Pilot Study of Grey Wolf (*Canis lupus*) Feeding Ecology in the Brittany Triangle and Nemiah Valley Progress Report: May 2013 to February 2014

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LEGAL COVENANT FROM THE XENI GWET'IN GOVERNMENT

When the draft of this report was completed in March 2014, the following legal covenant was included: *The Tsilhqot'in have met the test for aboriginal title in the lands described in Tsilhqot'in Nation v. British Columbia 2007 BCSC 1700 ("Tsilhqot'in Nation"). Tsilhqot'in Nation (Vickers J, 2007) also recognized the Tsilhqot'in aboriginal right to hunt and trap birds and animals for the purposes of securing animals for work and transportation, food, clothing, shelter, mats, blankets, and crafts, as well as for spiritual, ceremonial, and cultural uses throughout the Brittany Triangle (Tachelach'ed) and the Xeni Gwet'in Trapline. This right is inclusive of a right to capture and use horses for transportation and work. The Court found that the Tsilhqot'in people also have an aboriginal right to trade in skins and pelts as a means of securing a moderate livelihood. These lands are within the Tsilhqot'in traditional territory, the Xeni Gwet'in First Nation's caretaking area, and partially in the Yunesit'in Government's caretaking area. Nothing in this report shall abrogate or derogate from any aboriginal title or aboriginal rights of the Tsilhqot'in, the Xeni Gwet'in First Nation, or any Tsilhqot'in or Xeni Gwet'in members.*

On June 26, 2014, the Supreme Court of Canada (SCC) (*Tsilhqot'in Nation v. British Columbia*) granted the Xeni Gwet'in aboriginal title over part of their claim area that includes the Nemiah Valley portion of my wolf study, Elkin Creek, but only a small portion of the Brittany Triangle.

Acknowledgements

The researcher would like to offer thankfulness and appreciation to the Xeni Gwet'in community of the Tsilhqot'in First Nations for welcoming us onto their traditional territory to carry out this research. Sechanalyagh!

The researcher would like to express gratitude for the time and input of Drs. Paul Paquet, Shelley Alexander, and Chris Darimont; their scientific insight and guidance on this project has been indispensable. Thank you as well to the Canid Ecology Lab at the University of Calgary, Department of Geography, for collaboration and assistance, and special appreciation goes to graduate students Victoria Lukasik and Jamie Lantz for assisting in scat analysis.

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A special thank-you goes out to Wayne McCrory, David Williams, David Setah, and Rye Green for taking the time to show me around this incredibly rich and unique biological area.

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Progress Report and Summary of Findings

This study was commissioned by the Valhalla Wilderness Society (VWS) to provide a preliminary assessment of grey wolf (*Canis lupus*) feeding ecology in the Brittany Triangle and Nemiah Valley within the Chilcotin region of British Columbia, Canada.

This Year 1 progress report outlines a summary of the field work, research, and findings to date performed by Sadie Parr of Wolf-to-Willow Wildlife Services on behalf of the Valhalla Wilderness Society and in partnership with Friends of Nemaiah Valley (FONV), Wolf Awareness Inc., and the Xeni Gwet'in community of the Tsilhqot'in First Nations.

Field work for this pilot study was performed during four separate visits to the research area in May/June, August, and September/October of 2013 and February 2014. Results are preliminary and further study is recommended. All comments of a scientific nature should be addressed to the author; email: sadieparrwolfpact@gmail.com.

Cover photo taken from remote camera set up by Sadie Parr in Brittany Triangle.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

This progress report outlines the results of background and field research for a pilot study focused on examining the dietary niche of grey wolves (*Canis lupus)* in the Brittany Triangle and Nemiah Valley of the Chilcotin region of British Columbia (BC).

In 2013, field research was initiated and carried out during May 1-June 6, July 25-30, September 25-October 15. Winter field research was conducted February 5-March 4, 2014.

The study was preliminary and focused on acquiring baseline data about the annual diet and feeding ecology of the grey wolf, an arch predator, in two adjoining parts of the Chilcotin region: (a) the remote Brittany Triangle and (b) areas of the Nemiah Valley occupying ranch lands. Although wolves have been documented as a keystone species capable of causing trophic cascades (Beschta et al. 2014, Ripple and Beschta 2011, Hebblewhite et al. 2002), very little is known about wolves in the Chilcotin.

Within this region, some ranchers and sustenance hunters believe that wolves are responsible for recent cattle, moose, and/or horse declines (personal communication with various local residents). This study hopes to address these concerns through the gathering of reliable information on the food habits of the wolves in the area. Using wolf scats and stable isotopes from hair and tooth samples collected in the field, the researcher hopes to determine what prey species wolves are selecting as food resources, including wild horses and domestic cattle. Besides providing baseline information to the management agencies and local ranching community, the study will also shed light on trophic relationships and energy flow in this region, and help to detect the occurrence of wolf dietary specialization and the presence of dietary seasonal shifts in feeding behaviours.

Wild horses are unique to the study area, and their interactions with wolves (and other predators) as a method of top-down population control and behavioural ecology has gone largely undocumented. This study will help to provide insight into predator-prey relationships among wolves and wild horses, as well as many other potential prey species.

The intentional reduction of wolves across North America up until the 1970s has facilitated ungulates to thrive in many areas (Musiani and Paquet 2004). Inflated ungulate populations have been linked to causing various environmental effects: soil loss, compaction, and erosion; reducing growth of vegetation; reducing plant species richness; inducing mortality of native trees through bark-chewing; damage to bog habitat; damage to water bodies; and the facilitation of weed invasion (Nimmo and Miller 2007).

The foraging ecology of wolves serves as an essential component to understanding the role that top carnivores play in shaping the structure and function of terrestrial ecosystems; this project will constructively address related knowledge gaps that exist in the Chilcotin ecosystem.

Understanding the feeding ecology and trophic relationships among wolves and their prey has ecological, evolutionary, and conservation implications. Free-ranging large predators make this area unique when compared to most other parts of the world. Comprehending the biological requirements of large carnivores can help ensure that sound management decisions are made to ensure that planning meets and is in sync with ecological and conservation objectives.

1.1 Key Findings

1.1.1 Biological

- Verified presence of wolves in both study areas through tracks, scat, and remote camera images.
- Conducted preliminary interviews with 39 people.
- Spent more than 70 days doing field surveys over 3.5 months.
- Covered approximately 550 km of field transects.
- Set up 4 remote camera stations; organized 167 videos/photos from 433 camera days.
- A wide variety of potential prey available for wolves within the study area was documented through remote camera capture, direct observation, or observation of their sign including: wild and domestic horses, moose, mule deer, beaver, salmon, small mammals, and domestic cows. Several temporal (seasonal) shifts were observed during which opportunities were created such that wolves could potentially benefit from a peak vulnerability of a specific potential prey species. These events were observed and also learned about through informal interviews with local residents of the Nemiah Valley.
- There is an abundant supply of spawned sockeye salmon available to wolves in the fall on the shores of Chilko Lake as well as in Nemiah Creek. Small numbers of spawned chinook are also available in Elkin Creek.
- High growing and robust willow bushes (*Salix* spp.) surrounding the banks of streams and rivers in the Brittany Triangle are potential indicators of a healthy predator population in this ungulate-rich ecosystem, as described by Smith and Ferguson (2005) and Ripple and Beschta (2012) when documenting the return of wolves to Yellowstone National Park after a reintroduction program in 1995/96. This research introduced the concept of the "Ecology of Fear" whereby the mere presence of wolves on a landscape was documented to influence ungulate behaviour as well as numbers, thus affecting plant growth and ultimately contributing to various other direct and indirect trophic relationships (Beschta et al. 2014).
- Areas of higher wolf use and traffic were identified through tracks, scat, and remote camera images.
- Collected 10 wolf hair samples and 2 wolf tooth samples for future isotope analysis.
- Collected 67 samples from potential prey species (hair, tooth, bone, or antler) for future isotope analysis (to determine each species' isotopic signature).

Breakdown of potential prey samples for future isotope analysis:

- horse = 32 hair, 1 tooth (n = 33)
- moose = 13 hair, 2 antler (n =15)
- deer = 4 hair, 2 tooth (n = 6)
- beaver = 5 hair, 4 tooth (n = 9)
- muskrat = 1 hair (n = 1)

- Collected and analyzed 26 wolf scat samples (10 of these were from one dead wild horse site where the carcass appeared to be scavenged).
- Through macroscopic and microscopic examination of 26 wolf scats, observations confirmed that wolf scat in the research area (both Brittany Triangle and Nemiah Valley) contained horse hair, distinguishable by its length and colour, as well as other prey species (deer, beaver, small mammal (including rodent), and domestic cow). Notably, none of the scat samples analyzed contained evidence of moose remains.

Breakdown of scat analysis results for Nemiah Valley:

- N = 5 scat samples - all collected in February 2014.
    - horse = 1
    - deer = 1
    - beaver = 1
    - cow = 2
    - small amount of small mammal remains (feline and rodent) among one scat containing cow

Breakdown of scat analysis results for Brittany Triangle:

- N = 21 scat samples: May 2013 n = 3, October 2013 n = 2, February 2014 n = 16 *
- MAY 2013 (n=3)
    - horse hair (only) = 1
    - deer hair (only) = 1
    - mix of horse and deer hair = 1
- OCTOBER 2013(n=2)
    - deer hair mixed with small mammal (rodent) hair = 1
    - small mammal (rodent) mixed with berries = 1
- FEBRUARY 2014 (n = 16*)
  *Note that 10 of these samples were collected from one site where a horse carcass was identified and observed to have been shot through the lower jaw.
    - horse hair (only) = 10
    - deer hair (only) = 5
    - mix of horse and deer hair = 1
    - vegetation was also found in small and trace amounts

1.1.2 Human perceptions and management

Twenty-seven people were informally interviewed in relation to their knowledge of, perceptions about, and interactions with wolves in an effort to gauge and understand the range of attitudes and practices towards wolves within the research area. In the future, the researcher would like to conduct formal interviews using a standard format to elucidate and document this spectrum of opinions in greater detail. Shareholders interviewed included:

- six Xeni Gwet'in First Nation community members
- two non-First Nations local residents

- two local ranchers
- one local trapper
- fifteen youth
- three provincial government wildlife managers (Conservation Officer, Provincial Predator Conflict Prevention and Response Coordinator, and Director of Resource Management - Ministry of Forests, Lands and Natural Resource Operations-FLNRO)

The interviews indicated that there is a discrepancy of attitudes and perceptions about wolves among the local people in the Nemiah Valley, with a coinciding wide range of management methods (e.g., from baiting and killing them to not hunting them at all).

- Dialogue with local residents revealed that there were concerns about wolves killing domestic cattle and both wild and domestic horses.
- It is not uncommon practice for local residents with domestic stock to leave the carcasses of livestock that died available to be fed upon by wolves (and other scavengers).
- Traditional Xeni Gwet'in knowledge holds wolves in high regard, with unique cultural practices surrounding this species.
- In 2012, a $73,000 FLNRO government-funded trapping and training program occurred in the Chilcotin region aimed at teaching local First Nations residents to trap wolves and other furbearers, and to restore wild horse corrals as part of a "moose recovery program" (Rodger Stewart, pers. comm.). This was overseen at the provincial level by Rodger Stewart, the director of Resource Management for the Cariboo District, and operated in partnership with the Tsilhqot'in First Nations Government (TNG) and administered by Tribal Chief and Chair Joe Alphonse. Only four wolves were reported to have been trapped through this program (Rodger Stewart, pers. comm.).

2.0 CONTEXT AND STUDY AREA

This research project is focused on examining the dietary niche of grey wolves (*Canis lupus)* in a remote and unique part of the Chilcotin region of British Columbia (BC). Beginning in May 2013, baseline data began to be acquired on the foraging ecology of wolves within the Brittany Triangle, one of Canada's three remaining wild horse (*Equus caballus*) territories (McCrory 2002, FONV 2008).

The Brittany Triangle is located in the Chilcotin region of central BC, approximately 200 km north-northwest of Vancouver and within the Rainshadow Wild Horse Ecosystem (McCrory 2002). The "Triangle" is approximately 155,000 ha contained within the natural boundaries of the Chilko and Taseko rivers. This study area is comprised of a large foothills plateau, as well as the eastern ranges and foothills of the Coast Mountains (McCrory 2002). The Triangle has only one small protected area, Nunsti Provincial Park (20,898 ha). The Triangle remains remote and is bounded on the south by Ts'il?os Provincial Park. The study area is within the Xeni Gwet'in First Nation's traditional territory, known as the Nemiah Aboriginal Wilderness Preserve (1989) and research was done with the permission of Xeni Gwet'in. BC Parks provided a research permit for work in Nunsti Park.

Wild horses in the Brittany Triangle are common and contribute to a unique ecosystem hosting a full range of potential prey for wolves, which are also known scavengers. This area provides essential habitat and wildlife corridors for a full guild of large carnivores, including the grey wolf, grizzly bear (*Ursus arctos)*, mountain lion (*Puma concolor*), wolverine (*Gulo gulo*), and lynx (*Lynx canadensis)* (McCrory 2002).

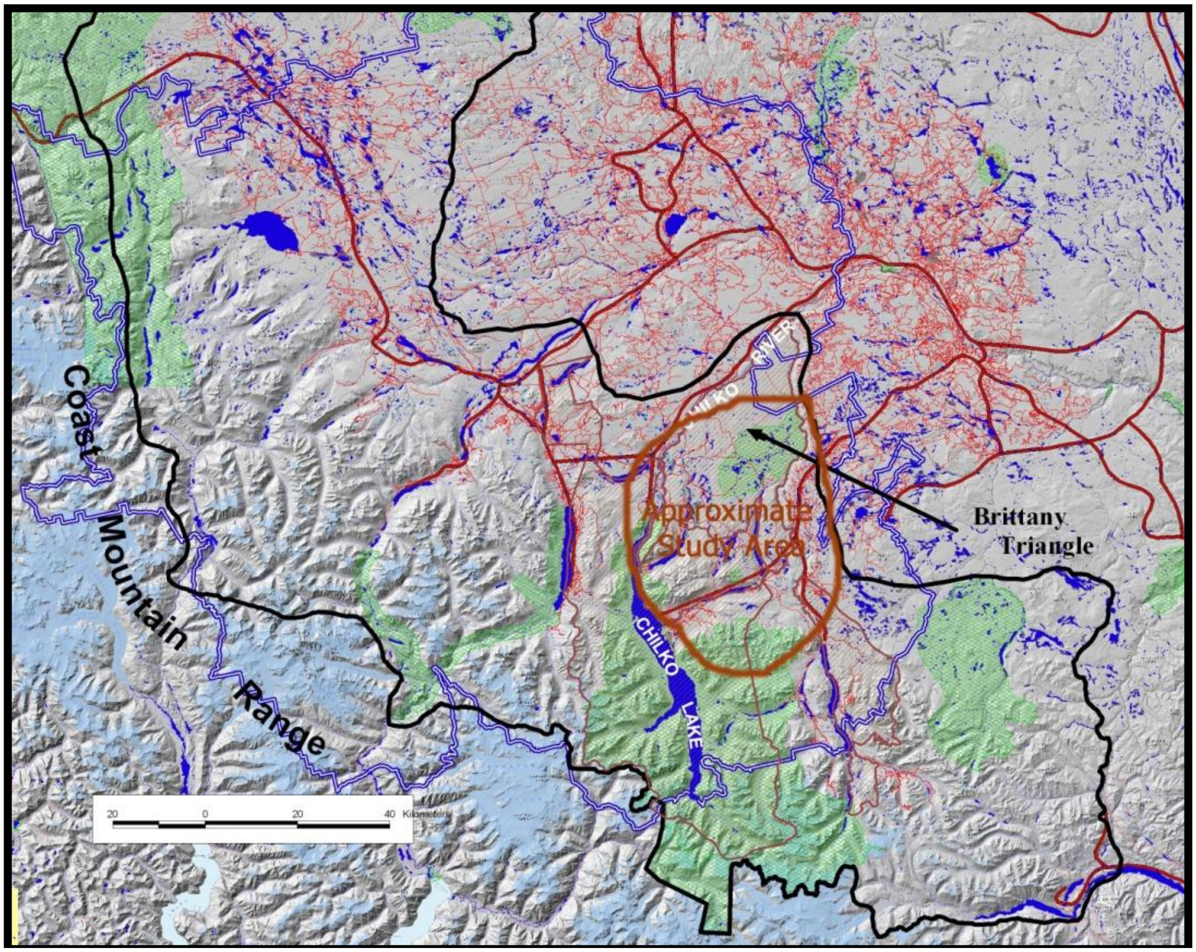

Figure 1. Map of approximate study area location.

The study area extends to the adjacent Nemiah Valley, where wolves still range in habitats that overlap with small ranches and tenured open range for domestic cattle (*Bos primigenius*) and horses. The two areas will be treated separately and compared.

Wolves are relatively protected from human pressures within the grassland-forest matrix of the Brittany Triangle. Conversely, the Nemiah Valley abuts the Brittany Triangle on the south and is occupied by Xeni Gwet'in First Nation and settler families with small cattle-ranching operations, thus not affording wolves the same level of isolation from anthropogenic features.

The Brittany Triangle is a unique region of study for several reasons: 1) It has managed to remain fairly isolated from human encroachment. 2) In addition to wolves, it supports all of North America's top predators. 3) It supports horses that exist in wilder conditions compared with herds in the US, where most or all of their potential predators have been extirpated

(McCrory 2002). 4) It will enable a comparison of management-driven ecological factors and implications among exploited versus non-exploited wolf populations.

The potential existence of predator-prey interactions among wolves and other species was preliminarily examined using direct field observations; indirect observations through field sign, scat, and tracks; and by capturing wildlife images with a timestamp on remote cameras. Some of the species identified in this way included wild horses, moose (*Alces alces*), mule deer (*Odocoileus hemionus*), beaver *(Castor canadensis*), spawning salmon (family *Salmonidae*), and small mammal species. A continuation of this study would also attempt to determine predation on domestic cattle and domestic horses and, if sufficient hair samples can be obtained, California bighorn sheep (*Ovis canadensis*) and mountain goat (*Oreamnos americanus*).

2.1 Background Ecological Factors

Although the grey wolf is one of the world's most widely distributed animals, approximately one-third of its range has been reduced by human persecution and/or habitat fragmentation, and it has been extirpated from much of Western Europe, the United States, and Mexico (Ripple et al. 2014). Habitat loss, persecution, depletion of prey, and human intolerance are threatening large carnivores around the globe, with three-quarters of the world's largest carnivores now in decline (Ripple et al. 2014). At the same time, we are only just beginning to understand the dynamic and important ecological influences and economic benefits that large carnivores, such as wolves, contribute to the ecological health of the planet.

Wolves and other large carnivores exert many direct and indirect effects on ecosystems. For example, wolf direct effects have been documented for controlling populations of ungulates and mesopredators, while indirect effects have been documented for a variety of other species and services, including but not limited to small mammals, scavengers, songbirds, insects, vegetation growth, stream morphology, disease control, carbon sequestration, and mesopredator control (Ripple et al. 2014, Ripple et al. 2012, Hebblewhite et al. 2002, Schmitz et al. 2103, Vic Stronen et al. 2007, Smith and Ferguson 2005).

The decline of large carnivores, including wolves, in North America and around the world has disrupted ecosystems, causing cascading changes that have resulted in a decrease in biodiversity, and created artificially inflated ungulate populations as documented in Yellowstone and Banff national parks (Ripple and Beschta 2012, Hebblewhite et al. 2002). Where wolf populations have been extirpated or exploited in North America, a cascade effect is observed in which small mammals, fish, insects, birds, amphibians, ungulates, tree species, and vegetation all suffer (Hebblewhite et al. 2002). The impoverished state of the ecosystem in Yellowstone that resulted from the extirpation of wolves has since been dramatically reversed through the re-introduction of wolves into their native area; however, not all wolf reintroduction efforts are successful (Ripple and Beschta 2012, Smith and Ferguson 2005).

Wolf predation on large herbivores has been well documented (Hebblewhite et al. 2002, Mech and Boitani 2003, Rutledge et al. 2010, Smith and Ferguson 2005, Urton 2004, Urton et al. 2005). However, predatory interactions between grey wolves and wild/feral horses has not been well investigated in North America (L.D. Mech, pers. comm. through Wayne McCrory). A knowledge gap also exists in my study area for interactions among wolves and cattle, salmon, beavers, small mammals, and various wild ungulates including moose, mule deer, California bighorn sheep, and mountain goats.

Wild horse survival rates in many areas of North America appear high because few areas contain substantial numbers of their original natural predators. Without predators to keep these animals in check, herds can double every four years (Wild Horse and Burrow Program 2008). Where predation of horses is known to occur, few studies have been conducted, with most of those being in the United States.

An estimated 1600 feral horses live in the Chilcotin region of British Columbia (David Williams pers. comm.) and a knowledge gap exists concerning their ecology and their role within the ecosystem. There have been contrasting suggestions on the growth rate of herds, some stating that their numbers are uncontrollable whereas others argue they are being kept in check by predators and starvation winters.

If these horses are being kept at moderate population levels, which predators are likely to be consuming them? Wolves are flexible and opportunistic predators that are adapted to feeding on a diverse array of foods (Mech and Boitani 2003) and these carnivores may bear influence on horse populations since they have been known to regularly feed on them in Spain and Mongolia (L.D. Mech pers. comm. through McCrory).

In a study in the Montgomery Pass Wild Horse Territory along the California-Nevada border, Turner and Morrison (2001) found that the mountain lion population significantly influenced the number of horses by predating on foals. Mountain lions appeared to prefer foals with a sorrel coat colour, possibly due to the similarity in colour to the coats of mule deer, their preferential prey (Turner and Morrison 2001). Other areas in Nevada have also reported high predation on foals by mountain lions (Greger and Romney 1999).

The birthing season of wild horses coincides with increased energy requirements for wolves as young pups are growing quickly at this time. McCrory believes that horse numbers would be maintained at appropriate management levels if wolves were not being adamantly persecuted by individuals. However, many people who believe there are too many horses also think there are too many wolves (David Williams, pers. comm.).

It is interesting to note that the size of individual wolf packs may also influence the selection of prey species (and age) that wolves are able to successfully take down, as well as contribute to the amount of prey consumed by wolves and thus kill rates (Hayes 2010, Zimmerman 2014, Haber and Holleman 2013). For example, a Yukon wolf study by Hayes et. al. (2005) found that:

> *... ravens steal seventy-five percent of the moose killed by small packs, and they got less and less as wolf pack size increases*

For this reason, among others, remote cameras and track counts along survey routes will also be used to estimate the size of wolf packs using this study area.

Wolves can be an essential limiting factor in keeping ungulate populations in balance. Wolf kills also provide important food resources for scavengers (Ripple and Beschta 2012, Smith and Ferguson 2005, Mech and Boitani 2003). Knowledge of the feeding behaviour and a greater understanding of the role wolves play in this unique Chilcotin ecosystem will help guide accurate perceptions; influence planning, management, and conservation decisions; and facilitate preparation for future coexistence among wolves and local ranchers.

In this report, the term wild horses will be used to describe the free-ranging horses found within the Brittany Triangle, although it is important to note that the wild horses in this paper are referred to as feral horses elsewhere in the literature (the terms are often used interchangeably). I feel that wild describes a species that lives in the wilderness, performs ancestral wild behavioural patterns, and has a survival-oriented life cycle, as the horses of the Brittany Triangle have been documented and described by Wayne McCrory (2002).

2.2 Wolf Social Factors and Implications

Efforts to control wolves through hunting and trapping do not lead to a predictable nor consistent change in wolf populations, but they do fracture stable family groups (Rutledge et al. 2010, Wallach et al. 2009). Contemporary research suggests that a disruption of wolf social structure (through indiscriminate killing) can also negatively influence the ecological role of wolves (Rutledge et al. 2010) and lead to increased conflicts with livestock and humans (Wallach et al. 2009). One observable negative symptom of pack disintegration (loss of social stability regardless of population size) caused by wolf reduction programs appears to be an increase in attack rates on livestock (Muhly et al. 2010, Wallach et al. 2009, Wydeven et al. 2004).

Drs. Chris Darimont, Paul Paquet, and Linda Rutledge are among several wolf biologists who urge that conservation of wolves and ecosystems requires managing the species at the level of the family unit. This will require maintaining not only viable populations, but also naturally functioning populations where "fitness is likely to be optimized when evolutionary adaptation is driven by natural rather than artificial (i.e., human-mediated) selection pressures" (Rutledge et al. 2010, and personal communication).

Rutledge et al. (2010) states that the wolves' "social component may stimulate natural regulation at other trophic levels" and is "evolutionarily important." **The stability of wolf packs may be as important to their role as a keystone species as is population size, but this critical factor is often not considered in conservation management plans for wolves in North America**.

2.3 Conflicts Between Ranchers and Wolves Related to Domestic Livestock

The background research and interviews I did for this study indicate that some parts of the Nemiah Valley study area support domestic cattle where legal grazing rights have been secured by private owners. There are also some small herds of cattle that roam wild. Horses also roam freely within the Nemiah Valley, known as "Qayus" or Wild Nemiah Horses. Some of these animals have been halter-broke and are may be considered semi-domestic. When Xeni Gwet'in run out of hay in late winter, they traditionally let their horses free range as a survival strategy and then capture them (when they can) through seasonal round-ups (Roger Williams, pers. comm.). There are a number of local residents in or near the Nemiah Valley study area that report domestic cattle and horses killed by wolves.

Where wolves and livestock overlap, there will always be occasional losses; however, this usually amounts to less than 3% of all livestock deaths (Muhly and Musiani 2009). Throughout the lifespan of a domestic animal, weather, genetics, birthing, disease, vehicle collisions, and transportation all pose much greater risks to survival (Muhly and Musiani 2009, Musiani, M., Boitani, L., & Paquet, P. (Eds.). (2009).

Wolf biologists have spent decades investigating the correlations between wolf depredations and raising livestock. Most research indicates that culling wolves has not been shown to reduce depredation rates over time, unless wolves are exterminated (Musiani, pers. comm.). Indeed, there is no evidence to show that indiscriminately killing wolves works as a long-term solution; depredations occur in areas that have been practicing lethal control for decades (Muhly et al. 2010, Musiani and Paquet 2004, Wallach et al. 2009). In a comprehensive review by Wielgus and Peebles (2014), twenty five years of data indicated that the number of wolves killed in one year is positively correlated with the number of livestock depredations the following year. In other words, this report provides more evidence that killing wolves can create and lead to increased conflicts with humans with an increased number of livestock depredations.

The BC government currently administers a livestock loss compensation program that compensates ranchers for 75% of the value of the animal(s) lost to natural predators. According to the BC Ministry of Agriculture website[1], ranching occurs on 10 million hectares (ha) of BC land and, of this, 8.5 million ha (85,000 sq km or 32,819 sq miles) is Crown (public) land.

2.4 Wildlife Management

A government-funded trapping program for wolves (and other fur-bearers) took place during 2012 in parts of the Chilcotin close to the study area (see results for objective 3: Investigating Human Perceptions and Management, p. 40). This was part of a "moose enhancement" program (Rodger Stewart, pers. comm.). In recent years, such programs have been used to target wolves in an effort to address concerns about declining moose populations and livestock depredations. In some manner, government wolf-trapping programs continue at the time of writing this report through current policies calling for conservation officers (COs) to hunt/trap wolves on public land where livestock concerns arise.

Wild horse round-up programs have also occurred in and around the study area within the past decade as a means of controlling numbers, although this is based on anecdotal information (Wayne McCrory, pers. comm.). Therefore, an examination of the dietary behaviour of wolves will help to manage accurate public perception regarding wolves as they relate to livestock and the wild horse herds within and around the Brittany Triangle and Nemiah Valley, as well as provide insight into predator-prey relationships within the study area.

The wolf's diet forms the core of human conflict with this carnivore (Mech and Boitani 2003). Biologist Wayne McCrory, who provided the 2002 Preliminary Conservation Assessment of the Rainshadow (Brittany Triangle) Wild Horse Ecosystem for FONV, believes that wolves are in the greatest need of protection among a plethora of wildlife in the Brittany area (McCrory, pers. comm.).

As well as a current lack of information pertaining to wolf predator-prey dynamics in the study area, there is a lack of information and understanding about how current wolf management practices in BC (exploited population versus protected population) affect social dynamics, ecological role, and/or occurrences of human/livestock-wolf conflicts. The current proposed *Provincial Management Plan for the Grey Wolf* itself has been criticized by renowned biologists and NGOs as neglecting to include relevant and contemporary wildlife science (Raincoast Foundation's Dr. Chris Darimont and Dr. Paul Paquet, pers. comm.). A public education component as well as open communication and interviews with affected local people will be part of the project as it continues.

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[1] Source: http://www.gov.bc.ca/agri/

3.0 STUDY OBJECTIVES AND METHODOLOGY

3.1 Study Objectives

By obtaining baseline data on the foraging habits of wolves in the Chilcotin region, the community and the province will be better equipped to make informed decisions on ecosystem management and conservation. Conservation and heritage values can thus be better provided for and maintained by collecting this information.

The primary goals of this pilot study were as follows:

- to assess whether further research on wolves (specifically in regard to feeding ecology) in the study area is feasible by documenting wolf sign and activity abundance;
- to determine areas of high wolf use within the study area and to establish survey routes for tracking and sample collection, as well as determine best locations for remote camera stations;
- to collect wolf and potential prey hair samples in the study area for future analysis;
- to collect and analyze wolf scat from within the study area;
- to gain a preliminary understanding of wolf feeding habits in the study area, including seasonal changes; and
- to investigate local human perceptions and practices regarding wolves to assess (preliminarily) the spectrum of both.

The first year of this wolf feeding ecology study focussed on three main objectives using a complement of non-invasive field techniques:

- Objective 1: Scat collection and analysis
- Objective 2: Hair and inert tissue collection for future isotope analysis
- Objective 3: Preliminary investigation of the human dimension

Documentation of the wide menu of grey wolves in the Brittany Triangle and Nemiah Valley may help facilitate the preservation of sufficient habitat to ensure the protection of a full range of biota for ecological as well as cultural, economic, and other reasons. Research for this study included:

- recording instances of wolf sign and censusing using remote cameras;
- establishing transect routes based on topographical knowledge, knowledge of typical wolf movements, accessibility to researcher, representation of study area, and observations of wolf sign;
- gathering local knowledge from a diverse array of interests (Xeni Gwet'in, horse ranchers, trappers, wildlife managers);
- reviewing current wolf management practices as well as hunting and trapping regulations for the study area;

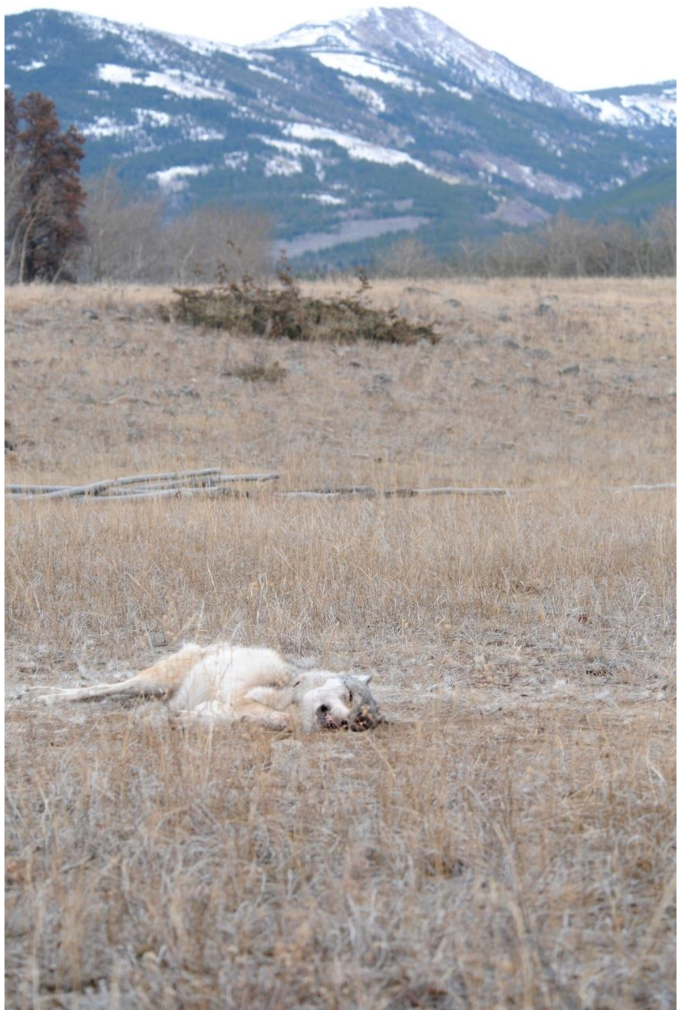

Figure 2. Wolf shot dead within the Nemiah Valley, Nov. 2012, near the rodeo grounds. Photo courtesy of Wayne McCrory.

- reviewing scientific literature about non-invasive methodology, specifically stable isotope analysis;
- setting up and checking beaver hair traps to collect hair samples;
- collecting hair, bone, tooth, and antler samples from potential prey species along survey routes and opportunistically within the study area to be analysed in the future for isotopic niche signatures;
- collecting wolf fur along transect routes and from local trappers as well as opportunistically within the study area for future isotope analysis;
- collecting wolf scat along transects and opportunistically within the study area; and
- analysing wolf scat samples for contents using a dissecting microscope.

Open-ended interviews were used in the first year and will continue to be used as this research continues to corroborate quantitative findings with socio-political dimensions of the research question.

3.1.1 Objective 1: scat analysis

Wolves are elusive and shy animals with wide-ranging territories, making them difficult to study. Previous studies on wolf feeding ecology have used scat analysis for its simplicity and non-invasive technique. This practice has become widely used.

Scat analysis can only provide insight into what a wolf has recently fed upon, as gastric emptying occurs approximately every 8 to 56 hours (Darimont and Reimchen 2002). Repeated collection of wolf scat along established transects will provide for sufficient samples to be safely analysed later. Collecting the scat samples at the end of each season will help to elucidate dietary seasonal shifts, if they occur.

Scat analysis can also provide an estimate of the proportion of different prey species consumed by wolves (Darimont and Reimchen 2002, Ciucci et al. 1996). During this pilot project, only preliminary collections and analyses were carried out, while it is recognized that a larger sample size is needed. (Wolf scat can be potentially dangerous to humans if not handled properly, as it can carry parasites such as the tapeworms *Echinococcus granulosus* and *Echinococcus multilocularis*, which cause hydatid disease in people).

Objective: Identify areas to survey for wolf scat sample collection. Begin to obtain faecal samples of grey wolves within each adjacent study area to evaluate and compare prey items consumed in various seasons. Analyse wolf scat samples collected during pilot study to identify prey remains for preliminary findings.

3.1.2 Objective 2: isotope analysis

Ratios of $\delta^{13}C$ and $\delta^{15}N$ stable isotopes in animal tissues are related to diet. These ratios can be measured by analysing inert tissues and used to understand trophic levels as well as patterns and relationships among predator-prey interactions.

In order to analyse wolf guard hairs, this study first requires knowing what the food sources (potential prey) look like chemically in order to recognize what the consumer (wolf) ate.

When a wolf consumes its prey, an isotope amount from that species is transferred to the wolf. Each species has a unique amount of carbon and nitrogen isotopes. Metabolically inactive tissue, such as hair, reflects the diet during its growth period and can represent a period of time from months to years to lifetime (Urton and Hobson 2005, Hilderbrand et al. 2005). By analyzing the amounts of isotopes in wolf hair, information on prey selection and composition in diet can be examined.

By incorporating stable isotope analysis using wolf guard hairs, which grow annually, information about feeding behaviour can be obtained over a longer period than scat analysis alone can reveal. Hair samples from wolves can provide information about variation in diet on a larger temporal scale using $\delta^{13}C$ and $\delta^{15}N$ signatures (Urton 2004, Darimont and Reimchen 2002).

One constraint to using wolf guard hairs to analyse diet is that fully grown guard hairs will only represent the time period of wolf feeding during which the guard hair was growing, which is during summer and fall (Darimont, pers. comm.). Collection of wolf scat during winter and spring will help to ensure that these seasons are included when analysing the grey wolf's annual diet.

Isotope analysis may also enable the identification of dietary shifts among seasons during summer and fall, which coincides with the growth period of guard hair (Darimont and Reimchen 2002). However, this is only possible if different prey species have distinct enough isotopic signatures.

Objective: Collect hair samples from potential wolf prey species and wolf guard hairs within the study area. The approach used was to opportunistically collect hair from dead animals or search for hair in the field, such as by following wolf tracks in the snow, etc. These samples will be used in future isotope analyses.

Wolf scat collection and analysis will coincide to be compared for consistency in results. In instances where scat deteriorates too quickly during warm months, or if wolves move out of the study area during this time, hair isotope analysis will help ensure that information about wolf feeding ecology can still be captured for this time period.

3.1.3 Objective 3: investigating the human dimension

The quality of wolf and other large carnivore habitat is largely determined by the attitudes of humans living within or surrounding protected areas. Human perceptions are important factors in influencing wildlife management. This aspect is considered to be of importance as historic misperceptions and misunderstandings about wolves are still common and have led to wolf extinction in many areas of North America, Europe, and elsewhere (Beschta et al. 2014).

Human activities within the study area may be affecting the behaviour and feeding patterns of wolves, especially with regard to domestic cows and horses. Several commercial trappers also actively catch and sell wolf hides in the study area. Thus, by documenting human influences, such as human-caused mortality, I will be better able to understand wolf feeding behaviour.

Objective: Investigate local residents' management practices and perceptions regarding wolves through informal interviews to gain insight into the range of opinions and practices.

A continuation of this study would see the researcher perform a review of depredation cases and interviews with stakeholders (Xeni Gwet'in, ranchers, tourism operators, guide-outfitters, trappers, and hunters) to compare quantitative and qualitative data.

Annual human-caused and natural mortality will also be documented as best as possible.

3.2 Methods and Approaches

All methods and approaches in this study used a non-invasive approach.

3.2.1.Scat sample collection methods

Scat-sampling survey sites were selected non-randomly to ensure even distribution and represent areas of wolf use identified during this pilot study. Samples of fresh wolf scat (less than one week old) were collected along survey transects and opportunistically. Unless wolf tracks could verify wolf presence, only scats greater than 30 mm in diameter were collected (Urton 2004) to avoid collecting feces from coyote, *Canis latrans*. Considerations are noted and adjustments made where a disproportionate number of scats were collected around a kill or carrion site.

During visits to the study area, samples of potential prey hair were collected opportunistically to be used as tools/keys to help with identification during wolf scat analysis.

Survey areas for scat and hair collection included bush roads and fireguards within the Brittany Triangle, which are used as wildlife trails. Secondary roads and trails on both sides of the Nemiah Valley made up the survey areas for wolf scat and hair collection outside of the Brittany Triangle. In future studies, the back-roads of the ranchlands located west of the Brittany Triangle will also be included as scat sampling survey sites

Surveys for scat were conducted on trail networks and corridor intersections since wolves have a tendency to deposit more faeces (Darimont et al. 2008). The UTM locations of scats were recorded, and scat was collected and stored in labelled (date, time, location) autoclave bags that were placed inside zip-lock plastic bags and stored frozen until analysis could occur.

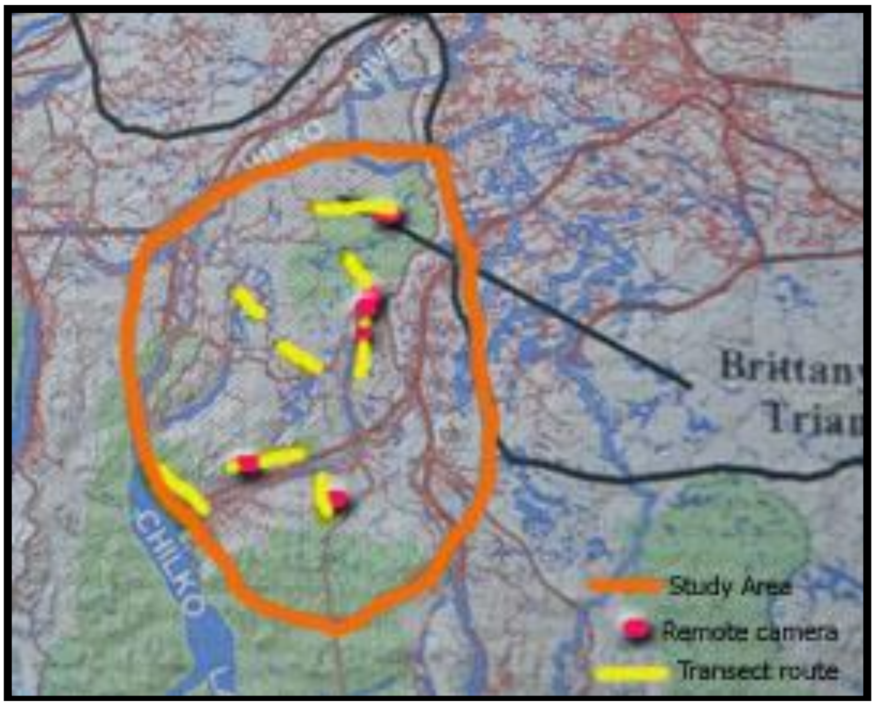

Figure 2. Map of study area indicating transect survey routes and remote camera locations.

Scat samples were autoclaved at 130ºC for 30 minutes, to eliminate the danger of any parasite transmission to the analyst, particularly that of the granular tapeworm (*Echinococcus* spp). Sanitized scats were then examined; all components in each scat were identified, including bones, hairs, seeds, feathers, and other materials The sanitized scats were then weighed and spread on aluminum trays to be visually inspected for prey remains. Samples were separated using dissection kits and remains were identified macroscopically. All components in each scat were identified, including bones, hairs, feathers, vegetation, and other materials. Hairs were identified to the species level by comparing the scale and medulla patterns of guard hairs as seen through a compound microscope to known hair samples collected from the field (voucher specimens); hair keys from the University of Calgary Biogeography Department; and sample photos and reference guide materials (Kennedy and Carbyn 1981, Adorjan and Kolenosky 1969). Mammalian species were identified to the lowest taxonomic level possible without sacrificing certainty, typically to species level (Lukasik and Alexander 2011). I did not attempt to identify plant material.

Following the identification of dietary components, the percent by volume composition was estimated for each component using the point-frame method (Chamrad and Box 1964). The percentage was obtained by placing a clear plastic 2.5 cm grid over the dissected and separated sample and counting the number of squares occupied by each food item (Lukasik and Alexander 2011). This number was then divided by the total squares occupied by the sample and converted to a percentage. Items that made up less than two percent of the scat volume were considered "trace" and removed from further analysis in order to minimize biased emphasis (Weaver 1993, Lukasik and Alexander 2011).

Two indices were used to describe wolf foraging ecology: (1) Indices of occurrence/feces (OF) were calculated, which describe the frequency that an item occurs in all scat samples, and (2) indices of occurrence/item (OI) were calculated, which describe the frequency a prey item occurs among all items identified in all scats combined (Urton 2004).

There are some limitations to note regarding scat analysis. Mule deer and white-tailed deer guard hairs were indistinguishable by microscopic comparison (according to the reference guides used), so both types of deer were clumped together. Horse guard hairs have distinct diagnostic features when using a dissecting microscope, however, portions of horse guard hair have the same microscopic appearance as deer hair, so the presence of other items (dew claw, thick tail, or mane hair) helped to verify which prey species was consumed when there was uncertainty.

Scats can offer a biased picture of foods consumed due to differences in digestibility and detectability. Expression of prey occurrence as a percentage of scats may over-represent the amount of small mammals consumed, as small animals have a larger surface to volume ratio and more hair per mass to be identified within scat remains (Weaver 1993, Urton 2004). Biomass calculations combined with scat analysis can provide more representative information about the quantity and mass of prey species consumed when there are differences in size, however, this is outside of the scope of this project (Weaver 1993, Urton 2004).

Problems may arise from misidentifying scat contents; therefore, observer reliability was evaluated by re-analyzing random samples (Mech and Boitani 2003).

3.2.2 Hair, tooth, and antler sample collection methods for future isotope analysis

Ratios of $\delta^{13}C$ and $\delta^{15}N$ stable isotopes related to diet are stored in a variety of animal tissues. For these reasons, the researcher has decided to adapt isotope analysis methods to include samples of horn, antler, and tooth as well as hair to facilitate ease of gathering samples (Hobson and Sease 1998, Hilderbrand et al. 1998, Myles Stocki, pers. comm.).

Hair, antler, and tooth sample collection was initiated for all potential prey species in order to determine the isotopic niche signature of each species so that it may be recognized when wolf hair samples are analyzed. More samples will need to be collected in the future.

To determine the unique isotopic signature of each species, the researcher aims to collect and analyze a minimum of fifteen samples from each species to ensure robustness (Dr. Chris Darimont, pers. comm.). Potential prey hair samples were collected opportunistically along survey transects or from specimens found dead in the field or previously killed by humans. In the future, samples would also be accepted from animals killed along transportation routes and from a variety of other sources including: known denning, bedding or kill sites; from wolves that have been killed along transportation routes; and wolves that have been hunted or trapped or destroyed due to conflict with humans.

Several hair snags were set up for beavers at two separate locations within the Brittany Triangle.

GPS coordinates were recorded to identify where individual hair, tooth, or antler samples have come from. Samples were collected using sterile tweezers and are stored in paper envelopes at room temperature until future analysis.

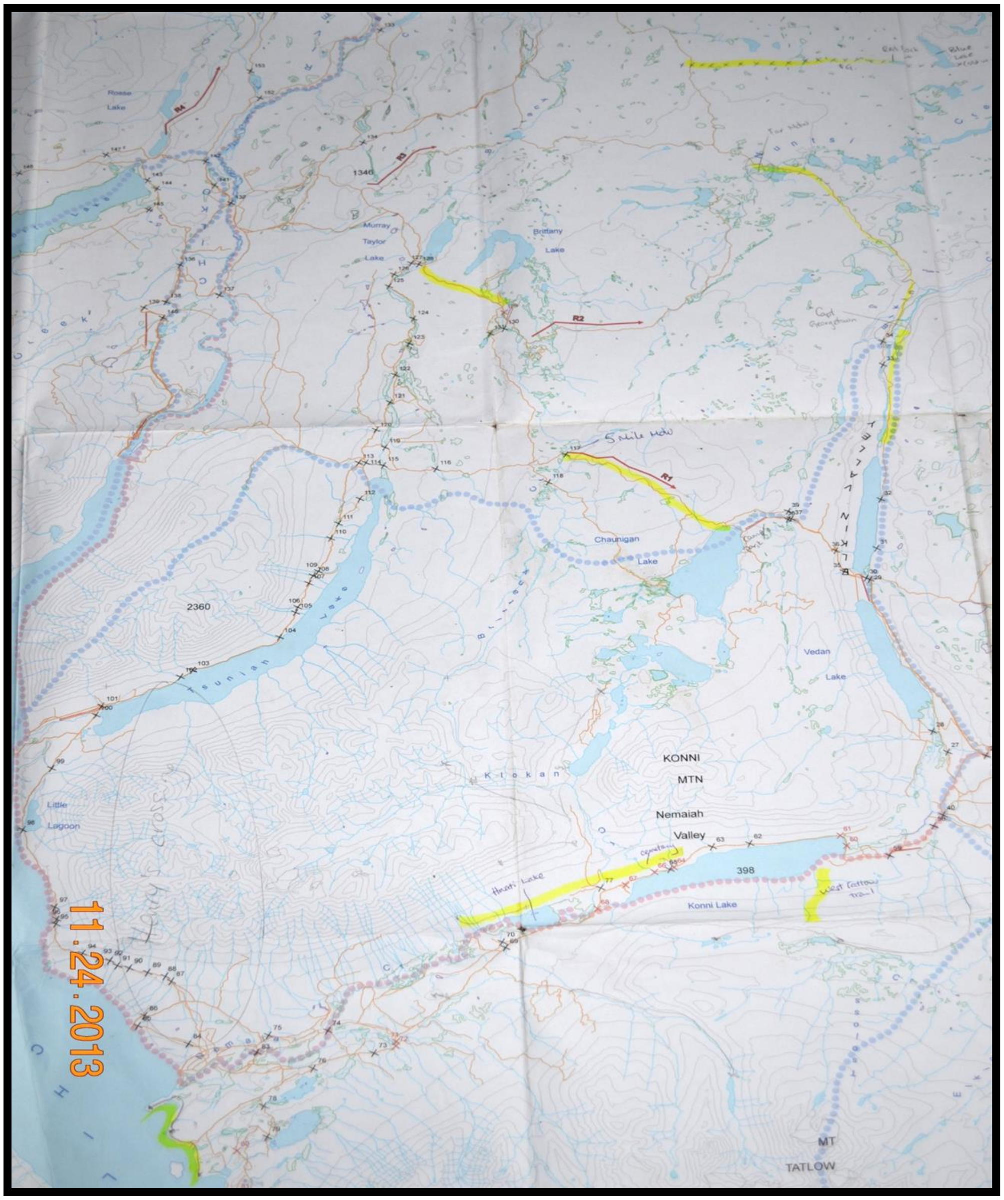

Figure 3. More detailed map of study area indicating transect survey routes.

In the future, data from isotope analyses of these samples and wolf guard hair can be corroborated with scat analysis and compared for seasonal dietary shifts as well as to infer short-term and long-term diet composition.

Hair samples will need to be collected from wolves in the winter period to ensure fully grown guard hairs (Darimont and Reimchen 2002).

3.2.3 Human dimension investigation methods

During the pilot study, the researcher met with Xeni Gwet'in Chief Roger William and band councillors. A formal protocol establishment for the research project is currently under review by Xeni Councillor Marilyn Baptiste.

The researcher also spoke with various community members of the Nemiah Valley about their perceptions of wolves in the area and wolves in general, documenting a wide range of views.

In the future, to supplement field research, Traditional Knowledge (TK) about wolves will also be sought in greater detail through a more formal interview process with elders and various members living within the community. Formal interviews will also be established in the future with members of the wildlife management service, BC Trapper's Association, BC Cattlemen's Association, tourism operators, and guide-outfitters as this study continues.

3.2.4 Other non-invasive methodologies utilised

Six remote cameras were set up to help document the presence, numbers, and behaviour of wolves and their potential prey within the study area. These were set up along established transects in areas where wolf activity had been documented through observation of wolf sign during time in the field.

In September 2013, the researcher visited known salmon spawning areas in search of wolf tracks and salmon carcasses having the upper portion of the head (brain) eaten, which is indicative of wolves feeding on the brains (Darimont et al. 2003, Darimont and Reimchen 2002).

4.0 SUMMARY OF FIELD FINDINGS

4.1 Objective1—Scat Collection

A total of 26 wolf scat samples were collected between April 2013 and March 2014; these were stored at freezing temperatures until analysis in June 2014.

The two study areas were analysed separately. Of the six food items identified in 26 scats, the most common items in both OF and OI indices within the adjacent study areas were cow in the Nemiah Valley (40% and 28.6%, respectively), and horse in the Brittany Triangle (57.1% and 48%, respectively). Following this, OF and OI indices for the Nemiah Valley were horse (20%, 14.3%), deer (20%,14.3%), beaver (20%, 14.3%), small mammal (20%, 14.3%), and vegetation (20%, 14.3%). Remaining OF and OI indices for the Brittany Triangle were deer (42.9 %, 36%), small mammal (4.8 %, 4%), and vegetation (14.3%, 12%), see tables 1 and 2. Trace amounts of vegetation (> 0.05 %) were not considered in OF nor in OI calculations. Preliminary results indicate a moderately variable diet for wolves in both the Nemiah Valley and Brittany Triangle.

Appendix 2 lists the locations for wolf scat as well as hair, tooth, or antler sample collection from wolf and potential prey species. A map depicting the locations where wolf scat (and hair) samples were obtained can be seen below in Figure 5.

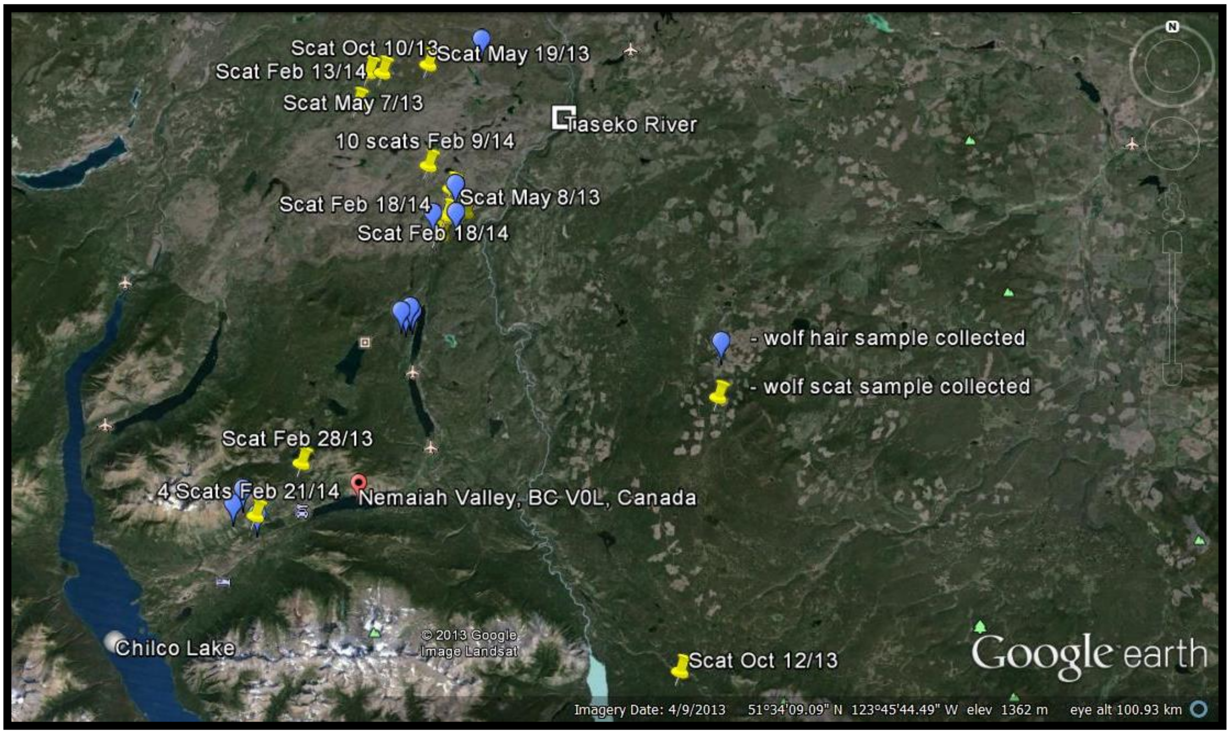

Figure 5. Google Earth map showing locations of wolf scat and hair sample collection.

Wolf scat was most abundant (N = 24) along the transects within the Brittany Triangle study area during the spring and winter field seasons (months of May and February) but much less common in summer and fall (N = 2). During field visits in summer and early fall, many of the transects experienced repeated use by motorized vehicles, making potential samples non-useable and more difficult to find. During the warmer months, scat also decays quicker. It is also likely that wolves in the study area change their movement patterns as the seasons change, covering the widest territory in winter months in search of food and remaining more centralized in spring and summer if pups are born.

All 26 wolf scats (fecal samples) that were found in the study area were examined microscopically to begin to establish baseline information on wolf diet composition.

Microscopic analysis verified that wolf scat in the research area contained hairs and other remains from horse, deer, cow, beaver, and small mammals (*Rodentia* spp. and *Felis* spp.); distinguishable by diagnostic microscopic hair characteristics as well as macroscopic features, such as dew claws, teeth, and claws. Of the 26 scat samples analyzed, small mammal hair (excluding beaver) was identified in 2 out of 26 samples, however, teeth from small mammals were also found in scats where no small mammal hair was observed, likely due to differences in digestibility.

Finally, due to the small sample size analyzed, prey selectivity patterns are not clear.

Table 1. Prey species identified through microscopic analysis of wolf scat collected in the Nemiah Valley.

Species	No. of scats	%OF*	%OI*
Horse	1	20	14.3
Deer	1	20	14.3
Cow	2	40	28.6
Beaver	1	20	14.3
Small mammal	1	20	14.3
Vegetation	1	20	14.3

No. of feces = 5
No. of items = 6

Table 2. Prey species identified through microscopic analysis of wolf scat collected in the Brittany Triangle.

Species	No. of scats	%OF*	%OI*
Horse	12	57.1	48
Deer	9	42.9	36
Small mammal	1	4.8	4
Vegetation	3	14.3	12

No. of feces = 21
No. of items = 25

*Occurrence/Faeces (O/F): the frequency that an item occurs in all scat samples

*Occurrence/Item (O/I): the item's frequency among all items identified in all scats combined.

Figure 4. Wolf scat dissected showing deer dew claw, hair, articulating bone, and vegetation from Brittany Triangle sample.

4.2 Objective 2—Hair, Tooth, and Antler Collection for Future Isotope Analysis

Samples of hair, antler, and tooth were also collected in 2013 and 2014 from wolf, wild horse, moose, beaver, mule deer, and domestic cattle specimens.

Some hair samples of potential prey were successfully collected from natural tree or deadfall snags, roll areas, bedding sites, or from carcass remains found within the study area. In the case of beavers, hair-traps were also set around active dams and lodges. A total of 56 hair samples, 8 tooth samples, and 2 antler samples were collected during the pilot study. The number of samples collected and still required from each species can be seen in Table 3. While many hair (and other inert tissue) samples from a variety of potential prey species were obtained, more are still required in order to accurately identify each species' isotopic niche signature for all species except wild horses and moose.

Wolf hair samples were extremely difficult to find during the spring-summer-fall seasons, despite the constant presence of wolves along field transects. In 2013/14, 10 wolf hair samples and 2 wolf tooth samples were collected in the field; 4 of these wolf guard hair samples were obtained from a local trapper and 2 were provided by Wayne McCrory, who collected the hair from two wolves shot by local Xeni Gwet'in in the Nemiah Valley in September 2012.

Figures 7, 8, and 9 depict the location of each sample collected, as indicated by colourful marker placements on the map. Each colour represents a different species. Wolf hair and scat sample locations are shown in Figure 5.

Samples are being stored at room temperature in labelled paper envelopes for future isotope analysis. The possibility of dietary shifts between seasons will be further assessed in the future if the research continues.

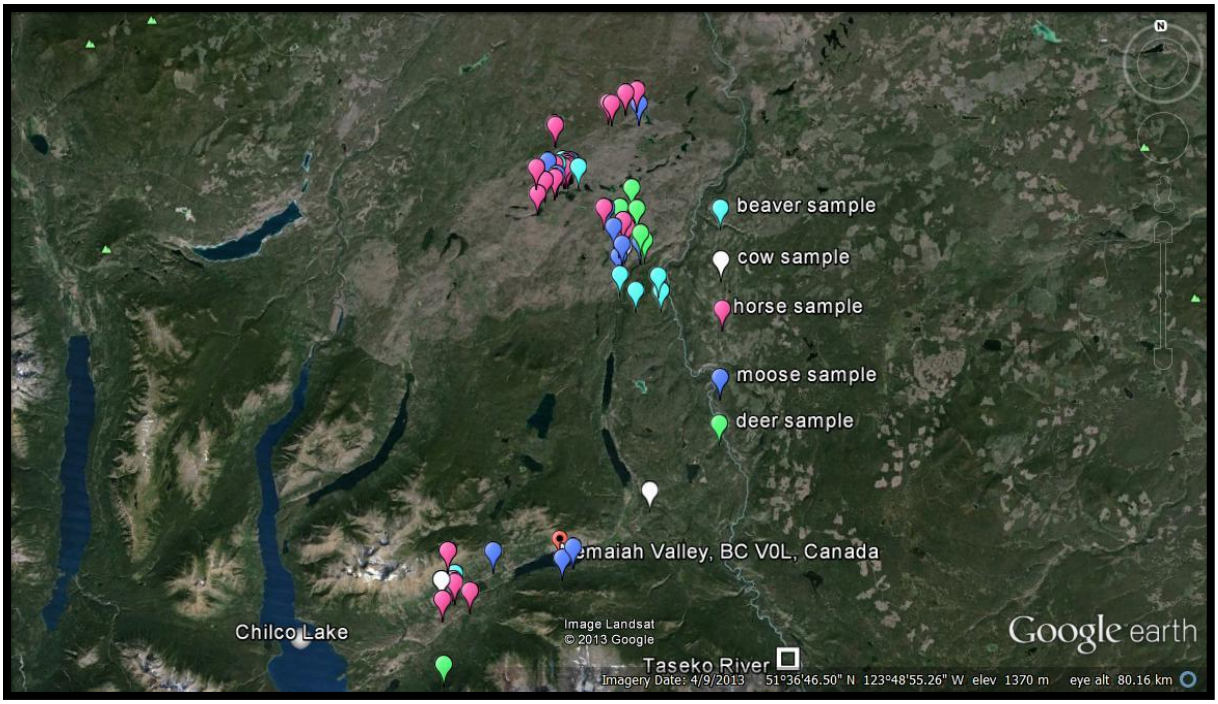

Figure 5. Google earth map showing locations of wolf potential prey hair/tooth/bone/antler samples collected.

Table 3. Number of samples collected from each species for isotope analysis

Number of samples collected to be analysed for isotopic signature through isotope analysis (a minimum of 15 samples are desired for each species)	#Collected	# Still Required
Wild horse	33	0
Moose	15	0
Domestic cattle	3	12
Beaver	9	6
Mule deer	6	9
Mountain goat	0	15
WOLF	12	3
Other possible prey species that might be considered-		
Birds (e.g. waterfowl)	0	15
Muskrat	1	14
California bighorn sheep	0	15
Hoary marmots	0	15
Other		

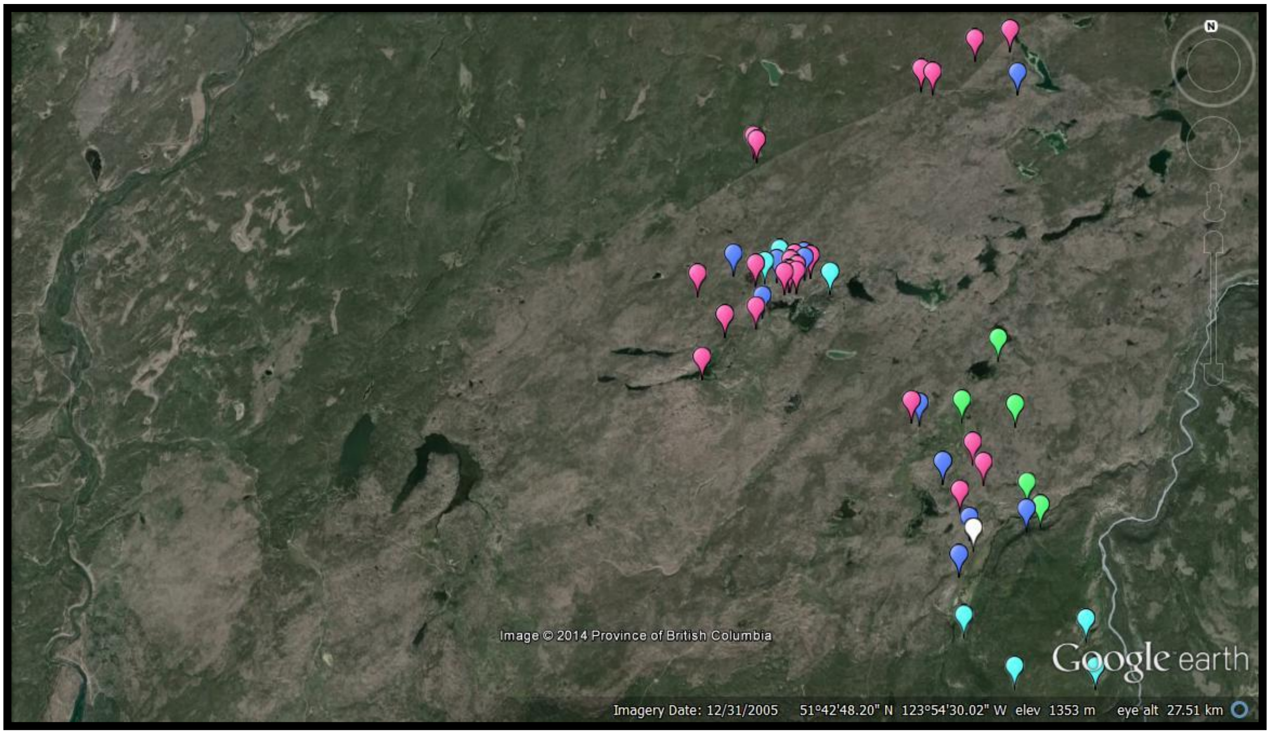

Figure 6. Google Earth map showing northern locations within study area of wolf potential prey hair/tooth/antler samples collected.

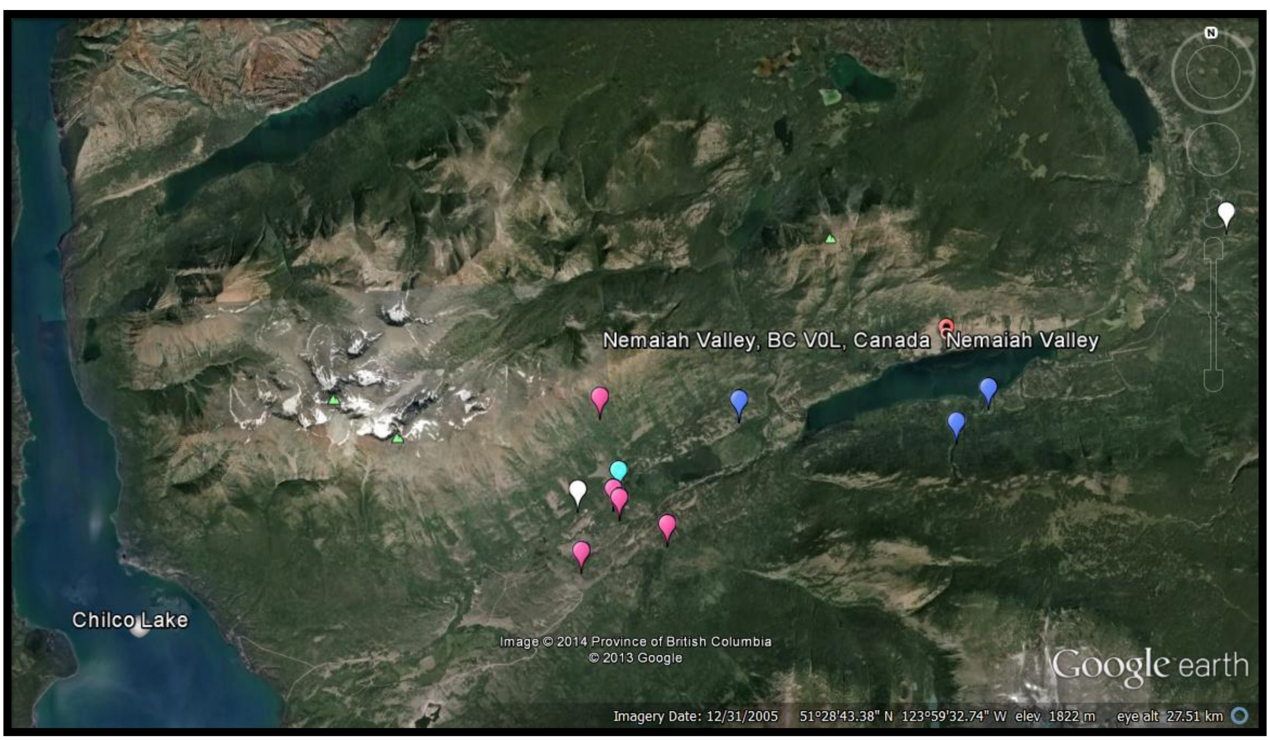

Figure 7. Google Earth map showing southern locations within study area of wolf potential prey hair/tooth/antler samples collected.

4.3 General Observations

4.3.1 Remote cameras

Remote cameras were set up at six locations during the pilot study. Two of these locations did not produce any images because of technical problems. A total of 464 camera days were recorded at the four operational cameras, capturing 167 separate photo events of wildlife. Images of lone wolves were captured at various locations, but no packs were recorded on camera.

Of the 167 photo events, the highest number involved mule deer (n = 60), free-roaming horse (N = 57). grey wolf (n = 12), grizzly bear (n = 10), and moose (n = 8).

Individual wolf images were recorded throughout the year and included:

- a single wolf travelling south along a bush road between Captain Georgetown and Far Meadows (Brittany Triangle) research stations at the end of May and in early June 2013;
- a wolf sniffing the ground in front of the old wolf den site at Blue Lake in July 2013 (Brittany Triangle);
- a wolf travelling east along a bush road northeast of Bald Mountain in December 2013 and January 2014 (Nemiah Valley).

Some of these images were likely of the same individual, but this has not been verified. The data suggests either a low density of wolves in this part of the study area or that wolves were not traveling the bush roads very much but were using alternate travel routes, such as the large network of wild horse trails in the same area.

There are three remote cameras currently remaining in the field to be retrieved and analyzed at a later date, two in the Nemiah Valley (North of Bald Mountain and along West Tatlow trail) and one in the Brittany Triangle (Upper Place junction). These were set up in February 2014 in areas where wolf tracks were observed to be relatively abundant.

Note that due to battery life, the time it takes to set up and take down cameras, and camera failure, not all cameras are necessarily active for the entire survey duration.

Table 4. Combined wildlife images recorded from four remote camera stations over a total of 433 camera days.

Species	Total number of camera detections
Grey wolf	12
Black bear	4
Coyote	3
Grizzly Bear	10
Mountain lion	2
Canada lynx	0
Moose	8
Mule deer	60
White tailed deer	8
Free-ranging horse	57
Other (Fox, Canada goose)	3
Total species recorded = 11	**167**

Table 5. Wildlife images recorded from two remote cameras approximately 1 km apart set up on the bush road between Captain Georgetown and Far Meadows research stations - Brittany Triangle. One camera was set from June 24, 2013 to Sept 24, 2013. The second camera was set from July 28, 2013 to Sept 24, 2013. Together a total of 151 camera days were recorded.

Species	Total number of camera detections	Comments
Grey wolf	2	Possibly same individual
Black bear	4	
Coyote	1 - 2	1 pair detection
Grizzly Bear	9	1 pair detection
Mountain lion	2	1 pair detection
Canada lynx	0	
Moose	4	
Mule deer	50	Several pair and trio detections
White tailed deer	0	
Wild horse	11	

Table 6. Wildlife images recorded from remote camera set up at Blue Lake between May 31, 2013 and October 26, 2013 - Brittany Triangle. A total of 149 camera days were recorded.

Species	Total number of camera detections	Comments
Grey wolf	4	Separate incidents of lone wolf investigating area in front of old den and travelling west, possibly all of the same individual (mixed grey colouring)
Black bear	0	
Coyote	0	
Grizzly Bear	1	Headed east
Mountain lion	0	
Canada lynx	0	
Moose	4	
Mule deer	9	
White tailed deer	0	
Wild horse	9	Some grazing, some running

Figure 10. Remote camera image of lone wolf travelling along survey route in Brittany Triangle. Camera station was set up by researcher.

Table 7. Wildlife images recorded from remote camera set up north of Bald Mountain between October 12, 2013 and February 21, 2013 - Nemiah Valley. A total of 133 camera days were recorded.

Species	Total number of camera detections	Comments
Grey wolf	6	Separate incidents of lone wolf travelling east and west along back road, possibly all of the same individual (mixed grey colouring)
Black bear	0	
Coyote	1	Trailing lone wolf by one hour
Grizzly bear	0	
Mountain lion	0	
Canada lynx	0	
Moose	0	
Mule deer	0	
White tailed deer	0	
Wild or domestic horse	37	Some wearing halters. Many of these are the same horses spending time in the same area.
Domestic cattle	4	Maximum of 6 together in image, one bull
Human	18	10 on foot, 8 in vehicle (ATV, truck, excavator)
Dog	1	No human in image

Figure 8. Remote camera image of lone wolf travelling along survey route in Nemiah Valley.
Camera station was set up by researcher.

The remote camera images were also very important in determining presence of different prey species, including mule deer (60 detections), moose (8 detections), and free-roaming horses (57 detections).

Figure 12. Remote camera image of mule deer with fawn, Brittany Triangle.
Camera station was set up by researcher.

Figure 13. Remote camera image of bull moose in the Brittany Triangle.
Camera station was set up by researcher.

Figure 14. Remote camera image of domestic or feral cattle walking a back road in the Nemiah Valley. Camera station was set up by researcher. Normally, in winter, cattle are supposed to be kep and fed on the ranchlands.

A variety of other wildlife species was also image-captured, as summarized in Table 7 and listed in Appendix 1.

Figure 15. Image of cougar pair travelling within the Brittany Triangle Sept. 1, 2013; from Remote Camera 3 set up by researcher.

4.3.2 Vocalizations

Wolves were heard vocalizing (by the researcher) on two occasions in the Brittany Triangle during mid-February 2014, while in the field. This timing coincides with mating season, when wolves can be quite vocal. Other people in the area reported to the researcher that they had heard wolves howling throughout the pilot project.

4.3.3 Observations of some potential prey species

Field visits in May coincided with wild horse foaling season, as well as wolf pup growth, following birthing in April.

Several foals (approximately five; some were observed more than once) were observed by the researcher for periods of time in the field during May. One newborn foal was observed alone with its mother and a stallion. To the researcher, the foal appeared very vulnerable to natural predators; weak, uncoordinated, and unable to move far without stumbling or falling. This initial uncoordinated behaviour after birth is common among horses. At the time of observation, the foal was not in the presence of a band of horses large enough to effectively defend the newborn from a group of wolves (in the opinion of the researcher). This may be because some pregnant mares choose to withdraw from their founding band and go off to bear their young by themselves (David Williams. pers. comm.).

Figure 16. This newborn foal with its mother observed in the Brittany Triangle during May 2013 (with one other horse not in image) would be easy prey for a group of wolves.

This was interesting to me since some predators are known to prey on newborn ungulates by working the birthing grounds, such as grizzly bears hunting moose calves in Alaska (Steve Stringham, pers. comm. via Wayne McCrory). In one study of wild horses in Nevada, mountain lions were found to act as an agent of population control by preying on foals in the spring (Greger and Romney 1999.)

Horse foaling season may provide a time of increased vulnerability of horses to wolves and other predators, however, many of the horse carcass remains (bones) that were found in the study area were those of adults that likely died from starvation or were killed by predators in the winter.

On February 10, 2014, the researcher directly observed seven horses in close proximity (within 600 m) to two wolves in a meadow within the central region of the Brittany Triangle. The wolves were likely in the area due to food; remaining close to a horse carcass that was nearly consumed. The horses were grazing in the same area. The atmosphere was relaxed and all animals seemed unconcerned with each other until the two researchers arrived, after which all wildlife left the area.

Upon close inspection of the horse carcass, it became clear that the animal had been shot through its lower jaw with a bullet and likely starved to death. It remains unknown if this horse was depredated or scavenged. There was not enough of the body remaining to check the former nutrition levels of the dead horse by cutting through cartilage. There were several sets of wolf tracks around the carcass, and 10 wolf scat samples were collected and analysed to confirm contents. Although the large portion of scat collected from one kill site can create sample bias, these scats were collected to be analyzed due to the small sample size available and this consideration is noted.

Figure 17. Researcher collecting wolf scat from the remains of a horse carcass in the Brittany Triangle. The horse had been shot with a bullet through its lower jaw.

4.3.4 Observations of seasonal patterns

Within the study area, opportunities were observed to exist where potential prey may be more exploited on a temporal scale due to increased vulnerability. In effect, this could provide a greater energy return to wolves with reduced risk, such as during salmon runs in the fall or wild horse foaling in the spring.

Another example of increased prey vulnerability that may influence a seasonal shift in wolf diet includes in spring and late fall during annual deer winter migrations between the South Chilcotin Ranges and wintering grounds along the Fraser River-Canyon “breaks” and grasslands. While some mule deer are known to remain over the winter in the Brittany Triangle (McCrory 2002), others are known to migrate up to 100 km.

During the two migration periods, deer travel together in small numbers along traditional migratory routes. The deer travel across the Taseko River in order to reach their favoured destination (Xeni Wild Horse Ranger David Setah, pers. comm.). In some areas, they cross at known specific sites that are confidential information to the Xeni Gwet'in. Wolves are known to linger around certain river crossing areas to take advantage of the predictability and vulnerability of these prey animals (David Setah, pers. comm.).

Similarly, wolves in the study area may be utilizing major salmon spawning runs in late summer through the Chilko and Taseko rivers and tributaries, which will be determined through future stable isotope analysis of wolf guard hairs and scat analysis. The researcher arrived just after spawning season had ended for sockeye salmon along Chilko Lake and in Nemiah Creek, and for chinook salmon in Elkin Creek. Brief field surveys along some areas of Chilko Lake found an abundant supply of spawned-out sockeye salmon on the shoreline available to wolves and other scavengers at the end of September, but no wolf feeding was verified by tracks or by the typical pattern of wolves just eating the brains of salmon. This area was highly used by grizzly bears at this time as evidenced by the sockeye remains. A spot check by Wayne McCrory of spawning chinook salmon in Elkin Creek in early September showed no evidence of wolves.

Figure 18. Remains of a sockeye salmon eaten by a bear along the shore of Chilko Lake.

Figure 19. One of many spawned sockeye salmon observed on the shores of Chilko Lake in late Sept. 2013.

Unlike salmon, large ungulates as potential prey can be dangerous for wolves, as they are well-equipped to defend themselves during predator-prey interactions. A wolf is suspected to have been killed by wild horses in the Brittany Triangle in September 2010, after witnesses heard howling and found a wolf dead near the Far Meadows research station (at North Meadows) with horse tracks all around. The researcher tried to locate and recover any remains of this wolf, but the water had risen substantially and this was not possible.

Figure 20. Dead wolf found in Brittany Triangle in 2010 thought to be killed by wild horses.
Photo courtesy VWS and FONV.

4.3.5 Results of denning and/or rendezvous sites surveys

As this study continues, knowledge of wolf rendezvous and den site locations will be important in aiding the collection of wolf guard hair samples, as well as providing insight into reproductive success, movement patterns, and other aspects of wolf behaviour. Active den sites should only be approached after denning wolves have moved on in June to avoid disrupting natural behaviour and to remain non-invasive.

A general area for wolf denning was identified by the Xeni Gwet'in within the Nemiah Valley near a landform known as "Bald Mountain." During field surveys, I was unable to locate a den site. Bald Mountain and the surrounding area is also used by a semi-wild band of horses (direct observation, remote camera capture, and Wayne McCrory pers. comm.). Both domestic and "wild" cattle also use this area (direct observation and remote camera capture). A significant number of wolf tracks (during winter) and scats were observed by the researcher in this area, which is comprised of beaver lodges, small rivers, and wetlands. Wetland complexes are often important denning locations for wolf families as they provide a nearby water source for lactating females and offer a supply of easy prey for wolves during the summer months, including muskrat, beaver, waterfowl, and fish (Hayes 2010).

A wolf rendezvous site is the home site, or area of main activity, used by wolves after the denning period but prior to the period in fall and winter where the pack hunts nomadically. Pups are brought to rendezvous sites and remain there until they are weaned under the watch of an older caregiver until they are ready to join the pack on their hunting forays. Like den sites, rendezvous sites may be associated with nearby food sources; many packs return to these established areas and will use a series of such sites. No rendezvous sites were located during the 2013/14 field surveys, however one hillside north of Bald Mountain was identified in the Nemiah Valley as an area that likely suits this purpose, as determined by the high presence of wolf tracks, numerous trails through vegetation, and an interview providing local traditional knowledge. This area will continue to be monitored by the researcher over time.

Bones and skulls from horse, cow, beaver, and unidentified ungulate carcass remains were observed by the researcher in the Bald Mountain area during all field visits. A remote camera was set-up in September 2013 at a back-road intersection used by wolves just northwest of Bald Mountain (as evidenced by scat deposits). The camera was retrieved February 22, 2014, and one lone wolf was image captured, along with other animals and people (see Appendix 1 for a list of remote camera images captured). A remote camera has been re-set in this area along a wolf trail discovered in February 2014.

The location of an old wolf den was documented within the mid-upper Brittany Triangle at Blue Lake (Figure 21). It was shown to the researcher by David Williams. A remote camera was set up nearby and a lone wolf was image-captured investigating the area on three separate occasions in July 2013, and walking by on a fourth.

The northern fireguard transect within the Brittany Triangle leads to Blue Lake, where the old wolf den is located. I documented a travel route frequently used by wolves in spring along the transect west of Blue Lake. Transect observations in May revealed several scat deposits, including one blood scat from a recent kill. Mudded areas along this transect were marked with several wolf tracks within a short period of time, determined through repeated transecting in May 2013 (Figure 22).

Figure 21. Old wolf den at Blue Lake in Brittany Triangle with south-facing entrance.

Figure 22. Heavy wolf use of Northern Fireguard transect in Brittany Triangle as evidenced by numerous sets of wolf tracks made over short time period in May 2013.

On February 19, 2014, blood was observed in wolf urine (Figure 23) along one of the survey routes within the Brittany Triangle, verified by four sets of wolf tracks less than 12 hours old. This timing coincides with wolf mating season and verifies that there is at least one viable female capable of reproducing in Spring 2014 within the study area.

Figure 23. Blood in wolf urine during February 2014 indicates the presence of a reproductively fertile female.

Figure 24. Evidence of ungulate carcass remains in the Bald Mountain vicinity were commonly observed in May 2013.

4.4 Objective 3—Investigating Human Perceptions and Management

Human tolerance for wolves and willingness to coexist are matters of social and psychological influences rather than ecology.

In 2013, the researcher began to investigate local, deep-rooted social identities through informal interviews and dialogues with local residents and wildlife managers. Twenty-seven informal interviews and discussions took place between the researcher and local people having a variety of backgrounds. Often, such psychological constructs influence tolerance for wolves as much or more than actual encounters. Table 8 provides a summary of the various perceptions and management practices regarding wolves that were encountered by the researcher through discussions with a broad spectrum of cultural demographics.

Initial interviews showed that although some in the Xeni Gwet'in community still regard wolves as animals to be shot, many place both wolves and wild horses in the highest regard.

The researcher learned that during October 2012 to March 2013, the BC Ministry of Forests, Lands and Natural Resource Operations (FLNRO) funded a $73,000 "moose enhancement program" that included rounding up and killing 14 wild horses and teaching Tsilhqot'in community members to trap wolves[2] (Rodger Stewart, pers. comm.). This was a government-funded trapping and training program that occurred in the Chilcotin region north of Alexis Creek aimed at teaching local First Nation residents to trap furbearers as well as restore wild horse corrals. The project was overseen at the provincial level by Rodger Stewart, the director of Resource Management for the Cariboo District, operated in partnership with the Tsilhqot'in First Nations Government (TNG) and administered by Tribal Chief and Chair Joe Alphonse. Only four wolves were reported to be trapped through this program (R. Stewart, pers. comm.). While this trapping program occurred outside of the research area, regional trapping programs such as these may influence wolves dispersing from the targeted area and affect wide-scale human attitudes towards wolves and management of them.

As of February 20, 2014, TNG continues to request and pursue funding from the provincial government (FLNRO) to resume the trapping and training program and "wolf management" in targeted areas of the Chilcotin (R. Stewart, pers. comm.). The areas in question are north of the study area for this research project, and extend all the way west to Tweedsmuir Provincial Park (R. Stewart, pers. comm.). In 2008, a similar government program paid Xeni to kill wild horses to use for wolf bait.[3] Among the bait used to trap the wolves were horse carcasses of free-roaming domestic horses caught within the Nemiah Valley.

During this pilot study, the researcher met with government wildlife managers to discuss current practices. The managers were made aware of the "Rancher's Toolkit" produced by the researcher and it was shared among the Conservation Officer Service in Williams Lake as a resource. The researcher also provided wolf education programs to the two local schools in the

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[2] Source: Vancouver Sun article by Larry Pynn, http://www.vancouversun.com/technology/pays+First+Nation+round+wild+horses+auction+meat+prices/8340941/story.html

[3] Source: Vancouver Sun article by Larry Pynn, http://www.canada.com/vancouversun/news/westcoastnews/story.html?id=7513b6c0-141f-4222-915b-bc1ac3f5bef9

area, as well as had several one-on-one conversations with adults living within the Nemiah Valley who wanted to learn more about wolves.

Figure 25. Wolf artwork by student on wall of school in Nemiah Valley.

Table 8. Summary of various perceptions and management of wolves from a broad spectrum of cultural demographics, learned through informal interviews by the researcher.

Description of cultural demographic & date contacted	General perception regarding local "wolves"	Action/Management
Trapper 1 Oct. 13/13	There are many wolves in the area. Trapping (wolves) is a hobby that brings economic gain.	Activated trap line along Chaunigan Mtn. Rd. during winter 2013/14 targeting wolves. Processes the animals and sells hides privately. Had trapped 4 by the time of publication.
Trapper 2 As told by local resident May 31/13	Believes new wolves are coming into area and displacing resident wolves. (This may be a result of the wolves killed by humans in the Nemiah Valley Nov./12.)	Actively traps wolves and other furbearers.

[Table 8 continued]

Small guide-outfitter with horses June 2/13	Wolf numbers are increasing. These wolves are killing some domestic stock. Has seen yearlings (horses) walking around "with their haunches chewed up".	Has lost 3 horses to wolves over the past few years: 1) A few years ago a young horse of his was injured (chewed haunches) by wolves witnessed by friend chasing horse in pasture (mid-day sometime in July/Aug). Local put the horse down (shot) and watched wolves feeding on it the next morning (9 in total). 2) A few years ago in winter local snowmobiler phoned him in town to report that 2 horses in pasture were down, due to wolves. Outfitter returned to site repeatedly overnight on snowmobile (to protect other horses and deter wolves). The 2 horse carcasses were finished off in 1.5 days. Has left domestic stock carcasses nearby and unattended to watch wolves feeding on them. Interested in community meeting. A few years ago a wolf "jumped" his dog before taking off. Dog uninjured.
Horse rancher (formerly had cattle, too) May 31/13	Wolves have started using property, have interacted with dogs and horses. Unsure of how to prevent potential conflicts. (Provided with information).	Sees wolf tracks in his fields in winter. Several direct wolf observations on his property: 1) In late winter-early spring a few years ago observed wolves walking past cows in pasture on property and circling horses. Wolves tested horse who kicked and wolves left. 2) Sometime between Feb - April a couple years ago a lone black wolf was observed watching yearlings. Rancher fired warning shot and wolf vanished. 3) During March a few years ago observed 2 wolves following a cow-calf pair in March. Rancher attended in truck- wolves took off. 4) Spring 2012 rancher's dog was "jumped" by a wolf. Dog was uninjured. Wolf left when rancher arrived. Keeps horns on his cattle. Wants to learn more about wolves and prevention methods. Interested in community meeting.
Local Xeni elder June 1/13	Wolves are killing moose. Mentions in Big Creek area wolves are causing concerns with calves/cows. Says most Xeni are "scared of wolves", but have high respect for.	Reported to others that he had been hanging bait-hooks for wolves on his property, however this is unverified.
Local Xeni elder Feb 20/14	Wolves are highly respected, although sometimes they are killed by people. They are called "Nun" in local dialect.	Her husband observed a wolf chasing a cow in the Nemiah Valley (bottom of rodeo race trail) and shot wolf. Current community regulations allow wolves to be shot when they are observed harassing livestock. Custom was followed of not touching body until it had cooled. Recently observed lone wolf at mile 44 on road.

[Table 8 continued]

Local Xeni elder Feb 6/14	Wolves have a place in this natural world. Protection of this land is important for all wildlife and people as well.	Has observed wolves on several occasions and enjoys the experience.
Resident of Nemiah Valley 1, homesteaders May 28/13	Admire wolves and the wilderness they represent and enjoy hearing wolves howling nearby.	Supportive of wolf conservation efforts and protection of wilderness areas.
Resident of Nemiah Valley 2, hunting guide elsewhere May 3/13	Enjoys wilderness but concerned wolves may be killing too much game locally.	Interested in learning more about wolves and wants to know about predator-prey interactions.
Xeni hired to trap wolves elsewhere in the Chilcotin April 29	Experienced a transformation of regard for wolves after he interacted with one (now respected more). Previously was hired to trap wolves north of the study area (west of Williams Lake) in winter 2012/2013. Was taught methods for wolf handling by both FLNRO trapping program and Xeni Elders.	Was unable to fulfil his trapping quota for FLNRO and refuses to trap wolves again. This was after finding a live wolf in one of the traps that he set.
Conservation Officer Oct. 4/13	Admits that the CO Service has been trapping wolves, but not always sure why. Has observed ranchers asking COs to set wolf traps on crown and private land when unable to monitor their own stock and/or property. (Mentioned to contact Rodger Stewart who is in charge of Chilcotin wolf trapping program).	Has been involved in wolf trapping on behalf of the province for the past few years. Does not immediately respond to all wolf calls as previously instructed by CO Service. Shared the Ranchers' Toolkit prepared by the researcher with his CO peers.
Director of Resource Management - Ministry of Forests, Lands and Natural Resource Operations) Feb. 20/14	Caribou and moose numbers are declining in the Chilcotin, especially north of study area. Being approached by TNG to fund more trapping training programs.	2012 FLNRO funding was used to provide training for trapping (wolves and other furbearers).
Provincial Predator Conflict Prevention and Response Coordinator March 3/14	There is no wolf management plan *per se*. There are many wolves in BC. Claims that many ranchers surrounding Williams Lake are losing large numbers of calves to wolves each year, but cannot verify how it is known to be wolf depredations. States that most ranchers around the Williams Lake area use Range Riders, and some use Livestock Guardian Dogs	Teaches ranchers how to verify depredation event. Wolf trapping by COs only occurs for livestock purposes where ranchers are practicing responsible husbandry methods. Would like to see a provincial wolf count. Would like to see a project around Williams Lake where wolves and cattle are radio-collared to detect and document depredation events. Was not consulted in proposed BC Wolf Management Plan (released Nov 2012).
Tsilhqot'in National Government Tribal Chair Chief Feb. 22/14	Wolves have an important ecological role, which not everyone can appreciate. There are current imbalances regarding moose, pine beetle, logging, wolves, and ranching.	Unknown. Was in charge of 2012 wolf trapping program funded by FLNR.

In this researcher's opinion, a better understanding of local wolf feeding behaviour (including accurate data) combined with increased local knowledge about preventive husbandry practices gained through outreach could reduce many potential conflicts with wolves and other large carnivores.

Not much is known nor has been documented regarding livestock management techniques in the study area. For example, practices such as dragging dead stock into the wild or leaving it near living herds may attract predators into the area and exacerbate potential livestock losses. During informal interviews, this practice was mentioned on several occasions.

5.0 CONCLUSIONS AND DISCUSSION

Scat analysis results infer that wolves do forage on wild horses within the study area, although this may be a result of scavenging as well as predation . Although the sample size for scat analysis was small, preliminary results indicate a variable diet among individual wolves in both study areas as would be expected in an area of high and variable potential prey abundance. The direct observation of 7 horses and 2 wolves occupying the same area in the Brittany Triangle in a relaxed atmosphere on February 10, 2014, may also denote that these two species have established a long understood predator-prey relationship.

Preliminary conclusions from observations of wolf scat containing hairs from wild horse, deer, cow, beaver, and small mammals (n = 26) verified that wolves within the study area do consume these animals as part of their regular diet, however the rate of occurrence, proportions of diet, and seasonal changes remain unknown. This pilot study of grey wolf feeding ecology in the Brittany Triangle and Nemiah Valley verified that continued research is feasible and required to learn more.

Of the 167 photo events recorded over 464 camera days, 12 wolf images were captured; all of these were of individual wolves. Winter track observations indicated one wolf group consisting of four wolves travelling together in the Brittany Triangle. Winter tracks along frozen rivers in both the Brittany Triangle and Nemiah Valley indicated that these travel routes were used by wolves regularly, however it was difficult to determine group sizes (or individual travels) of wolves without fresh snowfall covering old tracks. Scat observation and collection also provided fewer samples than had been expected. Both of these findings lead to preliminary conclusions that the wolf population in the study area is not high. Furthermore, large packs were not documented. Pack size may influence feeding behaviour in wolves in terms of prey selection, handling time, and kill rates (Hayes 2010).

Remote camera events also verified that there was a relatively abundant and diverse array of potential prey and food resources for wolves. For example, out of 167 photo events, a minimum of 94 images of wild ungulate species were captured (not including horses recorded at Bald Mountain - Nemiah Valley); mule deer n = 60; moose n = 8, wild horse n = 20; white-tailed deer n = 6). In addition to this, the researcher observed droppings, tracks, and other sign from all of these species within the study area, as well as directly observing these animals and other small mammals, such as beavers and muskrats, while in the field.

Direct observations of spawned sockeye salmon carcasses at Chilko Lake and reports of chinook carcasses along Elkin Creek and other tributaries (McCrory, pers. comm.) during fall also verify this as another potential and abundant food resource for wolves. The researcher believes it to be highly feasible that wolves within the study area feed on various species throughout the year and most likely take advantage of temporal vulnerability in each species. In other words, wolves likely switch their feeding patterns and preferred prey seasonally, depending upon which species is most abundant and/or vulnerable at the time. This would limit the amount of energy required by wolves to find and secure their food, as well as provide a minimum risk in obtaining it. To verify this and elucidate it further, more field studies are required and scat analysis as well as isotope analysis will need to be undertaken.

Through interviews, it has become clear that wolves in the Nemiah Valley are more threatened by and subject to being killed by humans (due to trapping, conflicts with livestock, or human intolerance) than in the more remote Brittany Triangle except along one active trapline. It has also become clear through interviews that there exists a mixed understanding of wolves and a broad spectrum of opinions about if and how they should be managed.

Wolf trapping within the region may be influencing wolf (feeding) behaviour within the study area directly through the disruption of social stability and/or changes to pack size. It may also affect local wolf behaviour indirectly by keeping wolves near a bait station or by creating a vacancy through trapping local resident wolves that allows wolves from the surrounding area (non-locals) to move in. More research needs to be done in order to better understand the ways that human actions towards wolves are influencing their feeding behaviour, if at all.

Human attitudes towards wolves within the study area range widely. Perceived risk can be as important as actual experience in shaping attitudes towards natural predators (Treves and Bruskotter 2014). Therefore, education about wolves and other large carnivores, as well provision of information about methods of coexistence, will be critical for establishing a foundation for future sustainability of wolves and other natural predators in this biologically unique area, as well as around the globe (Beschta et al. 2014).

6.0 SUMMARY OF ASSOCIATED 2013/14 PROJECT COSTS

Below is a tally of expenses incurred as project costs thus far.

Table 9. Summary of project costs for pilot study.

DESCRIPTION	SOURCE	DATE (2013)	AMOUNT
Travel, lodging, field supplies	VWS - special funds	April 29 - June 6/13	$1000
	VWS- Patagonia	Feb. 4 - March 4/14-outreach	$1359
Field wage	Private donor -F. Green	April 29 - June 6/13-research	$1000
	VWS- McLean Fndn.	July 24 - 29/13-research	$1000
	VWS- McLean Fndn.	Sept. 26 - October 15 -research	$1000
	VWS - Patagonia	Feb. 4 - March 4, 2014-outreach	$1,000
Grant writing, lit. reviews, newsletter	McCrory Wildlife Services - private donor	August 8/13	$500
	VWS- Special Projects	Jan. 1/14	$1,000
Camera for field work	Wildsight - Golden	September 26/13	$500
TOTAL EXPENSES			**$8,359**

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APPENDIX 1. RESULTS OF FOUR REMOTE CAMERA SET-UPS, BRITTANY TRIANGLE AND NEMAIAH VALLEY STUDY AREAS 2013/14

Below is a chart summarizing the results from four remote camera stations. Camera's were set up along trails or bush roads as well as near an old wolf den site.

Due to camera failure and other limitations, images captured are only a bare minimum of the movement through the camera traps. Although a remote camera was set up near the Captain Georgetown research station in the Brittany Triangle as well as along the West Tatlow trail in the Nemiah Valley, there were technical malfunctions preventing image capture and so no data was collected.

Table 10. Results of remote camera set up along trail between Captain Georgetown and Far Meadows research stations, about 1 km South of Upper Place - Brittany Triangle. Camera was set up for 124 camera days.

South Upper Place Remote Camera Results

Date	Species	Time	Comments	Camera Days
May 24/13	2 Mule deer	12:40	Grazing and travel N on trail	
May 25/13	Mountain lion	00:35	Travel N on trail	
May 25/13	Grizzly bear	4:48	Checking out remote camera	
May 25/13	Stallion	9:40	Travel S on trail	
May 28/13	Mule deer	11:28	Travel N, stop in front of camera	
May 29/13	Canada Goose family (2 adults, 6 goslings)	10:26	Travel N on trail	
May 29/13	Wolf - tan with black, black tip on tail	13:38	Travel S on trail	
Summary	**3 Mule deer, Mountain lion, Grizzly bear, Wild Horse, Canada Goose family, wolf**			**6 camera days**
June 5/13	Mule deer	5:34	Checks camera	
June 6/13	2 Mule deer	8:57	Travel N on trail, one checks camera	
June 6/13	Wolf - tan with black	12:38	Travel N on trail- trotting	
June 6/13	Stallion (dark brown)	14:16	Crossing trail	
June 8/13	Stallion (dark brown)	10:27	Travel N on trail	
June 10/13	Fox	14:07	Travel N on trail at a trot	
June 11/13	Doe and 2 fawns	8:45	Nursing	
June 15/13	Stallion (white flecks on R shoulder)	14:56	Travel S on trail	
Jun 18/13	Grizzly bear (thin)	20:57	Travel N on trail	
June 24/13	Moose (young)	7:24	Run across tail	
June 24/13	Grizzly bear	14:53	Travel S on trail	
June 26/13	Fox	01:24	Travel N on trail	
June 26/13	Doe and 2 fawns	9:31	Stop in front of camera, travel N on trail	
June 26/13	Doe and 2 fawns	5:32	Travel S on trail	
June 26/13	Mule deer - buck	23:36	Travel N on trail	

June 27/13	Mule deer - buck	5:13	Checks camera	
June 28/13	Grizzly bear	17:06	Travel N on trail	
June 30/13	Black bear	19.01	Travel S on trail	
Summary	**7 mule deer, wolf, 2 horse, fox (2?), 2 (3?) grizzly bears, moose, black bear**			**30 camera days**
July 1/13	Mule deer	7:12	Travel S on trail	
July 2/13	Moose (juvenile)	22:29	Travel N on trail	
July 3/13	Black bear	17:23	Travel N on trail	
July 8/13	Mule deer - buck	6:07	Travel S on trail	
July 8/13	Mule deer - buck	9:21	Travel N on trail	
July 10/13	Mule deer - buck	4:35	Travel S on trail	
July 11/13	Stallion (dark brown)	14:16	Travel S along trail	
July 13/03	Doe and fawn	10:48	Travel N on trail	
July 15/13	Mule deer - buck	12:36	Travel N on trail	
July 16/13	Coyote pair	18:53	Travel S on trail	
July 16/13	2 Grizzly bears	21:21	Travel N on trail	
July 16/13	Grizzly bear	23:52	Travel N on trail	
July 17/13	2 Mule deer	5:05	Cross trail E-bound	
July 17/13	Mule deer - buck	10:57	Travel N on trail	
July 19/13	Mule deer - buck	10:49	Travel N on trail - trot	
July 19/13	2 Mule deer	23:26	Travel N on trail	
July 20/13	Grizzly bear	9:04	Travel N on trail	
July 20/13	Mule deer - buck	9:46	Travel N on trail	
July 23/13	Mule deer	8:26	Cross trail traveling E	
July 23/13	Mule deer	12:27	Travel N on trail (trotting)	
July 24/13	Grizzly bear	5:41	Travel N on trail	
July 25/13	Doe and fawn	9:21	Travel S on trail	
July 30/13	Mule deer	8:51	Travel N on trail	
Summary	**6 (+?)separate mule deer, juvenile moose, black bear, horse, coyote pair, 3 - 6 grizzly bears**			**30 camera days**
Aug.14/13	Young deer	8:51	Sniffing ground	
Aug. 22/13	Mule deer - buck	12:47	Travel N on trail	
Aug. 25/13	Horse	00:12	Dark, travel S?	
Aug. 25/13	Horse	2:23	Dark, travel N?	
Aug. 27/13	Horse	7:32	Travel S on trail	
Aug. 27/13	3 horses	18:54	Travel N on trail	
Sept. 5/13	Horse (near black)	9:17	Head down along trail S.	
Sept. 14/13	Horse (chestnut)	15:03	Travel N along trail	
Sept. 15/13	Horse (near black)	8:57	Across trail heading E	
Sept 20/13	Moose (bull)	23:04	Travel N along trail	
Sept. 24/13	3 mule deer	8:40	Travel N along trail	
Summary	**3 - 6 mule deer, 2 - 5 horses, moose**			**57 camera days**
TOTAL				**124 camera days**

Table 11. Results of remote camera set up along trail at Upper Place junction - Brittany Triangle. Camera was set up July 27, 2013 to September 24, 2013 for a total of 58 camera days.

South Upper Place Remote Camera Results

Date	Species	Time	Comments	Camera Days
July 27/13	Mule deer	20:41	Travel S along trail	
July 28/13	Mule deer	00:58	Travel S along trail	
July 28/13	Mule deer - doe	6:03	Travel W along trail	
July 29/13	Mule deer - doe	10:40	Travel S along trail	
July 29/13	Mule deer - buck	15:44	Travel W along trail	
July 30/13	Moose	20:51	Running N along trail	
Summary	**2-4 Mule deer, 1 moose**			**4 camera days**
Aug. 1/13	Mule deer - doe	15:41	Checks out camera	
Date	**Species**	**Time**	**Comments**	**Camera Days**
Aug.7/13	Mule deer - doe	10:23	Travel S	
Aug. 8/13	Mule deer - young	5:35	Travel W along trail	
Aug. 10/13	Black bear	22:01	Travel W along trail - dark	
Aug. 11/13	Mule deer - buck - strange circle on R side	00:34	Travel S along trail	
Aug. 12/13	2 Mule deer. doe and buck	13:47	Travel W along trail	
Aug. 12/13	Black bear	21:58	Travel S along trail	
Aug. 20/13	Mule deer	7:07	Travel W along trail	
Aug. 21/13	Mule deer-doe, marks on R side	11:25	Travel W along trail	
Aug. 22/13	2 Mule deer	5:32	Stopped, 1 sniffing ground	
Aug. 24/13	Horse	2:16	Head only in photo, appears Southbound?	
Aug. 25/13	Mule deer- buck	21:23	Travel S along trail	
Aug. 26/13	Mule deer -young	9:38	Travel S along trail	
Aug. 26/13	Mule deer - doe	9:41	Travel S along trail	
Aug. 28/13	Mule deer	00:58	Travel S along trail	
Aug. 28/13	Mule deer - doe	8:47	Travel S along trail	
Aug. 30/13	Fox or coyote? (only back end)	20:38	Travel S along trail	
Aug. 31/13	Horse	16:44	Travel N along trail	
Summary	**5-14 Mule deer, 1-2 black bears, 1-2 horses, 1 fox or coyote**			**31 camera days**
Sept. 1/13	2 Mountain lions	7:20	Travel W along trail	
Sept. 7/13	2 Mule deer, does	8:53	Stopped. Eating, sniffing ground	
Sept. 20/13	Mule deer-doe, small lumps on 1/2 of back	18:41	Sniffing/itching	
Sept. 24/13	2 Mule deer	14:12	Travel S along trail	
Summary	**2 Mountain lions, 3-5 Mule deer**			**24 camera days**
TOTAL				**58 camera days**

Table 12. Results of remote camera set up near old wolf den at Blue Lake - Brittany Triangle. Camera was set up May, 2013 to October26, 2013 for a total of 149 camera days.

Blue Lake Remote Camera Results

Date	Species	Time	Comments	Camera Days
May 31/13	Moose (bull)	6:33	Travelling west	
June 1/13	2 horses	4:52	Eating along slope	
June 9/13	Horse	16:01	Nose to ground	
June 10/13	Moose	7:18	Travelling east	
June 10/13	Mule deer (buck)	9:04	Travelling east	
June 14/14	Mule deer (buck)	7:43	Stopped, looking west	
June 19/13	Horse	5:43	grey, travelling west	
June 19/13	Horse	21:40	Stopped	
June 26/13	Moose (bull)	8:19	Close-up image, left side	
June 27/13	Deer	3:03	Hind end only visible, travelling north	
Summary	**3 moose, 5 horse, 3 deer**			**28 camera days**
July 7/13	Wolf	8:24	Sniffing ground, grey/brown coat	
July 7/13	Wolf	11:08	Possibly urinating	
July 11/13	Deer	6:33	Hind end only visible, heading to lake	
July 15/13	Mule deer (buck)	8:36	Heading to lake	
July 16/13	Wolf	10:05	Hind end only visible, travelling west	
July 18/13	Deer	5:50	Hind end only visible, travelling west	
July 25/13	Wolf	8:26	Investigating ground	
Summary	**4 wolf, 3 deer**			**28 camera days**
Aug. 3/13	Deer	4:14		
Aug. 19/13	Grizzly bear	11:06	Hind end only visible, travelling west	
Aug. 28/13	Deer	8:14	Hind end only visible, travelling west	
Sept. 2/13	4 horses	7:45	Sniffing ground, remaining in area on slope	
Sept. 14/13	Deer	10:01	Travelling west	
Sept. 25/13	Moose (bull)	8:35	Travelling east	
Summary	**1 grizzly bear, 1 moose, 4 horses, 3 deer**			**62 camera days**
Oct. 6/13	Horse	10:00	Heading to lake	
Oct. 11/13	Horse	14:14	Travelling east	
Oct. 16/13	2 horses	8:42	Grazing	
Oct. 17/13	2 horses	10:16	Running east	
Oct. 18/13	Horse	00:36	Close-up	
Oct. 26/13	Horse	15:16	Hind end only visible, travelling west	
Summary	**8 horse**			**31 camera days**
TOTAL				**149 camera days**

Table 13. Results of remote camera set up back- road junction near Bald Mountain- Nemiah Valley. Camera was set up October 12, 2013 to February 21, 2014 for a total of 133 camera days.

Bald Mountain Remote Camera Results

Date	Species	Time	Comments	Camera Days
Oct. 12/13	Human	16:55	Pick-up truck	
Oct. 12/13	Human	17:48	Walker	
Oct. 14/13	Human	17:39	Runner	
Oct. 15/13	Human	13:40	Pick-up truck	
Oct. 15/13	3 horses	14:28	East along road	
Oct. 16/13	Human	15:00	Runner	
Oct. 16/13	Horse	15:29	Eastbound along road, wearing halter	
Oct. 21/13	Horse	4:10	Westbound along road	
Oct. 21/13	Human	14:34	Runner	
Oct. 21/13	Horse	17:06	Bay with black mane	
Oct. 21/13	5 domestic cows and bull	17:19	Eastbound along road	
Oct. 22/13	Human	15:14	Pick-up truck	
Oct. 23/13	Horse	7:40	Eastbound along road, pure white	
Oct. 23/13	Horse	7:45	Eastbound along road, white with black "painted" spots	
Oct. 23/13	Human	10:43	Hitachi Excavator	
Oct. 23/13	Human	15:55	Pick-up truck	
Oct. 23/13	Human	16:19	ATV	
Oct 24/13	5 horses	16:29-16:37	Northeast along road	
Oct. 26/13	5 cows/calves	18:29	West along road	
Oct. 27/13	Horse	1:42	East along road	
Oct. 27/13	Horse	1:44	East along road	
Oct. 27/13	Dog	12:37	Sniffing ground	
Summary	**15 horses, 11 cows, 10 humans (4 on foot, 6 vehicles), 1 dog**			**16 camera days**
Nov. 3/13	Horse	9:06	West along road	
Nov. 7/13	2 horses	14:42	West along road, 2 bays	
Nov. 7/13	2 horses	16:38	East along road, one bay one black	
Nov. 8/13	Horse	2:31	East along road, wearing halter	
Nov. 13/13	Human	16:33	Runner	
Nov. 17/13	Horse	18:05	West along road	
Nov. 20/13	Horse	1:21	West along road, white socks	
Nov. 20/13	Horse	1:23	West along road, no socks	
Nov. 20/13	Horse	1:37	West along road, light colour	
Nov. 27/13	Human	15:23	Runner	
Summary	**8 horse, 2 humans on foot**			**34 camera days**
Dec. 1/13	Wolf	17:44	East along road, mixed grey	
Dec. 18/13	2 horses	21:42	West along road	
Dec. 18/13	Horse	22:06	West along road	
Dec. 20/13	Human	17:28	Pick-up truck	

Dec. 21/13	3 horses	17:50	West along road	
Dec. 21/13	Horse	18:13	West along road, white and skinny	
Dec. 25/13	Horse	22:12	West along road	
Dec. 25/13	3 horses	22:15	West along road	
Dec. 30/13	Human	17:05	Pick-up truck	
Summary	**1 wolf, 11 horses. 2 human vehicles**			**30 camera days**
Jan. 1/14	Human	16:58	Walker	
Jan. 3/14	Human	17:03	Walker	
Jan. 4/14	2 horses	13:50	East along road, 1 bay with white socks and 1 buckskin	
Jan. 4/14	Horse	14:04	East along road, bay with white socks and black mane	
Jan. 4/14	Horse	14:48	East along road, chestnut	
Jan. 4/14	Human	16:59	Walker	
Jan. 6/14	Horse	19:39	West along road	
Jan. 7/14	Wolf	19:22	West along trail	
Jan. 28/14	Wolf	9:07	East along road. Grey, brown, black coat.	
Jan.28/14	2 horses	18:55	West along road	
Jan. 30/14	2 horses	20:00	West along road	
Jan. 31/14	Wolf	19:17	West along road, sniffing trail	
Summary	**3 wolf, 9 horse, 3 human on foot**			**32 camera days**
Feb. 3/14	Horse	1:56	West along road	
Feb 10/14	Horse	14:00	West along road	
Feb. 13/14	Horse	2:45	West along road	
Feb. 16/14	Wolf	8:39	East along road	
Feb. 19/14	Wolf	10:12	East along road	
Feb. 19/14	Coyote	11:12	Sniffing road, east along road	
Feb. 21/14	Human	15:25	Researcher on foot	
Feb. 21/14	7 cows/calves	18:02	West along road	
Summary	**2 wolf, 1 coyote, 3 horse, 7 cows, 1 human on foot**		**21 camera days**	
TOTAL			**133 camera days**	

APPENDIX 2. DATE AND GPS COORDINATES OF SAMPLES COLLECTED

Table 14. Summary of locations and dates of wolf scat samples collected

Sample ID for Lab	Date Collected dd/mm/yy	NORTHING	WESTING	Area collected from and Analysis Observations
3	07/05/13	514359.7	1235338	Brittany. Contains horse and deer hair; bone shards, hoof fragment of deer dewclaw or horse neonate.
4	08/05/13	514107.9	1234726.1	Brittany. Contains horse hair (reddish colour) and bone fragments, trace of vegetation.
1	19/05/13	514556.9	1234905.5	Brittany. Contains deer hair, dew claw and articulating bone, trace of vegetation
5	10/10/13	51451	123525	Brittany. Contains small mammal hair (most likely vole), and berries.
2	12/10/13	51212	123298	Brittany. Contains deer hair, and rodent teeth and bones (most likely squirrel).
19*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, trace of vegetation.
20*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, bone shards.
21*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, bone shards.
29*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, bone shards, vegetation.
30*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains deer hair and dew claw as well as horse hair including tail/mane.
31*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane.
32*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, bone shards, parts of hoof.
33*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, large bone shards, parts of hoof.
34*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains horse hair including tail/mane, bone shards.
35*	8/02/14	5141.607	12348.493	Brittany -Horse carcass (shot through jaw). Contains deer and bone shards.
6	13/02/14	5145.523	12351.661	Brittany. Contains horse hair, trace of vegetation, and unidentified bone fragment.
9	16/02/14	5139.666	12348.025	Brittany. Contains deer hair, apparent rumen contents, bone shards and vegetation.
10	18/02/14	5139.785	12347.804	Brittany. Contains short body hair (no mane/tail), bone, vegetation.
11	18/02/14	5139.914	12347.479	Brittany. Contains deer hair, bone fragments and part of hoof.
18	18/02/14	5139.938	12347.429	Brittany. Contains deer hair, dew claw and bone fragments.
12	18/02/14	5140.565	12346.202	Brittany. Contains deer hair, parts of hoof and bone fragments.
8**	21/02/14	5126.674	12401.211	Nemiah Valley. Contains horse hair and vegetation.
14**	21/02/14	5126.674	12401.211	Nemiah Valley. Contains cow hair, 8 feline claws (most likely bobcat or domestic cat), 3 rodent claws and bones (likely stomach contents of feline).
15**	21/02/14	5126.674	12401.211	Nemiah Valley. Contains deer hair.
17**	21/02/14	5126.674	12401.211	Nemiah Valley. Contains cow hair.
16	28/02/14	5128.414	12357.190	Nemiah Valley. Contains beaver hair and small-medium bone shards.
* = 10 scats collected at same location on same date, horse carcass ** = 4 scats collected at same location on same date, cow carcass				

Table 15. Wolf Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected dd/mm/yy	NORTHING	WESTING	Comments
WOLF1	__/11/12	5128	12400	HAIR from shot wolf N. of Bald Mtn -N. Valley
WOLF2	__/11/12	5128	12400	HAIR from shot wolf N. of Bald Mtn -N. Valley
WOLF3	2002	BIG MDW	BIG MDW	TOOTH from old collected skull at Big Mdw- Brittany
WOLF4	21/02/14	5126.719	12401.301	TOOTH from skull near Bald Mtn-N.Valley
WOLF5	14/02/14	514653.4	1234553.6	HAIR from Blue Lake den - Brittany
WOLF6	28/12/13	12349.5	5135.6	HAIR from Male 73 lbs. caught by trapper
WOLF7	__/01/14	12349.5	5135.6	HAIR from female caught by trapper
WOLF8	__/01/14	12349.5	5135.6	HAIR from female caught by trapper
WOLF9	15/01/14	12349.5	5135.6	HAIR from Male 100 lb caught by trapper
WOLF10	19/02/14	12348.837	5135.223	HAIR from scent post Capt. GT - Brittany
WOLF11	18/02/14	12346.482	5140.519	HAIR along Elkin Creek, N of Capt GT - Brittany
WOLF12	18/02/14	12346.306	5140.531	HAIR (guard and undercoat) Elkin Creek - Brittany

Table 16. Moose Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected dd/mm/yy	Approx. Location	NORTHING	WESTING	Comments
M1	13/10/2013	West Tatlow Trail -N.Valley	5140.980	12347.365	HAIR shed on branch
M2	02/10/2013	Near Upper Place -Brittany	5141.68	12348.276	ANTLER
M3	07/05/2013	North Meadow -Brittany	514351.8	1235220.9	HAIR shed
M4	09/05/2013	Eli Lake - Brittany	514628.5	1235105.6	HAIR found dead moose
M5	08/02/14	Capt. GT -Brittany	5139.671	12347.998	HAIR from bedding site
M6	08/02/14	Upper Place - Brittany	5141.508	12347.836	HAIR
M7	9/02/14	Brittany	5127.861	12356.914	HAIR
M8	9/02/14	Far Mdw. - Brittany	5143.451	12350.641	HAIR from bedding site
M9	10/02/14	Far Mdw - Brittany	5143.589	12351.416	HAIR
M10	10/02/14	Far Mdw - Brittany	5143.550	12351.229	HAIR from bedding site
M11	14/02/14	Blue Lake - Brittany	5146.795	12345.852	ANTLER
M12	15/02/14	Nuntsi Creek - Brittany	5143.517	12350.797	HAIR
M13	17/02/14	Capt. GT - Brittany	5139.598	12348.049	HAIR
M14	18/02/14	Elkin Creek - Brittany	5140.515	12346.371	HAIR
M15	21/02/14	West Tatlow Trail - N.Valley	5140.530	12346.305	HAIR

Table 17. Beaver Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected dd/mm/yy	Approx. Location	NORTHING	WESTING	Comments
B1	28/09/2013	Near Capt. GT	5139.257	12348.304	TOOTH
B2	28/09/2013	Near Capt. GT	5139.392	12347.984	TOOTH
B3	28/09/2013	Capt. GT	5139.546	12348.053	HAIR from hair trap
B4	28/09/2013	Capt. GT	5139.589	12348.027	HAIR from hair trap
B5	01/10/2013	Far Meadows	5143.517	12351.206	TOOTH
B6	21/02/14	Bald Mtn area	5126.674	12401.256	TOOTH
B7	10/02/14	Far Meadow	5143.282	12351.205	HAIR from hair trap
B8	10/02/14	Far Meadow	5143.280	12351.205	HAIR from beaver hut
B9	17/10/13	Fishem Lake	5115	12340	HAIR from trapper

Table 18. Cow Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected dd/mm/yy	Approx. Location	NORTHING	WESTING	Comments
C1	28/09/2013	Capt. GT - Brittany	5139.326	12348.283	BONE from old carcass
C2	26/02/14	Bald Mtn - N. Valley	5126.513	12401.382	TOOTH from skull
C3	20/02/14	Elkin Creek Ranch	5130	12347	HAIR from dead cow

Table 19. Deer Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected Dd/mm/yy	Approx. Location	NORTHING	WESTING	Comments
D1	29/09/2013	Near Upper Place	5141.376	12347.628	TOOTH
D2	18/02/14	N of Capt GT - Brittany	5140.604	12346.191	HAIR
D3	8/02/14	Capt. GT - Brittany	5140.541	12347.413	HAIR
D4	8/02/14	Capt. GT - Brittany	5140.388	12347.408	HAIR
D5	26/09/13	Chilco Lake, near Traditional Village - N. Valley	5123.553	12407.382	TOOTH
D6	8/02/14	Capt. GT - Brittany	5140.329	12347.380	HAIR from bedding site

Table 20. Wild Horse Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected dd/mm/yy	Approx. Location	NORTHING	WESTING	Comments
H1	01/06/2013	Bald Mtn -NV	5125.594	12401.143	HAIR found w jaws, vertebrae, wolf scat
H2	07/10/2013	NV	5127.519	12400.078	HAIR
H3	22/05/2013	Upper Place - BT	5140.461	12348.229	HAIR from horse leg carcass (Trapper's Lk)
H4	14/05/2013	BT	5141.339	12347.531	HAIR
H5	27/07/2013	Upper Place - BT	5141.384	12347.599	HAIR
H6	26/07/2013	Upper Place - BT	5141.522	12347.799	HAIR
H7	18/05/2013	Chewitt Lake - BT	5142.322	12353.019	HAIR
H8	13/05/2013	BT	5143.152	12352.01	HAIR
H9	01/10/2013	BT	5143.173	12351.013	HAIR
H10	01/10/2013	BT	5143.223	12351.067	HAIR
H11	26/07/2013	1 km S of FM -BT	5143.308	12349.943	HAIR
H12	01/10/2013	BT	5143.35	12350.496	HAIR
H13	01/10/2013	BT	5143.517	12351.206	TOOTH
H14	03/05/2013	Far Meadows -BT	5143.518	12351.206	HAIR (body) from branch snag
H15	01/10/2013	BT	5143.564	12351.477	HAIR
H16	01/10/2013	BT	5143.565	12351.588	HAIR
H17	01/10/2013	BT	5143.573	12351.446	HAIR
H18	01/10/2013	BT	5143.576	12351.344	HAIR
H19	02/05/2013	BT	5143.585	12353.396	HAIR
H20	19/05/2013	BT	5146.116	12347.526	HAIR (short) from roll area
H21	11/10/13	N. Valley	5126.561	12401.235	HAIR
H22	11/10/13	N. Valley	5126.567	12401.198	HAIR
H23	08/02/14	Upper Place - BT	5141.607	12348.493	HAIR, dead horse shot through lower jaw, wolf scavenged
H24	08/02/14	Upper Place - BT	5141.631	12348.455	HAIR, short
H25	13/02/14	3 km W of Blue Lake - BT	5146.236	12348.043	HAIR
H26	13/02/14	Sable Mdw -BT	5145.480	12351.673	HAIR
H27	11/02/14	Tiernan Mdw- BT	5144.689	12352.971	HAIR
H28	13/02/14	Blue Lake -BT	5146.785	12345.860	HAIR
H29	13/02/14	Blue Lake - BT	5146.769	12345.909	HAIR
H30	10/02/14	Far Mdw - BT	5143.409	12350.654	HAIR
H31	15/02/14	Nuntsi Creek - BT	5143.553	12350.096	HAIR
H32	15/02/14	Nuntsi Creek - BT	5143.596	12349.945	HAIR from rub stick
H33	21/02/14	N of Bald Mtn - N. Valley	5126.527	12401.523	HAIR from carcass

Table 21. Small Mammal Samples Collected for Isotope Analysis

Sample ID for Lab	Date Collected dd/mm/yy	Approx. Location	NORTHING	WESTING	Comments
MUSKRAT1	17/10/13	Fishem Lake	5115	12340	Muskrat HAIR from trapper

APPENDIX 3. PROPOSED OPTIONS AND RECOMMENDATIONS FOR CONTINUATION OF THE PROJECT

SCAT SAMPLE COLLECTION AND ANALYSIS

A further two years of field sample collections are required, preferable consecutively, to gain enough information and samples to analyze for seasonal patterns in wolf feeding ecology. Field scat collection will continue to follow a modified version of protocol (Darimont et al. 2003). Collection times should occur at the end of each season in order to detect changes in prey consumption as they occur, and before scat deteriorates. A minimum of 300 scat sample are desired for robust testing (Chris Darimont, personal communication). All scats will be stored frozen until they can be prepared for safe handling and analysis. During future analysis, autoclaved scats will be immersed in water for 48 hours and washed in a sieve with a mesh size of 1.0 mm to separate large and small materials and to remove debris from guard hairs (Urton. 2004. Kennedy and Carbyn. 1981).

Future analysis will be carried out either by the researcher or by a qualified technician in collaboration with the Canid Ecology Lab at the University of Calgary.

HAIR, TOOTH, AND ANTLER SAMPLE COLLECTION

Sample collection of hair, bone, tooth and antler will need to be continued for all species other than wild horse and moose.

SAMPLE ISOTOPE ANALYSIS

An evaluation of the seasonal shift in wolf prey consumption will occur through stable isotope analysis to add further details on wolf foraging ecology to scat analysis. Urton (2004) describes laboratory procedures for analyzing hair samples; however, this would not be carried out by the researcher, but rather sent to a laboratory for analysis.

Preparation of hair samples for isotope analysis will follow existing protocol[4]. Samples would then be sent to Myles Stocki at the University of Saskatchewan, Soil Sciences Department for analysis. During this pilot study, precedence was given to collecting sufficient samples of potential prey hair to establish isotopic niche signatures, however more samples are still required.

Note that neither scat nor isotope analysis will enable determination of predation versus scavenging.

[4] Laboratory Protocol: Bear Hair Sample Preparation for Isotope Analysis, Applied Conservation Science Lab, University of Victoria, British Columbia.

WOLF TRACKING

Wolf scat collection will coincide in the winter months along established transects with tracking, which is often used to determine species presence, activity and/or relative abundance. Wolf tracks can also be backtracked to help identify prey at kill sites. The secondary roads and trails chosen for transect surveys often serve as movement corridors for wolves and other carnivores in forested areas. Winter movements and behaviour can be observed through tracking and this should be carried out.

Figure 26. Fresh wolf tracks around a recent deposit of wild horse manure in the Brittany Triangle, February 2014.

THE HUMAN DIMENSION

Formal interviews with local ranchers, Xeni Gwet'in First Nation members, guide-outfitters, tourism operators, hunters/trappers, and other community members are required to collect historical and anecdotal information to compare with findings. This would also supplement the information from the diet study where it relates to domestic cattle, domestic and wild horses and concerns about moose population declines. Interviews will be carried out with Xeni Gwet'in elders and others to determine local traditional knowledge and management of wolves. The quantitative data obtained through field sampling will be compared with public perception and livestock depredation concerns.

A review of case history complaint data from the BC Conservation Officer Service, the Nemiah Valley Stockman's Association, and the BC Cattleman's Association and others should be conducted to coincide with hair and scat collection surveys over the first two years of the study. The quantitative data obtained through field sampling will be compared with livestock depredation claims to address the public perception of wolves.

This study recognises the importance of wildlife management and conservation catering to the goals of local community members, particularly when conflicts arise involving the principles of conservation biology, such as protecting apex predators in order to facilitate top- down effects. The project would continue to include the involvement of the Xeni Gwet'in community and the results obtained from this research may be incorporated into the ongoing refinement of the Xeni Gwet'in Stewardship Plan.

By proactively assessing wolf predator-prey dynamics in the Brittany Triangle, this study is necessary because horse management will become a growing issue in British Columbia, as will potential wolf-livestock conflicts, the role of wolf predation in moose numbers, and general wolf management and conservation. Future economic and environmental decisions made for the Chilcotin area will require knowledge of such interactions to complement planning, policy, and conservation.

This research project aims to incorporate wolf social dynamics, ecological role, and human cultural values in assessing current trends and planning for future conservation values. The quality of wolf habitat is ultimately determined by the behaviour of people sharing the area.

APPENDIX 4. FUTURE BUDGET

Below is an outline of the predicted costs of this research project to be carried out in full over a two-year period.

ACTIVITY		$ Amt	Sub-total
Personnel			
field researcher 8 months @ $1,500/month		12,000	
researcher time to prepare samples for isotope analysis		2,000	
microscopic scat analysis		5,000	
			17,200
Contracts	University of Sask, Myles Stocki isotope work		
prey niche signature, 15 samples of 6 prey at $15/ea		1,850	
wolf guard hair analysis; 15 samples @ $100/sample		1,500	3,350
Office Expenses and Communications			
printing Rancher's Toolkit		1,000	
printing newsletters and mail outs		700	
website design and production		1,000	
publicity and promotion (press releases & presentations)		2,000	4,700
Travel			
travel to Brittany, meals and lodging, 4 seasons X 2 years @ $1000/trip		8,000	
travel within study area for sample collection, 8 seasons X $400		3,200	
travel to Calgary for lab work 10 X @ $100 return trip (scat microscope analysis & isotope sample preparation)		1,000	12,200
Other			
tools for preparing samples for isotope analysis		500	500
TOTAL		**37,950**	

Each one-month trip to the research area made by the researcher will cost approximately $2,500, including transportation. If a Xeni field assistant is hired ($100/day) an additional $1,400 will be needed to cover 14 days of field work by the assistant, for a total of $3,900 quarterly for travel and field work, not including lab expenses.

Ideally, the researcher would like to have samples analyzed for isotope niche signatures ASAP. This would cost a total of approximately $1,850 through the services of Myles Stocki at the University of Saskatchewan. Preparation of these samples will be required prior to processing by Dr. Stocki, which will require about $500 in equipment, plus time and use of a lab for the researcher to prepare them ($2,000), or they could be prepared by a hired technician for an additional $30 - 40/sample [$35 x 15 samples (6 species) = $3,150].