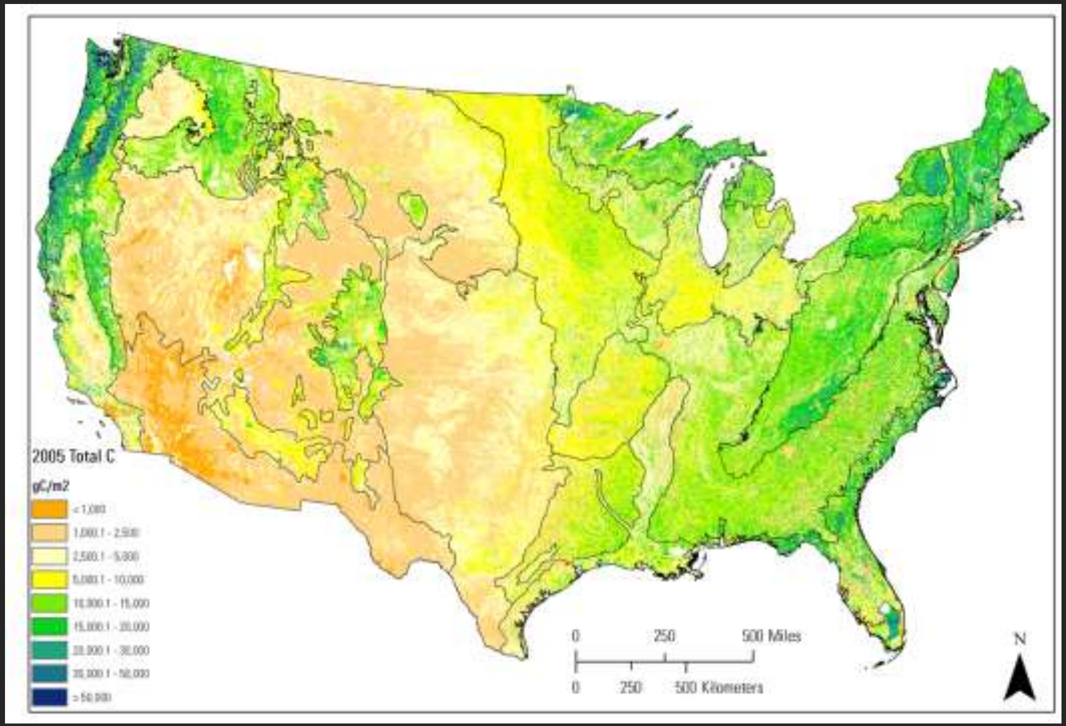
National Assessment of Ecosystem Carbon Sequestration and Greenhouse Gas Fluxes



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Energy Independence and Security Act § 712 calls for DOI to:

- Determine the current stocks and fluxes of ecosystem carbon and other greenhouse gases (methane and nitrous oxide)
- National assessment covering all major terrestrial and aquatic ecosystems
- Estimate potential capacity of ecosystems to increase carbon sequestration
- Consider policy applications (e.g. adaptation and mitigation applications)
- Consider effects of climate change and other controlling processes such as land use and ecosystem disturbances
- Consult with DOI bureaus and other organizations

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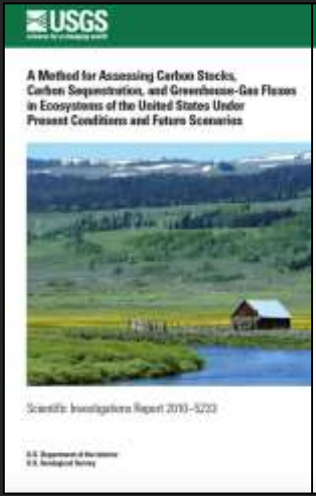
Timeline of Assessment Reports

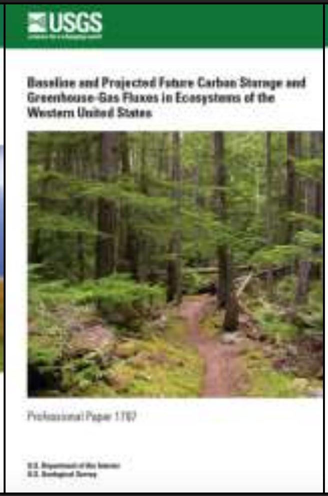
- 2010 – published Methodology document
- 2011 – assessment for Great Plains
- 2012 – assessment for Western US
- 2014 – assessment for Eastern US
- 2016 – assessments for Alaska

Methodology 2011

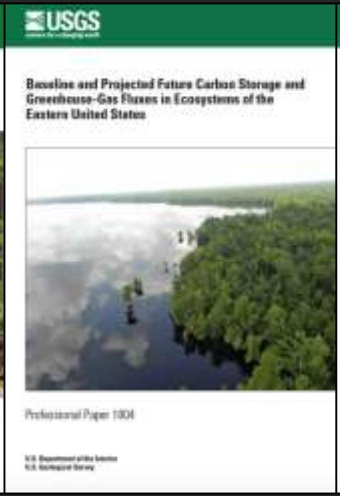


Great Plains 2011

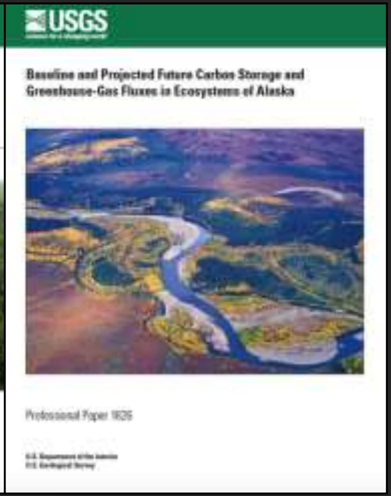
Western U.S. 2012



Eastern U.S. 2014



Alaska 2016



Baseline and Projections

- **2001-2005 are the Baseline years for carbon reporting**
- **Perform land change and Carbon projections to 2050, based on 3 climate models (with a range of temperature and precipitation trends) and 3 IPCC Special Report on Emissions Scenarios (SRES) storylines:**
  - A1B – rapid economic growth, high technology innovation
  - A2 – moderate economic growth, high population increase
  - B1 – moderate economic growth, environmental sustainability

Unique Use of Remote Sensing

- National Greenhouse Gas Inventory is largely based on USDA's Forest Inventory and Analysis (FIA) and National Resource Inventory (NRI) *in situ* observations. The USGS assessment uses FIA and NRI data and supplements significantly with remote sensing data:
  - **Landsat**
    - Land cover (National Land Cover Database)
    - Land cover change (NLCD and Vegetation Change Tracker)
    - Fires (Monitoring Trends in Burn Severity)
  - **MODIS**
    - Net primary production
    - Irrigation

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Extensive Use of Models

- **A series of models were used in this analysis**
  - Land change projections (IMAGE, FORE-SCE)
  - Fire extent and emissions (CONSUM, FOFEM)
  - Biogeochemical models (General Ensemble Modeling System)
    - Century
    - Erosion Deposition Carbon Model
    - Land Greenhouse-gas Accounting Tool
  - Hydrology
    - SPARROW
    - LOADEST

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Conterminous US Results: Baseline and Projected Land Use and Land Cover Change

	Baseline Area (km²)	% of total area		2050 Area (km²)	% of total area		Change in % composition
Forest	2,323,458	29.6		2,214,153	28.2		-1.40
Agriculture	2,033,000	25.9		2,158,948	27.5		1.60
Shrub/Grass	2,657,306	33.8		2,510,995	32.0		-1.80
Wetland	311,482	4.0		313,717	4.0		-
Other	531,380	6.8		658,813	8.4		1.60
Total	7,856,626			7,856,626			

Less forest and shrub/grass, more agriculture and urbanization, stable wetland numbers

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Land Change Modeling: SE USA example

- Demand for forest harvesting
- Increased urbanization
- Little new forest land

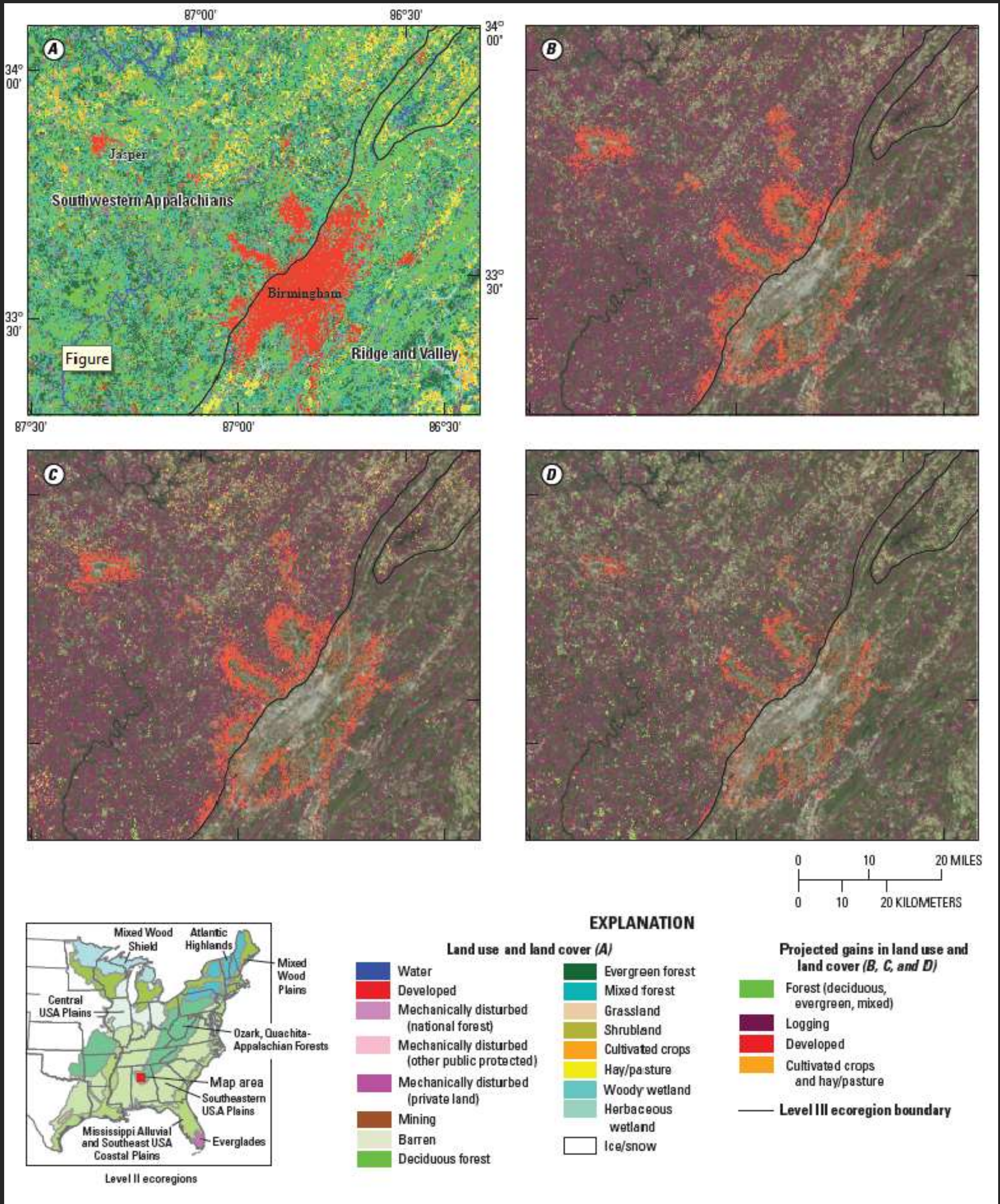

Figure 3–14. Maps showing *A*, land use and land cover (LULC) and a comparison of the projected LULC change in scenarios *B*, A1B, C, A2, and *D*, B1 in 2050 for the area Birmingham, Alabama, in the Ozark, Ouachita-Appalachian Forests ecoregion. Changes were projected to be the result of land-use change (agricultural lands, forests, developed lands) or forest clearcutting.

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Conterminous US Carbon stock* by Ecosystem type (TgC)

	2000	2010	2020	2030	2040	2050
Forest	26756 (23524-29010)	29613 (27318--31704)	32318 (30382-34864)	34888 (32361-38401)	37253 (334416-79420)	39499 (36114-45653)
Agriculture	7907 (7789-8072)	8306 (7982-8817)	8734 (8076-9759)	9285 (8337-10500)	9888 (8708-11222)	10467 (9057-12108)
Grass/Shrub	6098 (5618-6914)	6505 (5776-7503)	6704 (5842-7902)	6811 (5887-8010)	6979 (6039-8361)	7168 (6223-8731)
Wetland	4051 (3670-4310)	4441 (4127-4752)	4966 (4666-5303)	5470 (5106-5868)	5948 (5568-6363)	6375 (5952-6823)
Other	339 (75-572)	391 (172-612)	460 (235-687)	525 (288-747)	572 (333-778)	594 (359-777)
Total	45151 (41687-47246)	49256 (47078-51883)	53190 (50592-56704)	56987 (53672-61355)	60658 (57074-66354)	64107 (59992-71082)

USGS

* In this table, stocks are averaged for each decade over 3 SRES scenarios, 3 GCMs, and 2 BGC models. Range of results is in parentheses.

Carbon flux* by Ecosystem type in TgC/yr

	2010	2020	2030	2040	2050
Forest	-292 (-59 to -533)	-276 (-46 to -550)	-256 (-77 to -578)	-236 (-15 to -512)	-225 (7 to -610)
Agriculture	-44 (47 to -128)	-39 (103 to -136)	-46 (52 to -117)	-53 (55 to -154)	-49 (10 to -146)
Grass/Shrub	-44 (37 to -138)	-22 (43 to -148)	-11 (48 to -106)	-17 (-54 to -111)	-19 (59 to -111)
Wetland	-39 (-27 to -82)	-53 (-20 to -81)	-52 (-28 to -75)	-48 (-15 to -70)	-43 (-5 to -80)
Other	-5 (1 to -15)	-7 (-1 to -14)	-6 (-1 to -13)	-5 (2 to -11)	-2 (8 to -9)
Total	-431 (-163 to -808)	-405 (-124 to -776)	-378 (-83 to -804)	-367 (-31 to -733)	-345 (-11 to -793)

* In this table, flux averaged for each decade over 3 SRES scenarios, 3 GCMs, and 2 BGC models. (range of results in parentheses). Negative numbers indicate carbon sink, positive numbers indicate carbon source.

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Carbon stock and flux by Ecosystem type

- Wide range of results are highly dependent on scenario and model used
- Most results indicate a growing carbon stock
- Under most scenarios, there is a decreasing carbon sink in the conterminous US

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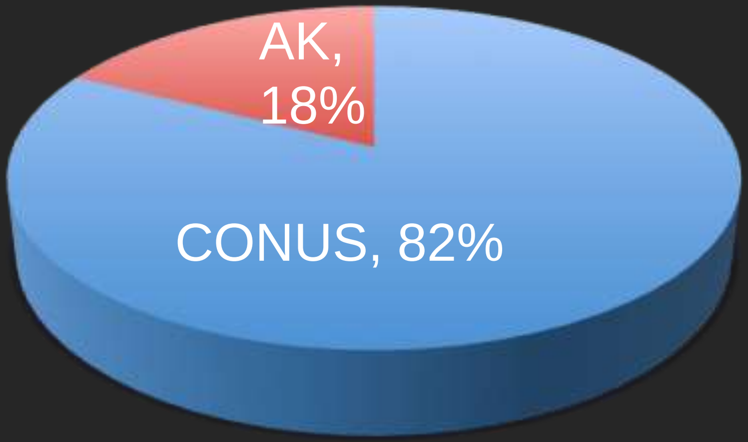
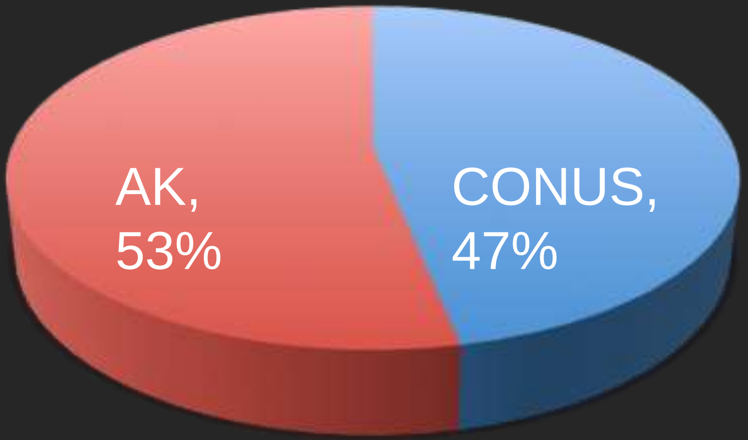
Alaska contains massive carbon stocks

Alaska has 225 million acres of Federal land (61.8% of the state). Federal land holdings in Alaska constitute 36% of all Fed lands across U.S. (623.3m acres).

Total area



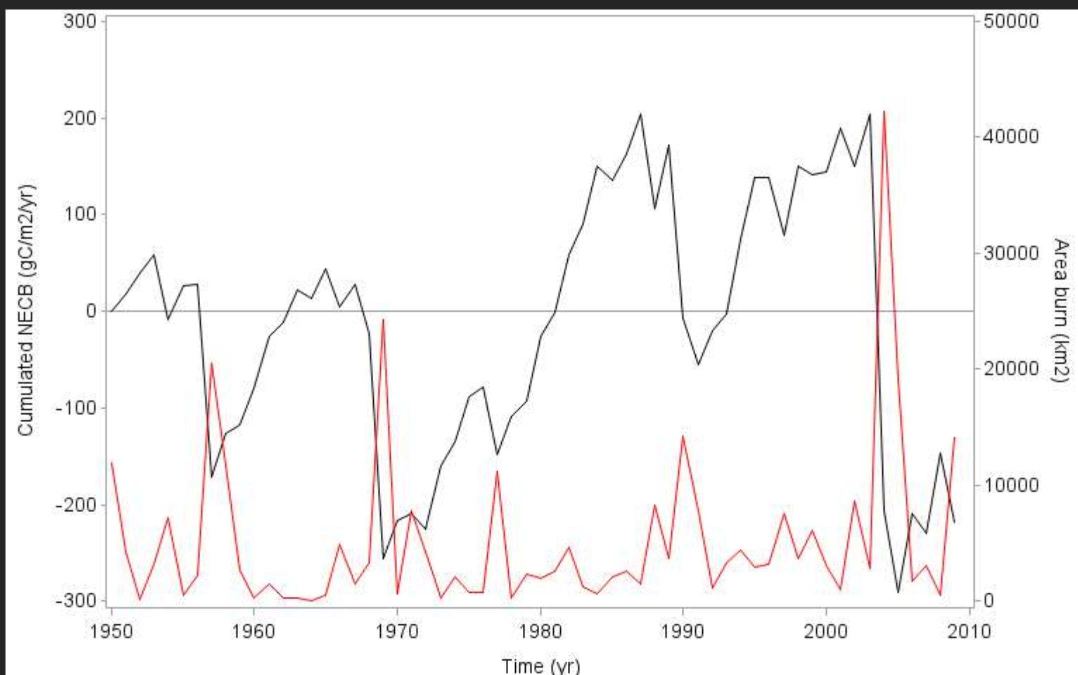
Total carbon stock[1]



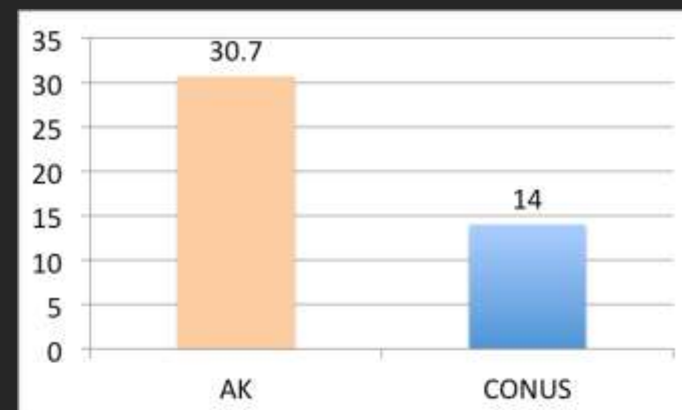
[1]Zhu and McGuire, eds., 2016

The role of fire in GHG emissions in Alaska

Relationship between cumulative carbon sequestration (black line) and area of fire (red line)



GHG emissions by fires



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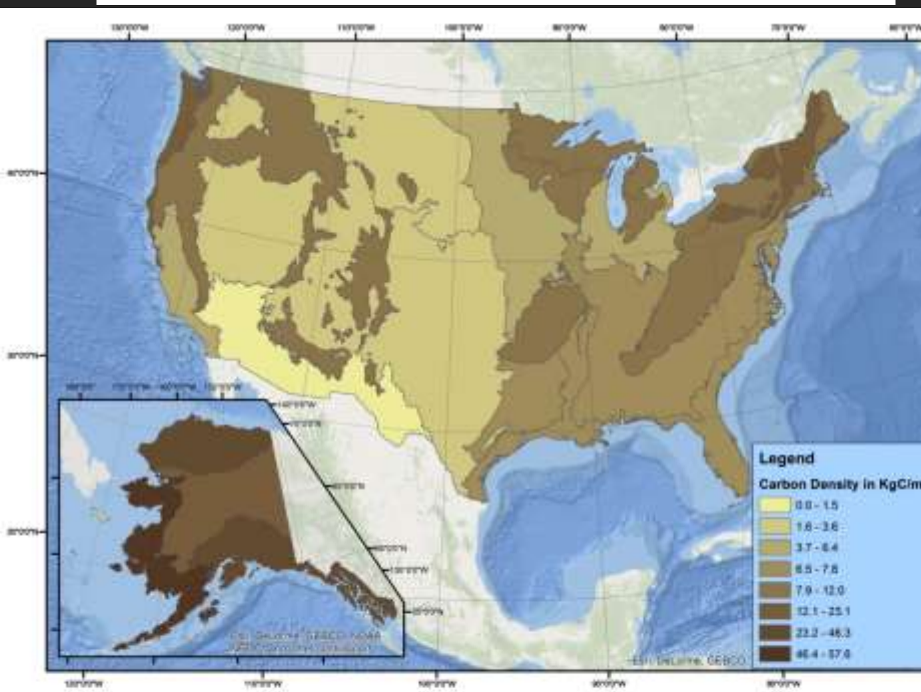
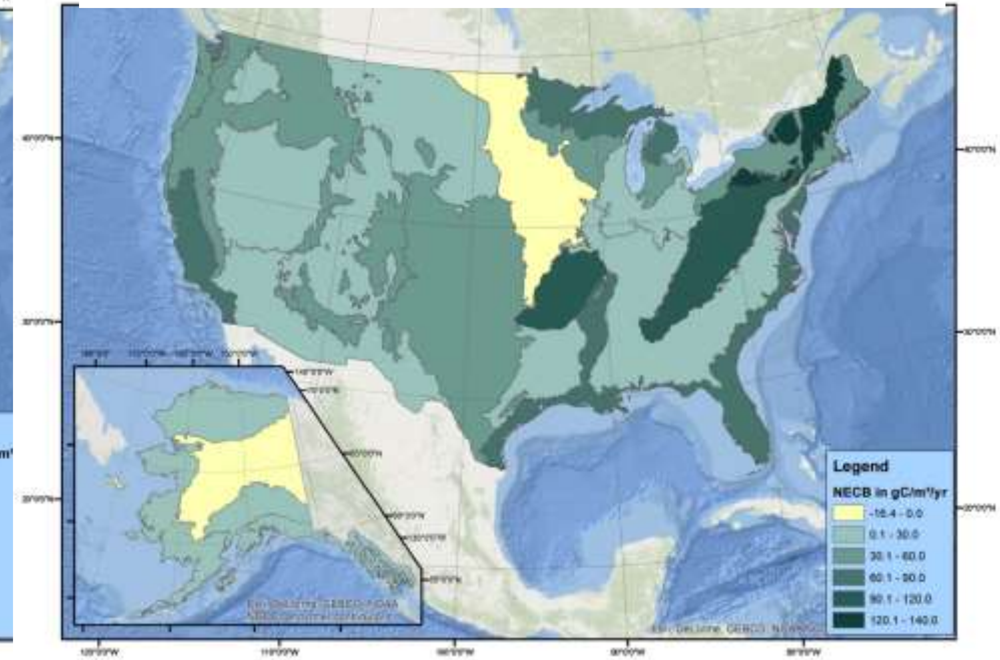
Alaska is a weak carbon sink

Carbon stock (KgC/m²)



Net ecosystem carbon balance (gC/m²/yr)



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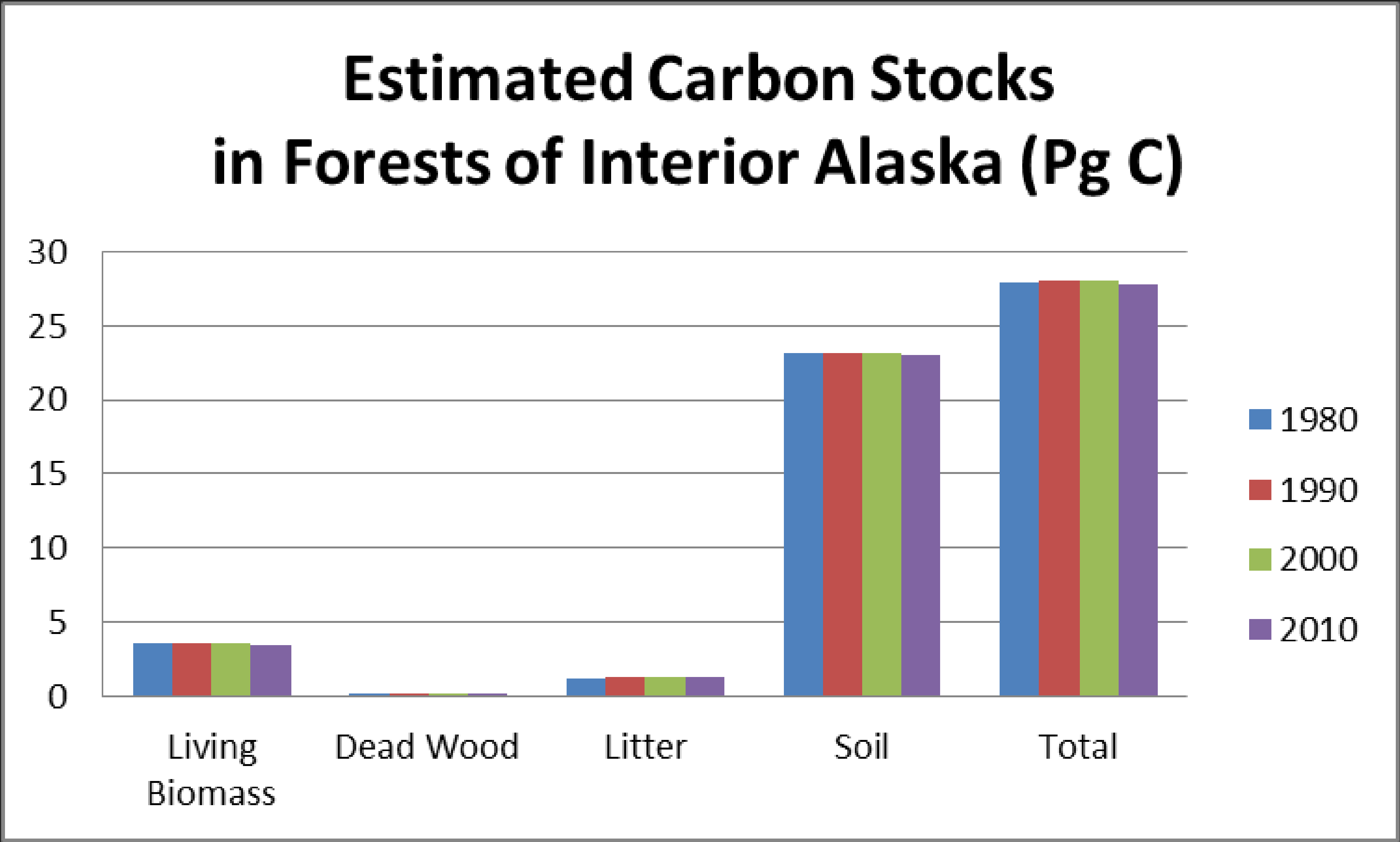
Even though Alaska stores more carbon than the rest of the U.S. combined, the state as a whole is a weak carbon sink ~ 3.7 TgC/yr. And the boreal region is a carbon source by 7.9 TgC/yr.

Zhu and McGuire, eds., 2016


Estimated Carbon Stocks
in Forests of Interior Alaska (Pg C)
30
25
20
15
10
5
0
Living Biomass
Dead Wood
Litter
Soil
Total
1980
1990
2000
2010

USGS

Next Steps

- Complete assessment (2017)
- Regular assessments of Interior lands

Using Assessment to support Decision Making

- Decision support to land managers
- Develop capabilities to routinely update the assessments, tracking the effects of wildfire, drought, and other changing conditions on carbon storage (partnerships with other Interior Bureaus)

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USGS

Partnership with USFWS
(Great Dismal Swamp and other NWRs)

- **Provide information on C balance; understand how management and/or restoration could potentially increase C storage**
- **Estimate effects of hydrologic management on carbon sequestration, fire management, and establishing selected types of vegetation communities**
- **Enhance carbon sequestration on public lands while quantifying ecosystem service tradeoffs**




Biological Carbon Sequestration

Closing thoughts:

- USGS has completed an assessment of biological carbon sequestration in the conterminous US
- It appears that the US will continue to be a carbon sink, although the strength of the sink may be weakening
- Work is underway to integrate the assessment into land management actions

Thank you!

For more information:

https://www2.usgs.gov/climate_landuse/land_carbon

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