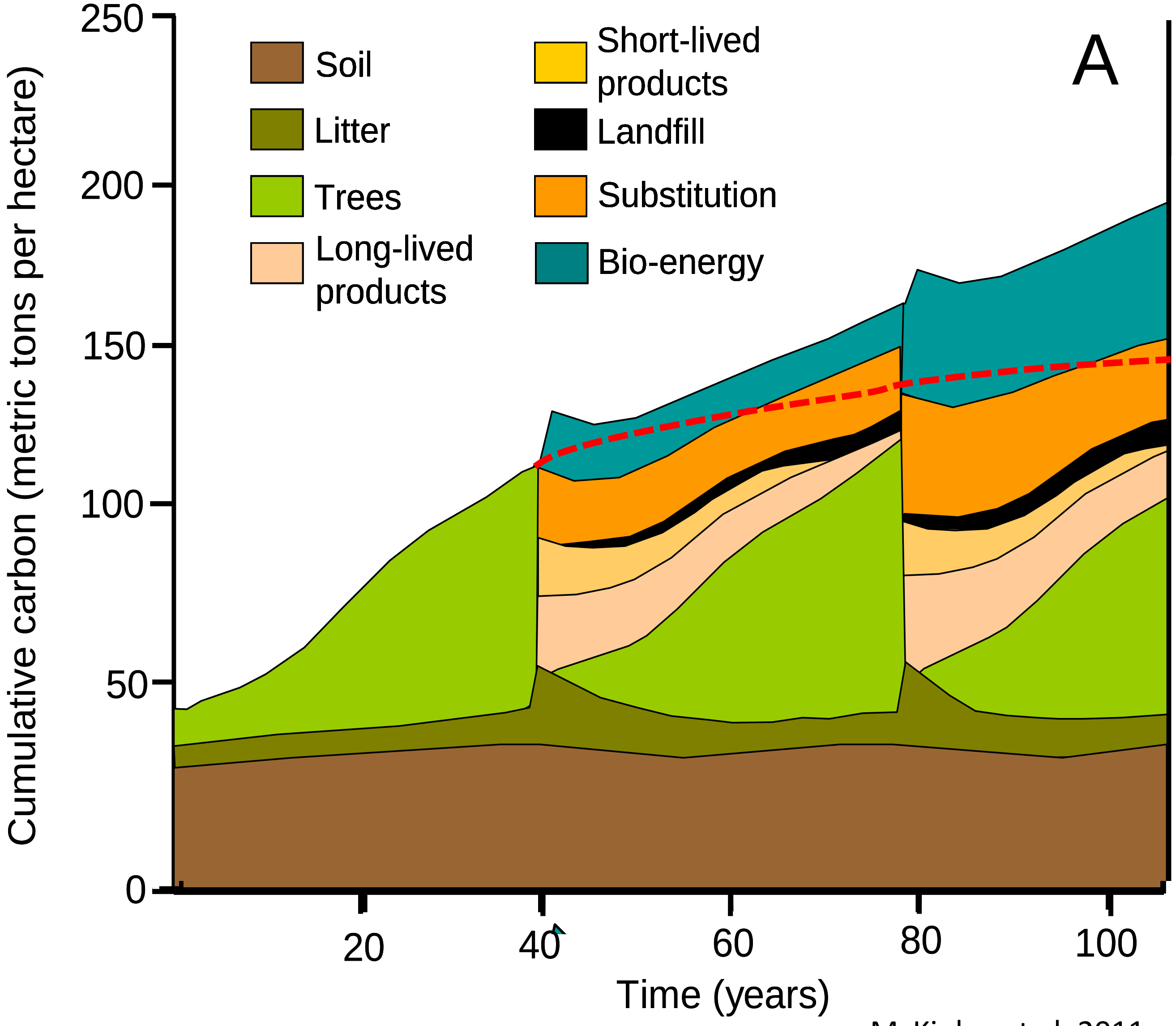
Biogenic carbon is part of a relatively rapid natural cycle that impacts atmospheric CO_2 only if the cycle is out of balance.



Fossil fuel combustion transfers geologic carbon into the atmosphere. It is a one-way process.

"Open loop"

Broad view of the Forest System



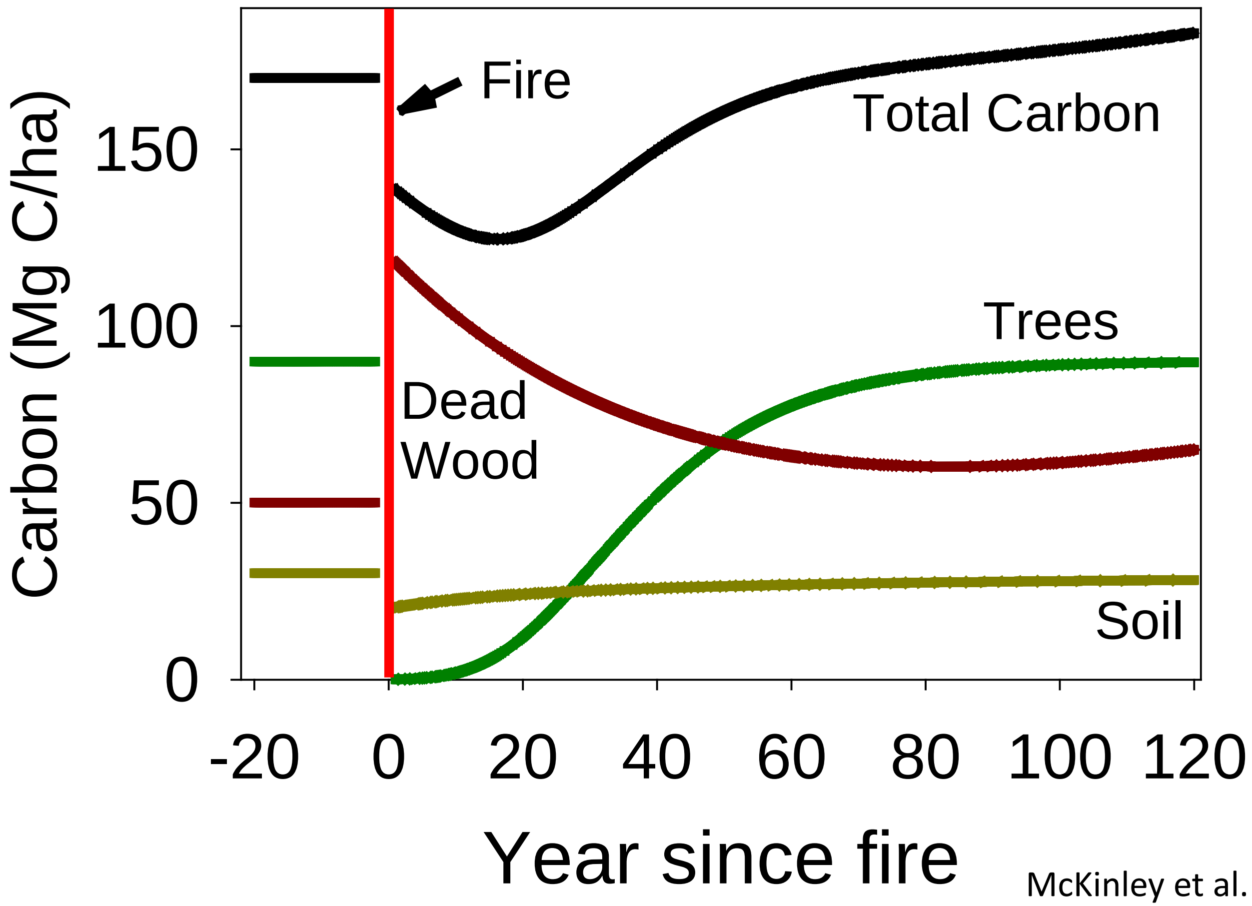
McKinley et al. 2011

- Concerned with emissions/carbon loss on longer time scales and broader geographical extent
- Considers what happens to carbon once it leaves the forest system
- Impacts of management activates are considered more holistically – closer to what the atmosphere actually "sees."
- Supports a broader range of activities that influence carbon positively

E.g., timber harvesting would have a positive impact right away.

Temporal scale:

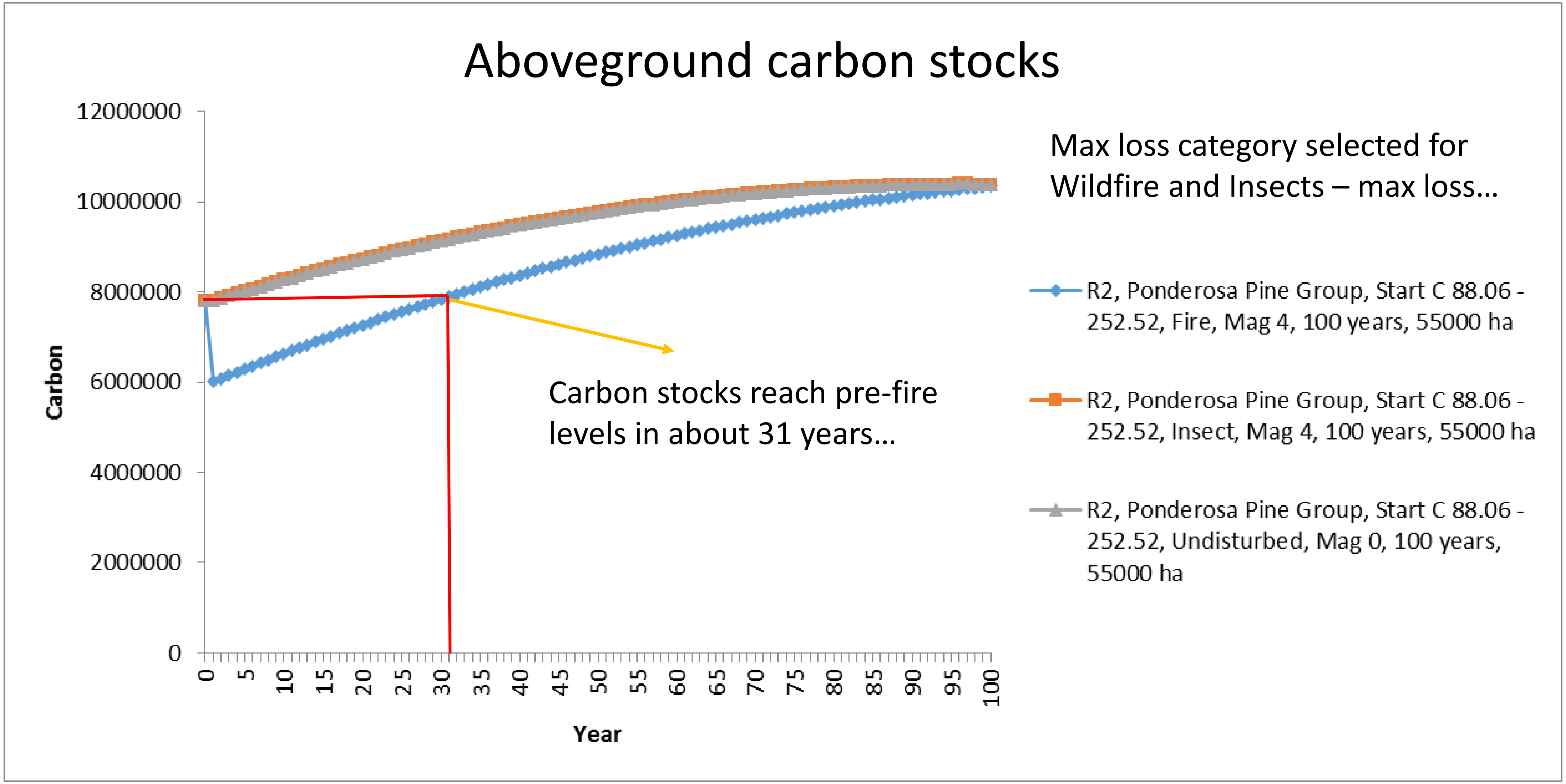
Ecosystems that regenerate forests after disturbance (e.g., fire, bugs, disease) will recover all of the carbon lost, given time



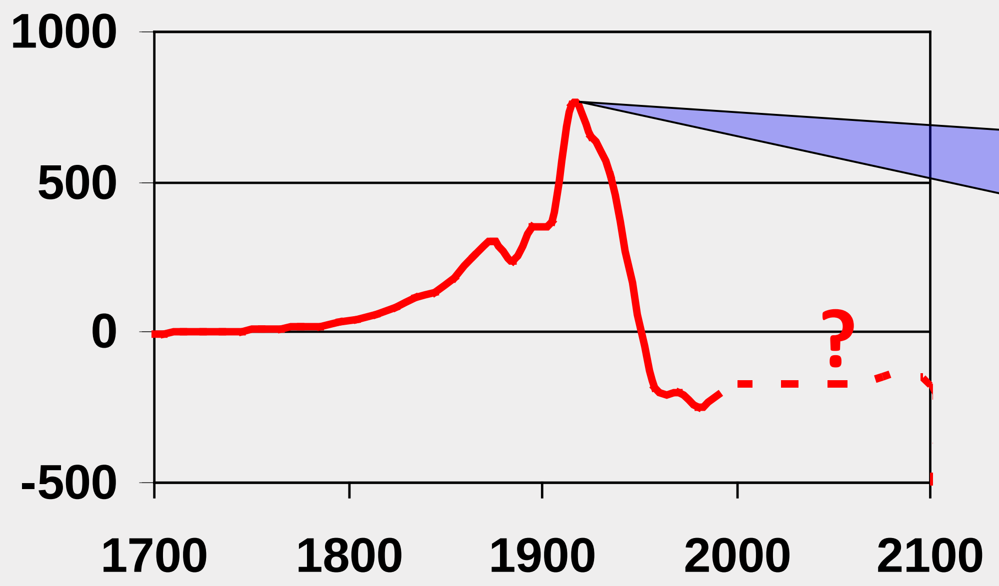
McKinley et al. 2011

Impact of disturbances on carbon (FVS-based carbon tool)

e.g., R2 ponderosa pine forest type (135,000 acres)



U.S. Forest Carbon Balance 1800-1950: Forest Disturbance on a Massive Scale-the Industrial Revolution



Birdsey, R., K. Pregitzer, and A. Lucier. 2006.

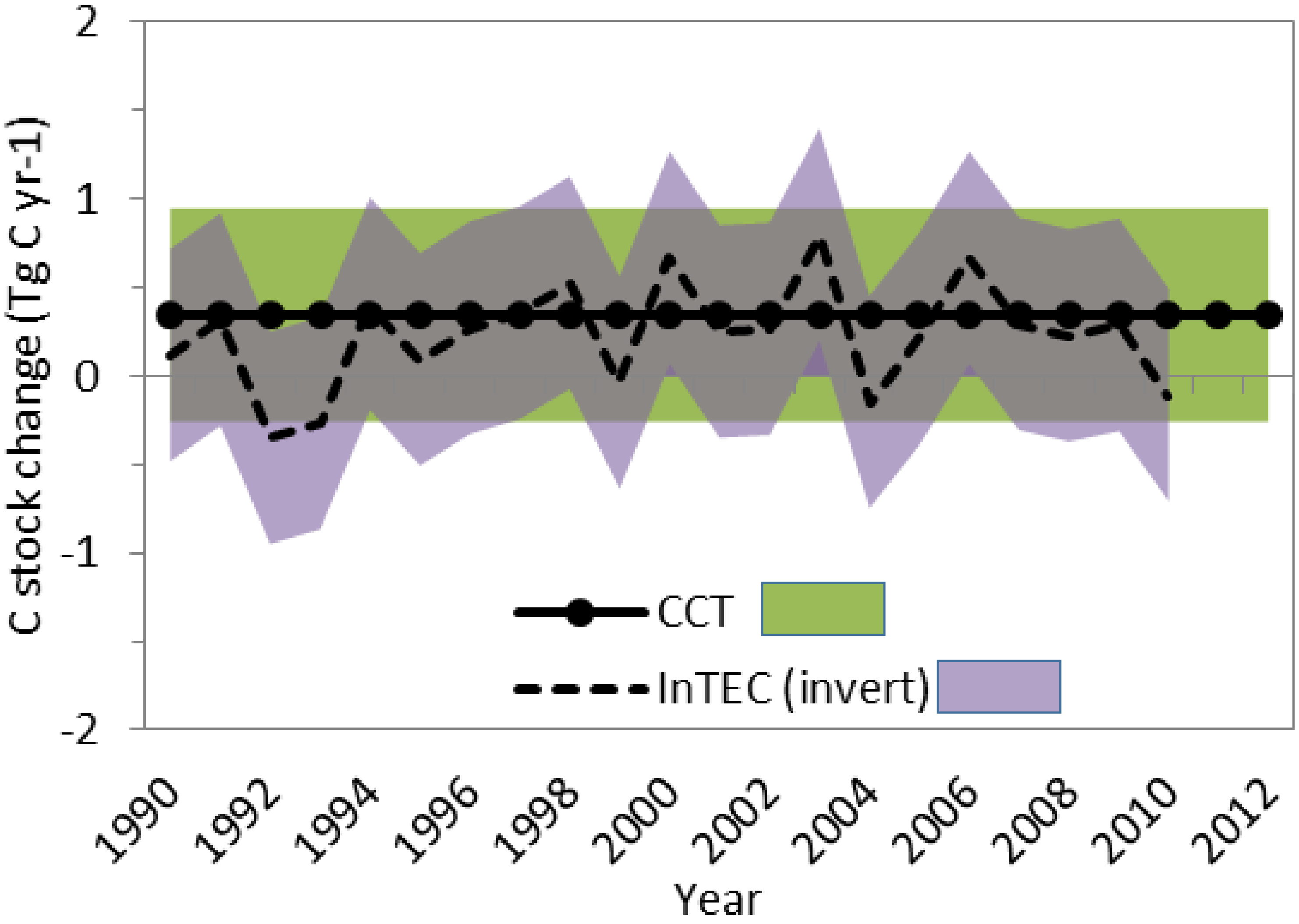
In 1915, emissions from forests were 760 million tons C per year

- 60 percent of total U.S. forest C stocks were lost during this period!

Photo courtesy of University of Washington Libraries, Special Collections, KIN084.

*41,000 million tonnes = total forest C stocks in the conterminous U.S.

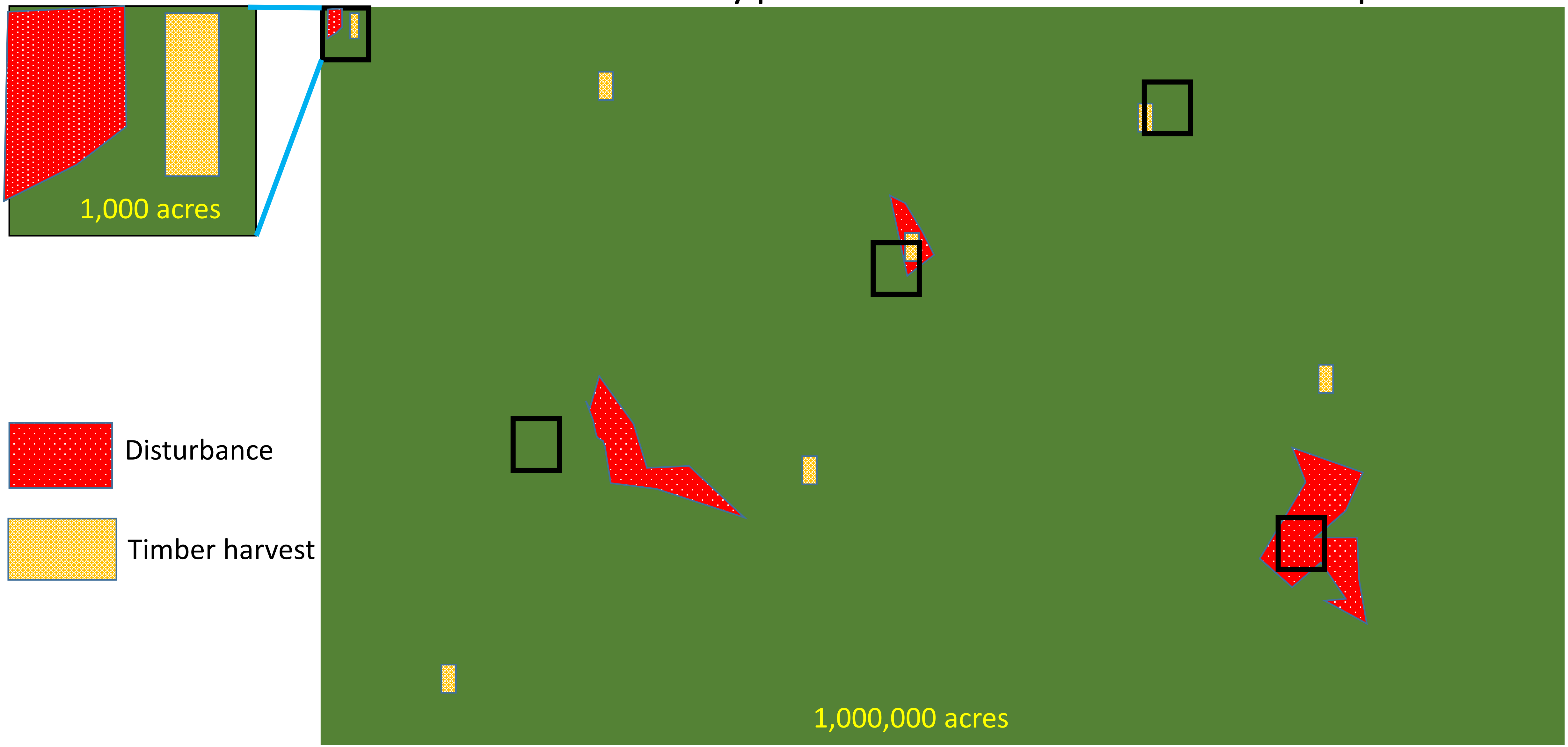
Source or Sink?
Fine temporal detail can distract…



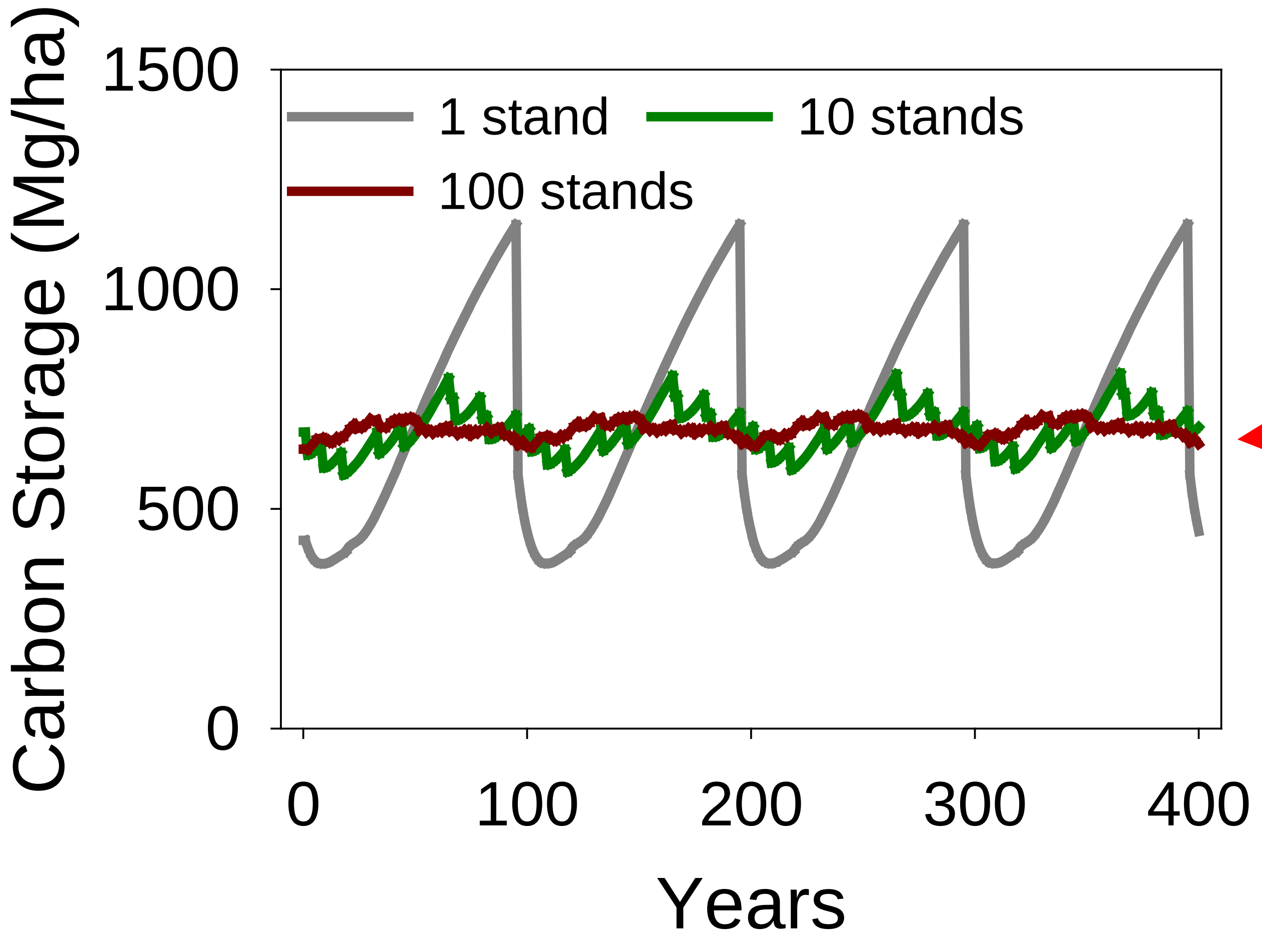
e.g., Helena NF

Spatial scale:

Disturbances on a hypothetical forest landscape



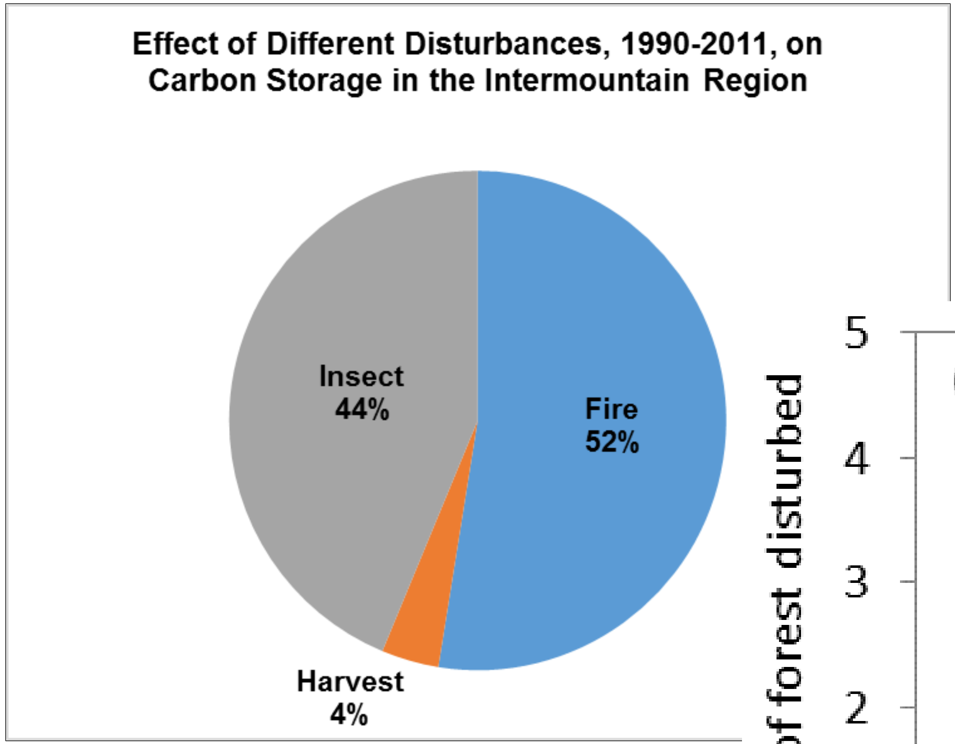
The larger the landscape considered, the more accurate the representation of the forest and the more stable the carbon seems



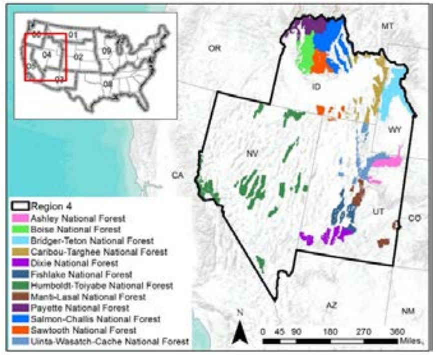
Best scale to identify trends related to environmental change and land-use

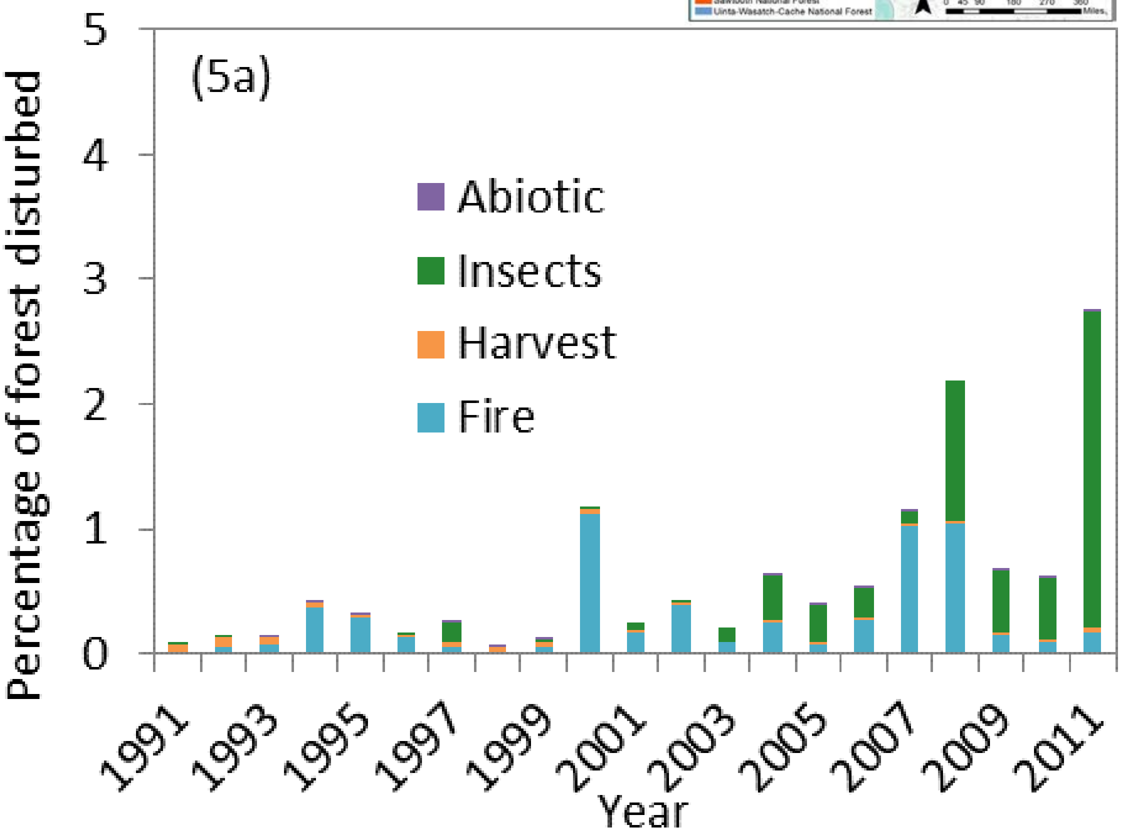
McKinley et al. 2011

Disturbances in regional context: natural disturbance dominated



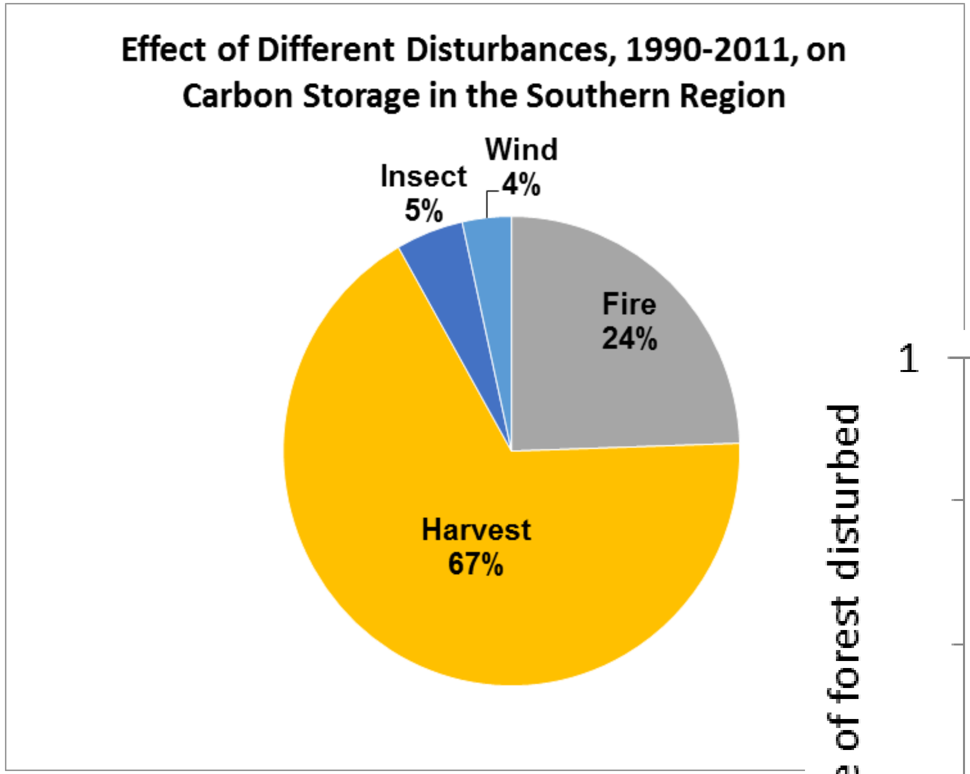
12 National forests



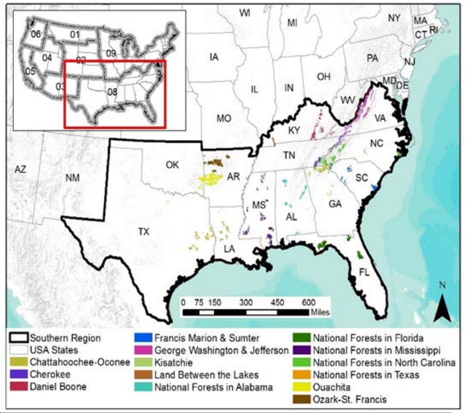


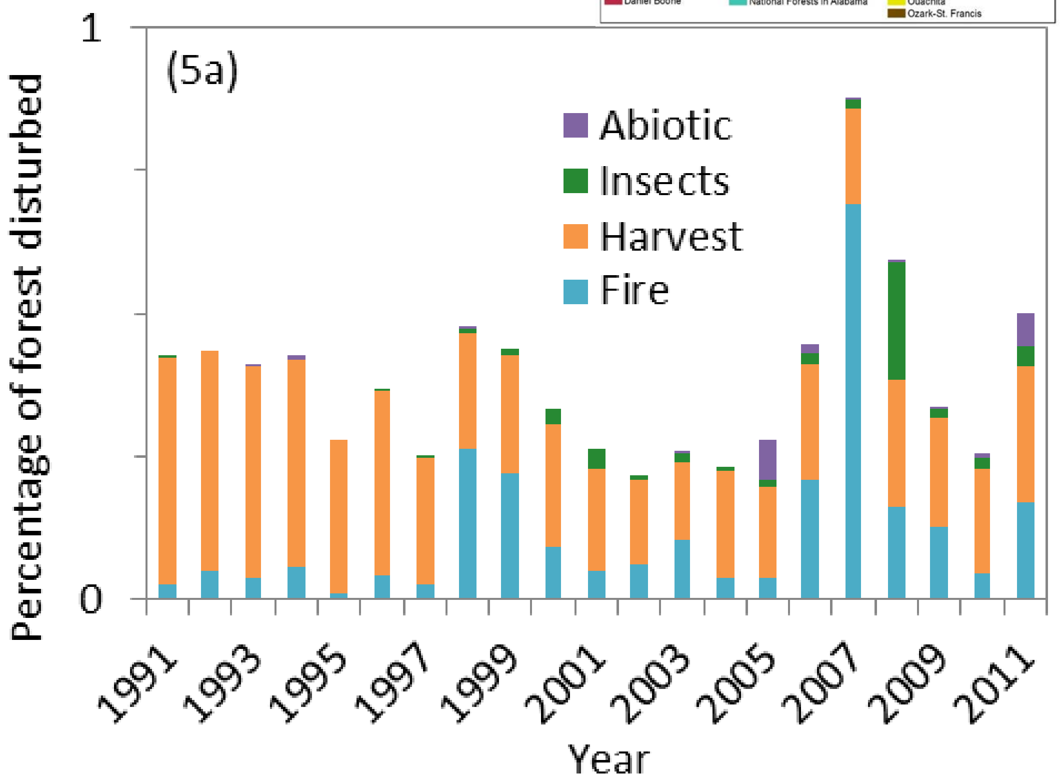
Healey et al. in review

Disturbances in regional context: management dominated



14 National forests



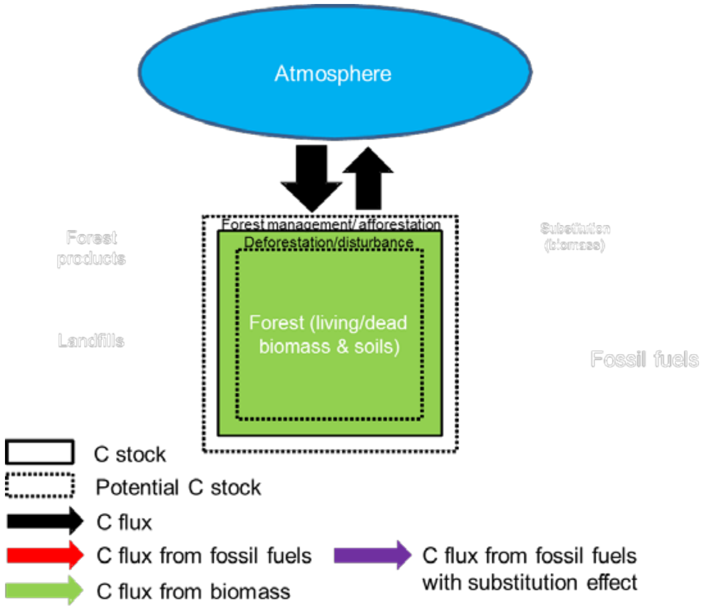


Healey et al. in review

Some Implications of differing perspectives

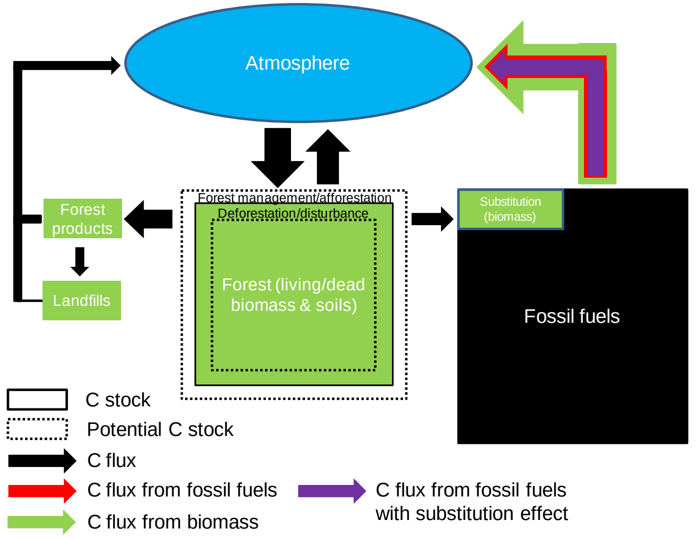
Narrow view:

- Carbon impacts from management are not represented well
- Source/sink is overly emphasized:
  - Tends to overly emphasize single events.
  - Tends to focus on short periods of a forest lifecycle, perhaps as short a single year.
- Carbon emission from management ≈ fossil fuel emission
- Most management the Forest Service conducts leads to carbon loss



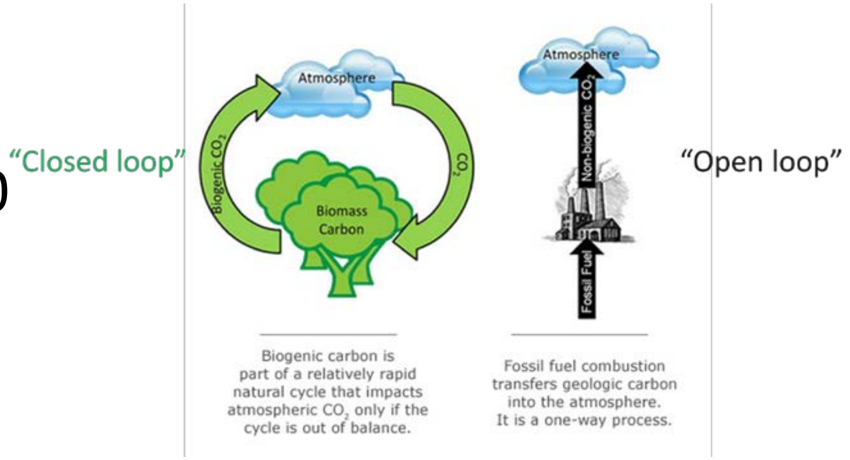
Broad view:

- Carbon impacts from management are represented well
- Source/sink is used to detect potentially concerning patterns and trends
  - Stochastic events are incorporated in broader trends and patterns.
  - Tends to focus on long periods of a forest lifecycle, perhaps many decades.
- Carbon emissions from management ≈ biogenic emissions
- Most management that the Forest Service conducts would have negligible impact on carbon, if not positive.



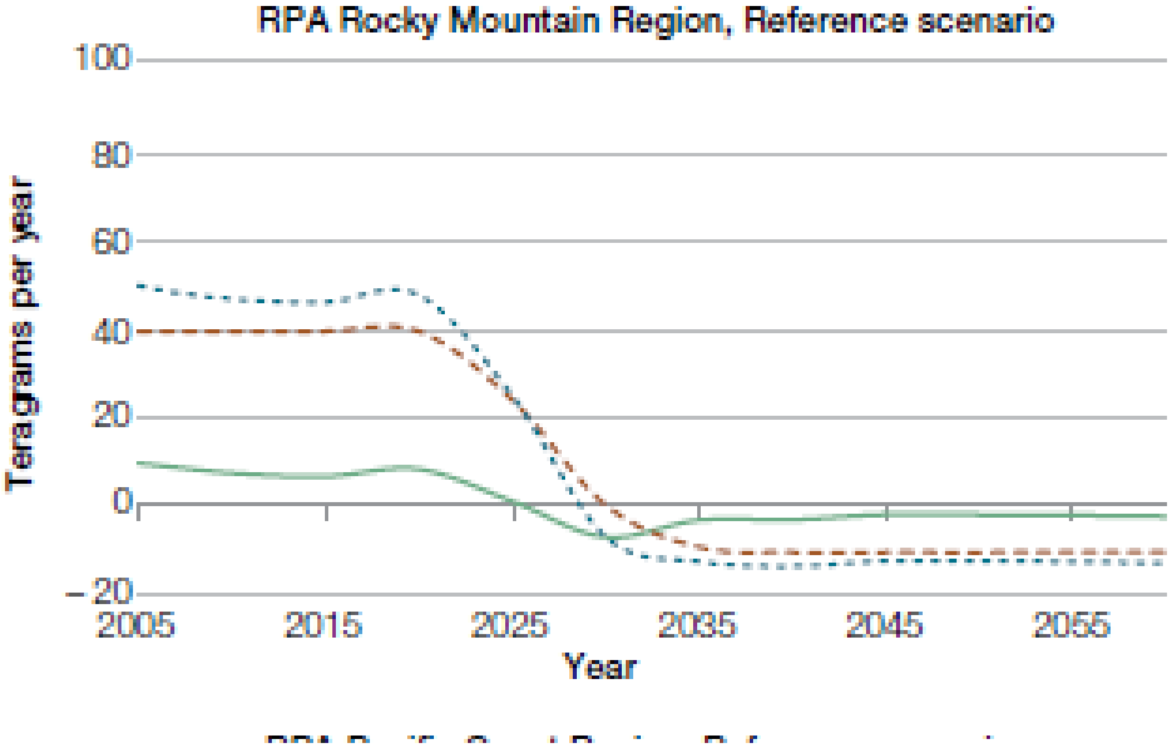
Keeping Forests as Forests is the major concern with respect to carbon

- Development, conversion to agricultural or other use. Important for U.S., not just tropics
  - 2000-2005 gross deforestation rate in U.S. was 600,000 ha/yr, but about 1,000,000 ha/yr of non-forested land reverted to forest during this same time.
  - Globally, deforestation releases 1,400-2,000 million tonnes of C per year
  - 156,000 million tonnes of C have been released globally due to land use change (1850-1998)
- Carbon cycle does not close, effectively making the impact of biogenic emissions the same as fossil fuels

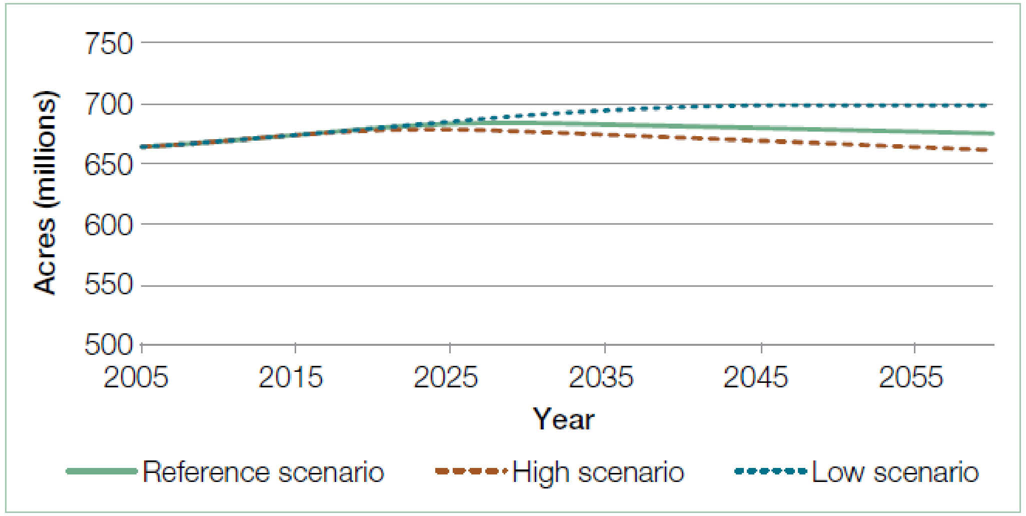


Loss of forest land is primary driver of forest carbon loss in the future

Projections of U.S. carbon stock changes, including transfers associated with land-use change



Area of U.S. forest land use

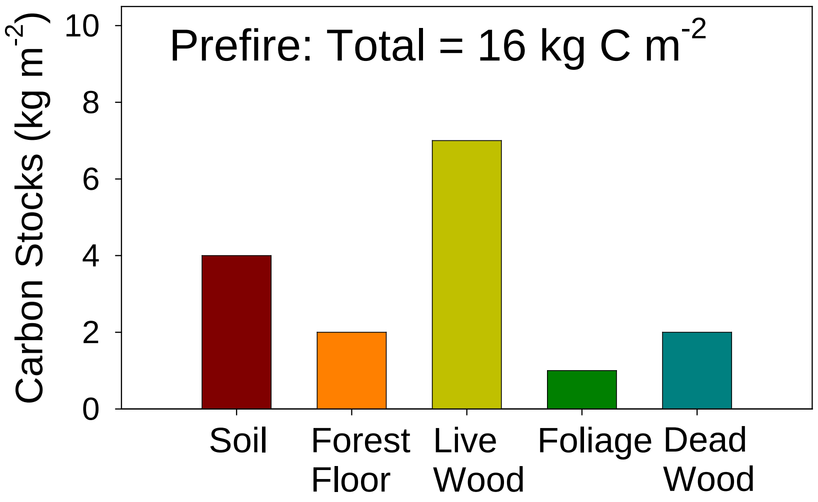


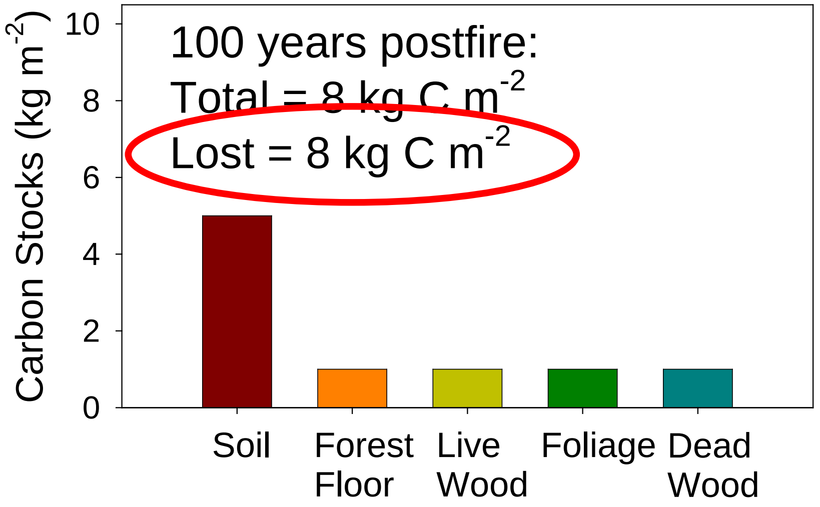
Net sequestration: forest carbon stock change minus land-use carbon transfers

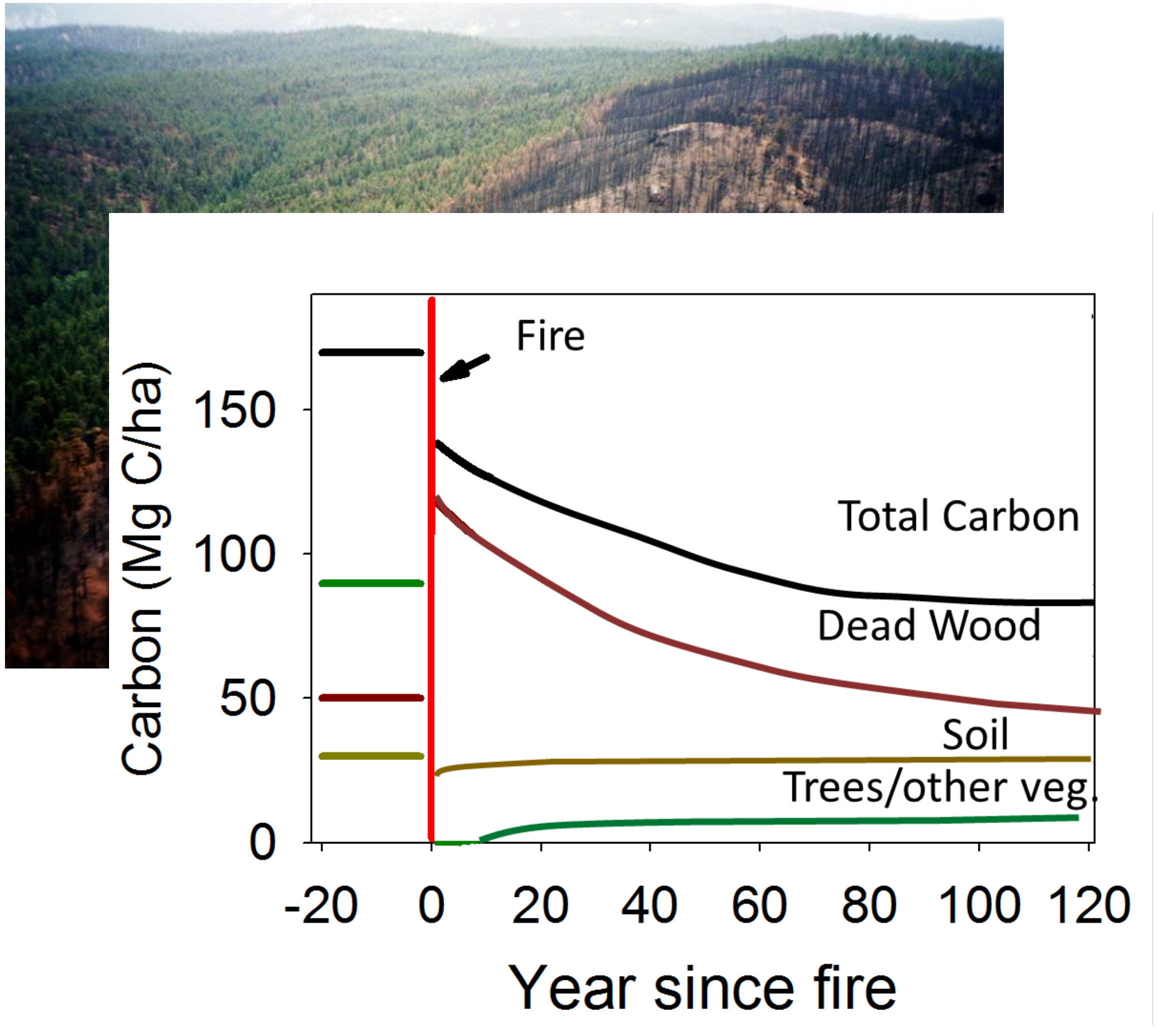
RPA assessment 2016

What happens to carbon with no regeneration? Main concern for NFS lands

Example: Hayman Fire, Colorado, 2002

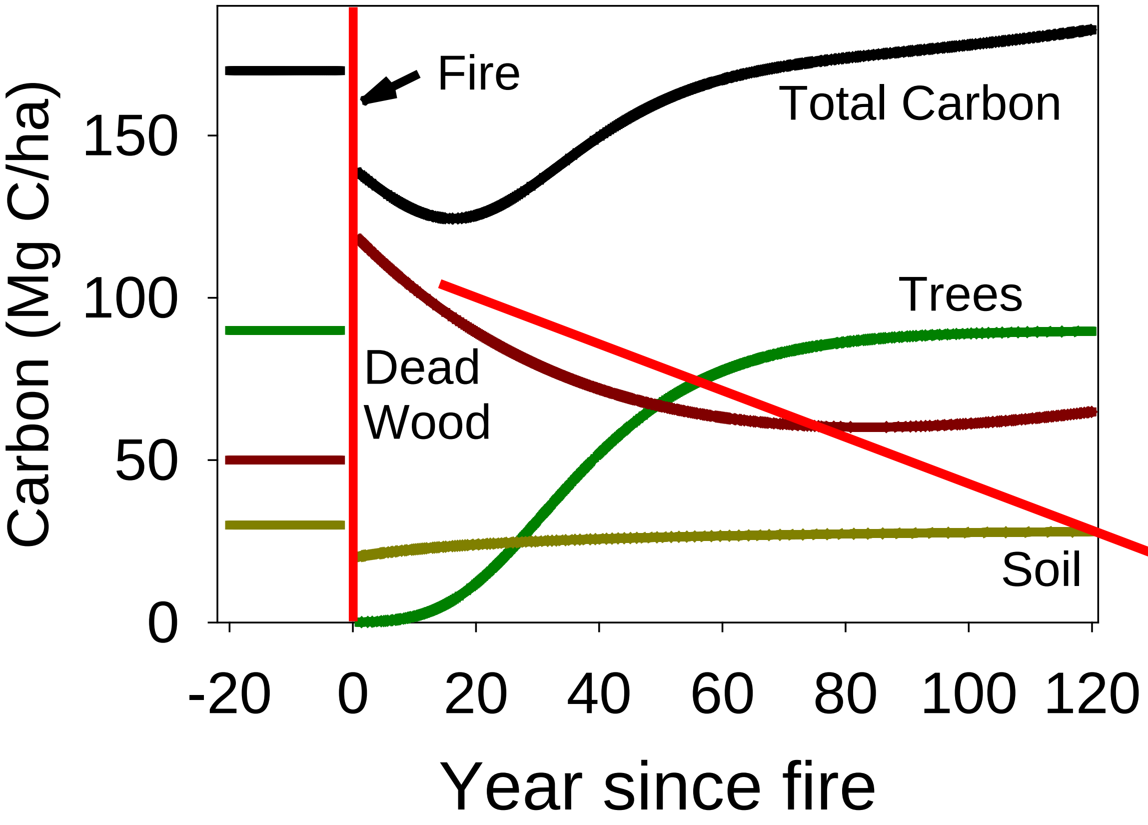


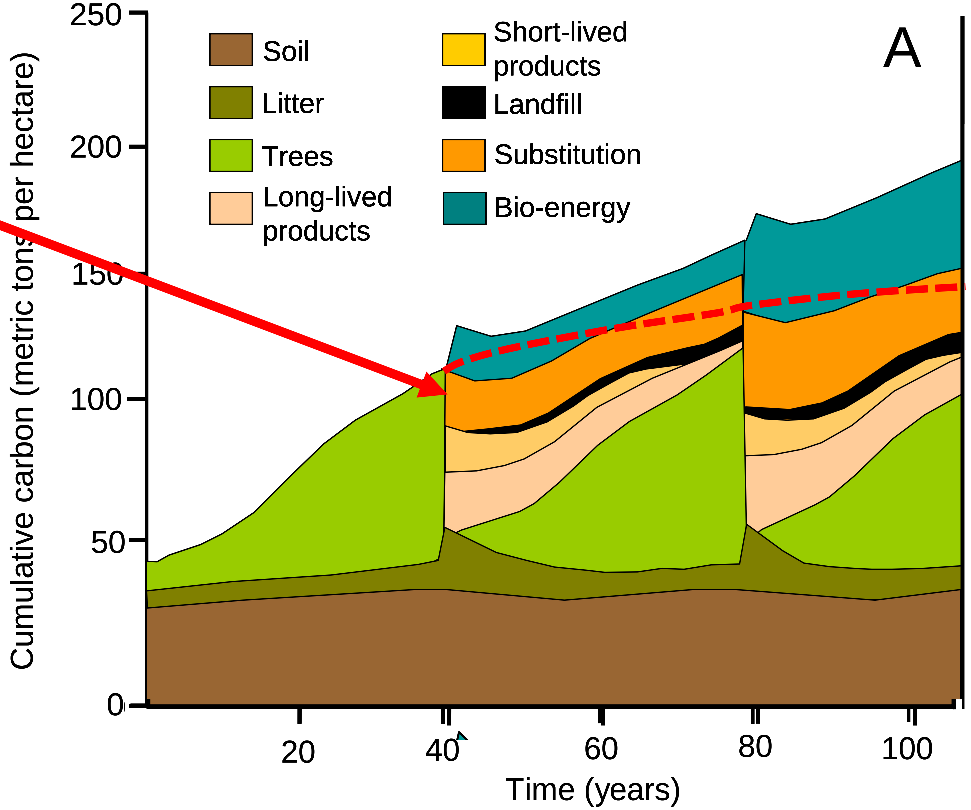




M.G. Ryan

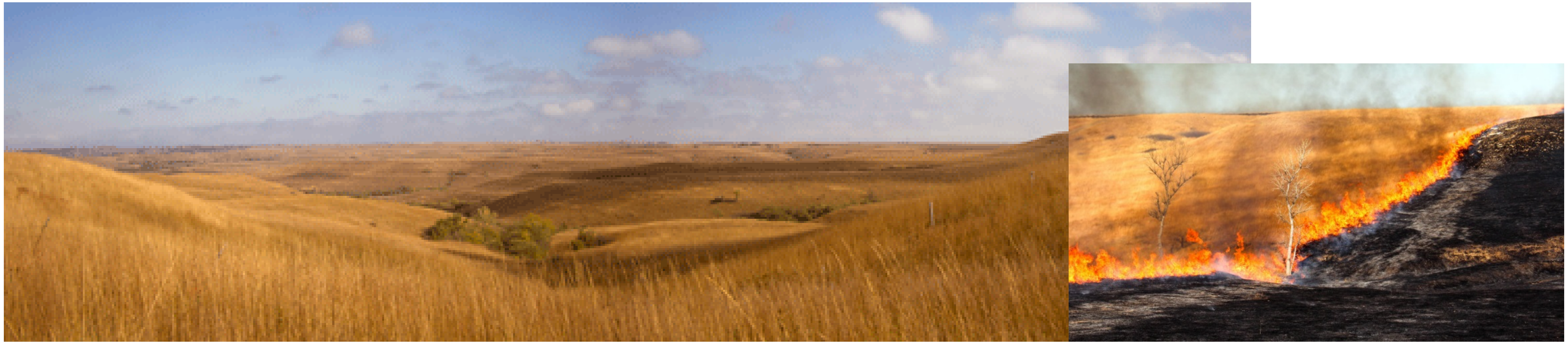
What happens to carbon with salvage harvest?





Two fates: decay naturally or used in a way that could reduce carbon emissions to the atmosphere…

Concepts that apply to forests apply to grasslands and rangelands



90-95% of the carbon is belowground in soils and roots/rhizomes – very stable

Carbon loss from very stable pools -soils

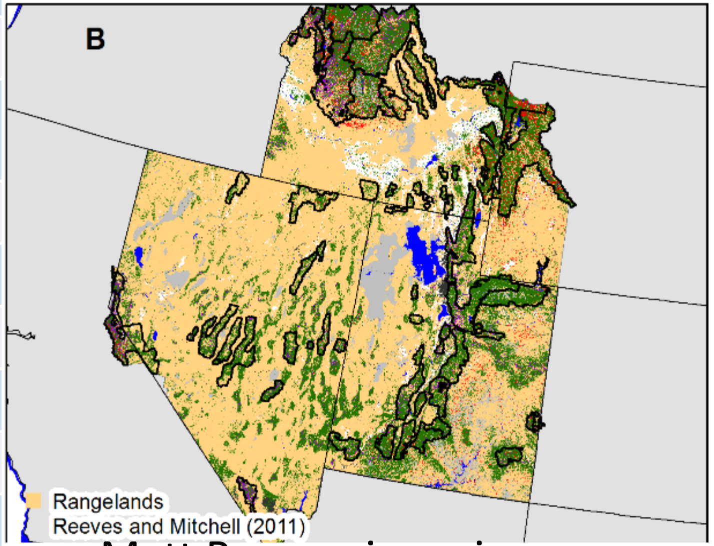
Native grasslands are in steady state – no changes in carbon is the most desirable condition in most situations

Carbon gain leads to loss of grasslands – conversion to shrub system

Carbon assessment for shrub lands in Region 4

Table 9. Standing carbon density of shrubs in the non-forest domain of R4. Units are Mg ha^{-1}. Area is the area represented in the modeling (all non-forest areas).

National Forest	Area	Maximum	Average	Minimum
	ha		Mg ha^{-1}	
Uinta-Wasatch-Cache National Forest	280,720	6.48	5.06	3.63
Boise National Forest	179,803	3.89	2.67	1.61
Caribou-Targhee National Forest	341,063	3.08	2.35	1.52
Fishlake National Forest	140,290	10.55	9.62	8.91
Ashley National Forest	125,121	4.80	4.08	3.60
Humboldt-Toiyabe National Forest	1,256,071	7.48	6.16	5.26
Sawtooth National Forest	381,122	5.38	4.49	3.25
Salmon-Challis National Forest	357,765	3.19	2.10	1.03
Payette National Forest	36,791	2.72	1.90	1.09
Dixie National Forest	114,065	13.33	12.45	11.75
Bridger-Teton National Forest	362,678	1.38	1.19	0.61
Manti-La Sal National Forest	111,428	7.27	6.46	5.83



Matt Reeves, in review

Key Points - science

- Forests naturally go through boom and bust cycles in the context of carbon.
  - Elucidating patterns and trends requires disentangling signal(s) from this noise.
- Disturbance and harvesting do not cause carbon loss in the context of the broad view, *unless*
  - Poor or no regeneration – e.g.,
    - Climatic conditions no longer support pre-disturbance levels of biomass
    - Disturbances that increase in intensity and frequency compared with the historical range of variability
  - Changing land-use, from forest to non-forest, is greatest threat to forest carbon stocks and strength of U.S. carbon sink
- Greatest opportunity: Keeping forests as forests; fostering resilience to environmental change
- Generally speaking, good forest management = good carbon stewardship!

Is measuring forest carbon for plan alternatives useful for decision making?

Exploring technology and relevance

Alternative A (1): (“*No-Action*”) is considered the

≈ 4,060 acres per year for first 10 years, then about 2,000 acres until year 20

60,600 total acres

Alternative C (3): (“*Multiple-Use Alternative*”) involves slightly more aggressive prescription burning and a near doubling of the salvage harvest rate.

- ≈ 7,320 acres per year for first 6 years, then about 2,540 acres until year 20

76,940 total acres

Alternative B (2) (“*Proposed Action*”) represents a slight increase in prescription (Rx) burning in both the first and

≈ 4,260 acres per year for first 10 years, then about 2,000 acres until year 20

62,600 total acres

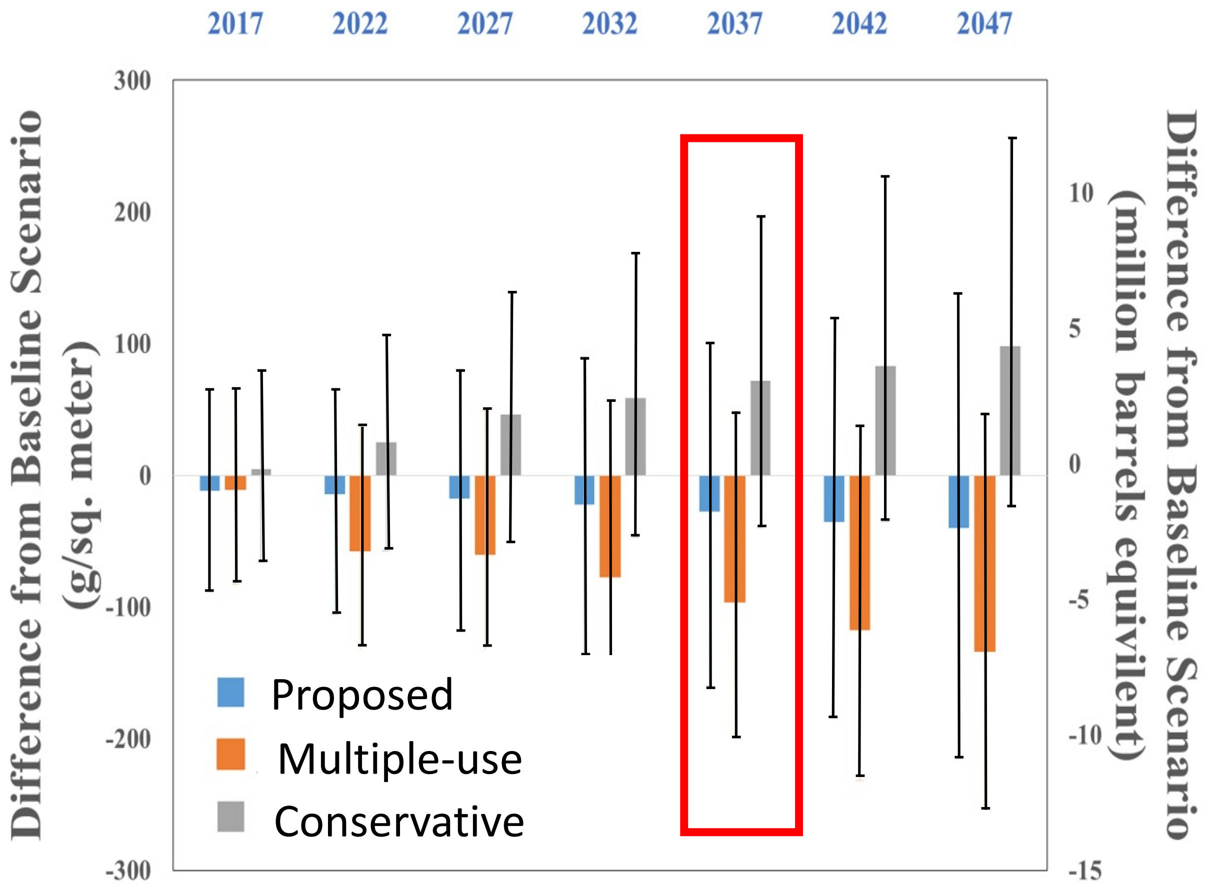
Alternative D (4): (“*Conservation Alternative*”) involves approximately the same level of prescription burning as the baseline, but a nearly 50 percent

≈ 2,730 acres per year for first 10 years, then about 2,000 acres until year 20

47,300 total acres

Total forested area on the Rio Grand NF 1.35 million acres; about 5 percent of the forested area would be managed

Projected carbon storage differences in the Rio Grande National Forest of Alternatives in relation to the storage projected under the "No-Action" alternative



After 20 years, the greatest difference from the *status quo* is the Multiple-Use Alternative (C), which is about:

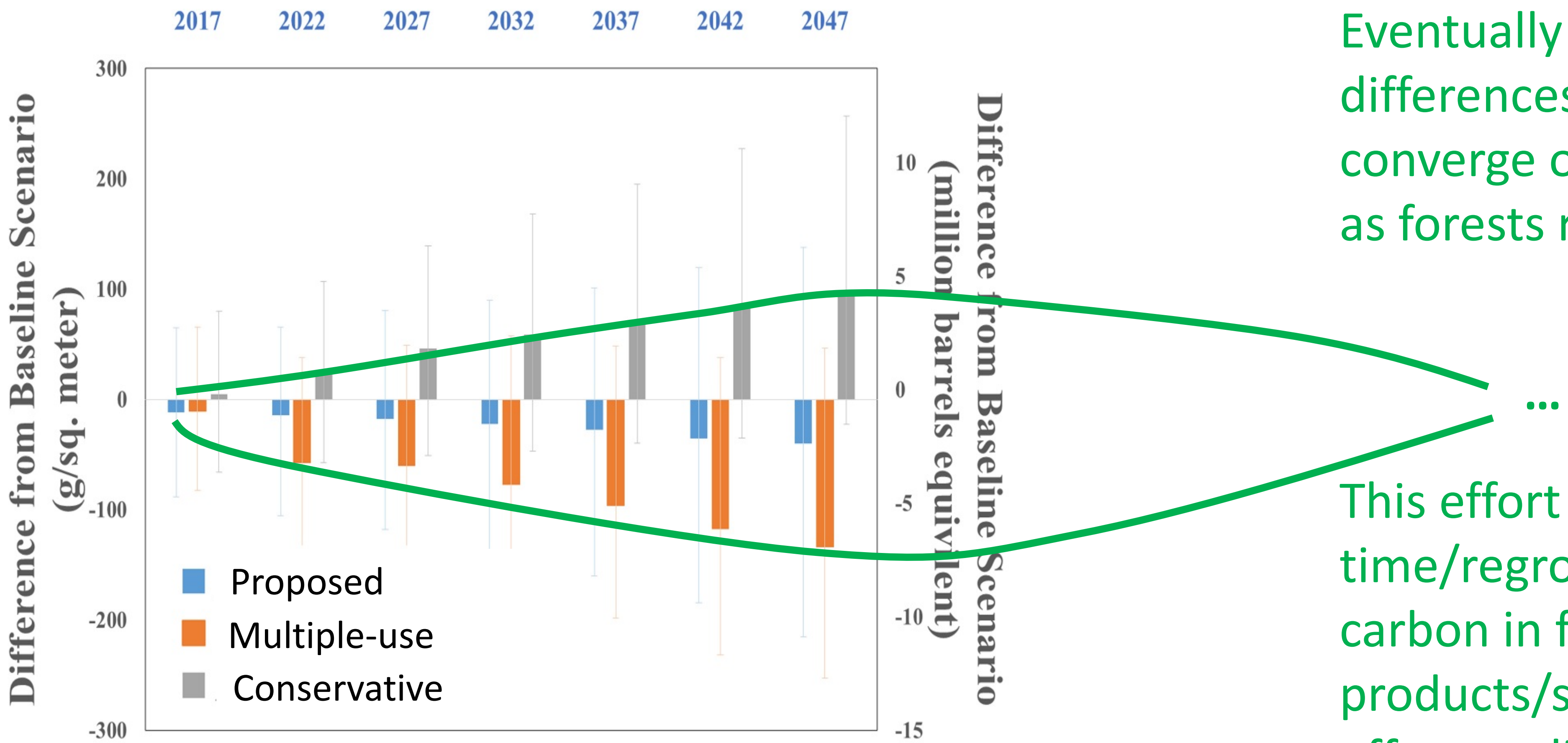
- 549,000 tonnes or 0.54 Tg C;
- 0.7 percent of the total forest carbon.
- 27,450 tonnes C per year*

There is an estimated 80 million tonnes are present in the forest in 2013, plus or minus 5 million tonnes.

A lot of statistical noise:

- Difficulty in telling difference between alternatives statistically, but… if we could…
- Total estimated flux in most robust alterative after 20 years is small and represents about 1/20th of the error in the carbon stock estimates for the forest.

Projected carbon storage differences in the Rio Grande National Forest of Alternatives in relation to the storage projected under the "No-Action" alternative



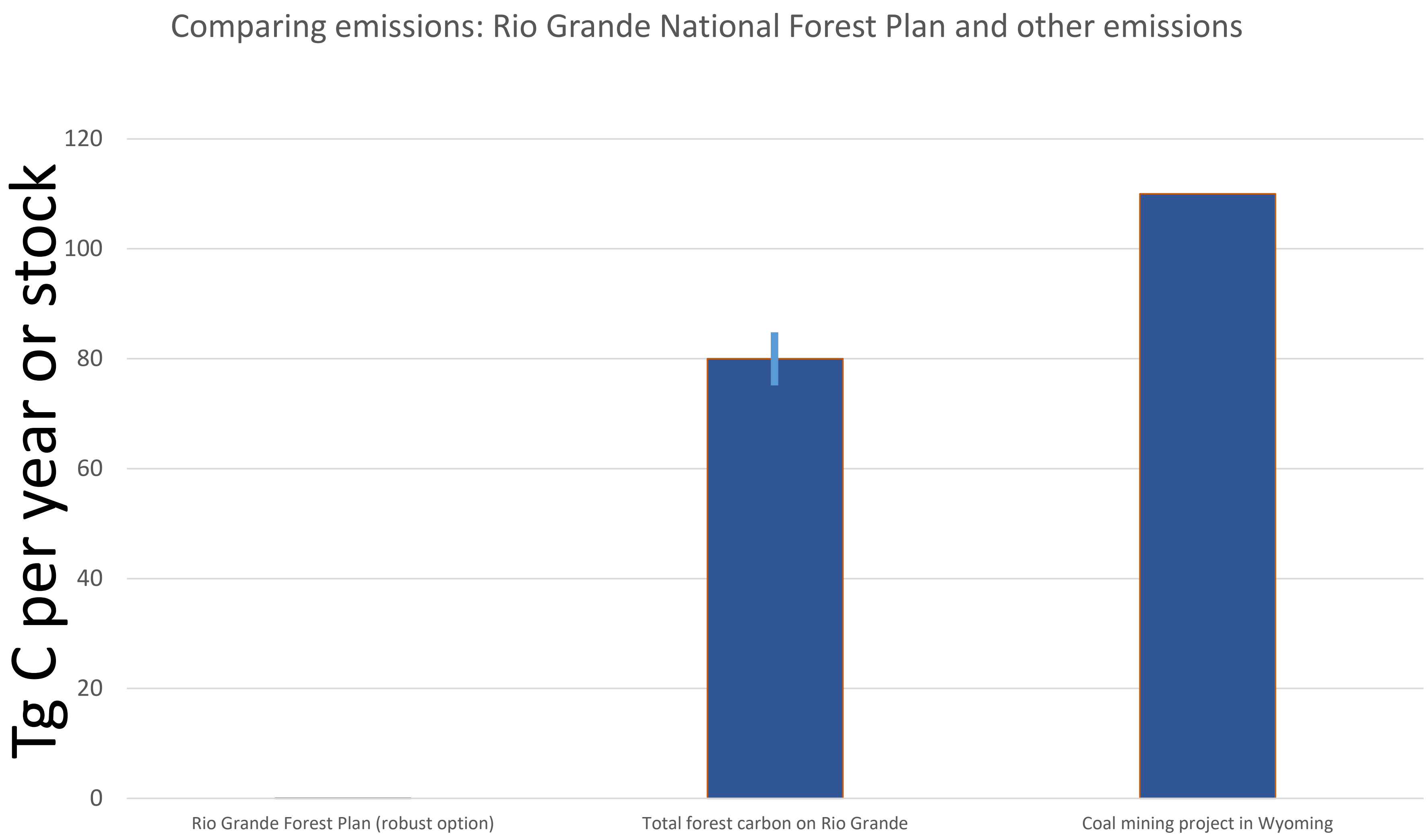
Given enough time these differences will converge

Eventually these differences will converge over time as forests regrow…

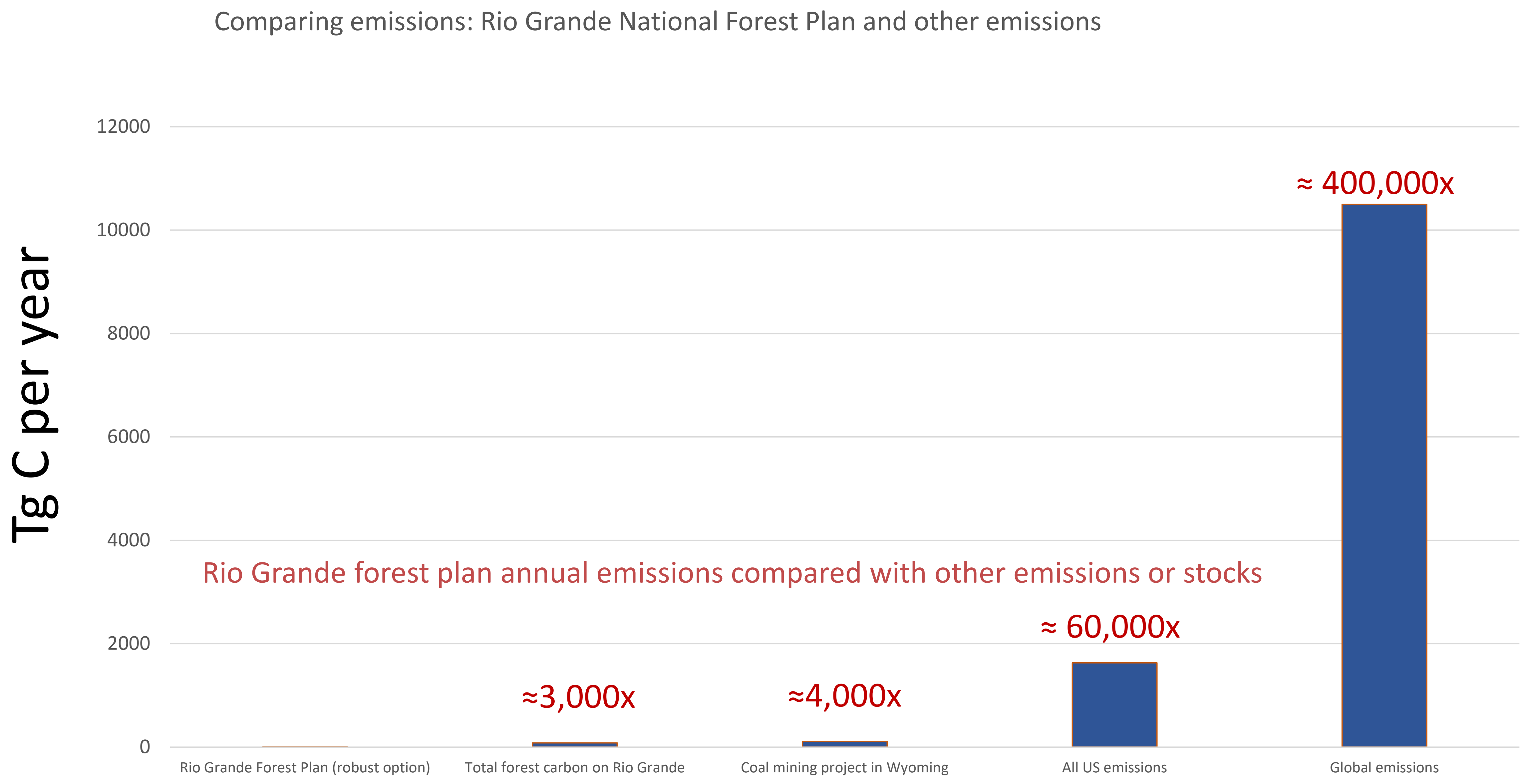
This effort considers time/regrow, but not carbon in forest products/substitution effects… differences would be much less if they were included…

Carbon in perspective

Impact of vegetation management in context

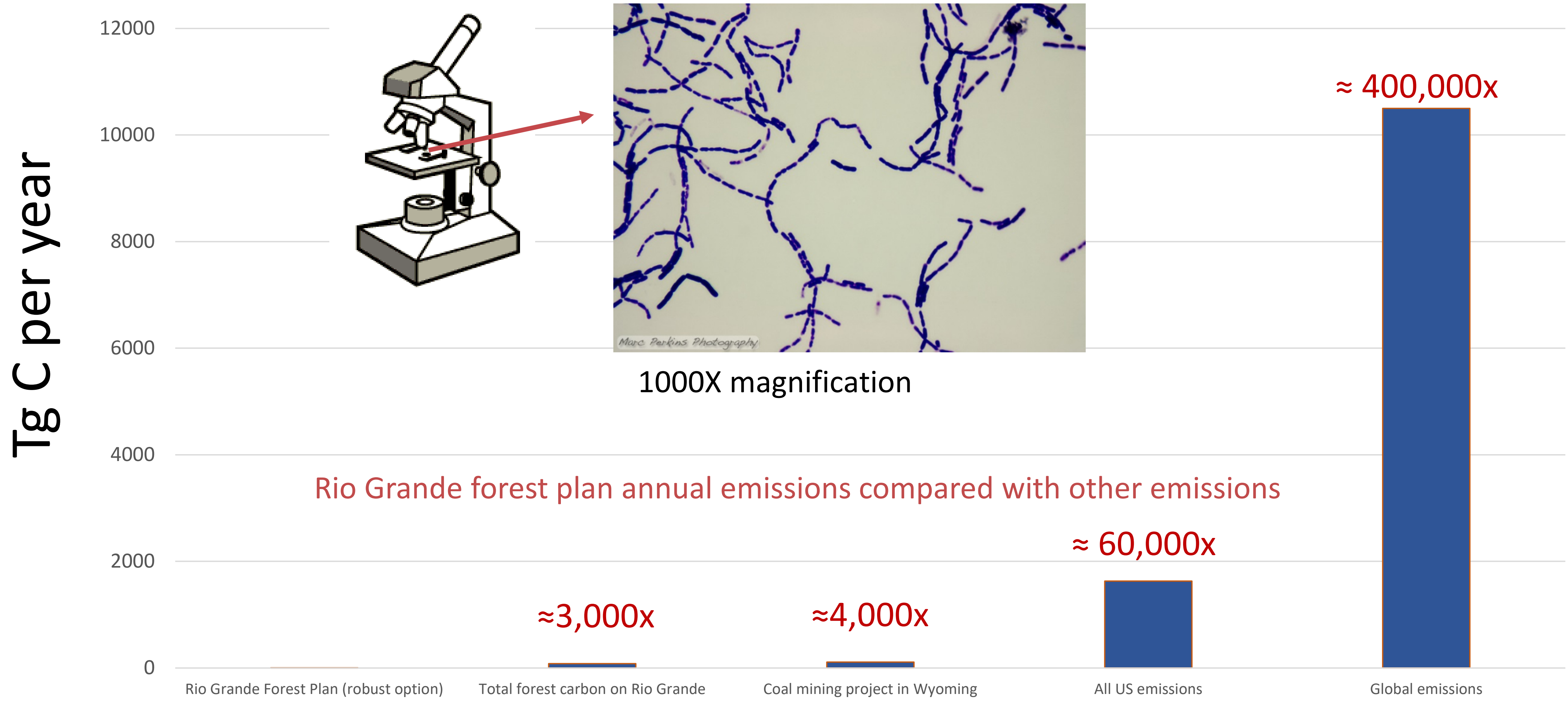


Impact of vegetation management in context



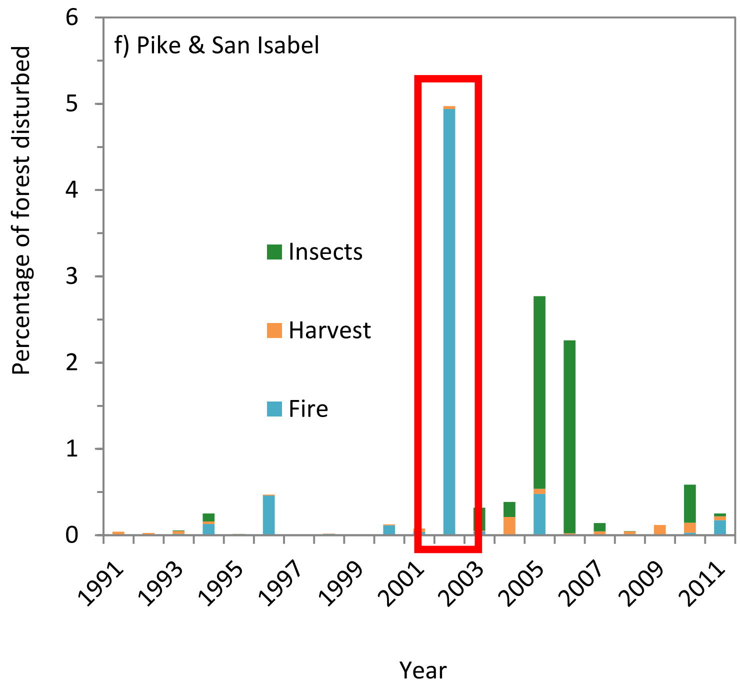
Impact of vegetation management in context

Comparing emissions: Rio Grande National Forest Plan and other emissions

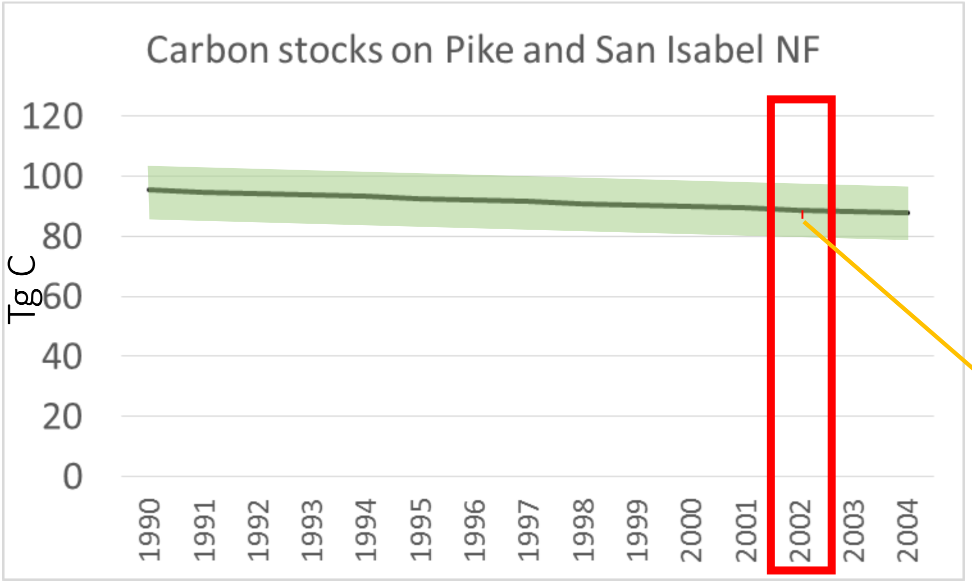


Detecting changes in carbon stocks after large disturbances: "Hayman fire"

- Burned about 135,000 acres (211 sq. miles) in the Pike & San Isabel National Forest, largest fire in CO state's history
- Although stunning visually, only about 4.9 percent of the total forested area was affected by fire.
- Assuming high severity fire on all acres burned, about 1.76 Tg C could have been volatilized during wildfire.
- In 2013, total carbon stocks were 82.7 Tg C ± 8 Tg C
- Consistent downward trend since 1990, suggests broad-scale change



Disturbance assessments



Baseline assessments

Approximate immediate impact of wildfire on carbon stocks

Carbon trends on a regional scale: forest carbon stocks are increasing…

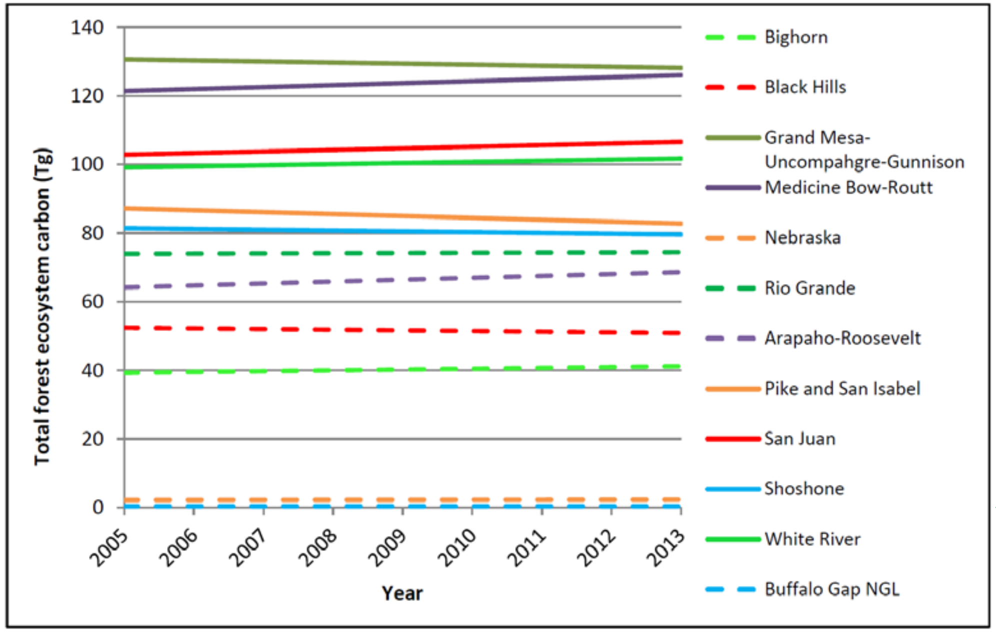
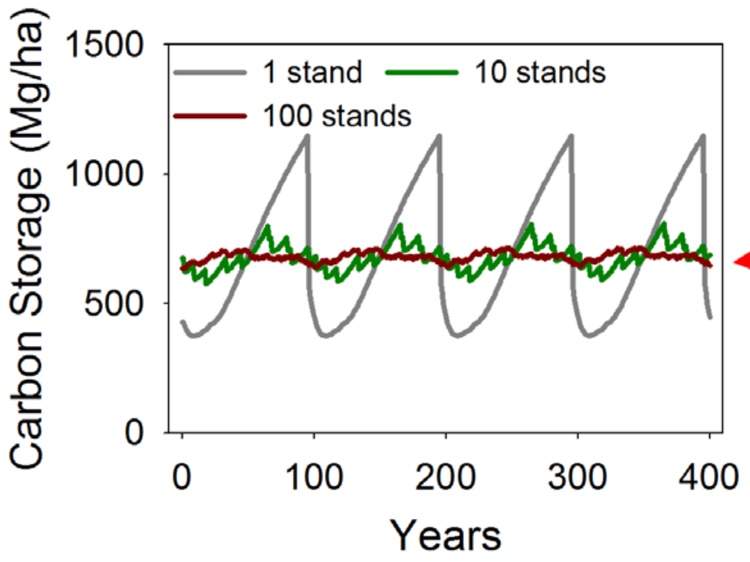


Figure 4. Total forest ecosystem carbon (Tg) for the national forests and grassland in the Rocky Mountain Region from 2005 to 2013.



Best scale to identify trends related to environmental change and land-use

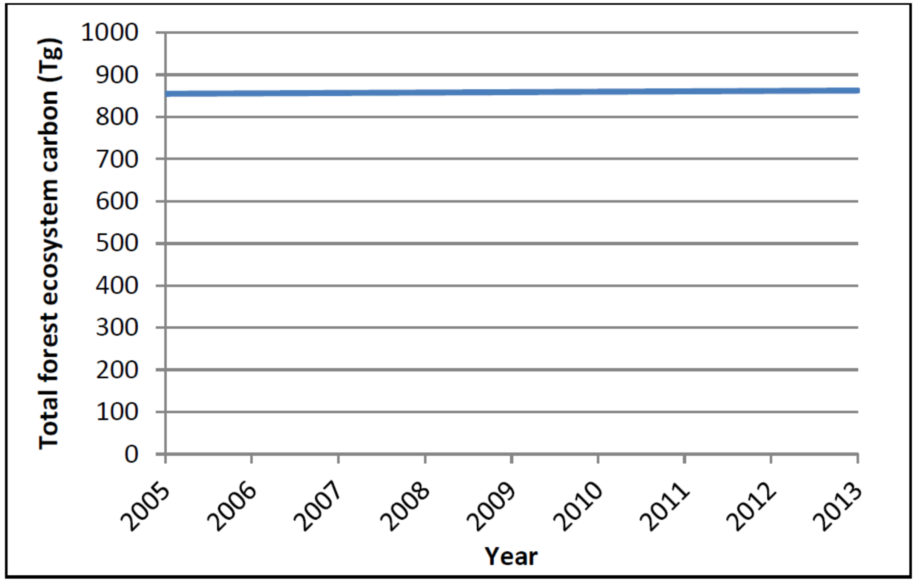
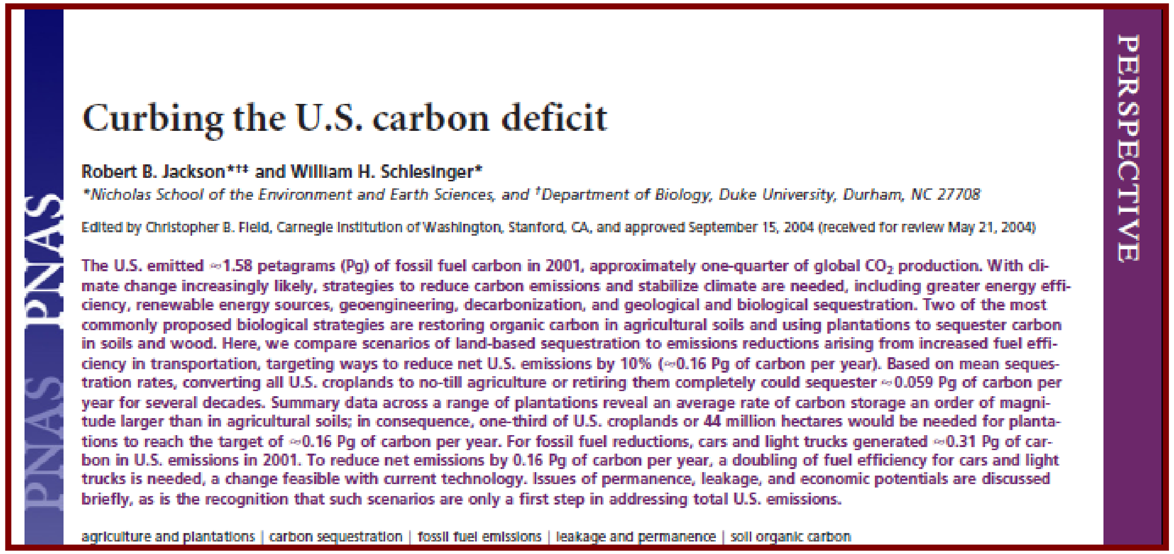


Figure 3. Total forest ecosystem carbon (Tg) for the Rocky Mountain Region from 2005 to 2013.

- Pike & San Isabel and Grande Mesa-Uncompahgre-Gunnision trending downward
- All other forests and region trending upwards

The sequestration side of the coin: what it would take to sequester the equivalent of 10% of the U.S. emissions



PNAS PNAS

PERSPECTIVE

Curbing the U.S. carbon deficit

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*Nicholas School of the Environment and Earth Sciences, and †Department of Biology, Duke University, Durham, NC 27708

Edited by Christopher B. Field, Carnegie Institution of Washington, Stanford, CA, and approved September 15, 2004 (received for review May 21, 2004)

The U.S. emitted ≈1.58 petagrams (Pg) of fossil fuel carbon in 2001, approximately one-quarter of global CO_2 production. With climate change increasingly likely, strategies to reduce carbon emissions and stabilize climate are needed, including greater energy efficiency, renewable energy sources, geoengineering, decarbonization, and geological and biological sequestration. Two of the most commonly proposed biological strategies are restoring organic carbon in agricultural soils and using plantations to sequester carbon in soils and wood. Here, we compare scenarios of land-based sequestration to emissions reductions arising from increased fuel efficiency in transportation, targeting ways to reduce net U.S. emissions by 10% (≈0.16 Pg of carbon per year). Based on mean sequestration rates, converting all U.S. croplands to no-till agriculture or retiring them completely could sequester ≈0.059 Pg of carbon per year for several decades. Summary data across a range of plantations reveal an average rate of carbon storage an order of magnitude larger than in agricultural soils; in consequence, one-third of U.S. croplands or 44 million hectares would be needed for plantations to reach the target of ≈0.16 Pg of carbon per year. For fossil fuel reductions, cars and light trucks generated ≈0.31 Pg of carbon in U.S. emissions in 2001. To reduce net emissions by 0.16 Pg of carbon per year, a doubling of fuel efficiency for cars and light trucks is needed, a change feasible with current technology. Issues of permanence, leakage, and economic potentials are discussed briefly, as is the recognition that such scenarios are only a first step in addressing total U.S. emissions.

agriculture and plantations | carbon sequestration | fossil fuel emissions | leakage and permanence | soil organic carbon

- 10% would require 110 million acres of ag. land – an area larger than the state of California or 65% of the land area of Texas
- ~1 million acres of NFS lands has been identified as needing tree planting, according to NFF
- Just doing 1/10th of 1 percent would require 1.1 million acres or about 1,700 square miles
- Current agency cost of planning 1 acre with trees is about $600 (maintenance costs not included), thus cost to replant 1.1 million acres approaches $700 million.

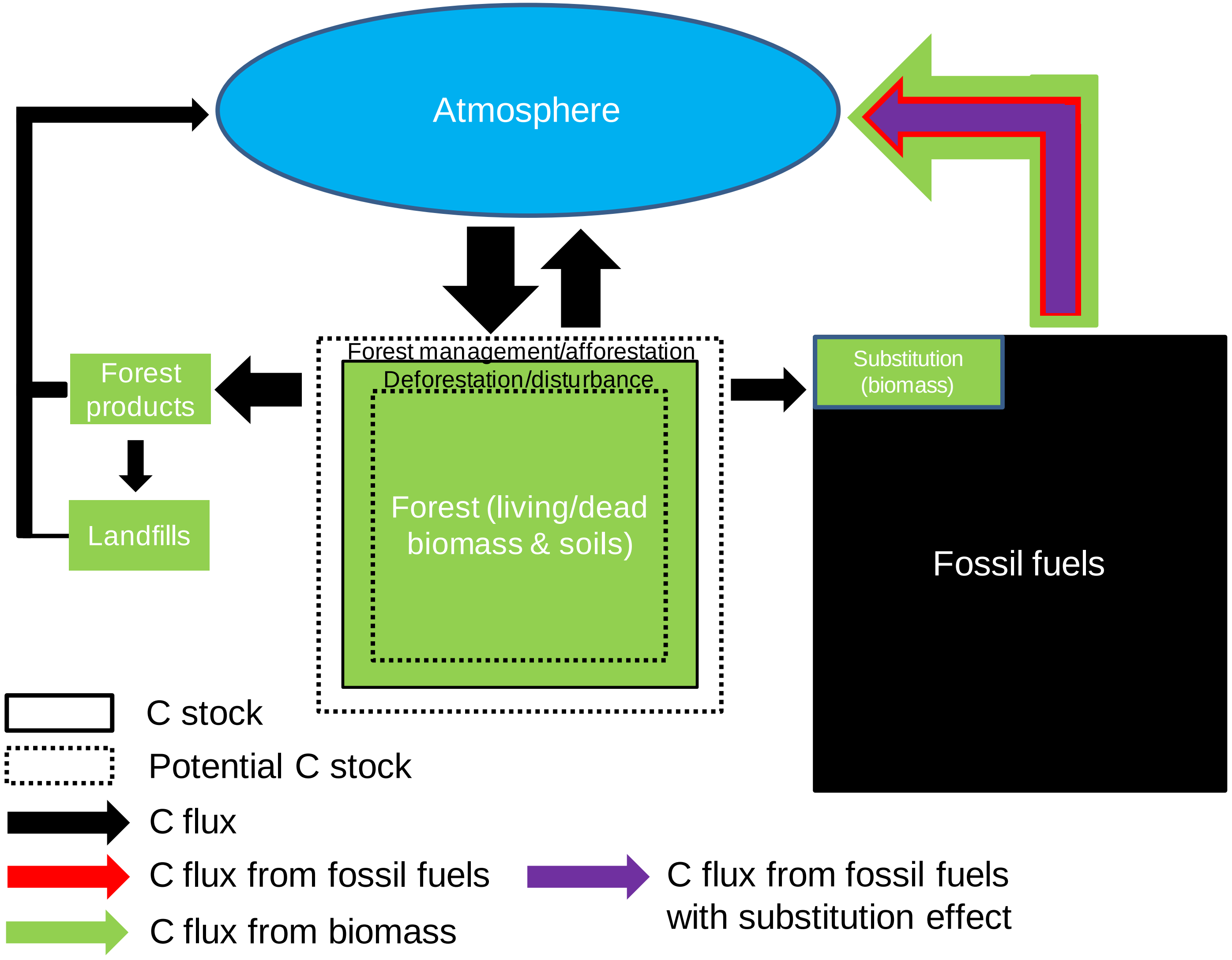
Can we put *individual* management actions or disturbances in context of forest-level dynamics?

Not in a meaningful way at current level of management!

- We can't determine the impact of individual disturbances and management actions (even very large ones) on the broader trends and patterns on the forest, nor should we…
    - Determining the trajectory of carbon (carbon loss or carbon gain) from a cause requires the ability to detect a "signal" from background noise.
    - Patterns and trends are determined by many events over space and time.
    - Massive and sustained human inputs/underlining environmental conditions are needed to move the needle enough (signal) to see effects on carbon.

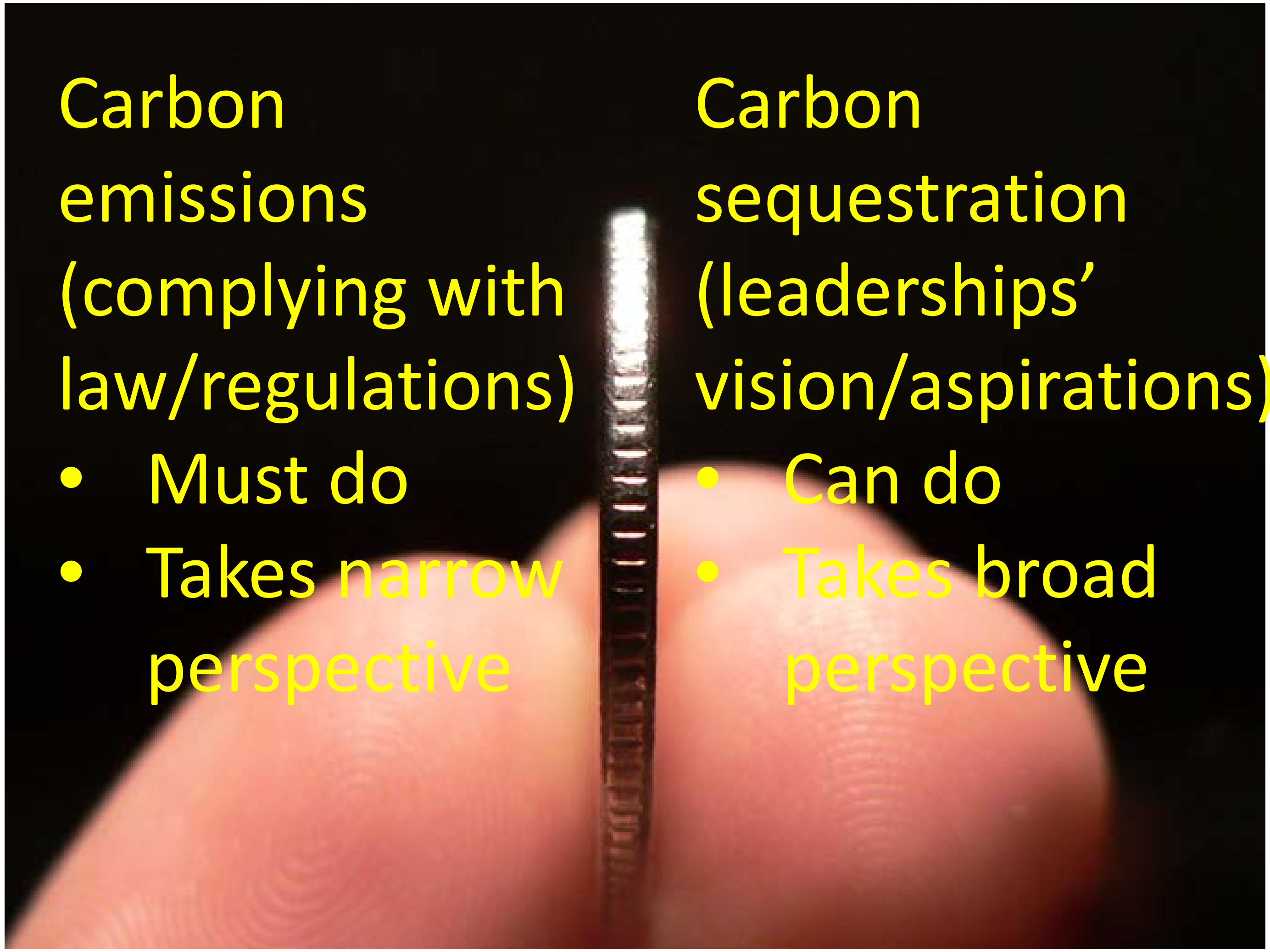
- Footnote:
    - The Baseline Assessments are ideally suited to detect patterns and trends.
    - The Disturbance Assessments have the most value in potentially elucidating mechanisms influencing the trajectory of carbon (e.g., increasing frequency and intensity of disturbances or age/class relationships).

Role of NFS Lands?
A policy perspective



McKinley et al. 2011

Problem/Solution to the carbon problem



Carbon timeline – an evolving vision of mitigation for federal forests

- **2005-2009: focus on "markets for ecosystem services"**
  - Voluntary carbon markets
    - Offset credits
    - Carbon reserves
    - Carbon insurance
- **2014 -2018 USDA Strategic Plan (GHG 17% below 2005 level by 2020):**
  - "help maintain forests as a carbon sink"
    - Plant trees
    - Minimize deforestation
    - Land acquisitions
    - Conservation easements

Broad view

?

- **2010 FS CC Roadmap:**
  - Actively managing carbon stocks
    - Reforestation after disturbance
    - Conserve working forests
    - Tech assistance to increase carbon thru afforestation, reforestation, and forest health
    - Retain greenspace and plant trees in cities
  - Demo projects for development of markets for carbon (private lands)
- **2015 USDA Building Blocks (GHG 26-28% below 2005 level by 2025):**
  - "… Stewardship of federal forests Building Blocks are designed to recover, maintain, and enhance resilience of the carbon sink… through restoration/reforestation"
    - Reforest post-disturbance NFS lands (320,000 acres)
    - Fuel treatments in WUI
    - Sustain or restore watershed function and resilience

Some guiding principles…

1. **Emphasize ecosystem function and resilience.** Carbon sequestration capacity depends on sustaining and enhancing ecosystem function to maintain resilient forests adapted to changing climate and other conditions.
2. **Recognize carbon sequestration as one of many ecosystem services.** Carbon sequestration is one of many benefits provided by forests, grasslands, and forest products, now and in the future. Carbon sequestration should be considered in context with other ecosystem services.
3. **Support diversity of approaches in carbon exchange and markets.** Recognize that decisions about carbon in America's forests are influenced by ownership goals, policy, ecology, geography, socioeconomic concerns, and other factors that vary widely.
4. **Consider system dynamics and scale in decision making.** Evaluate carbon sequestration and cycling at landscape scales over long time frames. Explicitly consider uncertainties and assumptions in evaluating carbon sequestration consequences of forest and grassland management options.
5. **Use the best information and methods to make decisions about carbon management.** Base forest management and policy decisions on the best available science-based knowledge and information about system response and carbon cycling in forests, grasslands, and wood products. Use this information to deal directly with uncertainties, risks, opportunities, and tradeoffs through sound and transparent risk management practices.

Broad view

Forest Service carbon principles

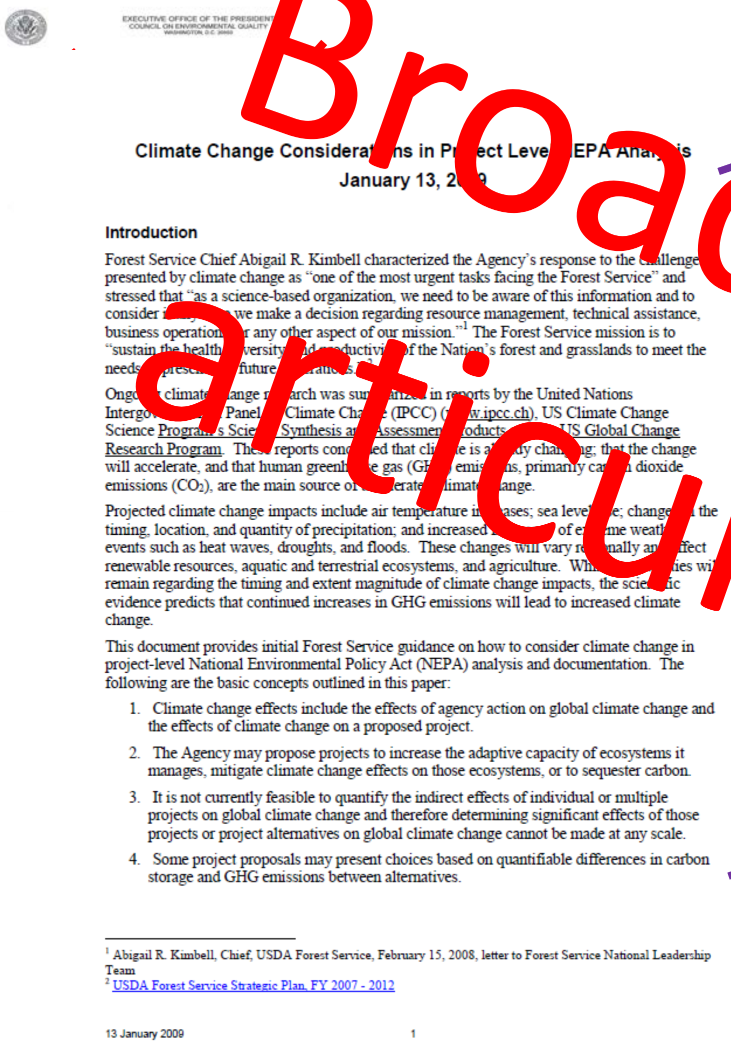
Our directives do not dictate which perspectives to take (broad/narrow nor sequestration/emissions)...

FS Direction (FSH 1909.12.4) related to carbon for planning:

- Assessment of carbon stocks to understand how:
  - The plan area plays a role in sequestering and storing carbon
  - Disturbances, projects, and activities influenced carbon stocks in the past and may affect them in the future
  - Where carbon is stored, how the storage is changing, and how storage might be influenced by management
- Responsible official <u>may</u> consider:
  - Whether existing conditions and trends of vegetation (aboveground carbon pool) indicate that the plan area is a carbon sink or carbon source; and
  - The future trend of the plan area in sequestering and storing carbon under existing plan guidance

No view

NEPA guidance on emissions: compliance with laws and regulations


EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
WASHINGTON, D.C. 20503

Climate Change Considera[illegible]ns in Pr[illegible]ect Leve[illegible]EPA Ana[illegible]is
January 13, 2[illegible]9

Introduction

Forest Service Chief Abigail R. Kimbell characterized the Agency's response to the [illegible]allenge presented by climate change as "one of the most urgent tasks facing the Forest Service" and stressed that "as a science-based organization, we need to be aware of this information and to consider i[illegible] we make a decision regarding resource management, technical assistance, business operation[illegible]r any other aspect of our mission."[1] The Forest Service mission is to "sustain the health[illegible]versity[illegible]of the Nation's forest and grasslands to meet the needs [illegible] future [illegible]."[2]

Ongo[illegible] climate [illegible]ange r[illegible]arch was sum[illegible] in reports by the United Nations Intergo[illegible] Panel [illegible] Climate Cha[illegible] (IPCC) ([illegible]w.ipcc.ch), US Climate Change Science Program's Scie[illegible] Synthesis a[illegible] Assessmen[illegible]roducts [illegible] US Global Change Research Program. The[illegible] reports con[illegible]ed that cli[illegible]te is a[illegible]dy cha[illegible]ng; that the change will accelerate, and that human greenh[illegible]e gas (GH[illegible]) emis[illegible]ns, primarily ca[illegible] dioxide emissions (CO_2), are the main source o[illegible]erate[illegible]limate[illegible]ange.

Projected climate change impacts include air temperature i[illegible]ases; sea leve[illegible]e; change[illegible] the timing, location, and quantity of precipitation; and increased [illegible] of e[illegible]me weat[illegible] events such as heat waves, droughts, and floods. These changes will vary re[illegible]nally an[illegible]ffect renewable resources, aquatic and terrestrial ecosystems, and agriculture. Wh[illegible]ies wi[illegible] remain regarding the timing and extent magnitude of climate change impacts, the scie[illegible]ic evidence predicts that continued increases in GHG emissions will lead to increased climate change.

This document provides initial Forest Service guidance on how to consider climate change in project-level National Environmental Policy Act (NEPA) analysis and documentation. The following are the basic concepts outlined in this paper:

1. Climate change effects include the effects of agency action on global climate change and the effects of climate change on a proposed project.
2. The Agency may propose projects to increase the adaptive capacity of ecosystems it manages, mitigate climate change effects on those ecosystems, or to sequester carbon.
3. It is not currently feasible to quantify the indirect effects of individual or multiple projects on global climate change and therefore determining significant effects of those projects or project alternatives on global climate change cannot be made at any scale.
4. Some project proposals may present choices based on quantifiable differences in carbon storage and GHG emissions between alternatives.

[1] Abigail R. Kimbell, Chief, USDA Forest Service, February 15, 2008, letter to Forest Service National Leadership Team
[2] USDA Forest Service Strategic Plan, FY 2007 - 2012

13 January 2009 1

Forest Service NEPA guidance

"As GHG emissions are integrated across the global atmosphere, it is not possible to determine the cumulative impact on global climate from emissions associated with any number of particular projects. Nor is it expected that such disclosure would provide a practical or meaningful effects analysis for project decisions.

Where a proposed project would be anticipated to emit relatively large amounts of greenhouse gases (e.g., large-scale oil and gas development project), the following may be appropriate.

1. Quantify the expected annual and total emissions from the project, where possible, using already generated data from air quality analyses;
2. Provide context for these numbers by comparing to other emission sources (e.g., individual, regional, national, global); and
3. Qualitatively describe the effects of GHG emissions on climate change."

"Climate change mitigation could be an objective or a complementary objective for a particular proposal." e.g., referred to avoided emission at some point in the future…

Broad view, but poorly articulated

Congress has weighed in, a bit…

H.R.244 - Consolidated Appropriations Act, 2017, signed into law 5/5/17. Section 428, Polices relating to biomass energy, Pages 901-902

- Federal agencies to recognize the carbon neutrality of forest biomass when used for energy
- Conditional on "providing] the use of forest biomass for energy production does not cause conversion of forests to non-forest use."

Broad view

The law is consistent with the "broad" view of the forest system by recognizing the closed carbon loop associated with biogenic emissions.

ROLE OF NFS LANDS…

Carbon emissions:

- No caps/limits on emissions
- CO_2 not regulated
- Need driven by NEPA case law

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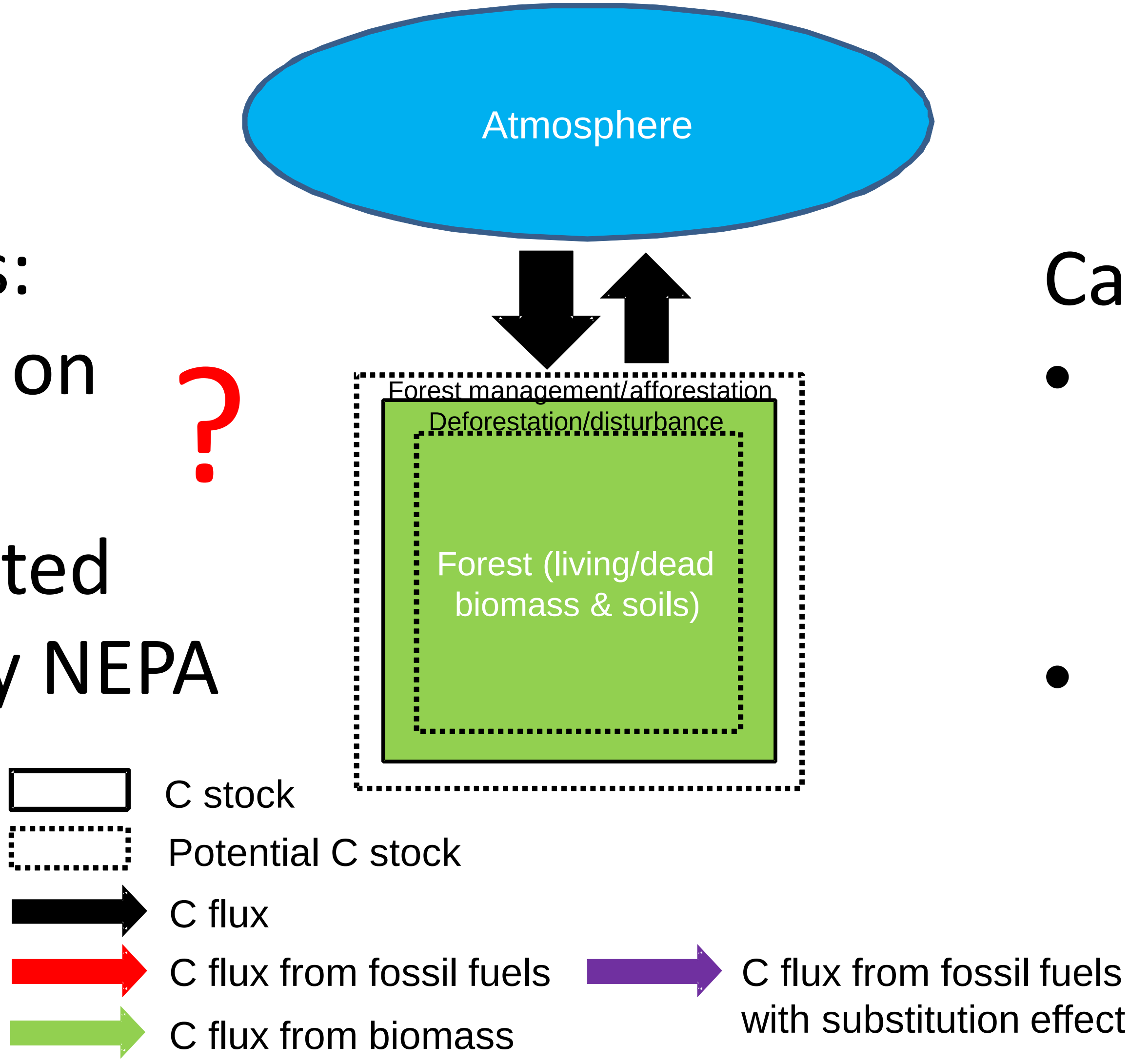


Carbon sequestration:

- As articulated by agency "vision" documents
- optional

McKinley et al. 2011

Key Points – policy perspective

- *****_Science and policy perspectives agree exceptionally well!_ The currently defined role for NFS lands in carbon mitigation is articulated as simply maintaining the carbon sink through restoration to keep forests healthy and keep forests as forests
- The Forest Service may have additional roles related to carbon, that <u>do not</u> involve NFS lands
- Agency policy and direction do not establish specific goals for management of carbon – units maintain discretion
- No law/regulation defines a “large” emission or otherwise establishes a threshold to trigger a quantitative analysis for NEPA

Some ideas about what this might mean for your work…

Forest Service guidance and strategies fully support taking a broad view, which means that specialists can…

- Emphasize the carbon benefits inherent to most vegetation management activities

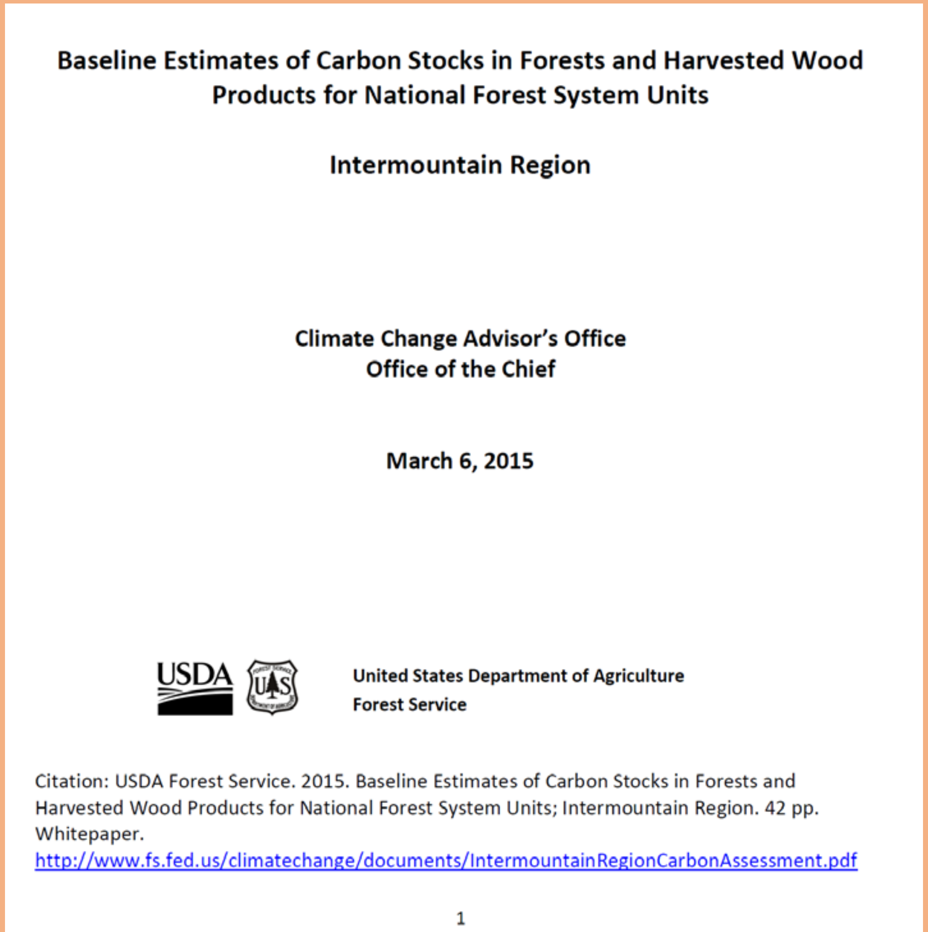
- Put carbon loss/emissions in context: more thoughtful about effects on carbon with respect to scale and fate of carbon once it leaves the forest system (e.g., wood products)

- Focus on what's really important with respect to carbon – e.g., avoiding loss of forest (grassland) land

- FS veg. management is good carbon stewardship! Own it!!

Background: two standardized reports for each NFS region

Stocks



Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units

Intermountain Region

Climate Change Advisor's Office
Office of the Chief

March 6, 2015

USDA

United States Department of Agriculture
Forest Service

Citation: USDA Forest Service. 2015. Baseline Estimates of Carbon Stocks in Forests and Harvested Wood Products for National Forest System Units; Intermountain Region. 42 pp. Whitepaper.
http://www.fs.fed.us/climatechange/documents/IntermountainRegionCarbonAssessment.pdf

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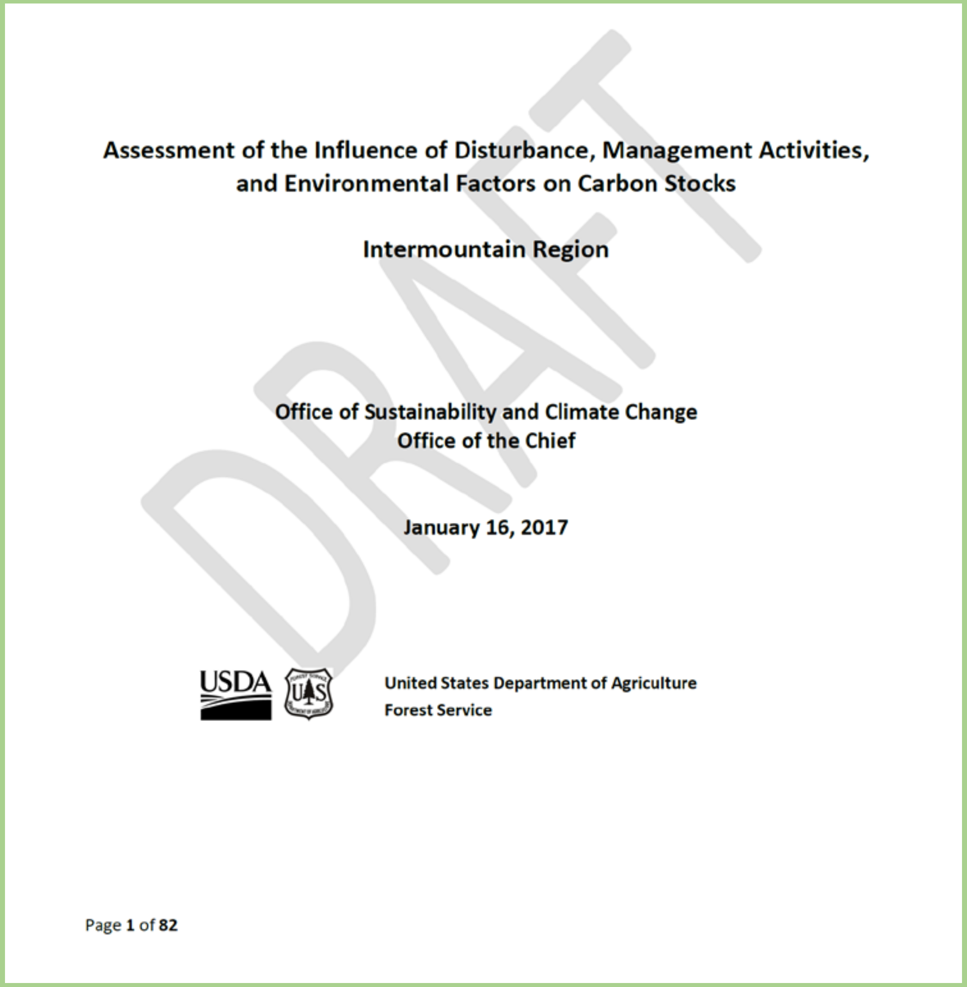
Impact of Management and Disturbance



Assessment of the Influence of Disturbance, Management Activities, and Environmental Factors on Carbon Stocks

Intermountain Region

Office of Sustainability and Climate Change
Office of the Chief

January 16, 2017

DRAFT

USDA

United States Department of Agriculture
Forest Service

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These reports can provide information relevant to the 2012 Planning Rule

FOREST CARBON WORK PLAN

Implementation Timeline	Phase 1	Phase 2	Phase 3
	Complete September 2018(?)	Begin May 2018	Begin October 2018
	Finalizing guidebook (in press)	Internal campaign	External campaign on forest carbon and mitigating activities
Goal	Finalize guidebook and begin creating awareness and education	Piloting templates and communication products with R/S/A Coordinators and Planners	Creating external educational materials for public, NEPA commenters
Communications	Guidebook (GTR)	3 Templates, White Paper, Webinar, Talking Points/FAQs	Fact sheets: carbon and wildfire; carbon and prescribed burning; carbon and salvage harvesting
Evaluation			Reduction of carbon comments in NEPA. Increased engagement with partners.

Questions?

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