Ecological Reserve Monitoring

Summary Report for the Maine Outdoor Heritage Fund and The Nature Conservancy

Mt. Abraham Ecological Reserve

Maine Natural Areas Program
June 2009

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Executive Summary

Nearly 100,000 acres of state-owned lands in Maine are now managed as Ecological Reserves. The Department of Conservation (DOC) manages approximately 86,000 acres of Reserves in northern and eastern Maine, and the Maine Department of Inland Fisheries and Wildlife (IFW) manages 11,000 acres of Reserves primarily in southern and coastal Maine (Figure 1). In addition to these state-owned Reserves, roughly half a million acres of other conservation lands in Maine are being managed with similar purposes.

Reserves were established on state lands by DOC in 2000 following enactment of Title 12, Section 1805 by the Maine Legislature. According to the legislation, Reserves were established to serve as benchmarks against which change can be measured, to protect habitat for those species whose needs may not be met on managed forests, and to serve as sites for scientific research, monitoring, and education. Beginning in 2002, the Department of Conservation worked with a multi-disciplinary committee to draft an *Ecological Reserve Monitoring Plan* that guides periodic data collection at the landscape, stand, and species levels. The monitoring program ties closely to other state and national forest monitoring programs that use U.S. Forest Service Forest Inventory and Analysis (FIA) methods.

This Project Update, the second since inception of the Ecological Reserves Monitoring Program, summarizes data collection and analyses conducted since 2005. Baseline monitoring was conducted on Big Spencer Mountain and St. John Ponds in 2006, the Wassataquoik Reserve and Great Heath in 2007, and Chamberlain Lake, the Mahoosucs, Lower Kennebec, Mt. Agamenticus, Killick Pond, and Forest City in 2008. In all, 147 permanent plots have been established on DOC Reserves since 2005 (bringing the total to 462), and 29 permanent plots have been established on IFW Reserves. In addition, over 250 permanent plots have been established on lands owned by The Nature Conservancy. Because DOC lands were the aim of this OHF grant, this report focuses on preliminary results from DOC Reserves but notes initial results from TNC and IFW lands as well.

Information collected from the monitoring effort is assessed to suggest how forest structure and processes differ between forests managed for timber harvest and forests managed for natural processes. In 2005, initial analyses based on data from ten Reserves indicated that Ecological Reserves have higher basal areas, more large trees (live and dead) and more coarse woody debris than the "average acre" of Maine woods according to Maine Forest Service Inventory and Analysis (FIA) data. Conversely, Maine Ecological Reserves appear to be younger and lacking many of the structural attributes of true old growth forests. Initial analyses with the updated dataset (through 2008) confirm these assessments, but additional data analyses are planned for the winter of 2009/2010.

In addition to the monitoring effort, the Maine Natural Areas Program has convened the Ecological Reserves Scientific Advisory Committee to review the status of Ecological Reserves in Maine, including recreational access and the criteria and process of Reserve designation. A separate report, entitled, *Ecological Reserves in Maine: A Status Report on Designation, Monitoring, and Uses* (July 2009) summarizes the deliberations of that Committee from July 2008 to June 2009.

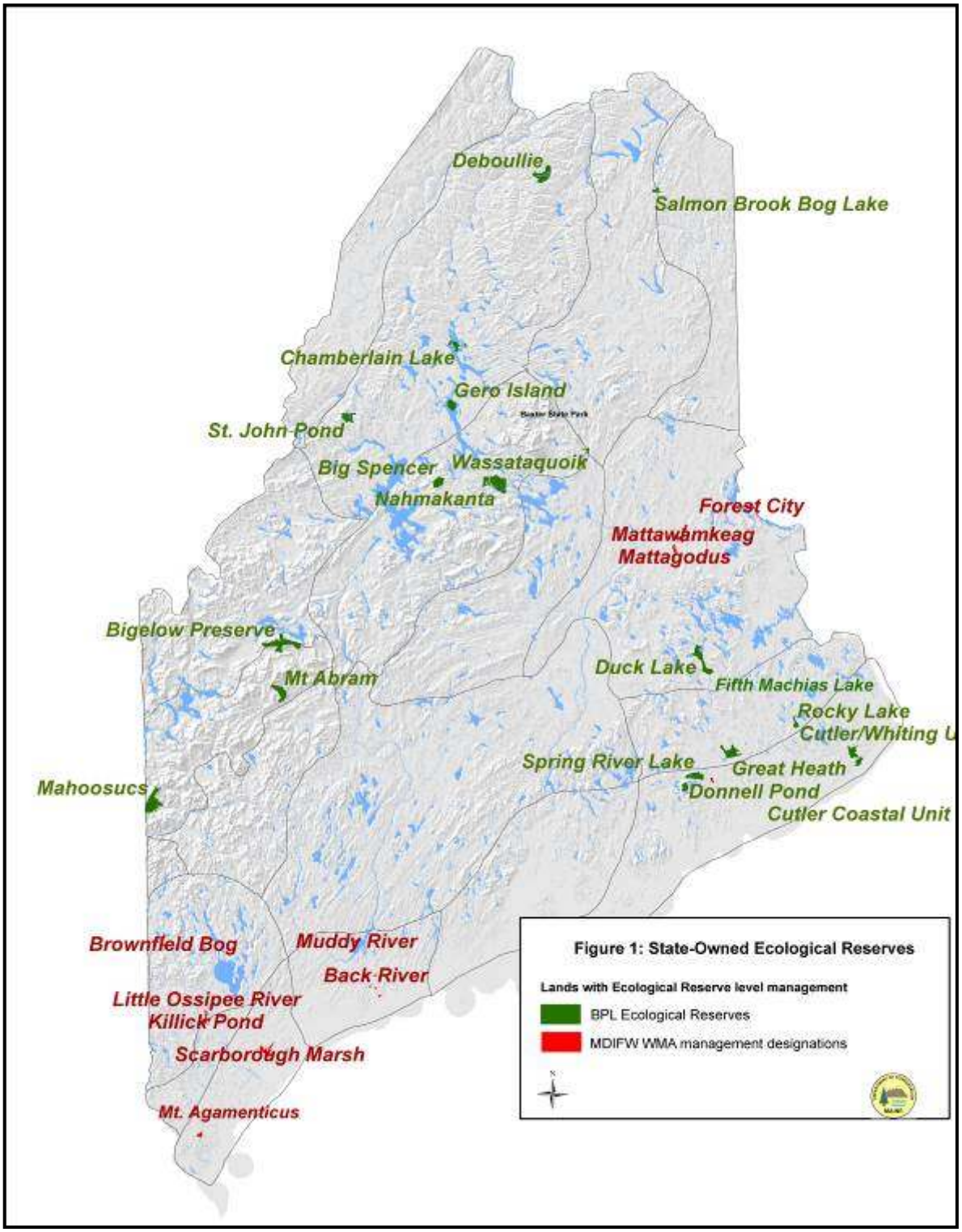

Figure 1: Ecological Reserves in Maine, June 2009

1. Landscape Level Monitoring

Natural Community Mapping

Natural communities have been mapped for seven Reserves using true color air photos (see 2005 report for discussion of methods and results). While this method produces natural community maps at a fairly high resolution, it is time consuming and subject to inconsistencies based on the individual photo interpreter. In the last five years significant advances have been made in the use of remote imagery for land cover mapping and monitoring, including working forest easements in northern Maine (e.g., Sader et al 2005). In particular, Ecological System maps currently being developed as part of the nationwide Landfire project show promise for this purpose. (Ecological Systems are part of a relatively new national ecological classification framework that incorporates land cover and biophysical setting; see Comer et al [2003] for details on the classification, and see www.landfire.gov. Ecological Systems are at a coarser scale than natural communities; there are approximately 40 Ecological Systems in Maine, for example, compared to 100 natural community types.)

Figure 2 depicts Ecological Systems mapped for the St. John Ponds Ecological Reserve. An initial 'ground-truthing' of Ecological Systems was conducted, based on field verified plots, for all of the DOC ecological Reserves. Each plot was assigned a match category of 'good', 'fair' or 'poor',

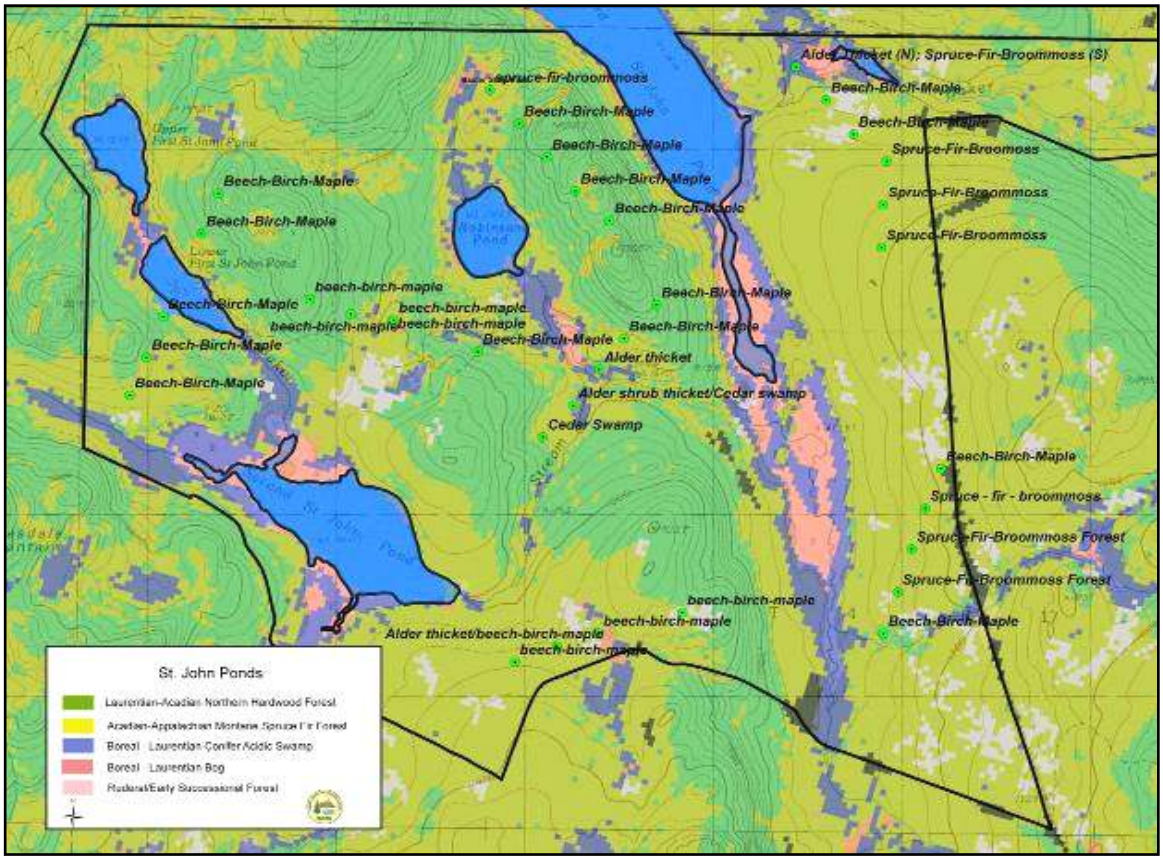

Figure 2: Sample of Ecological System map for St. John Ponds; points are monitoring plots with the assigned natural community type.

reflecting the degree to which the field-identified natural community matches the remotely identified Ecological System. This was not a 1:1 exercise, due to the mis-match in the scale of classifications. Nonetheless, in ground-truthing Ecological Systems mapped across all DOC Ecological Reserves, 73% of plots were 'good' matches and 25% were 'fair'; only 2% were 'poor matches'. This pattern is reflected in the depiction of field verified plots and Ecological System maps for St. John Ponds.

Landscape Context:

The following land uses and roads have been mapped within ½ mile of the DOC Ecological Reserves. Ortho-rectified 2007 air photos and have been used to digitize the following features:

- Mileage of paved roads
- Mileage of dirt roads
- Mileage of paved or dirt roads forming boundary
- Acreage of early regeneration
- Acreage of mature forest
- Acreage of conservation land (including easements)
- Acreage of agricultural land
- Number of structures

As suggested by Table 1 and Figure 3, the landscapes surrounding Reserves vary widely. While a few of the Reserves are well embedded within conservation lands, others such as Great Heath are virtually surrounded (96%) by private lands. However, nearly all DOC Reserves are abutted by mature forest. Even Great Heath, with the least amount of adjoining conservation land, has over 85 percent of its buffer in mature forest condition.

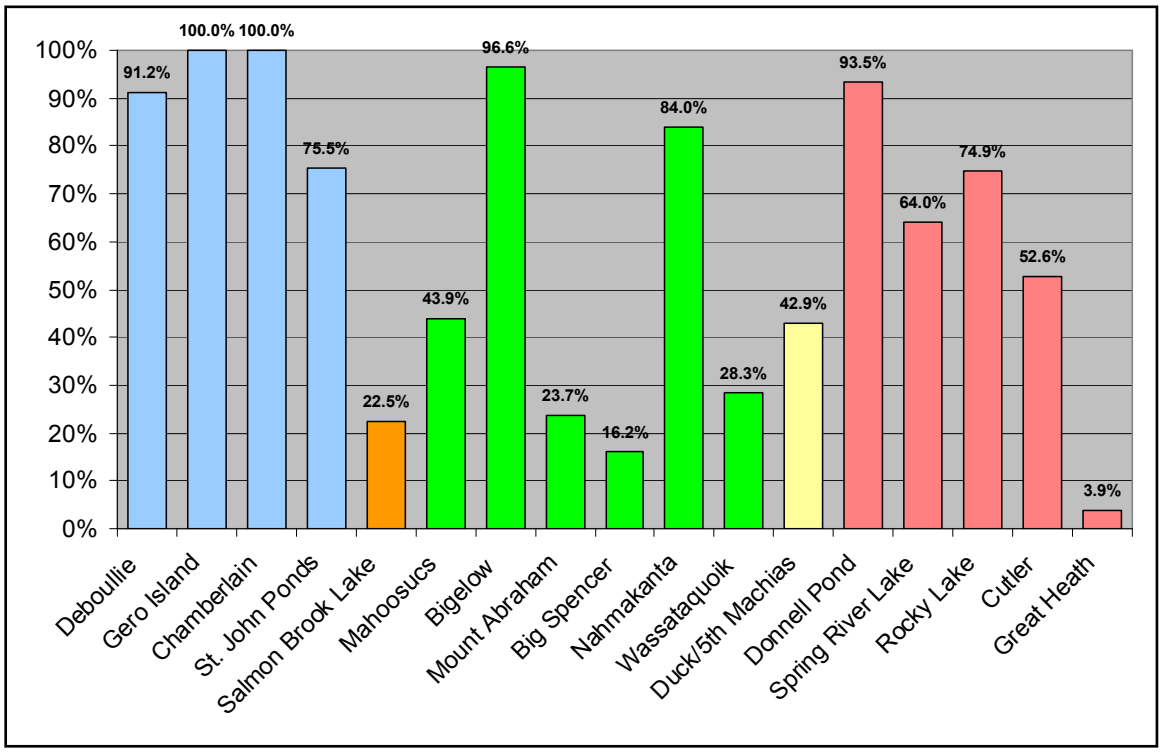

Figure 3: Proportion of ½ mile buffer zone in conservation ownership (or water). Colors indicate biophysical "section" (geographic region) of the state in which Reserves occur.

Table 1: Land uses within ½ mile buffer of perimeter of Reserves

Attribute	Deboullie	Gero Island	Chamberlain	St. John Ponds	Salmon Brook Lake	Mahoosucs	Bigelow	Mount Abraham	Big Spencer	Nahmakanta	Wassataquoik	Duck/5th Machias	Donnell Pond	Spring River Lake	Rocky Lake	Cutler	Great Heath	Mean
Dirt Roads Within Reserve (miles)	2.33	0.00	0.00	16.80	0.00	0.00	0.00	2.71	4.00	7.23	0.09	0.00	0.00	0.00	0.00	0.00	2.00	
Dirt Roads forming boundary (miles)	4.34	0.00	0.00	6.56	0.54	0.00	0.00	0.00	1.60	0	1.36	0.00	2.34	0.00	0.00	2.06	0.60	
Paved Roads forming boundary (miles)	0.00	0.00	0	0	0.00	0	0.00	0.00	0	0	0	0.00	0.00	0.49	0.00	0.72	0	
Dirt Roads within buffer (miles)	9.84	0.22	1.80	18.91	5.92	17.10	3.48	7.16	13.00	2.2	1.91	1.85	3.77	1.50	0.00	8.81	31.00	
Paved Roads within buffer (miles)	0.00	0.00	0	0	0.00	0.88	0.00	0.00	0	0	0	0.00	0.00	1.92	0.00	2.95	1.59	
Buffer Road Density (miles/sq. mile)	**1.06**	**0.04**	**0.19**	**2.43**	**1.22**	**1.43**	**0.21**	**0.82**	**2.28**	**0.17**	**0.43**	**0.09**	**0.83**	**0.47**	**0.00**	**0.94**	**3.05**	**0.92**
Powerlines within buffer (miles)	0.0	0.0	0.0	0.0	0.0	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Agricultural Land (acres)	0	0.0	0.0	0.0	453	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	106.2	674.6	
% Ag land in buffer	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**14.6%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**1.3%**	**9.9%**	**1.5%**
Early regen within Buffer (clearcut to 5 years) (acres)	0.0	0.0	255.1	2,923.8	0.0	1,015.7	0.0	355.5	1,570.9	1,000.6	579.0	37.7	0.0	0.0	150.8	341.8	105.7	
# of structures	0	0	0	0	16	1	0	0	0	2	3	0	0	30+	0	6	1	
Area in buffer (acres) (incl. water)	5967	3285	6184	4976	3099	8038	10836	5568	3655	9003	2834	12940	2924	4666	3375	8025	6844	
Area in buffer (sq. miles)	9.3	5.1	9.7	7.8	4.8	12.6	16.9	8.7	5.7	13.0	4.4	20.2	4.6	7.3	5.3	12.5	10.7	
Conservation land in buffer (acres)	5066	417	3015	3331	698	3527	10262	1319	549	6234	721	3158	2560	2458	2339	2710	119	
% conservation land within buffer	84.9%	12.7%	48.8%	66.9%	22.5%	43.9%	94.7%	23.7%	15.0%	72.7%	25.4%	24.4%	87.6%	52.7%	69.3%	33.8%	1.7%	45.9%
Area of water in buffer (acres)	376	2923	3841	428	0	4	206	0	43	1332	81	2389	173	529	189	1510	145	
% Conservation land or water in buffer	**91.2%**	**100.0%**	**100.0%**	**75.5%**	**22.5%**	**43.9%**	**96.6%**	**23.7%**	**16.2%**	**84.0%**	**28.3%**	**42.9%**	**93.5%**	**64.0%**	**74.9%**	**52.6%**	**3.9%**	**59.6%**
Mature Forest or Water in Buffer (ac)	5967	3285	5929	2053	2646	7022	10836	5213	2084	7165	2255	12902	2924	4666	3224	7577	6063	
Mature Forest or Water in Buffer (%)	**100.0%**	**100.0%**	**95.9%**	**41.2%**	**85.4%**	**87.4%**	**100.0%**	**93.6%**	**57.0%**	**87.7%**	**79.6%**	**99.7%**	**100.0%**	**100.0%**	**95.5%**	**94.4%**	**88.6%**	**88.6%**

Notes:
1. "Protected land" includes both fee ownership and conservation easements.

2. Stand/Natural Community Monitoring

Plot Placement

To date 463 permanent forest plots have been placed on DOC Ecological Reserves (Table 2). Plot density averages 1 plot/167 acres but ranges from 1 plot per 75 acres at Salmon Brook Lake to 1 plot per 345 acres at the Mahoosucs. Notably, 26 plots (5.6%) are over 2700' in elevation, reflecting the fact that 13.4% of the land area of DOC Ecological Reserves is over 2700'. This proportion is in sharp contrast to the state as a whole, which has only 0.7 % of land area over 2700'.

Table 2: Plot density on BPL Ecological Reserves

Reserve	Year	# of Plots	Reserve Area (acres)	Plot Density (ac/plot)
Bigelow	2002	48	10,561	220
Donnell/Spring River	2002	48	6,223	130
Salmon Brook Lake	2002	14	1,055	75
Deboullie	2003	33	7,267	220
Duck Lake/ 5th Machias	2003	26	6,815	262
Rocky Lake	2003	10	1,519	152
Mt. Abraham	2004	29	5,295	183
Cutler	2004	35	5,188	149
Gero Island	2004	23	3,180	138
Nahmakanta	2005	50	11,100	220
Big Spencer	2006	35	3,960	113
St, John Ponds	2006	36	3,887	108
Great Heath	2007	14	6,113*	130
Wassataquoik	2007	17	776	46
Mahoosucs	2008	29	9,993	345
Chamberlain	2008	16	2,895	181
TOTAL (Average)		**463**	**85,827**	**(185)**

* For Great Heath, plot density was calculated for forested acres only (1,820).

In addition to the 463 plots on DOC Ecological Reserves, there are now over 250 plots on Nature Conservancy lands, 29 plots on lands from MDIFW Ecological Reserves, and over 80 plots on lands managed compatibly by the Appalachian Mountain Club. The 800 monitoring plots from reserves all across the state now form a robust dataset with which to conduct analyses. (The 80 plots from AMC were not available for analyses discussed in this report).

Forest Structure

In the prior analyses (Maine Natural Areas Program, 2005), Ecological Reserves were shown to have older trees, higher basal areas, more large trees (live and dead), more dead trees, and more coarse woody debris than the "average acre" of Maine woods. Analyses with the updated dataset (through 2008) confirm these assessments.

This current analysis also confirms a wide variability among Reserves, reflecting differences between regional forest types and human and natural disturbance histories. For example, the Bigelow and Chamberlain Lake Reserve, with an abundance of well-stocked, northern hardwood and spruce-fir forest, respectively, have higher average basal areas and more large live and dead trees than the overall Reserve average. Cutler and Rocky Lake, on the other hand, have experienced fire, budworm damage, and past harvesting, resulting in comparatively low measures for many of the metrics. Most strikingly, the St. John Ponds Reserve is dominated by early to mid-successional forest, with average basal area only 37 square feet/acre of live trees 5" or diameter or above – well below the Maine average of 74 square feet/acre (K, Laustsen, personal communication 2009). Nearly all of plots within the St. John Ponds showed evidence of past harvesting, and 61% of the plots had been heavily cut within the past 20 years.

Size Classes

Stand size class is perhaps the most basic measure of forest structure. As Figure 4 illustrates below, Maine forests are divided more or less evenly between seedling/sapling, pole timber, and saw timber stages. Ecological Reserves, not surprisingly, are weighted toward sawtimber stands, with half of the plots falling in this category. This proportion is closer to the size class distribution hypothesized for pre-settlement forests by Lorimer (1977), Lorimer and White (2002), and others, which suggested that the majority of forest acres were in late-successional to old growth conditions.

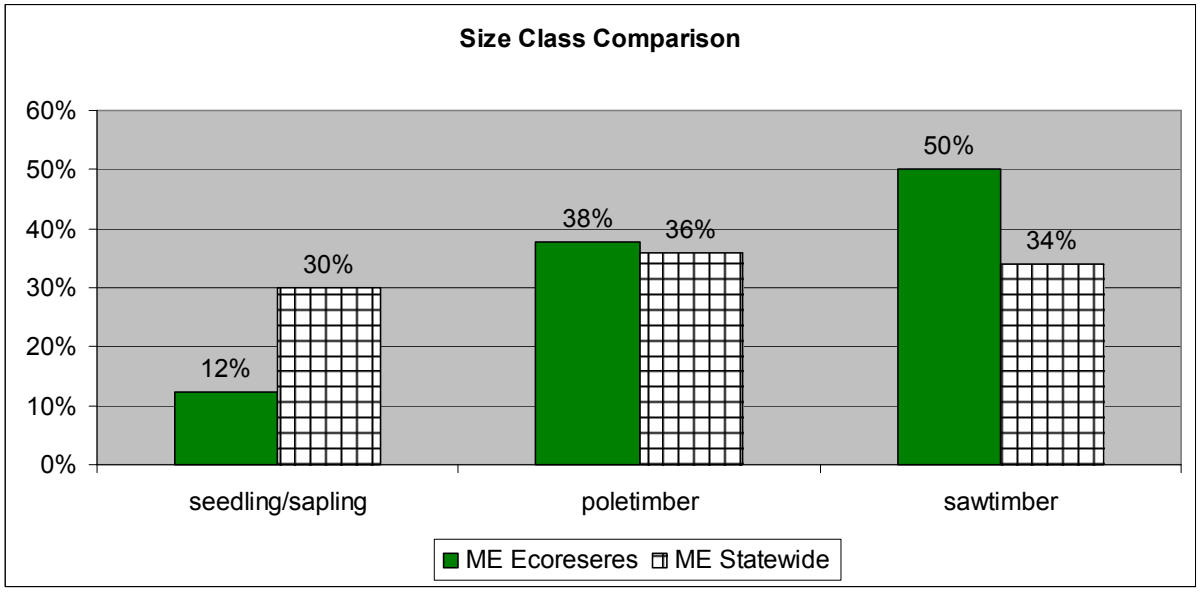

Figure 4: Comparison of stand size classes between Maine Ecological Reserves (DOC, TNC, & IFW), and Maine statewide averages

The Ecological Reserve size class distribution is also closer to the idealized distribution for wildlife species proposed by Degraaf (1992) (Figure 5).

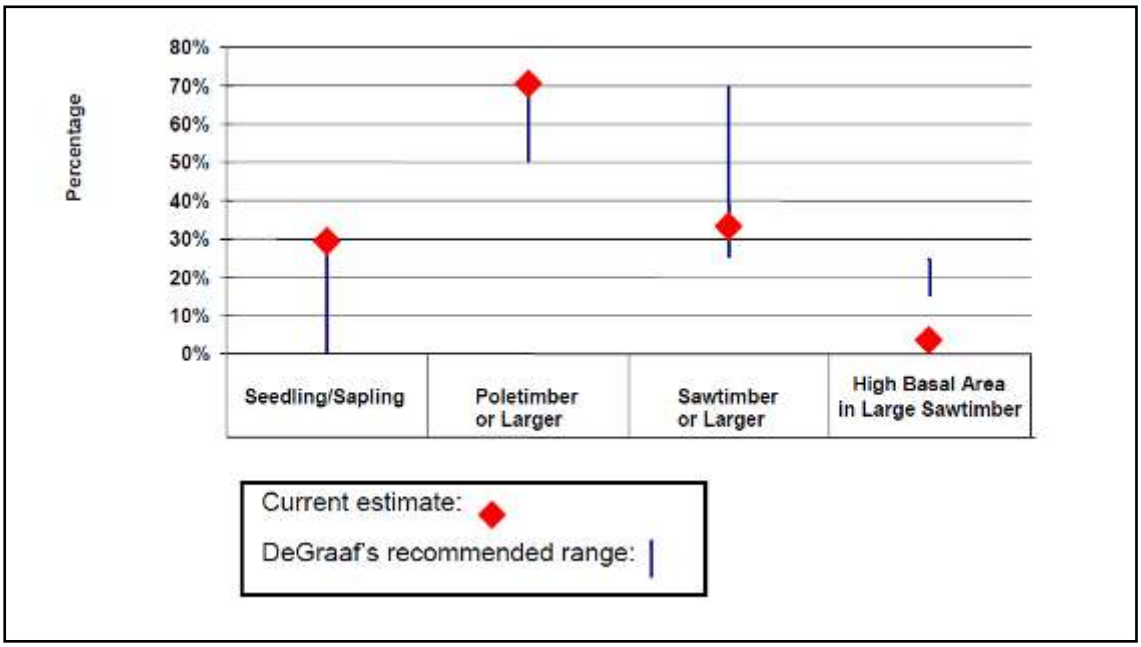

Figure 5: Idealized forest stand structure and current statewide timberland structure (from the Maine Forest Service, 2005, adapted from DeGraaf 1992).

Canopy Tree Ages

Over 400 trees have now been cored on DOC Ecological Reserves. Based on the initial data analyses, trees are considerably younger in Ecological Reserves than in two reference cases of late successional/old growth forest. Only one of the seventeen DOC Reserves had a mean canopy tree age older than those in Big Reed Forest (Figure 6). The mean age of 175 spruce trees cored on DOC Ecological Reserves, 92, is 100 years less than the mean age (192) of 1050 spruce trees noted in the 'Report of Forest Commissioner' from 1894. Moreover, the age range of canopy trees in Ecological Reserves is significantly skewed to the lower ages as compared to the 1894 data (Figure 7)..

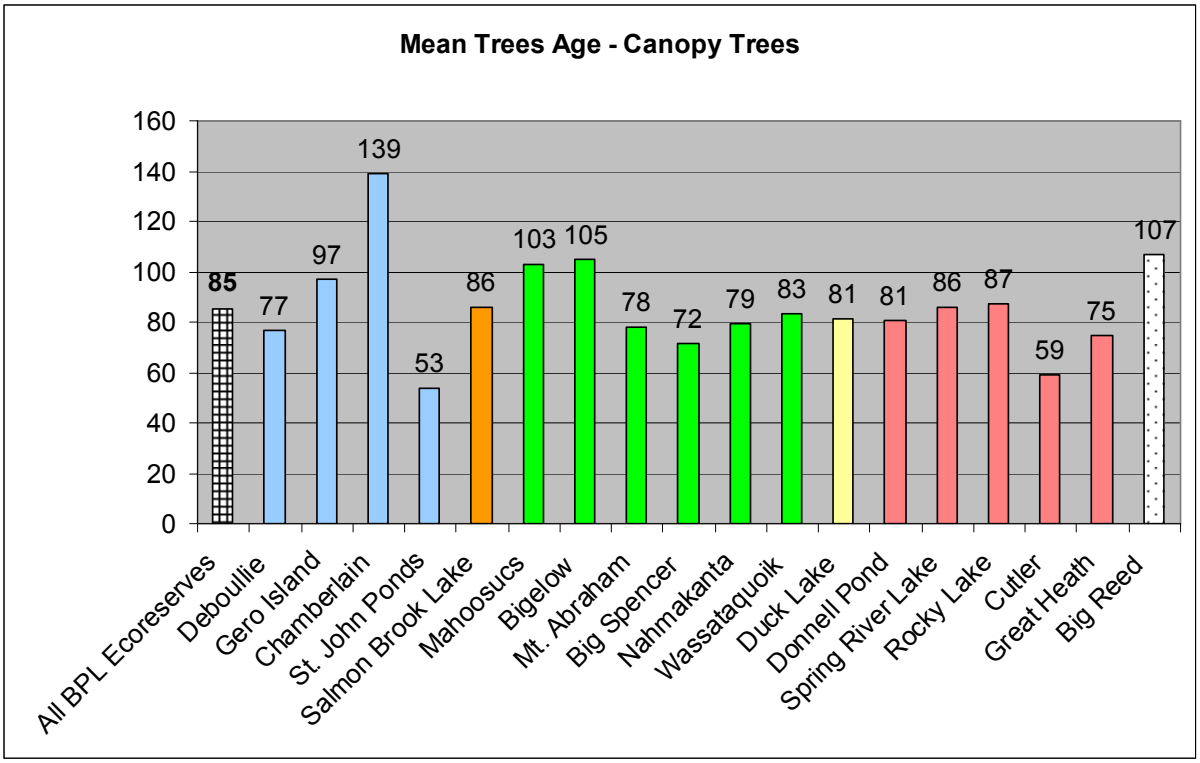

Figure 6: Mean age of canopy trees on DOC Ecological Reserves and on Big Reed Forest. (Data from Big Reed have been provided by Fraver [2004] and Hagan [2004]).

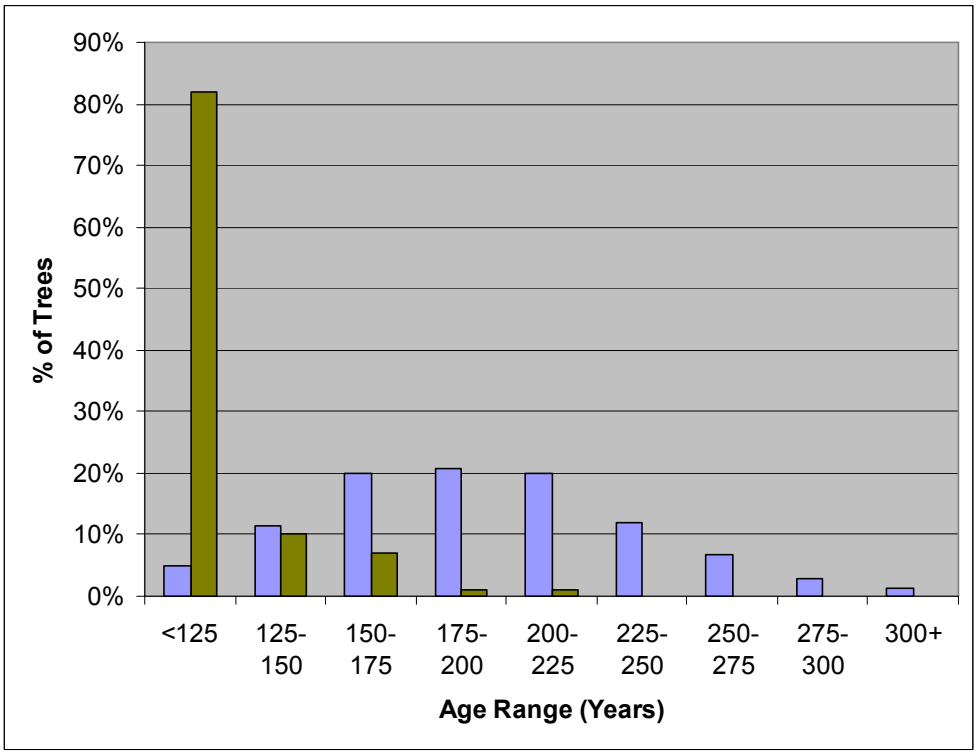

Figure 7: Age range of 175 spruce trees on Maine Ecological Reserves (left bar) and age range of 1050 spruce trees from Maine, 1894 (Cary 1894).

Live Basal Area

Live basal area is one of the most common measures of forest stocking. Initial analyses indicate that all three Ecological Ownerships (DOC, IFW, TNC) have at least 27% more basal area than the 'Maine average' (K.Laustsen, Maine Forest Service, personal communication 2009) (Figure 8).

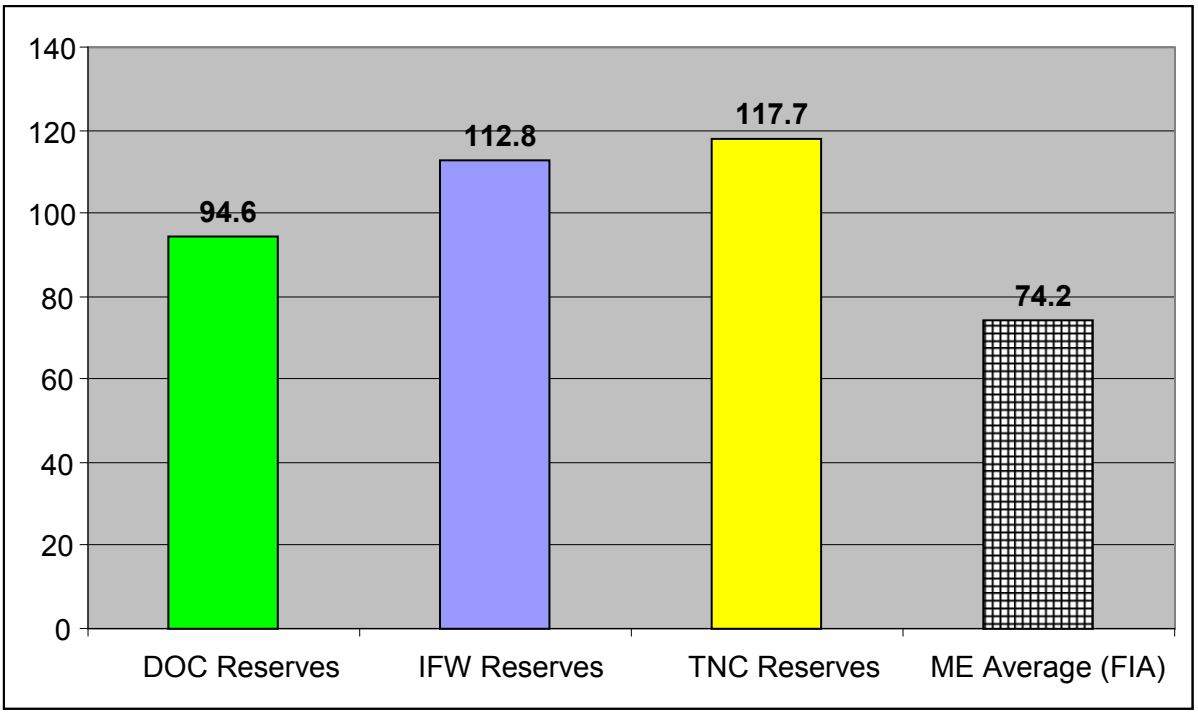

Figure 8: Basal Area (square feet/acre) on three ownerships of Ecological Reserves and the Maine statewide average (MFS).

3. Remaining Analyses

While the initial data analyses described here provide a glimpse of the differences among Reserves and those between Reserves and managed lands, a number of additional analyses are planned, using the full dataset of over 800 plots from DOC, IFW, and TNC. These analyses, which will replicate many of the same metrics and assessments done in 2005 with a smaller data set, will be conducted in the winter of 2009/2010

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