

A review of the historical and current status of American Beaver (*Castor canadensis*) on Prince Edward Island, Canada

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Abstract

Evidence supporting the native status of American Beaver (*Castor canadensis*) on Prince Edward Island (PEI) before European contact in 1534 has yet to be established; however, the postglacial and archaeological records have not previously been reviewed in this context. We demonstrate the coincidence of a land bridge between the mainland and PEI and the occurrence of beavers in the region dating between 9500 and 5000 BP (before present, with present defined as 1950). We provide an archaeological record of 14 beaver incisors in six locations, deposited between 500 and 1650 AD and also show that beavers could swim to PEI. Based on this evidence, we conclude that beavers were native to the province. The current population, originating via reintroductions from New Brunswick, has populated much of the available habitat and engendered considerable controversy.

Key words: American Beaver; *Castor canadensis*; status; dispersal; Prince Edward Island; history; archaeology

Introduction

The historical status of mammals of Prince Edward Island (PEI) during the early years of European contact and settlement has been extensively researched by Sobey (2007). While admitting that American Beaver (*Castor canadensis*) may have been extirpated from PEI before 1700, he believed that the evidence supporting native status for this species in the province was remarkably weak. In a more recent review of mammal status in the region, the beaver has been described as extirpated from PEI and reintroduced (Forbes *et al.* 2010), but without supporting details. With regard to the existing population, Cameron (1958) noted the reintroduction of beavers to PEI from Algonquin Park, Ontario, in 1908–1910 and Dibblee (1994) found contemporary records of importation by private individuals; however, both efforts were unsuccessful because of unregulated trapping. The current PEI population originated via reintroductions from New Brunswick (NB) after 1940 (Cameron 1958; Dibblee 1994).

It is perhaps the uncertainty about beaver status on PEI that led the Atlantic Salmon Federation to label the beaver a non-native species and to call for its removal from several eastern PEI rivers as part of a conservation strategy for Atlantic Salmon (*Salmo salar*; Guignon 2009). Similarly, Cairns *et al.* (2010) suggested that the beaver's effect on Atlantic Salmon associated with river damming could be classified as (negatively) anthropogenic, rather than natural. However, management decisions about beavers on PEI should be based on a comprehensive understanding of the historical and current status of the species.

When assessing mammal colonization of islands, Mazza *et al.* (2013) suggest considering palaeontological, climate and sea-level evidence, characteristics and behaviour of the species, the historical record, and the primary source of information, the fossil record. To determine whether the beaver is an alien species on PEI or a native mammal that was extirpated and reintroduced, we reassess the historical evidence from Sobey (2007) and others, as well as

the post-glaciation history and geography of the province, and archaeological materials. Finally, we present the current status of the beaver in the province.

Methods

We reviewed both historical and scientific literature for references to beavers and beaver habitat on PEI and elsewhere. Our search included local history documents, scientific literature, government reports, archaeological reports, and collections at the Canadian Museum of History and Parks Canada (Halifax). Sobey's (2002, 2006a,b, 2007) wildlife history research covered much of the historical account.

Archaeological field research was undertaken by D.L.K. from 1980 to 2008 and by H.E.K from 2009 to 2018. Dating of beaver teeth from these archaeological studies was based on the site characteristics, cultural associations, and, more specifically, radiocarbon dating of associated charcoal in shell middens at South Lake and Greenwich. An incisor from MacMillan's Point was radiocarbon dated through accelerator mass spectrometry at Beta Analytic Testing Laboratory (Miami, Florida, USA). Dr. Frances Stewart, a peer-recognized leading zooarchaeologist for eastern Canada with an extensive reference collection of skeletons, determined the species identity of bones at George Island.

The distance beavers may have swum or rafted to get to islands was calculated using Google Earth (Keyhole, Inc., Mountain View, California, USA). Where island hopping was possible, the longest open-water swim using islands was calculated, as well as the straight-line distance through water.

Monitoring of beaver populations from 1972 to 2007 was conducted by R.L.D. while employed by the PEI government. Areas of beaver-influenced wetlands were delineated and measured on aerial photos from 1990, 2000, and 2010 captured at a 1:17 500 scale (PEICLUI 2010). Beaver dams and the triangular flooded areas behind them are readily recognized at this scale. Wetland sizes ranged from 0.1 to 240 ha.

In 1990 and 2000, coverage of PEI included the use of infrared photography. Both active and inactive beaver dams were delineated on the 1990 photographs. Each photo was overlain with a same-scale transparent map showing roads and streams. These lines were then transferred to the map and digitized to create the first vector-based PEI wetland inventory. In 2000, the analog film was then scanned and the resultant imagery used to create complete orthorectified imagery of PEI. Using the orthomaps and existing digital 1990 inventory, the 2000 PEI wetland inventory, including beaver dams, was incorporated into a province-wide digital land use inventory.

In 2010, digital imagery was acquired in both col-

our and colour-infrared with 40-cm resolution. Soft-copy photogrammetry was used to generate the PEI 2010 Land Use Inventory in which the same interpretation parameters were applied.

Results

*Historical evidence of *Castor canadensis**

Cameron (1958: 45) listed the beaver as a native mammal in PEI, taking as proof "the presence of beaver tooth marks on sticks found in peat bogs", but presented no further details. Sobey (2007) acknowledged no firsthand account of beavers in the PEI historical record since French settlement in 1721. There are two early French reports. In 1721, Denys de La Ronde stated that there were no beavers in Ile Saint-Jean (as it was then named; Sobey 2007). However, footnoted evidence reveals that Père René-Charles Breslay, who lived in Ile Saint-Jean from 1721 to 1723, took eight beaver skins to France (Sobey 2006a). Beavers were included in an 1802 shipment of pelts and an 1808 list of pelt prices from PEI. It is notable that credible mammal listers (e.g., Johnston 1822; MacGregor 1828) in the early 1800s failed to include the beaver for the island. Peter Sinott emigrated to PEI in 1821 and stated in 1876 that the beaver had been present when he was younger (Sobey 2006b), whereas, in the late 19th century, the opinion of a permanent resident, Sutherland (1861), and the visiting Rowan (1876) indicated an absence of beavers (Sobey 2007). A Summerside Journal article by Marks (1900) related the words of an old gentleman that the last beaver he saw had been killed 40 years earlier, ca. 1860, and the 31 October 1916 Charlottetown Guardian reported that the late Professor Caven of Prince of Wales College, Charlottetown, had found traces of beaver dams on the Dunk River (Dibblee 1994). Naturalist Francis Bain (1890) reiterated that remains of beaver dams could still be seen.

Glacial and post-glacial history, geography, and dispersal

The current PEI mammalian fauna arrived after glaciers retreated about 11 000 BP (before present, with present defined as 1950; Shaw *et al.* 2006). Although overland access to PEI was necessary for some species and facilitated by a land connection that was in place from 9500 to 5000 years BP across what is now Northumberland Strait (Kranck 1972; Shaw *et al.* 2002), it is unlikely that the now-flooded strait is a barrier to beaver dispersal (Table 1). On PEI, several specimens of River Otter (*Lontra canadensis*), previously regarded as extirpated, have been collected since 2016 (G. Gregory pers. comm. 20 June 2019) including a juvenile that was whelped on PEI, although at least some have swum or travelled on ice across 13+ km of marine waters, identical to distan-

TABLE 1. Unassisted occupation of islands by American Beaver (*Castor canadensis*) and the shortest straight-line distances by water, measured using Google Earth.

Island and jurisdiction	Water body	Distance to mainland or island (km)	Salinity	Reference
Nueva Island, Chile	South of Beagle Channel	6.5–11.5*	Marine	Anderson <i>et al.</i> 2009
Lennox Island, Chile	South of Beagle Channel	6	Marine	Anderson <i>et al.</i> 2009
Admiralty Island, Alaska	Stephens Channel	3.5	Marine	MacDonald and Cook 1996
Isle Royale, Michigan	Lake Superior	23	Fresh	Mech 1966
Grand Manan Island, NB	Bay of Fundy	11	Marine	Ingersoll and Gorham 1978
Newfoundland, NL	Strait of Belle Isle or other route	17+	Marine	Cameron 1958
Cape Breton Island, NS	Strait of Canso	1	Marine	Cameron 1958
Prince Edward Island	Northumberland Strait	13	Marine	Cameron 1958; this study
George Island, PEI	Malpeque Bay	1	Marine	This study

Note: NL = Newfoundland and Labrador, NB = New Brunswick, NS = Nova Scotia, PEI = Prince Edward Island.

*With possible island hopping, the longest open-water swim using islands is shown as well as the shortest possible distance by water.

ces regularly swum by River Otters in marine waters of Alaska (Blundell *et al.* 2002). The beaver and the otter were regarded as equally effective dispersers in colonizing insular Newfoundland and Labrador (Dodds 1983), and possibly not via the narrow but turbulent Strait of Belle Isle (Cameron 1958).

Beavers from Minnesota, USA, have dispersed to Isle Royale, Michigan, USA, at least twice across 23 km of freshwater in recent times (Mech 1966), far exceeding the 13 km that a beaver would need to swim to PEI. American Beavers commonly occupy inshore islands in Canada (Naughton 2012), and a rejuvenated beaver population in Newfoundland arrived at several smaller offshore islands in the mid-1900s (Dodds 1983). R.C. has twice seen a beaver swimming along the shore in coastal areas of PEI, as well as a beaver dam constructed across a coastal salt marsh. Beavers are well adapted to an aquatic environment, and they have several features that also protect them in marine waters. They breathe only through the nose and can prevent accidental swallowing of water. When they are underwater, flaps close off their nose and ears and a membrane protects the eyes (Naughton 2012). They are also buoyant and predisposed to enter the water, characteristics that enable colonization of islands (Mazza *et al.* 2013).

On Cape Breton Island, Nova Scotia (NS), beaver presence was recorded by 9500 years BP (Gorham *et al.* 2007); thus, they were present in the Maritimes during the 4000-year period when the extensive land connection between PEI and NB and NS was in place (Kranck 1972; Shaw *et al.* 2002).

Archaeological record of beavers on Prince Edward Island

Sobey (2007) acknowledged the beaver incisor excavated at South Lake by Keenlyside (1982, 1983) but did not look for other records. The archaeological record for the Maritimes has been evaluated

(Murphy and Black 1996). Because of the great influence of coastal erosion and relative rise in sea level, many possible sites of older coastal encampments of Indigenous peoples have long since disappeared under water. As well, pre-contact shell middens were systematically spread on the land by PEI farmers to counteract soil acidity and, thus, their contents were plundered and/or dispersed (Gesner 1846).

There are 14 archaeological collections of beaver material from six sites, all with deposition dates after the postglacial flooding of Northumberland Strait (Table 2). Incisors are the most easily identified beaver remains and, thus, are often noted immediately when found, as at the Sutherland site, Greenwich (CcCp-7; Keenlyside 2002).

Faunal remains of beaver are currently known from four prominent archaeological sites on PEI (Figure 1). The MacDonald site (CcCm-12), located in South Lake, Kings County (Keenlyside 1982, 1983), consisted of two cultural components: a probable Acadian early-mid 18th century historical occupation, and a second underlying late Maritime Woodland occupation dating to about 600–900 AD. Associated with the earlier indigenous occupation was a cut beaver incisor section that appears to have been used as a bit for a cutting or incising implement. No post-cranial elements were identified in the site faunal sample.

The finds from the Sutherland site at Greenwich (CcCp-7) located on the north shore of St. Peters Bay, Kings County, now part of Prince Edward Island National Park (PEINP; Keenlyside 2002), included a modified incisor recovered from a test pit in a shell midden deposit, one of several found. The site revealed extensive habitation covering 2–3 ha and dates from 800 to 900 AD, a similar period as at the MacDonald site.

The split incisors found at Rustico (Robinson) Island in PEINP were used as a knife by Indigenous

TABLE 2. Known remains of American Beaver (*Castor canadensis*) incisors deposited 500–1650 AD and obtained from archaeological excavations and opportunistic collecting on Prince Edward Island during 1980–2017.

Sample	Location collected	Collection date	Collector*	Approximate years deposited, AD \pm SD (range)	Normalized age, [†] years BP/1950 \pm SD	Voucher	Reference documents	Comments
Piece of incisor	MacDonald site, South Lake (CcCm-12)	Several seasons 1980s	DLK	900 \pm 100 (800–1000)	1480 \pm 160	CMC CcCm-12: 506	Keenlyside 1982, 1983; Morlan n.d.	From shell midden
Piece of incisor	MacDonald site, South Lake (CcCm-12)	1980	DLK	900 \pm 100 (800–1000)	1480 \pm 160	CMC CcCm-12: 343	Keenlyside 1982	23–28 cm deep
Incisor	Sutherland site, Greenwich, PEI National Park (CcCp-7)	1994–1995	DLK	750 \pm 250 (500–1000)	1200 \pm 250	CMC CcCp-7: 1481	Keenlyside 2002	In bank
Two incisor fragments	Sutherland site, Greenwich, PEI National Park (CcCp-7)	1985	DLK	1100 \pm 300 (800–1400)	1280 \pm 100	CMC CcCp-7: 481, 482	Keenlyside 2002; Morlan n.d.	Eroding bank with shell midden; dated by ceramic inclusions; 1.8 cm cut; 1.9 cm fractured and cut (one side only)
Lower incisor	Sutherland site, Greenwich, PEI National Park (CcCp-7)	2000–2001	DLK	1100 \pm 300 (800–1400)	1280 \pm 100	CMC CcCp-7: 1928	Keenlyside 2002; Morlan n.d.; Stewart 2002	Split, end cut and smoothed; in plough zone
Enamel fragment of incisor and fragment of incisor	Sutherland site, Greenwich, PEI National Park (CcCp-7)	2000–2001	DLK	1100 \pm 300 (800–1400)	1280 \pm 100	CMC CcCp-7: 2209, 2245	Keenlyside 2002; Morlan n.d.; Stewart 2002	34–43 cm deep
One upper and one lower incisor	Robinsons Island, PEI National Park (CcCt-1)	1987–1988	BWF	1480 \pm 50 (1430–1530)	470 \pm 50	7F2J1-800; 7F11D5-801 [‡]	Leonard 1989; Wallace Ferguson 1989	Split, ground, and polished for use as a knife
Lower incisor	MacMillan's Point, Covehead Bay	1991	WJ	1560 \pm 90 (1470–1650)	320 \pm 30	Private collection	Kristmanson pers. comm.	Calcined tooth in a fire pit, plowed field; buried about 30 cm in soil

TABLE 2. Continued.

Sample	Location collected	Collection date	Collector*	Approximate years deposited, AD \pm SD (range)	Normalized age, [†] years BP/1950 \pm SD	Voucher	Reference documents	Comments
Lower incisor	George Island, Malpeque Bay (CdDw-5)	2006	HEK	Undated (N/A)	Unknown	To be deposited PEIMHF	Kristmanson 2007, 2009	In woodland opening; no evidence of modification or use-wear
Incisor fragment	George Island, Malpeque Bay (CdDw-5)	2017	HEK	Undated (N/A)	Unknown	To be deposited PEIMHF	Kristmanson 2018	From <i>in situ</i> deposits, pre-contact to historic shell midden site, Pitawelkek
Upper incisor	Darnley Basin, Malpeque (CdCw-9)	2017	HEK	Undated (N/A)	N/A	To be deposited PEIMHF	Kristmanson unpubl. data	Surface collected from pre-contact to 18th century site

Note: CMC = Canadian Museum of History, PEIMHF = Prince Edward Island Museum and Heritage Foundation (2 Kent Street, Charlottetown, Prince Edward Island C1A 1M6), SD = standard deviation.

*Collectors: BWF = Birgitta Wallace Ferguson, DLK = David Keenlyside, HEK = Helen Kristmanson, WJ = Wayne Jordan.

[†]Age of the site based on radiocarbon dating.

[‡]Parks Canada Collections and Conservation Facility, 50 Neptune Crescent, Dartmouth, Nova Scotia.

people (Leonard 1989; Wallace Ferguson 1989), but not all teeth were modified. For instance, the complete incisor at a George Island (Pitawelkek) site, where exploration continues, showed no modifications of any kind (Kristmanson 2007, 2009), nor did the MacMillan Point specimen. The latter had been found in an old fire pit in a plowed field about 6 km from the Rustico Island site (H.E.K. unpubl. data).

A rib fragment from an immature beaver, an undated phalanx, and incisor fragments were recovered from excavations at the Pitawelkek site on George Island. These are in general association with radiocarbon dates of ca. 700–800 AD through to the recent historical period. For now, the age of the occupation has been cautiously extended back to at least 0 AD based on the collection of diagnostic artifacts at the Pitawelkek site and other locations on George Island (Kristmanson 2019). The Malpeque site is a cultivated field where it is believed that shell middens were spread on the land (Gesner 1846).

Current status of beaver

The history of beaver reintroductions was investigated by Dibblee (1994). Following the earliest importations from Ontario in 1908 and from an unconfirmed source in 1912, the population rose to an estimated 500 beavers over several river systems. However, high fur prices in the 1920s and unregulated trapping resulted in the animals' disappearance. No beaver dams were detected on 1935 aerial photos. In the late 1940s, a migratory birds protection officer, Spurgeon Jenkins, obtained beavers from NB biologist Bruce Wright, and introduced them into PEI. Thus, Dibblee concluded that all beavers now present in PEI originated from NB.

Beavers were initially introduced east of Charlottetown, but by 1973 the population had expanded. Between 1973 and 1979, government personnel removed 32 beavers from eastern PEI where they were considered to be a nuisance and released them into watercourses of Prince County, where no beavers were present. In January 1981, the first short open season for trapping beavers took place in Prince County, when 20 beaver "problems", such as blocked culverts and flooded driveways indicated an expanded population (Dibblee and Curley 1980). By 2000, the island was well populated with beavers, although few were recorded in the hilly central portion of the island with its flashy streams (a flashy stream is one that rapidly collects flows from the steep slopes of its watershed basin and produces flood peaks soon after the rain but the flow quickly subsides after the rainfall ends). This habitat is less suitable for beavers (Novak 1987), and most are situated to the east and west on rivers with low gradients (Figure 1).

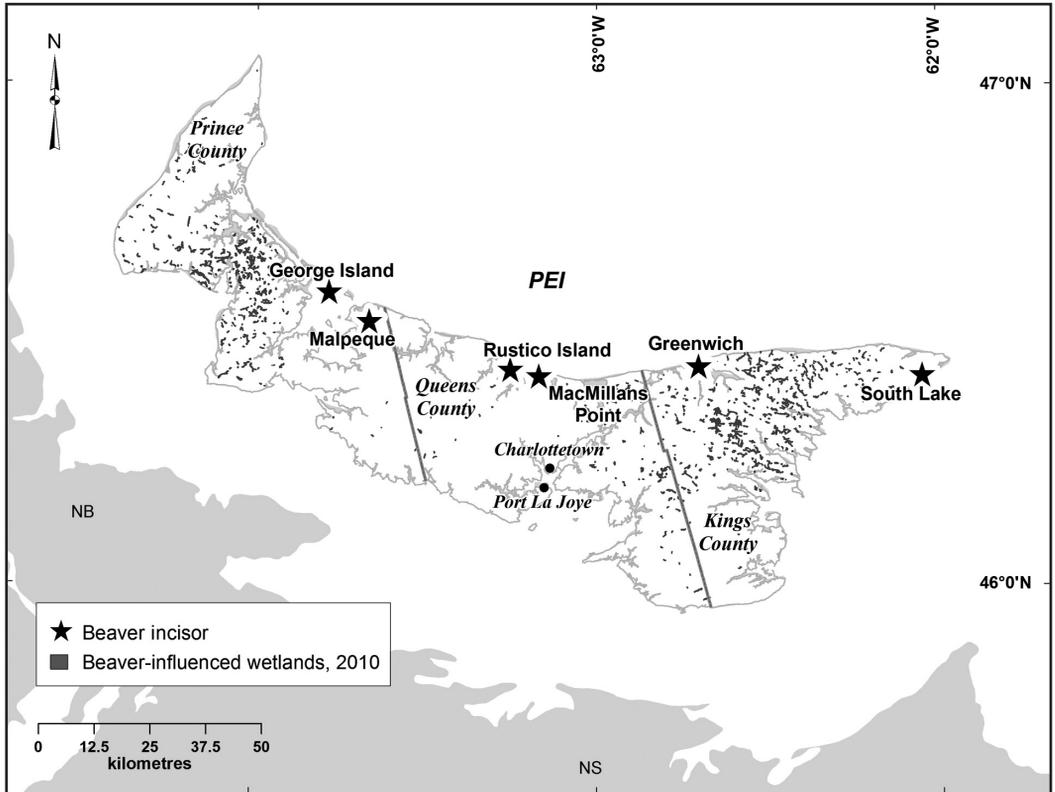


FIGURE 1. Locations of intact or partial American Beaver (*Castor canadensis*) incisors and other geographic points of interest, Prince Edward Island, Canada, plus active and inactive beaver-influenced wetlands delineated in the Prince Edward Island Corporate Land Use Inventory (PEICLUI 2010).

According to data maintained by the provincial fish and wildlife agency, from 1975 to 2015, an average of 465 beavers (one per 11 km²) were trapped each year, varying from 91 in 1975 to 917 in 2011. Between 1972 and 2002, aerial surveys of index watersheds totalling 1363 km² of predominantly forested habitats were conducted by the province. Results indicate a peak of 276 active colonies in 1993 and 160 in 2002. The total wetland area of both active and inactive beaver flowages in PEI was calculated from aerial photography as 2233 ha in 1990, 3395 ha in 2000, and 5304 ha in 2010.

Beavers dams are often perceived as detrimental to salmonid populations (Kemp *et al.* 2012), and watershed enhancement groups express concerns regarding Brook Trout (*Salvelinus fontinalis*) and Atlantic Salmon migration. Beaver numbers fluctuate inversely with fur prices and are a continuing issue for wildlife managers dealing with complaints. Many of the 24 community-based watershed groups have considered beavers in their long-term management plans, as encouraged by the PEI Beaver Management Policy (Anonymous 2011). In practice, plans often

direct removal of beavers from the main stem of a river. A local watershed group continues to remove all beavers from northeastern rivers on PEI to support spawning of a unique population of Atlantic Salmon (Moore *et al.* 2014).

Discussion

Previous records of beavers

In evaluating the historical evidence of PEI mammals, Sobey (2007) gave credence to first-hand accounts or records as verifying or disputing the presence of various species. The acceptance of claims that beavers were not present in the province led him to explain away a considerable body of evidence that beavers may have been present. Two (Sutherland 1861 and Rowan 1876) of three mammal recorders who stated that beavers were not present produced their reports in the last half of the 19th century when the few beaver records may have been of new arrivals from the mainland after a long period of absence. Rowan (1876), a travel writer who merely visited the province, also later stated in the same publication that beavers were extirpated from PEI.

These writings likely do not meet the standard of a first-hand account, nor, we assert, would the observations by Denys de La Ronde, a naval officer, who spent only 13 months in PEI beginning in 1721, including time to travel to Louisbourg, Cape Breton Island (Sobey 2002). Although Denys de La Ronde visited all active PEI harbours, the French population in 1721 was perhaps 200 (Harvey 1926). Local knowledge of wildlife would be cursory and cleared land scarce. Denys de La Ronde could not have spoken from personal knowledge of PEI beaver habitats, which would consist mainly of forested river systems extending to the coast in a land mass exceeding 5000 km². He may have obtained information from Mi'kmaq traders at Port la Joye, the seat of French government in Ile Saint-Jean, or from fishermen, but he did not acknowledge the source of his information. Harvey (1926) also calls into question his veracity as a reliable reporter.

Novak (1987) reasoned, based on food availability, that beavers likely existed at lower densities in mature forests of the 1500s and the 1600s compared with the high beaver populations in the food-rich early successional riparian forests of today. Beavers prefer young saplings as food and only cut large trees further away from water when saplings are depleted (Gallant *et al.* 2004). PEI has short river systems and human travel in the pre-settlement mature forests dominated by American Beech (*Fagus grandifolia* Ehrhart) was relatively easy, with some exceptions (Sobey 2002). Thus, we speculate that beavers, present according to the archaeological record, were relatively accessible. They live in families of two adults and potentially three or four kits and two or three yearlings (mean group size in central Ontario is 7.5; Novak 1987), and their lodges are easily identified and exploited.

Fur trading began in the Maritimes in the mid-1500s when Basque and French vessels began fishing for cod in the Gulf of St. Lawrence and exchanging goods with the Mi'kmaq (Ray 1987; Cook 1993; Whitehead 1993). Nicolas Denys had an exclusive license to enter into trade for fur and fish in the gulf dating from 1654, and PEI was included in his grant. A cod fisherman and now respected author, Denys (1672) recorded the presence of Basque ships in PEI waters and discussed how beaver pelts were obtained. The Mi'kmaq scared beavers from their lodges in winter, clubbed or harpooned them, taking all within the colony, and also took beavers during ice-free seasons by draining their dams and attacking them with spears and arrows. They met a strong economic demand for beaver pelts from Europeans, and extirpation in PEI in the 1600s or earlier is a possibility, as noted by Sobey (2007). A reinterpretation of Sobey's

information discarding Denys de La Ronde's opinion might also indicate that the beaver persisted into the 1800s. The decades of greatest beaver harvest in North America as a whole were 1700–1709 and 1790–1799 (Novak 1987; Obbard *et al.* 1987).

Archaeological record, glacial, and post-glacial history

Sobey's research (2007) does not take into account the archaeological record for PEI. In 1995, archaeological research on PEI constituted only 2% of published and unpublished primary studies in the region (Murphy and Black 1996). Studies are needed from inland freshwater sites where beavers might naturally be found.

Additional factors may also explain the lack of bones. According to religious custom assuring continuation of the beaver, bones from beavers that were consumed by Mi'kmaq were not thrown into the fire or river, nor fed to dogs, although practices vary in detail and by location (Denys 1672; Wallis and Wallis 1955; Robinson and Heller 2017). Bone material and metal goods are generally not preserved in the acidic soils of PEI except in acid-neutralizing shell middens (Murphy and Black 1996). Indigenous peoples consumed beavers, and because beaver incisors were often used as cutting tools, their remains are found in the common areas of preservation, kitchen middens.

Of the 14 records of beaver teeth presented here, not all have been dated, but dated specimens were deposited from about 500 AD to as late as 1650 AD. The teeth could have been imported to PEI as tools (Sobey 2007; M. Betts pers. comm. 12 June 2013) but we have also shown that beavers swim or raft to islands, sometimes far offshore. The simplest explanation for the presence of beaver teeth at PEI archaeological sites is that they are the remains of PEI beavers. As well, the rib bone of an immature beaver at a site that may be 2000 years old, suggests that beavers were breeding on PEI. Discounting this, one must find an explanation as to why beavers did not swim or raft to PEI, as they did to Newfoundland, or disperse to PEI when a land bridge was in place for 4000 years.

With postglacial warming temperatures, vegetation on the island changed rapidly from tundra (suitable for beavers; Aleksjuk 1970; Jung *et al.* 2016; Tape *et al.* 2018) to forest, a spruce (*Picea* sp.)–nonarboreal birch (*Betula* sp.) association between 10000 and 8000 years BP, followed by pines (*Pinus* sp.; Anderson 1980). The presence of beaver on Cape Breton Island 9500 years BP (Gorham *et al.* 2007) aligns well with the maximum connection of the PEI land mass to the mainland 9000 years BP, a continuous land mass lasting until 5000 years BP (Shaw *et al.* 2002). Beavers are also efficient dispersers (Leege 1968; Hodgdon 1978; Sun *et al.* 2000) and can swim

long distances. We cannot identify any impediments to beavers populating the non-island in early post-glacial times or any dramatic ecosystem changes that would preclude beavers colonizing PEI. A land bridge and the presence of beavers in the region might suggest that they inhabited PEI soon after deglaciation. The ability of beavers to swim or raft to islands is convincing evidence that they inhabited PEI prior to 1534. Archaeological evidence indicates the presence of beavers until at least 1650 AD.

Current status of beaver

The second-growth riparian forests of PEI provide suitable beaver habitat and the beaver has populated most of it. It is likely that human conflicts with beavers and their dams will persist as long as beavers flood transportation corridors and are viewed as negatively influencing the spawning success of salmonids.

Conclusion

It is quite credible that the beaver could have been extirpated from PEI in the roughly 200 years before French settlement in 1721. Extinction rates of mammals are orders of magnitude higher on islands than elsewhere and are often related to human predation in historical times (Loehle and Eschenbach 2012). Caribou (*Rangifer tarandus*), Canada Lynx (*Lynx canadensis*), North American Black Bear (*Ursus americanus*), River Otter, and American Marten (*Martes americana*) were all extirpated from PEI following European settlement (Sobey 2007). Although Caribou in Nova Scotia were extirpated by 1921 (Benson and Dodds 1977), none were reported after 1765 in PEI. Human exploitation was also responsible for the loss of Walrus (*Odobenus rosmarus*) from the Gulf of St. Lawrence beginning in the 1500s (McLeod *et al.* 2014), and Great Auk (*Pinguinus impennis*) became extinct in 1844, aided in part by their exploitation at Bird Rock in the Magdalen Islands, Quebec (Montevocchi and Kirk 1996).

Cameron (1958) contended the beaver was “exterminated” from PEI, and the data presented here support its status as native, at least since 500 AD and possibly as early as 9500 years BP. Evidence that might allow determining the point of extirpation is less clear, but it is almost certain that a beaver population was no longer present in PEI after 1860. It may well have been the first mammal extirpated from PEI, before 1700. Although the current beaver population is known to be derived from animals introduced from NB, it is also possible that some individual beavers have reached PEI via natural dispersal from NS or NB and could account for the late 19th century records from PEI. Future genetic studies may shed light on whether NS beavers have contributed to the current gene pool. In addition, and considering there are

no known endemic species in PEI because of its geologically recent land connection with the mainland, beavers sourced from NB are predicted to be similar genetically to the original PEI population. It may be possible to test this using more archaeological remains of beavers as they become available. Additional radiocarbon dating of beaver incisors from middens may also reveal new information. Finally, because beaver-chewed sticks were seen as an indication that beavers were native mammals (Cameron 1958), monitoring bogs that are being mined for peat might yield older beaver records.

Although the founders of the current population were introduced to support fur harvesting (Dibblee 1994), the population meets International Union for the Conservation of Nature guidelines as a reintroduction, being “the intentional movement and release of an organism inside its indigenous range from which it has disappeared” (IUCN/SSC 2013: 2). We suggest that the American Beavers now extant on PEI be regarded as a native population and that the provincial government apply the precautionary principle in the unlikely event that population decline threatens the species. The second-growth riparian forests of PEI provide suitable beaver habitat and the beaver has populated most of the island. It is likely that human conflicts with beavers and their dams will occur as long as beavers flood transportation corridors and are viewed as negatively influencing spawning success of salmonids.

Author Contributions

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