2014 Interior Alaska Highlights:
Forests of the Tanana Valley State Forest and Tetlin National Wildlife Refuge Alaska

This briefing is a synopsis of a more detailed report that is being published by the FIA program (Pattison et al. in press).

The Forest Inventory and Analysis (FIA) program of the United States Forest Service monitors the status and trends in the forests of the United States. One key region of the US that has yet to be inventoried is Alaska's interior boreal forests. Remoteness, limited road network and lack of infrastructure have prevented the FIA program from establishing an inventory in the region (Barrett and Gray 2011).

Increases in temperature, permafrost melt, and wildfire may be causing reduced tree growth, increased tree death, and loss of forestland. Better understanding of these changes will help us determine whether interior forests are a carbon source to the atmosphere, and assess a sustainable rate of forest use for local communities.

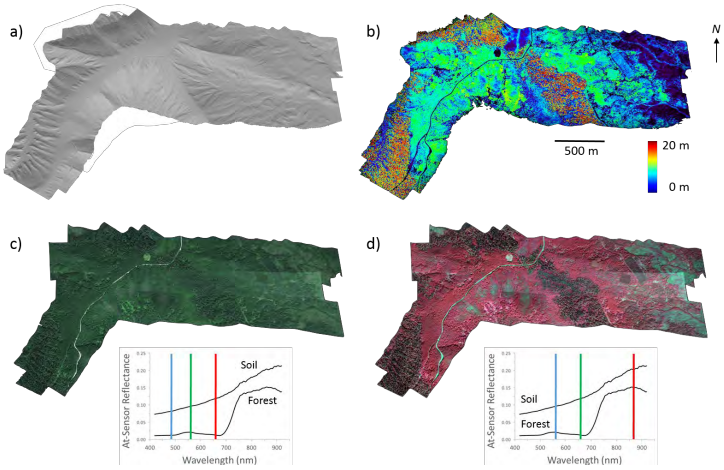
In 2014 the Pacific Northwest Research Station's FIA (PNW-FIA) program along with NASA Goddard's Space Flight Center carried out a pilot inventory in the Tanana River Valley of interior Alaska. The inventory occurred on the State of Alaska's Tanana Valley State Forest (TVSF) and the US Fish and Wildlife Service's Tetlin National Wildlife Refuge (TNWR).

The inventory was a partnership between multiple agencies and organizations including **Alaska Division of Forestry, University of Alaska, US Fish and Wildlife Service, US Geological Survey, US National Aeronautic and Space Administration, and Oregon State University.** The design and protocols tested during this pilot were refined for the implementation of the large scale inventory of forests of interior Alaska that started in 2016.

Working in remote locations like interior Alaska is logistically difficult. The sheer size of the area involved (110 million acres) requires a different approach to forest inventory. We've partnered with NASA's Goddard Space Flight Center to more efficiently cover the ground from the sky than we typically could by visiting the standard Forest Inventory and Analysis network of plots.

Each point here will be imaged with airborne LiDAR and visited by crews to measure trees and their condition.

By utilizing cutting-edge Remote sensing technologies we are able to perform an efficient and cost effective inventory and collect additional data that can answer critical questions.



Examples of G-LiHT measurements for an area within Bonanza Creek Experimental Forest. a) LiDAR-derived terrain model, b) LiDAR-derived canopy height model, c) normal-color image derived from hyperspectral sensor data, d) color-infrared image derived from hyperspectral sensor data. Continuous spectral profiles for various features (soil (left) and forest (right)) are shown in insets.

2014 Interior Alaska Highlighted Findings

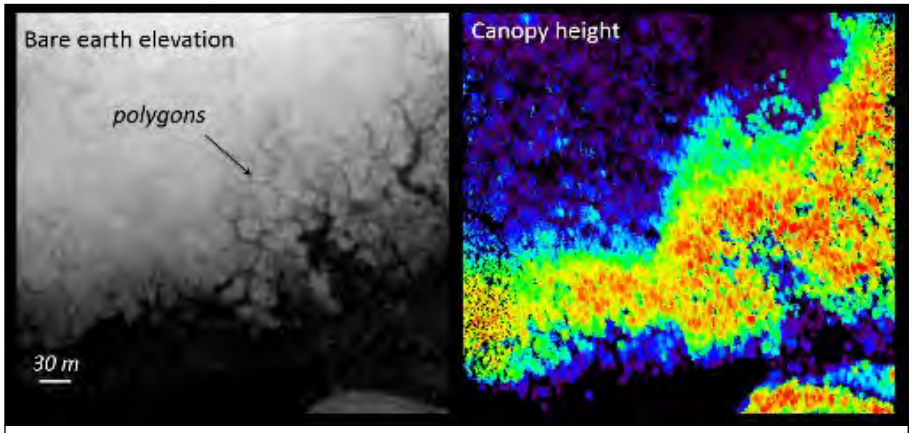
With the data collected during the 2014 pilot study we report findings on:

- **G-LiHT imaging of forest structure**
- **Forest types**
- **Tree biomass**
- **Forest vegetation**
- **Forest down woody material**
- **Soil carbon**
- **Ground layer: moss and lichen mats**
- **Forest carbon pools**

G-LiHT Imaging of Forest Structure

Example of G-LiHT airborne remote sensing data collected in the Tanana Valley. A LiDAR point cloud colored with hyperspectral (normal color) image.

By partnering with NASA's Goddard Space Flight Center to cover the ground from the sky we're conducting an extremely cost effective forest inventory while working in an extremely remote and logistically difficult location. In interior Alaska, we'll visit one plot every 30,000 acres and supplement this sample of field visited ground plots with the remote sensing system G-LiHT that uses **LiDAR**, **Hyperspectral**, and **Thermal** imaging components. Together these systems are used to identify relationships with a subset of the measurements and data that field crews collect when they visit the ground plots.

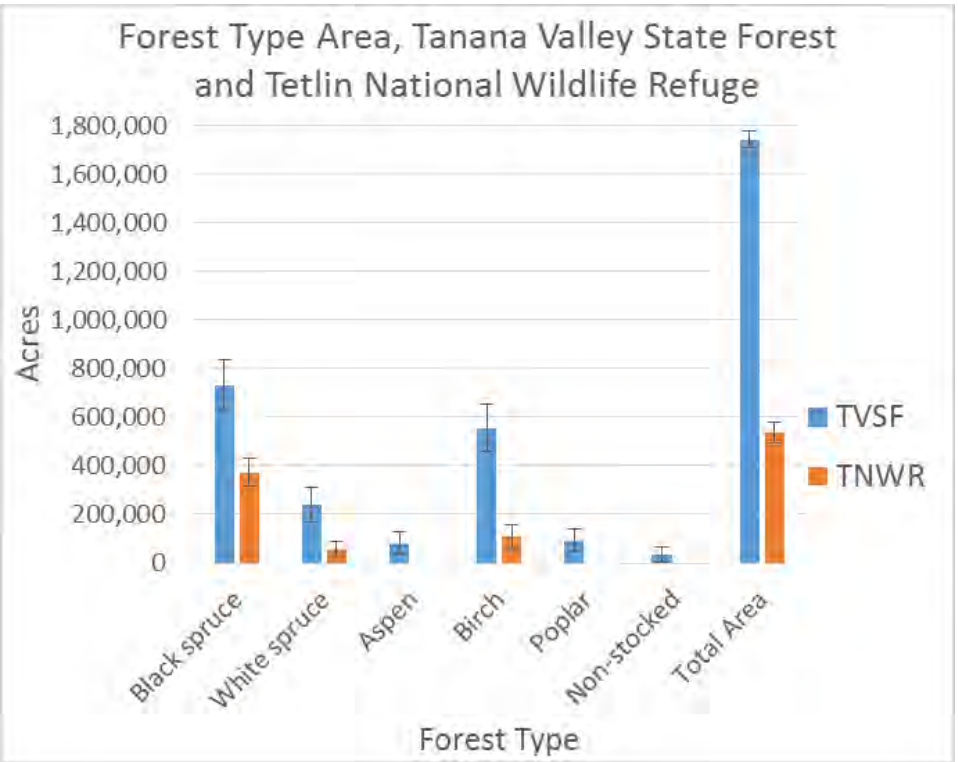


Example of small-scale geomorphological features (patterned ground (polygons) in permafrost soils) captured in G-LiHT high-resolution LiDAR terrain model

For example, biomass estimated from field measurements of diameter and height for individual trees and forest types are related to the three-dimensional canopy structure derived from the G-LiHT LiDAR metrics. Once the relationships between field measurements and the G-LiHT components are tested, the G-LiHT data are used to provide more precise estimates of key landscape components, like numbers of trees, volume, biomass, and carbon mass according to forest types. More detailed information about the G-LiHT sensor can be found at: https://gliht.gsfc.nasa.gov/

G-LiHT data are being acquired in 250 meter wide swaths spaced at 9.3 km intervals for the area of interest. Flight lines include FIA plot locations and will help to asses the variability in aboveground biomass.

2014 Interior Alaska Highlighted Findings



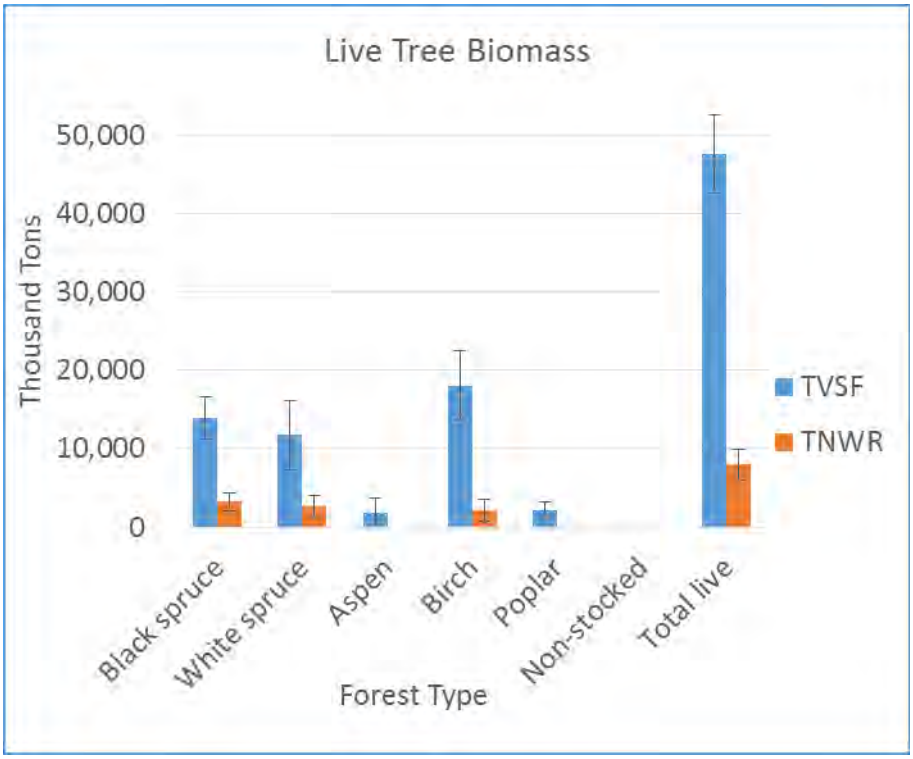
Number of acres by forest type in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR).

Forest Types

- Interior forests are dominated by a few forest types. About half the forest area was **black spruce** (*Picea mariana*) forest type and almost a third was **birch** (*Betula neoalaskana*).
- **Black spruce** was the most common forest type, covering 49 ± 5 percent of the forested land area (total ± standard error).

Tree Biomass

- Most of the above-ground live tree biomass was found in **birch** (18.0 ± 4.4 million tons) and **black spruce** (13.9 ± 2.7 million tons) forest types on the TVSF.
- However **white spruce** (*Picea glauca*) forest types had the highest mean aboveground live tree biomass per acre on both the TVSF (48.8 ± 11.6 tons per acre) and TNWR (46.2 ± 4.8 tons per acre). **Black spruce** forests on the TNWR had the lowest mean biomass per acre (8.8 ±2.8 tons per acre).
- Standing dead tree biomass was 8 percent of the amount in the live tree pool, with the greatest amounts in the **white spruce** forest type.



Total tree biomass in thousands of tons by forest type in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR).

2014 Interior Alaska Highlighted Findings

Forest Vegetation

- Mean cover of tally tree species was greater on TVSF than TNWR.

- Mean shrub and grass cover were comparable among units, while forb cover was greater on TVSF than on TNWR.

- Low shrubs are an important component in all forest types but tall shrubs are most important in **white spruce**, **birch**, and **balsam poplar** (*Populus balsamifera*) forest types.

- The most common vascular plant species recorded overall include (in descending order): **lingonberry** (*Vaccinium vitis-idaea)*, **black spruce**, **Alaska birch**, **bog Labrador tea** (*Ledum groenlandicum*), **white spruce**, **green alder** (*Alnus viridis*), **bog blueberry** (*Vaccinium uliginosum*), and **prickly rose** (*Rosa acicularis*).

Most common abundant species and percentage of plots where recorded overall and by forest type

		Forest type					
Species common name	**All Plots (n=98)**	**Black spruce (n=38)**	**Alaska birch (n=20)**	**White spruce (n=8)**	**Balsam poplar (n=3)**	**Aspen (n=3)**	**Other (n=25)**
		Percentage of plots where recorded					
Lingonberry	72 [1]	84 [3]	65 [4]	38	0	33	88
Black spruce	68 [2]	100 [1]	45	0	0	33	76
Alaska birch	67 [3]	53 [4]	100 [1]	88 [2]	0	67 [2]	68
Bog Labrador tea	62 [4]	87 [2]	55 [5]	0	0	33	64
White spruce	58 [5]	34	70 [3]	100 [1]	67 [2]	67 [2]	72
Green alder	53 [6]	40	75 [2]	63 [3]	0	67 [2]	60
Bog blueberry	38 [7]	53 [4]	25	0	0	33	44
Prickly rose	36 [8]	8	70 [3]	88 [2]	67 [2]	33	32
Bluejoint	28 [9]	13	40	38	67 [2]	67 [2]	28
Dwarf birch	24 [10]	42 [5]	5	0	0	0	24
Field horsetail	16	11	20	63 [3]	67 [2]	33	16
Quaking aspen	16	11	30	25	0	100 [1]	4
Fireweed	12	3	25	13	33	67 [2]	8
Thinleaf alder	8	0	5	38	100 [1]	0	4
Balsam poplar	6	0	5	13	100 [1]	0	4
Redosier dogwood	2	0	0	0	67 [2]	0	0

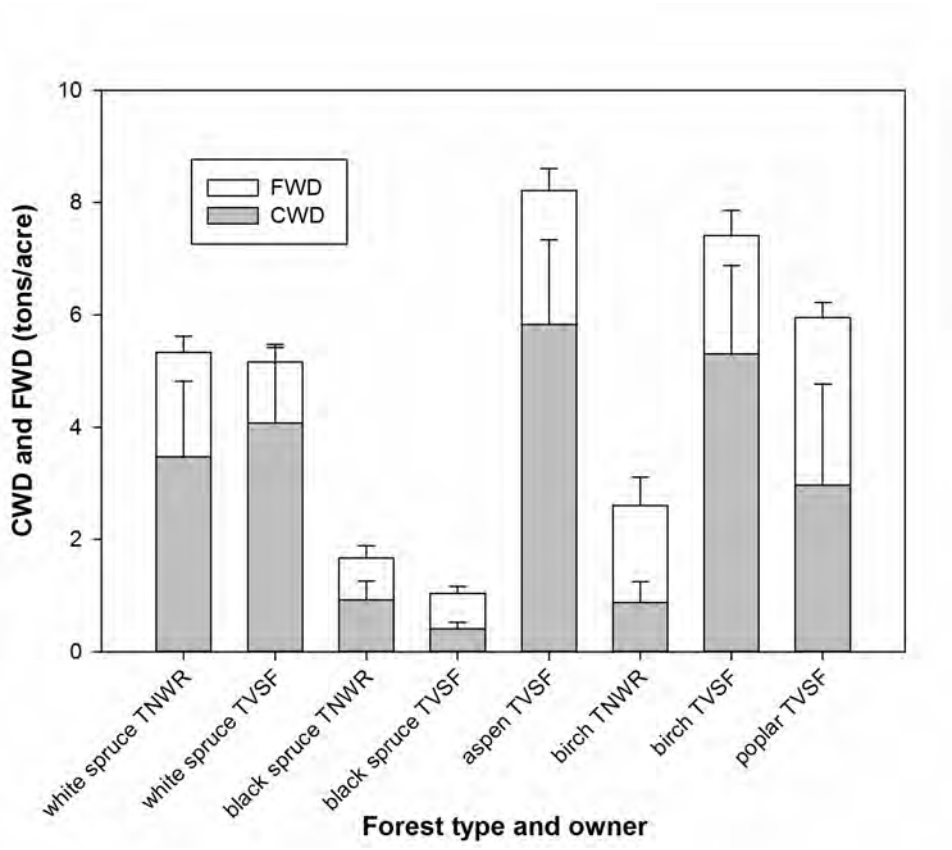
Note: Superscripts indicate the rank of the five most common species within each forest type
n = number of plots

2014 Interior Alaska Highlighted Findings

Forest Down Woody Material

Down woody materials (DWM) are an important component of forest ecosystem structure and function. Down woody materials influence nutrient cycling, contribute to wildlife habitat, forest fires and can contain a substantial proportion of terrestrial ecosystem biomass.

Relative to other regions the role of DWM in boreal forests is poorly understood . Both Coarse Woody Debris (CWD) ≥3 inches diameter and fine Woody Debris (FWD) <3 inches diameter were studied.



Downed woody material biomass on an area basis for each of the forest types in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR). Error bars represent the standard error of the estimates.

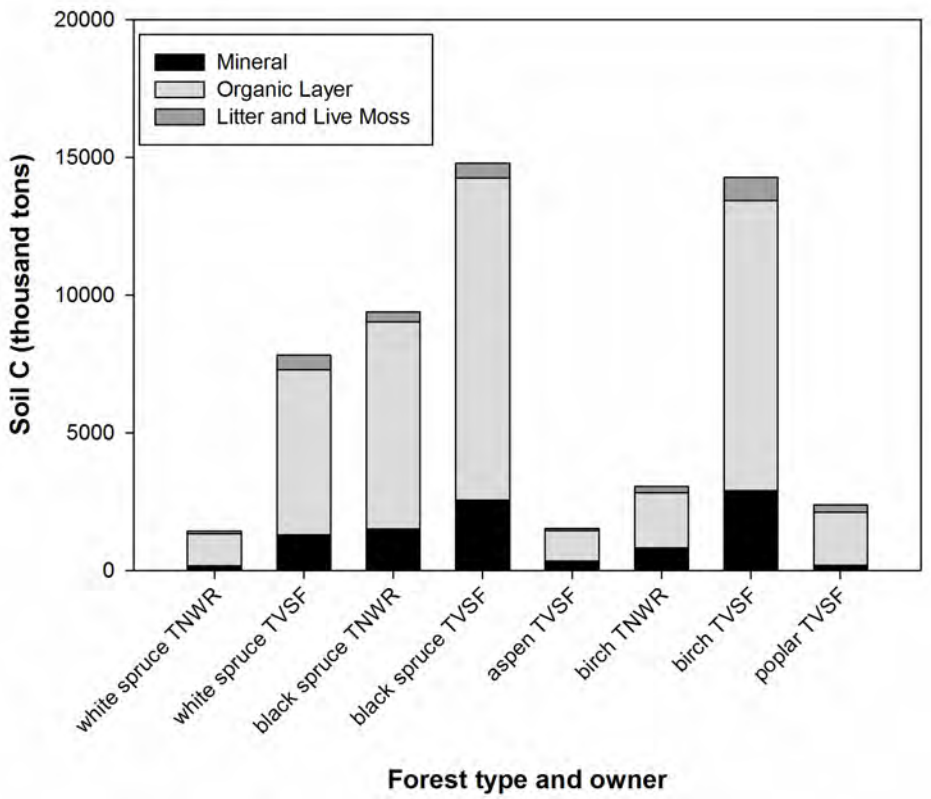
- The highest CWD biomass per acre was in forests comprised mainly of **birch** (5.3 ± 1.6 tons per acre) and **aspen** (*Populus tremuloides*)(5.8 ± 1.5 tons per acre) on the TVSF land.
- The highest FWD biomass per acre was in **poplar** forests on TVSF land (3.0 ± 0.3 tons per acre).
- **Black spruce** forests on TVSF lands had the lowest CWD biomass per acre (0.4 ± 0.1 tons per acre) and FWD biomass per acre (0.6 ± 0.1 tons per acre).

2014 Interior Alaska Highlighted Findings

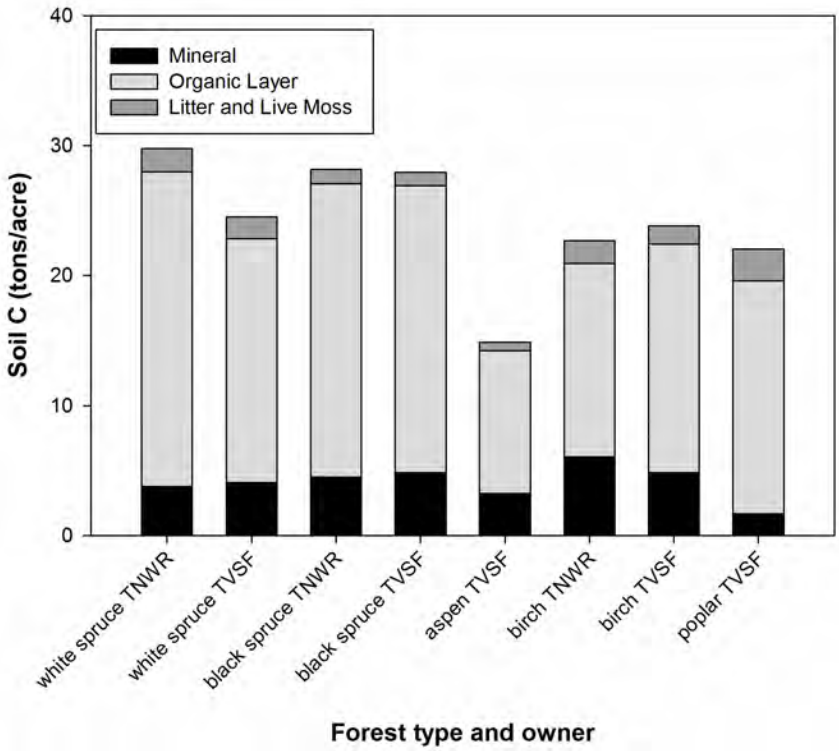
Soil Carbon

- The majority of the carbon in these boreal forest ecosystems often occurs in soils. In addition to their carbon storage capacity boreal forest soils are important components of ecosystem productivity due to their role in nutrient cycling and the limitations frozen soils place on tree growth.

- The majority of the soil carbon (C) in the litter, organic and the top 1 inch of mineral soil occurred on **black spruce** (36 percent) and **birch** (23 percent) forest types across the two inventory units.



Soil C (litter and live moss, organic layer and one inch of mineral soil) for the different forest types in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR).



Distribution of soil C between litter and live moss, organic and mineral (1inch) soil layers on a per acre basis for forest types in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR).

- Soil carbon per acre in the measured layers was highest in **white spruce** forests on TNWR land (29.8 ± 4.4 tons per acre) with **black spruce** on both TNWR and TVSF closely behind (28.0 ± 2.6 tons per acre).

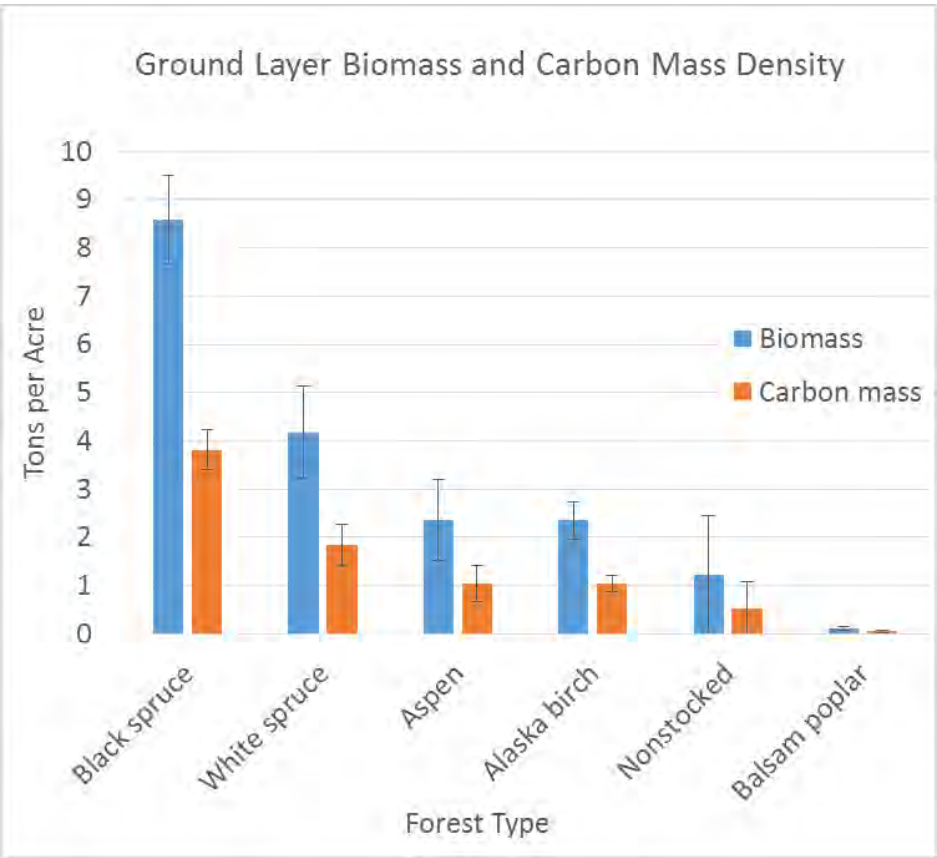
- Soil carbon was lowest in **aspen** forests on TVSF land (14.9 ± 6.7 tons per acre).

2014 Interior Alaska Highlighted Findings

Ground Layer: Moss and Lichen Mats

Moss and lichens in the ground layer accumulate carbon and nitrogen and contain vital forage species for native wildlife.

We evaluated ground layer attributes at 96 sites in the study area using the FIA Ground Layer Indicator. Briefly stated, this indicator converts field-measured depth and cover of ground-dwelling mosses and lichens into a plot-level estimate of biomass, carbon, and nitrogen for each functional group.



Ground layer biomass and carbon mass in tons per acre by forest type in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR).

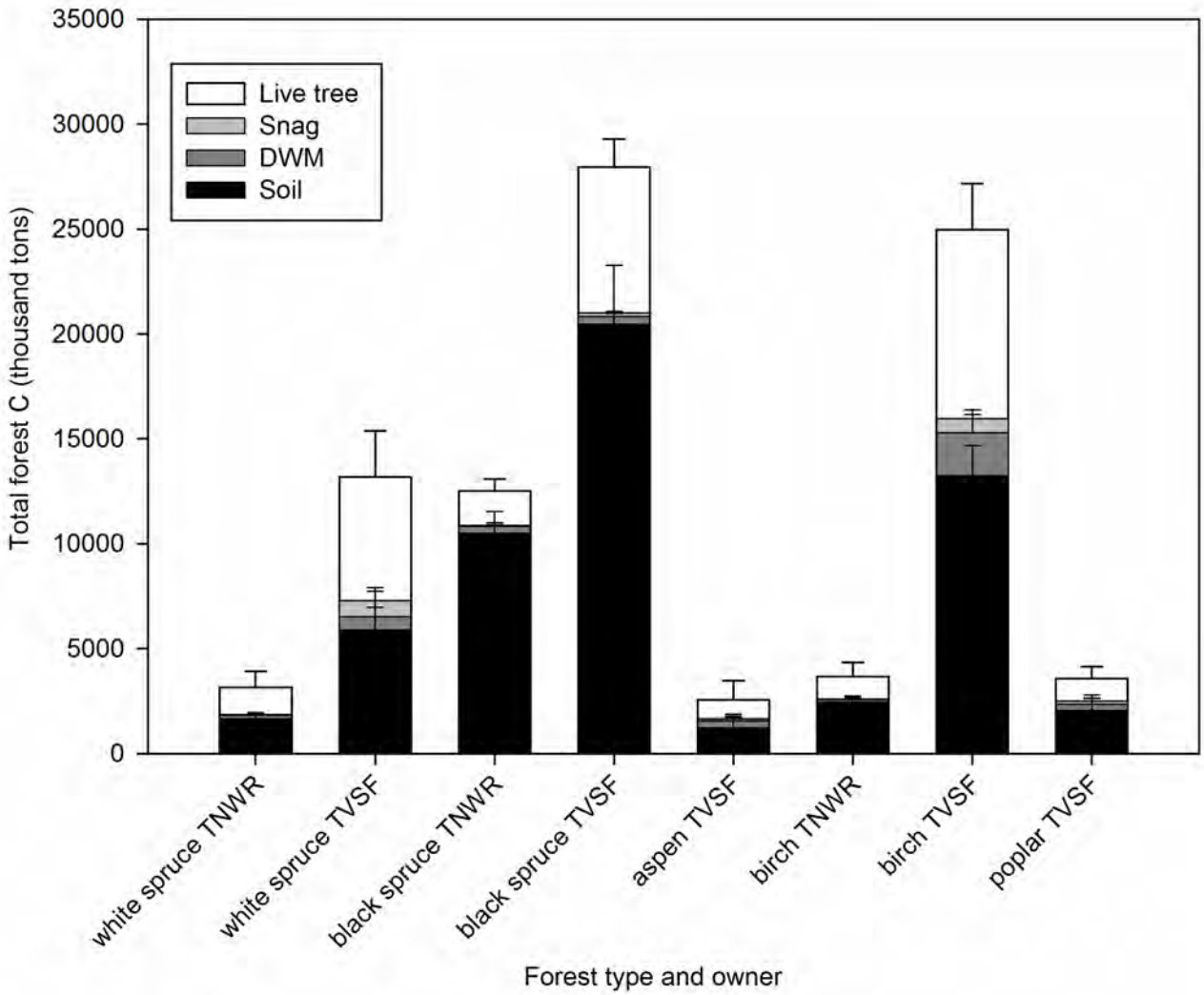
- Biomass of ground layers (i.e., moss and lichen mats) was greatest on **black spruce** forests on the TVSF (10.5 ± 1.3 tons per acre). These forests had almost twice the biomass per acre of any other forest type.
- Most of the non-vascular ground cover in the inventory unit was in the form of **nitrogen fixing feather mosses** (57 ± 5 percent).

Nitrogen fixing feather moss

2014 Interior Alaska Highlighted Findings

Carbon Pools

The results of this pilot inventory found that soil (organic layers plus mineral soil to a 1 inch depth) had 47- 84 percent of total ecosystem carbon (including all carbon from live trees, standing dead trees, DWM, and soil), depending on forest type and location.

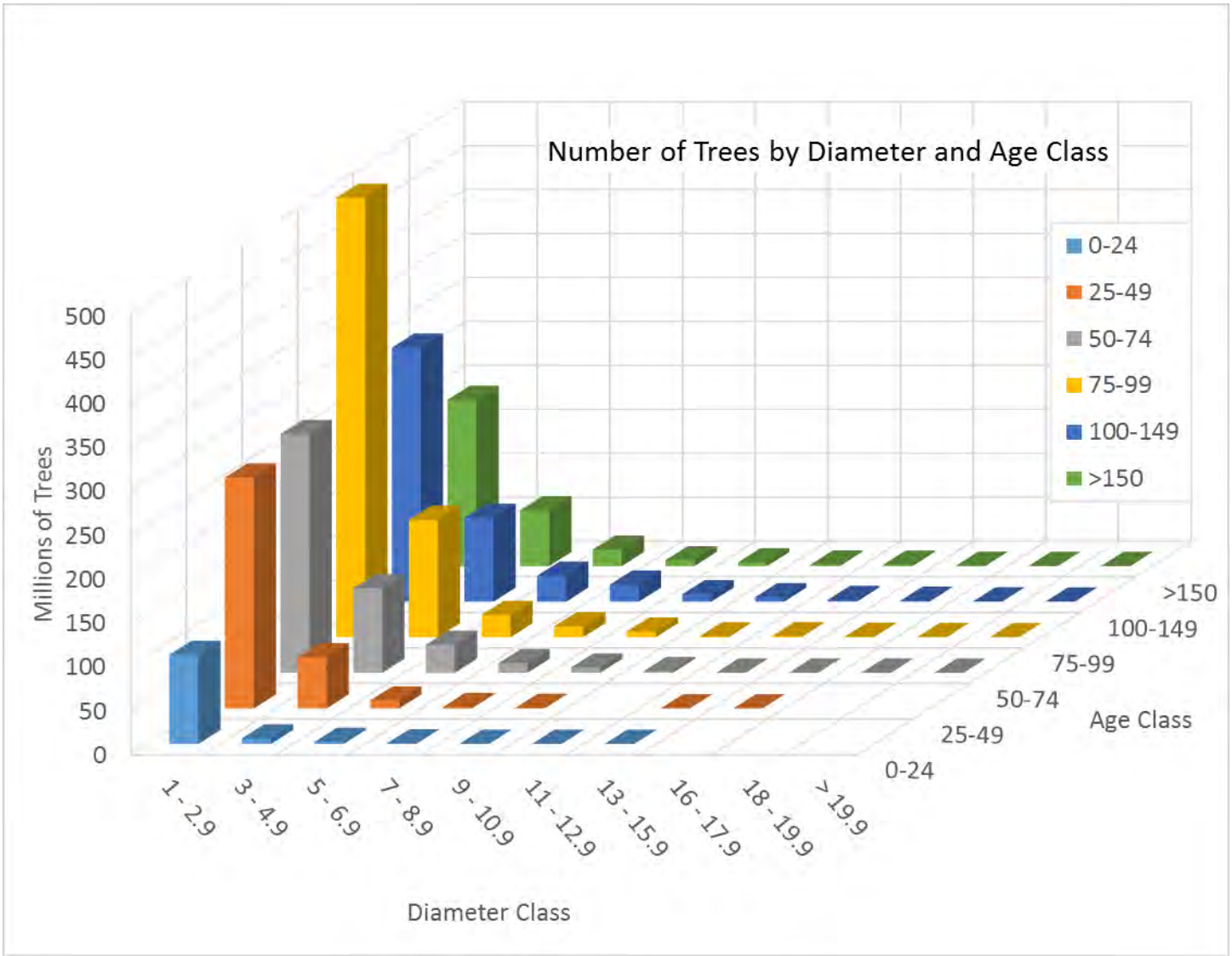


Estimated C in trees, down woody material (DWM) and soils in thousands of tons as a total for each of the forest in the Tanana Valley State Forest (TVSF) and Tetlin National Wildlife Refuge (TNWR). Error bars represent + 1 SE of the estimated totals for trees, DWM and soils in each category.

2014 Interior Alaska Highlighted Findings

Tree Ages and Diameters

- Tree diameters tend toward smaller size classes with the vast majority of trees less than seven inches in diameter.
- Seedling-sized trees, (less than 1-inch diameter), were also exceptionally abundant.
- The age distribution demonstrates small-diameter individuals can be quite old, with peaks in the age distribution in the 75 to 99 year-old category.



Millions of trees by diameter class from 1 inch to >19.9 inches. Most trees in these forests are small diameter yet moderately old-aged.

For More Information

- **Pattison, Robert; Andersen, Hans-Erik; Gray, Andrew; Schulz, Bethany; Smith, Robert J.**, **Jovan, Sarah, tech. coords., (In Press).** Forests of the Tanana Valley State Forest and Tetlin National Wildlife Refuge Alaska: results of the 2014 pilot inventory. Gen. Tech. Rep. PNW-GTR-XXX. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. XX p.
- **Barrett, T.M.; Gray, A.N.; 2011.** Potential of a national monitoring program for forests to assess change in high-latitude ecosystems. Biological Conservation, 144(5), pp.1285-1294.

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