

Sustainability of Reindeer Herding in Alaska: 1900-1940

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## *I. Introduction*

In 1890 when travelling with Captain Michael A. Healy of the United States Revenue Cutter along the Alaskan coast, Sheldon Jackson, General Agent for Education in Alaska and the most senior American official in the Alaska Territory and a committed Presbyterian minister and missionary, observed what he perceived as deprivation and starvation among native peoples of the Bering Strait coast. Without a doubt food insecurity was a reality of aboriginal life. Weather conditions, changes in animal migration patterns, increased commercial whaling could have threatened native access to traditional food sources and Jackson's concerns over food insecurity in the region well founded. Yet, in the face of what was always a stark reality, aboriginal societies constructed social and cultural norms to attenuate the potentially life-threatening outcomes which would not be visible from a ship.<sup>1</sup>

At the same time, one must accept that Jackson's response to his perception of the situation was inspired. In visits to Siberia, Healy had observed native interaction with domesticated reindeer. In what is probably the first 'heifer international' program, Jackson and Healy arranged to import reindeer from Siberia to the Seward Peninsula as a source of food and to provide a "dependable source of cash income and employment" in rural Alaskan villages from the sale of hides, meat and antler velvet (Dillingham, 1999).

The establishment of the Alaska Reindeer Service by Jackson was one of the first attempts to provide low-income rural households with livestock to establish a consistent source of food and income. Based on this program, Canada developed the Canadian Reindeer Project to

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<sup>1</sup> Sharing or an ethic of generosity was universal, with gift-giving being a central component. Gifts received one year are expected to be returned in another allowing gift-giving to be conceived of as a form of saving for the giver and borrowing for the receiver. Such sharing minimized risk (Winterhalder). Social structures such as the potlatch of the Pacific Northwest were another redistributive mechanism between those who had more and those who had less, and such redistribution may also reduce conflict over the resource base (Johnson).

provide reindeer to Inupiat villages in the Canadian arctic in the 1920s. Similar to the Alaskan version of the program, the Canadian Reindeer Project was intended to ease food shortages (Stuhl, 2011).<sup>2</sup> More recently, programs such as World Vision, the International Humanity Foundation, Heifer International, and Maasai Association provide livestock to impoverished families in developing countries.<sup>3</sup>

The initial herd comprised the 16 animals that survived the winter in the Aleutian Islands, plus two fawns born there. These animals were transported to the newly established Teller Reindeer Service Station at Port Clarence-Cape Prince of Wales on the Seward Peninsula (Baiki.org, 2012). More reindeer were imported in subsequent years until the importation of reindeer ended in 1902, when Russia prohibited the sale of reindeer to Alaska. By this time, there were an estimated 5,148 reindeer on the Seward Peninsula (Stern et al., 1980). The herd size grew to an estimated 640,000 reindeer in Western Alaska (Willis 2006, 296) by the 1930s after which time the animal population collapsed. In 2010, the Alaska Department of Fish and Game stated that there were 18,000 reindeer in Alaska of which 12,000 were on the Seward Peninsula ([http://www.adfg.alaska.gov/index.cfm=wildlifeneews.view\\_article&articles\\_id=484](http://www.adfg.alaska.gov/index.cfm=wildlifeneews.view_article&articles_id=484)).

Reindeer herding is a way of life in much of the Arctic region from the Sami region in northern Scandinavia to the Inuit of Siberia for centuries, yet neither reindeer herding nor reindeer husbandry found a foothold in Alaska or the Canadian Arctic regions. Here we do not explore why native peoples in the North American Arctic did not pursue reindeer herding nor do

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<sup>2</sup> Unlike the Native Alaskans on the Seward Peninsula, however, reindeer were a perfect substitute for a traditional food source, wild caribou, which were traditionally hunted by Canadian First Nations. Although wild caribou are found in abundance in the Alaska tundra, they no longer migrated through the Seward Peninsula from the early 1800s until the mid-1900s (Schneider, Kielland, and Finstad, 2005).

<sup>3</sup> It is not known the extent to which these contemporary programs offer livestock to families that are already engaged in, or have the necessary training to care for provided animals. Alaskan and Canadian indigenous peoples have no cultural or historical basis for herding, which may have affected the outcomes of the program. The programs in Alaska and Canada may be unique in the fact that Sámi herders were imported along with reindeer to take Native apprentices and educate them in herding practices.

we ask about the impact of reindeer on native communities (see Massey, Carlos, Marein 2017a). In this paper, we assess the viability and sustainability of reindeer husbandry in Alaska in the first half of the twentieth century. In so doing, we ask a very basic question: what was the population of reindeer on the Seward Peninsula from the end of Russian imports until 1940? Despite assertive statements in the literature on the number of reindeer present in the first four decades, no one to date has explored the veracity of those numbers which form the basis of the history of reindeer in the region.

We begin with a short description of the history of Alaska, followed by discussion of the reindeer program introduced by Jackson. Using the number of reindeer imported from Siberia in conjunction with the population dynamics of reindeer, we present estimates for possible reindeer populations under differing mortality and fertility conditions. Our simulations show that the number quoted for the number of reindeer present in the 1930s is almost exactly our simulation of the population under very standard fertility, mortality and population density rates. This must surely be a basis for concern. We also use various climate and mortality events to simulate the level of collapse of the population suggested by the literature with little success. This exercise makes us very wary of the extant reindeer population figure. It also changes any assessment of the sustainability of reindeer herding on the Seward Peninsula.

## *II. Alaska and Its People*

The “discovery” of Alaska is credited to the Russian Navy crew of the *Saint Peter* in 1741 and its captain, Danish navigator, Vitus Bering, after whom the Strait is named. Of course predating the region’s discovery by Europeans, the Inupiat people had been living and migrating across the Arctic region for centuries. However, the purchase of black sea otter pelts during

Bering's and subsequent voyages laid the foundation for a commercial fur trade by the Russian American Company, giving "constructive control" over the fur trade to the Russian Empire (Utter, 2001). Although the Russian American Company developed a permanent settlement in Alaska on Kodiak Island in 1784, Russia never permanently colonized the region.

Russian expansion into the Alaska mainland was not merely the result of the great ocean voyages of discovery but also from the hardening of territorial borders with China which directed Russian trade to the north and east towards the Bering Strait (Bockstoce, 104). The financial success of the Russian American Company depended on the steady flow of furs and other trade goods which the presence of British and American ships exploring the Arctic region and the growing presence of whaling vessels disrupted. In addition to competition along the coast, the growing presence of the Hudson's Bay Company (HBC) coming overland from the east further disrupted the flow of furs and pelts to Russian American traders especially when the HBC created a permanent settlement at Fort Yukon in 1847. Five years later, the loss of the Crimean War (1853-56) prompted an examination of the lands and borders of the Russian Empire by the government, resulting in a review of the Company whose charter was to expire in 1862. Declining trade and the rising costs led to a general consensus to pull out of Alaska, eventually resulting in the negotiated sale of Alaska to America in 1867 (Bockstoce 288-295).

The Treaty with Russia for the Purchase of Alaska made Alaska a territory of the United States. Under the treaty, Russian citizens who stayed in Alaska after three years automatically became American citizens. This extended to the few native peoples who had acquired Russian citizenship when they adopted Christianity; those who had not converted were considered uncivilized native tribes rather than domestic nations. This had very important implications for most of the peoples of Alaska who now became "subject to such laws and regulations as the

United States may, from time to time, adopt in regard to aboriginal tribes of that country” (Ray 1975: 185-186).

Alaska was initially governed by the War Department as a military district from 1867 to 1877 and then under the Navy to 1884. The Organic Act of 1884 provided for a civil government in a district designated as a civil, judicial and land district. The land district status ensured ownership of the land by the Federal Government and allowed the application of US mining laws without any consideration of any tribal land rights. The district had neither a delegate to Congress nor a home legislature, though the Organic Act did call for the creation of territory schools for Native and non-Native children (who were few in number). Assimilation efforts typically took the form of teaching Christianity and English which was in line with the Bureau of Indian Affairs in the mainland United States’ attempts to “civilize” Native peoples. In 1885, Sheldon Jackson, a Presbyterian missionary from New York, was appointed by the Federal Bureau of Education as the General Agent of Education in Alaska and the Government Agent for the region.

Alaska became the 49th state in 1959. Native land claims, however, were to unaffected by statehood and not to be settled until 1971 when the Alaska Native Claims Settlement Act (ANCSA) was signed into law by President Nixon on December 18. The act abrogated native claims to aboriginal lands and, in return, Natives received title to 44 million acres and were paid \$950 million. The Act transferred title to twelve Alaska Native regional corporations and over 200 local village corporations. A thirteenth regional corporation was later created for Alaska Natives who no longer resided in Alaska (43 U.S.C. 1601 et seq ).

### *III. Reindeer in Alaska*

Sheldon Jackson envisioned Native Alaskans herding reindeer for subsistence needs as well as an income source from the sale of offspring, hides, meat, and various other goods such as antler velvet (Jackson, 1891). To fund his project, he proposed a bill to Congress on January 8, 1891, which was rejected. He then sought public donations through a series of newspaper appeals to the public to help the starving natives by funding the acquisition of reindeer. He obtained \$2,146 (simple PPP calculation gives relative 2017 value as \$58,400).<sup>4</sup> Despite Congressional rejection of the plan, the Secretary of the Treasury provided in kind support through the use of Captain Healy and the Revenue Cutter to transportation reindeer. The first sixteen reindeer were brought to the Aleutian Islands on July 4, 1891 (Jackson, 1893).

In 1892, the original 16 animals that had survived the winter in the Aleutians, plus two fawns, were brought to the newly established Teller Reindeer Service Station at Port Clarence-Cape Prince of Wales on the Seward Peninsula (See Map 1). Reindeer continued to be imported until 1902, when Russia prohibited the sale of reindeer to Alaska. By this time, there were estimated to be 5,148 reindeer in Alaska (Stern et al., 1980). Jackson had been instructed to spend “all the time that could be spared from the schools” on the establishment of the reindeer stations (Jackson, 1893).

The Teller/Port Clarence Reindeer Station was the first but the program grew to include several other mission stations. In 1894, 100 reindeer were given to each of the following: The Congregationalist at Cape Prince of Wales contiguous to Port Clarence; the Swedish Evangelical Church, at Golovin Bay; the Roman Catholic Church, on the Yukon River; and the Presbyterian Church, at St. Lawrence Island (Jackson, 1894). In an annual report Jackson (1894) stated that

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<sup>4</sup> Jackson made appeals in the Mail and Express of New York City, the Boston Transcript, the Philadelphia Ledger, the Chicago InterOcean, Washington Star and religious newspapers. Value calculation <https://www.measuringworth.com/uscompare/relativevalue.php>

“with the increase of the herd it is proposed to offer a similar number of reindeer to other Christian denominations at work in that region who may wish to receive and care for them.” Outside of this statement, it is not clear how missions were selected to receive reindeer. Most likely, it was at the discretion of Jackson and perhaps the superintendent of the Teller Station. The presence of reindeer was only the first step. The Inupiat had also to learn how to herd and husband the animals. To do that, Jackson had four Chukchi accompany the animals. Unfortunately the presence of the Chukchi was not appreciated and feeling threatened, they returned to Siberia. Undaunted, Jackson advertised in Norway for Sami to migrate to Alaska and, in 1894, six Sami arrive to instruct Native apprentices.

Although initially conceiving of reindeer as a way to provide food and income, Jackson quickly saw reindeer and missions as indistinguishable as the means for ‘civilizing’ the local community. Apprentices to the mission schools would receive food, board, and an uncertain number of reindeer for each year of the five-year apprenticeship (Jackson pg. 131-132, 1894). At the end of five years, an apprentice should have been in a position to own his own herd along with a loan of 50 reindeer from the mission (Olson, 1969).<sup>5</sup>

In addition to using reindeer as a way to convert and civilize, Sheldon Jackson saw reindeer as way to bring native groups into the market economy, not realizing that the Inupiat people had long been engaged in local and long-distance trade. Despite Jackson’s early concern about food scarcity, five years after the importation, few Natives received any reindeer, apart from Charlie Antisarlook of Cape Rodney who received a loan of 100 head in 1895 to dispel doubts that had been growing. The loan was crafted such that he had use of the herd for five years after which time, he would return the 100 head but keep any additions to the stock. At the

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<sup>5</sup> One issue that is not addressed is the size of a sustainable herd. Fifty to 100 reindeer is probably not a sustainable size. Of the five reindeer herds started in the Mackenzie River delta, only one survived (Scotter, 1972).

same time, the rules were that to maintain herd growth no native could slaughter a reindeer or sell a female reindeer.

With the discovery of gold in the Klondike in 1896, Jackson further re-envisioned reindeer again as a source of food but now for miners, well as providers of transportation services. Jackson's rhetoric was such that he persuaded the Federal Government of an imminent threat of starvation among the thousands who converged on Dawson City. In turn, the government authorized \$200,000 to purchase 500 more reindeer from Sweden, of which just over 100 arrived in Alaska, along with Sami herders who were to be paid in reindeer (Willis, 289). Jackson responded to each possibility of starvation by moving herds around, for example, taking 100 reindeer from Anitsarlook and driving them to Barrow having heard of iced in whaling vessels.<sup>6</sup>

In 1907, the provision of education was taken out of missionary control and placed under the Bureau of Education which began employing superintendents. Under this new regime, Alaskan Natives no longer had to complete apprenticeships to obtain reindeer and could simply purchase reindeer from other herders, though sale of female deer to non-Natives was not permitted (Willis 2006, 292).<sup>7</sup> Along with this policy change, the new superintendent began organizing annual reindeer fairs to promote reindeer herding and to hold seminars on herd management (Olson, 1969).

Although natives were prohibited from selling female deer, non-native owners faced no prohibitions. In 1914, a Sami herder, who has acquired reindeer for his services, sold his herd of 1,200 reindeer to Carl Lomen, a Nome business man, who then formed 'Lomen and Company'. Lomen pursued Jackson's dream of an international market in reindeer meat and hides, investing

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<sup>6</sup> Few reindeer survived the trek. The whalers were found to be well provisioned.

<sup>7</sup> To give an idea of the size of the apprenticeship program before it ended, in 1906 there were 31 apprentices supported by missions and 14 supported directly by the Bureau of Education (Jackson, 1907).

in four cold storage plants and transportations routes to markets in the contiguous US states.

Despite statements that he would not compete against native groups, his herd was served by the same ranges as were native herds (Stern et al. 11980).

From the mid-twenties to the mid-forties, the Native Alaskan herders created joint-stock companies with one share equal to one deer, while still maintaining the fiction of individual family ownership (Stern, Arobio, Naylor, and Thomas, 1980). By 1933, there were 78 such companies with 5,878 members (Olson, 1969). Joint ownership enabled herders to consolidate their herds and take shifts caring for the deer, thus allowing owners to spend more time in the village and to pursue other subsistence activities (Schnieder, Kielland, Finstad, 2005).<sup>8</sup> Against these benefits were the costs of less than careful attention to herd husbandry such as which animals would be slaughtered, or indeed, focusing on how many animals there were in the herd and the state of the winter range land.

Prior to the gold rush, local markets for reindeer products were few.<sup>9</sup> When the gold rush ended by the early 1920s, the size of local markets returned to their pre-gold levels (Olson, 1969). In attempt to maintain herding, the Bureau of Education worked to locate viable markets for reindeer products outside of Alaska, and Department of Interior vessels began carrying hides to Seattle (Olson, 1969). However, freight charges for transportation to outside markets made up

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<sup>8</sup> According to Olson (1969), in a joint-ownership system, a chief herder was appointed by the members. Chief herders were in complete control of managing the herd and any member wishing to obtain reindeer meat had to obtain a permit to slaughter a certain stated amount of deer. Chief herders also hired assistants to assist in caring for the herd. Records of stock ownership were kept in a journal. Taxes collected from the members went into a treasury to pay for equipment and groceries.

<sup>9</sup> It was remarked during the beginning of the Nome gold rush by Sheldon Jackson that for an investment of \$1.00 in a four year old male reindeer trained to pull a sled, the top sales price ranged from \$60 to \$150. Jackson, Sheldon, Thirteenth Annual Report on the Introduction of Domestic Reindeer into Alaska 1903, U.S. Government Printing Office, (1903), pp138-9.

approximately 11 percent of a herder's overall production costs (Olson, 1969: 88).<sup>10</sup> In addition, Lomen and Company had the scale to dominate this market, selling 6.5 million pounds of reindeer meat in the United States by 1929 but this represented only five percent of the estimated 640,000 reindeer in Western Alaska (Willis 2006, 296). With the Great Depression, this market evaporated.

Over the 1920s increasing complaints against Lomen led to Congressional hearings. A Congressional report in 1931 reaffirmed the legality of Lomen and Company. But native complaints and political activism mounted, resulting in the Alaska Reorganization Act of 1936 which encouraged Alaska Natives to form village government and offered federal loans for Native economic activities. The Act, however, did not relate directly to reindeer matters. So in 1937, Congress passed the Reindeer Industry Act which restricted ownership of domestic reindeer in Alaska to Natives only. It also transferred control of the program to the Alaska Division of the Office of Indian Affairs. At the same time, having concluded that reindeer were an important part of Indian culture that should be preserved,<sup>11</sup> the Federal Government decided to purchase the Lomen reindeer business for \$500,000 (Willis, 299-300). In the early 1990's the Bureau of Indian Affairs allowed a Canadian citizen to import Canadian reindeer into Alaska, and in 1997 the Ninth Circuit held that the 1937 Act did not preclude non-Natives owning or selling reindeer (Dillingham 1999; 650).

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<sup>10</sup> Direct labor and camp meat consumption made up 55.4% of costs, operating plant and equipment costs account for 18.3% of production costs, financing costs were 5.5%, and miscellaneous expenses made up 9.9% of production costs (Olson, pg. 88, 1969).

<sup>11</sup> Despite the fact that few native communities had reindeer and reindeer had only been introduced four decades earlier. The statement that reindeer husbandry was an important component of Indian culture remains to the present.

#### *IV. Reindeer Ecology*

Discussion of the reindeer populations in Alaska all report that between fertility and further imports from Russia, by 1902 there were 5,146. By 1940, it is reported that the population grew to 640,000 (Stern et al 1980: 17-18; Dau 2000). Herd numbers were reported to have crashed and continue to fall for the next five decades. There are currently said to be 18,000 to 25,000 reindeer in Alaska with perhaps 12,000 to 21,000 of those on the Seward Peninsula (Alaska Dept of Fish and Game; Ihl & Klein 2001).

Reindeer numbers for the first half of the twentieth century are often reported as accurate counts despite being, at best, estimates (Stern et al., 1980: 18). Yet it is unclear how, during the first four decades of the twentieth century, these estimates were determined. Calculating reindeer numbers is difficult. Numbers can be counted when reindeer are corralled for calving or corralled at other times of the year, as has been done by the Sami over centuries. But even here, one cannot be sure that all reindeer have been corralled and so the count is a lower bound. Reindeer are also counted by researchers walking through the summer range land and counting every reindeer seen and accounting for dead animals. Others use helicopters or light planes to do aerial surveys. Regardless, all these methods provide only estimates of herd numbers (Klein 1968) again with the numbers reported as lower-bound estimates. Though native groups on the Seward Peninsula did tend the reindeer to some degree during the fawning season, there are few if any reported counts. Indeed, when the federal government sought to corral its newly purchased Lomen herd, claimed as 500,615 reindeer in 1938, and for which it had paid \$500,000 in that same year, yet only 84,001 animals were actually rounded up.<sup>12</sup>

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<sup>12</sup> The purchase of the Lomen herd ended non-native ownership of reindeer in Alaska for the next five decades.

The literature further claims that the reindeer population crashed during the 1930s which accounts for the fewer numbers at the round up (Stern et al, 1980: 72). However, we actually do not know how many reindeer there were in Alaska/Seward Peninsula from 1902 to 1940 despite the much quoted number of 640,000 animals in the early 1930s. In this section we explore reindeer ecology and population dynamics to explore what we know about the forces that operate on reindeer populations. Based on the reindeer ecology and taking the population of reindeer in Alaska in 1902 as our starting point, in the next section, we simulate reindeer population under differing parameters. This allows us to look at differing trajectories for reindeer populations during the first four decades and to assess the sustainability or viability of reindeer herding in Alaska given these parameters.

Reindeer and caribou are the same genus and species (*Rangifer tarandus*). In Europe they are called reindeer. In North America, the term reindeer is used to refer both to the Eurasian populations and to semi-domesticated herds, with caribou being used to refer to the wild population and we will follow this protocol. Caribou/reindeer populations are native to the Arctic, subarctic, tundra, boreal and mountains found throughout the circumpolar region. What differentiated the Alaska and the Canadian Arctic from the other Arctic regions is that reindeer herding never took hold. As shown in Figure 2, herding takes place in Siberia on the same latitude as the Seward Peninsula, a fact noted by Jackson in his request for Congressional funding (Sheldon, 1894). Similar to eastern coast of Siberia, the arctic tundra in Western Alaska provides suitable range land for reindeer (Jackson, 1981). The fact that the Inupiat people did not herd reindeer did not mean that they did not know about reindeer herding. Family connections with groups in Siberia and a trade in hides across the Bering Straits suggests that

those on the Alaskan side of the Strait knew about herding but for some reason chose not to engage in this economic activity.

Reindeer are domesticated only in the sense that they are herded and live with humans such as in the case of the Sámi. Reindeer herding involves moving the herds from range to range to ensure sufficient fodder during the various seasons, especially winter. Reindeer husbandry requires being involved at the fawning season to reduce mortality from predation and possibility weather and understanding the structure of the herd so that culling maintains a strong population. Rutting season takes place during September and early October, with fawning in April and May. Reindeer tend to return to a customary range to fawn, requiring vigilance by herders when starting a new herd in a new location.

Reindeer population dynamics, like any living organism, is a function of fertility and mortality. When one is considering a semi-domesticated herd, population size will also be affected by animals joining or leaving the herd. Reindeer belong to the *cervidae* family, but unlike other deer species (elk, deer), caribou/reindeer give birth to one fawn annually. Females are fertile in their second year and depending on the environment will give birth as two-year olds or as three-years. Females live to be about 14-16 years, implying twelve fecund years. Males have about the same life span (Krebs, 1959, 1961). As we show below, the unconstrained growth rate is exponential.

Reindeer migrate between summer pastures at lower elevations and winter pastures at higher elevations. Although often said that reindeer only consume highly digestible lichen in the winter, reindeer also eat shrubs, hummocks, low birches and graminoids (grasses and sedges) (Ihl and Klein 2001: 966). The main constraint on reindeer population size is the environment in which the herd resides. For any herd, the area available for forage is greater in the summer than

in winter (due to snow pack) and as a result, the winter forage can be a constraint and, if unavailable, will lead to malnourishment or starvation for some or many animals. Starvation-induced mortality will immediately lower the herd size, but malnourishment due to constrained access to food over the winter can lead to fewer live births in the spring and lower fertility in females in the following year. Despite the fact that summer pasture is more extensive, summer conditions also can be problematic. Swarms of insects such as black flies and mosquitos can harry the animals and interfere with grazing activities to the extent that the animals are unable to feed intensively and go into the winter with less stored fat, resulting in lower fertility and perhaps increased mortality.

The early literature on reindeer dynamics focused on the constraining role of winter lichen grounds arguing for an essentially Malthusian relationship between the herd and its environment (Krebs 1961; Scheffer 1951) and to a tragedy of the commons (Hardin 1968).<sup>13</sup> What has been found, not surprisingly, is that as a result of high animal density in a region (12 caribou per kilometer squared (Pape and Loffler 2012: 422)) and some other negative shock, the population can collapse. In more recent decades, the role played by climate has been examined more systematically, and for regions bordering the north Atlantic, the role of the North Atlantic Oscillation measured. Bad winters, where bad might mean very deep snow or an ice event, will, for any population size, make it more difficult for herds to forage. An inability to reach the winter forage will lead to outright starvation and death.

The interplay of these forces, density dependence interacting with a negative weather shock, can be seen in the St. Mathew Island reindeer population. In 1944, 29 reindeer were introduced on this island with no predators or human population. The reindeer population

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<sup>13</sup> This literature often asked which of fertility, mortality or migration had the greater impact on herd size (eg Krebs 1961). The term Malthusian is never used, rather this literature refers to density dependence.

increased to 6,000 by 1963. This is a reasonably accurate estimate because the population was tracked over the intervening years by human counts in the summer made by walking the island, and by a complete survey of the island by two US Coast Guard helicopters in 1963. Surveys of fawn and yearling numbers suggest that the rate of population growth was declining by 1963 suggesting some population pressure on the food resource. Three years later when scientist returned to count the population, they found 42 animals all female. An extreme snow accumulation in the winter of 1963-64 resulted in an inability to dig down to the led the population collapse and to its end (Klein 1968). Similar patterns of rapid growth and then collapse have been found on other island populations. For example 25 reindeer introduced on the St. Paul Island in 1911 grew to over 2,000 by the late 1930s. In 1942 the population collapsed as a result of the combination of density combined with four years of below normal temperatures and an ice event in 1942. By 1950, the herd size was 8 animals (Swanson and Barker 1991:40).

Density dependence has a direct impact on herd size; while climate has an impact independent of herd size can together generate large inter-annual variation in population size (Solberg et al. 2001). For example, for any herd size an ice event in winter which makes it impossible for an animal to forage will cause at best malnutrition and at worst starvation and death. Malnourishment leads to lower fertility in the following season(s) but the lower numbers will allow for greater forage and to a rebuilding (Solberg et al, 2001). Thus the population can oscillate and indeed, such oscillations are evident in the Swedish herds in Fennoscandia (Pape and Loffler, 2012: 422 figure 1).

To this point, we have discussed herd sizes as a function of natural fertility and mortality interacted with herd size and the extent of the winter forage, intensity of summer insect swarms, and climate events. But reindeer herds, as is any wild and semi-domesticated migratory herd,

can be affected by predation. Thus, the level of the predator populations also determines herd size. For reindeer, predators are wolves and brown bear, predominantly. Evidence from Fennoscandia suggests predation rates from 5% to 20% of the winter stock, generally older deer and fawns (Pape and Loffler, 2012: 428). The evidence from the Seward Peninsula, however, is that there were few predators present in the first four decades. Predators such as wolves are codependent on the animal presence and the literature states that the wild caribou population (such as the West Arctic Herd) was not present on the Seward Peninsula during the early decades of the twentieth century and thus wolves were not present. In fact, there were no other mammals to attract these serious predators. Other mammals such as moose and muskox were introduced in the last quarter of the twentieth century.

Yet, if predators were not a concern for reindeer population size in the first half of the twentieth century, the fact remains that the reindeer is a wild deer. If not constantly tended or allowed to roam unherded, reindeer will revert to a semi-wild state. In regions without a wild caribou population, animals might just wander away from the herd and perhaps rejoin or not at a later date. But the situation is much more problematic when reindeer herding is taking place in an environment with migratory wild caribou. If not corralled or closed tended, reindeer will just join the migrating caribou herd. The Seward Peninsula was protected in the early years by the fact that the Western Arctic Herd appears to have ceased its migration through the region. That is no longer the case. In an interview describing his herd size and his herding experience in the early twenty-first century, Clifford Weyiouanna told the interviewer that “the last good count I had was 700. Then it got stormy for almost for a week to where we did not go out, some caribou come in, all we saw was tracks, one line going east and that was the end of my herd.” (Schneider et al, 2006: 44). One very apt phrase is that the reindeer ‘go caribou’.

## *V. Reindeer Population Simulations*

In this section we run a series of population simulations using information from the reindeer ecology literature and the number of reindeer reported for the Seward Peninsula at the end of Russian imports in 1902. We map out population under various scenarios to explore what the likely number of reindeer in Alaska might have been by 1940. We use climate events as shown in tree rings to recreate bad winters or warm and wet summers to explore the interactive relationship between the populations, the land area and the food source.

We start with the 5,148 reindeer reported for 1902, the final year of reindeer importation. In our first exercise, we allow for population growth based solely on fertility and mortality without any element of density dependence. For simplicity, we assume that all reindeer live to age 14 and that the male-female ratio is consistently 0.50.<sup>14</sup> We also assume that all cows reach sexual maturity at age 2 and give birth at age 3 and every subsequent year until death. Each year, 90 percent of cows become pregnant and of those 85 percent give birth to healthy calves. This unconstrained growth is nearly exponential and, based on these parameters, average annual compound growth converges to 23 percent. By 1940, the reindeer population is almost 12 million animals, which clearly infeasible but it does show the power of unconstrained growth rates.

We now move on to a more realistic, standard Lotka-Volterra logistic model and incorporate density dependence in the model:

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<sup>14</sup> [http://www.biokids.umich.edu/critters/Rangifer\\_tarandus/](http://www.biokids.umich.edu/critters/Rangifer_tarandus/)

$$F(X) = aX - bX^2, \quad a, b > 0$$

where  $X$  is the animal population,  $a$  is the maximum proportional growth rate of the population, and  $b = a/\bar{X}$ , where  $\bar{X}$  is the upper limit to population size of the maximum population size. The choice of  $a$  and  $\bar{X}$  is central to the population estimates. Again we use the reindeer ecology literature and information on reindeer densities from the Fennoscandia experience which give an upper bound estimate of stocking density at 12 animals per kilometer squared (Pape and Loffer, 2012: 422 Figure 1). For  $a$ , we use 0.23, the value derived from the unconstrained growth simulation discussed above. The results of this basic simulation are depicted by the solid red line in Figure 3. By 1940, we estimate a population of almost 636,000, roughly the unexplained estimate of 640,000 found throughout the literature.

This simulation, while it incorporates the impact of the land area, entirely neglects climatic shocks. Climate has its biggest impact in the form of ice events during the winter but summer weather can also determine the extent to which the reindeer enter the winter nourished or malnourished. Unfortunately, there are few direct measures of precipitation by month for the Seward Peninsula during these decades. However, we do have annual tree ring data from the Seward Peninsula from four sites shown in Figure 4. Tree rings measure the growth rate of the tree during the growing season (summer). Rings that are further apart show a high growth rate and those closer together a low rate of growth. Tree growth depends on moisture and temperature. What is very evident in Figure 4 is that something happened to summer climate for the decade 1912 to 1922. Tree ring growth at each of the four sites decreased steeply and consistently over these ten years.

We argue that these summer conditions may have seriously affect not just tree growth but overall plant growth resulting in below normal food supply. If this was the case, then the reindeers' ability to receive adequate nourishment may well have been affected and they would have entered the winter less well nourished. Malnourishment, as discussed in the previous section, affects the ability of animals to carry their pregnancies over the winter, with fewer live births in the spring and greater winter mortality. We somewhat arbitrarily decrease the growth rates by 50 percent each year over this period to account for this potential malnourishment. The result is shown in figure 3 as the blue dashed line.

The population numbers are identical to those the previous scenario until 1911. But given the lowered fertility and mortality impact, the population numbers are lower. The population is 35,548 in 1912 and grows to 96,186 by 1922 rather than 228,981. Although the growth rate is flatter, without any further shocks, the population nearly recovers by 1940. The simulations have the population with these summer weather shocks at 598, 376, which while lower than 636,000, the difference is not large.

Next we consider the effect of severe winter conditions on population growth. Although we lack data for this entire period, there are weather data for St. Paul Island which lies north of the Aleutian island chain. The periods 1933-1934 and 1938-1940 had midwinter temperatures that were well below normal, with 1940 being particularly cold. During that 1940 winter, "a crust of glare ice remained on the snow for several weeks, hindering the deer in their efforts to browse." With the ground covered in ice, "herds may suffer great losses through starvation, since the animals cannot paw through hard crust to get food" (Scheffer, 1951: 358-359). We assume that the same winter events also occurred in the Seward Peninsula. We simulate

increased mortality in each of these periods with 10%, 20% and then 30% mortality in 1934 and again in 1940. The results are shown in Figure 5.

The population scenario in Figure 5 includes both the poor summers from 1912 to 1922 and the winter weather shocks in the 1930s. The population estimated for 1940 is now 256,900 animals, under half the reported number for 1940 in the literature, but still larger than the 84,001 animals rounded up in 1938 as part of the Lomen herd. Even if we double this to account for native animals, that is still only 168,000. The feature of this simulation that is important is the oscillations we have now induced into the population with a population of roughly 400,720 in 1932 falling to just over 270,219 in 1934, rising again in three years to 381,036 before falling to 256,900. Reindeer populations can be prone to oscillations as shown in the population figures for the Swedish reindeer numbers over the last fifty years (Pape & Loffler, xxx).

Regardless of the reductions in fertility or increases in mortality, the population numbers for 1940 remain large. It is possible that there was extreme mortality that the population fell to the estimated 25,000 by 1950, but it is also possible that there never were 640,000 reindeer in Alaska, or more particularly in the Seward Peninsula by 1940.

## VII. *Sustainability of Reindeer Herding on the Seward Peninsula*

The simulations presented above show that, based on an assumed population in 1902 of 5,148 and standard life spans and fertility, a standard Lotka-Volterra Logistic gives the maximum size of the herd of 640,000 reindeer in 1940. This is almost exactly the number given as the actual count of reindeer in all the literature. It is, of course, possible that this was the actual herd size but it also may be that at some point, this same exercise was conducted.

Sheldon Jackson imported reindeer into the Seward Peninsula in 1892 to provide a dependable source of meat. He quite quickly realized that the presence of reindeer could be used to shift the Inupiat from a subsistence hunter-gathering economy to a cash economy and to Christianity through his use of the mission schools as the point of introduction. Jackson presumed, as did many, that native groups did not interact with a market economy. Yet Inupiat and other indigenous groups had been trading and exchanging products with other villages and other communities for centuries and with non-indigenous traders for over 100 years (Carlos and Lewis, 2010). They understood the operation of a market economy.

Willis (2006: 301) has argued that the introduction of reindeer was very poorly managed and brought “more work than reward” to Native Alaskans (Willis, 2006 pg. 301). It is clear that for those mission and those families/villages that had reindeer, reindeer could be a source of meat. However, if we accept that there were 640,000 reindeer in 1940, the 72,324 people living in Alaska in 1940 (1940 census) had almost 9 reindeer per man, woman and child. From Sheldon to the present, those involved have a conception of a commercial market for reindeer meat, antler velvet or even animal blood. Recent newspaper articles expand on the possibilities in the meat market both in Alaska and in the contiguous US. One example is an article from March 12 Boston Globe that talks about the village of Mekoryuk desire to provide reindeer meat fare and wide.<sup>15</sup> But what is clear is that this village is no further ahead in this endeavor than was the Lomen Company or native groups in the 1920s.

Not knowing the true herd size at different points in the first four decades makes it somewhat more difficult to measure the viability and the sustainability of reindeer herding in this

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<sup>15</sup>[http://www.bostonherald.com/news/national/2017/03/eskimo\\_village\\_aims\\_to\\_serve\\_up\\_reindeer\\_meat\\_far\\_and\\_wide](http://www.bostonherald.com/news/national/2017/03/eskimo_village_aims_to_serve_up_reindeer_meat_far_and_wide)

region. What the ecology literature and the simulations make very clear is that reindeer populations are subject to large and sometimes quite violent inter-annual changes to the extent that the herds might go extinct as seen in the St. Mathew Island, St. Paul Island and five of the six herds in the Mackenzie River delta populations. Larger populations such as that in Sweden and Finland and more recently Norway show large oscillations and this is for well-managed herds. Despite statement about the importance of reindeer to the cultural life of native communities, very few communities in Alaska or Canada have actually actively managed reindeer herds.

Working in reindeer husbandry is a difficult and low return venture. A recent *National Geographic* article (October 2017) shows just how difficult reindeer herding and husbandry is for the Nenets of the Russian Arctic who currently migrate 800 miles a year with their herds. Indeed, one major point made in the piece relates to the impact of climate change noting that tens of thousands starved to death as a result of a deep freeze and the reindeer inability to dig through the ice to find the necessary lichen.<sup>16</sup> For communities in Alaska the prospects, regardless of the hopes and aspirations, are perhaps even more bleak. Climate change and oil exploration (the second major issue facing the Nenets) also affect all sub-arctic and arctic communities in Alaska. Both make reindeer herding less viable. However, for herders in Alaska, the presence of wild caribou herds means that unless herders can fence in their semi-domesticated reindeer, they will all eventually ‘Go Caribou’ and the herd will just disappear and leave behind merely a set of tracks.

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<sup>16</sup> <http://www.nationalgeographic.com/magazine/2017/10/nenets-yamal-herders-energy-development/>

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Map 1 – NOAA stations in Western Alaska

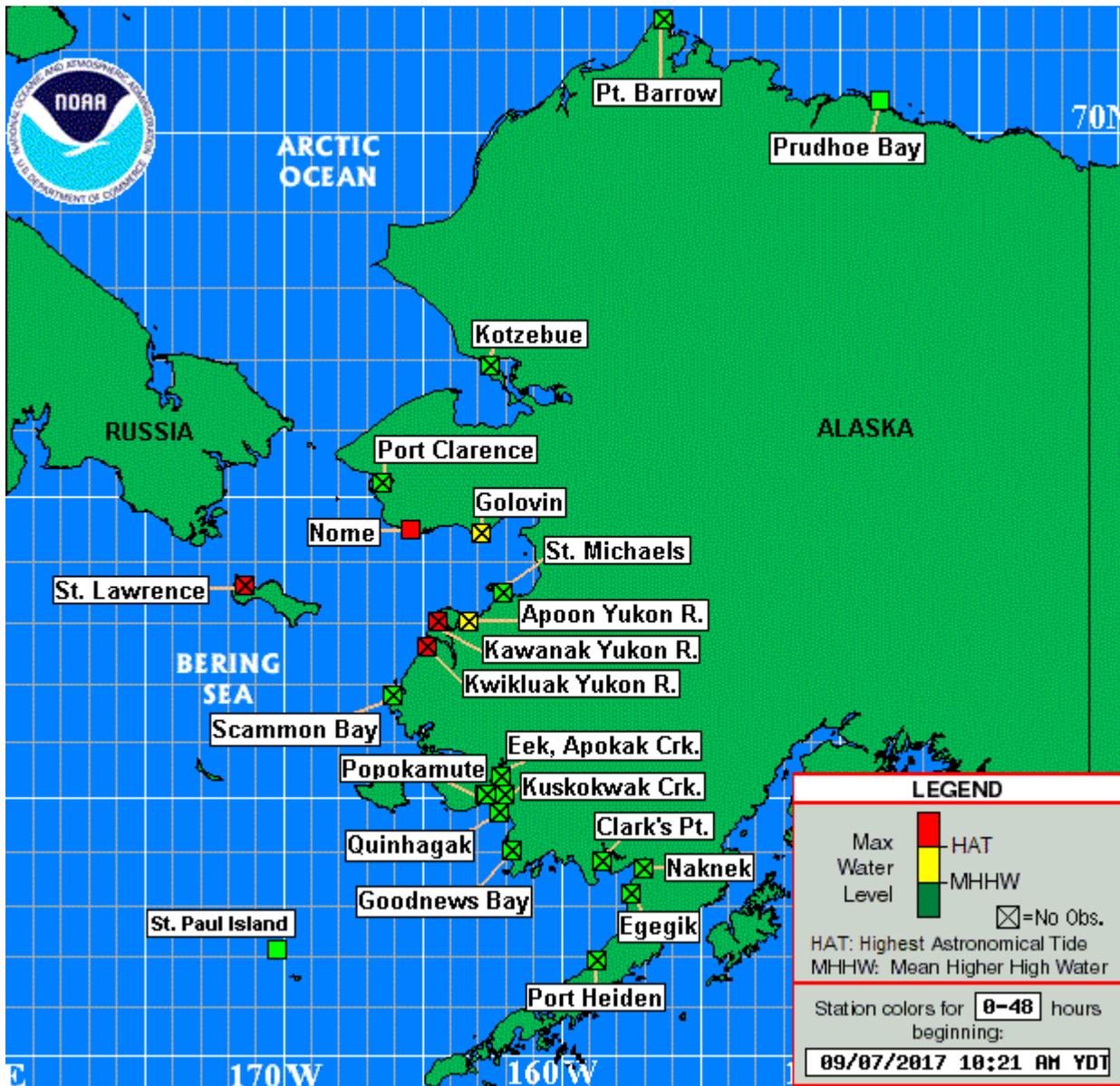
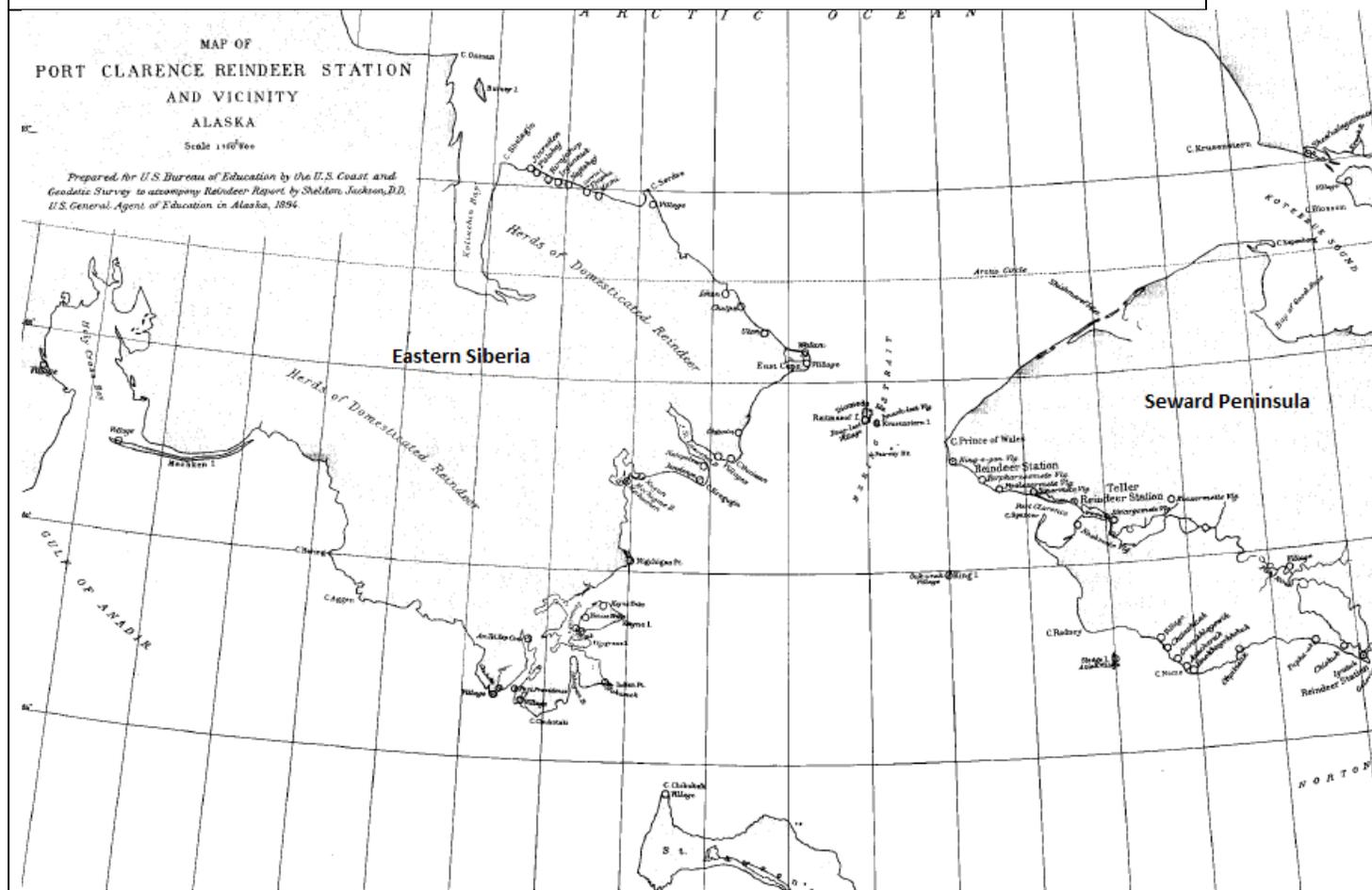


Figure 2: Geographic Similarity between Eastern Siberia and the Seward Peninsula



Source: Congressional Record 1984. Reindeer were obtained for Alaska from indigenous groups living on the coast of Eastern Siberia.

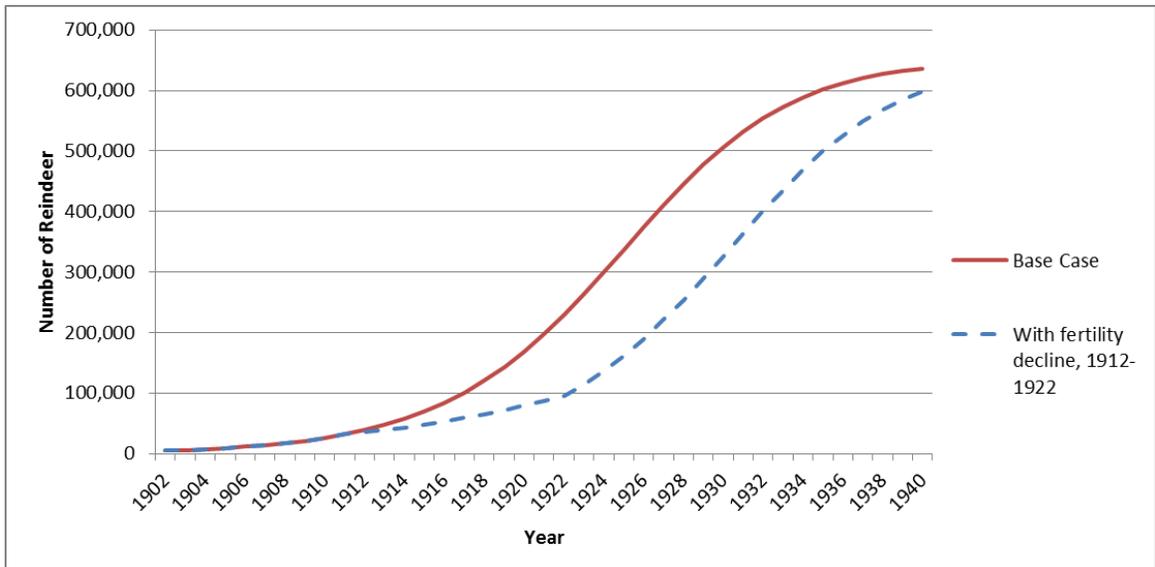


Figure 3: Simulated Reindeer Population – 1902 to 1940

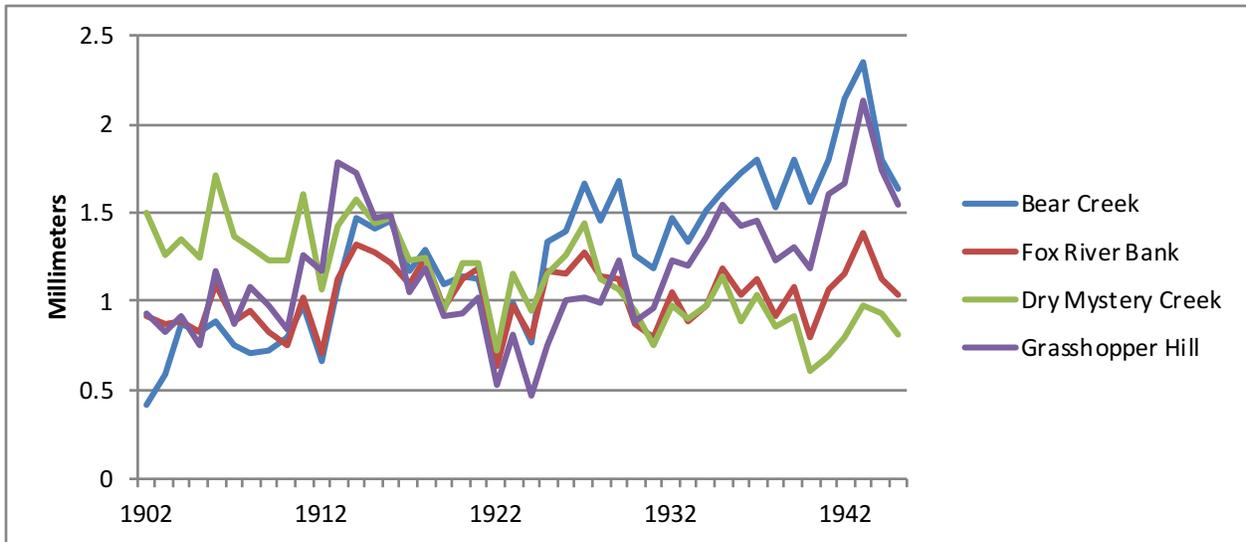


Figure 4: Tree Ring Date from the Seward Peninsula

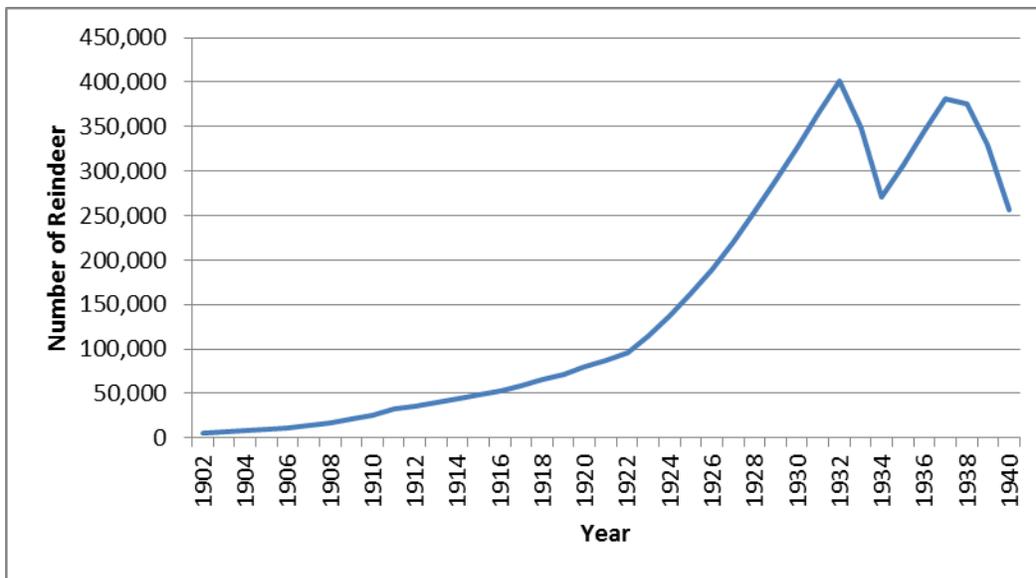


Figure 5: Poor summers 1912-1920 and winter mortality events in 1930-34 and in 1938-1940