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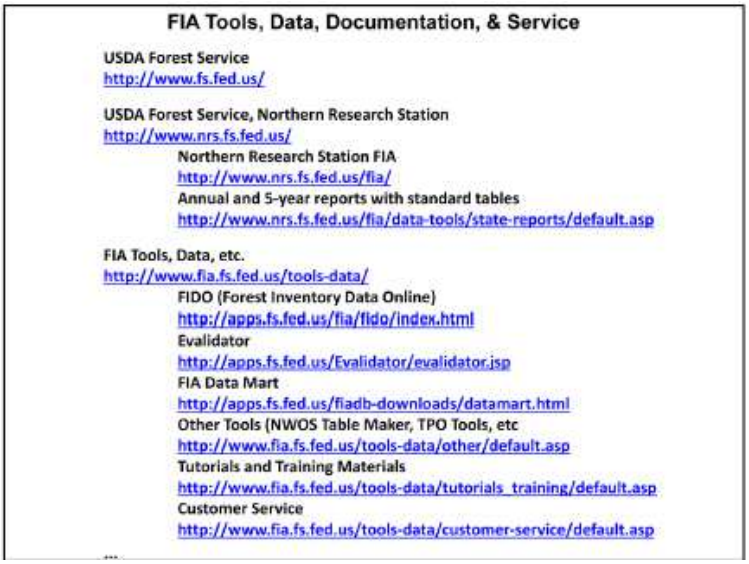

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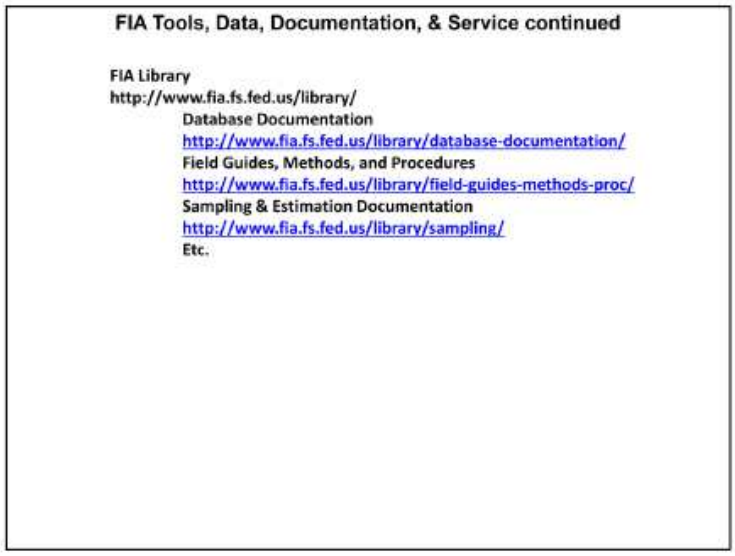


Michigan has over 20 million acres of forest land, the highest estimate since the 1935 inventory. Increases in volume, biomass, and number of large-diameter trees have accompanied the increase in area of forest land and large-diameter stands in Michigan.

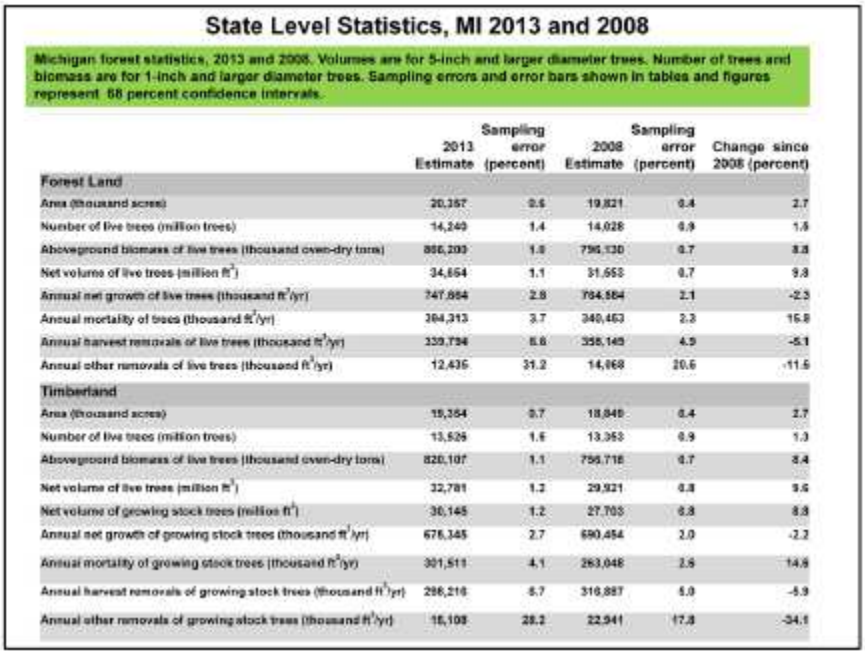
There are approximately 3,513 million live trees (at least 5-inch diameter) on forest land accounting for approximately 34,654 million ft3 of volume and 782,119 thousand oven-dry tons of aboveground biomass. Volume and biomass each increased by 9.8 percent since the 2008 inventory. Contributing to this increase, notable gains in volume were observed for sugar maple (*Acer saccharum*), red maple (*Acer rubrum*), eastern white pine (*Pinus strobus*), black cherry (*Prunus serotina*), white oak (*Quercus alba*), white spruce

(*Picea glauca*), and silver maple (*Acer saccharinum*) at 11, 18, 21, 27, 16, 19, and 35 percent, respectively.

Due to an artificially high estimate of annual net growth for the 2008 inventory, the current estimate is comparably 2.3 percent less. An overestimation of reversion (change from nonforest to forest) growth caused the high estimate for the 2008 inventory. Some reversions that occurred in the 1990s to early 2000s were not identified until the 2008 inventory (see Pugh 2013; Research Note NRS-165). Disregarding net growth attributed by reversions, net growth for live trees on forest land rose 7.2 percent from the 2008 to 2013 inventory (627,780 to 673,272 thousand ft3). Contrary to the overall overestimation in the mid 2000s, red pine and northern hardwood forest types had high reversions in the early 2000s, bumping up net growth for these types in the 2004 inventory.

Mortality has reduced net growth for species such as ash and American beech accounting for an increase of 62.5 million cubic feet from the 2008 to 2013 inventory. These species also experienced significant increases in mortality from the 2004 to 2009 inventory. Paper birch experienced a significant increase in mortality from the 2004 to 2009 inventory but not from 2008 to 2013. From 1980 to 2004, mortality held fairly constant . Since 1980, removal estimates have been fairly constant. There is substantial sampling error associated with the removal estimates making it difficult to discern significant change.

Slide 4



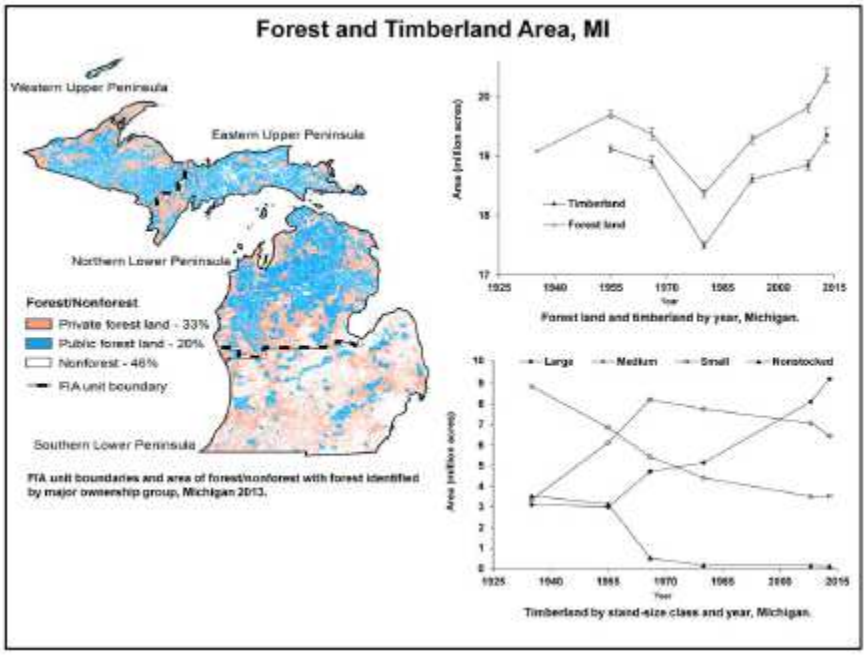
State Level Statistics, MI 2013 and 2008

Michigan forest statistics, 2013 and 2008. Volumes are for 5-inch and larger diameter trees. Number of trees and biomass are for 1-inch and larger diameter trees. Sampling errors and error bars shown in tables and figures represent 68 percent confidence intervals.

	2013 Estimate	Sampling error (percent)	2008 Estimate	Sampling error (percent)	Change since 2008 (percent)
Forest Land					
Area (thousand acres)	20,357	0.6	19,821	0.4	2.7
Number of live trees (million trees)	14,249	1.4	14,028	0.9	1.6
Aboveground biomass of live trees (thousand oven-dry tons)	806,200	1.0	796,130	0.7	8.8
Net volume of live trees (million ft³)	34,664	1.1	31,653	0.7	9.8
Annual net growth of live trees (thousand ft³/yr)	747,864	2.8	704,584	2.1	-2.3
Annual mortality of trees (thousand ft³/yr)	364,313	3.7	340,463	2.3	15.8
Annual harvest removals of live trees (thousand ft³/yr)	339,734	6.6	358,145	4.9	-5.1
Annual other removals of live trees (thousand ft³/yr)	12,436	31.2	14,068	20.6	-11.6
Timberland					
Area (thousand acres)	19,364	0.7	18,849	0.4	2.7
Number of live trees (million trees)	13,529	1.6	13,353	0.9	1.3
Aboveground biomass of live trees (thousand oven-dry tons)	820,107	1.1	756,718	0.7	8.4
Net volume of live trees (million ft³)	32,781	1.2	29,921	0.8	9.6
Net volume of growing stock trees (million ft³)	30,145	1.2	27,703	0.8	8.8
Annual net growth of growing stock trees (thousand ft³/yr)	676,345	2.7	690,454	2.0	-2.2
Annual mortality of growing stock trees (thousand ft³/yr)	301,511	4.1	263,048	2.6	14.6
Annual harvest removals of growing stock trees (thousand ft³/yr)	286,216	6.7	310,887	5.0	-8.9
Annual other removals of growing stock trees (thousand ft³/yr)	16,108	28.2	22,941	17.8	-34.1

The following is from the 2009 inventory (Pugh et al. 2012, Resource Bulletin NRS-66): The Upper Peninsula of Michigan accounts for only 29 percent of the land in Michigan but has 45 percent of the forest land (4.2 and 5.0 million acres for eastern and western Upper Peninsula, respectively). The southern Lower Peninsula has the least amount of forest land (3.3 million acres or 17 percent of forest land) even though it is the largest region. The northern Lower Peninsula has the most forest land (7.4 million acres).
The high amount of forest land in 1955 was the result of the forest base recovering from the land clearing, timber harvests, and fires in the 1800s and early 1900s. During the 1980s and early 1990s, the area of forest and timberland increased. Abandoned cropland and pasture reverted to forest, and marginal forest lands, once classified as less productive, were reclassified as productive timberland (Schmidt et al. 1997, Resource Bulletin NC-179).

Slide 5



The following is from the 2012 inventory (Pugh 2013, Research Note NRS-165):
Nearly 46% of timberland and forest are owned by families and individuals. The state owns a substantial amount at 21%, followed by the U.S. Forest Service and corporate (13-14% each).

Slide 6

Forest and Timberland Ownership, MI, 2012

Area and percent of forest and timberland by owner, Michigan, 2012. Change in forest and timberland by owner, Michigan, 2007 to 2012.

State includes state-owned forest and timberland. Corporate includes real estate investment trusts and timber management organizations. Other private includes nongovernmental conservation and natural resource organizations; unincorporated local partnerships, associations, and clubs; and Native Americans. Other public includes local governments such as counties or townships and other federal such as U.S. Fish and Wildlife Service, U.S. Department of Defense, and U.S. Department of Energy. All National Park Service forest land is reserved by law prohibiting management for the production of wood products.

Forest land estimates	Estimate (1,000 acres)	Estimate (%)	Sampling error (%)	Change since 2007 (%)
Owner				
Family or individual	9,246	45.6	1.6	2.3
State	4,236	20.9	1.7	1.9
U.S. Forest Service	2,723	13.4	0.8	2.1
Corporate	2,666	13.2	3.9	-1.8
Other private	659	3.2	9.7	32.1
Other public	530	2.6	10.4	26.1
National Park Service	218	1.1	15.2	12.2
Total	20,296	100.0	0.6	3.0
Timberland estimates				
Owner				
Family or individual	9,169	46.6	1.6	2.2
State	4,132	21.0	1.8	1.9
Corporate	2,667	13.6	3.9	-1.3
U.S. Forest Service	2,564	13.0	1.2	2.4
Other private	659	3.3	9.7	32.1
Other public	505	2.6	10.6	26.6
National Park Service	NA	NA	NA	NA
Total	19,696	100.0	0.6	3.0

The following is from the 2013 inventory (Pugh 2014, Resource Update FS-7):
White (*Fraxinus americana*) , green (*Fraxinus pennsylvanica*), and black ash (*Fraxinus nigra*) each experienced dramatic increases in mortality since the 2008 inventory (total increase of 57,188 thousand ft3 or 260 percent). The emerald ash borer (*Agrilius planipennis* Fairmaire) was the probable cause for most of this mortality.

Negative net growth estimates for white and green ash indicate that mortality was greater than growth for these species. American beech (*Fagus grandifolia*) also experienced a large increase in mortality (93 percent) and negative net growth. American beech has been suffering from the adverse effects of beech bark disease (*Cryptococcus fagisuga* and *Neonectria*). Significant increases in mortality were observed for ash and American beech starting in 2004 but net growth was positive. Paper birch has experienced increases in mortality but mortality estimates did not increase from 2008 to 2013..

Eastern white pine and eastern hemlock (*Tsuga canadensis*), each shade tolerant species, experienced gains in net growth since the 2008 inventory (27 and 51 percent, respectively). Northern red oak and black oak (*Quercus rubra and velutina*) had noticeably lower mortality since the 2008 inventory (54 and 48 percent reductions, respectively). Given the variability in estimates of removals, it is difficult to determine if total average annual removals actually differed from the 2008 to 2013 inventory. However, red pine (*Pinus resinosa*) and American basswood (*Tilia americana*) annual harvest removal estimates increased by 82 and 108 percent, respectively.

Slide 7

Species Level Statistics, MI 2013

Number, net volume, oven-dry biomass, net growth, mortality, and harvest removals of live trees on forest land, Michigan 2013 (selected prominent species).

Species	Trees[a] (million trees)	Net volume[a] (million ft³)	Aboveground biomass[b] (thousand tons)	Net growth[a] (thousand ft³/yr)	Mortality[a] (thousand ft³/yr)	Harvest removals[a] (thousand ft³/yr)
Sugar maple	447	5,079	157,747	105,077	18,103	49,088
Red maple	476	4,708	127,232	124,075	19,197	43,900
Northern white-cedar	463	2,808	46,551	41,654	11,271	7,467
Red pine	218	2,364	43,094	77,564	5,744	38,257
Northern red oak	97	1,742	53,154	64,487	2,995	11,841
Eastern white pine	101	1,673	28,649	65,522	6,685	3,467
Quaking aspen	182	1,627	36,822	28,433	50,387	31,551
Bigtooth aspen	116	1,271	27,637	26,641	24,919	20,906
Eastern hemlock	74	1,076	20,771	15,635	4,797	3,432
Black cherry	89	1,042	26,859	30,361	10,673	9,035
Green ash	66	587	17,823	-15,966	46,443	4,896
American beech	39	569	16,921	-210	10,904	11,176
White ash	32	452	13,241	-6,529	24,125	3,985
Black ash	64	332	11,433	2,411	8,570	1,434

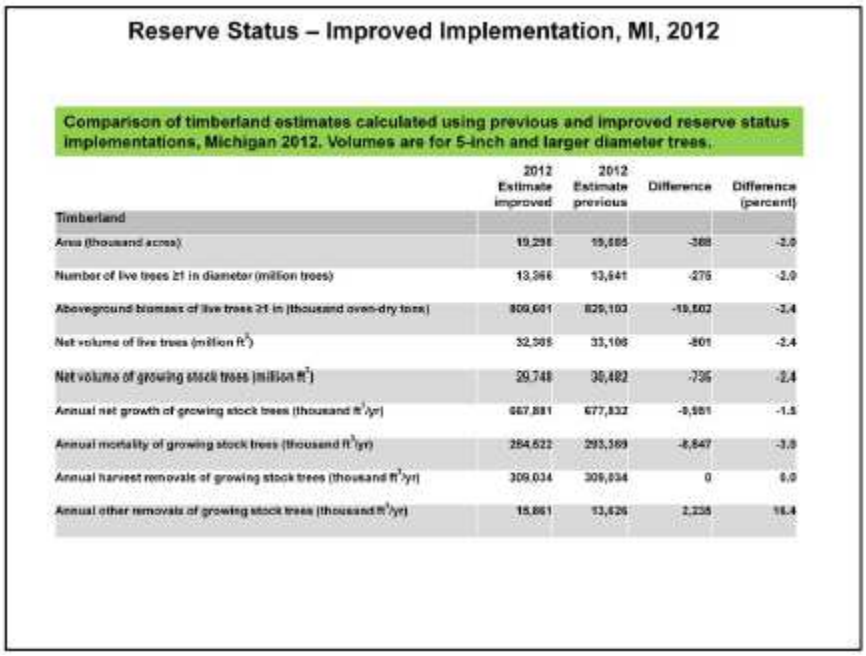
The following is from the 2013 inventory (Pugh 2014, Resource Update FS-7):
FIA defines reserved forest land as forest land withdrawn by law(s) prohibiting the management of land for the production of wood products (not merely controlling or prohibiting wood-harvesting methods). All private forest land, regardless of conservation easements that may restrict harvesting, is not reserved. Timberland does not include reserved forest land.

In an effort to increase consistency among states and across inventory years, a refined set of procedures determining reserve status have been implemented with version 6.0 of the FIA field manual which took effect with the 2013 inventory year (began October 2012). Furthermore, all previously collected annual inventory data (1999

to present) have been updated using the new standardized interpretation.

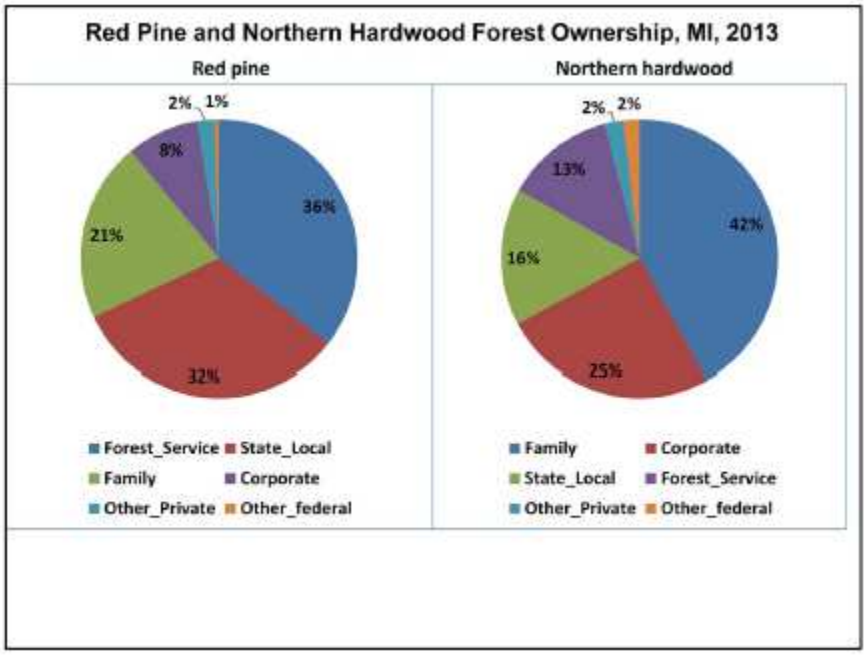
Starting with the 2013 inventory, timberland estimates generated for earlier annual inventories can differ from previously published estimates. The 2012 inventory was the last inventory in which all data were available under the previous and improved implementations. Small but significant changes are associated with timberland acreage, number of trees, volume, and biomass. The changes associated with the remaining timberland estimates are minor given the inherent variability in the associated estimates. The improved implementation of the reserve status definition increases the spatial and temporal precision of timberland estimates allowing for higher quality trend analyses and potentially better forest management decisions.

Slide 8



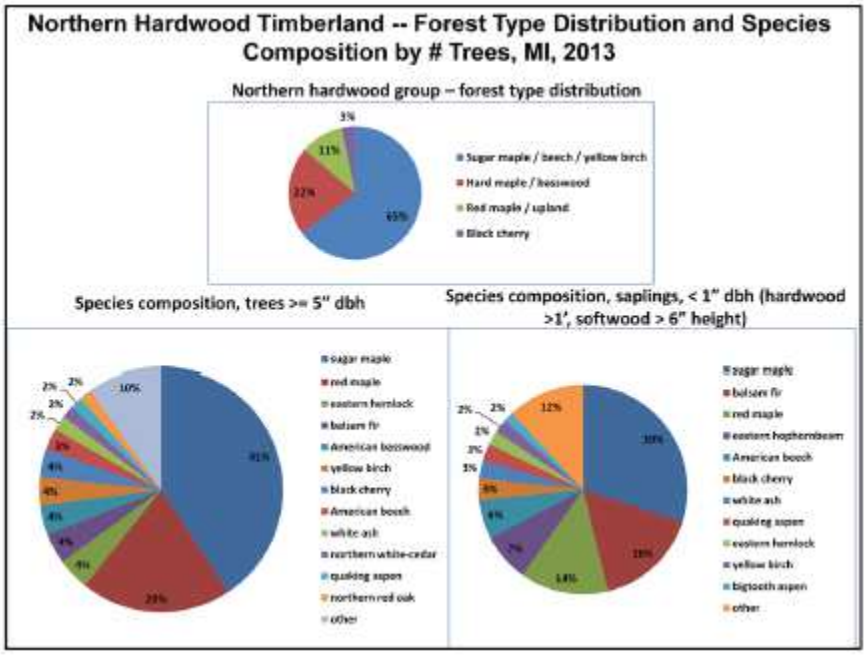
There is a difference between red pine and northern hardwood stands in ownership distribution with most northern hardwood stands owned privately and most red pine stands owned publicly.

Slide 9



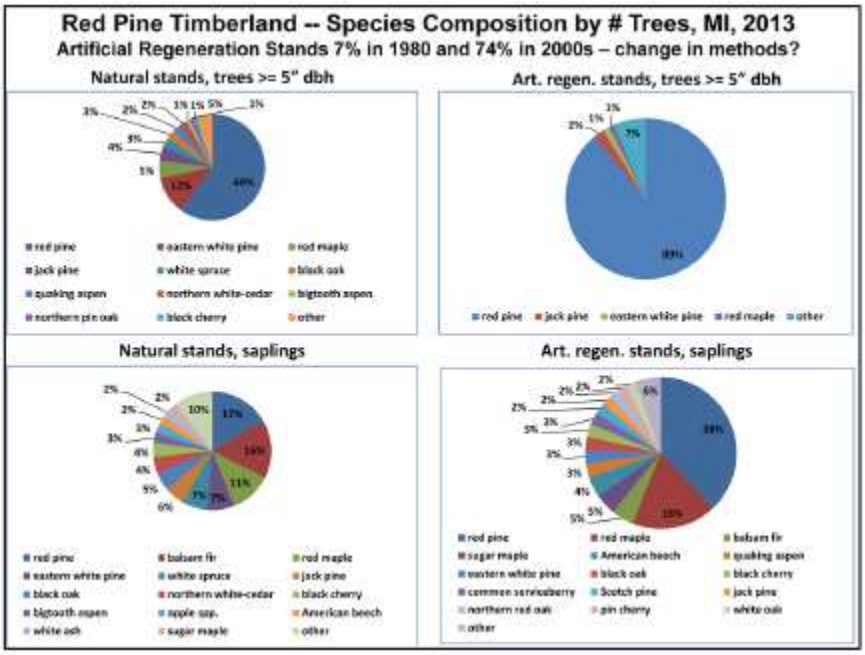
Most of the northern hardwood group is in sugar maple-beech-birch, sugar maplebasswood, and red maple upland. The majority of trees at least 5" dbh in sugar and red maple. The majority of saplings is in sugar maple, balsam fir, and red maple.

Slide 10



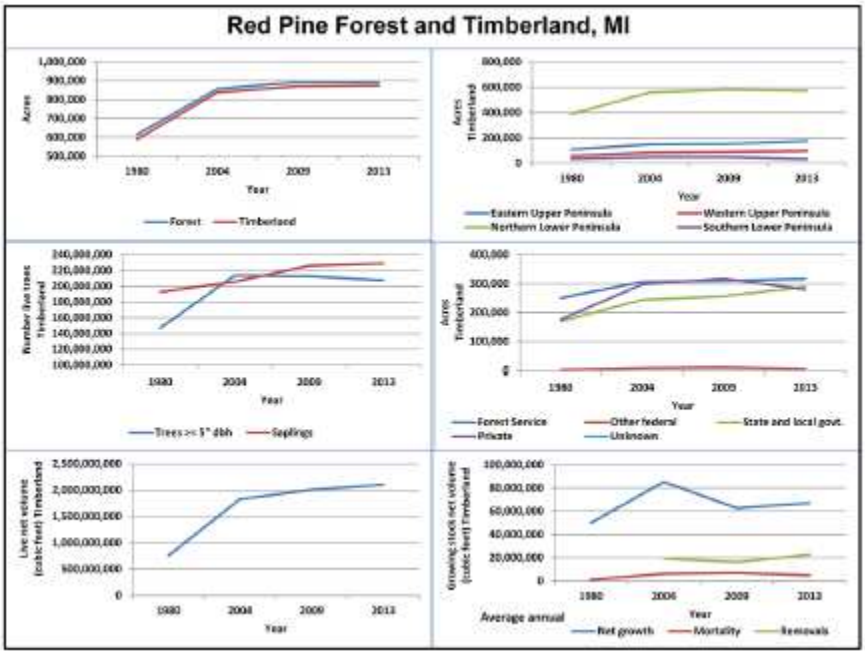
There is a difference in species composition between natural and artificial regeneration red pine stands with greater diversity of species in natural stands. Balsam fir saplings are more predominate than red maple saplings in naturals stands. Eastern white pine is a notable component for saplings and larger trees in natural stands.

Slide 11



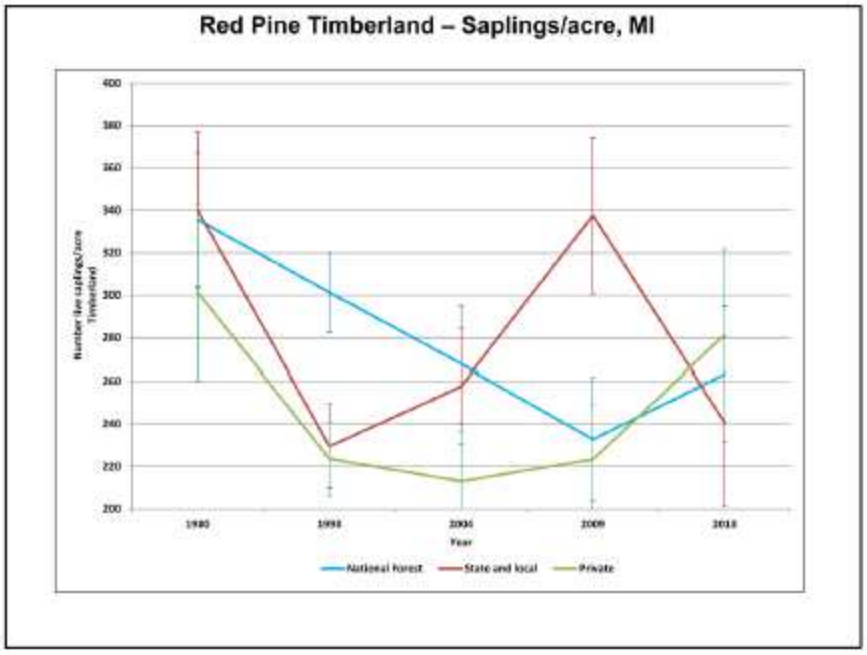
Acreage and volume are increasing. Most red pine acreage is in the northern Lower Peninsula. Area estimates among U.S. Forest Service, state and local government, and private are fairly close. Net growth, mortality, and removals are covered in more detail later.

Slide 12



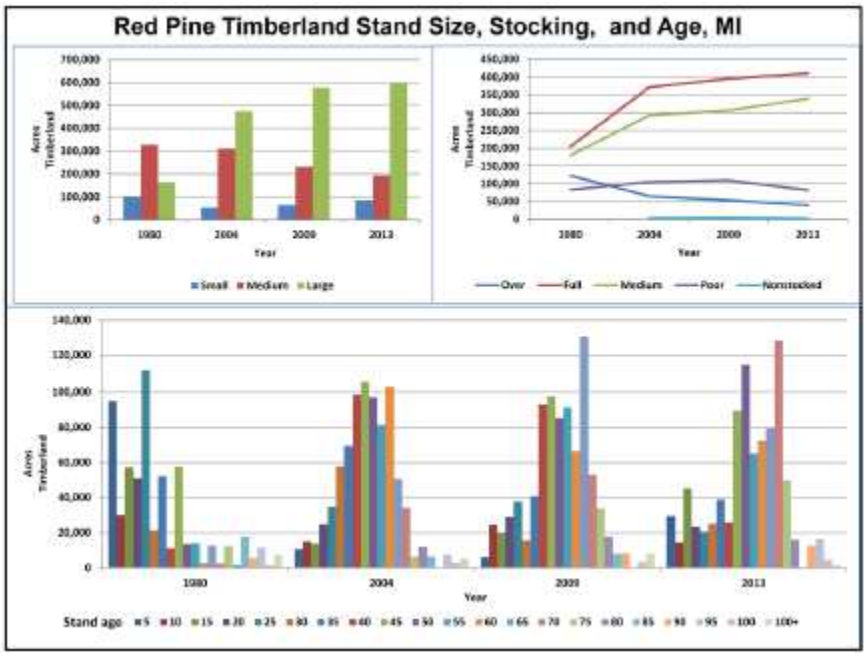
Large swings in State and local estimates are suspect. 1980, 2004 and 2013 estimates show no difference in saplings/acre between ownership groups. There may be a decrease in saplings/acre National Forest and State and local ownership between the 1980 and 2013 estimates (22 and 29 percent, respectively).

Slide 13



Red pine acreage is increasing over time and trees are growing larger with area increases of full and over stocked stands. Age classes are shifting to older stands. Periodicity in acreage by stand age in 1980 is due to fact that stand age was recorded by nearest the 10 years in the 1980 inventory.

Slide 14



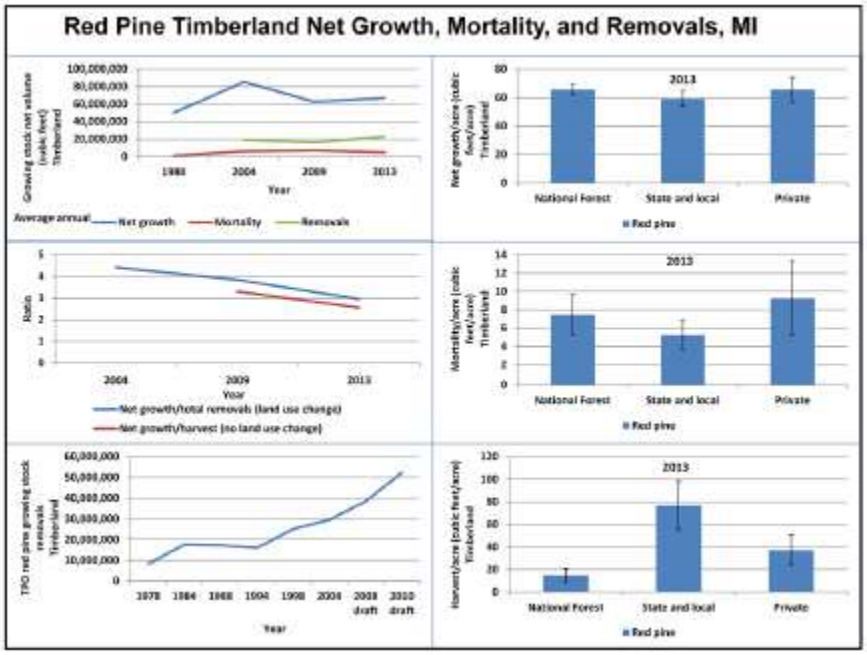
The net growth estimate decreased approximately 18 million cubic feet from 2004 to 2013. Most of this is associated with approximately 14 million more cubic feet of reversion in the 2004 vs. 2013 inventory. There is also a higher "survivor + ingrowth" net growth in 2004 by about 2 million cubic feet. Mortality was not a factor with approximately 1.3 million less in 2013 compared to 2004. There was notably more mortality in 2004 compared to 1980, approaching six times more and still net growth increased by approximately 34% from 1980 to 2004. The increase from 1980 to 2004 is related to an increase in red pine stand area and larger trees by 2004.

The net growth to removals (includes land use change) ratio has dropped since 2004, mostly due to the 18 million cubic feet drop in net growth. Also, there was an 18% increase (3.4 million cubic feet; harvest removals increased by 19%) in total removals on timberland from 2004 to 2013 but given sampling error this increase does not indicate a significant increase in removals by its self. However, harvest/acre rose substantially from 21 to 43 ft3/ac from the 2008 to 2013 inventory and the timber product output estimates (TPO, mill surveys) show an increasing removals trend since 1994. Combining all this info, it appears that harvests in red pine stands have been increasing since the late 1990s.

Note that net growth to harvest ratios for growing stock trees (timberland-to-timberland observations - without land use change) are not available for the 2004 inventory (missing in the graph). In the 2013 inventory, the net growth to harvest ratio (timberland-to-timberland) is 2.6 (SE 25% so min to max of 1.9 to 3.2). By ownership, the ratios of net growth to harvest (timberland-totimberland) for 2013 are approximately 1.9 (SE 38%), 2.1 (SE 45%), and 5.4 (SE 45%) for state and local government, private, and U.S. Forest Service, respectively.

For comparison, the overall net growth to harvest ratio for growing stock trees (all growingg stock at state level, timberland-to-timberland) is 2.1 (SE = 7%). In 2008, the overall ratio was 1.9 (SE 5%). By ownership, harvest/acre appears to be higher on state and local government timberland.

Slide 15

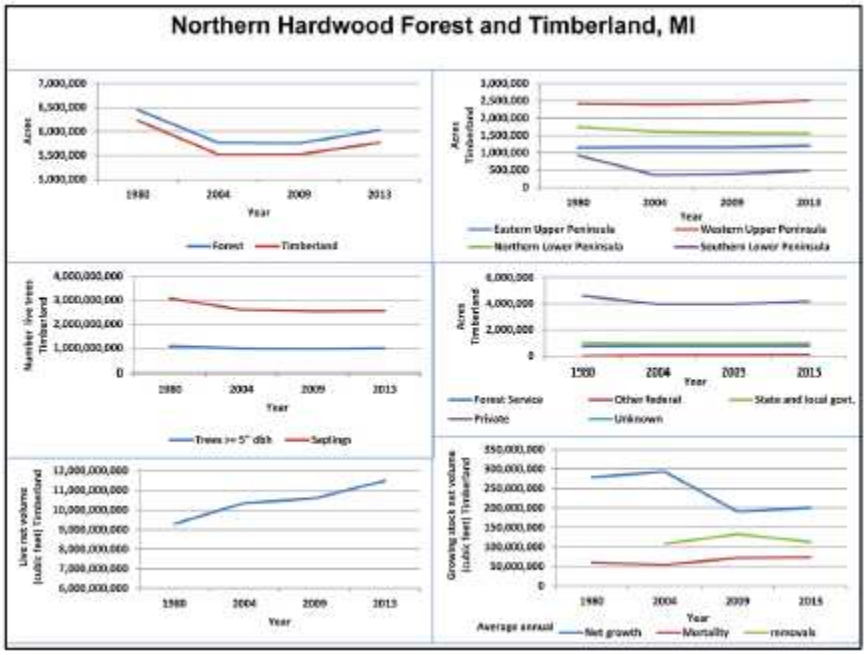


There is a northern hardwood acreage decrease apparent from 1980 to 2000s but there was a forest type definition change in the 2000s that reduced the acreage estimate by approximately 9% and that makes the 1980 and 2000s estimates indistinguishable. Even though acreage appears to decrease (probably due to definition change), the volume is increasing.

There is a noticeable drop in acreage from 1980 to the 2000s in the southern Lower Peninsula. This is directly associated with the drop in private ownership also apparent since 1980. Between 86 and 95% of northern hardwood acreage has been held in privateownership in the southern Lower Peninsula since 1980.

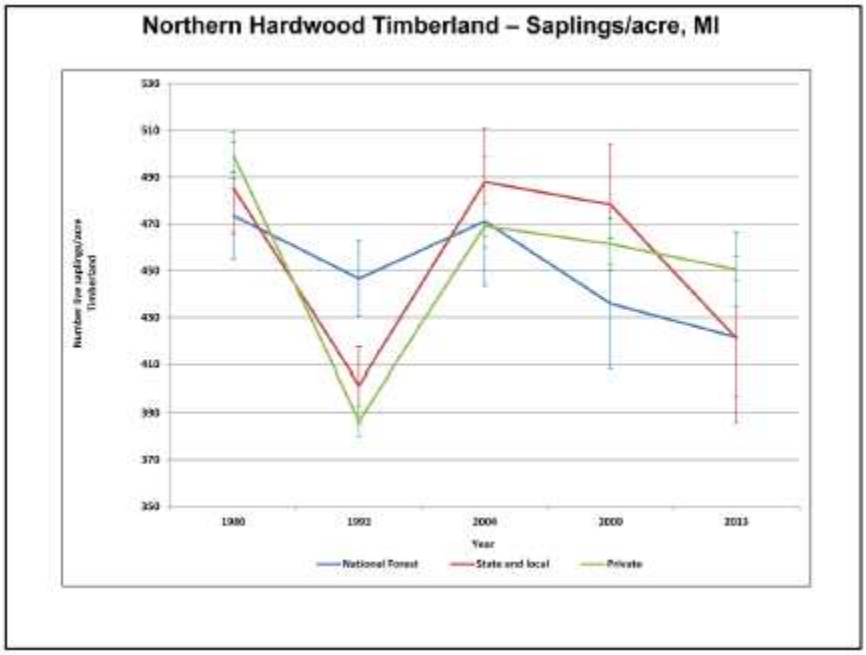
More to come on net growth, mortality and removals for northern hardwoods.

Slide 16



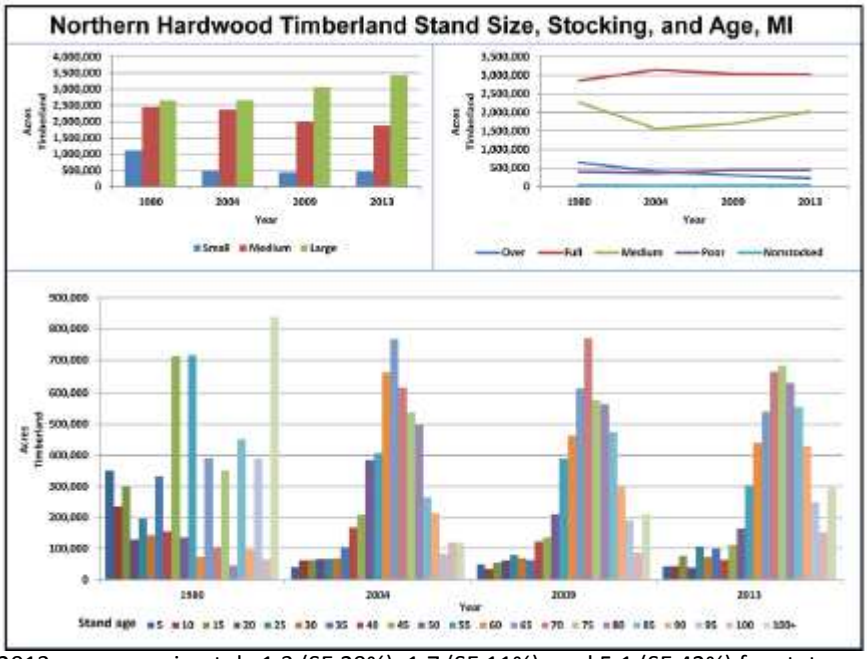
Given the sampling error it is difficult to say that there is a difference in saplings/acre between groups for a given inventory year. Between the 1980 and 2013 estimates, there may be a discernable decrease in saplings/acre (approximately 10%) on private ownership.

Slide 17



Overall, the trees are growing larger and increases are occurring in large-stand acreage and total volume. The amount of acreage in older age classes appears to be increasing. Similar but more pronounced trends are evident with red pine stands. Most acreage is in full and medium stocked stands. Periodicity in acreage by stand age for 1980 is due to the fact that stand age was recorded by 10-year increments in the 1980 inventory.

Slide 18

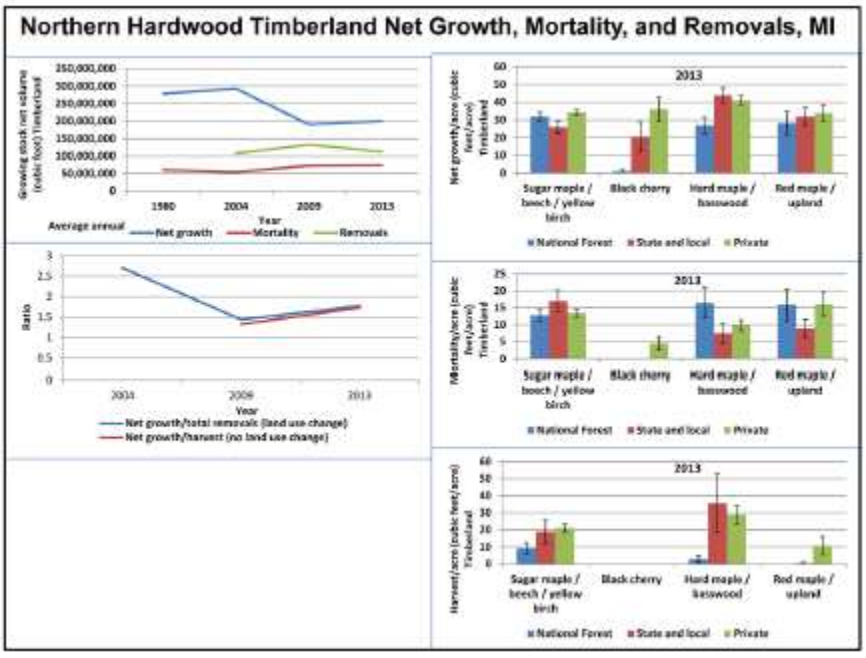


The net growth estimated decreased from the 2004 to 2013 inventory by approximately 93 million cubic feet. Mortality is 25 million less, reversions are 11 million more, and "survivor + ingrowth" is 52 million more in 2004. This accounts for most of the apparent decrease accounting for 88 million cubic feet. So only considering the previously mentioned factors, nearly 60% is associated with greater "survivor + ingrowth," 28% with less mortality, and 13% with more reversion in 2004.

The ratio estimate of net growth to total removals decreased from 2004 to 2013 (2013 ratio 1.7, SE 10%) mainly due to the decrease in net growth. In comparison, the difference in removals was minor.

By ownership, the ratios of net growth to harvest (growing stock, timberland-totimberland) for 2013 are approximately 1.3 (SE 29%), 1.7 (SE 11%), and 5.1 (SE 42%) for state and local government, private, and U.S. Forest Service, respectively. It appears that there may be lower net growth, lower harvest, and more mortality per acre on U.S. Forest Service timberland for the hard maple/basswood forest type.

Slide 19

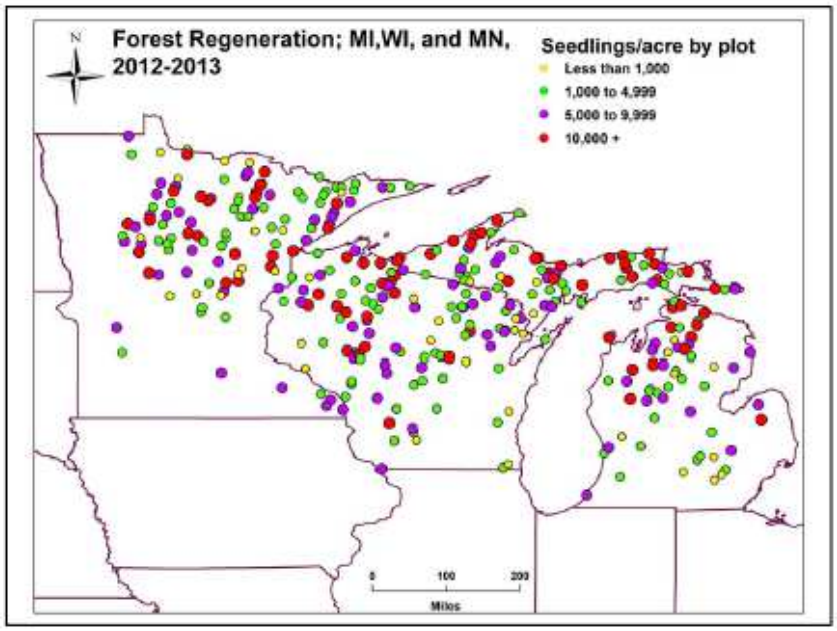


Plots with at least one forested condition and all subplots with forested conditions were sampled for regeneration.

This is a new inventory indicator program, the advance tree seedling regeneration indicator. FIA has been collecting sapling counts by species throughout the year, even in snow, and the main purpose was to determine minimum stocking (i.e., does the plot meet minimum stocking requirements to qualify as forest or timberland). Six and 12 inch minimum heights (less than 1" dbh) were designated for soft and hardwoods, respectively.

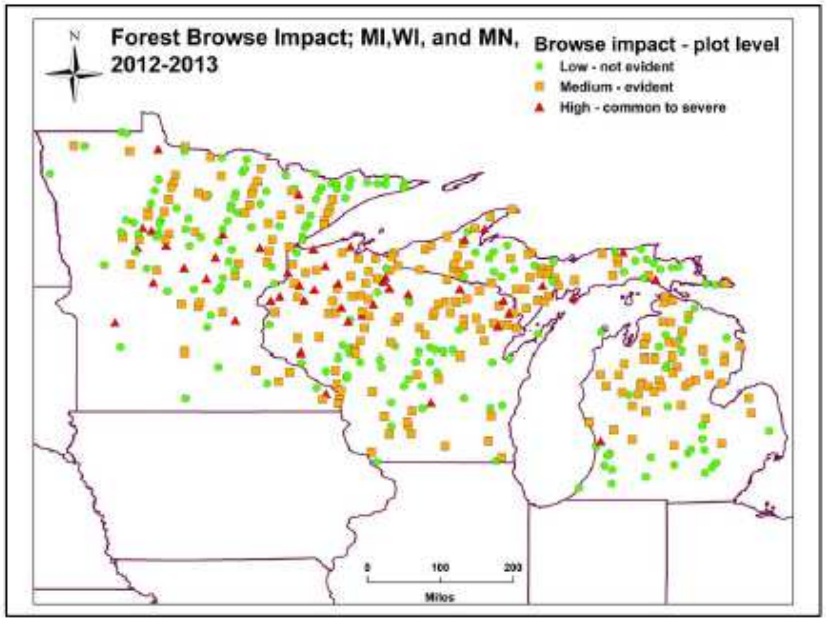
The focus of the new program is on regeneration. The collection is during summer months (one plot/48,000 acres) and includes more size classes down to 2 inches in height. A browse impact is identified at each plot and rules can be developed to identify "adequate regeneration" based on stocking, site class, seedling characteristics, and browse impact.

Slide 20



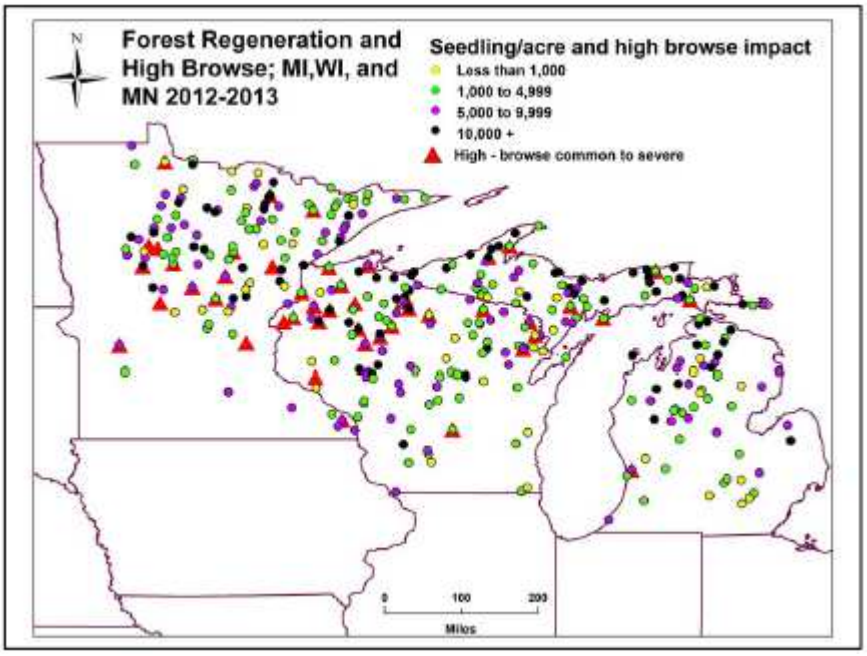
These are all plots with at least one forested condition and sampled for browse impact. The browse impact is assessed at the plot level.

Slide 21



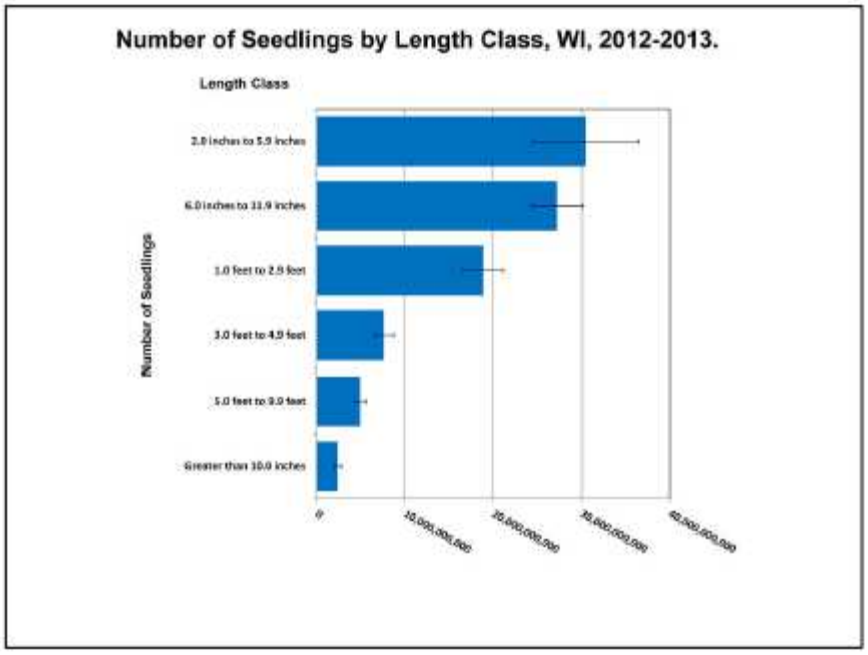
Combination of seedlings/acre and high brose impact from the previous two slides.

Slide 22



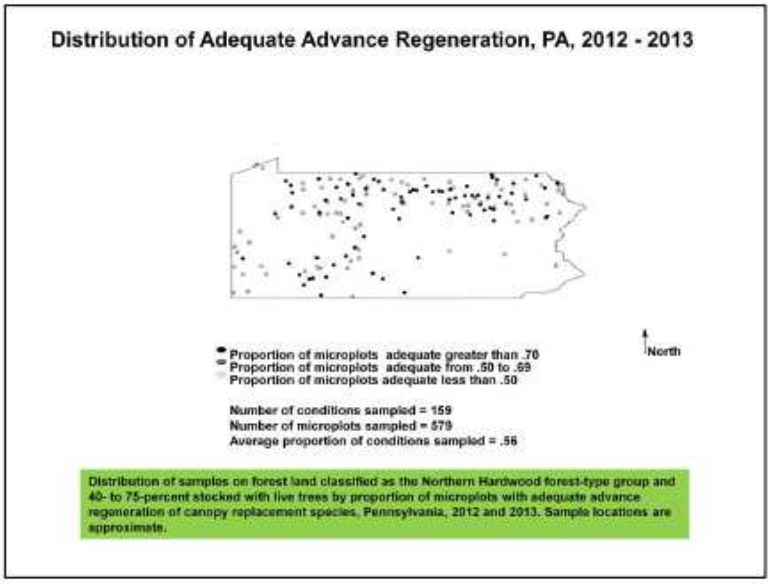
Total seedlings by length class for WI. These estimates could be filtered by condition attributes such as forest type or by tree attributes such as species. These estimates will be available for other states within the upcoming months.

Slide 23



Adequacy of regeneration by proportion of microplots on a plot. Based upon specific rules by stocking, site class, seedling type (e.g., competitive status and length class), and browse impact class (more impact then more seedlings/acre required). The FIA species/species groups provide the opportunity to characterize regeneration for a wide range of research objectives. Some common analytical questions of interest include evaluating FIA species/species groups that are 1)native, 2)endemic, 3)non-native, 4)invasive, 5)preferred for timber production, 6)able to achieve high canopy position, 7)match overstory species, and 8)combinations of these and other characteristics.

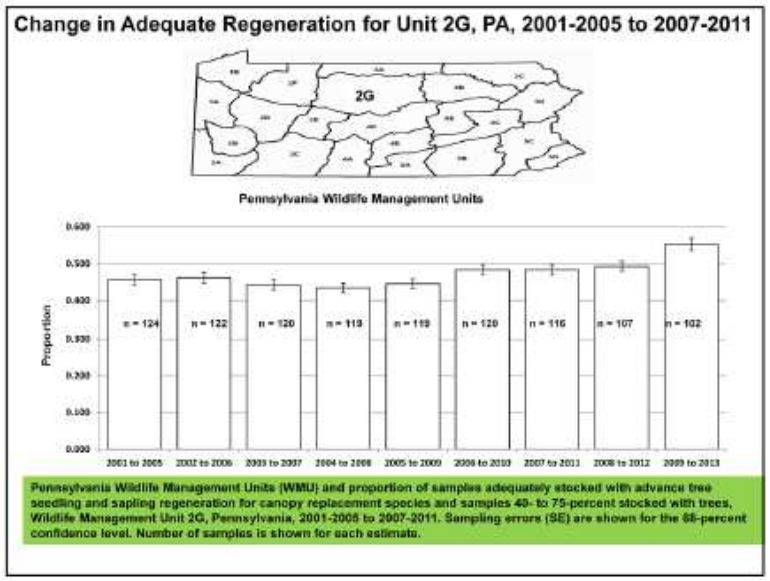
Slide 24



The proportion of adequately stocked microplots has increased significanlty for PA which has had this study going longer than the rest of the region (PA since 2000 using the recently implemented FIA system, rest of region since 2012). Uses:

- Identify adequate/inadequate regeneration.
- Broad-scale forest projection models, e.g., the Forest Vegetation Simulator (FVS), typically
- require a method to account for initial seedling recruitment (Crookston and Dixon 2005)
- and could be used to predict composition, structure and quality of the forest including
- regeneration.
- Wildlife habitat assessment
- Carbon stocks
- Tree species migration, etc.

Slide 25



Slide 26