2013

UBC Forestry Grad essay – Frst 497

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[Review of Coastal Elk Management Projects in British Columbia]

ABSTRACT

The populations of coastal British Columbia's Roosevelt Elk (*Cervus canadensis roosevelti*) decreased greatly from first European settlement to the start of the 1920s. This has been credited to pressures from hunting and decreased habitat, both of which were caused by humans. The remainder of the 20th century was categorized by a period of strict hunting regulations; facilitating a, while slow, re-growth in numbers. Beginning in the latter part of the 20th century, "elk management projects" were also initiated. The goal of these projects was the translocation of elk into areas where their numbers were threatened. During the past decade these projects have intensified and transitioned into translocating elk into drainages where it has been determined that they have been extirpated from. This paper does not determine any negative or positive factors within these projects. However it does investigate potential question's that should be asked about such projects. These questions are shaped in response to the examination of three case studies: Newfoundland's introduction of Moose (*Alces alces americana*), Haida Gwaii's introduction of Sitka black-tailed deer (*Odocoileus hemionus sitkensis*), and New Zealand's introduction of Red Deer (*Cervus elaphus*).

Key Words: Roosevelt Elk Management, translocation, Newfoundland, Haida Gwaii, New Zealand.

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Intro

The term “ungulate” is an unofficial technical name used to describe “hoofed mammals”. This term evolved from the Latin word *unguis,* meaning a nail or claw (Shackleton, 1999). The keratinized epidermis sheath layer, which covers these hooves, as well as classifying these species under this group, is a common source of confusion. Elk, along with a number of differentiated species are classified by this term mutually exclusive of their respective Orders. Collectively, these species all fall into the Mammalia class.

Until 2004 elk were considered a sub-species of the European Red Deer (*Cervus elaphus*). However recent mitochondrial DNA surveys have proven that they hold more similarities with other members of the genus *Cervus* than with the red deer. Roosevelt Elk (*Cervus canadensis roosevelti*) are placed in the Certartiodactyla Order (Huffman, Subvfamily Cerninae, 2011). This Order is a combination of even-toed ungulates as well as whales and dolphins. Following the Roosevelt Elk down the taxonomy ladder, these hoofed mammals are members of the sub-order “Ruminantia” and then the “Cervidea” family (Deer) (Huffman, Subvfamily Cerninae, 2011).

The Cervidae, like many other land mammals with large bones, have provided numerous fossil records. These fossils first appeared in the early Miocene of Asia where the wide variety of niches facilitated the expansion and adaptation abilities of this group. This period was characterized by the expansion of the Cervidae range. Land bridges aided the migration of these mammals to North and South America. Within the Cervidae family, elk can be further classified under the sub-family Cervinae (Huffman, Subvfamily Cerninae, 2011). Within this sub-family there are currently 5 sub-species under the classification of *Cervus canadensis*; one of these being *Cervus canadensis roosevelti*.

Globally, all members of the Cervidae family are important prey for many species, including humans. For example, First Nations hunted elk for generations prior to European settlement.

B.C. Distribution

Elk, like most ungulates, left British Columbia Canada during the last glacial advance. As the last great glaciers disappeared approximately 15,000 to 10,000 years ago, the adaptive ungulates began to repopulate the newly available habitat in Canada. At European first contact there were 6 different sub-species of elk. Currently, there are only 4 sub-species left on the continent: Manitoba Elk of the Great Plains (*C.c. manitobensis*), the Rocky Mountain Elk of the Rocky Mountains and adjacent ranges (*C.c. nelsoni*), Roosevelt Elk of the Pacific Northwest Coast (*C.c. roosevelti*) and the Tule Elk of California (*C.c. nannodes*). .

Although the traditional territory of the Rocky Mountain and Roosevelt Elk has gradually diminished because of human settlement, they still exist in British Columbia. Other than artificially moving them into regions that they would not otherwise have colonized, Roosevelt Elk are found in the Fraser Valley west of the Cascade mountain range, along the south coast, and on numerous islands in the Strait of Georgia. Their presence is most predominant on Vancouver Island. Rocky Mountain Elk have settled into several locations in the interior, particularly in and around the Rocky Mountains. However their choice of habitat continues to shrink due to increasing encroachment of human settlement(s), negatively impacting their ability to exist. As the number of Roosevelt Elk continues to decline, interest in their future has intensified.

Roosevelt Elk

Roosevelt Elk have been hypothesised as having differentiated during the last great glaciations as a consequence of isolation. When the Wisconsin Glacier moved south, this group of elk were trapped by the Cascade Range to the east after their forced southern migration (Quayle, 2003). As the glaciers began to recede, the elk of North America began to repopulate the northern reaches. The northern reaches of the Roosevelt Elk's newly settled range was dominated by the Fraser River Basin west of the Cascade Range, the south coast of what is now British Columbia and what is now known as Vancouver Island. The southern region of their range reached as far as San Francisco, California (Quayle, 2003).

By the time the glaciers began to recede, the Roosevelt Elk had evolved into a sub-species; setting them apart from their neighbours on the other side of the Cascade Range, the Rocky

Mountain Elk. . Except for moose, this specific sub-specie of elk is the largest of the Cervidae family found in North America. Roosevelt Elk bulls commonly reach up to 400 kilograms and females can grow to 250 kilograms (Quayle, 2003). They are characterized by the dark color of their head and neck as well as the distinctive creamy yellow-brown rump patch and short tail surrounded by a dark brown or black stripe (Quayle, 2003). Their antlers size can be used as an indicator of health and dominance. For instance, the elk that has the largest, the widest and the most tips on their antlers often becomes the dominant individual. Typically mature bulls (four years or older) have antlers that are 110 to 160 cm long with upward sweeping beams that reach back behind the shoulders (Blood, 2000). In addition to the main tip, the antlers of mature bulls generally have four to five other tips (Blood, 2000) (Quayle, 2003).

Life Cycle and Reproduction

Roosevelt Elk can live up to 20 years in captivity. However in the wild, their average life span is 10 to 13 years with predation being the most common determinant. Elk are very social animals. They typically band together into groups of adults and yearling cows, calves, and yearling bulls. More than 100 elk can be in a group (Quayle, 2003) which in time can break into multiple smaller groups. Any of these groups are often referred to as a herd. In contrast, when referring to groups of elk for management purposes, a herd or a local population is considered to be all groups located within a watershed (Guiguet, 1962).

Mature bulls with branched antlers generally remain apart from females and immature dominated groups. They will often form their own groups, sometimes referred to as “bachelor groups” (Quayle, 2003). During breeding season (September and October) these mature bulls will fight for exclusive breeding rights to up to 30 females (Quayle, 2003).

As previously mentioned, male dominance is determined by body size and antler size. Antler size is linked to the quality and abundance of summer forage. They are shed every year in the late winter or early spring for larger mature bulls, and start to regrow immediately. Immature bulls, while sexually mature, lack the fully developed antlers and size to compete with the fully mature bulls. Immature bulls are often referred to as yearling “spike” bulls. Two year old “raghorns” are immature bulls whose antlers often have broken tips and have a much more shabby appearance. Jointly, body and antler size display an elk’s potential to win in a “pushing” match.

During breeding season (September and October) mature bulls fight for exclusive breeding rights to up to 30 females (Quayle, 2003). Dominant bulls will produce a muffled squealing noise as a challenge to other rutting males. Those bulls that accept this challenge are those who partake in this pushing match to determine dominance if not bestowed by pure posture and strut (Quayle, 2003). Outside of breeding season, the cow-calf herds have an open association and allow for members to come and go without much difficulty (Franklin, 1975).

Female elk, or cows, have a short estrus cycle of only a day or two and mating usually involves a dozen or more attempts (Wikipedia, 2013). Reproduction is most common when a cow weighs at least 200 kilograms. However by their second year, cows can reproduce one, or rarely two, offspring. The incubation period is 240 to 262 days and the newborn offspring normally weigh between 15 and 16 kilograms. Cows tend to isolate themselves and their offspring until the offspring is large enough to escape from predators (Wikipedia, 2013). Offspring join the herd when they are two weeks old. They are fully weaned at two months of age. At one year of age, around the time the next year's offspring are produced, calves leave their mothers presence.

Habitat

Roosevelt Elk are found in the coastal regions of the Pacific North West. This region is very distinct as compared to the habitat of similar ungulates across the world because of the abundance of water. Owing to the fact that there is no shortage of water, the limiting factor in their habitat is the availability of food. As a result, food source and cover or shelters are the determining factors for suitable habitat for Roosevelt Elk (Quayle, 2003). Next to focused taste preferences, elk centre their feeding on plants that are within their reach. Plants with edible leaves higher than the elk's reach are not useful to them.

Edge effects, gaps, and drooping branches provide the Roosevelt Elk with their food source. Habitats that restrict the elk from these conditions set the criteria for winter survival, their ability to quickly replenishing lost fat reserves in the spring, summer growth, and antler re-growth. These criteria greatly affect mating possibilities. Keeping in mind the elk's focus on low-level vegetation such as sedges, grasses, and ferns, these elk also have a preference for plant species such as willows, elderberry and blueberries (Blood, 2000). Gaps and edges are where the light requirement needed for the growth of these plants is supplied. Cedar and hemlock (Blood, 2000) are also preferred feeding species for the Roosevelt Elk. However they are often either out of reach, depleted where population numbers are high, or only available for a short period of time due to disturbances such as wind-throw.

Food restrictions are inter-connected with the survival ability throughout every season. Feeding in each season is inter-connected. For example, if low quality habitat and feeding occurs in one season the effects are directly felt in the following seasons (Quayle, 2003). Winter is commonly the season in which the most stress is put on elk (Quayle, 2003). This makes feeding during the preceding seasons especially important. Low quality summer and fall habitat depletes the amount of fat reserves that the elk depends upon during the winter. The most significant threats to the survival of elk during the winter months are the lack of fat reserves, movability (and the amount of energy required for it), and the amount of winter forage. Both movability and winter forage are determined largely by snow levels and stand structure. Old growth type stands with stands that contain old trees which have large lateral branches as well as numerous gaps, are best suited to be elk winter ranges.

Population Restrictions

Lack of appropriate habitat has been at the heart of limiting elk population size. On account of B.C's historic logging practices, the amount of old-growth areas has been severely diminished on Vancouver Island and the mainland South Coast. As a result, Aboriginal reserve land and protected parkland provide the elk with their main winter ranges. As this is comparatively a small amount of area available for winter use, the elk population on Vancouver Island has been negatively impacted.

British Columbia's valley bottoms are characterized with rich soils and an inherent abundance in vegetation. Together, these features make them a prime habitat for elk. However valley bottoms have become increasingly fragmented due to urbanization. Additionally, harvesting is also another major source of species stress. Forestry activity tends to regenerate a homogeneous forest spread over large areas. This creates a type of landscape which is unable to be used as easily as natural, more dynamic stands. In response, elk must expend excessive energy to move around these areas as well as adopt behavioural strategies to cope with these changes (Schroer, 1988).

Predation is another key threat to the population of the Roosevelt Elk. Authors have speculated that Vancouver Island may be home to the highest concentrated populations of cats on the North American continent (Guiguet, 1962). While collared elk do not seem to have problems with cougar attacks, yearlings can have a high mortality rate because of these predators (Cooperrider, 2005). Wolves and black bears are also a major problem for Roosevelt Elk on Vancouver Island as well as on the mainland South Coast. However, wolves and cougars are the predominant threats (Taber, 1982). Individual elk caught on their own are more vulnerable to attacks by these predators and predation of young elk is where population growth is more frequently slowed.

Adaptability

Geist (1982) describes elk as an old world species because of their lack of changes in physiology and the morphology of elk across the wide range of habitats that they are found in. Their adaptation to a variety of new situations is the result of learning from previous experiences. Elk have evolved in regions with a wide range of seasons, surrounded by many types of mega fauna. However they have never had time to fully adapt to their current, specific, individual environments. The adaptability of the elk is continuously demonstrated as humans persist in their movement to expand urban areas, subsequently invading and fragmenting the elk's habitat. As observed on British Columbia's Sunshine Coast where hunting is prohibited around urban areas, elk are becoming increasingly acquainted with human presence (Shackleton, 1999). These elk readily choose to live in and around urban settlements if not caused harm rather than escaping to surrounding accessible and available habitat. As a result, elk are now considered pests when they remain near settlements with large human populations. The pest designation comes from their interactions with vehicles, agriculture lands, as well as other human planned environments.

Elk Management Projects on the Coast

Summary

By 1900 it was recognized that Roosevelt Elk (*C. c. roosevelti*) populations had declined to the point of extirpation from the southern mainland coast of British Columbia (Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), 2012). However the story of elk on Vancouver Island is much different. With less of their habitat being fragmented in comparison to that of the southern mainland coast, elk populations were at a more sustained level. As time continued and human populations continued to grow, human expansion increasingly came into contact with the elk's habitat.

"Elk Management Projects" were first set up by the Ministry of Wildlife between 1987 and 1989 to augment the diminishing Sunshine Coast populations (Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), 2012). 22 elk were translocated from Vancouver Island to the Sechelt Peninsula, followed by 5 elk in 1994 to Powell River. These numbers were quickly supplemented with an additional 20 individuals from the previously set up Sechelt population (Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), 2012). These localized populations quickly flourished and the Elk Management Projects were very successful in revamping a provincial population that was in a state of disrepair.

The Lower Mainland Roosevelt Elk Recovery Project (LMRERP) was first initiated in 2000/2001 with the intent of relieving the conflicting interactions that elk populations were having with humans. These conflicts included a wide range of encounters, including an increasing amount of road and highway accidents (Brunt, 2001), agriculture plundering, as well as a continued high interest from hunters of both First Nation and non-First Nation ethnicity (Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), 2012). Initially, 11 different Roosevelt Elk Population Units (REPU's) were determined before translocating 257 Roosevelt elk to these areas. The REPU's were locations ranged from Jervis Inlet, various locations along the Sechelt Inlet, an assortment of locations in the Squamish Inlet and River, as well as Indian River and Pitt River. This immense task was completed with the support of local stakeholders, First Nations, the Habitat Conservation Trust Foundation (HCTF) and many volunteers. In 2007 an additional 5 year LMRERP was implemented. This new found plan was created with the intent of managing localized populations in the Sunshine Coast region as well as the continual expansion of the distribution of elk throughout the South Coast region (Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), 2012). In this second phase, 188 elk were translocated throughout the 5 years of the project to 10 different REPU's. While the first project focused on areas close to the Sechelt peninsula/inlet and north east of Vancouver where urban sprawl started to meet wilderness, the second 5 year project expanded north to the

Powell River region and nearby inlets/drainages, and moved further east of Vancouver into areas such as the Stave Lake watershed.

As of 2012, 23 REPU's have received elk as a result of this project. A total population estimate of 1411 is spread over these 23 units. While 10 are still classified as "recovering" units, 13 units have been defined as "recovered". A recovered unit is classified by a population that has reached a level of greater or equal than 50 individuals containing the correct age/sex composition. The project plans to determine a maximum sustained yield (MSY) for each population once each unit reaches this "recovered" classification equalling 50% of the carrying capacity.

Goals

A diminishing elk population in the Sechelt area spurred relocating elk in the 1980s. This region required an influx of individual elk to help it recover to its former strength. With the strong ability to facilitate a rapid increase in population numbers, like most individuals of the deer family carry (Cote, 2004), the Sechelt population rose quickly. Interestingly, by the late 1990's the population had begun to be considered a pest while still holding a position on the Provincial Blue Listed Species. Being on the Provincial Blue List indicates that while they are not extirpated, endangered, or threatened, they are a species of special concern and are vulnerable, and/or sensitive to human activities (Roddan, 2012). Because of the remarkable line that the provincial government was toeing by classifying this species as both, there was an obvious incentive to implement a strategy to solve both problems. In response, the question then became how a wildlife manager can reduce elk activities that interact with humans and identify them as pests, without diminishing their numbers? The solution was to relocate them into areas where their opportunity to connect with humans would be limited and/or areas where close interactions that did occur in areas of dense human population would not be an issue. The theory behind this thinking was that these projects would allow for a huge potential of population increase and would eventually take the Roosevelt Elk species off the provinces blue list. In addition, these projects would alleviate the pest problems where the source population was located and increase hunting access. A removal of the "Blue listed" classification would mean that native and non-native hunters could then increasingly harvest this species. Prior to 2001, only a handful of hunters were granted the right to hunt elk. Since the initiation of this project in

2001 the number of hunters whose applications have been approved has climbed to over 10 times.

Assumptions

A couple of major assumptions were made by the B.C. government's wildlife branch when creating this project. The biggest assumption made was that Roosevelt Elk populated these drainages before European settlement. While there is no question that they did populate a good portion of the units, it is uncertain if they populated all of them. Authors like Toweill and Thomas in "North American Elk: Ecology and Management" and Nyberg and Janz in "Deer and Elk Habitats in Coastal Forests of Southern British Columbia" are examples of how the literature describes elk population distribution prior to European settlement. These authors describe the Canadian range of Roosevelt Elk as being found predominantly on Vancouver Island. They also include populations on numerous islands in the Strait of Georgia and the Fraser River drainage west of the Cascade mountain range (Including the Indian Arm and south coast regions). In 2003 Quayle and Brunt from the B.C. Ministry of Water, Land and Air Protection Biodiversity Branch released the report "Status of Roosevelt Elk in British Columbia" in the Wildlife Bulletin No. B-106. In their report, they articulate that because detailed hunting techniques were found as far north as Bella Coola they have made the assumption that this is the northern tip of the Roosevelt Elk's historic distribution. Yet their assumption directly conflicts with previous literature. Nyberg and Janz concluded that the elk species in this area was the interior sub-species (Rocky Mountain). Additionally, Quayle and Brunt conclude that if the Bella Coola area was the historic northern tip, then the range of the modern Roosevelt Elk is substantially less than 150 years ago. Essentially Quayle and Brunt are assuming that because of this information, everything in between can be defined as historical elk range. Based on the lack of literature on coastal First Nation's hunting practices in this region and the regions in-between, this rational may have been overly confident in its 'rightness', especially when one considers that it was used as the foundation for developing a significant portion of an introduction project without further analysis. In addition, if elk had populated this area at one time, it would have been prudent to consider what sub-species they might have been. For example, elk on the south coast and mainland regions have been described as less pure than those herds of Vancouver Island. To assume that the introduction of a species that does not necessarily contain the same genetic material as the extirpated population is appropriate, is an assumption that has been continuously questioned by conservation biologists (Cooperrider, 2005).

Effects of the Presence of Elk in a Drainage

It has been hypothesised that the mere definition of "disturbance", defined as "a rapid release or reallocation of resources in a forest community" (White, 2001), ignores more gradual changes to forest community development which can be caused by irruptive population phases or overpopulations of herbivorous mammals, especially deer (Cervidae) (McLaren, 2004). (Cote, 2004). Davidson (1993) suggests that these changes to forest community development have the potential to be considerable, unpredictable and relatively irreversible. For example, creating a presence of elk in a drainage that they were not historically in has the potential to have extremely detrimental effects. At a first glance one might make the argument that adding a new species into an ecosystem would increase the biodiversity of the area. On the other hand, elk (as have other related deer species) have often been described as a keystone species (Cooperrider, 2005). As a keystone species, elk have the great potential to affect a lot of areas in an ecosystem. To illustrate this point, I will describe 3 examples of deer introductions around the globe and the inherent effects that have unintentionally arisen because of it.

Case Studies

Haida Gwaii – Deer

Haida Gwaii has been described as "The Canadian Galapagos" (Foster, 1982) by Haida and environmental activists in the 1970's due to its isolation from the mainland and its unique ecosystem make-up (Wikipedia, 2013). Because of this, as in Galapagos, its ecosystem is highly vulnerable to effects caused by invasive and alien species. Without this knowledge and insight into the inevitable companionship of plants and animals brought by European settlers, the later part of the 18th century can be characterized by this introduction phase (Golumbia, 2002). To date, 10 non-native mammals have been introduced to Haida Gwaii. 5 of these mammals originated as domesticated animals but have since set up feral populations. This represents almost half of the mammal species found on the islands today.

European Red Deer were first introduced to Haida Gwaii in 1918 from New Zealand. At the time of their release the new herd consisted of a buck, 4 does and 3 fawns. They quickly became a pest to the residents. However, this status was short-lived. The large herd that had formed by the 1940s had its numbers declined abruptly during World War 11 because of local hunting and overhunting by transient service personnel (B.C. Game Commission 1956; Carl and Guiguet 1972). The second attempt to introduce a new species to Haida Gwaii was in 1929 with the introduction of the interior species of Rocky Mountain Elk. While populations were initially successful, a combination of a harsh winter in 1969/70, the end of a temporary phase of succession following a fire in 1920 in and around the Tlell River, and the choice of the interior species over the coastal Roosevelt elk, negatively impacted the population. Currently the Interior Elk continue their limited distribution in these niche areas that sustain them, although they have not expanded as rapidly as other introductions to the island.

Sitka black-tailed deer were the first ungulates introduced to Haida Gwaii. Reverend William Collison, who lived in Masset from 1876 to 1879, is believed to have brought seven Sitka black-tailed deer to the island via a Hudson's Bay Company steam ship in 1878 (Golumbia, 2002). The deer thrived near Masset under the protection of a Hudson's Bay Company officer, but were quickly hunted to near extirpation after his departure (Golumbia, 2002). In 1911 The B.C. Game Commission felt that a new game species on Haida Gwaii was appropriate. The next 3 years saw over 30 deer introduced following by further introductions until 1925. Locals described the 1930s as a time of incredible abundance. Although the deer population suffered a decrease due to disease and a severe winter in 1950, populations were considered to be plentiful in 1951 and overabundant by 1954 (Golumbia, 2002).

This pattern of the population follows a model of growth, peak, and crash cycle based on the combination of food shortage, weather, and disease (Golumbia, 2002). This pattern is also supplemented by the increased amount of logging in the mid-20th century by creating an increased amount of forage available for deer. Current populations are suggested to be around 27-34 deer/km^2; which puts a total population at around 225,500 deer on Haida Gwaii.

The impact of overabundant Sitka black-tailed deer has been widespread. Similar to other ungulates in the deer family, black-tailed deer are selective browsers. This puts certain vegetation at much more of a risk to browsing than others. Species known to be impacted on the islands by deer include huckleberry (*Vaccinium* sp.), false azalea (*Menziesia ferruginea)*, salal (*Gaultheria shallon)*, salmonberry (*Rubus spectabilis)*, devil's-club (*Oplopanax horridus)*, sword fern (*Polystichum munitum)*, deer fern (*Blechnum spicant)*, Nootka rose (*Rosa nutkana)*, skunk cabbage (*Lysichiton americanum)*, Pacific crab apple (*Malus fusca)*, foamflower (*Tiarella trifoliate)*, and Western red-cedar (Banner, 1989). Records show that the incredibly high abundance of understory that used to characterize the large diameter old growth forests of Haida Gwaii has been severely reduced. This loss of foliage has had indirect effects on the local insect population which also translates to the local bird population. A correlation of the situation on Haida Gwaii can be found with multiple studies done on the effects of deer on plant diversity (Stockholm 2002) (Chollet, 2013).

Newfoundland – Moose

Towards the end of the 19th century the Canadian government initiated a moose introduction plan to Newfoundland. One male and one female moose were first introduced in 1878 from Nova Scotia followed by two adult males and females from New Brunswick in 1904. While moose have since become a cultural staple through hunting, evidence indicates that the likely reason for the initiation of this program was spurred for the desire to bring in tourism (Gaston, 2002). These efforts have been described by Anthony J. Gaston et al (2002) as a "way to support the struggling transportation systems arising in the late 1800's". This is contradictory to what government representatives had stated around that time. These representatives referred to this project as addressing the "...very great need down there for ample supplies of fresh meat during the winter..." (Gaston, 2002).

In 1898 the first passenger train ran on the trans-Newfoundland railway beyond the Avalon Peninsula. In 1917 the *Newfoundland Quarterly* proudly estimated that 300 tourists had visited the west coast of the island. This publication was also frequently boasted about the fine quality of hunting grounds found in Newfoundland compared to around the world for the use of tourists, sportsmen, and health-seekers. This idea that sport fishing and hunting were to be major attractions for visitors and would provide large revenues to the government continued until the end of the colonial government period. Douglas Pimlott initiated the first moose management efforts in the early days of the post-colonial government (1935-1958). By the 1960's Pimlott had seriously questioned the mandate of deer introduction. He rationalized that while moose had the potential to provide a meat source for both local and non-resident hunters, they also had the potential to damage forests. He later acknowledged that moose had had a negative influence on forests and that it was “a problem of considerable interest” for Newfoundland (Mercer, 2002).

It has been a realization that the management of the moose population is a necessity, and should have been managed from the beginning of Newfoundland’s post-colonial government. Since that time, the interest in the impact of the presence of moose on the island of Newfoundland has increased immensely. When analysing the impact it is important to keep in mind that hunters’ are the primary source of predation this population experiences. W.E. Mercer (2002) studied the effects of carrying capacities in Newfoundland moose. They found that while some of the decrease in moose numbers during the declines of 1958 and 1986 were the result of management, “changes to population size relative to K (carrying capacity), as well as changes to K in some areas, resulted in density dependant reproduction effects explaining >10% and up to 76% of the decrease”. They go further to say that their results are consistent to the general hypotheses of Saether (1997) who defines the relative importance of density-dependant versus density-independent factors for fluctuations in ungulate populations in the absence of predation. Mercer and McLaren also point out that in areas more easily accessible by hunters, the potential for hunters to impact population numbers is greater as compared to areas that are less assessable to hunters and therefore much more likely to hit K.

The effect of the overabundance of moose on the Newfoundland landscape and ecosystem continues to interest researchers. McLaren et al (2004) state that moose are having significant influences on three aspects of some ecosystems: forest succession and composition, soils, and other wildlife. Moose, like many other ungulates are very selective in their browsing. Because of their dietary preferences species such as balsam fir and selected hardwoods (both pioneer and shade tolerant species) have been greatly reduced over the landscape. As a result, the lack of preferred species surviving succession has created an open, spruce and larch dominated forest. Concerns of moose impacts on soil are dominated by the removal of low level plants acting as soil stabilizers that subsequently increases the amount of soil erosion. Finally, there is the potentially that other wildlife will be negatively impacted by the overabundant moose populations. The limitations of this paper prevent this author from fully exploring the details described by Cote et al (2004) in “Ecological impacts of deer overabundance”.

New Zealand – Red Deer

New Zealand's natural world, comparable to that of Haida Gwaii, evolved in the absence of any browsing mammals (New Zealand Government, 2013). Like other examples around the world in which a region is separated from the widespread of certain mammals, New Zealand's separation has created a composition of unique flora and fauna. During the 1800's European settlers brought numerous large grazing and browsing mammals (more than 50 species (Drew, 2012)) to New Zealand (New Zealand Government, 2013). Red deer were by far the most successful (Drew, 2012) and between 1851 and 1919 more than 250 European Red Deer were imported (New Zealand Government, 2013). With a vast food supply in an area with no predators or legal hunting (initially), these mammals easily adapted to New Zealand's environment.

By 1923 approximately 1000 Red deer had been liberated into the wild (New Zealand Government, 2013) and by the late 1940's 44% of New Zealand's mainland had established herds. This created substantial economic impacts because of the damage these mammals caused to agriculture crops, plantation forests, and the increase of disease transmission (New Zealand Government, 2013). As their numbers increased, plant species favoured by the Red deer disappeared from accessible areas (New Zealand Government, 2013). As a result, they transitioned from their favored species onto less favored species as well as the fallen leaves of preferred sub-canopy trees species (Fraser, 2005).

Similar to the findings of studies researching the moose in Newfoundland, Red deer populations in New Zealand have been found to be dominated by density dependant factors (Fraser, 2005). These Red deer typically pass through a population irruption which is classically described in three phases: pre-peak phase, peak phase, and post-peak phase. The first phase is characterised by the initial invasion and by an exponential increase in numbers. The second phase is comparatively stable in terms of (although highest) population numbers. This phase is characterized by population growth being prevented by a simultaneous decrease in fecundity and an increase in fawn mortality. Falling population numbers and the quality of available food distinguish the third phase. Populations in this phase normally reach relatively close to the long-term carrying capacity of the habitat. While populations reach carrying capacity in this phase, browsing continues to prevent the regeneration of long-lived, shade tolerant, tree species, significantly changing the stand dynamics in heavily populated areas.

The solution to New Zealand's deer population problem came in the 1960's through the creation of a feral venison export industry. Harvest was initially focused in areas and parks that were heavily populated but grew into deer farms. These were located on private properties with the realization of the economic success. To date New Zealand has approximately 4,000 deer farms that produce products such as venison, velvet antlers, co-products (pizzles, sinews and blood products), hides and leather (Deerfarmer.com, 2003). 90% of these products are exported with a total 1999 value of just over NZ$209 Million. While this provides incentives for wild Red deer hunting that contributes to balancing population numbers, this species can no longer be eradicated (Hollond, 2012). At this stage, one begins to question at what density should New Zealand aim for? Why that number? And who decides?

Discussion

The Sitka deer in Haida Gwaii, the moose in Newfoundland, and the Red deer in New Zealand share many similarities. All three of these previously isolated areas had ungulate introductions by European settlers for the purpose of hunting. Moreover, each area had distinct boundaries, which inflicted an island type boom and bust population cycle that was historically new to the presence of large ungulate browsers. And finally, the disregard of the importance of natural predators during the introduction process occurred in all three areas. As seen through the presented case studies, the European settler's repeatedly disregarded the potential effects these large ungulates could have on the land. As this disregard happened repeatedly, we have very good examples to study the results. The results point to the conclusion that because of the lack (or low levels) of predation, it is highly likely that population numbers will continue to increase until food supply becomes their limiting factor, regardless of hunting.

In Haida Gwaii the deer population is uncontrollable and irreversible (Gaston, 2002) and as a result the "Galapagos of the north" will never be the same. In a time when environmental knowledge was unknown and uncared about, the decision made by a select few has ruined one of nature's incredible miracles. With Hiada's unique forest, distinct boundaries and lack of natural predators, the exponential expansion of the deer population along with their keystone effects have changed the Haida Nation forever. The unfortunate addition in the Haida Gwaii case is that these stunted black tailed deer do not provide a quality meat source or much economic gain for locals. This is unlike the other case studies, which have this to lean on in retribution.

In Newfoundland, there are more than 80,000 resident registered hunters. Despite these high numbers the economic benefit provided by non-resident hunters is still a much higher fraction of revenue collected from fish and game licenses. This revenue totalled $4.3 million in 2002. Additionally, the provincial government and the Newfoundland and Labrador Outfitters Association mutually recognized that the economy involving non-resident hunters was an estimated $40 million (Mercer, 2002). This accounts for approximately 16% of an estimated $250 million tourism industry which makes up less than 1% of the total economic activity in the province (Gaston, 2002). While this industry provides modest economic gain for the province of Newfoundland, the environmental effects are irreversible and will greatly change the forest structure for the younger generations.

New Zealand has had the greatest success with their introduction out of the three case studies. Since the 1960’s the venison export industry has become a major economic industry for the people of New Zealand. Despite the success of this industry New Zealand still faces many challenges in terms of Red deer management. Currently there is an “uncomfortable mix of regulation between treating them as invasive pests threatening indigenous species and environments and benefiting from the socio-economic purposes they provide” (Figgins, 2012). As it has been widely recognized that the species would be impossible to eradicate, the economic gain these deer provide for many New Zealanders comes at a catastrophic price.

The Elk Management Projects that have been the dominant goal of the coastal B.C. wildlife branch in the past decade have had a very positive effect on the future possibility of removing Roosevelt Elk from the Provincial Blue List. Additionally, the amount of approved hunting applications has increased ten folds with the potential for further increase in the near future (Wilson, 2012). With the entire B.C. Roosevelt Elk population spread over a larger distance, there is the potential for increased hunting of Vancouver Island herds. This would assist in reducing elk – human interactions, which is another major goal for the branch. With these three issues as the primary incentives for the project, one can look at it as a great success in terms of meeting project goals.

Looking at this project from a different angle the possibility of a different future can be envisioned. The three case studies described provide an illustration of many ungulate populations around the globe that have become problematic. I have discussed how the lack of natural predators and a boom-bust population cycle is common. Without natural predators to keep population numbers at a constant level, herbivore levels are variable. As their numbers increase the selective browsers that ungulates are, tends to present a forest floor very different than one lacking these high populations. For plant species that are shade tolerant and have a long life span, this could be detrimental. For example the gradual loss of Balsam fir on Newfoundland as well as the loss of Cedar in Haida Gwaii illustrates this point. Cedar is a major component in these coastal drainages as well as being the most valued. Losing, or reducing, the presence of this species will have negative impact on the future forest industry that should not be taken lightly. In addition, selective browsing can potentially mean the further loss of biodiversity. Secondly, the extent of this project might seem worrisome. As previously stated, the assumption regarding the extent of the range, which Roosevelt elk historically occupied, is relatively un-documented in previous literature. While literature on the subject has continuously stated that elk were much more widely distributed historically, it is often only been described in terms of the lower mainland/Fraser Valley area west of the Cascade mountain range, the south coast, and Vancouver Island. Furthermore, while human pressures have been a primary force in reducing elk population numbers, it seems unlikely that this would have been the case in these remote drainages during the time period of focus. Thirdly, while the combination of purposes for this project seem to balance each other out, arguments can be made of which purposes held more weight. A report by the B.C. Wildlife Federation in 1994 shows that almost all money received from hunting and fishing licenses equals the wildlife management budget across Canada. While this is averaged over the entire country, this provides some insight on where incentives for which projects to focus on might come from. The question then becomes: are our wildlife managers and conservationists managing for ecosystem biodiversity and resilience or have they switched over to managing for freezer meat?

While all three of these possible implications are up for discussion, it is important to keep in mind that this discussion has the potential to be dominated by values. Despite the fact that all three case studies are very relatable, the major factor that differentiates these drainages is that it is reasonable to assume that predators are present in (if not all) a majority of these drainages.

Recent wolf presence studies that have focused on the central and north coast of British Columbia found that they are present on most islands that support deer populations (Darimont, 2002). Darimont and Paquet stated that wolves' ability to swim is quite high and they can swim up to 2 kilometers in fresh water. While the ocean requires much more energy for swimming, currents could potentially play a part as well. It is possible that wolves and their ability to swim to isolated coastal areas and islands may be the answer in keeping ungulate numbers in check. In contrast though, examples in Alaska show that deer and wolves can coexist at a relatively high equilibrium although the potential for under representations of preferred species is still highly present (Kirchhoff, 2002). This returns this discussion back to the question: should elk be in these drainages at all? And, were the historic, or current, stand dynamics of the south coast ever influenced by the presence of these large ungulates?

Conclusion

Elk management projects have been a large portion of the B.C. government's wildlife branch's efforts for the past decade. While in terms of their own goals this project has been deemed a success, questions arise over whether there are possibilities for a potential backfire. Examples around the world have shown that predicting ungulate population trends can be extremely difficult as well as pose the possibility of severe negative impacts. Moreover, questions regarding drainage choices arise with conflicting views over the boundaries of historic elk ranges. A lack of documentation and local knowledge provides little room for defense on either side. Finally, management strategy aside, the weighting of which goals most effected this project's initiation is controversial. While these goals were not concealed, some may have been more of a benefit than goals. These questions provide important insight to further research that is required to fully understand the long-term effects of these projects. Further insight will answer the question of whether these projects, or their extent, were appropriate.

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