CARB / BOF
Forest carbon inventory comparison

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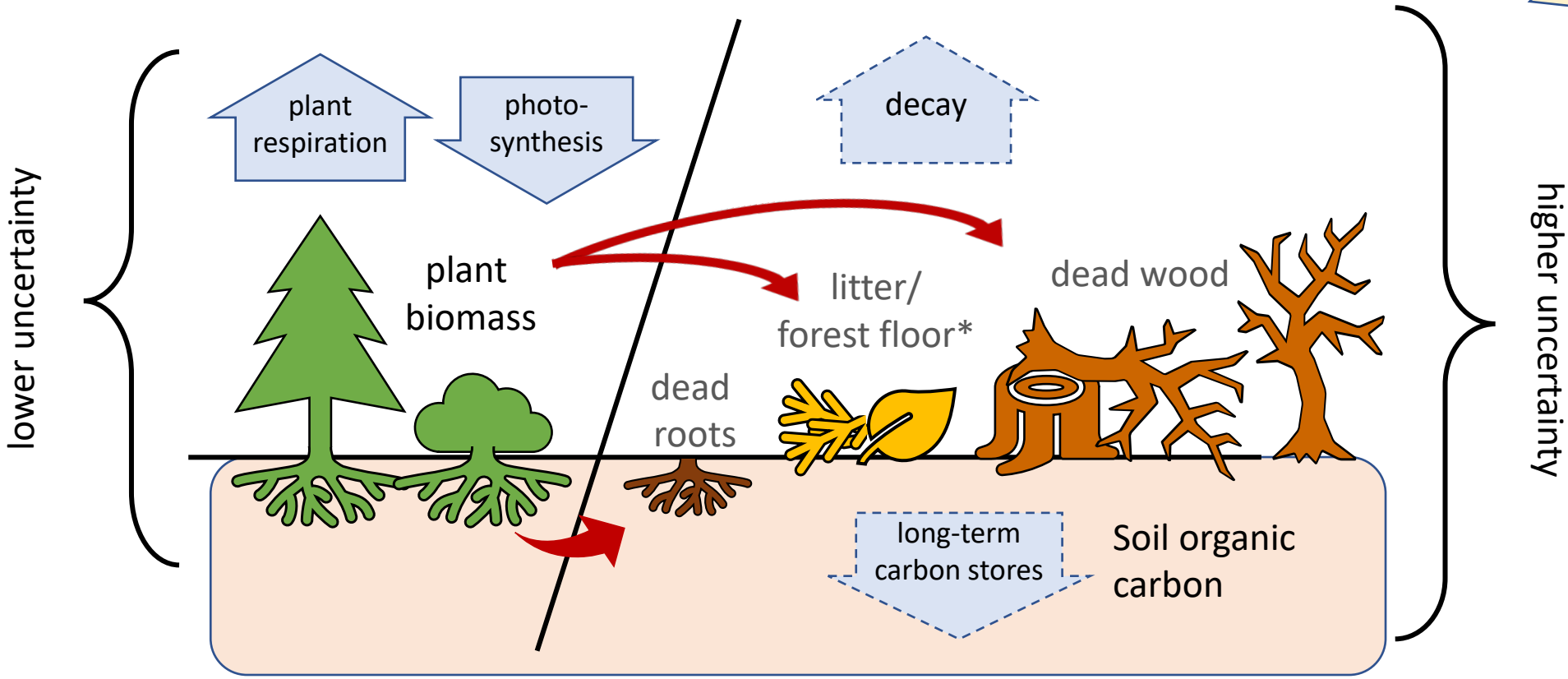
Forest Carbon Cycle

Dynamic by nature, difficult to measure and/or estimate

This stuff is hard!



The Two Forest Carbon Inventories

	CARB NWL Inventory	BOF F+HWP Inventory
Inventory Scope	• Statewide GHGI for all sectors in CA economy • All natural lands: • **Tree/shrub-dominated land (forest),** open woodland, grassland, wetland • All working lands	• Ensure FPRs sufficient for forests to sequester 5 MMT CO2e/yr, sustainable forest management • Monitor overall forest health • **Tree-dominated only (forest)** • 2 HWP pools
Forest Results	**Stock change (FF + conversions):** - 17.4 MMT C/yr (2001-2010) +7.8 MMT C/yr (2012-2014) **Stock:** 4.5 billion metric tons (2012-2014)	**Stock change (FF + conversions):** +7.6 MMT C/yr (2017 reporting period) **Stock:** ~ 3.4 billion metric tons (2017 RP)

- ***Inventories are not as different as they appear***
- ***Two inventories can be good***

The Two Forest Carbon Inventories

	CARB NWL Inventory (the Forest & Other Natural Lands portion only)	BOF Forest + HWP Carbon Inventory
Perspective of Accounting	**Forest Ecosystem:** IPCC Stock-change **HWP C:** IPCC Atmospheric Flow Approach	**Forest Ecosystem:** IPCC Stock-change via FIA Growth, Removals & Mortality (GRM) approach **HWP C:** IPCC Production Approach
Time Step of Each Inventory Update	Every 2 years – approx. 4 year data lag, maybe less	Annual – approx. 2 year data lag
Primary Data Source	A combination of satellite-based data (LANDFIRE/MODIS) and ground-based measurement data (e.g., FIA data)	FIA (direct ground-based measurements on permanent plots)

FIA Net Change – 2017 reporting period

- 2001 plots re-measured in 2011
- 2002 plots re-measured in 2012
- 2003 plots re-measured in 2013
- 2004 plots re-measured in 2014
- 2005 plots re-measured in 2015
- 2006 plots re-measured in 2016
- 2007 plots re-measured in 2017

AGL net change = Gross growth – mortality – removals (GRM)

Dead tree net change = wood entering pool through mortality – wood leaving pool by falling over and entering down dead pool, decay, burning

Annual net change for 2017 reporting period =

average net change for all pools from 7 sets of re-measurements / 10 years

*Designed to ascertain large-scale, long-term decadal trends
*Difficult to attribute change to specific year/events

The More Eyes the Better

Estimating carbon is complicated

Verification important in IPCC guidelines

Approaches can address different questions

CARB

- Forest cover & carbon change
  - Where, when
- Disturbance detection/type
  - Vegetation transitions
  - Annual changes

BOF

- Growth, removals, mortality
- Detailed forest attributes
  - Forest health
  - Supports RS
  - Long term trends

The Two Forest Carbon Inventories

	CARB NWL Inventory (the Forest & Other Natural Lands portion only)	BOF AB 1504 Forest Carbon Inventory
Forest Definition	*Land cover perspective*: Any land ≥ 0.22 acres that currently has >10% tree or shrub canopy cover	*Land use perspective*: Any land ≥ 1 acre and 120' wide that has or once had >10% tree canopy cover in the past 30 years, or will be artificially or naturally regenerated. Shrub-dominated lands excluded
C fraction of biomass	0.47	0.5
Time periods compared in this analysis	Stocks – 2001, 2010, 2012, 2014 Net change – 2001-2010, 2010-2012 2012-2014 (annualized)	2017 reporting period: Stocks – 10 year rolling average (e.g., 2006-2017) Net change – plots initially measured beginning 2001-2007, re-measured 2011-2017 (annualized)

Land use vs. land cover

Example 1: Intensively grazed pasture where trees are dominant

NWL = forest land

BOF = agricultural land

Example 2: Recent clear-cut forest where shrubs are the dominant plant life form

NWL = shrub = forest land

BOF = forest land

Example 3: A change from shrub-dominated Forest Land to Grassland following a high-severity fire

NWL = forest land-to-grassland transitional category

- forest carbon stock / area loss

BOF = n/a

- no forest carbon stock / area loss

Example 4: A change from tree-dominated Forest Land to Grassland following a high-severity fire

NWL = forest land-to-grassland transitional category

- forest carbon stock / area loss
- changed area attributed to a carbon density value using the new land cover type (i.e., Grassland cover type), that generally has a lower carbon density
- carbon remaining in dead wood not counted

BOF = forest land, tree cover must regenerate by year 30

- forest carbon stock loss, no forest area loss
- carbon remaining in dead wood counted

Forest Area (acres, tree-dominated forest land)

BOF inventory (FIA)	NWL inventory (LANDFIRE-C) [b]
31,746,000 ± 200,000 (SE)[a]	31,180,847 (2010 tree-dominated forest land) (<2% lower than AB 1504)
	32,877,986 (2001 tree-dominated forest land)

[a] Area of forest land 2017 reporting period, from Table A9 in Christensen et al. (2019)

[b] Analysis completed by CARB staff for this comparison

(NWL has additional 30+ million acres of shrub-dominated lands)

Included Forest Carbon Pools

	Carbon Pool	BOF Inventory (FIA)	NWL Inventory (LANDFIRE-C)
FIA Forest and NWL tree-dominated Forest Land			
Live Biomass	Tree Bole, Bark, Stems	✓	✓
	Tree Foliage	✓	
	Below-ground-live tree (roots)	✓	✓
	Understory, above- and below-ground live*	✓	✓
Dead Biomass	Dead tree standing, above-ground	✓	✓
	Dead tree standing, below-ground (roots)	✓	✓
	Dead down	✓	✓
	Litter (i.e., forest floor)	✓	✓
Soil Organic Carbon		✓	quantified separately outside of LANDFIRE-C
FIA nonforest, NWL shrub-dominated Forest Land			
Live Biomass	Live shrub, above- and below-ground		✓
	Live understory		✓
	Grass/herbaceous		✓
Dead Biomass	Woody debris		✓
	Litter		✓
Soil Organic Carbon			quantified separately outside of LANDFIRE-C

*includes trees < 1.0" dbh, shrubs/woody vines/forbs and graminoids

Please note:
BOF dead biomass estimates from a newer FIA-based model include the following updates that will be included in the next NWL inventory as well:

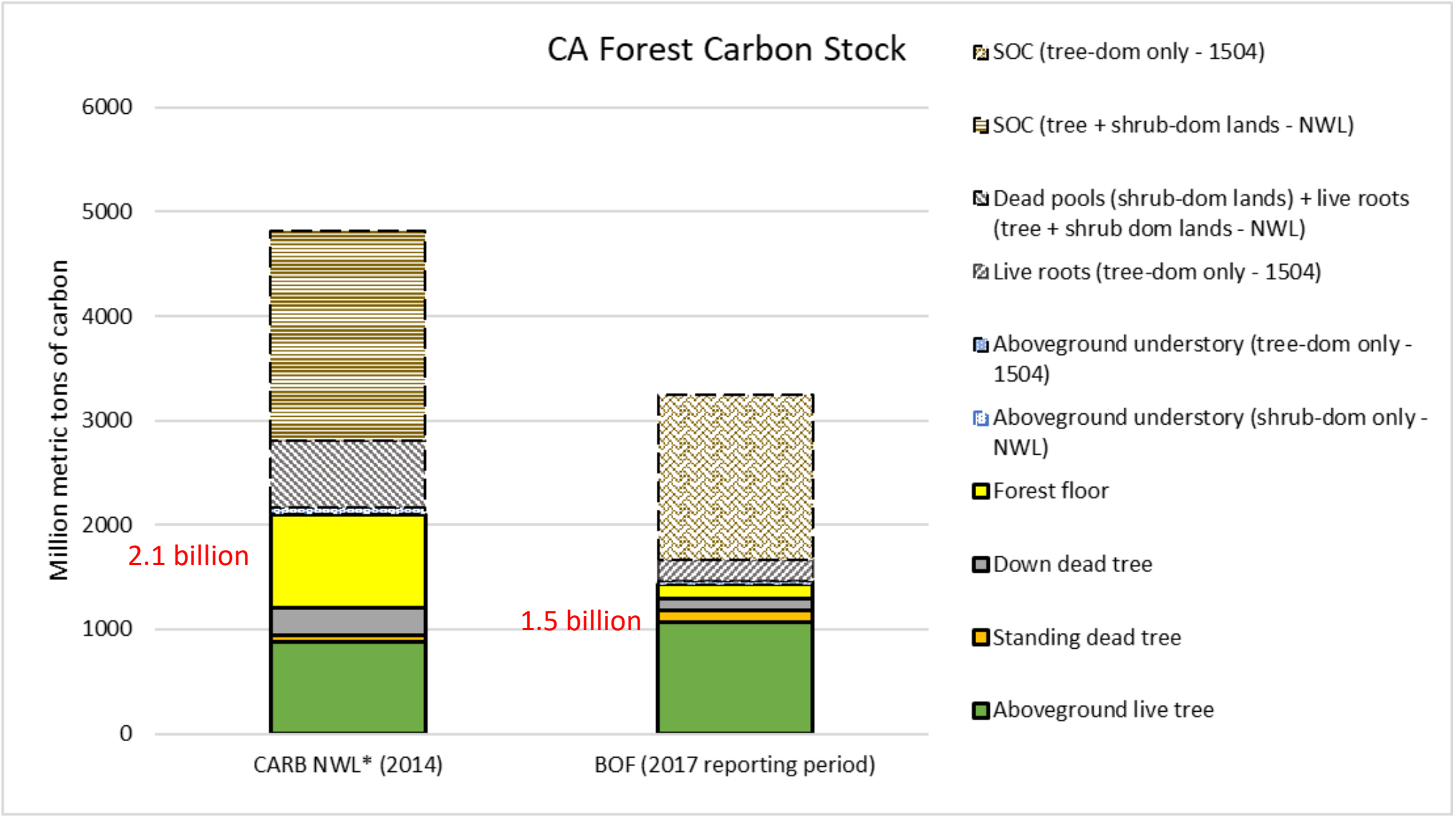
- Wood decay and snag degradation rates
- Fine wood (<3" dia.) reported in the down dead wood pool rather than litter pool

Tree-dominated lands only Forest C Stock Estimates

NWL FONL
(Shrub + tree-dom, Soils)
4.8 billion MT C

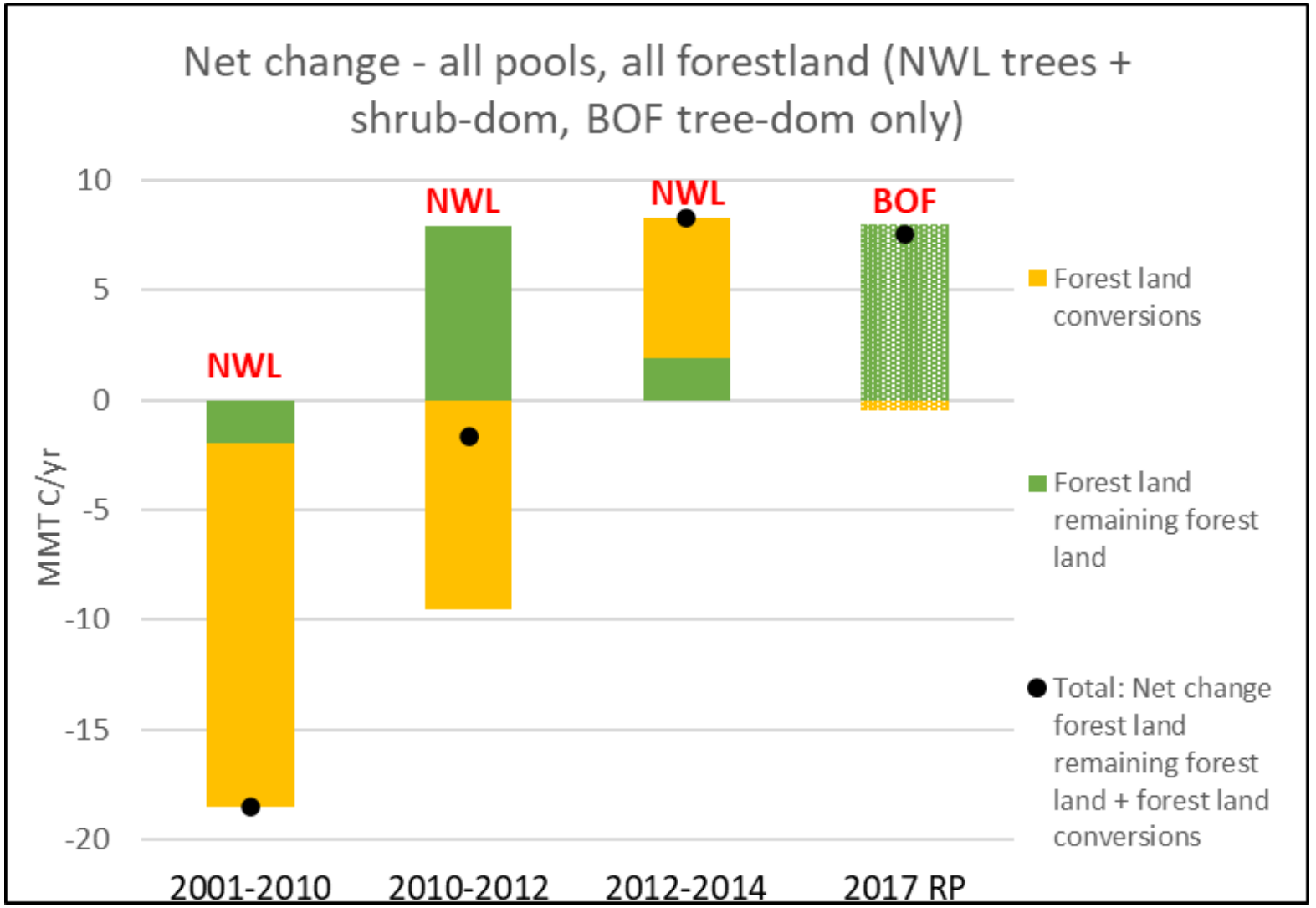
BOF
(Tree-dom, Soils, HWP)
3.4 billion MT C

Please remember:
- estimating some pools very complicated
- knowledge gaps for all
- ongoing improvements in both inventories



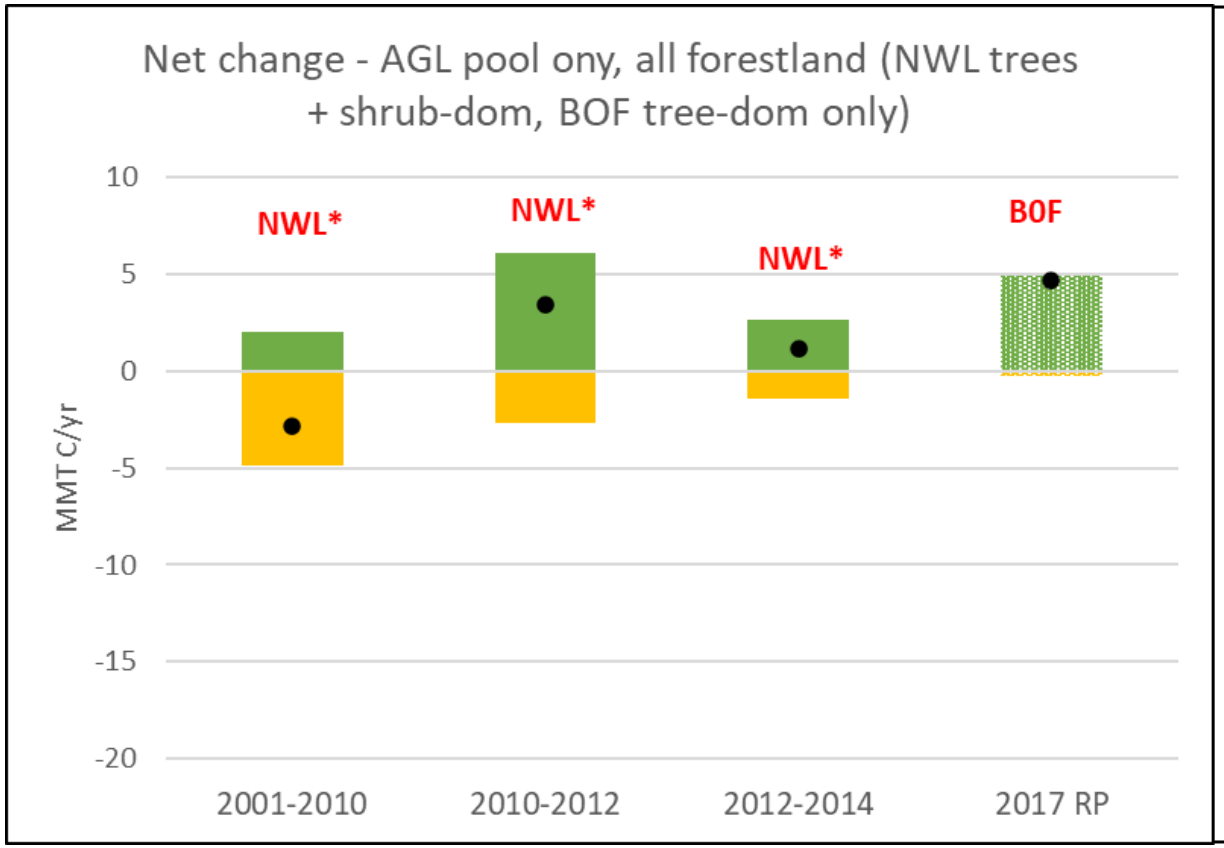
*NWL estimates based on older FIA db than AB 1504 estimates; most recent FIA db to be used in subsequent inventories; adjusted to carbon fraction of biomass = 0.5 rather than 0.47 in NWL inventory reports

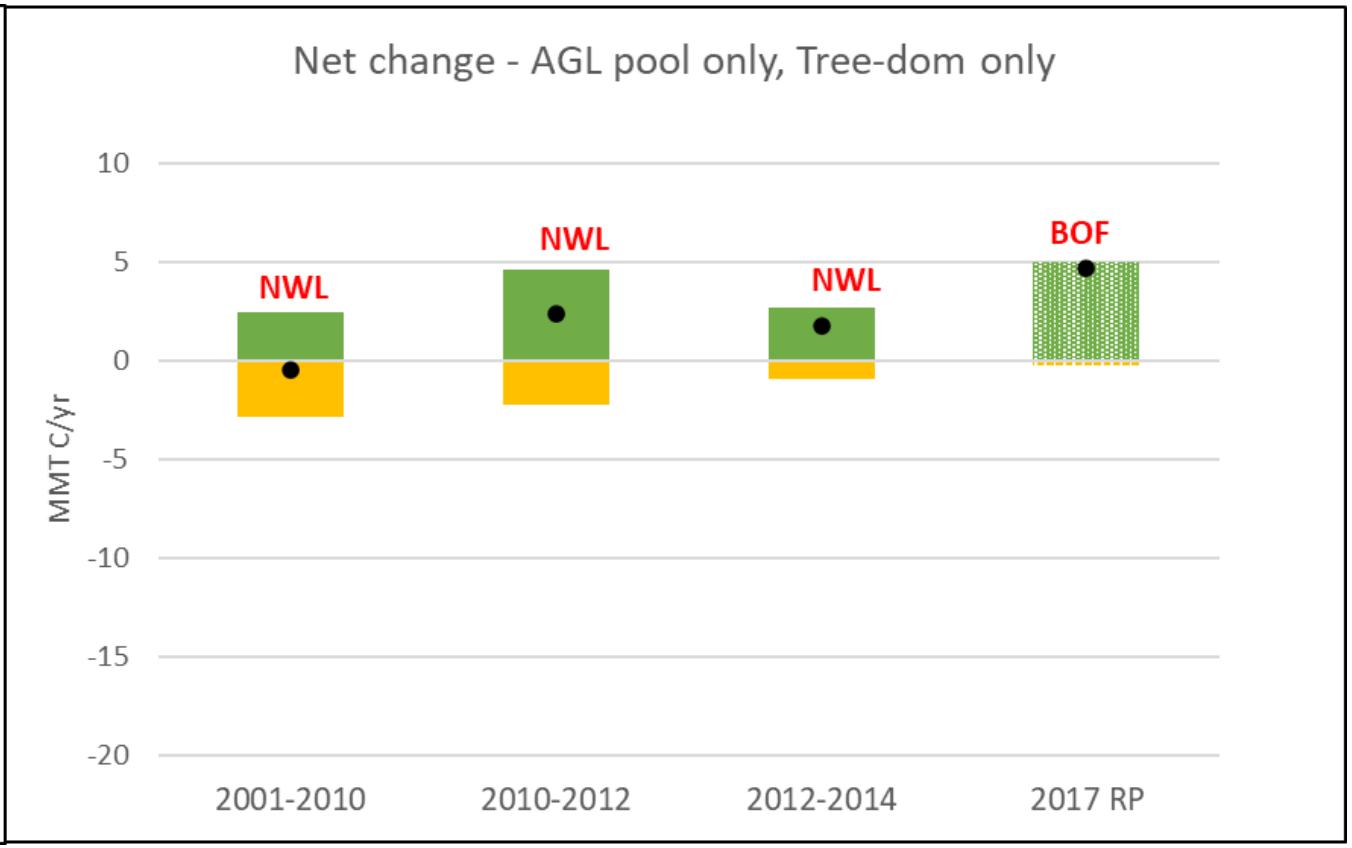
Forest land Stock-Change, all pools, NWL Tree + Shrub dom, BOF Tree-dom only (MMT C/yr)



*NWL estimates based on older FIA db than AB 1504 estimates; most recent FIA db to be used in subsequent inventories; adjusted to carbon fraction of biomass = 0.5 rather than 0.47 in NWL inventory reports; applies FIA-derived growth factor on undisturbed, tree-dominated lands

Forest land Stock-Change, AGL pool only, with and without NWL shrubs (MMT C/yr)





- Looking at AGL pool only, with or without shrubs, smooths out differences in estimates

Key Differences

- Time periods of analysis for change estimates.
- C fraction of biomass
- Shrubs
- Tree foliage
- Incremental growth detection
- Dead pool (standing and down dead, litter) estimates
- Land cover vs. land-use
- Differences in how changes in carbon from disturbances are attributed (i.e., forest land conversions, fire, harvest).

NWL great for annual change
BOF great for long term trends

Key Similarities

Forest health is being challenged!

- Annual disturbance impacts shown in NWL
- Trend of declining carbon storage in BOF
- Slowing productivity in both!

Key Messages

- Science staff teams work well together and meet regularly
- Interested in learning from each other, understanding how system works, and improving methods
- The 2 inventories complement & support each other
- Help identify opportunities for refinement
- Corroboration and different scales of verification are important (IPCC Guidelines)
- Inventory is always a work in progress

Questions?