Moose in Northern New England – Adapting to Climate Change

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Moose (*Alces alces*), or "twig eater" in Algonquin language, and commercial forestry are inextricably linked in northern New England. In fact, northern New England (Maine, New Hampshire, and Vermont) is the stronghold of moose in the lower 48 states, with Maine having more moose than the other 47 states combined! However, the New England moose story is very recent and still playing out – the rebound in the moose population occurred in a short period from the mid-1970s through the 1990s, and longtime Canadian moose biologists speak of 20-30 year cycles in moose populations! A myriad of factors are at play including moose population dynamics (growth, decline, stability), both moose and forest harvest strategies, economics and cultural values, and parasites/pests including the winter tick (*Dermacentor albipictus*), brainworm (*Parelaphostrongylus tenuis*), and spruce budworm (*Choristoneura fumiferana*), with climate change adding to the mix and forcing managers to reconsider certain ecological relationships.

Moose readily consume most northern hardwood tree species year-round [e.g., maples (*Acer* spp.), birches (*Betula* spp.), aspen (*Populus* spp.)] and balsam fir (*Abies balsamea*) in winter. They preferentially forage in young-aged stands (3-15 years) year-round (Fig. 1), and use the canopy provided by older stands in summer and softwood stands in winter for seasonal thermal cover. The constant availability of young-aged stands from commercial forest harvesting provides a shifting mosaic of preferred forage across their large home ranges that can exceed 50 km^2 (20mi^2). Most believe that the spruce budworm epidemic in the late 1970s-1980s and the associated large cut blocks provided the habitat base that allowed the Maine moose population to increase quickly - in essence, an unprecedented amount of preferred habitat was created and moose responded in numbers and range expansion. Their complete protection and a drop in the fur market that allowed increase of beaver (*Castor canadensis*) populations also

Fig. 1. Moose preferentially forage in 3-15 year old stands year-round; forestry operations provide this abundant and nutritious forage across northern New England. Note hair loss in April from rubbing to remove winter ticks.(photos courtesy of D. Ellingwood, UNH).

contributed to this rapid population growth. The habitat base has been sustained through continual forest harvest (Fig. 2), and moose are well established in the 3 states; however, populations have generally declined in the last decade (except in northwestern Maine), and integrated management of both moose and forests is of primary concern to landowners, moose managers, and the general public that views moose as a regional iconic symbol.

Given their sheer size (they can consume > 50 lb. of forage daily), moose can retard forest regeneration and alter species composition – examples exist from Scandinavia to Isle Royale, Michigan. Given the high density of moose in all three states by the early 2000s, and growing concern about possible impacts, research was initiated to determine the extent of forest damage that appears obvious in the 0-5 year age class. However, studies in all 3 states have found minimal impact when accounting for growth out to 20 years (Fig. 3), with the exception of certain stands adjacent to traditional wintering areas that can be pushed to softwood (red spruce, *Picea rubens*) with low stocking rate (Fig. 4). The impact is analogous to

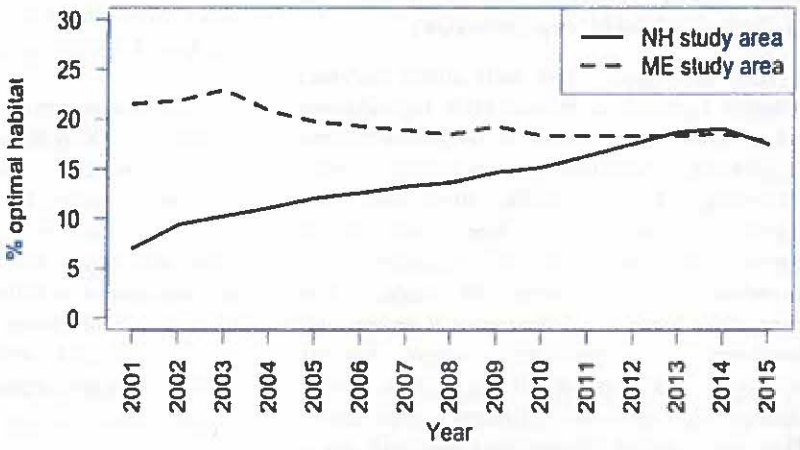

Fig. 2. The proportion of optimal moose habitat (4-16 year old age class) on the landscape has increased/been stable in New Hampshire and Maine for 15 years. This age class provides preferred forage for moose year-round (Figure by K. Ball, University of New Hampshire).

that associated with traditional winter deer yards and illustrates the seasonal, locally high density of animals. Recent research in Scandinavia suggests that moose prefer specific trees within such areas, and damage is thus focused on individual trees; however, forage choice is limited to birch or Scotch pine (*Pinus sylvestris*) in Scandinavia! In remote areas of western Maine where damage to extremely valuable northern hardwood stands is of concern, unique incentive programs may be required to provide better access and accommodations for moose hunters to ensure an adequate harvest level.

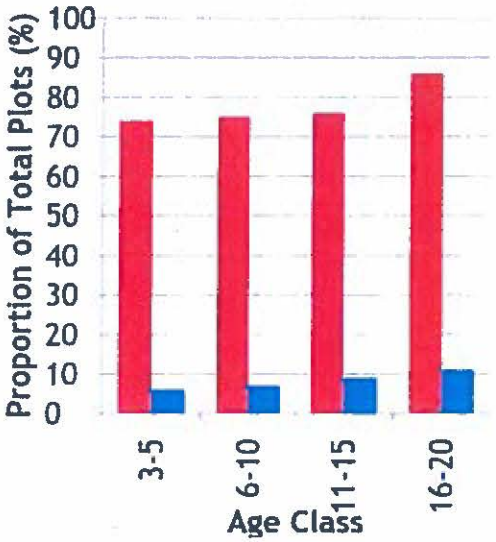

Fig. 3. The proportion of plots with a dominant commercial tree (red) and the proportion of those with severe damage (blue) in northeastern Vermont. Similar fieldwork in New Hampshire and Maine also identified minimal permanent forest damage from moose browsing overall (Figure by H. Andreozzi, NH Coop Extension).

Across the region in the early 2000s, harvests produced no lack of trophy bulls, high success rates, and represented a once-in-a-lifetime opportunity. Although moose harvests were increasing into the 2000s, they were still conservative relative to moose abundance/density that was high in comparison to anywhere in the lower 48 states. The exceptions were in northeastern Vermont and northern New Hampshire where harvest strategies were employed to reduce forest damage and vehicular collisions, respectively. That said, moose density was still high on a relative basis, but ecotourism was also reviving many northern communities and visible moose were a key attraction. Arguably, moose behavior was also changing – the animal had been hunted for nearly 20 years, traditional viewing sites were growing in, and animals were simply smarter and less visible. Balancing public desires was paramount and not surprising, given that moose had literally come back from the dead and forgotten – but it wasn't that challenging, in large part, because optimal habitat was in constant production.

Fig. 4. An 11-15 year old clearcut where commercial hardwoods appear to be suppressed by moose browsing, pushing it to an understocked, spruce-dominated stand. Such stands are typically proximate to traditional moose wintering areas where seasonal density can be abnormally high (photo by D. Bergeron, NH Fish and Game Department).

Moose management and research in New England steadily increased in all states including the Berkshires in Massachusetts. Advances in population surveys, capture techniques and GPS radio-collars, in-common harvest data, and strategic harvest strategies all added to more advanced moose management. But, in New Hampshire's core moose range, the population was suspected of decline in the early 2000s, and the first documentation of a winter tick epizootic with radio-collared calves (>50% mortality) occurred in the winter of 2003; no subsequent epizootic was identified the following 3 years. The winter tick (Fig. #) is an ectoparasite of moose (the host) and an epizootic typically requires a high moose density and favorable environmental conditions that allow its proliferation. The parasite load is typically in the 15,000-20,000 range, but can exceed 70,000 in an epizootic year – quite literally, calves lose so much blood to feeding, adult female ticks that they die of acute anemia in a 2-3 week period in early-mid April (Fig. 5).

In cooperative research in central Maine and northern New Hampshire involving >200 radio-collared cows and calves, we have documented winter tick epizootics with >70% calf mortality for the past 3 winters. Further, reduced productivity in the population has also been identified – very low twinning rates and minimal breeding by yearling cows – near maximum rates of both occurred in the 1990s. Based on winter reports and surveys, it is believed that 5 epizootics have occurred since 2008, an almost unprecedented frequency. Population models based on current productivity and survival data clearly point to a slow, long-term moose decline. It is important to recognize that these epizootics and population decline are occurring despite excellent and abundant moose habitat.

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Moose in New England, continued

However, any host-parasite relationship cannot maintain itself indefinitely. Both eventually decline to the point that parasite abundance on the host becomes insignificant – in this case, moose productivity and survival would eventually rebound, and importantly, in excellent habitat maintained by commercial forest harvests. However, this is where climate change could play a major role: 1) by influencing the frequency of epizootics, and 2) possibly lowering the threshold moose density where the host-parasite relationship breaks. In effect, climate change will likely lead to a lower "stable" moose population because of the increased influence of winter ticks; rather than sporadic events, epizootics will become more frequent.

Fig. 5. A typical calf moose mortality in mid-April from a severe winter tick infestation; tick loads commonly exceed 50,000 per animal during epizootic years and calf mortality can exceed 70%. Note emaciated condition, hair loss, and open ground – access to food is not the issue (photo courtesy of D. Ellingwood, UNH).

Spring and fall weather have large influence on the abundance of winter ticks across a range of moose density. April ground conditions (snow or clear) influence survival of egg-laying, adult female ticks, and ground conditions (snow or clear) and temperature (frost) in November-December influence the questing or host-seeking period of larvae. The fall questing period, typically mid-September through early-mid November, is probably the most critical period because a warm fall extending into late November and December increases the probability that moose pick up larval ticks. In 2015 the questing period extended into mid-December and we measured the highest tick loads ever documented in the northeast – the questing period was almost double the typical length. The overall effect of shorter winters, particularly when starting later, plays to the advantage of the winter tick and means heavier tick loads on moose. Further, extended questing periods will allow a lower abundance of ticks to have a similar effect as higher abundances, effectively lowering the threshold moose density at which the host-parasite relationship breaks.

Where does this leave population management strategies and the role and importance of forest management for moose in northern New England? Commercial forestry operations, in large part, provided the resources necessary to build the moose densities across northern New England that rivaled some of the highest in the world. However, such high densities were probably not sustainable relative to density dependent factors such as habitat and behavior, economic concerns of landowners, and clearly not the parasitic winter tick that increases in abundance with high moose density and enjoys the shorter winters associated with climate change. It would seem that a balanced, if not novel management approach will be necessary moving forward if recent seasonal weather patterns persist. Despite slow population decline, this might include higher harvests that limit winter density of moose in an attempt to reduce tick abundance on the landscape, while promoting increased productivity of moose. Because adult moose mortality from winter tick parasitism is uncommon, yet productivity is lower presumably due to reduced body condition, enhancing productivity will depend on the continual availability of optimal habitat provided by commercial forestry. And most ironically, the looming wave of spruce budworm headed into northern New England might reset the abundant habitat that began this moose story only 40 years ago.

"Adapt. Adopt. Advance: Resiliency in Forestry"

Please plan to attend the NESAF 2017 Annual Meeting, scheduled for March 8 – 10, 2017.

The Maine Division is hosting the upcoming annual meeting, and our new chosen location is the Cross Insurance Center in Bangor, ME. There are both on-site and nearby hotels. Kris Hoffmann is serving as General Chair and Ron Lemin as Arrangements Chair. We will be showcasing what the Bangor area has to offer in terms of forestry field trips and local amenities.

Also being offered on Friday, March 10 is a NESAF Leadership Academy.

So plan ahead and realize that Bangor is ***ONLY*** another cup of ***COFFEE*** further north from Portland, well actually according to MapQuest, just 129 miles or 124 minutes, door-to- door.

Please check the NESAF website for updates, and also feel free to contact Laura Audibert at la4568@roadrunner.com, or Ron Lemin at Ronald.Lemin@cpsagu.com for more information.

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Special points of interest:

- *Advertising and publication information page 3*
- *Annual Winter Meeting in Bangor Maine! page 12*
- *Nominate a colleague for a NESAF Award page 16*

Inside this issue:

Québec Multi-Aged Silviculture Tour – Tony D'Amato

NESAF members headed North of the border August 24-26 to spend several days on a field tour hosted by the Québec Ministry of Forests, Wildlife, and Parks (MFFP) examining different silvicultural systems for managing northern hardwood and temperate mixedwood forests in southern Québec. The tour was organized by **Patricia Raymond**, Research Forester with the MFFP, **Tony D'Amato,** Co-Chair of the Forestry Program at the University of Vermont, **Nancy Patch,** County Forester for the Vermont Department of Forests, Parks and Recreation, and **Bennet Leon**, Chair of the NESAF Silviculture Working Group. The tour included 24 foresters and other natural resource professionals from the US and 12 scientists and research staff from the Québec MFFP allowing for rich discussions over the three days regarding differences and similarities in management approach between northern hardwood and mixedwood forests on either side of the border.

There were many highlights of the multi-day meeting, and it goes without saying that the hospitality and rich exposure and discussions of forest management experienced throughout the tour left many looking forward to the next opportunity to visit the great work being accomplished by Québec MFFP on northern hardwood and mixedwood silviculture. The proceedings for the field tour can be downloaded from the welcome page on the NESAF website for those of you that missed the tour, but are interested in the great work happening in this region.

Forest Wildlife Research in New England

News Quarterly **Science Theme– Dr. Anthony D'Amato, Theme Editor**

The forests of New England are valued for many reasons with wildlife habitat often one of the first things on a landowner's list. We are fortunate to work in a region where a large body of long-term research and practical experience on forest wildlife habitat relationships exists to guide management designed to meet wildlife-related objectives.

This theme highlights the body of work that has been conducted examining the impacts of different silvicultural systems on forest birds by the USDA Forest Service Northern Research Station at the Bartlett Experimental Forest, NH and the growing body of knowledge being generated by scientists at the University of New Hampshire on the factors affecting moose population dynamics in northern New England.