USDA United States Department of Agriculture

US Forest Service Carbon Estimation Tools

Coeli M. Hoover, Northern Research Station

Forest Service November 2018

Outline

- Foundation of the carbon tools
- Introduction of selected Forest Service carbon tools
  - Summary of benefits and limitations of each tool
- Choosing the right tool for the right job
- Where to find the tools and additional information

Carbon Tools Background

- Most tools are based on forest inventory data from the US Forest Inventory and Analysis Program (FIA)
- Many tools are periodically updated to reflect ongoing data collection, changes to methods, etc.
- None of these tools provide a lifecycle analysis, they simply report forest carbon pools or fluxes

Tools with output at various scales

- Forest Stand
- Landscape
- County
- State
- Region or ecoregion
- National

FVS-FFE
GTR-343

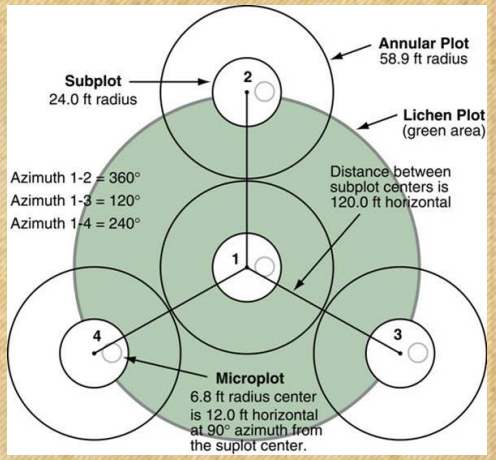
COLE
CCT

All tools except FVS-FFE based on FIA data

Forest Inventory and Analysis (FIA) Overview

FIA Sampling Design

- **Phase 2 - forest inventory**
  - 1 plot per 6,000 ac
  - visit plot every 5 years (10 in West)
- **Phase 3 – forest health**
  - each 16th Phase 2 plot
  - soils, forest floor, down dead wood
  - 1 plot per ~ 96,000 ac
  - soils sampled every 2nd visit
- **Phase 1 – remote sensing**
  - reduce variance through stratification



Where to find FIA data and tools

- **DATIM – Design and Analysis Toolkit for Inventory and Monitoring**
  - Four components, including basic tables (spatial component)
  - Suitable for a wide variety of users
- **Evalidator**
  - Estimates and ***sampling errors*** for selected areas
  - Can customize tables; easy to use
- **Data Mart** – download or query FIA database
- *Many other products available*

https://www.fia.fs.fed.us/tools-data/

USDA FOREST SERVICE

Forest Service National Lir

Forest Inventory and Analysis National Program

(enter query)
Search

- U.S. Forest Service
- Forest Inventory & Analysis
- Regional Offices
- Program Features
- FIA Data and Tools
- Other Tools
- Spatial Data Services
- Maps
- Customer Service

- FIA Library
- FIA Stakeholder Mtg
- Links
- Contact Us
- Site Map

- Regulations.gov
- Employee Search
- Information Center
- National Offices and Programs
- Phone Directory

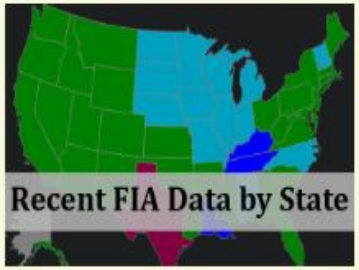
- Evaluate Our Service

We welcome your comments on our service and your suggestions for improvement.

FIA User Alerts.

Database Documentation

Data and Tools



FIA Data User?

Click here to tell us how YOU are using FIA Data

Carbon Tools Overview

Tools Caveats

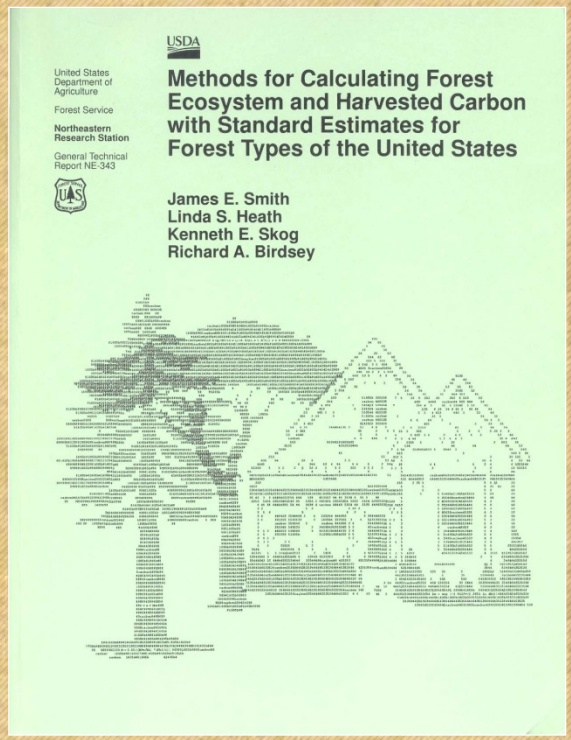
- "All models are wrong, but some are useful."

  -George Box, 1979

- There is no one all purpose tool or model
- Whether a model is empirical or process based, there are tradeoffs
  - Generality vs Accuracy (don't forget $, data required)
  - No free lunches! (i.e. remotely sensed data still need field data for equation development/validation, learning curve)
- Consider spatial scale, underlying data, key assumptions, data requirements

Standard Tables (GTR 343)

- Forest carbon and carbon in harvested wood from summary tables or simple calculations
- Intended for low cost or limited information applications
- Represent regional averages for common forest types
- Simple and transparent
- Consistent with international methods and Good Practice Guidance



GTR 343 – Standard Tables

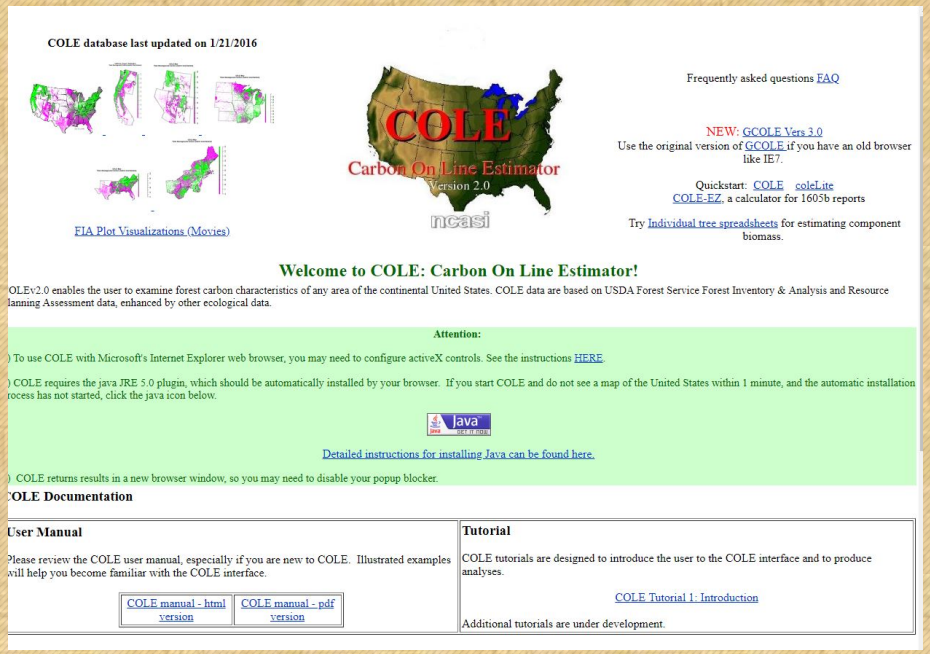
CAN

- Provide a quick estimate, based on regional data
- Serve as a "reality check" against which to compare your estimates
- Give a general estimate of what kind of carbon increases might occur over time

CAN'T

- Substitute for field inventory data for a specific project area
- Serve as a definitive projection of future conditions for a project area
- Reflect possible outcomes of management actions

COLE: Carbon OnLine Estimator



- Works with the FIA database (last update 2016)
- Produces a variety of maps and tables
- Reports many C pools
- County, state, and multi-state areas
- Can choose reports

Can be reached through NRS tools page or FIA tools page (under Other Reporting Tools)

COLE and gCOLE

CAN

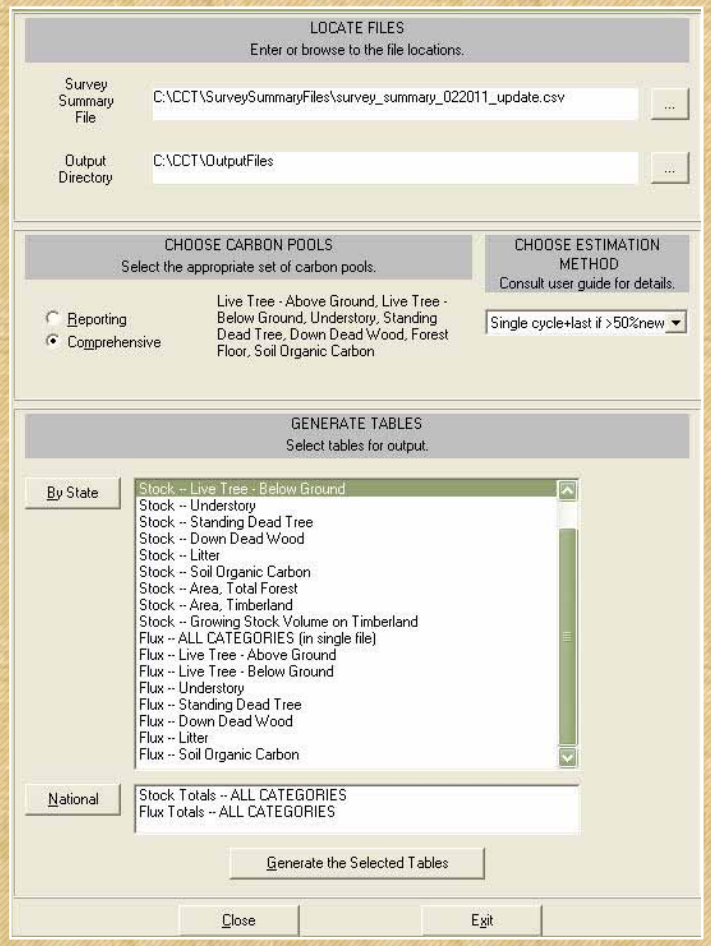
- Provide a quick estimate, based on county/state level data
- Produce estimates of standard errors for selected variables
- Show differences between forest types, age classes, etc. (but watch # of plots!)

CAN'T

- Be used for smaller spatial scales (stands)
- Substitute for detailed forest inventory data for a project area
- Estimate fluxes
- Project outcomes from changes in management

Carbon Calculation Tool (CCT)

- Annual carbon pools and change from 1990 to present
- Comes with FIA data for mainland US
- Can download and use new data
- Produces annualized estimates
- State-level output
- Last update: 2017



CCT

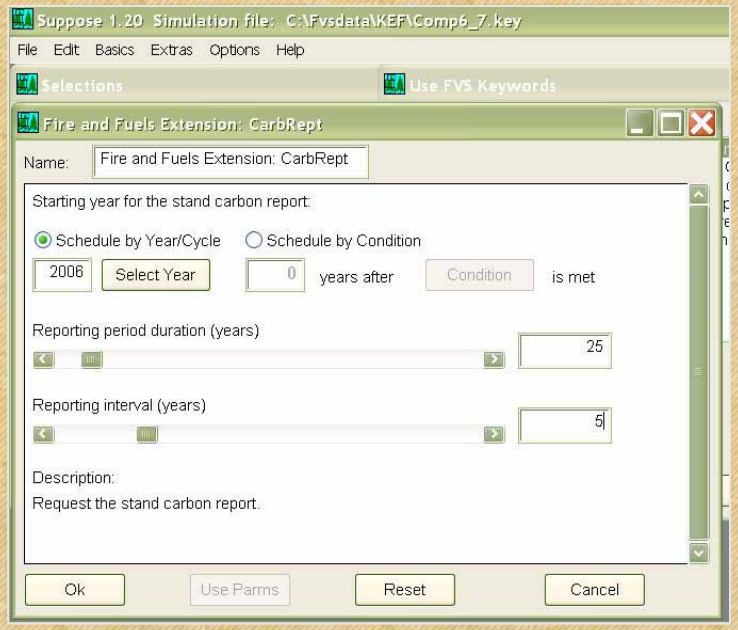
CAN

- Produce stock and flux estimates
- Produce annualized estimates
- Be updated with current FIA data by user
- Produce nationwide estimates

CAN'T

- Generate estimates at levels smaller than state
- Provide estimates prior to 1990
- Be initialized with site specific data by user
- Project scenarios

Forest Vegetation Simulator (FVS)



- Stand-level growth and yield model
- Uses field inventory data
- Simulates nearly any type of management
- Covers conterminous US
- Can generate reports on forest carbon stocks
  - Includes harvested wood products

****** CARBON REPORT VERSION 1.0 ******
STAND CARBON REPORT
STAND ID: 2849 MGMT ID: NONE

	Aboveground Live		Belowground		Stand	Forest			Total Stand	Total Removed	Carbon Released
YEAR	Total	Merch	Live	Dead	Dead	DDW	Floor	Shb/Hrb	Carbon	Carbon	from Fire
	T/HA	T/HA	T/HA	T/HA	T/HA	T/HA	T/HA	T/HA	T/HA	T/HA	T/HA
2006	114.4	75.2	21.4	12.5	0.0	18.1	14.9	0.7	182.1	48.5	0.0
2011	119.6	77.8	24.3	10.1	0.1	11.4	15.7	0.7	181.9	0.0	0.0
2016	123.2	80.4	23.5	9.1	1.2	10.2	16.2	0.7	184.1	0.0	0.0
2021	128.2	83.4	24.2	7.6	1.1	9.7	16.6	0.7	188.1	0.0	0.0
2026	132.7	85.8	25.0	6.5	1.6	10.2	17.1	0.7	193.7	0.0	0.0
2031	138.2	88.6	26.0	5.5	1.8	10.8	17.4	0.7	200.4	0.0	0.0

FVS Carbon Reports

CAN

- Assess carbon impacts of many management actions, including prescribed fire
- Estimate increases in carbon stocks over time
- Be used at the stand and landscape scales

CAN'T

- Be used without detailed inventory data from the site
- Be used in "plug and play" mode – extensive training is required
- Provide soil C estimates

Other tools

- Other FIA tools: DATIM, Evalidator, Data Mart
  - Provide estimates of forest carbon and many other forest attributes in a variety of formats
  - Range from easy to use to more complex
- i-TREE Products: Produces estimates of harvested carbon in wood products from harvest data
  - Similar to HWP C report from FVS
  - Two modes accommodate general and more specific data
- Variety of other tools
  - Many specific to a geographic region
  - Some specific to particular user groups, i.e. National Forests
  - Many “carbon footprint” calculators also available

Right tool for the right job...

- What is the relevant spatial scale?
- Do you need estimates of stocks, fluxes, or both?
- What level of accuracy do you need?
- Is the tool appropriate for your forest type/region?
- Do you want to use your own data?
  - What kind of data do you have?
- Do you want to compare management scenarios?
- Which carbon pools are of interest?
- How important is ease of use?

More caveats on tools….

- A tool is often developed in response to a specific need (i.e. 1605b, UNFCC) and may not be updated once that mandate expires
- Tools developed and supported by a researcher may not be updated or continued when the researcher retires or changes jobs
- Support for a tool may be discontinued if funding is no longer available
- A tool developed for a specific geographic region may require considerable modification in order to be used in another region/forest type

Where do I find the carbon tools?

https://nrs.fs.fed.us/carbon/tools

Your gateway on the web for forest carbon inventory tools and information

- Each tool has a downloadable fact sheet

These tools and more can also be found at: https://www.fs.usda.gov/ccrc/tools

Search
Go
Browse by Subject
- Research Programs
- Publications & Data
- Tools & Applications
- Locations
- Scientists & Staff
- About NRS
- Partnerships
- NRS News

Contact Information
Northern Research Station
11 Campus Blvd., Suite 200
Newtown Square, PA 19073
(610) 557-4017
(610) 557-4132 TTY/TDD

Carbon

Tools for carbon inventory, management, and reporting

Accurate estimates of carbon in forests are crucial for forest carbon management, carbon credit trading, national reporting of greenhouse gas inventories to the United Nations Framework Convention for Climate Change, calculating estimates for the Montreal Process criteria and indicators for sustainable forest management, and registering forest-related activities for state and regional greenhouse gas registries and programs.

Our scientists have contributed to developing a toolbox full of basic calculation tools to help quantify forest carbon for planning or reporting. The following tools are currently available:

- PRESTO: an online tool to estimate carbon in harvested wood products
- Measurement guidelines for the sequestration of forest carbon
- Field Measurements for Forest Carbon Monitoring: A Landscape-scale Approach
- Standard tables of forest ecosystem and harvested wood carbon
- Carbon OnLine Estimator (COLE)
- FORCARB2: An updated version of the U.S. Forest Carbon Budget Model
- U.S. Forest Carbon Calculation Tool (CCT)
- Forest Vegetation Simulator (FVS)
- CVal
- i-Tree
- CarbonPlus Calculator: A locally customizable emissions calculator for individuals and businesses

PRESTO: An online tool to estimate carbon in harvested wood products

UPDATE

PRESTO has a new home! PRESTO, an online tool for

Carbon
- Carbon Home
- Literature resources for carbon inventories
- Tools for carbon inventory, management, and reporting
- Tools Workshop
- Summaries
- Webcasts
- Carbon Factoids

Carbon Tools
- PRESTO: an online tool to estimate carbon in harvested wood products
- Measurement guidelines for the sequestration of forest carbon
- Field Measurements for Forest Carbon Monitoring: A Landscape-scale Approach
- Standard tables of forest ecosystem and harvested wood carbon
- Carbon OnLine Estimator (COLE)
- FORCARB2: An updated version of the U.S. Forest Carbon Budget Model
- U.S. Forest Carbon Calculation Tool (CCT)

Remember……

- All tools have strengths and limitations
  - Know the “design specs”....errors increase when a tool is used outside its intended limits. Modifications may be needed.
- Spatial scale is very important when choosing the right tool for the job
- There are always tradeoffs!

Acknowledgements

- Jim Smith, Linda Heath, Ken Skog, Rich Birdsey
  - GTR 343, Standard Tables
- Paul VanDeusen, NCASI, Linda Heath
  - COLE
- Jim Smith, Linda Heath, Mike Nichols
  - CCT
- Stephanie Rebain and ESSA Technologies
  - FVS Carbon Reports
- And of course, many more….

Questions?

choover@fs.fed.us