# MAINE FORESTRY CARBON CALCULATOR

**The table below describes important components of full life cycle carbon accounting for forestry mitigation options and is followed by an accounting template for analysis of greenhouse gas reductions.**

| Variable | Description |
|---|---|
| **Acres Treated** | Specified by technical work group proposals as cumulative acreage, by forest type, over 15 years, and also translated into an average annual number |
| **Harvest Method And Intensity** | Specified by technical work group proposals |
| **Regeneration Method And Intensity** | Specified by technical work group proposals, or by default with biomass replacement assumed to occur completely over 58.2 years (the average age of forested stands in Maine as measured by FORCARB) |
| **Percent Harvested Biomass Directed To/From Energy Recapture Vs. Wood Products** | Specified by technical work group proposals or by default using HARVCARB averages based on a weighted average of Maine hardwood vs. softwood as measured |

| | |
|---|---|
| | by FORCARB |
| **Percent Biomass Directed To/From Pulp Vs. Saw Timber** | Specified by technical work group proposals or by default using HARVCARB averages based on a weighted average of Maine hardwood vs. softwood as measured by FORCARB |
| **Disposition Rates Of Harvested Biomass To/From:**<br>• **Wood Products**<br>• **Landfill Storage**<br>• **Waste Emissions**<br>• **Energy Emissions** | HARVCARB regional data applied to Maine FORCARB data<br>Specific rates vary by hardwood vs. softwood, and by saw timber vs. pulp<br>A weighted average based on FORCARB results is used for average stands |
| **Estimated Forest Carbon In Biomass** | FORCARB as revised with Maine biomass equations from Wharton and Griffith (1998), component equations from Jenkins and others (2003)<br>Soil carbon data from Amichev and Galbraith (2004)<br>Species specific equation are used for restocking programs (e.g. Spruce)<br>Carbon replacement of natural stands uses 2002 Maine FORCARB data |
| **Volume And Decay Of Logging Residue** | Estimates of non merchantable biomass volume from Turner (1993) as reported in Sampson and Hair (1995); intermediate harvest rates used<br>Hardwoods: 36.4 percent of total harvested biomass left on site<br>Softwoods: 35.4 percent of total harvested biomass left on site |
| **Carbon Decay Rate Of Forest Floor And Coarse Woody Debris** | Currently not quantified, but can be increased by intensive harvest levels and certain harvest methods – see Yanai (2003) |
| **Mortality Rate Of Undisturbed Stands** | Currently not quantified, but can be reduced by density management (thinning) |

| | |
|---|---|
| **Electric Power Displacement From Biomass Feedstocks** | Marginal displacement rate of 950 pounds per MWh provided by Tellus (2004) using NEMS, roughly equal to natural gas combined cycle |
| **GHG Displacement From Wood Products That Substitute For Building Materials** | Data from Bowyer (2003) from CORIMM using case studies from Minneapolis and Atlanta<br>Combined effect of steel and concrete energy displacement = 28.7 percent of biomass carbon in wood products that substitute |
| **Sustainability Constraints** | Long term biomass growth estimates assume sustained acreage levels, no unnatural disturbance, complete regeneration of harvested biomass<br>Thinning, light and selective harvests assume minimal disturbance to forest floor and coarse woody debris |
| **Levelized, Annual Greenhouse Gas Savings** | Forestry options propose a cumulative number of acres be treated over a 15-year period. To calculate a representative (or average) year, the cumulative 15 year acreage is calculated as if it were treated in the middle year (2012.5) and divided by 15 to give average annual results. No ramp-up periods are specified. |
| **Discounting** | Emissions and emissions reductions are not discounted.<br>Costs assume a 5 percent discount rate. |
| **Time Periods** | Method One: 2005-2020, no benefits or costs counted beyond 2020<br>Method Two: 2005-2020, addition of benefits and costs that accrue by 2100 as a direct result of actions taken between 2005-2020. Biomass replacement of harvested stands is calculated over 58.2 years to match average stand age in Maine. HARVCARB wood products effects are |

| | |
|---|---|
| | calculated to 2100. These are added to annual savings in 2005-2020 to show full life cycle effects. |

# Forestry Carbon Accounting Template

| **Proposed Forestry Option: X** | **MTCO2e** |
|---|---|
| Acres treated by forest type 2005-2020 | Proposed |
| Cords removed/reserved per acre | Proposed |
| MTCO2e removed/reserved per acre (2.079 MT CO2e/cord) | › |
| Annual MTCO2e removed/reserved | › |

| **% Harvested Biomass To/From Wood Products** | Proposed |
|---|---|
| MTCO2 to/from saw timber (durable wood), or pulpwood | › |
| ***Products in use*** – carbon storage | + |
| ***Landfill*** – carbon storage | + |
| ***Biomass energy*** – carbon emission | - |
| ***Displaced energy*** – carbon reduction | + |
| ***Other WP emission (processing residue)*** – carbon emission | - |
| ***Forest Sequestration*** – carbon storage | + |
| ***Logging residue*** – carbon emission | - |
| ***Building materials substitution*** – carbon reduction | + |
| ***Stand mortality*** – carbon emission or reduction | + - |
| ***Forest floor/CWD decay*** – carbon emission | + - |
| **Total GHG Savings** | **SUM** |

| **% Biomass To/From Energy Recapture** | Proposed |
|---|---|
| ***Biomass energy*** – carbon emission | - |
| ***Displaced energy*** – carbon reduction | + |
| ***Forest Sequestration*** – carbon storage | + |
| ***Logging residue*** – carbon emission | - |
| ***Stand mortality*** – carbon emission or reduction | + - |
| ***Forest floor/CWD decay*** – carbon emission | + - |
| **Total GHG Savings** | **SUM** |
| **Option Total GHG Savings** | **SUM** |

| | |
|---|---|
| **Proposed** | = Policy Action Proposed By Technical Work Group |
| › | = Calculated From Proposal Based On Conversion Factors |
| + | = Reduced Flow Of Emissions Or Accounting Credit |
| - | = Increased Flow Of Emissions Or Accounting Debit |
| **SUM** | = Net Sum Of Accounts |

**HARVCARB**

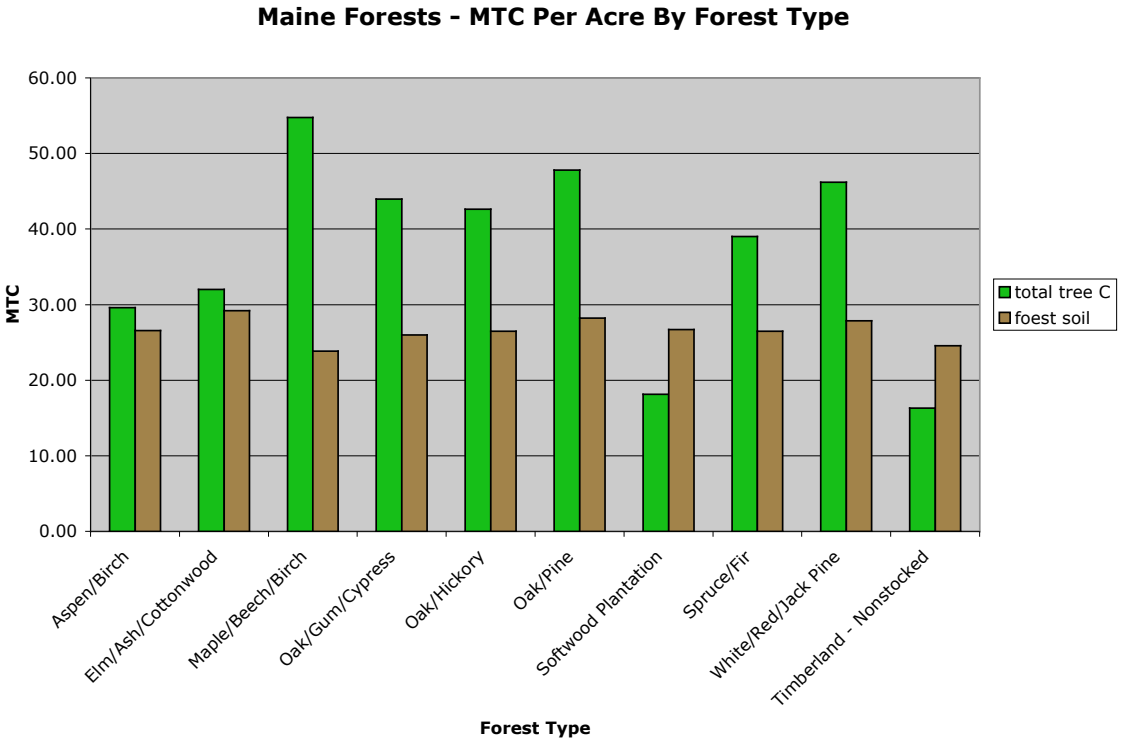
**Disposition Of Harvested Wood Products For The Northeastern U.S. (Maine Adjusted)**

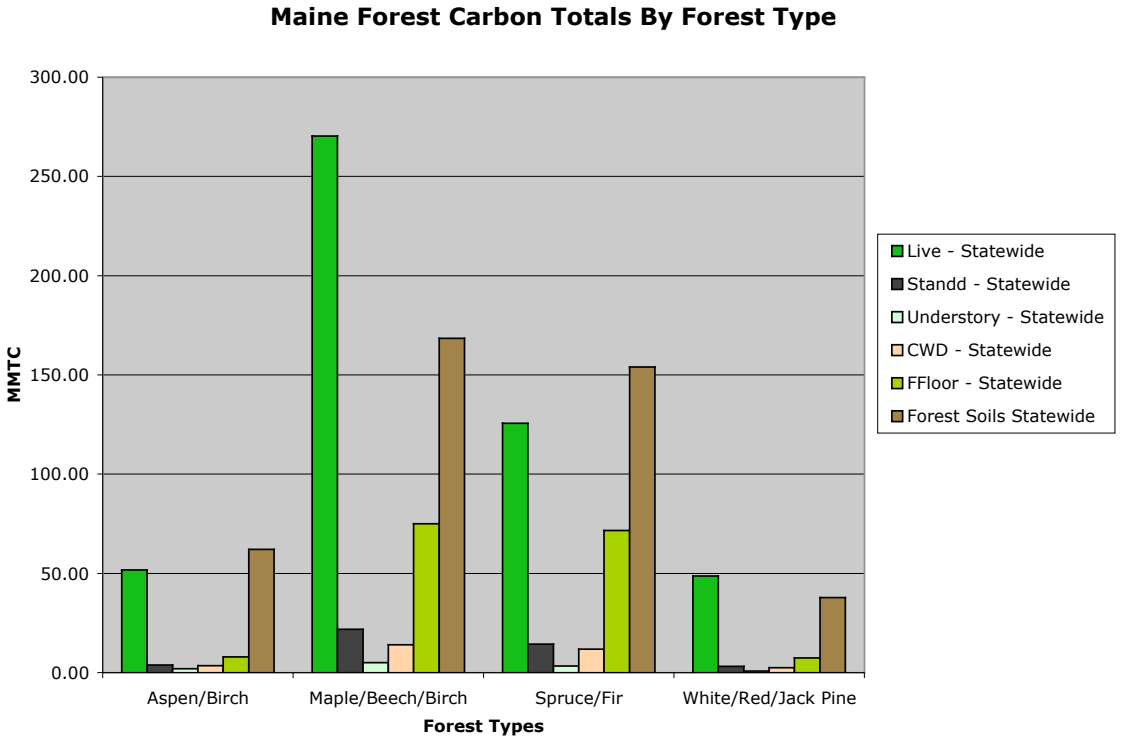
| Biomass End Use | Years | | | |
|---|---|---|---|---|
| **Average Pulpwood** | **0** | **7.5** | **60** | **100** |
| Products | 29.55% | 23.56% | 2.95% | 2.45% |
| Landfills | 0.00% | 7.90% | 13.00% | 10.45% |
| Energy | 41.35% | 41.77% | 43.25% | 43.25% |
| Emissions | 29.10% | 30.72% | 40.85% | 43.85% |
| **Average Saw timber** | | | | |
| Products | 27.40% | 23.77% | 7.10% | 5.55% |
| Landfills | 0.00% | 5.06% | 11.85% | 11.05% |
| Energy | 42.95% | 43.20% | 44.35% | 44.50% |
| Emissions | 29.60% | 30.45% | 36.70% | 38.95% |
| **Statewide Average** | | | | |
| Products | 28.48% | 23.67% | 5.03% | 4.00% |
| Landfills | 0.00% | 6.48% | 12.43% | 10.75% |
| Energy | 42.15% | 42.48% | 43.80% | 43.88% |
| Emissions | 29.35% | 30.58% | 38.78% | 41.40% |

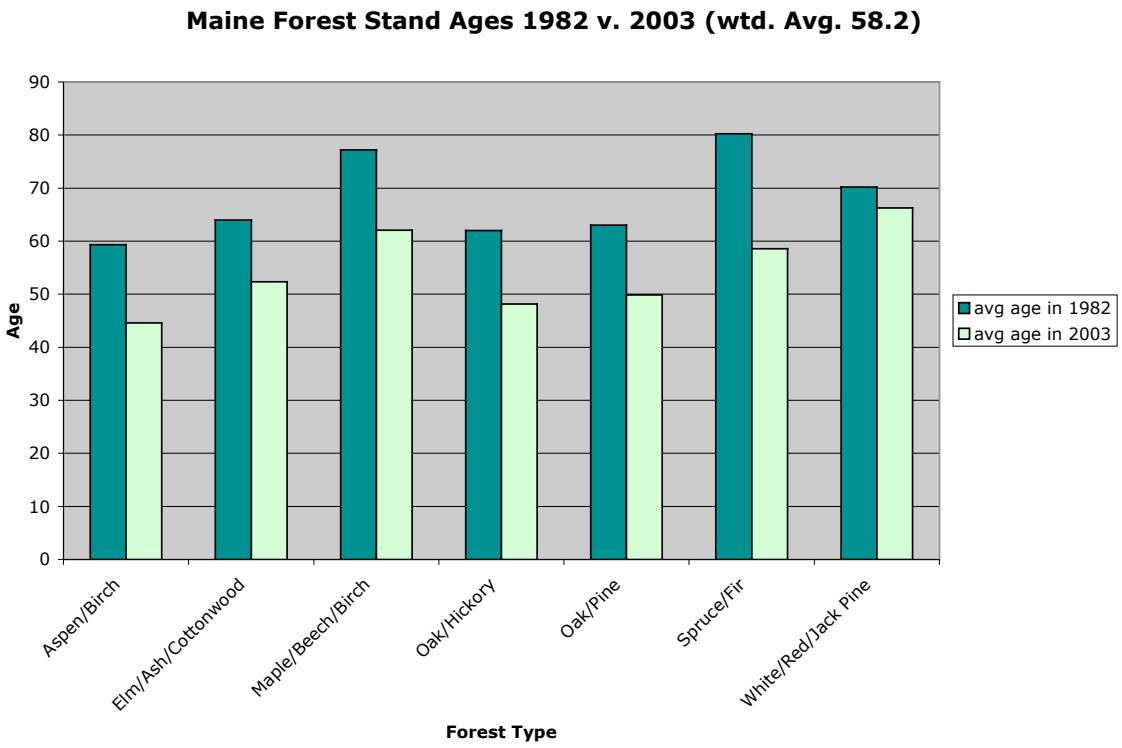
**Key Issues For Later Discussion, Potential Refinement:**

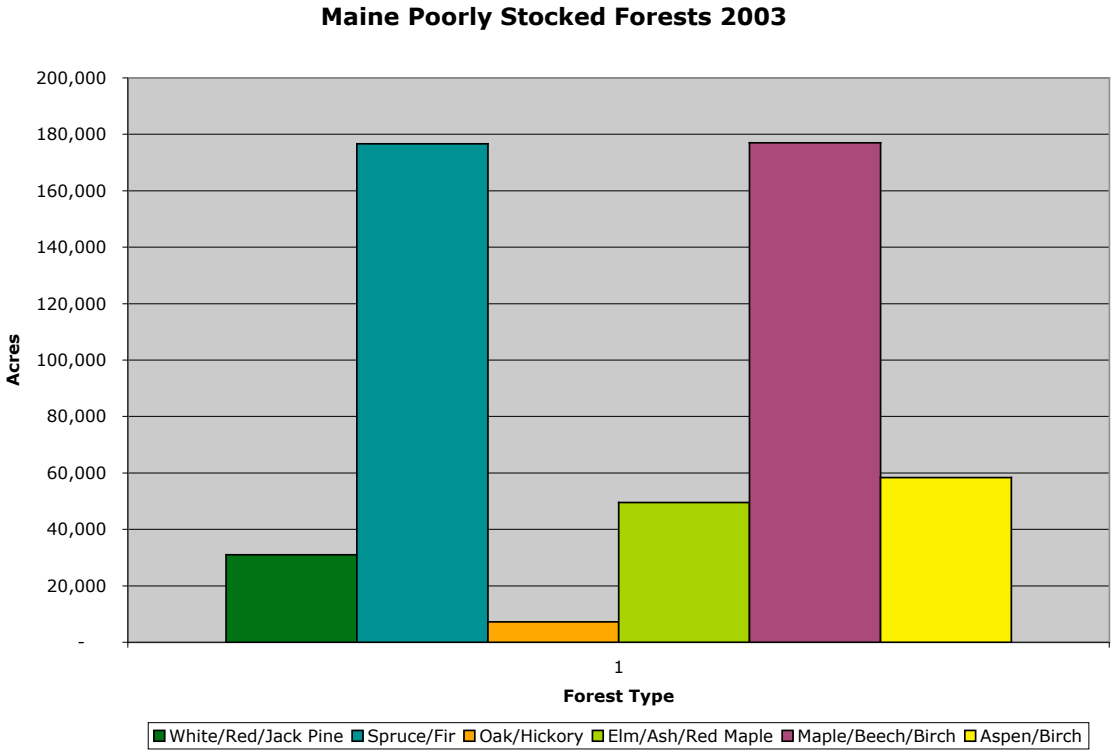
- Level of waste emissions (mill residue) estimated by HARVCARB (may be outdated and high)
- Harvest risk during biomass grow back period (analysis stops at age 58.2, average stand age in Maine, without interruption – may need risk adjustment; also need average age of harvests)
- Level and recovery rate of logging residue (may be outdated and low)
- Logging residue rate for pulp vs. saw timber (market based)
- Rate of natural stand mortality (may be lower with harvest)
- Rate of carbon release from forest floor and coarse woody debris (may be higher with certain harvest methods)
- Ecological risk (disease, storms, climate change – may need risk adjustment)

- Displacement rate of biomass power (no BGCC, natural gas prices?)
- Rate of wood products substitution for concrete and steel (market penetration?)
- Time value of assets (discounting of benefits same as costs?)


Maine Forests - MTC Per Acre By Forest Type
60.00
50.00
40.00
30.00
20.00
10.00
0.00
MTC
Aspen/Birch
Elm/Ash/Cottonwood
Maple/Beech/Birch
Oak/Gum/Cypress
Oak/Hickory
Oak/Pine
Softwood Plantation
Spruce/Fir
White/Red/Jack Pine
Timberland - Nonstocked
Forest Type
total tree C
foest soil


Maine Forest Carbon Totals By Forest Type
300.00
250.00
200.00
150.00
100.00
50.00
0.00
MMTC
Aspen/Birch
Maple/Beech/Birch
Spruce/Fir
White/Red/Jack Pine
Forest Types
Live - Statewide
Standd - Statewide
Understory - Statewide
CWD - Statewide
FFloor - Statewide
Forest Soils Statewide


Maine Forest Stand Ages 1982 v. 2003 (wtd. Avg. 58.2)
Age
90
80
70
60
50
40
30
20
10
0
Aspen/Birch
Elm/Ash/Cottonwood
Maple/Beech/Birch
Oak/Hickory
Oak/Pine
Spruce/Fir
White/Red/Jack Pine
Forest Type
avg age in 1982
avg age in 2003


Maine Poorly Stocked Forests 2003
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
-
Acres
1
Forest Type
White/Red/Jack Pine
Spruce/Fir
Oak/Hickory
Elm/Ash/Red Maple
Maple/Beech/Birch
Aspen/Birch

## Maine Forest Growth Rates

**R3. Northeast, Maple, Beech, Birch**

| Age | Mean Volume | Mean Carbon Density | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Live tree | Standing dead tree | Under-story | Down dead wood | Forest floor | Soil organic | Total nonsoil |
| Years | m3/ha | Metric tons carbon per hectare | | | | | | |
| 0 | 0 | 0 | 0 | 0.8 | 9.9 | 27.7 | 59.0 | 38 |
| 5 | 0 | 22.1 | 0.8 | 1.9 | 7.1 | 20.3 | 59.0 | 52 |
| 15 | 28 | 36.9 | 2.4 | 1.8 | 5 | 16.3 | 59.0 | 62 |
| 25 | 58 | 52.6 | 3.4 | 1.8 | 4.8 | 17.6 | 59.0 | 80 |
| 35 | 90 | 68.9 | 4.4 | 1.7 | 5.3 | 20.3 | 59.0 | 101 |
| 45 | 119 | 83.9 | 5.3 | 1.7 | 6.1 | 23 | 59.0 | 120 |
| 55 | 147 | 97.7 | 6 | 1.7 | 7 | 25.3 | 59.0 | 138 |
| 65 | 172 | 110.4 | 6.6 | 1.7 | 7.9 | 27.4 | 59.0 | 154 |
| 75 | 196 | 122 | 7 | 1.7 | 8.7 | 29.2 | 59.0 | 168 |
| 85 | 217 | 132.5 | 7.2 | 1.7 | 9.4 | 30.7 | 59.0 | 181 |
| 95 | 237 | 141.9 | 7.3 | 1.7 | 10.1 | 32 | 59.0 | 193 |
| 105 | 254 | 150.3 | 7.2 | 1.6 | 10.6 | 33.1 | 59.0 | 203 |
| 115 | 270 | 157.7 | 7.1 | 1.6 | 11.2 | 34.2 | 59.0 | 212 |
| 125 | 283 | 164.1 | 6.9 | 1.6 | 11.6 | 35.1 | 59.0 | 219 |
| 135 | 295 | 169.4 | 6.7 | 1.6 | 12 | 35.9 | 59.0 | 226 |
| 145 | 304 | 173.9 | 6.5 | 1.6 | 12.3 | 36.6 | 59.0 | 231 |
| 155 | 312 | 177.4 | 6.3 | 1.6 | 12.6 | 37.3 | 59.0 | 235 |
| 165 | 317 | 180 | 6.1 | 1.6 | 12.7 | 37.9 | 59.0 | 238 |
| 175 | 321 | 181.6 | 6 | 1.6 | 12.9 | 38.4 | 59.0 | 241 |

**R6. Northeast, Spruce & Balsam Fir**

| Age | Mean Volume | Mean Carbon Density | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Live tree | Standing dead tree | Under-story | Down dead wood | Forest floor | Soil organic | Total nonsoil |
| Years | m3/ha | Metric tons carbon per hectare | | | | | | |
| 0 | 0 | 0 | 0 | 0.6 | 9.6 | 33.7 | 65.4 | 44 |
| 5 | 0 | 19.3 | 1 | 1.6 | 7.7 | 23.6 | 65.4 | 53 |
| 15 | 11 | 24.3 | 3.1 | 1.5 | 5.6 | 18.6 | 65.4 | 53 |
| 25 | 29 | 31.9 | 4 | 1.5 | 4.9 | 20.7 | 65.4 | 63 |
| 35 | 52 | 41.5 | 5.1 | 1.5 | 4.9 | 24.2 | 65.4 | 77 |
| 45 | 77 | 52 | 6.2 | 1.4 | 5.4 | 27.7 | 65.4 | 93 |
| 55 | 103 | 62.6 | 7.1 | 1.4 | 6.1 | 30.7 | 65.4 | 108 |
| 65 | 126 | 72.2 | 7.8 | 1.4 | 6.9 | 33.3 | 65.4 | 122 |
| 75 | 149 | 81.3 | 8.2 | 1.3 | 7.6 | 35.5 | 65.4 | 134 |
| 85 | 171 | 89.9 | 8.6 | 1.3 | 8.4 | 37.4 | 65.4 | 146 |
| 95 | 192 | 97.9 | 8.7 | 1.3 | 9.1 | 39.1 | 65.4 | 156 |
| 105 | 211 | 105.4 | 8.8 | 1.3 | 9.7 | 40.6 | 65.4 | 166 |
| 115 | 230 | 112.3 | 8.8 | 1.3 | 10.4 | 41.9 | 65.4 | 175 |
| 125 | 247 | 118.9 | 8.7 | 1.3 | 11 | 43 | 65.4 | 183 |
| 135 | 264 | 125 | 8.6 | 1.3 | 11.5 | 44 | 65.4 | 190 |
| 145 | 279 | 130.7 | 8.4 | 1.3 | 12.1 | 45 | 65.4 | 197 |
| 155 | 294 | 136 | 8.2 | 1.3 | 12.5 | 45.8 | 65.4 | 204 |
| 165 | 310 | 142 | 7.9 | 1.3 | 13.1 | 46.6 | 65.4 | 211 |
| 175 | 326 | 147.7 | 7.6 | 1.2 | 13.6 | 47.3 | 65.4 | 217 |

## Maine Tree Equation Data For FORCARB, As Revised

Summarized from the current Maine FIADB and FORCARB2
"Wharton equations" where individual tree biomass equations from Wharton 1998 (Northeastern Resource Bulletin NE-142) In Metric Tons Carbon Per Acre

| **Source of estimate:** | **Wharton equations** | **Wharton equations** |
|---|---|---|
| Forest type | Live tree | Standing dead |
| Aspen/Birch | 22.14 | 1.69 |
| Elm/Ash/Cottonwood | 17.62 | 2.40 |
| Exotic Softwoods | 11.99 | 0.09 |
| Maple/Beech/Birch | 38.32 | 3.11 |
| Non-stocked | 1.14 | 2.21 |
| Oak/Gum/Cypress | 29.72 | 2.04 |
| Oak/Hickory | 35.88 | 1.25 |
| Oak/Pine | 32.66 | 1.83 |
| Spruce/Fir | 21.59 | 2.47 |
| White/Red/Jack Pine | 35.83 | 2.40 |

## Maine Forest Stand Age Comparison 1982 Vs. 2003

| **Type** | **Avg Age 1982** | **Avg Age 2003** | **Change** | **2003 Acres** |
|---|---|---|---|---|
| Aspen/Birch | 59 | 45 | -15 | 2,341,937 |
| Elm/Ash/Cottonwood | 64 | 52 | -12 | 407,184 |
| Maple/Beech/Birch | 77 | 62 | -15 | 7,055,581 |
| Oak/Hickory | 62 | 48 | -14 | 320,044 |
| Oak/Pine | 63 | 50 | -13 | 334,384 |
| Spruce/Fir | 80 | 59 | -22 | 5,819,039 |
| White/Red/Jack Pine | 70 | 66 | -4 | 1,359,302 |
| | | Wtd Avg 58 | | 17,637,470 |

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