THE STATUS AND MANAGEMENT OF MOOSE IN NORTH AMERICA-CIRCA 2000-01

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ABSTRACT: At the turn of the century 2000, the North American moose population was estimated at about 1 million distributed in 28 jurisdictions. Populations occur in 11 Canadian provinces or territories, and in at least 17 U.S. States. Densities are believed to be increasing in 12, stable to increasing in 14, and stable to decreasing in only 2. Moose continue to expand their range in New England and several western U.S. States. In 2000-01, an estimated 382,951 licensed moose hunters harvested 82,619 moose in 23 jurisdictions, down from 418,619 and 89,027 a decade earlier. Additional harvests by Native and subsistence users although largely unquantified, are believed substantial in Alaska, Minnesota, and all 11 Canadian jurisdictions. A wide variety of active and passive harvest strategies used to manage moose are discussed. Population estimates are presented for 28 of 35 National Parks where moose occur, but where licensed hunting is prohibited.

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Key words: distribution, First Nations, harvest, harvest strategies, hunter numbers, license qualifications, moose population status, National Parks, seasons, subsistence

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The status and management of North American moose (*Alces alces*) circa 2000-2001 is updated from that reported by Timmermann and Buss (1995). A comprehensive 10-page questionnaire similar to that used by Timmermann (1987) and Timmermann and Buss (1995) was used to update the current status, population estimates, as well as harvest and non-harvest strategies used by 23 jurisdictions that manage an annual licensed moose harvest. An additional 5 jurisdictions where hunting is currently prohibited were contacted to determine population status. Tabulated data were returned for final perusal and changes or corrections solicited. This paper reports on current (year 2000-2001) population status and strategies used to manage hunting harvest and non-harvest management.

HISTORICAL DISTRIBUTION AND CURRENT STATUS

The distribution of moose in North America during the latter half of the 20th century has been described by several authors including: Peterson (1955), Telfer (1984), Kelsall (1987), Karns (1998), Franzmann (2000), and Rodgers (2001). Four subspecies are recognized, namely *A. a. gigas*, *andersoni*, *americana*, and *shirasi* (Peterson 1955). During the past 30 years, Kelsall and Telfer (1974), Karns (1998), and Peek and Morris (1998), detailed expanding distributions in both western and eastern states. Currently, moose (*A. a. americana*) appear to still be expanding and re-establishing on their former range in the states of Maine, Vermont, New Hampshire, Massachusetts, New York, and Connecticut (Hicks 1986, Alexander 1993, Bontaites and Guftason 1993, Morris and Elowe 1993, Vecellio et al. 1993, Al Hicks, New York State Department of Environmental Conservation, personal communication 2002, Howard Kilpatrick, Connecticut Department of Environmental Protection, personal communication 2002, Bill Woytek, Massachusetts Wildlife, personal commu-

nication 2002; Fig. 1). Moose in Vermont have re-occupied all suitable habitat and are currently believed to be increasing (Cedric Alexander, Vermont Fish and Wildlife, personal communication 2001). Current moose populations in Maine are considered unacceptably high and need to be reduced according to Karen Morris (Maine Department of Inland Fisheries and Wildlife, personal communication 2002). Likewise, populations of *A. a. shirasi* continue to increase and expand in the western states of Washington (Donny Martorello, Department of Fish and Wildlife, Washington State, personal communication 2002), as well as Idaho (Compton and Oldenburg 1994), Utah (Jim Karpowitz, Utah Division of Wildlife Resources, personal communication 2002), Wyoming (Hnilicka and Zornes 1994), and Colorado (Kufeld 1994, Kufeld and Bowden 1996, John Ellenberger, Colorado Division of Wildlife, personal communication 2002). Low predator densities, reduced deer populations, reversion of farmland to forest, increased logging and fire disturbance, legal protection, and conservative harvests are believed responsible (Karns 1998, Peek and Morris 1998).

Minnesota closed their northwestern moose range to harvest in 1997 due to a dramatic population decline from unknown causes (Mike Schrage, Fond Du Lac Band of Lake Superior Chippewa, and Gretchen Mehmel, Minnesota Department of Natural Resources, personal communications 2002). The estimated population declined from 4,264 in 1983 to 1,486 in 1995 to approximately 900 in 2001. A research study is currently underway in an effort to determine the causes of this decline.

Mainland Michigan population estimates are controversial and believed to be somewhere between 600 and 1,100, while those on Isle Royale were estimated at 900 (Aho et al. 1996, Dodge et al. 2001, Mary Hindelang, Michigan Technological University, personal communication 2002). Moose regularly move in and out of northern Michi-

Fig. 1. 2000-2001 post-hunt moose (*Alces alces*) population estimates for 28 North American jurisdictions.

gan and Minnesota into northern Wisconsin and Adrian Wydeven (Wisconsin Department of Natural Resources, personal communication 2002) estimates the current Wisconsin population at 20-40.

Periodic winter aerial surveys based on the Gasaway method are used by most agencies to estimate populations and trends (Gasaway et al. 1986, Peterson and Page 1993, Timmermann 1993, Smits et al. 1994, Lynch and Shumaker 1995, Bisset 1996, Lenarz 1998, Timmermann and Buss 1998, Bisset and McLaren 1999, Bontaities et al. 2000, Ward et al. 2000). Most agencies estimate total jurisdictional populations based on the cumulative total of specific management areas sampled every 3 or more years. Such jurisdictional estimates are considered relatively crude and are primarily used to compare population trends over time. New Hampshire, Maine, and Vermont rely heavily on deer hunter reported moose observations and vehicle collision incidents to estimate moose trends. New Hampshire and Vermont also use annual deer hunter observations and a regression formula developed from concurrent infrared aerial surveys obtained over a 3-year New Hampshire study to estimate regional moose populations (Bontaites et al. 2000). Continental moose populations in 28 jurisdictions (circa 2000-2001) are estimated at 938,350 to 1,064,130 (Fig. 1). Population estimates from 23 of 28 agencies which manage an annual licensed harvest are similar to those given in 1991 (Table 1).

In summary, current moose densities in 23 jurisdictions are believed to be stable to decreasing in Minnesota, decreasing in Alaska, and relatively stable or increasing in the balance (Table 1). Five states where hunting is prohibited report expanding populations in four (Michigan, Massachusetts, Connecticut, New York) while those in Wisconsin are considered stable (Fig. 1).

MANAGING A HARVEST

Economic Impact

Moose hunting provides a significant annual economic impact in some jurisdictions. The value of resident moose hunting in British Columbia, for example was estimated to be Canadian (CAN) $15.8 M in 1995 (Reid 1997), while Legg (1995) estimated CAN $134.7 M in Ontario for all hunters in 1993. Legg and Kennedy (2000) estimated moose hunting in Ontario contributed CAN $77.0 M to the gross provincial income and sustained 1,645.8 person years of employment in 1996. Regelin and Franzman (1998) estimated the economic impact of 33,000 resident and 1,000 nonresident Alaskan hunters to represent US $32.6 M in the late 1990s. Bisset (1987) reported a gross value of CAN $464 M generated in 19 North American jurisdictions in 1982.

Harvest Control Objectives

Two territories and 9 provinces in Canada, and 12 states in the USA, administered a moose hunt in 2000 (Table 1). Collectively, 385,569 licensed moose hunters harvested an estimated 82,466 moose in 2000-2001. A decade earlier, 417,072 licensed hunters killed 89,100 (Table 1). Hunting regulations continue to become more restrictive and complex as the demand on moose populations and corresponding success rates increase due in part to increased road access and use of mechanized equipment (Timmermann and Buss 1998). Control of hunting is required to affect the desired allocation of moose harvest among licensed hunters, to secure the sustainability of moose populations, and achieve other specified management objectives for a particular area. British Columbia, for example, has recently suggested future management objectives focus on maintaining appropriate adult sex ratios, provide diverse hunting opportunities, and optimize recreational days

Table 1. Numbers of sport hunters, harvest, and post-hunt population estimates for 23 North American jurisdictions, 1990-91 vs 2000-01.

	Total hunters		Non-resident hunters		Total estimated harvest		Estimated moose population	
Agency	1991	2001	1991	2001	1991	2001	1991	2001
Yukon Territory	2,040	1,410	387	342	640	716	50,000	70,000+
Northwest Territories	1,300	1,300	60	65	1,400	1,400	9,000	20,000+
British Columbia	39,400	31,500	1,860	2,250	13,500	9,200	175,000	165,000*[4]
Alberta	50,000	20,429	1,150	1,139	12,200	7,971	100,700	92,000*
Saskatchewan	12,000	10,000	1,170	5,260	4,100	3,412	50,000	46,000*
Manitoba	6,500	5,409	100	100	1,100	1,000	27,000	35,000+
Ontario	92,000	100,000	2,700	3,000	11,000	11,000	120,000	100,000*[5]
Quebec	150,000	130,000	2,500	2,000	11,900	14,000	67,500	100,000+[6]
New Brunswick	5,200	4,174	—	97	1,700	2,537	20,000	25,000+
Nova Scotia[1]	200	200	—	—	113	186	3,000	6,000+
Newfoundland	29,200	40,449	1,400	3,044	21,000	19,322	140,000	125,000*[7]
Alaska	22,000	30,000	2,410	3,200	6,100	5,509	155,000	120,000-
Washington[1]	8	69	—	—	8	64	200	1,000+[3]
Idaho[1]	500	1,011	—	—	490	774	5,500	15,000+
Utah	299	182	290	7[2]	290	175	2,700	3,400+
Wyoming	1,713	1,379	218	199	1,475	1,215	13,645	13,865+
Montana	675	609	19	16	511	596	4,000	4,000*
North Dakota[1]	110	132	—	—	107	117	550	700+
Colorado[1]	7	74	—	—	7	64	425	1,070+
Minnesota[1]	1,820	442	—	—	410	125	6,700	5,100-*
Maine	2,000	6,000	200	300	960	2,550	23,000	29,000+
Vermont	—	215	—	22	—	155	1,300	3,500+
New Hampshire	100	585	20	76	89	378	4,000	5,000+
TOTAL	417,072	385,569	14,484	16,117	89,100	82,466	979,220	985,635

+ increase, - decrease, * no change.

[1] No non-resident season.

[2] Plus 36 permits available for resident and non-resident hunters.

[3] Range 850-1,000.

[4] Range 130,000-200,000.

[5] Range 100,000-110,000.

[6] Range 95,000-105,000 winter 2002.

[7] Range 115,000-140,000, with 1,000 in Labrador.

per harvested moose. This would replace traditional objectives associated with population size, harvest, hunter numbers, and hunter days, which are difficult to achieve or measure (Hatter 1999).

Harvest policy is currently guided by a written approved or draft moose management policy, including goals and objectives in 15 jurisdictions, while 8 employ an unwritten or generalized wildlife policy. Specific moose management plans, guidelines, or statements have been prepared or are being updated in Maine (Morris and Elowe 1993, Anonymous 2000a), Vermont (Alexander et al. 1998, Anonymous 2001), New Hampshire (Anonymous 1997), Utah (Anonymous 2000b), Colorado (Kufeld 1994), Wyoming (Wyoming Game and Fish Commission 1990, Hnilicka and Zornes 1994), Idaho (IDFG 1990, Leege 1990), Ontario (OMNR 1980), Québec (MLCP 1993), Saskatchewan (Arsenault 2000), British Columbia (British Columbia Ministry of Environment, Lands and Parks 1996), Yukon (Yukon Renewable Resources 1996, 1999), and Alberta (Alberta Natural Resources draft pending). Alaska uses a dated 1980 moose policy (Alaska Department of Fish and Game 1980) and currently manages 45 distinct populations individually. Examples of specific moose plans include those for Region 1, southeastern Alaska, as well as the Yukon Flats and Koyukuk River (Alaska Department of Fish and Game 1990, 2001). Several agencies have recently attempted to review and evaluate their moose harvest program and policy. These include Ontario (Simmons 1997, Provincial Auditor 1998, OMNR 2001, Timmermann et al. 2003), British Columbia (Hatter 1999), Saskatchewan (Arsenault 2000), Newfoundland (Mercer and McLaren 2002), Québec (Courtois and Lamontagne 1999, Lamoureux 1999, Sigouin et al. 1999), and Alaska (Schwartz et al. 1992, Hundertmark and Schwartz 1996, Hundertmark et al. 1998, Kovach et al. 1998, Regelin and Franzmann 1998).

Allocation of Hunting Opportunities

Moose are essentially publicly owned and held in trust by provincial, territorial, and state wildlife agencies. The first priority of most agencies is to ensure the long-term conservation of moose populations and their habitats. Harvest allocation is given prime consideration to subsistence use by Native people under Treaty or other legal agreements in at least 10 of 23 jurisdictions that manage a harvest. Resident hunters are typically favored over non-residents and non- resident aliens, in allocating harvest opportunities.

Added controls, such as increased license fees, resident only seasons, guide requirements, and limited permits are commonly placed on non-resident hunters, giving residents priority in allocation of hunting opportunities. In 2000-2001, non-residents were eligible to hunt 17 of 23 jurisdictions (Table 1). A guide was required by 8 of 23 agencies, and at least 2 agencies required non-residents to register with a licensed tourist outfitter to stimulate local economic benefits. Allowances to enable some non-residents to hunt with resident hunters have been made. For example, a non-resident of British Columbia, who is a resident of Canada or a Canadian citizen, may be accompanied by a resident of British Columbia who holds a $40.00 Permit to Accompany (British Columbia Ministry of Water, Land and Air Protection 2001).

Some agencies restrict or limit moose hunting opportunities. They are limited in all U.S. States except Alaska. Washington, North Dakota, and Minnesota offer 1 moose hunt per lifetime, while Colorado and Utah limit hunters to 1 antlered animal per lifetime. Others require a waiting period between hunts; Idaho and Maine 2 years, New Hampshire and Vermont 3 years,

Wyoming 5 years, and Montana 7 years after a moose is taken. Hunters in Alaska and all 11 Canadian jurisdictions may hunt annually within quotas whether they were successful or not the previous year. Ontario has introduced a pilot study in 1 Wildlife Management Unit that offers moose hunting opportunities for physically-challenged hunters only (Armstrong and Simons 1999).

Control Concepts

Agencies employ a variety of strategies to regulate harvests and distribute hunting pressure (Timmermann 1987). Passive strategies used include season length and timing, access restrictions, weapon requirements, and license qualification prerequisites; while active measures include limiting license sales or specifying the sex, age, or number of animals taken by specific area. Objectives often include the harvest of predetermined numbers to sustain, increase, or decrease populations. Both New Hampshire and Vermont have recently applied harvest rates and antlerless quotas aimed at reducing moose densities in some areas to help reduce impacts of browsing on regenerating forests and vehicle collisions (Cedric Alexander, Vermont Fish and Wildlife, personal communication 2002). In 2000-01, 10 agencies offered unlimited selective or non-selective harvest opportunities while all (23 of 23) restricted or limited harvests on a selective or non-selective basis in some management areas (Fig. 2). In addition, closed seasons were employed to prevent licensed harvests in specific moose inhabited areas, including some provincial, territorial, state, and National Parks.

Alaska, for example, has eliminated or restricted any-sex seasons and now uses regulations limiting bull harvests to specific antler shape and size in much of the road accessible portions of the state (Schwartz et al. 1992, Hundertmark and Schwartz 1996, Huntertmark et al. 1998, Kovach et al. 1998, Regelin and Franzmann 1998).

License Qualifications and Fees

In 2000, proof of hunting proficiency, including either a previous license or completing a hunter safety education course, was required to obtain a moose hunting license in all jurisdictions. In 2001, resident license fees averaged CAN $35.76 in Canada (range $10.00 Northwest Territories to $ 57.50 in Nova Scotia and New Brunswick), while non-resident licenses averaged CAN $204.41 (range $20.00 Northwest Territories to $460.00 in New Brunswick). Resident fees in the U.S. averaged US $106.00, (range $20.00 in North Dakota to $ 310.00 in Minnesota), while non-resident fees averaged US $727.70 (range $80.00 in Vermont to $1,643 in Idaho). Some agencies, including Alaska and Maine for example, charged higher fees to non-resident aliens. Export permits or trophy fees are required in addition to the license fee to transport an animal out of Alaska, Northwest Territories, Alberta, and Ontario (Table 3). Currently, no jurisdictions require moose hunters to demonstrate shooting proficiency using conventional firearms, as described by Buss et al. (1989). Both New Brunswick and Newfoundland had previously required hunters to pass a shooting and written test before qualifying for a big game hunting license (Timmermann and Buss 1995). Alaska however, requires all archery and black powder hunters to pass a proficiency test (Wayne Regelin, Alaska Department of Fish and Game, personal communication 2002).

Seasons

Season length and timing are used to control the amount of hunting opportunity available, hunter success due to moose vulnerability based on behavior, and seasonal access. Seasons are generally specific to

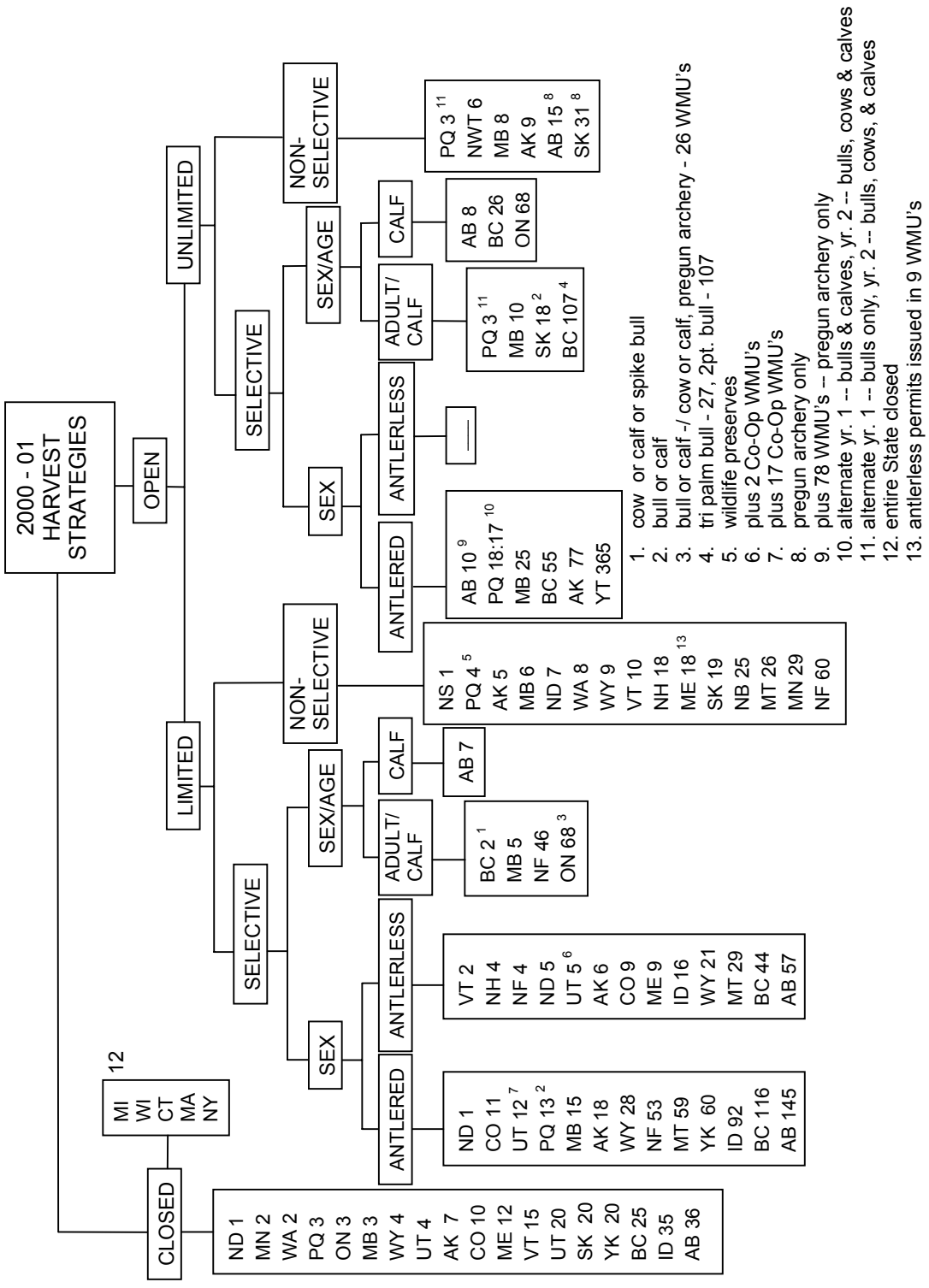

Fig. 2. Moose (*Alces alces*) harvest strategies employed by 28 North American jurisdictions (circa 2000-2001). Numbers of management areas or subdivisions under each harvest strategy in each jurisdiction are indicated.

firearm type (e.g., conventional firearms, black powder, or archery). In addition, seasons tend to be longer in more remote areas and shorter in roaded areas closer to population centers. Alaska provides the most liberal season length (243 days), extending from August to March in some Game Management Areas (Table 2). Season lengths for all hunts in parts of Idaho, Wyoming, Montana, Yukon, Northwest Territories, British Columbia, Alberta, Manitoba, Ontario, Québec, and Newfoundland equal or exceed 3 months, while New Brunswick, Vermont, and New Hampshire restrict season length to 3, 4, and 9 days, respectively. Special early archery seasons are offered by 9 agencies (Table 2), while most offer firearm seasons beginning during the latter portion of the rut period (Wilton 1995) and extending into November or December. Split seasons (early vs late fall) occur in at least 8 jurisdictions.

Management Areas and Harvest Strategies

All agencies have subdivided their moose range into various sized areas (Wildlife, Game, or Moose Management Units) to facilitate specific harvest control measures. Moose management areas vary in size from 53 km^2 (Vermont) to 1,629,049 km^2 in the Northwest Territories, and number 4 in Washington State to 445 in the Yukon (Table 2). All jurisdictions except the Northwest Territories continue to employ either a selective or non-selective limited hunter participation strategy, or a combination of both (Fig. 2). Most favor some form of limited selective or limited non-selective strategy to control sex and/or age related harvests. Alaska alone continues to employ registration hunts which require mandatory kill registration and season termination once a prescribed harvest is achieved.

A selective harvest strategy allowing control of harvest size and composition was introduced in Saskatchewan in 1977 followed by British Columbia, Ontario, Newfoundland, and Québec between 1980 and 1994 (Timmermann and Buss 1995). This strategy's objective is to promote herd growth by reducing the adult female harvest while maintaining or increasing adult bull and calf harvest (Stewart 1978). A selective bull harvest strategy based on antler architecture is used in Alaska and British Columbia (Child and Aitken 1989, Schwartz et al. 1992, Timmermann and Buss 1995, Hatter 1999). The objective is to increase the number of bulls in areas where low bull numbers are a concern because of low reproduction, by diverting harvest pressure to young (spike and forked antlered bulls) and old bulls (antlers with >3 brow tines on 1 antler, or larger than 106 cm spread), and away from prime (6-10 year-old) bulls. Québec introduced an alternating hunting strategy in 1994 by offering combinations of bull-only, bull/calf, female draw, and either sex depending on year and location (Courtois and Lamontagne 1997, 1999; Lamoureux 1999; Sigouin et al. 1999).

Sharing a moose between >2 hunters optimizes hunting opportunities and accommodates hunters who wish to hunt with friends. Some agencies, such as Minnesota since 1971, require all eligible hunters to apply together in groups of up to 4 individuals for the chance to harvest 1 animal (Judd 1972). More recently, several agencies have introduced additional limiting or sharing mechanisms. British Columbia offers a "Group Hunt" whereby up to 4 persons can combine their applications and have them entered as 1 application. If drawn, each hunter within the group receives an authorization to shoot 1 moose (British Columbia Ministry of Water, Land and Air Protection 2001). In addition, British Columbia introduced new Limited Entry Shared hunts in 2001. If drawn, a group of 2 is allowed to take 1 moose and a group of 3 or 4 can take

Table 2. Characteristics of moose hunting seasons in North America, 2000-2001.

	Number of management areas				Season length/timing		
Agency	With moose	Size (km²) Min.	Max.	With open Season	Max days	Earliest	Latest
Yukon Territory	445	64	2,919	431	92	Aug. 01	Oct. 31
Northwest Territories	6	57,379	1,629,049	6	153	Sept. 01	Jan. 31
British Columbia	193	465	18,980	169[1]	118[2]	Aug. 15	Nov. 30
Alberta	148	210	33,700	148[1,4]	91[2]	Aug. 25	Nov. 30
Saskatchewan	60	2,000	120,000	40[1,4]	64[2]	Aug. 26	Nov. 30
Manitoba	46	585	139,214	43[1,4]	117[2]	Aug. 27	Dec. 22
Ontario	68	1,700	85,800	68[1,4]	88	Sept. 15	Dec. 15
Quebec	24	2,150	225,200	21[1]	92	Sept. 01	Dec. 01
New Brunswick	25	826	6,402	25[4]	3	Sept. 27	Sept. 29
Nova Scotia	2[5]	3,000	4,400	1[4]	12	Sept. 24	Oct. 13
Newfoundland	64	116	4,500	64[1,4]	120[6,7]	Sept. 09	Jan. 06
Alaska	94	290	5,300	83[1]	243[2]	Aug. 01	Mar. 31
Washington	10	680	700	10	61	Oct. 01	Nov. 30
Idaho	88	246	6,480	53	86	Aug. 30	Nov. 23
Utah	13	1,200	8,000	9	41[2]	Sept. 09	Oct. 29
Wyoming	41	450	4,100	37[1]	76	Sept. 01	Nov. 20
Montana	80	250	2,500	80	87	Sept. 01	Nov. 26
North Dakota	9	1,350	17,000	8[1]	79[2]	Sept. 01	Dec. 17
Colorado	21	130	1,540	11	25	Sept. 08	Oct. 09
Minnesota	31	202	772	29[3]	16	Sept. 28	Oct. 20
Maine	30	4,000	13,800	18[4]	12[2]	Sept. 23	Oct. 12
Vermont	21	53	203	10	4	Oct. 20	Oct. 23
New Hampshire	22	490	1,810	22	9	Oct. 15	Oct. 24

[1] Special archery seasons in some areas.

[2] Split seasons.

[3] NW Region closed since 1997.

[4] Closed Sundays in some or all areas.

[5] Cape Breton Island and Nova Scotia mainland.

[6] Special winter season in one area.

[7] Labrador 197 days- Sep 08-Mar 16.

2 moose only. All members must hunt together and those who apply for these special Limited Entry Shared Hunts will have an advantage in the draw over a single applicant. Alberta introduced a Special Antlered Moose Partner license to increase resident hunting opportunities in 2000. Residents who did not apply or were unsuccessful in the license draw could partner with a resident holder of an Antlered Moose Special license. Residents who were successful could also designate a non-resident (in an area that offered a non-resident hunt) and a resident as a partner. Nova Scotia allows residents who have drawn a license to designate up to 2 companions who may fully participate in the hunt; provided the designated licensee is within hailing dis-

tance of the license holder at all times and possesses a Companion Moose Hunting Stamp. Manitoba issues some moose licenses on the basis of 1 tag for 2 hunters and each must sign the other's license. If hunting alone, the licensee must be in possession of the game tag and may not sign up with another party. Manitoba resident hunters may also purchase a Conservation Moose License together (2 licenses / 1 tag) allowing for a shared harvest of 1 moose. Québec authorizes a bag limit of 1 moose per 2 hunters in most areas and 1 moose per 3 hunters in some ZECs (organizations that manage specific areas). In addition, the limit is 1 moose per group composed of 3 or 4 hunters in limited access wildlife reserves. Yukon hunters who wish to hunt together may apply jointly and if the application is drawn, both applicants receive a permit for the same subzone. The voluntary "Hunt with a Partner" slogan encourages Yukoners to share 1 moose. Maine, New Hampshire, and Vermont all manage a short season, whereby each successful permittee may select a subpermittee to hunt with them and harvest 1 moose.

Several agencies have developed mechanisms to grant hunters a higher success rate in a limited random draw. Wyoming hunters are given 1 Moose Preference Point every year in which they are unsuccessful in the draw. Alternatively applicants may purchase a preference point for US $7.00 instead of applying for a license. Successful applicants are generally those who have the highest preference points. Both Ontario and Newfoundland either encourage or give preference to a party over individual draw applicants. Newfoundland restricts party size to 2 individuals who may hunt for 1 moose provided they are within sight of each other when both are hunting. Members of a party license may hunt alone provided they carry the license and tag. In addition, Newfoundland gives party applicants preference over individuals and to those who were unsuccessful in previous years in each of 5 pools, thereby maximizing hunter opportunity. Ontario has offered a voluntary Group Application System for adult moose since 1991 (Timmermann et al. 2003). This system was designed to allow a more equitable allocation of harvest opportunities among more hunters. A 2-pool preference system gives hunters who were unsuccessful in obtaining a tag the previous year a preference over those who received a tag when re-applying the following year. In 2000, for example, 42% of Ontario hunters applied in groups of 2 or more. The average group size was 4.43 hunters per group and 63% of groups received a moose tag compared to only 18% of individual applicants (OMNR 2001:35). In addition, a tag is guaranteed to a group of hunters when the number of Pool 1 hunters in the group meets a pre-determined size.

Harvest Assessment

All sources of mortality must be assessed to monitor the effectiveness of various harvest strategies. Hunters are required to report their hunting activity in 9 of 23 jurisdictions, whether successful or not, while kill registration is compulsory in the majority (16 of 23, Table 3). Thirteen of these 16 agencies apply a non-compliance penalty to hunters failing to report, although enforcement of these requirements varies among agencies. New Brunswick has experimented with interactive voice response technology (Redmond et al. 1997) and Alberta has used a telephone questionnaire (Lynch and Birkholz 2000) to help assess moose harvests. Modeling is also used to predict population changes resulting from various harvest strategies (Heydon et al. 1992, Schwartz 1993, McKenney et al. 1998). Timmermann and Buss (1998) provide a more detailed description of this subject.

Harvest by Native and Subsistence Users

Kay (1997) suggested that historically moose were extremely vulnerable to predation by Natives in western North America and that Native peoples had no effective conservation practices. Reeves and McCabe (1998) estimated annual consumption of moose for North American Indians living in moose range to be 0.142 moose per person. Currently, most North American moose management agencies give primary consideration to subsistence use by Canadian First Nation peoples and Native American peoples in recognition of obligations made under historical Treaties signed by both Federal governments (Crichton et al. 1998). In many areas, they have unfettered access to moose year round and current regulations are considered liberal and unrestrictive given the widespread use of modern technology (Courtois and Beaumont 1999). The harvest by Natives is difficult to quantify and unfortunately little effort has been made to measure the magnitude of this harvest, which some managers believe approaches or exceeds the licensed harvest.

In the USA, 4 of 12 agencies reported formal agreements governing moose harvests have been signed with some tribal bands. They include Montana, Utah, Maine, and Minnesota. The latter state has signed agreements with 2 Ojibwe bands, another is being negotiated and 2 Minnesota bands have closed seasons on their reserves due to low populations. Schrage (2001) reported 80 moose taken by Minnesota Natives compared to 125 by all non-natives in 2001. Bands in Montana, Utah, and Maine regulate harvests on tribal lands.

In Canada, First Nations have signed a few formal agreements with 5 of 11 jurisdictions. They include the Yukon and Northwest Territories, British Columbia, Ontario, and Québec. In the Yukon, those agreements have yet to be implemented and managers currently estimate harvest levels to equal or exceed those of the licensed harvest based on limited data. The Northwest Territories Land Claims Agreement governs subsistence harvesting by First Nations in the Inuvialuit, Gwich'in, and Sahtu areas (Marshal 1999). British Columbia, Ontario, and Québec have signed several agreements, while others are being negotiated, and many jurisdictions have no agreements in place. However all current harvests by First Nation peoples are poorly documented. In Ontario, the only formal agreement was a 10-year history of annual agreements with the Algonquins of Golden Lake to take moose in Algonquin Provincial Park from 1990-2000. No agreement was signed in 2001 and documentation of kill magnitude was difficult to obtain under previous agreements.

The annual moose harvest by First Nation peoples is "substantial" in specific local areas of British Columbia and Ontario. Moose managers in Ontario estimate the harvest by First Nation and Metis peoples may approach the licensed hunting harvest for some Wildlife Management Units in northwestern and northeastern Ontario in areas adjacent to First Nations communities (Ted Armstrong and Peter Davis, Ontario Ministry of Natural Resources, personal communications 2002). First Nation moose harvests are believed to equal or exceed the total licensed harvest in Alberta (7,971 +), at least 50% of the licensed harvest in Saskatchewan (1,706+), equal to double in Manitoba (1,000-2,000), slightly more than half in New Brunswick (1,300+), at least double in Nova Scotia (360+), at least 1,000 in the Northwest Territories, and is thought to equal or exceed harvests by non-First-Nation peoples in the Yukon (743). There are no reliable statistics on harvests by First Nations in Québec, except in the James Bay region where their harvests are considered

Table. 3. Moose harvest assessment strategies used in North America, 2000-2001.

Agency	Hunt activity report		Kill registration		Non-compliance penalty[4]
	Compulsory	Voluntary	Compulsory	Voluntary	
Yukon Territory	X		X		Fine
Northwest Territories		X	X[2,3]		Fine
British Columbia		X	X[1]		Fine
Alberta		X	X[2]		None
Saskatchewan		X		X	N/A
Manitoba		X		X	N/A
Ontario		X	X[2,3]		N/A
Quebec		X	X		Fine & loss of license
New Brunswick		X	X		Fine & loss of license
Nova Scotia	X		X		Fine & jail & 7 yr. Wait-out
Newfoundland	X		X		Fine
Alaska	X[1]		X[1,2]		None
Washington	X		X		None
Idaho	X		X		Fine, jail & loss of license
Utah		X		X	N/A
Wyoming		X		X	None
Montana		X		X	N/A
North Dakota		X		X	None
Colorado	X			X	Ineligible for draw
Minnesota		X	X		Fine & loss of license
Maine	X		X		Fine & jail & loss of license
Vermont		X	X		Fine & loss of license
New Hampshire	X		X		Fine, jail & loss of license

[1] Limited draw hunts only (British Columbia – Regions 3,4,5,6,7A,8-incisor and kill information).

[2] Export permit/trophy fee.

[3] Non-resident hunter only.

[4] Variable enforcement.

of the same order or greater than that of licensed hunting (St.-Pierre 2001, Réhaume Courtois, Québec Ministère de l'Environment et de la Faune, personal communication 2002). Newfoundland has only 1 First Nation reserve and currently no allowances are made for harvesting of moose by their people. First Nation use of moose in Labrador is limited due to the low moose population (Paul Saunders, Newfoundland and Labrador Department of Tourism, Culture and Recreation, personal communication

2002). Moose managers generally presume that First Nation peoples take a higher proportion of cows than bulls, although such data are speculative and poorly documented.

Both Metis and non-status Indians are testing their perceived rights in court. Metis are considered as any persons of mixed Indian and white ancestry not considered an Indian (Swail 1996). In Ontario, self-identified Metis are considered to be members of and accepted by their local Metis community and organization, which retain a historic Metis community connection in areas where moose hunting is considered a historic activity (Richard Stankiewicz, Ontario Ministry of Natural Resources, personal communication 2002). On February 23, 2001, the Ontario Court of Appeal decided the case of R. V. Powley et al. (2001), 53 O.R. (3rd) 35, ruling in favor of 2 Metis who claimed moose hunting was an "integral practice, custom or tradition of that Metis community". This case is currently on appeal to the Supreme Court of Canada (OMNR 2002). Another judge in an Alberta case (the Crown vs Fergeson) ruled that Metis have the right to hunt anywhere where they have right of access at any time without a license, provided they were raised in the Indian culture (could speak "Indian", grew up hunting and trapping, etc.), according to Lynch (Alberta Wildlife Management Consulting, personal communication 2002). In Canada, First Nation peoples are restricted to their Treaty areas with respect to unlicensed harvest.

Harvest of wildlife by First Nation peoples and Metis, including moose, remains a controversial subject and is considered a substantial undocumented kill in most jurisdictions (Crichton 1981, Feit 1987, Kay 1997, Hatter 1999). Co-management between government agencies, First Nations, and Metis is believed by some managers to offer the potential for local control of the moose resource, as long as hunting rights are balanced with conservation efforts (Feit 1987, Nepinak and Payne 1988, Graf 1992, Messier 1996, Crichton et al. 1998, Marshal 1999, Arsenault 2000, Crichton 2001). Crichton (2001) offers 4 ingredients for successful co-management. First Nations must have: a decision making role in development of management programs; be supportive of partnerships; there be recognition of traditional cultural and economic values, including a removal of cultural and linguistic barriers to facilitate use; and, a dispute resolution process to resolve disagreements.

Regelin and Franzmann (1998) reported that new laws in Alaska, primarily the Alaska Native Claims Settlement Act, have dictated a priority for harvest by rural citizens, using subsistence regulations to redistribute harvest among users. This law also shifted management responsibility from the state to the federal government. Under this law, all Alaskan residents are potentially qualified as subsistence hunters. As such, there is potential for subsistence use to increase significantly (Alaska Department of Fish and Game 2001). Alaska estimated a subsistence harvest of 2,000 compared to 5,000 for the 2001 licensed harvest. Regional managers in British Columbia may issue a possession permit for the purpose of sustenance, while local Fish and Wildlife offices in Alberta report issuing about 100 subsistence licenses for "those on the land" (Ian Hatter, British Columbia Wildlife Branch, and Gerry Lynch, Alberta Wildlife Management Consulting, personal communications 2001). Future sustainable harvests and population goals will largely remain elusive until the total harvest, including harvests by First Nation and Metis peoples and subsistence users, are agreed to and are verifiable.

Illegal hunting losses (Timmermann and Buss 1998) appear to be significant in some jurisdictions, including Colorado (Kufeld 1994), Utah (Anonymous 2000b), and On-

tario (Harnish 2000). Most agencies encourage all hunters to report illegal infractions using a toll-free telephone number. Ontario has recently introduced a "Moose Watch" Program to help reduce moose poaching (Harnish 2000).

MANAGING A NON- HARVEST

Parks, Refuges, and Special Areas

Most North American jurisdictions where moose occur, provide for areas where hunting is not a primary management objective. Currently 5 U.S. States do not have an open moose hunting season and 19 of 23 jurisdictions provide closed seasons in anywhere from 1 to 36 management areas (Fig. 2). The assumed common objective of closed areas including game or wildlife reserves, national, provincial, territorial, or state parks, or nature reserves, is the preservation of moose in representative natural habitats for education and recreational enjoyment. Further maintenance of biodiversity and ecosystem function is often a stated objective. Only 6 of 23 responding jurisdictions indicated management considerations or special objectives had been developed for pro-active management in such protected areas. The provision of viewing opportunities and natural history interpretations were commonly integrated in their park's programs. A review of moose management objectives and programs in parks, refuges and special areas is detailed by Timmermann and Buss (1995). Moose are native to at least 35 North American National Parks in 16 jurisdictions (Table 4). Isle Royale is perhaps the most famous, boasting a 43-year continuous ecological study of wolves and moose beginning in 1959 (Peterson 2002). Jordan et al. (2000) summarized moose related studies and provided an extensive list (150+) of research papers. A sampling includes a report on osteoporosis and other skeletal pathologies by Hindelang et al. (1992), studies on tooth wear and perodontal disease by Hindelang and Peterson (1993, 2001), and the impact of wolves and moose on vegetative succession by McLaren and Peterson (1994, 1995). Several other National Parks have also yielded moose related research. They include: data on 151 moose (*A. a. andersoni*) weights and measurements from Elk Island National Park, Alberta, following a herd reduction program (Lynch et al. 1995); ecological status of moose and white-tailed deer in Voyageurs National Park, Minnesota (Gogan et al. 1997); and, a description of extreme moose demographics in Gros Morne National Park, Newfoundland (McLaren et al. 2000). Population estimates vary from unknown in several Alberta and Alaskan National Parks to as high as 7,738 in Gros Morne National Park, Newfoundland. Bisset (1987) estimated that the value associated with wildlife appreciation (non-consumptive use, vicarious recreation, etc.) could have been as much as CAN $1,623 M in the early 1980s.

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Table 4. Moose population status in North American National Parks (N.P.).

Jurisdiction/Park	Location State/Province	Population estimate	Year of survey	Estimated by
Acadia N.P.	Maine	6	2000	Guess
Banff N.P.	Alberta	—	—	—
Beringland Bridge Preserve	Alberta	—	—	—
Cape Breton Highlands N.P.	Nova Scotia	2,500	2001	Aerial survey
Denali N.P. & Preserve	Alaska	2,000	1990	Aerial survey
Elk Island N.P.	Alberta	400	2002	Guess
Forillion N.P.	Quebec	122	1997	Aerial survey
Fundy N.P.	New Brunswick	123	1993	Aerial & ground
Gates of Arctic N.P. & Preserve	Alaska	—	—	—
Glacier N.P.	Montana	100	1985	—
Grand Teton N.P.	Wyoming	120	1988	—
Gros Morne N.P.	Newfoundland	7,738	1995	Aerial survey
Isle Royale N.P.	Michigan	900	2001	Aerial survey
Ivvavik N.P.	Yukon Territory	300	—	Guess
Jasper N.P.	Alberta	100-150	1992	Ground survey
Kenai National Wildl. Refuge	Alaska	—	—	—
Kejimkujik N.P.	Nova Scotia	0-5	2001	Guess
Kluane N.P.	Yukon Territory	700	1997	Aerial survey
Kootenay N.P.	British Columbia	75	1985	CWS biologists
Kouchibouguac N.P.	New Brunswick	110	1995	Aerial survey
Lac Mauricie N.P.	Quebec	212	1989	—
Lake Clark N.P. & Preserve	Alaska	—	—	—
Mt. Revelstoke & Glacier N.P.	British Columbia	15-20	1991	Ground survey
Nahanni N.P.	Northwest Territories	300	1979	Aerial survey
Noatak Preserve	Alaska	—	—	—
Prince Albert N.P.	Saskatchewan	950+	1997	Aerial survey
Pukaskwa N.P.	Ontario	411±143	1999	Aerial survey
Riding Mountain N.P.	Manitoba	5,000	2000	Aerial survey
Terra Nova N.P.	Newfoundland	150-200	2002	Guess
Voyageur N.P.	Minnesota	80-100	1998	Aerial survey
Vuntut N.P.	Yukon Territory	875	—	Guess
Waterton Lakes N.P.	Alberta	50	1988	Aerial & ground
Wood Buffalo N.P.	Alberta	1,300	1989	—
Wrangell St. Elias N.P.	Alaska	—	—	—
Yellowstone N.P.	Montana	200	1990	Aerial survey

of Lake Superior Chippewa, Conservation Department, Cloquet, MN; Gretchen Mehmel, Minnesota Department of Natural Resources, Roosevelt, MN; Karen Morris, Maine Department of Inland Fisheries and Wildlife, Bangor, ME; Kristine Bontaites, New Hampshire Fish and Game, New Hampton, NH; Cedric Alexander, Vermont Fish and Wildlife, St. Johnsbury, VT; Howard Kilpatrick, North Franklin, CT; Bill Woytek, Massachusetts Wildlife, Westborough, MA; Rick Ward, Yukon Department of Renewable Resources, Whitehorse, YK; Alasdair Veitch, Wildlife Management Division, Department of Renewable Resources, Yellowknife, NWT; Ian Hatter, British Co-

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