BROCCOLI AND MOOSE, NOT ALWAYS BEST SERVED TOGETHER: IMPLEMENTING A CONTROLLED MOOSE HUNT IN MAINE

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ABSTRACT: In eastern Aroostook County, Maine abundant populations of moose (*Alces alces*) within an agricultural-woodland setting negatively impact cole crops and incur a high rate of moose-vehicle collisions. Despite increases in antlerless hunting permits and relatively high hunter success rates, the recreational hunting framework was not effective in reducing these negative impacts, and hunter behavior had strained landowner relations and reduced access. Continuing landowner relation problems and loss of access were counterproductive to the effective distribution of hunters and reducing moose abundance. In 2009 a controlled moose hunt was implemented to reduce immediate impacts on cole crops by moose, affect short-term population reduction, and facilitate cooperation and communication among stakeholders. This paper describes the rationale and framework for implementation of the controlled moose hunt, use of a co-managerial approach, and how the hunt addressed moose management goals and objectives. Development and application of this controlled moose hunt in Maine provides managers with another critical tool to affect population trajectory and address tangible social issues associated with moose populations above social carrying capacity.

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Agricultural damage by a wide range of wildlife species has been a chronic problem across North America (Conover and Decker 1991). Damage and economic losses from deer (*Odocoileus spp*.), elk (*Cervus elaphus*), and moose (*Alces alces*) can be both extensive and intensive depending on local populations and specific agricultural crops. As a consequence, controlling damage by deer has become a critical element of state and federal agency duties (Smith and Coggin 1984). However, moose damage to agricultural crops is not well documented in North America which is likely due to few moose occupying agriculturally dominated landscapes, and the relative scarcity of commercial farmlands in typical moose habitat. Research and management of moose related to "crop" damage is usually associated with commercial forestlands (e.g., Andren and Anglestam 1993, Gunderson et al. 2004, Bergeron et al. 2011) as opposed to orchard damage by deer (Mower et al. 1997) or elk damage to haystacks (Kantar 2002).

Moose are managed by the Maine Department of Inland Fisheries and Wildlife (MDIFW) under a Moose Management System (Morris 2002) that describes both the decision-making process and management actions that develop population goals and objectives set by a public working group. The 3 primary management approaches include recreational hunting, public safety, and compromise areas that seek to balance the positive social aspects of moose hunting and viewing with the negative impacts of road collisions and crop damage.

Cole crops (i.e., broccoli and cauliflower) are important commercially in eastern Aroostook County in the northeastern portion of Maine, and are highly palatable to moose. Moose cause extensive damage by feeding directly on plants and as they move through croplands. Spruce (*Picea spp.*)-fir (*Abies balsamea*) woodlands and wetlands provide

ample cover, forage, and resting sites for moose in close proximity to these croplands. Farmers and MDIFW personnel have documented >40 moose in a single field (R. Hoppe, MDIFW, pers. comm.), and moose may intensively and continuously use these areas for >4 months. In particular, broccoli is very frost tolerant and becomes more palatable after a heavy frost increases its sugar content (D. Hentosh, local farm manager, pers. comm.). Its use and associated damage increase throughout fall as woody browse senesces.

Techniques to minimize and prevent wildlife damage typically follow a step-down approach (MDIFW Administrative Nuisance Policy J1.6) incorporating deterrents, repellents, hazing (i.e., cracker shells, trained domestic dogs), and fencing. However, several years of local hazing proved ineffective especially during the September-October breeding season. When non-lethal approaches fail to prevent damage, provide necessary relief, or cannot be applied practically, lethal removal may ensue. Using hunters to affect population change can help reduce crop damage (Conover 2001), increase cooperation with landowners, and improve agency credibility in resolving conflict (Chase et al. 2000).

In 1999 a Big Game Public Working Group (WG) was formed to "guide and develop" moose management goals and objectives over the next 10 years. The WG defined a Compromise Management Area as a WMD where current (i.e., 2000) population levels were too high and would be reduced to minimize moose-vehicle collisions (Table 1). The population reduction would be balanced with the ability to provide hunting opportunity and maintain a population comprised of 17% bulls >4 years old. Herd composition would be determined annually from moose surveys by deer hunters and the age of harvested moose.

Moose hunting had occurred in and around eastern Aroostook County croplands since 1980, and Wildlife Management Districts (WMD) 3 and 6 were managed as a Compromise Management Area. Permits in 1999 were either any-moose (AMP) or antlerless permits (AOP). In 2003 to provide better control over harvest composition, these districts received both bull-only (BOP) and AOP allocations; by 2003 WMDs 3 and 6 were allocated 670 permits, 290 AOP and 380 BOP. The following year with the moose population still above the desired level, an additional 195 AOP and 65 BOP were added; in 2007 an additional 25 AOP were added for a total allocation of 510 AOP and 445 BOP (Table 2).

In 2001 moose populations in WMDs 3 and 6 were estimated at 4.9 and 1.2 moose/km^2 based on deer hunter survey data (Bontaites et al. 2000). From 2001-2009 moose populations remained above goal and damage to crops and annual moose-vehicle collisions (234) were

Table 1. Annual moose-vehicle collisions within townships in the controlled hunt area, 2001-2009, Maine, USA.

Town	2001	2002	2003	2004	2005	2006	2007	2008	2009
Caribou	24	15	21	19	19	19	33	15	21
Connor Twp	6	12	10	8	11	8	5	5	4
Easton	2	6	8	2	9	5	5	1	3
Fort Fairfield	9	6	6	7	13	6	9	7	6
Limestone	4	4	4	3	4	1	2	2	4
Presque Isle	12	9	16	22	15	19	27	12	10
Washburn	3	3	1	5	5	4	5	3	3
Westfield	6	8	3	6	6	1	3	1	3
Woodland	8	2	6	6	6	7	10	2	6
Total	74	65	75	78	88	70	99	48	60

at high levels relative to the rest of Maine; in response, AOP continued to increase (Table 2) to reach the population objective. Hunter success was consistently high for both permit types (82 and 81%); however, despite an apparent downward trend of moose in WMD 6 (Fig. 1), local moose-vehicle collisions and crop depredation warranted further remediation.

Under Maine statute, authority is given under the nuisance animal law (Chapter 921, Sec. 12402-1 and 2) to address specific crop or orchard damage. Except for grasses, clovers, and grain fields, farmers "may take or kill wild animals night or day, when wild animals are located within the orchard or crop, and where substantial damage to the orchard or crop is occurring." Section 12402-2 specifies that a game warden may issue depredation permits authorizing farmers to employ agents to kill wildlife observed damaging qualifying crops or nursery and orchard stock**.** Depredation permits typically identify a specific individual(s) as the shooter, a specific location and crop, and a specific number of offending animals to be killed over a specified time frame.

Farmers with depredation permits had removed 2-10 moose annually from croplands, and hunting pressure was high around croplands during the recreational hunt; approximately 60-70 moose were removed from a single farm during 10 years of recreational hunting (D. Hentosh, pers. comm.). While this removal likely alleviated some crop depredation, it also resulted in trespass issues, damage to agricultural fields, and associated problems within farmlands.

One alternative to depredation permits is a controlled hunt, and under Maine statute (Chapter 903, Sec. 10105-1), the MDIFW Commissioner has the authority to issue permits for the taking of wildlife, including controlled hunts. The purpose of a controlled hunt is to reduce negative impacts caused by wildlife. Although a controlled hunt can occur within a recreational hunt, hunts outside this timeframe are permissible. The MDIFW may limit the number of participants during controlled hunts, and biologists authorize hunting methods, weapons, bag limits, and other provisions to ensure the harvest. Importantly, moose killed during controlled hunts would not count against bag limits specified for the recreational hunting season. To initiate a controlled hunt the MDIFW proposes rule making that is reviewed by the MDIFW Advisory Council (MDIFW Commissioner and 10 county representatives) after receiving public comments for 3 months within a 3-step process; at the third step the rule is voted on by the Advisory Council.

To address negative landowner-hunter interactions, reduce the number of moose dam-

Table 2. Annual moose permit allocations for Wildlife Management Districts 3 and 6 from 2001-2009 in Maine, USA.

		2001	2002	2003	2004	2005	2006	2007	2008	2009
WMD 3	AMP*	175	175	0	0	0	0	0	0	0
	AOP*	100	100	150	220	220	220	230	230	230
	BOP*	0	0	160	225	225	225	225	225	225
	TOTAL	275	275	310	445	445	445	455	455	455
WMD 6	AMP	220	220	0	0	0	0	0	0	0
	AOP	100	100	140	265	265	265	280	280	280
	BOP	0	0	220	220	220	220	220	220	220
	TOTAL	320	320	360	485	485	485	500	500	500

*AMP = Any moose permit, AOP = antlerless only permit, BOP = Bull only permit.

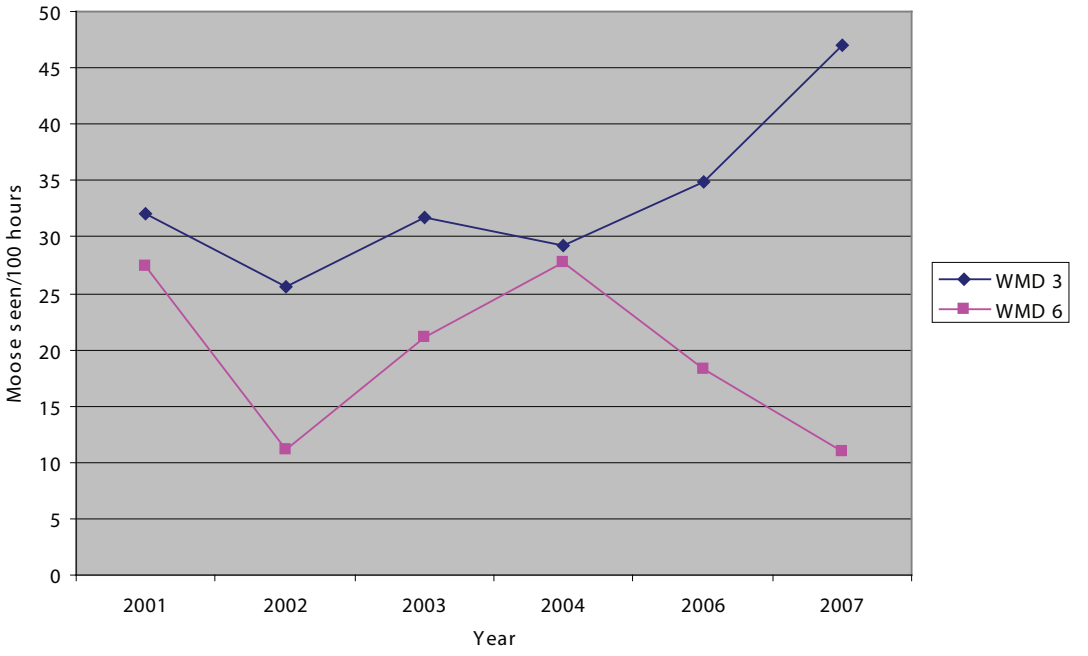

Fig. 1. Moose seen per 100 hours of deer hunting in Wildlife Management Districts 3 and 6, 2001-2007, Maine, USA. Due to administrative error, the 2005 deer hunter survey was invalid.

aging cole crops, and reduce moose numbers within the surrounding cropland areas, the MDIFW designed and implemented a controlled moose hunt in 2009. The controlled hunt targeted moose prior to the recreational hunt when crops were most vulnerable, and exerted additional pressure on localized moose populations that were causing damage without putting undue burden on landowners to remove additional moose. Thus, implementation of a controlled hunt provided a 3-tiered approach to managing moose numbers: recreational hunting within a traditional framework to achieve publicly derived population goals, a controlled hunt to alleviate crop depredation and reduce moose-vehicle collisions, and depredation permits to provide immediate relief from crop damage. This approach serves to manage moose abundance at both the landowner and WMD scales, while providing flexibility and responsiveness to moose-human conflicts. This paper describes the implementation of the controlled hunt as a novel management tool to help reduce crop damage by a locally overabundant moose population in Maine.

STUDY AREA

Aroostook County, Maine is large (17,687 km^2) with its eastern portion comprised mostly of farmland, >131,118 ha with about 76,000 ha as cropland; currently <1% of croplands contain cole crops (Maine Department of Agriculture, Food and Rural Resources). However, cole crops are distributed across numerous townships and active fields are rotated annually; the size of fields range from about 5->200 ha with the majority 16-40 ha; fields are typically on a 4-year rotation (D. Hentosh, pers. comm.). WMDs 3 and 6 overlap these lands and comprise about 5,970 km^2 (Fig. 2); forested areas are dominated by spruce, balsam fir, northern white cedar (*Thuja occidentalis*), and white pine (*Pinus strobus*) with mixed hardwoods of aspen (*Populus spp.*), birch (*Betula spp.*), beech (*Fagus grandifolia*), and maple (*Acer spp.*). Other species highly palatable to moose include red-osier dogwood (*Cornus stolonifera*) and willow (*Salix spp.*).

METHODS

The controlled moose hunt was modeled after similar hunts for white-tailed deer (*O. virgininaus*) in Maine where traditional hunting seasons aimed at providing recreational opportunity failed to reduce negative impacts from deer and high human density restricted hunter access. Over the course of a year MDIFW biologists met in both informal meetings with local landowners, and formal meetings with invited stakeholders including local farmers, sportsmen, landowners, the Farm Bureau, and Warden Service to discuss moose numbers, crop depredation problems, recreational hunting, landowner access, and hunter behavior. Regional MDIFW biologists and District Wardens had addressed moose crop depredation complaints over time and had in-depth knowledge of the issues, layout of croplands, and the dynamics of recreational moose hunting in the region. Discussion focused on exerting additional hunting pressure around the cropland area and designing a season structure outside of the normal recreational hunt. Different approaches were presented informally to stakeholders to identify issues and potential problems. Once local stakeholders accepted the preliminary framework, MDIFW staff refined and formalized the proposed controlled hunt.

Since damage to broccoli crops can start as early as July and extend into October and November after the initial frost, the controlled hunt needed to include a longer time period than the traditional 6-day recreational season. Therefore, the controlled hunt was scheduled from 17 August-19 September (5 weeks excluding Sundays), leaving a 1-week interlude prior to the recreational season. Since any moose regardless of sex or age can damage crops, it was determined that the controlled hunt would target a total of 100 moose based on historical recreational permit levels in the area (~10% of recreational permit levels, Table 2). This harvest level had the objective of reducing impacts in a localized area (approximately half the WMD) without (presumably) affecting the benefit for those in the recreational hunt.

Of the 100 permits, 55 were assigned to qualifying landowners to hunt on their property if it was >80 acres (32 ha) in size and within the controlled hunt area (Fig. 2); landowner permits were designated as AMP to facilitate harvest and increase success rates. The remaining 45 permits were issued (3 each, 1 AMP and 2 AOP) to 15 Registered Maine Guides

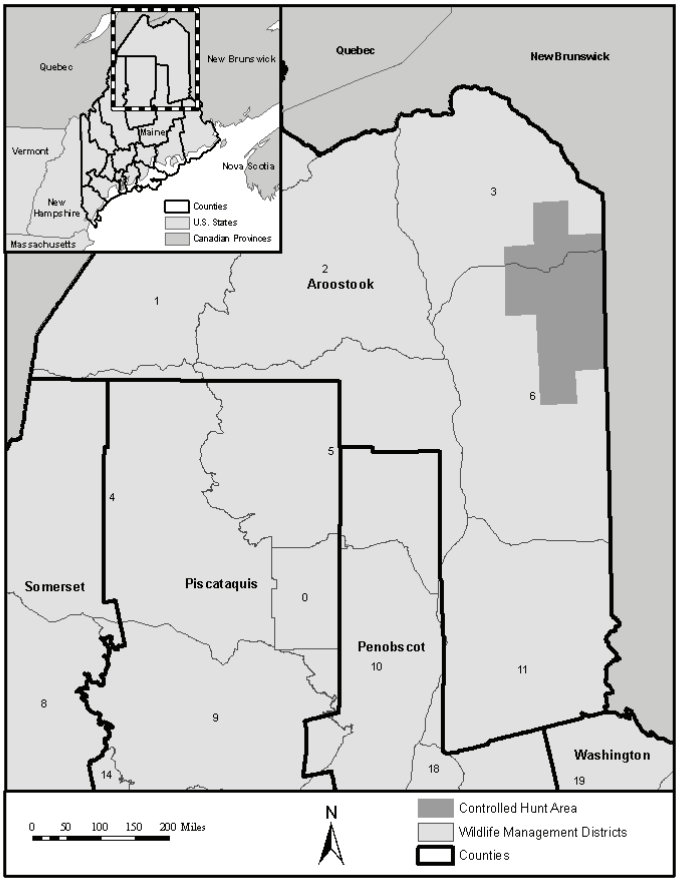

Fig. 2. Location of controlled moose hunt and associated Wildlife Management Districts 3 and 6 in Aroostook County, Maine, USA.

selected by lottery; guides were used to ensure positive landowner relations, and to facilitate harvest and care of moose. Prior to issuance of permits, each guide was required to attend a training session conducted by MDIFW; failure to attend resulted in permit forfeiture and designation to runner-ups in the lottery.

All hunters were required to register their moose and provide for collection of biological data including a canine for aging, sex, weight, antler measurements, hunter information, town of kill, date of kill, and caliber of firearm. All hunters were required to fill out a survey to document number and type (adult/calf and sex) of moose seen, hours hunted, date of hunt, WMD, and number of deer and grouse (*Bonasa umbellus*) seen. Guides and hunters had to personally contact farmers to identify cropland areas open to hunting and specific landowner rules. Guides were instructed to harvest moose directly in the headlands or adjacent woodlands outside cropland to avoid direct damage to cole crops.

At the conclusion of the controlled hunt, agricultural interests, MDIFW biologists and wardens, and the moose registration station owner/operator gathered for a debriefing of the controlled hunt. Comments requesting input on the development and implementation of the controlled hunt were solicited from other stakeholders. Notes from the debriefing and letters from agricultural interests were reviewed by MDIFW staff.

RESULTS

MDIFW biologists conducted a mandatory evening seminar about the controlled moose hunt that outlined hunting rules and regulations, moose biology and behavior, and ethical hunting conduct. All permitted Maine Guides were in attendance as well as representatives from the 2 farms where the majority of hunting would occurr.

A total of 81 moose were harvested: 37 adult bulls (yearling and older), 41 adult cows (yearling and older), and 3 female calves. Landowners harvested 45 moose (82% success) and clients of guides harvested 36 (80% success). Hunters included 67 Maine residents and 24 non-residents from 15 states, the territory of Guam, and Quebec, Canada.

Both written responses (formal letter and email) and phone calls from the primary agricultural interests provided consistently positive responses about the management of the hunt and its outcome. The Maine Warden Service reported full compliance with the hunt rules with a single exception, a bull taken on an AOP; adherence to landowner rules and respect for landowner property met expectations.

DISCUSSION

Harvest rates in the recreational hunt in eastern Aroostook County were considered moderate, but were meeting district-wide objectives to reduce moose abundance in WMD 6. However, the palatability and distribution of cole crops provides a highly valuable and concentrated food source that likely reduces foraging and handling time for moose. This effect created persistent, locally overabundant populations despite reduction at the district-wide scale. While hunters are required to hunt in a specified WMD, within a district they are only restricted by landowner permission and firearm ordinances where applicable. While the distribution of hunters is acutely linked to where moose occur during the hunting season, landownership patterns and hunter density also influence hunter distribution. Within the context of the agricultural-woodland dynamic, the controlled hunt area is not characteristic of what hunters think of as moose habitat, access is limited, and within the traditional 6-day season hunters can quickly overwhelm croplands and dramatically elevate hunter density. Thus the benefits of hunting the croplands (increased visibility and moose density) are confounded by a reduced quality of the hunt. The relative small geographical size of the croplands relative to the larger WMD also confounds the ability to control

moose populations and damage through the traditional hunting framework.

Several key elements were critical to the implementation of the controlled hunt. The hunt needed to be biologically sound and provide relief to cole crop damage during the growing season with high compliance with landowner requests, and have potential to reduce moose-vehicle collisions. Based on known success rates of resident and non-resident hunters for AMP and AOP permits in the northeast zones, MDIFW predicted a harvest success rate of 88%, with a slight skew towards adult bulls. The actual harvest resulted in 20% fewer adult bulls, 11% more adult cows, and 40% fewer calves than predicted; relative to population control, this harvest was beneficial biologically and increased stakeholder satisfaction.

The intent of the controlled hunt was to strategically remove moose associated with localized croplands with emphasis on hunting as a management tool and not as another "opportunity." Although a focal point of the MDIFW throughout the process was to identify and describe the hunt in terms of a targeted and focused effort, certain stakeholders recommended that permits be allocated to other hunting interests with specific needs (e.g., veterans and disabled hunters). Despite in-depth explanation of the rationale and purpose of the hunt and MDIFW interest in keeping the framework straightforward, stakeholders continued to press for modification. While it remained critical to address stakeholder concerns, alleviating crop damage and addressing agricultural concerns were paramount to implementing a hunt that met the needs of all stakeholders. While the bulk of the permits went to 2 farms, local landowners and the general hunting public maintained a high level of satisfaction with this hunt believing it provided relief from crop damage.

Farmers were included during the entire process, and participated in the guide training session and hunt debriefing. Thus, the controlled hunt represents another step along the stakeholder continuum (Decker and Chase 2001) by incorporating elements of co-management rather than a transactional approach as exemplified by Maine's strategic planning process. The co-managerial approach provides flexibility that parallels the current legal framework of MDIFW and their responsibility to manage wildlife populations and respond to negative impacts. Current authority provides flexibility to design and implement management activities that help resolve both biological and social problems due to moose. When provided with these tools, biologists can formulate management actions necessary to meet publicly derived goals and objectives, and better address social issues that can either increase or detract from agency accountability and credibility.

Farmers had experienced substantial crop damage resulting in both financial loss and loss of resource investment in the controlled hunt area. While a mechanism was in place to alleviate immediate problems (depredation permits), most farmers do not have the time or are unwilling to remove moose throughout the growing season, and continual removal by farmers is impractical. Importantly, farmers preferred providing public opportunity in removing and utilizing the moose resource, although moose hunting in and around croplands during the recreational hunt incurred a cost (i.e., property abuse and damage). In its initial year the controlled hunt was considered successful because it provided relief from crop depredation and property abuse from hunters accessing croplands. Thus the "burden" of managing nuisance moose was born by multiple stakeholders that benefited from each other. Farmers realized lower depredation and property abuse, hunters provided a service to the MDIFW and landowners, and MDIFW was able to facilitate their moose management program and improve communication and credibility among stakeholders.

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