The History of Elk (*Cervus canadensis*) Restoration in Ontario

JOSEF HAMR[1], FRANK F. MALLORY[2, 3], and IVAN FILION[1]

[1]Applied Research, Cambrian College of Applied Arts and Technology, Sudbury, Ontario P3A 3V8 Canada
[2]Department of Biology, Laurentian University, Sudbury, Ontario P3E 2C6 Canada
[3]Corresponding author: fmallory@laurentian.ca

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Elk (*Cervus canadensis*) historically inhabited southern Quebec and central Ontario, but, by the early 1900s, the species was extirpated from this region. Attempts to re-establish an Elk population in Ontario during the first half of the 20th century had limited success. We reviewed historical documents, population census records, and a previous study pertaining to Elk reintroduced to Ontario in the early 1900s for clues to the cause(s) of their limited population growth. After an apparent rapid population increase in the 1940s followed by unregulated hunting during the subsequent 3 decades, Elk abundance in Ontario had not appreciably changed from 1970 to 1997, most likely because of the small founding population, unsustainable hunting, and accidental mortality. After the abolition of legal hunting in 1980, natural mortality appeared to be the main limiting factor. A limited sample of pregnancy and calf recruitment rates, body measurements, and physical condition parameters collected in 1993–1997, suggested that adults were healthy, reproducing successfully, and not limited by food availability; thus, it was concluded that remnant Elk populations could be augmented by introducing additional animals. A renewed Elk restoration effort, conducted from 1998 to 2001, imported 443 Elk from Elk Island National Park in Alberta to 4 release areas across central Ontario (Lake of the Woods, Lake Huron North Shore, Nipissing/French River, and Bancroft/North Hastings), resulting in a provincial population of about 800 Elk by 2013.

Key Words: *Cervus canadensis*; Elk; history; mortality; Ontario; restoration; population status

Introduction

Before the arrival of Europeans, an estimated 10 000 000 Elk (*Cervus canadensis*) were present across North America (Seton 1927). Historically, Elk, or Wapiti, ranged throughout the Eastern Deciduous Forest biome and the Great Lakes–St. Lawrence ecotone, including southern Quebec and central Ontario (Lett 1884; Peterson 1957, 1966; Bosveld 1996; Bowyer 1996). However, by the end of the 1800s to the early 1900s, Elk were extirpated from eastern North America (Larkin *et al*. 2001). In Ontario, sparse observations suggested that the headwaters of the Ottawa River may have been the last region inhabited by indigenous Elk (Lett 1884; Smith 1901; Peterson 1966).

The decline of Elk across North America was attributed mainly to overharvest and habitat loss (O'Gara and Dundas 2002). By the late 1970s, approximately 500 000 Elk remained, primarily in the western part of the continent (Bryant and Maser 1982). Since the extirpation of Elk from the eastern part of their North American range, numerous reintroductions have been attempted with varying degrees of success, including several failed efforts (O'Gara and Dundas 2002). Efforts to reintroduce Elk in Pennsylvania, Michigan, Arkansas, and more recently Kentucky, Wisconsin, and 2 regions of Ontario, can be considered successful, based on the establishment self-sustaining populations (Larkin *et al*. 2001; Popp *et al*. 2014).

Attempts to introduce Elk from Alberta into Ontario during the first half of the 20th century had limited success (Ontario Department of Game and Fisheries 1933; Peterson 1957; Ranta 1979). Although the source population was the prairie environment, Ranta (1979) presumed that the animals used as founders were of the Rocky Mountain subspecies (*C. c. nelsoni*), originally acquired from Yellowstone National Park. However, mitochondrial DNA analysis has shown that all extant populations of Elk east of the Rocky Mountains, including the so-called Manitoban Elk (*C. c. manitobensis*), are genetically identical to the Rocky Mountain subspecies, *C. c. nelsoni* (Polziehn *et al*. 1998, 2000). Although viable DNA could not be obtained from several museum specimens of Eastern Elk (*C. c. canadensis*), it is questionable whether indigenous Ontario elk were genetically different from those in Manitoba, given that they appeared to form a contiguous population around the Great Lakes provinces and states (Seton 1927; Peterson 1957). Only Tule (*C. c. nannodes*) and Roosevelt Elk (*C. c. roosevelti*) have shown distinct DNA structural differences from Elk populations east of the Rocky Mountains (Polziehn *et al*. 2000). In view of these findings, the transfer of Rocky Mountain Elk to Ontario can be considered a reintroduction of animals originating from the same genetic clade.

A remnant population of 40–50 Elk originating from earlier reintroductions persisted in the Burwash–French River area of central Ontario until the late 1900s (Ranta 1979; Rosatte *et al*. 2007). Here, we provide a review of historical information (late 1800s to 1997) on the status of reintroduced Elk in Ontario and identify potential threats and limiting factors responsible for historical population declines.

Methods

We searched files and correspondence of the Department of Lands and Forests (Ontario Ministry of Natural Resources and Forestry [OMNRF]), Burwash Industrial Prison Farm (Ministry of Government Services), and Ontario Veterinary College (University of Guelph), as well as newspaper articles, for historical information pertaining to Elk in Ontario. We obtained sporadic Elk harvest and population survey records from 1950 to 1989 from OMNRF. Several people who had hunted Elk during the 1960s and 1970s provided information on Elk kill dates, numbers, and locations. Former Burwash Industrial Farm employees provided information on the numbers of Elk kept at the facility and released into the wild. We also reviewed pertinent historical information summarized by Ranta (1979).

Results

An unsuccessful 1897 reintroduction of an unknown number of Elk into Algonquin Provincial Park (Ranta 1979) likely constitutes the first attempt by the provincial government to restore Elk to Ontario. Subsequently, Elk from the 660-km^2 Buffalo National Park (now Canadian Forces Base) near Wainwright, Alberta (Lothian 1987), were introduced at several locations in southern and central Ontario in the early 1930s. Sites in Ontario, where Elk from the captive Wainwright population were released, included the Pembroke Game Preserve, the Nipigon-Onamon Game Preserve, the Chapleau Game Preserve, the Goulais River Ranger Lake Game Preserve, and the Burwash Industrial Farm (Ranta 1979; Figure 1). During the 1930s and 1940s, a captive population was raised near Pembroke and used as a source for introductions into Algonquin Provincial Park, the Bruce Peninsula, the Nipissing Game Preserve, Redbridge, Apsley, the Abitibi Crown Game Preserve, Latchford, and Lake Wanapitei Provincial Park (Figure 1). By the late 1940s, Elk ranged freely at most of these Ontario sites and were still held captive at Burwash and Pembroke (Ranta 1979). The Burwash Industrial Farm (a medium security prison), located 20 km south of Sudbury, Ontario, received 2 shipments of

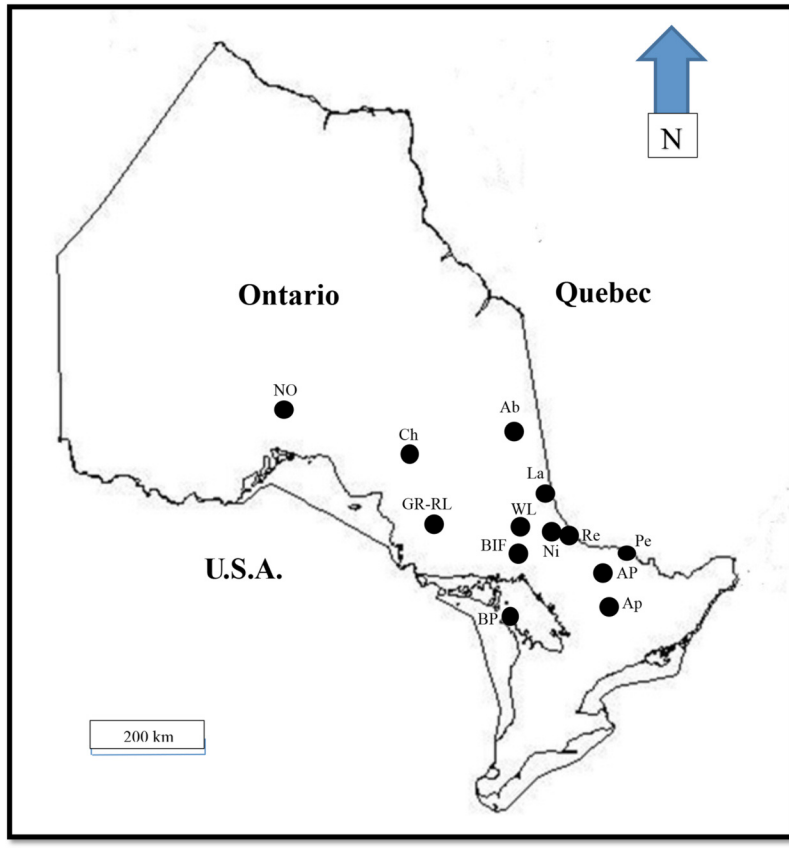

FIGURE 1. Sites of introduction of western Elk (*Cervus canadensis*) into Ontario during the 1930s and 1940s. Note: Ab = Abitibi, Ap = Apsley, AP = Algonquin Park, BIF = Burwash Industrial Farm, BP = Bruce Peninsula, Ch = Chapleau, GR-RL = Goulais River–Ranger Lake, La = Latchford, Ni = Nipissing, NO = Nipigon-Onamon, PE = Pembroke, Re = Redbridge, WL = Wanapitei Lake. Source: Ranta (1979).

approximately 50 Elk each from Wainwright in 1933 and 1934 (OMNRF files). Estimates of Elk numbers (captive and wild) at the Burwash Industrial Farm in the mid-1940s, provided by former employees, ranged from 300 to 1000 animals, with 300 thought to be the more accurate estimate in view of the size of the relatively small holding facility. Similar population increases were reported from other reintroduction sites, but no quantitative information was found (Ranta 1979).

In the late 1940s, Giant Liver Fluke (*Fascioloides magna*) was reported in Elk and cattle at the Burwash Industrial Farm, and the provincial government implemented a large-scale extermination program (Kingscote 1955). As a result, an estimated 300 Elk were slaughtered at the Burwash Industrial Farm between 1949 and 1950 (Lumsden 1955) and a legal harvest of free-ranging Elk, between 1950 and 1979, aimed to eliminate rather than manage the remnant animals (Kingscote 1955). In 1955, after 5 years of this extermination effort, an estimated 200–250 free-ranging Elk remained, distributed across 10 administrative districts in central Ontario, about 30% of the province's total area (Lumsden 1955; Figure 2). However, individual Elk populations were small, their distributions were highly localized, and approximately 66% of these animals were reported from the Sudbury area (Table 1). By the mid-1970s, Elk presence could be confirmed only in the Sudbury area (Ranta 1979). In 1980, the government called for a moratorium on Elk hunting as a result of Ranta's (1979) research and successful lobbying by the Ontario Federation of Anglers and Hunters. Ranta (1979) reported that the Sudbury area Elk population was very small (30-50 animals), but healthy and subjected to unsustainable hunting pressure during the 1970s.

By the early 1980s, occasional reports of Elk in various parts of the province virtually ceased. Between 1971 and 1989, the OMNRF conducted several aerial surveys for Moose (*Alces americanus*) and Elk between January and March throughout the presumed Elk range.

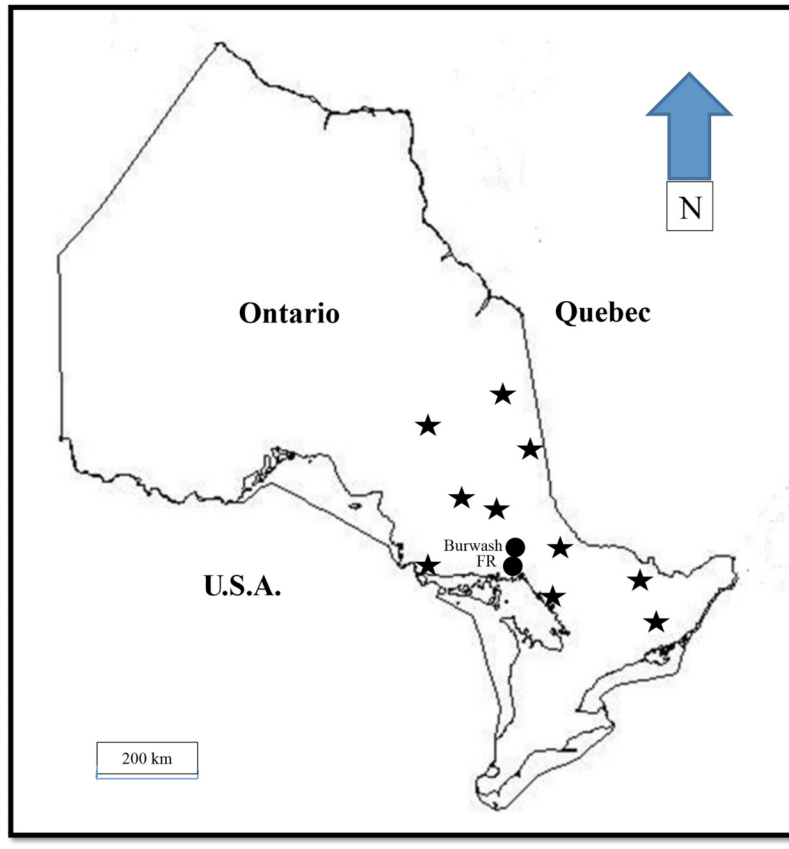

FIGURE 2. Reported presence of free-ranging Elk (*Cervus canadensis*) in 10 Ontario Ministry of Natural Resources administrative districts during 1955. Note: stars = free-ranging Elk, circles = Burwash/French River (FR) remnant Elk range. Seven other surveyed districts reported no Elk. Source: Lumsden (1955).

TABLE 1. Reported status of Elk (*Cervus canadensis*) in 10 administrative districts* of Ontario in 1955.

Administrative district	Estimated no. Elk present	Estimated no. Elk/km²	No. legally harvested Elk (1954)
Kapuskasing	few	0.06	0
Chapleau	few	0.06	0
Cochrane	27	0.10	0
Swastika	few	0.10	2
Sault Ste. Marie	18	0.06	0
Sudbury	100–150	0.10	11
North Bay	15	0.06	0
Parry Sound	few	0.06	0
Lindsay	45	0.10	10
Pembroke	few	0.06	0
Total	205–300		23
Mean		0.08	

Source: Lumsden (1955).
*Seven other surveyed districts reported no elk.

During this 18-year period, 203 Elk were observed in groups ranging from 2 to 22 (Table 2). Ranta (1979) studied range and habitat relations of the Elk near Sudbury by following tracks and conducting systematic aerial surveys and reported a mean group size of 3.5 (± 1.2 SD; Ranta 1979, 1981). He observed 43 groups and recognized at least 29 different individuals (4 adult bulls, 10 adult cows, 9 calves, and 6 yearling cows or bulls) and estimated the bull:cow:calf ratio at 1:4:2. Although a management plan for the remnant population was proposed in 1975, it was never adopted (Love 1975).

One year after abolition of legal Elk hunting in Ontario in 1980, 43 Elk were detected during 5 fixed-wing aircraft flights in the Sudbury area (Ranta 1981; Table 2). In March 1984, ground and fixed-wing aerial surveys estimated the total Elk population in the Sudbury area at 50 animals: 40 in the French River range and 10 in the Burwash range (Bennet and Echle 1984). A fixed-wing aircraft survey conducted in winter 1985 reported 39 free-ranging Elk in the French River area and only 1 Elk in the Burwash area (Haarmeyer 1985; Table 2). Sporadic aerial and ground surveys by the OMNRF during the late 1980s continued to report Elk sign and sightings in the Sudbury area; however, no reliable population estimates were produced (Table 2). Although sporadic unconfirmed sightings of Elk were reported by loggers and truck drivers in the Chapleau area up to the 1990s (G. Haarmeyer, personal communication), the persistence of Elk in the Chapleau area after the 1990s is suspect.

Historical review also revealed several causes of mortality of Elk, in addition to agricultural-related and legal harvest, that likely contributed to their observed low abundance from the 1970s to the 1990s. Several train accidents involving free-ranging Elk in the Bur-

TABLE 2. Results of Elk (*Cervus canadensis*) aerial surveys in the Sudbury District, Ontario, 1971–1989.

Year	Burwash sightings	French River sightings	Largest no. of Elk seen per flight (no. flights)	Area surveyed, km²	Total no. of Elk seen (population estimate)	Source*
1971	n/a	n/a	n/a (6)	n/a	22 (n/a)	Anonymous (1971)
1976	n/a	n/a	11 (14)	1536	14 (50)	Anonymous (1976)
1977	7	n/a	7 (1)	n/a	7 (about 100)	Haarmeyer (1977)
1981	5	38	22 (5)	400	43 (> 29)	Ranta (1981)
1984	n/a	32	17 (4)	300	32 (50)	Bennett and Echle (1984)
1985	1	39	15 (3)	1000	40 (< 50)	Haarmeyer (1985)
1988	n/a	9	9 (1)	n/a	9 (n/a)	Gross (1988)
1989	10	23	23 (3)			
			3 bulls, 8 cows, 12 unsexed	1000	33 (50)	Hamr, direct observation
Mean	5.3	28.2	11.6 (5.2)	847.2	25.2 (53.3)	

Note: n/a = not available.
*Ontario government documents from the 1970s and 1980s contained no explanation of how authors estimated total Elk population from the number of animals seen/minimum known alive. As no systematic survey method was used, and there were no marked animals in the populations, the estimates were "educated guesses." However, the 1980s estimates correspond closely to the mark-and-resight survey results obtained during the 1990s (Table 3).

wash area were reported during the 1950s and 1960s by train engineers, and drowned Elk were sporadically found throughout the 1970s, 1980s, and 1990s in the French River (E. Chevrette, R. Desrochers, P. Schennach, personal communication). In the early 1970s, the annual Elk harvest in the Sudbury area was 6–12 animals from a 640-km^2 area (Cheley 1974; Love 1975).

Several drowned Elk (2 in the French River and 7 in the Wanapitei River) were reported during the winter of 1973 (Love 1975). In addition, in the fall of 1973, 6 free-ranging Elk died in the Burwash range (5 harvested, 1 roadkill) and 2 were shot by hunters in the French River area (Cheley 1974). Ranta (1979) recorded 4 Elk shot in 1976, whereas in 1977, hunters saw 5–8 Elk and harvested 2. The Crombie Bay Hunt Club located in the French River area harvested 3 and observed 10 Elk between 1962 and 1977, and most kills were likely accidental while hunters were seeking White-tailed Deer (*Odocoileus virginianus*). Annual losses to poaching were estimated to be small and confined primarily to the vicinity of the previously (1975) abandoned Burwash Industrial Farm (Ranta 1979).

An unknown number of free-ranging Elk shot in the 1950s and 1960s tested negative for bovine tuberculosis, Brucellosis, and Giant Liver Fluke (Kingscote 1955). Ranta (1979) also found no evidence of Giant Liver Fluke in the livers of 6 Elk shot between 1975 and 1978 and no Meningeal Worm (*Parelaphostrongylus tenuis*) larvae in 14 fecal samples. One confirmed and 1 suspected Gray Wolf (*Canis lupus*) kill were reported during the late 1970s and it was suspected that American Black Bears (*Ursus americanus*) also killed newborn Elk calves (Ranta 1979). The chief natural cause of mortality (up to 15% of the estimated population in some years) during the 1970s appears to have been drowning through river ice in both the Burwash and French river areas (Cheley 1974; Ranta 1979). No mortality information was available for the 1980s.

In the 1990s, the remnant Burwash–French River Elk population occupied 2 distinct ranges located 25–30 km apart and was estimated at 36–55 animals by Brown (1998; Table 3). Further research using radiotelemetry confirmed drowning through ice (4 of 8 collared Elk deaths), mortality of calves during winter (3 deaths), and accidents with trains (1 death) as the main mortality factors (Jost 1997; Brown 1998; Jost *et al*. 1999). Predation by American Black Bears on newborn Elk calves was confirmed by Zuchliski (1995).

A recent provincial Elk restoration project, conducted from 1998 to 2001, saw 443 Elk from Elk Island National Park, Alberta, introduced at 4 locations in central Ontario: Lake of the Woods, Lake Huron North Shore, Nipissing-French River, Bancroft-North Hastings (Rosatte *et al*. 2007). By 2012, the provincial Elk population was estimated at 800-1000 animals (Rosatte 2013).

TABLE 3. Herd composition and Lincoln-Peterson mark–resight estimates for the Burwash and French River Elk (*Cervus canadensis*) herds obtained from systematic helicopter surveys during the winters of 1993–1997.

Year	Sightings (no. flights)		Minimum no. Elk known alive (both areas)	Calf:cow: bull ratio (both areas)	No. marked Elk present	Total population estimate ± SD
	Burwash	French River				
1994	27 (2.0)	14 (1.0)	24.0	1 : 1.9 : 0.3	0.0	n/a
1995	46 (4.0)	33 (2.0)	37.0	1 : 3.3 : 1.2	6.0	36.0 ± 5.5
1996	61 (5.0)	63 (5.0)	39.0	1 : 2.1 : 0.3	11.0	54.9 ± 9.5
1997	21 (2.0)	24 (2.0)	25.0	1 : 1.8 : 1.2	9.0	43.5 ± 7.1
Means	39 (3.0); 13/flight	34 (2.5); 14/flight	31.3	1 : 2.3 : 0.8	8.7	44.8 ± 7.4

Note: SD = standard deviation.
Sources: Lancia *et al.* (1996); Jost (1997); Brown (1998).

Discussion

Historical documents suggest that the initial Elk restoration efforts of the 1930s and 1940s were well on their way to re-establishing Elk in Ontario, until concerns over Giant Liver Fluke infestation prompted a province-wide Elk extermination campaign by the OMNRF, which was recommended by the Ontario Veterinary College in the early 1950s (Kingscote 1950, 1955). The official estimates of the Elk population of Ontario remained at 100–150 animals from the mid-1950s to the 1980s (Haarmeyer 1977). However, we were not able to find any empirical evidence supporting these numbers. As such, we suggest that the 30-year (1950–1979) Elk extermination campaign was largely successful and that consistent overestimation by the OMNRF was responsible for the view that Elk numbers in Ontario declined rapidly during the 1980s and early 1990s, when systematic aerial surveys were implemented. This is evident from the similar results of aerial Elk population surveys obtained in the 1970s (Haarmeyer 1977; Ranta 1981; Table 2) and those 20 years later. A density of only about 0.03 Elk/km^2 could be deduced from the early surveys. Detailed survey information (locations, numbers, sex, and age) was not available for most of the early surveys, but it was evident that the entire Elk range, estimated at about 1200 km^2 during the 1990s (Brown 1998), was covered by some flights (1976, 1985, and 1989). The total number of Elk

spotted during these surveys varied from 14 to 40 and suggested a minimum of 30–40 Elk present across the entire range during the 1980s.

The reason for fewer reported Elk sightings at Burwash than at the French River site was likely lower visibility of Elk because of greater conifer forest coverage at the former site than on the sparsely treed Georgian Bay shoreline at the French River delta. Also, most likely as an anti-predator strategy, Elk in the French River delta tended to concentrate on small islands surrounded by fast-flowing, open water during the winter, which made them easier to spot from aircraft (J. Hamr, personal observation). Although all of the aerial surveys in the 1980s and 1990s were conducted from low and slow-flying helicopters, Elk often remained bedded or standing in the shelter of conifers, which made their detection difficult. Consequently, the aerial survey results should be considered as potential gross underestimates of the true population size. McIntosh *et al.* (2007) developed a "sightability" model based on radio-collared animals known to be in the area. However, the model could be implemented only after the introduction of new Elk from Alberta (1998–2001).

The Giant Liver Fluke, which originated in North America, naturally infects cervids and bovids (Kingscote 1950; Foreyt and Todd 1976). Three wild North American cervids contribute significantly to the persistence and spread of the fluke as definitive hosts: White-tailed Deer, Elk, and Caribou (*Rangifer tarandus*; Pybus 2001). Historically, the only indigenous North American primary definitive host of this fluke is White-tailed Deer, as both Elk and Caribou are of Eurasian origin and entered North America across the Bering land bridge during the Pleistocene. Elk and Caribou most likely gradually acquired the parasite as they spread over the continent and their ranges overlapped with endemic White-tailed Deer in some parts of North America (Pybus 2001). Because White-tailed Deer historically occupied the eastern half of North America, it is most likely that the Giant Liver Fluke was present in Ontario well before the reintroduction of Elk there in the 1930s. The presumption by Kingscote (1950) that the parasite was introduced into Ontario by reintroduced Elk from western Canada was almost assuredly erroneous. Epidemiology of the Giant Liver Fluke and other endoparasites spread by snails as intermediate hosts indicates that infestations become more pronounced with increasing densities of ungulates (Foreyt and Todd 1976). Housing large numbers of Elk in breeding enclosures at several sites in central Ontario in the 1930s and 1940s likely created ideal propagation conditions for these parasites. As soon as Elk were released into the wild and dispersed over the landscape, Giant Liver Flukes could no longer be found in animals harvested during the 1950s, 1960s, and 1970s (Kingscote 1955; Ranta 1979). The decision to embark on a province-wide Elk extermination program in 1950 was, thus, bound to fail in its objective to eliminate the Giant Liver Fluke from the province, and, in hindsight, was a questionable measure to manage the prevalence of this parasite in the province's ungulate community.

The 3-decades-long extermination attempt nearly succeeded in eliminating all the formerly reintroduced Elk from Ontario. The numbers of dead animals (harvested and accidentally killed) reported in the Sudbury area during the 1970s (Cheley 1974) represented a minimum known annual mortality of about 30%, out of an estimated population of 50–60 Elk. In 1973, hunting was responsible for 41% of the reported annual population losses (Cheley 1974). Collisions with trains, drowning through ice, and predation also contributed to population reduction. The estimated annual removal of more than a third of a small Elk population clearly would have been unsustainable in the long term (Taber *et al.* 2002). The 1980 moratorium on Elk hunting probably stopped, or slowed, the population decline, but, by this time, the small population was more susceptible to natural (i.e., climate) and anthropogenic (i.e., train kill) stochastic events, as well as low levels of predation and apparent competition, which likely caused the population to stagnate. Combined with inbreeding depression in the long term, the situation would likely have led to eventual extinction (Pulliam 1988). The renewed restoration efforts from 1998 to 2001 augmented numbers and genetic diversity of the remnant population of reintroduced Elk in Ontario, thus bolstering its viability (Rosatte *et al.* 2007).

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