Species Status Assessment Report
for the
Alexander Archipelago Wolf
(*Canis lupus ligoni)*

Version 2.1

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U.S. Fish and Wildlife Service
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VERSION UPDATES

Substantive changes were made from the prior Alexander Archipelago Wolf SSA version 1.0 (Service 2015, 162 pp.). In this updated version of the SSA, we incorporated new information available on wolf harvest, timber harvest, climate change, disease, diet, genetics, and Traditional Ecological Knowledge (TEK). New information was incorporated directly into appropriate sections of the SSA, including our current condition and future condition analysis and resulted in a 2.0 version. After recommendation meetings, minor updates were also made to the SSA including updating references, re-wording sections, updating new hunting regulations for Southeast Alaska, and addressing 508 compliance, resulting in the current 2.1 version.

EXECUTIVE SUMMARY

This report summarizes the results of a species status assessment (SSA) that we completed for the Alexander Archipelago wolf (*Canis lupus ligoni*), which was undertaken to assess the viability of the subspecies. For the purpose of this assessment, we generally define viability as the ability of a species to sustain resilient populations in natural ecosystems within a biologically meaningful timeframe. This SSA compiles the best available scientific information regarding the Alexander Archipelago wolf's biology, its individual, population, and subspecies-level needs, and the factors that influence the subspecies' viability. Sources of information used to inform our analyses include peer-reviewed scientific literature, academic reports, survey data provided by State and Federal agencies, as well as input we elicited from various species and subject matter experts, including local wolf experts with Traditional Ecological Knowledge (TEK).

The analytical framework of the SSA is discussed in *Chapter 1 Introduction and Analytical Framework*. The SSA process can be categorized into three sequential stages. During the first stage, we compiled information on the natural history of the subspecies and its habitat in order to determine the individual needs of the Alexander Archipelago wolf (*Chapter 2 Species Biology and Individual Needs*). The next stage involved an in-depth review of the historical and current factors that have affected the viability of the subspecies, in terms of its demographics and habitat condition (*Chapter 3 Factors Influencing Viability*). We then used this information to assess the Alexander Archipelago wolf's current condition in terms of its resiliency, redundancy, and representation (together, the 3Rs) in *Chapter 4 Population and Species Needs and Current Conditions*. The final stage of the SSA involved describing possible future conditions of the Alexander Archipelago wolf in response to plausible changes in environmental and anthropogenic influences using the 3Rs over a conservative estimate of five generations, or over the next 30 years (*Chapter 5 Future Conditions*).

The Alexander Archipelago wolf is a subspecies of gray wolf (*Canis lupus*) that occurs along the mainland of Southeast Alaska and coastal British Columbia (B.C.) west of the Coast Mountains and on larger islands except Admiralty, Baranof, and Chichagof islands and all the Haida Gwaii, or Queen Charlotte Islands. There are gaps in our understanding of the life history of the species; thus, when appropriate, we have applied information from gray wolves and other gray wolf subspecies. Alexander Archipelago wolves breed between 22 to 34 months of age, and litters range from 1 to 8 pups. Denning typically occurs from mid-April through early July; throughout the rest of the year Alexander Archipelago wolves are traveling, hunting, or dispersing. Alexander Archipelago wolves are capable of dispersing long distances, both on land and water, although there are examples of Alexander Archipelago wolves avoiding water crossings. Pack sizes typically range between 2 and 12 wolves, although larger groups have been observed (30–40). Alexander Archipelago wolves are opportunistic predators that eat a variety of prey species yet, like gray wolves, ungulates compose most of their diet. Across the range of the subspecies, black-tailed deer and moose make up 75 percent of the wolves' diet. Alexander Archipelago

wolves, like many gray wolves, are also habitat generalists, typically utilizing whatever habitat their preferred prey use and avoiding areas of intense human activity. Old-growth forests, which Alexander Archipelago wolves select for, make up a majority of home range areas, and areas near freshwater are also selected by wolves during denning.

Evidence suggests timber harvest and associated development has altered the landscape within the range of the Alexander Archipelago wolf more than any other human activity and can influence several aspects of its habitat. Although the rate of logging has declined across much of the range of the subspecies, legacy impacts to the preferred habitat of the wolf's primary prey (black-tailed deer) may continue for hundreds of years. Additionally, in Southeast Alaska, most roads were constructed to facilitate timber harvest, and roads can adversely impact wolves by providing easier access for wolf hunters and trappers. Wolf harvest was identified as another primary threat to Alexander Archipelago wolf viability. Based on the best available population estimates of Alexander Archipelago wolf, mean reported annual wolf harvest between 1997 and 2021 represented 9–19 percent of wolf populations in Southeast Alaska. In B.C., between 1976 and 2018, reported annual wolf harvest represented 6–10 percent of wolf populations. These numbers don't take into account unreported wolf harvest, which can be high (up to half of total wolf harvest) in certain portions of the range.

Some Alexander Archipelago wolf populations have also exhibited evidence of inbreeding; high levels of recent, historical, and ancestral inbreeding in the Prince of Wales (POW) Complex and historical and ancestral inbreeding in Southern Southeast Alaska have been detected. While not definitely linked to inbreeding depression in these populations, these levels of inbreeding are likely to be negatively impacting population fitness and viability due to exposure of deleterious alleles as well as reducing overall genetic diversity and evolutionary adaptive capacity.

Estimating wolf abundance and densities in the temperate rainforests of Southeast Alaska and B.C. is challenging, and the only field-derived, empirical population estimates for Alexander Archipelago wolves exist for POW Island and the surrounding islands. Therefore, for most of the range, we used models linking wolf abundance to habitat capability or biomass of deer and other prey, as well as TEK, to inform our population growth assessments.

Alexander Archipelago wolves currently occupy five Analysis Units that span the historical range of the subspecies (Figure 2), three of which currently exhibit high resiliency (Northern and Southern Coastal B.C. and Northern Southeast Alaska), one with moderately-high resiliency (Southern Southeast Alaska), and one with moderately-low resiliency (POW Complex). Alexander Archipelago wolves appear to have high adaptive capacity, and we expect most populations to be able to adapt to near-term changes in their physical and biological environments. An exception is the POW Complex where high levels of inbreeding have been documented and ungulate prey richness is limited compared to the rest of the range. Given the wide distribution of populations across the historical range, and the moderate to high resiliency exhibited by most of the populations, we consider the Alexander Archipelago wolf subspecies to currently have high redundancy in the face of potential catastrophic events. The catastrophic event with the highest potential to impact Alexander Archipelago wolf redundancy is disease, and we are not aware of any significant disease outbreaks within Alexander Archipelago wolf populations currently.

To assess the future condition of the Alexander Archipelago wolf, we first identified the most significant and plausible factors that could affect the viability of the Alexander Archipelago wolf 30 years into the future. Across the range of the subspecies, we evaluated the potential effects of wolf harvest and disease. Within the Southeast Alaska Analysis Units, we also considered how inbreeding could continue to impact population growth, and within the POW Complex Analysis Unit, we analyzed how different amounts of annual precipitation as snow and historical and ongoing timber harvest activities could alter land cover and the availability of deer for Alexander Archipelago wolves.

Under a low threat scenario (Scenarios A1 and B1), we expect resiliency to remain similar to current conditions across most of the subspecies' range, and resiliency within the POW Complex Analysis Unit is expected to increase to moderate levels. If we look at Model B for the POW Complex under Scenario B1 (low wolf harvest, fewer severe winters, conservative old-growth harvest), we expect resiliency to remain at the current moderately-low level. All other Analysis Units exhibit moderately-high to high resiliency under Scenario A1. Therefore, we also anticipate redundancy for the subspecies to remain high. Under these scenarios it is projected that adaptive capacity within the subspecies will remain intact.

Under an average threat scenario (Scenarios A2 and B2), we expect resiliency to decrease in the Northern Southeast Alaska Analysis Unit. The POW Complex Analysis Unit exhibits moderately-low resiliency under these scenarios. All other Analysis Units continue to exhibit moderately-high to high resiliency. Therefore, if threats continue at current rates, we expect redundancy and adaptive capacity to remain stable, with the potential for a slight reduction, specifically in the northern portion of the range (Southeast Alaska Analysis Units).

Under a high threat scenario (Scenarios A3 and B3), we expect resiliency to decrease in the Northern and Southern B.C. Analysis Units and the Northern Southeast Alaska Unit. Using Model A, resiliency in the POW Complex under this scenario is low, while Model B projects this population to be functionally extirpated. All other units exhibit moderately-high resiliency under this scenario. We expect overall subspecies redundancy to be slightly reduced, and we also expect adaptive capacity to decline across the range. The POW Complex may reach a point where adaptive capacity cannot be sustained without intensive conservation (e.g., translocations, reintroductions).

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CHAPTER 1 – INTRODUCTION AND ANALYTICAL FRAMEWORK

This report summarizes the results of a Species Status Assessment (SSA) conducted by the U.S. Fish and Wildlife Service (Service) for the Alexander Archipelago wolf (*Canis lupus ligoni*) in Southeast Alaska and coastal British Columbia (B.C.). The SSA framework (Service 2016, entire) (Figure 1) is intended to be an in-depth review of the species' biology and threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The intent is for the SSA Report to be easily updated as new information becomes available and to support all functions of the Endangered Species Program from Candidate Assessment to Listing to Consultations to Recovery. As such, the SSA Report will be a living document that may be used to inform Endangered Species Act decision making, such as listing, recovery, section 7, section 10, and reclassification decisions (the former four decision types are only relevant should the species warrant listing under the Act).

Importantly, the SSA Report is not a decisional document by the Service; rather it provides a review of available information strictly related to the biological status of the Alexander Archipelago wolf. The listing decision will be made by the Service after reviewing this document and all relevant laws, regulations, and policies, and the results of a proposed decision will be announced in the Federal Register, with appropriate opportunities for public input.

For the purpose of this assessment, we generally define viability as the ability of the Alexander Archipelago wolf to sustain resilient populations within its range, over time. Using the SSA framework (Figure 1), we consider what the subspecies needs to maintain viability by characterizing the status of the subspecies in terms of its resiliency, redundancy, and representation (Wolf et al. 2015, entire; Service 2016, entire).

> <u>Resiliency</u> is the ability of a species to withstand environmental stochasticity or normal, year–to–year variations in environmental conditions such as temperature and rainfall; periodic disturbances within the normal range of variation such as fire, floods, and storms; and demographic stochasticity or normal variation in demographic rates such as mortality and fecundity (Redford et al. 2011, p. 40). Therefore, resiliency is the ability to sustain populations through the natural range of favorable and unfavorable conditions. We can best gauge resiliency by evaluating population-level characteristics such as demography, genetic health, connectivity, and habitat factors such as quantity, quality, configuration, and heterogeneity. Also, for species prone to spatial synchrony, or regionally correlated fluctuations among populations, distance between populations and degree of spatial heterogeneity, or diversity of habitat types and microclimates, are also important considerations.
>
> <u>Redundancy</u> is the ability of a species to withstand catastrophes. Catastrophes are stochastic events that are expected to lead to population collapse regardless of population

health and for which adaptation is unlikely (Mangel and Tier 1993, p. 1083). We can best gauge redundancy by analyzing the number and distribution of populations relative to the scale of anticipated species–relevant catastrophic events. The analysis entails assessing the cumulative risk of catastrophes occurring over time. Redundancy can be analyzed at a population or regional scale, or for narrow–ranged species, at the species level.

Representation is the ability of a species to adapt to both near-term and long-term changes in its physical (climate conditions, habitat conditions, habitat structure, etc.) and biological (pathogens, competitors, predators, etc.) environments. This ability to adapt to new environments—referred to as adaptive capacity—is essential for viability, as species need to continually adapt to their continuously changing environments (Nicotra et al. 2015, p. 1269). Species adapt to novel changes in their environment by either [1] moving to new, suitable environments or [2] by altering their physical or behavioral traits (phenotypes) to match the new environmental conditions through either plasticity or genetic change (Beever et al. 2016, p. 132; Nicotra et al. 2015, p. 1270; Beever et al. 2016, p. 132). The latter (evolution) occurs via the evolutionary processes of natural selection, gene flow, mutations, and genetic drift (Crandall et al. 2000, pp. 290–291; Zackay 2007, p. 1; Sgrò et al. 2010, p. 327). We can best gauge representation by examining the breadth of genetic, phenotypic, and ecological diversity found within a species and its ability to disperse and colonize new areas. In assessing the breadth of variation, it is important to consider both larger-scale variation (such as morphological, behavioral, or life history differences which might exist across the range and environmental or ecological variation across the range), and smaller-scale variation (which might include measures of interpopulation genetic diversity). In assessing the dispersal ability, it is important to evaluate the ability and likelihood of the species to track suitable habitat and climate over time. Lastly, to evaluate the evolutionary processes that contribute to and maintain adaptive capacity, it is important to assess [1] natural levels and patterns of gene flow, [2] degree of ecological diversity occupied, and [3] effective population size. In our species status assessments, we assess all three facets to the best of our ability based on available data.

To evaluate the current and future viability of the Alexander Archipelago wolf, we assessed a range of conditions to characterize the subspecies' resiliency, representation, and redundancy (together, the 3Rs). This SSA Report provides a thorough account of known biology and natural history and assesses the risk of threats and limiting factors affecting the future viability of the subspecies.

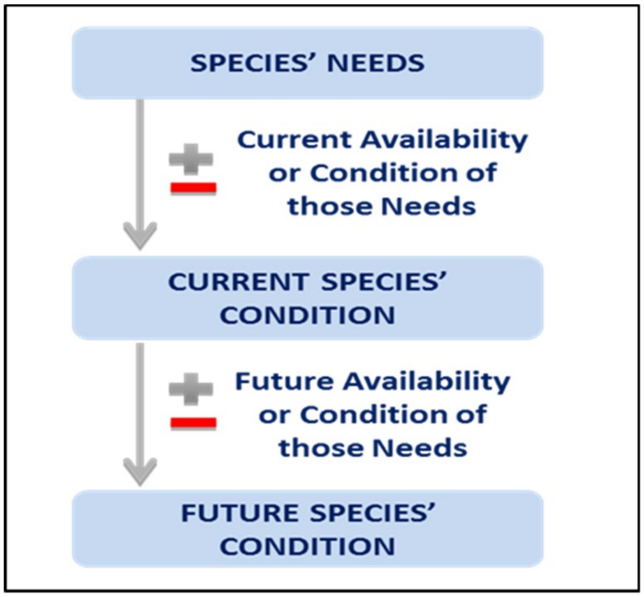


Figure 1 The three phases (blue boxes) of the SSA Framework used to guide this analysis (Service 2016, entire).

1.1 Sources of Information

This SSA provides a review of the best available scientific and commercial information regarding the biological status, or condition, of the Alexander Archipelago wolf. We collated existing information from published papers, final agency reports and pertinent archived datasets, personal communications with experts, and Traditional Ecological Knowledge/Indigenous Knowledge (TEK/IK). We also considered information submitted to the Service in the petition (Center for Biological Diversity et al. 2020, entire), during the 90-day finding public comment period, and in response to specific data requests. We worked directly with researchers actively studying the Alexander Archipelago wolf or aspects of the ecosystem in which it lives.

Due to time constraints, a comprehensive study of TEK/IK as it pertains to the Alexander Archipelago wolf was unable to be completed. Instead, a hybrid research study was developed, combining three well-established and compatible anthropological approaches: rapid appraisal, ethnography, and grounded theory. Several methods and sources of information were utilized, including notes from tribal consultation, informal conversations with local wolf experts, a mapping exercise, and personal history narratives for long-time wolf trappers and hunters. Open-ended conversations and semi-directed interviews were conducted with nine wolf and cultural experts living in Southeast Alaska and representing six community areas: Yakutat, Excursion Inlet, Kake, Klawock, Craig, and Hydaburg. Conversations were focused on biophysical and ecological aspects of wolves, wolf behaviors, wolf characteristics, and interactions between people and wolves (Brooks et al. 2022, pp. 13–14), and information gathered includes pack locations and territories, wolf movement patterns, reproductive rates, diet, and impacts of harvest.

Readers are encouraged to review the full TEK Report (Brooks et al. 2022, Appendix A) produced from this study prior to reviewing TEK information included throughout the SSA. The way that many Southeast Alaska Indigenous People understand and relate to the Alexander Archipelago wolf is by living closely with the wolf, practicing their culture, and continuing a subsistence way of life. Stories and experiences of the Alexander Archipelago wolf are passed down through the generations (Brooks et al. 2022, p. 15). This context of Southeast Alaska Native People being in constant communication and exchange with Alexander Archipelago wolves for thousands of years in their traditional homelands is imperative for understanding the full meaning of the TEK information provided throughout the SSA.

We aimed to comprehensively review behavior, ecology, resource needs, threats, and conservation relevant to the Alexander Archipelago wolf. We concentrated on information specific to the Alexander Archipelago wolf, drawing on information about the gray wolf (*C. lupus*) and its subspecies when necessary, for example, when there was a significant data gap or for context.

1.2 Geographical Extent and Analysis Units

In this assessment, we summarize information on Alexander Archipelago wolves throughout Southeast Alaska and coastal B.C. (Figure 2). For this assessment, we assume that the Alexander Archipelago wolf, *C. l. ligoni*, is a subspecies of gray wolf, (details in *Chapter 2.1 Taxonomy*), and we acknowledge that these wolves harbor unique ecological and genetic traits specific to this coastal region and that they appear to constitute a different group compared to continental wolves. Thus, for the purpose of this assessment, we use the Coast Mountain range, which extends 1,600 kilometers (994 miles) from the southwestern corner of Yukon Territory, Canada in the north to the mouth of the Fraser River in the south, as a geographic boundary. We define Southeast Alaska as the area extending from Yakutat in the north to Dixon Entrance in the south, including all islands in the Alexander Archipelago and the narrow strip of mainland eastward to the Coast Mountain range and the Canadian border (Figure 2). We delimit coastal B.C. to extend from the Dixon Entrance in the north to the Fraser River in the south, including all islands and the mainland west of the Coast Mountains (Figure 2). See *Chapter 2.3 Range and Distribution* for more detailed descriptions of wolf distribution in this region.

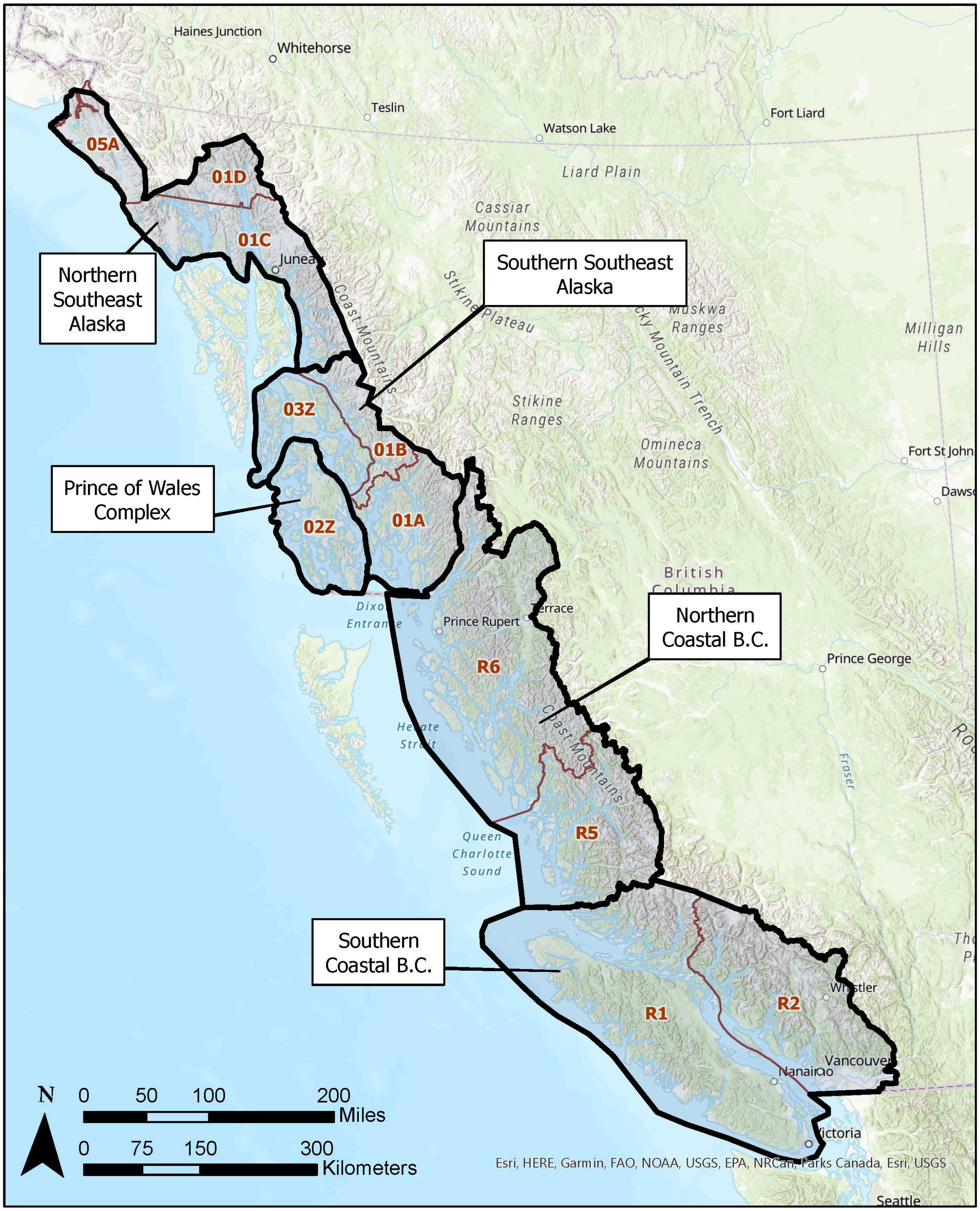


Figure 2 Alexander Archipelago wolf Analysis Units with Game Management Unit (GMU) labels in Alaska, and Administrative Unit numbers in B.C.

The first step in assessing current resiliency, representation, and redundancy was to identify our population (analysis) units. A paucity of genetic data exists to differentiate populations across the range of the Alexander Archipelago wolf, so we also relied on differences in ecology, geography, climate, ungulate distributions, and exposure to anthropogenic threats to define our Analysis Units.

For Southeast Alaska, we relied largely on the genetic population structure identified in Zarn (2019, p. 11), which grouped wolves into three populations using highest proportion ancestry from an admixture analysis. Our Analysis Units were also informed by biogeographic provinces (Smith 2016, pp 34–38). Variation between biogeographic provinces in Southeast Alaska can be summarized in a gradient approach. From southeast to northwest, mammal richness and glacial influence on the landscape increases, while plant richness decreases. Toward the west coast of Southeast Alaska, isolation increases as the landscape becomes increasingly disconnected from the mainland in the form of islands (or by channels and straits). Moving east through Southeast Alaska there is an increase in connectivity as various species have the ability to interact with mainland influences. We also considered ungulate prey distributions (Roffler et al. 2021, p. 5) and Alaska Department of Fish and Game (ADFG), Game Management Units (GMUs) (Figure 2).

For coastal B.C., we also considered genetic differentiation (Breed 2007, entire; Muñoz-Fuentes et al. 2009, entire; Stronen et al. 2014, entire) when defining our units, but the available data on genetic population structuring for Alexander Archipelago wolves in B.C. are very limited. We also looked at topographical, climatic, and ecological factors (Demarchi 2011, entire) and ungulate prey distributions. B.C. Ministry of Environment, Lands, and Parks Administrative Units and input from experts were also used to delineate our units in B.C. (Figure 2).

CHAPTER 2 – SPECIES BIOLOGY AND INDIVIDUAL NEEDS

In this chapter, we provide biological information about the Alexander Archipelago wolf, including its taxonomic history, morphological description, historical and current distribution and range, and known life history. We then outline the resource needs of individuals.

2.1 Taxonomy

The taxonomy of wolves in North America, including the recognition of *C. l. ligoni* as a subspecies, is a complex topic that has been debated for decades (Chambers et al. 2012, p. 41). For this assessment, we assume that the Alexander Archipelago wolf, *C. l. ligoni*, is a subspecies of gray wolf, although we recognize the uncertainty associated with this designation (see *Chapter 2.1.3 Uncertainty of Taxonomic Status*). There is substantial evidence that wolves in Southeast Alaska and coastal B.C. are ecologically and genetically distinct from other gray wolves. We recognize that zones of intergradation between coastal and interior continental wolves exist, and they are probably dynamic, especially in areas where few physical barriers to wolf movement are present (e.g., southern portion of coastal B.C.) or where major river valleys facilitate movement (e.g., northern portion of Southeast Alaska). Below, we summarize morphological and genetic information on the Alexander Archipelago wolves with an emphasis on recent studies.

2.1.1. Morphometric Analyses

The Alexander Archipelago wolf was first proposed as a subspecies of the gray wolf (*C. lupus*) in 1937 (Goldman 1937, pp. 39–40). Alexander Archipelago wolf (*C. l. ligoni)* was described as a dark colored subspecies of medium size with short pelage that occupied the Alexander Archipelago and the adjacent mainland of Southeast Alaska, northward along the Pacific Ocean coast to Yakutat Bay. In 1944, 23 wolf subspecies were described in North America, including *C. l. ligoni* (Young and Goldman 1944, entire) and *C. l. fuscus,* or the Cascade Mountains wolf, which may have shared ancestry with *C. l. ligoni* (see *Chapter 2.1.2 Genetic Analysis*). *C. l. fuscus*, located directly south of *C. l. ligoni*, was thought to inhabit forested regions from the Cascade Range in Oregon and Washington, west to the Pacific Coast, and north along the coast of B.C. to undetermined limits (Young and Goldman 1944, p. 455). In the 1980s, statistical analyses of morphological variation extended the southern boundary of the "*ligoni*" group southward (beyond the Alaska panhandle) (Friis 1985, entire).

In the mid-1990s, a revised taxonomy for wolves in North America was proposed and recognized five subspecies of gray wolf (*C. l. arctos*, *C. l. baileyi*, *C. l. lycaon*, *C. l. nubilus*, and *C. l. occidentalis*) (Nowak 1995, p. 375). In this taxonomic revision, wolves were recognized as *C. l. ligoni* within the broader *C. l. nubilus*, a subspecies believed to be formerly distributed from the western coasts of the United States and Canada, east to the Great Lakes region, and north through central and northeastern Canada (Nowak 1995, p. 396).

More recently, it has been suggested that morphological and genetic information distinguishes three subspecies (*C. l. baileyi*, *C. l. nubilus* [including *C. l. ligoni*], and *C. l. occidentalis*) with a possible fourth subspecies (*C. l. arctos*) (Chambers et al. 2012, entire), but too few data exist to verify its legitimacy. In this latest review, *C. l. ligoni* again was grouped with and referred to as *C. l. nubilus* (Chambers et al. 2012, p. 1; see *Chapter 2.1.3 Uncertainty of Taxonomic Status*).

In the first half of the 20th century, Tlingit sources described a larger (Yukon) wolf and a smaller (Southeast) wolf which was found in the southern part of the Yakutat region (within GMU 5) (de Laguna, 1972, p. 37). The recognition of two distinct wolves in the Yakutat region continues to this day. Yukon wolves are thought to enter the region through the Alsek River valley, and Southeast wolves enter along the coastal strip. One Indigenous expert noted that he has never seen any mixing of the two kinds of wolves in the Yakutat region. He has also never observed packs of Yukon wolves (only solitary), but he has seen packs of Southeast wolves (Brooks et al. 2022, p. 22–23). Two types of wolves have also been documented in the Excursion Inlet region (within GMU 1C), and are distinguished not only by body size, but also coat color; the larger "timber" wolf coat is gray or brown, while the smaller Alexander Archipelago wolf coat is black or brown with black guard hairs. Similar to reports from the Yakutat area, an Indigenous expert has also never observed the two types of wolves intermix, and he has seen packs of Alexander Archipelago wolves, but only solitary timber wolves (Brooks et al. 2022, pp. 27–28). We emphasize that our description of morphological analyses contains only the key studies related to taxonomy of wolves in Southeast Alaska and coastal B.C.

2.1.2. Genetic Analyses

Since 1997 when the first status assessment was completed for Alexander Archipelago wolf (Service 1997, 89 pp.), several molecular genetic studies have included wolves from Southeast Alaska and coastal B.C. Below, we summarize findings from key genetic studies of wolves in Southeast Alaska and coastal B.C. that are relevant to taxonomy, specifically *C. l. ligoni*; see *Chapter 4.3.3 Evolutionary Potential (Genetic Diversity)* for a more detailed discussion of genetic structuring and gene flow within the range of the Alexander Archipelago wolf.

Mitochondrial DNA

Analyses of mitochondrial DNA (mtDNA) support the delineation of Alexander Archipelago wolf as a distinct subspecies of gray wolf that inhabits Southeast Alaska and coastal B.C. In the early 1990s, the first genetic study of the Alexander Archipelago wolf was conducted by analyzing mtDNA (Shields 1995, pp. 6, 11). Based on a single fixed allelic substitution, wolves sampled in Southeast Alaska (assumed to be *C. l. ligoni*) were considered to be genetically distinct from wolves in interior Alaska and Yukon Territory, Canada (Shields 1995, pp. 6, 9, 11). Three additional studies using mtDNA have confirmed that coastal wolves in Southeast Alaska and coastal B.C. appear to be genetically differentiated from interior continental wolves (Muñoz-Fuentes et al. 2009, entire; Weckworth et al. 2010, entire; Weckworth et al. 2011, entire). Within Southeast Alaska, considerable genetic variability was documented among wolves, but no geographic structuring was detected to conclude that genetically unique subpopulations of wolves occurred on individual islands in the archipelago (Shields 1995, pp. 7–8).

Even among adjacent populations, strong genetic differentiation between coastal and inland wolves has been observed and is likely the result of dispersing wolves selecting familiar habitat, and not the result of geographic distance or physical barriers. Within B.C., eight haplotypes were documented from 160 wolves sampled (Muñoz-Fuentes et al. 2009, pp. 5, 7) and only two of those haplotypes were shared between coastal and inland wolves. Coastal wolves were the only sampled population across northwestern North America to have an endemic haplotype represented in such a large portion of the population (Muñoz-Fuentes et al. 2009, p. 9). Habitat (coastal, interior) explained 65 percent of the genetic variation among wolf populations (Muñoz-Fuentes et al. 2009, p. 8;), suggesting that ecological factors may be driving differentiation of wolves. Muñoz-Fuentes et al. (2009, p. 9) also determined that coastal wolves were more differentiated from *C. l. occidentalis* and *C. l. nubilus* than *C. l. occidentalis* and *C. l. nubilus* were from each other.

Similarly, wolves in Southeast Alaska were found to be distinct compared to wolves from other parts of Alaska, inland B.C., Yukon, and Russia. Weckworth et al. (2010, p. 366) analyzed mtDNA from a large sample of wolves from Southeast Alaska (n is equal to 130), interior continental North America (n is equal to 173, including wolves from Alaska and Canada), and Russia (n is equal to 4) and reported results similar to Muñoz-Fuentes et al. (2009). Of the seventeen haplotypes identified, only two were shared between the Southeast Alaskan group and the continental North American group, and the rest were unique to specific groups (four were only in Russian wolves, two were only in Southeast Alaskan wolves, and nine were only in the North American continental wolves) (Weckworth et al. 2010, p. 367). Subdivision of North American wolves into coastal and continental groups explained 56 percent of the genetic variation, and differentiation between coastal and continental groups was higher than within the coastal group (Weckworth et al. 2010, pp. 368–370).

Coastal wolves from Southeast Alaska and coastal B.C. show a close evolutionary relationship compared to other continental North American wolves. In a later study, Weckworth et al. (2011, p. 2) conducted the most comprehensive analysis of mtDNA from wolves in Southeast Alaska (n is equal to 130) and coastal B.C. (n is equal to 75) and compared results to wolves from continental North America (n is equal to 102; includes some sequences obtained from GenBank for pre-extirpated populations). Of the twenty haplotypes recorded, three were restricted to coastal B.C. and Southeast Alaska, with two being shared and one found only in Southeast Alaskan wolves. The most common haplotype found in the coastal region was shared with wolves in interior B.C. (Weckworth et al. 2011, pp. 2–3). When divided into coastal and continental groups, 51 percent of the genetic variation was explained (Weckworth et al. 2011, p. 5). Pairwise population comparisons indicated some genetic structuring within the coastal group, but the pattern was complex and did not conform to an isolation-by-distance pattern. The authors concluded that coastal lineages of wolves in Southeast Alaska and coastal B.C. are distinct from North American continental wolves (Weckworth et al. 2011, p. 5), corroborating mtDNA results of Muñoz-Fuentes et al. (2009, p. 9) and Weckworth et al. (2010, p. 372).

The historical range of the coastal rainforest ecotype may have reached as far south as southwestern Oregon. Hendricks et al. (2015, entire) attempted to characterize the maternal genetic ancestry of historical wolves from the Pacific Northwest by sequencing partial mtDNA control regions from museum specimens of wolves collected in California, Oregon and Nevada. Most of these specimens were sampled shortly before the time of the species' extirpation in these regions in the 1940s (Mech and Boitani 2003, p. 760). Three specimens collected in southwestern Oregon and originally identified as *C. l. fuscus*, shared a single haplotype, lu68. Other genetic investigations determined that this haplotype was unique to coastal B.C. wolves (Muñoz-Fuentes et al. 2009, p. 5; Muñoz-Fuentes et al. 2010, pp. 551–552; Weckworth et al. 2010, p. 367). The Hendricks et al. (2015, p. 763) study therefore provided the first evidence for the occurrence of lu68 in the coterminous U.S. The congruence of the taxonomic identification (*C. l. fuscus*) and the common maternal ancestry between the Oregon samples and the coastal

B.C. population supported Young and Goldman's (1944, p. 455) proposed historic distribution of the coastal rainforest ecotype from B.C. to Oregon. Hendricks et al. (2015, p. 763) further posited that because the Oregon specimens were collected in the vicinity of northern California, where there are no physical barriers to movement, this haplotype likely had a distribution across not only the Oregon and Washington coast, but also into California.

In summary, analyses of mtDNA indicate that wolves in coastal B.C. and Southeast Alaska are genetically distinct from other populations, which supports the delineation of Alexander Archipelago wolf as a distinct subspecies. Furthermore, *C. l. ligoni* may have shared ancestry with the extinct *C. l. fuscus*, which could have been distributed along the Oregon coast and possibly into California.

Nuclear DNA
Based on microsatellite markers of 101 wolves from Southeast Alaska and 120 wolves from interior continental populations, Weckworth et al. (2005, pp. 919, 924) found that coastal Southeast Alaska wolves appear to be geographically isolated from continental wolves. Within Southeast Alaska, two distinct clusters emerged, one on Prince of Wales (POW) Island and one that encompassed the remainder of Southeast Alaska (Weckworth et al. 2005, pp. 923, 926).

VonHoldt et al. (2011) analyzed SNPs of wolf-like canids (including domestic dog (*C. familiaris),* gray wolf (*C. lupus*), red wolf (*C. rufus*), Great Lakes wolf (*C. lycaon* or *C. lupus lycaon*), and coyote (*C. latrans*)) worldwide, including a few samples (n is equal to 3) from coastal B.C. Wolves on the B.C. coast formed a genetically distinct population when compared to wolves and their canid relatives globally (VonHoldt et al. 2011, p. 1297, Supplementary Table S5). Whole genome resequencing of North American wolf populations further confirmed the genetic distinctness of wolves from the Pacific Coast sample from wolves from the Alexander Archipelago in Southeast Alaska (Sinding et al. 2018, p. 4, Supplementary Table S1).

Cronin et al. (2015a, entire) used SNP genotyping that focused on wolves from Southeast Alaska. Their sample included 138 individual wolves from Southeast Alaska, 35 from B.C. (although only one wolf from the coastal area; n is equal to 1 population), and 132 from continental North America (including eight wolves from New Mexico where *C. l. baileyi* occurs) (Cronin et al. 2015a, p. 3). Among wolf populations, pairwise estimates of fixation (F_{ST}; magnitude of gene differentiation among populations with higher values indicating greater differentiation) were the highest comparing populations in New Mexico and GMU 2 (0.390; Cronin et al. 2015a, Supplementary Table 3). Mean F_{ST} between Southeast Alaska and B.C. was 0.120 (Cronin et al. 2015a, p. 7). The genetic variation observed among wolf populations across Southeast Alaska was equivalent to or surpassed variation between other populations in continental North America (Cronin et al. 2015a, p. 8). Generally, results of Cronin et al. (2015a, pp. 4–9) were similar to other studies of the Alexander Archipelago wolf described above, although interpretations of results differed; most notably, the authors suggest that *C. l. ligoni* is not a valid subspecies of the gray wolf (see *Chapter 2.1.3 Uncertainty of Taxonomic Status*).

In a study by Schweizer et al. (2016a, entire), a SNP genotyping array was used to uncover population structure and identify genomic signals of selection and local adaptation in 111 North American gray wolves from Canada and Alaska. The analysis revealed six major groupings associated with unique habitats and highlighted the differentiation of the B.C. ecotype (which included samples from B.C. and Southeast Alaska) (Schweizer et al. 2016a, p. 395, Supplementary Table S2). This study supports the idea that Alexander Archipelago wolves represent a unique ecotype with distinct genomic signatures of adaptation (Schweizer et al. 2016a, p. 398).

In a follow-up study, Schweizer et al. (2016b, entire) re-sequenced 980 candidate genes across an environmental gradient to test the utility of their previous SNP-based genome scan. They confirmed their original finding that B.C. coastal wolves have a unique suite of molecular adaptations (Schweizer et al. 2016b, p. 373). These results are concordant with previous large-scale studies of wolves in Canada, and the six major groupings correspond to specific habitats identified previously using microsatellite and SNP data: West Forest, Boreal Forest, Arctic, High Arctic, B.C., and Atlantic Forest (Geffen et al. 2004, entire; Carmichael et al. 2007, entire; Muñoz-Fuentes et al. 2009, entire; vonHoldt et al. 2011, entire).

Hendricks et al. (2019b, entire) confirmed prior work on population structuring of wolves in western North America (Carmichael et al. 2007, entire; vonHoldt et al. 2010, entire; vonHoldt et al. 2011, entire; Schweizer et al. 2016b, entire) and identified the first case of admixture between coastal and Northern Rocky Mountain wolves in the contiguous U.S. (Hendricks et al. 2019b, p. 143). They assessed the source populations of wolves in Washington by establishing maternal lineages, estimating local population structure, ancestry, and relatedness among individuals, and evaluating habitat preference of reestablished packs in the Pacific Northwest region. Two wolves sampled had a haplotype only known from populations in coastal B.C. (Muñoz Fuentes et al. 2009, entire; Muñoz Fuentes et al. 2010, entire; Weckworth et al. 2010, entire; Hendricks et al. 2019b, Supplementary Tables S1 and S2), and an estimated 5 percent of the Washington wolves were migrants from the coastal group (Hendricks et al. 2019b, p. 141, Supplementary Table S6), suggesting some gene flow from the coastal ecotype to wolves in Washington. However, of the 18 Washington wolf packs sampled, 17 packs had a greater probability of presence in interior environments than in coastal environments (Hendricks et al. 2019b, p. 142; Supplementary Table S7). The Lookout Pack in Washington is on the boundary of interior and coastal habitat and contained a wolf with evidence of ancestry to the coastal population (Hendricks et al. 2019b, Sample: RKW4318; Supplementary Table S4).

These results confirm previous findings that the coastal wolf may have extended to southwestern Oregon or northern California, as supported by the presence of haplotype lu68 in historic samples from southern OR (Hendricks et al. 2015, p. 143). It is unknown if immigration, territory establishment and subsequent breeding of coastal wolves in the PNW has occurred. Admixture is likely recent and therefore not yet in equilibrium (Hendricks et al. 2019b, p.135).

As of 2021, no breeding pairs of wolves or significant wolf activity has been documented in the coastal areas of western Washington (Smith pers comm, 2021).

Recently, Pacheco et al. (2022, entire) examined the phylogeographic histories of extant wolf populations around the Bering Strait (two inland populations from the Russian Far East, an inland Alaska population, an inland B.C. population, and coastal wolves in Southeast Alaska), using SNP genotyping. This study dated the split of coastal Southeast Alaska wolves and inland Alaska and B.C. wolves to circa 16,000 years ago, suggesting deep differentiation between inland and coastal Northwestern North America populations (Pacheco et al. 2022, p. 9).

We note that many other genetic studies, meta-analyses, and taxonomic interpretations of wolves in North America and beyond exist, but are not described above (Carmichael et al. 2007, entire; Carmichael et al. 2008, entire; Knowles 2010, entire). For brevity, we included only the key genetic studies specific to the Alexander Archipelago wolf.

2.1.3. Uncertainty of Taxonomic Status

In this assessment, we assume that *C. l. ligoni* is a valid subspecies, although we acknowledge uncertainty associated with this designation. We emphasize here that uncertainty in subspecies designations nearly always exists, largely because we lack a universally accepted subspecies definition (Haig et al. 2006, p. 1586). For *C. l. ligoni*, we found this to be the case with most of the uncertainty stemming from data types (e.g., morphological versus genetic data) and different interpretations of patterns in phenotypic and genotypic variation.

Cronin et al. (2015a, p. 9) concluded that wolves in Southeast Alaska do not comprise a genetically homogenous group and are not genetically isolated from other gray wolf populations and therefore do not qualify as a subspecies. This conclusion was challenged by Weckworth et al. (2015, p. 2) who argued that subspecies should not be defined on the basis of complete reproductive isolation; instead, subspecies should be viewed as groups of populations that are distinguishable and restricted to a geographic region where characters could overlap and interbreeding with adjoining subspecies may occur to a small degree. Weckworth et al. (2015, p. 2) stated that regardless of whether *C. l. ligoni* was recognized as a subspecies or not, a large set of characters (morphological, behavioral, and ecological) and genetic traits demonstrate that coastal wolves are distinctive from interior continental wolves, and that coastal wolf populations harbor a large amount of genetic variation of remaining North American wolf populations. Cronin et al. (2015b, pp. 2–3) responded to Weckworth et al. (2015, entire) defending their conclusion that too much genetic variation exists among wolf populations in Southeast Alaska relative to other North American wolf populations to justify a coastal subspecies of gray wolf.

Similarly, in the most recent meta-analysis of taxonomy of North American wolves, Chambers et al. (2012, entire) proposed five subspecies of gray wolf not including *C. l. ligoni*. Instead, the authors grouped wolves in Southeast Alaska and coastal B.C. with wolf populations in central and western United States, *C. l. nubilus* (Chambers et al. 2012, pp. 9, 40–41). Their reasoning was that wolves in Southeast Alaska and coastal B.C. had haplotypes both unique to the region and shared with historical samples from wolves in Kansas, Nebraska, and the western United States (Chambers et al. 2012, p. 41). The authors then hypothesized that coastal wolves were a northward extension of *C. l. nubilus* prior to extirpation of that subspecies in inland portions of the western United States (Chambers et al. 2012, pp. 41–42). Chambers et al. (2012, p. 41) postulated that the large proportion of unique, and apparently extinct, haplotypes in the historical sample of *C. l. nubilus* (Leonard et al. 2005, pp. 13–15) likely exaggerated the measure of divergence between the coastal populations and historical inland *C. l. nubilus* (Muñoz-Fuentes et al. 2009, p. 9). The grouping of coastal wolves with *C. l. nubilus* has been contested by several recognized experts that believe wolves in Southeast Alaska and coastal B.C. are ecologically and genetically distinct and warrant recognition as a distinct group (National Center for Ecological Analysis and Synthesis (NCEAS) 2014, pp. 10, 14, 17, 47–49, 61).

In summary, we recognize that the science informing taxonomy of wolves in North America is evolving and that some researchers have conflicting opinions, particularly on subspecies designations. However, persuasive evidence exists suggesting that wolves in Southeast Alaska and coastal B.C. form an ecologically and genetically distinct unit that corresponds with the taxonomic entity that has been identified as *C. lupus ligoni*.

2.2 Species Description

The Alexander Archipelago wolf has been described as darker and smaller, with coarser and shorter hair compared to continental gray wolves (Goldman 1937, pp. 39–40; Wood 1990, p. 1; Brooks et al. 2022, p. 22–23, 27–28). However, we are not aware of a recent comprehensive study or examination of specimens that supports this statement.

Like most gray wolves, fur coloration of Alexander Archipelago wolves varies considerably from pure white to uniform black with most wolves having a brindled mix of gray or tan with brown, black, or white. Based on recent harvest records (2000–2019), the black color morph is more common on the mainland of Southeast Alaska (20–30 percent; ADFG 2012, pp. 5, 18, 24; ADFG 2021a, p. 6) compared to the southern islands (2–4 percent; ADFG 2012, p. 34; ADFG 2018a, p. 9). On the B.C. coast, 25 percent of wolves were black in color and, of the remaining 75 percent that were gray, 40 percent had a brownish-red tinge (Darimont and Paquet 2000, p. 17). The pure white color morph appears to be rare throughout the region.

In Southeast Alaska, Alexander Archipelago wolves greater than six months old weigh between 49 and 115 pounds (22–52 kilograms) with males averaging 83.3 pounds (37.8 kilograms) and females averaging 68.8 pounds (31.2 kilograms) (Valkenburg 2015, entire). On some islands in the archipelago (e.g., POW Island) wolves are smaller on average compared to those on the mainland (Valkenburg 2015, entire; Table 1). Throughout B.C. (not just the coastal area), wolves generally weigh between 66 and 110 pounds (30–50 kilograms) (B.C. Ministry of Forests, Lands, and Natural Resource Operations (BCMF) 2014, p. 3). For context, in the Central Brooks Range, female wolves greater than one year old averaged between 81.3 and 88.4 pounds (36.9–

40.1 kilograms) and males were between 93.4 and 105.3 pounds (42.4–47.8 kilograms) (Adams et al. 2008, p. 8). In northwestern Minnesota, average weights of both sexes were lower (females averaging 66.1 pounds (30.0 kilograms), males averaging 79.1 pounds (35.9 kilograms)) (Mech and Paul 2008, p. 935) and were more similar to wolves in Southeast Alaska.

Table 1 Weights (kilograms) of Alexander Archipelago wolves greater than six months old by ADFG GMU in Southeast Alaska (Valkenburg 2015, entire).

GMU	**Geographic Area**	**Male**				**Female**			
		Mean	SE	n	Range	Mean	SE	n	Range
1	Mainland	36.6	1.5	23	22.7–47.2	30.3	1.3	23	17.2–41.3
2	POW Island Complex Island and surrounding islands	35.7	0.9	17	29.5–43.1	30.6	0.8	20	24.5–36.4
3	Kuiu, Kupreanof, Mitkof, Zarembo, Etolin, and Wrangell islands	39.1	0.8	48	27.7–51.7	32.2	0.7	34	20.9–43.1

2.3 Range and Distribution

The Alexander Archipelago wolf occurs along the mainland of Southeast Alaska and coastal B.C. west of the Coast Mountains and on larger islands except Admiralty, Baranof, and Chichagof Islands and all the Haida Gwaii, or Queen Charlotte Islands (Person et al. 1996, p. 1; BCMF 2014, p. 14; Figure 3). Its range is approximately 219,101 square kilometers (84,595 square miles) (Service 2015, Appendix I), stretching roughly 1,500 kilometers (932 miles) in length and 250 kilometers (155 miles) in width. The northern, eastern, and southern boundaries of its range are porous and therefore are not defined sharply or with certainty.

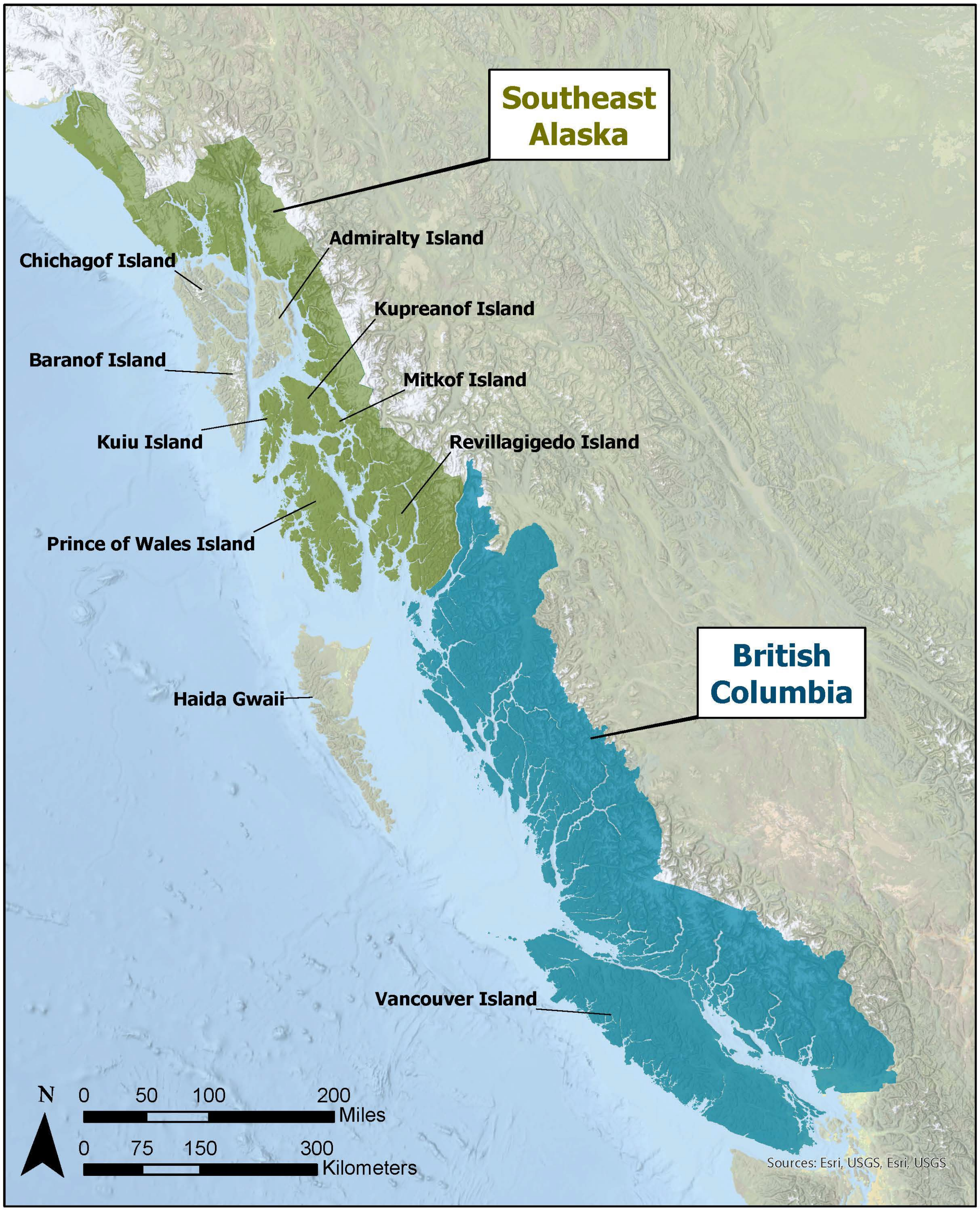


Figure 3 The assumed range of the Alexander Archipelago wolf in Southeast Alaska (green) and B.C. (blue), with major islands labeled.

In Southeast Alaska, Alexander Archipelago wolves occur throughout the mainland and on most of the islands south of Frederick Sound (GMUs 1, 2, 3, and 5A; Figure 3), excluding Coronation, Forrester, and the smaller, more isolated islands without an adequate prey base (Person et al. 1996, p. 1; MacDonald and Cook 2007, p. 71; Figure 3). Only the largest islands such as POW Island Complex, Kuiu, Kupreanof, Mitkof, Etolin, Revillagigedo, Kosciusko, and Dall islands likely support wolves consistently over time (Person et al. 1996, p. 1). For example, within GMU 2, only the three largest islands (POW Island Complex, Kosciusko, and Dall) are known to have been continuously occupied by Alexander Archipelago wolves for more than 20 years (Person and Ingle 1995, p. 10).

Wolves were experimentally introduced to Coronation Island in 1960 and 1963, but died out by the early 1970s, presumably due to starvation (Klein 1995, p. 280). Deer at their peak density on the island in 1959 (before the introduction of wolves) outnumbered wolves at their peak density in 1964 by 32–43 to one. Deer density, however, was much reduced by 1964 after wolves were introduced. As deer became scarce on the island, wolves consumed other prey (e.g., seals, marine invertebrates, birds, etc.) and eventually resorted to cannibalism rather than crossing the 900 meters of water necessary to reach the adjacent Spanish Islands where deer densities remained moderately-high throughout the study (Klein 1995, pp. 279–280).

Although no substantiated records of wolves were found on islands north of Frederick Sound in a 2007 review (MacDonald and Cook, p. 71), there are records of Alexander Archipelago wolves on Douglas Island near Juneau and Sullivan Island near Haines (ADFG 2015a, p. 2). On the mainland, the distribution of wolves probably is limited by icefields and high-elevation rugged terrain, even though they use these habitats occasionally (ADFG 2015a, p. 2). In addition, Alexander Archipelago wolves on the mainland occur within the six primary river drainages (Alsek, Chilkat, Taku, Whiting, Stikine, and Unuk rivers) that penetrate the Coast Mountains connecting interior B.C. and Southeast Alaska. Thus, we expect that these areas serve as intergradation zones between the Alexander Archipelago wolf and its continental counterpart.

In coastal B.C., Alexander Archipelago wolves occur continuously along the mainland and on all islands except Haida Gwaii (Darimont and Paquet 2002, p. 418; Figure 3). Wolves on Vancouver Island were probably extirpated between 1950 and 1970 (Muñoz-Fuentes et al. 2010, pp. 547–548), but have recolonized the island. On the mainland, wolves generally are restricted to a narrow coastal zone, but also occupy the few major river systems that connect interior and coastal B.C. such as the Nass, Skeena, Dean, and Fraser rivers. Alexander Archipelago wolves south of the Dean River probably intermix more regularly with other gray wolves than their northern counterparts and therefore the southern part of coastal B.C. likely is an intergradation zone (Weckworth et al. 2011, pp. 3–5). *Chapter 4.1 Population Abundance and Distribution* provides further information about the distribution of wolf packs within each Analysis Unit.

Wolf populations that historically inhabited the Pacific northwestern states from west of the Cascade Range to the Pacific coast (Oregon, Washington, and Idaho) likely also derived from distinct subspecies and ecotypes distributed throughout coastal B.C. (Hendricks et al. 2015, pp. 762–763; See *Chapter 2.1 Taxonomy*). Wolves in the Pacific Northwest were extirpated by the mid-1930s, but in recent years have naturally recolonized the region. The re-established wolves in Oregon and Washington are suspected to be migrants from adjacent wolf populations that consist of two ecotypes, the coastal ecotype (synonymous with Alexander Archipelago wolves) and the northern Rocky Mountain forest ecotype (Hendricks et al. 2019a, p. 143).

2.4 Life History

Table 2 The annual habits of gray wolves at various life stages.

<table>
<tr><th>Life Stage</th><th>Jan</th><th>Feb</th><th>Mar</th><th>Apr</th><th>May</th><th>Jun</th><th>Jul</th><th>Aug</th><th>Sep</th><th>Oct</th><th>Nov</th><th>Dec</th></tr>
<tr><td>Pup
(Less than 1 year)</td><td colspan="3">Travelling/hunting with natal pack</td><td colspan="3">Denning</td><td colspan="3">Relocating to rendezvous site</td><td colspan="3">Travelling/hunting with natal pack</td></tr>
<tr><td rowspan="2">Yearling
(1–2 years)</td><td colspan="3" rowspan="2">Travelling/hunting with or without pack</td><td colspan="6">Dispersing and searching for new pack</td><td colspan="3" rowspan="2">Travelling/hunting with or without pack</td></tr>
<tr><td colspan="6">Travelling/hunting with natal pack</td></tr>
<tr><td rowspan="3">Breeding Adult
(Greater than 2 years; Average Lifespan: 6–8 years; Maximum Lifespan: 13 years)</td><td colspan="3">Breeding</td><td colspan="3">Denning</td><td colspan="3">Relocating to rendezvous site</td><td colspan="3" rowspan="2">Travelling/hunting with or without pack</td></tr>
<tr><td colspan="9">Travelling/hunting with or without pack</td></tr>
<tr><td colspan="12">Dispersing and searching for new pack</td></tr>
</table>

2.4.1 Reproduction

Most wolf packs contain a pair of breeding adults plus other adults that may or may not breed (see *Chapter 2.4.3 Social Organization*). Age of first breeding of the Alexander Archipelago wolf is about 22 to 34 months (Person et al. 1996, p. 8). Female wolves can produce pups every year, and the average litter size of gray wolves in North America ranges from 4.4 to 6.9 pups (Fuller et al. 2003, pp. 175–177). Sizes of Alexander Archipelago wolf litters range from 1 to 8 pups with an average of 4.1 pups; new mothers produce fewer pups than older, more-experienced mothers (Person and Russell 2009, p. 216). Indigenous experts also report litters up to eight pups and have observed that the number of pups in a litter is a function of the female's experience and age, with older more-experienced females having more pups (Brooks et al. 2022, p. 58, 75). Although uncommon, some wolf packs fail to exhibit denning behavior or produce litters (Person and Russell 2009, p. 216).

Alexander Archipelago wolves use dens from mid-April through early July with peak activity between early May and the third week of June (Person 2001, p. 61; see *Chapter 2.5.2 Habitat and Space Use* for habitat description). Indigenous experts report denning starting as early as February near Excursion Inlet (Brooks et al. 2022, p. 32). During 2012–2016 on POW Island, the mean den entry date was 2 May (range 20 April–21 May) and the mean den exit date was 1 July (range 20 June–21 July; Roffler and Gregovich 2018, p. 5). Dens often have bone yards surrounding the site, remains from the food brought to pups until they are big enough to leave the den and hunt (Brooks et al. 2022, p. 58, 74). After early July, most dens are abandoned and pups are located to rendezvous sites typically less than 1 kilometer (0.62 mi) from the natal den, where they remain until October (Person and Russell 2009, p. 216). At this time, the pups typically are full size, although they weigh less than a yearling or adult, and begin traveling with the pack; most disperse the following spring as yearlings. Indigenous experts report pups being almost as large as adult wolves by 6 months of age and being taught to hunt during the first year with the pack (Brooks et al. 2022, p. 58).

2.4.2 Intra-Population Dispersal

Pups that survive to adulthood either remain in their natal pack or disperse (Person et al. 1996, p. 10). Dispersers typically search for a pack to join or associate with other wolves and ultimately form a new pack in vacant territories or in vacant areas adjacent to established territories. Hence, dispersal is a critical element of wolf ecology and social biology.

Gray wolves are capable of dispersing long distances, sometimes hundreds of kilometers (Fritts 1983, p. 166; Ballard et al. 1987, p. 20; Adams et al. 2008, pp. 10–11), and can quickly re-occupy vacant territories (Bergerud and Elliot 1986, pp. 1519–1523). Generally, young wolves are more likely to disperse than older ones (Adams et al. 2008, p. 11) and males are more likely to disperse than females, although females may disperse farther (Ballard et al. 1987, p. 20). Successful dispersal often is short in duration because dispersing wolves are more vulnerable than non-dispersers to hunting and trapping and being killed by other wolves (Peterson et al. 1984, p. 29). In one study, dispersing wolves did not survive longer than 86 weeks after commencing dispersal behaviors, unless they settled into a new pack (Person and Russell 2008, p. 1545). It has been postulated that Alexander Archipelago wolves in B.C. may prefer to disperse to ecological environments similar to their natal habitat (Stronen et al. 2014, pp. 1–2).

Within-population dispersal metrics for Alexander Archipelago wolves are available for GMU 2, where the annual rate of dispersal is 39 percent, with adults greater than two years of age composing 79 percent of all dispersers (Person and Ingle 1995, p. 20). The annual rate of survival of dispersing wolves is low (16 percent) with most killed by hunters and trappers before settling (Person and Russell 2008, p. 1547); therefore, successful dispersal may be more limited by low survival rates than by actual dispersal capability. Nonetheless, minimum dispersal distances from the point of capture range between 13–182 kilometers (8–113 miles). An Indigenous expert from the POW Complex indicated that wolves will cover a 48 kilometer (30 mile) area in one to two weeks, and that they typically use trails to move (Brooks et al. 2022, p. 70). Two of three wolves captured and radio-collared on Kosciusko Island dispersed long distances; one was located subsequently on the southern end of Dall Island, a minimum distance of 182 kilometers (113 miles) that required at least two swims greater than 350 meters (0.22 miles) each, and the other moved at least 160 kilometers (99 miles) to the south end of POW Island (Person and Ingle 1995, p. 23).

More recently, 12 wolves were radio-collared on POW Island, and 5 of these were classified as dispersers due to their movement either into or out of the study area in the northern region of POW Island (Roffler et al. 2016, p. 21). Dispersal of POW Island wolves was not linked to a particular season but instead occurred year-round. Straight-line dispersal lengths ranged from 50–120 kilometers, but actual routes travelled are likely much longer than straight-line estimates indicate, up to 240 kilometers for one wolf monitored (Roffler et al. 2016, p. 21).

Some evidence exists demonstrating that Alexander Archipelago wolves are capable of swimming large distances, although success probably depends on local water conditions (e.g., tidal current and strength). For example, Alexander Archipelago wolves have been found on isolated islands in coastal B.C. 5–13 kilometers (3–8 miles) from other large landmasses (Darimont and Paquet 2002, p. 418). In addition, a wolf was radio-collared opportunistically on or near Kupreanof Island in 1999 and was trapped and killed nearly three years later on Revillagigedo Island, roughly 134 kilometers (83 miles) straight-line distance from the capture location (USDA 2015a, entire). Although we do not know the travel route of the dispersing wolf, we know that at some point the wolf must have made at least four water crossings, with the shortest being about 2 kilometers (1.2 miles). Indigenous experts of Southeast Alaska report wolves consistently swimming between numerous islands within the POW Complex to find deer and other prey (Brooks et al. 2022, p. 55, 71).

There are also many examples indicating Alexander Archipelago wolves are resistant to disperse across water. An Indigenous expert from Craig, Alaska reports that swimming preference varies by the individual wolf; some like to swim and some do not (Brooks et al. 2022, pp. 71–72). Wolves introduced to Coronation Island in the 1960s ultimately starved yet did not swim 900 meters (0.56 miles) to nearby habitat with abundant food (Klein 1995, p. 280). In one study on POW Island, none of the 13 dispersing wolves that were tracked swam to other islands greater than 1 kilometer (0.62 mi) from POW Island or dispersed across Clarence or Sumner Straits, which separates POW Island from other islands in the archipelago and from the mainland (Person and Ingle 1995, p. 23). In another study on POW Island, none of the 12 GPS-collared travelled to adjacent islands within GMU 2 or crossed large bodies of water to reach areas outside of GMU 2 (Roffler et al. 2016, p. 23).

2.4.3 Social Organization

Gray wolves are social animals that live in packs usually composed of one breeding pair (i.e., alpha male and female), plus offspring 1–2 years old (yearlings), and any dispersers. Generally, the breeding pair guides packs activities, with the female leading pup care and defense and the male taking charge of foraging and food provisioning (Mech 1999, p. 1196). Occasionally, unrelated wolves are adopted into the pack, but usually the pack functions as a family or a small group of families. In one study on POW Island, a pack of wolves composed of four adults and three pups was observed at a den site 8 km from another pack composed of one adult and seven pups. A few months later, 16 wolves were counted in one pack in the same area, indicating that the two groups had united (Roffler et al. 2016, p. 18). Within the POW Complex, Indigenous experts also described instances of large family packs splitting into smaller hunting or denning groups and then coming back together once a large kill was made or pups were being reared (Brooks et al., pp. 87, 102).

The pack is a year-round unit, although all members of a wolf pack rarely are observed together, except during winter (Person et al. 1996, p. 7). Indigenous experts of Southeast Alaska report wolves moving through their territories in cycles that range from two weeks to two months, and these patterns have been maintained by some wolf packs for as long as a human lifetime (80 years) (Brooks et al. 2022, pp. 28, 53, 81). Wolf pack territories appear to be organized by streambeds and watersheds in some areas of Southeast Alaska (e.g. Yakutat, Excursion Inlet, Kupreanof Island, Kuiu Island) and by islands in other parts of the range (e.g. POW Complex) (Brooks et al. 2022, pp. 24, 39).

Loss of alpha members of a pack can result in social disruption and unstable pack dynamics. During this time, dominance relationships within and among packs and individuals are re-established, which may lead to higher rates of intraspecific strife and possibly multiple breeding pairs, although this is rare (Mech 1999, p. 1200; Packard 2003, pp. 52–56). Pack dynamics are complex and shift frequently as individuals age and gain dominance, disperse from, establish or join existing packs, breed, and die (Mech 1999, pp. 1197–1202; Brooks et al. 2022, p. 32–33). The social and reproductive fates of individuals are based mostly on the opportunities presented by these shifting dynamics (Packard 2003, p. 35). Although loss of breeding individuals impacts social stability within the pack, at the population-level, wolves appear to be resilient enough to compensate for any negative impacts to population growth (Borg et al. 2015, p. 183).

Pack sizes, especially in Southeast Alaska, are difficult to estimate because of heavy vegetation cover. Estimates of Alexander Archipelago wolf pack sizes on Revillagigedo Island range from 2 to 12 wolves with an average 5.4 wolves (time of year not specified consistently; Smith et al. 1987, pp. 4–7). On the POW Complex and Kosciusko Islands during the mid-1990s, fall pack size ranged from 2 to 12 wolves, but averaged 7–9 wolves (Person et al. 1996, p. 7). Most recently, a study of 5 packs on POW Island found that pack size ranged from 1 to 16 wolves, with an annual average of 5.1 wolves (Roffler et al. 2016, p. 23). Indigenous experts of Southeast Alaska report average pack sizes between 6–12 wolves and report at least three large packs from various regions with over 25 wolves (Brooks et al. 2022, p. 23, 29, 44, 56, 62). Mean wolf pack size varies seasonally (Roffler et al. 2016, p. 23). We are not aware of any similar counts for wolf packs in coastal B.C.

2.4.4 Survival

Natural causes of mortality for gray wolves include starvation, accidents, disease, and intraspecific strife (Fuller et al. 2003, p. 176), and it is likely that these factors similarly affect Alexander Archipelago wolf. A recent study of gray wolves in the Superior National Forest of Minnesota found adults were more likely to die of intraspecific strife, whereas pups were more likely to die of disease or starvation (Barber-Meyer et al. 2021, p. 9). Across regions, gray wolf pup survival in summer has been tied directly to prey biomass, with survival almost doubling when ungulate biomass is four times greater (Fuller et al. 2003, p. 176). Indigenous experts also report the growth rate of pups being directly correlated to the amount of food available (Brooks et al. 2022, p. 58). Survival rates between male and female wolves are similar (Fuller et al. 2003, p. 176).

Only one study has estimated survival rates of Alexander Archipelago wolves. The mean annual rate of survival for wolves in GMU 2 was 0.54 (Person and Russell 2008, p. 1545). This estimate does not include pups less than 4 months old so actual survival within the wolf population sample may have been lower. Survival did not differ between age classes or sexes but was higher for resident wolves compared to non-residents (i.e., wolves not associated with a pack; Person and Russell 2008, p. 1545).

Harvest by humans may be a dominant cause of mortality in portions of the Alexander Archipelago wolf's range, particularly in GMU 2. Between 1993 and 2002, 55 wolves were radio-collared in GMU 2. By 2008, 39 of these collared wolves had died: 18 wolves were killed legally by hunters and trappers, 16 died from unreported harvest, and 5 died of natural causes (Person and Russell 2008, p. 1545). Thus, 87 percent of wolves that died during the study were killed by humans. Between 2012 and 2018, researchers on POW Island collared 13 additional wolves. Twelve of the collared wolves died, and the fate of one was unknown. Of the twelve wolf mortalities, five (41.7 percent) were from reported human harvest and five (47.1 percent) were attributed to unreported human-caused mortality (one of which was from wounding loss). The two other wolf mortalities occurred naturally due to intraspecific strife (ADFG 2022, p. 11). Both studies involving radio-collaring wolves in GMU 2 took place in a portion of GMU 2 that is roaded and has higher levels of human use compared to unroaded portions; this may have inflated mortality rates. See *Chapter 2.5.3 Remoteness* (*Space From Human Activity*) and *Chapter 3.2 Wolf Harvest* for further descriptions of correlates of mortality of Alexander Archipelago wolves.

2.5 Resource Needs and Habitat

2.5.1 Prey

Food availability has a significant impact on wolf density, and across their geographic range in North America, wolf densities differ mainly because prey densities vary. Alexander Archipelago wolves are opportunistic predators that eat a variety of prey species, yet, like gray wolves, ungulates compose most of their diet (Mech and Peterson 2003, p. 131). There is a positive relationship between relative ungulate abundance and both wolf litter size and the proportion or number of wolf pups in packs, which supports the hypothesis that food is the ultimate factor influencing wolf numbers and density (Fuller and Murray 1998, p. 156). Given the general importance of ungulates in the diet of wolves (Mech and Peterson 2003, p. 131; Brooks et al. 2022, p. 22–24), presence (or absence) of ungulate species in an area is particularly relevant to habitat suitability for Alexander Archipelago wolves.

The biogeography of Southeast Alaska presents difficulties when assessing the diet of wolves because not all prey items are available on all islands (e.g., beavers do not occur on Coronation Island; MacDonald and Cook 2007, p. 27) and because prey species have been introduced to some islands (Table 3). Additionally, prey species ranges may expand or contract over time (e.g. moose expansions in Northern and Southern Southeast Alaska).

Table 3 Generalized distribution of ungulate species by Analysis Unit within the range of the Alexander Archipelago wolf.

Analysis Unit	Black-tailed deer	Moose	Mountain goat	Elk
	Odocoileus hemionus	*Alces americanus*	*Oreamnos americanus*	*Cervus canadensis*
Northern Southeast Alaska	Present	Present	Present	Absent
Southern Southeast Alaska	Present	Present	Present	Present[1]
POW Complex	Present	Absent	Absent	Absent
Southern Coastal B.C.	Present	Present	Present	Present
Northern Coastal B.C.	Present	Present	Present	Absent

[1]Elk were introduced and are now established on Etolin and Zarembo Islands, with credible sightings on large nearby islands (MacDonald and Cook 2007, p. 188).

One of the unusual aspects of the Alexander Archipelago wolf diet is the seasonal consumption of salmon (15–20 percent of lifetime diet; Szepanski et al. 1999, p. 327). Indigenous experts across Southeast Alaska report the seasonal consumption of salmon by wolves (Brooks et al. 2022, p. 25, 31, 59, 73). However, inland wolves in Denali National Park, Alaska also eat salmon in slightly lower, but similar quantities (3–17 percent of lifetime diet) (Adams et al. 2010, p. 251). This suggests that salmon may be common in wolf diets where salmon are available. Further, gray wolves in southwestern Alaska also feed regularly on salmon and other marine mammals when available (Watts et al. 2010, p. 145), indicating that consumption of salmon (and other marine-derived prey) is not unique to the Alexander Archipelago wolf. Regardless, salmon provides a seasonal alternate food source to Alexander Archipelago wolves during a period of year with high food and energy demands (i.e., provisioning pups; Darimont et al. 2008, p. 5).

Stable isotope analyses

Since 1997, several studies have assessed Alexander Archipelago wolf diet using stable isotope analyses. This method quantifies the relative proportions of identified food sources in wolf diet by measuring isotopic compositions of wolf tissues and comparing them to their prey. It is a useful technique because it allows for measurement of assimilated nutrients over time as opposed to scat analysis which reveals only an individual’s last meal. Additionally, stable isotope analysis avoids certain forms of bias inherent in scat analysis because of differences in prey size and digestibility. Although stable isotopes represent a longer time frame depending on the tissues used, it is important to note that they don't always provide definitive fine scale identification of species consumed, and misrepresentation of key diet categories can occur if trophic discrimination factor values are not carefully selected for (Johnson et al. 2020, pp. 2973, 2981).

According to one stable isotope analysis study, the diet of Alexander Archipelago wolves in Southeast Alaska (Kupreanof Island, POW Island, and mainland) during a portion of the year was approximately 45–49 percent deer, 34–36 percent other herbivores (moose, beaver, mountain goats, and voles), and 15–20 percent salmon (Szepanski et al. 1999, p. 331). Alexander Archipelago wolves relied on salmon in their diet significantly more than gray wolves studied in interior Alaska (Szepanski et al. 1999, p. 330). There was also greater variation in diet among individual wolves in Southeast Alaska compared to interior Alaska, with relative salmon content ranging from 2–88 percent in southeast wolves compared to only 2–27 percent in interior wolves (Szepanski et al. 1999, p. 330). In this study, it was noted that proportions of rarely consumed prey may have been overestimated, and commonly used prey may have been underestimated. Therefore, the model used provides only an indication of *relative* prey consumption (Szepanski et al. 1999, p. 329).

Stable isotope analyses on the northern and central coasts of B.C. indicate seasonal shifts from a deer-dominated diet in spring and summer, to a more varied diet in late summer and fall that included larger proportions of salmon (Darimont et al. 2008, pp. 7–8). The diet of wolves on the mainland of B.C. was composed mostly of deer, and wolves from the islands of coastal B.C., had more marine mammals and salmon in their diet (Darimont et al. 2009, p. 130). Note that this finding contradicts that of Darimont et al. (2004, p. 1871) based on frequency of occurrence in scat: deer occurred more frequently in wolf scats on the islands compared to the mainland (see the following *Scat analyses* section).

Scat analyses

Another common method for describing wolf diet involves collection and analysis of scat. Results and inference from scat analyses require careful interpretation because sampling design and protocol can have a strong influence on results, in part owing to the social organization and cooperative hunting by wolves. Recognizing these caveats, in this section we summarize results of scat analyses conducted for the Alexander Archipelago wolf using frequency of occurrence (primarily due to the nature of the available data). Table 4 below provides a compilation of results from the most detailed analyses of Alexander Archipelago wolf food habits based on scat.

Table 4 Proportion occurrence of prey remains in wolf scats from various locations in Southeast Alaska and coastal B.C. (See Appendix B for the full table of results).

	Northern Southeast Alaska	Southern Southeast Alaska	POW Island Complex	Coastal B.C.	**TOTAL PROPORTION**
Rodents (Total)	**4.42**	**6.08**	**11.88**	**1.85**	**6.06**
Hoary marmot	1.87	0	0	0	0.47
Beaver	0.11	5.94	11.71	1.48	4.81
Microtine	0.46	0.15	0.17	0	0.20
Porcupine	0.47	0	0	0	0.12
Squirrel	0.09	0	0	0	0.02
Unidentified rodent	1.41	0	0	0.36	0.44
Lagomorphs (Total)	**0.37**	**0**	**0.03**	**0**	**0.10**
Snowshoe hare	0.37	0	0.03	0	0.10
Carnivores (Total)	**4.57**	**7.51**	**19.77**	**11.57**	**10.85**
Black bear	0.48	4.35	14.44	5.46	6.18
Harbor seal	0.47	0.16	0.11	0.59	0.33
Sea otter	2.95	2.44	0.23	0	1.40
River otter	0.04	0.05	0.32	1.42	0.46
Pacific marten	0	0.11	0.05	1.66	0.46
Ermine	0	0.04	0	1.61	0.41
American mink	0	0.23	0	0.83	0.26
Wolverine	0.12	0.12	0	0	0.06
Unidentified carnivore	0.9	0	4.62	0	1.38
Ungulates (Total)	**89.15**	**85.19**	**65.84**	**81.19**	**80.34**
Moose	77.92	33.94	0	10.24	30.53
Black-tailed deer	1.03	51.06	65.84	62.65	45.14
Mountain goat	10.21	0.19	0	8.3	4.67
Other (Total)	**1.48**	**1.22**	**2.49**	**5.39**	**2.65**
Salmon	0.15	0.35	1.26	0	0.44
Other fish/shellfish	0.47	0.1	0.72	3.78	1.27
Unidentified other	0.86	0.76	0.51	1.61	0.94
References	Fox and Streveler 1986, pp. 192–193; Lafferty et al. 2014, p. 145; Roffler et al. 2021, p. 11; Roffler 2022, pers comm.	Smith et al. 1987, pp. 9–11, 16; Roffler et al. 2021, p. 11; Roffler 2022, pers comm.	Kohira and Rexstad 1997, pp. 429–430; Roffler et al. 2021, p. 11; Roffler 2022, pers comm.	Darimont et al. 2004, p. 1871	

Alexander Archipelago wolves were introduced to Coronation Island in 1960 and survived through 1968. Five years after introduction, a diet analysis based on 663 wolf scats indicated deer were the most common prey (78–97 percent of wolf scats; Klein 1995, p. 277). By 1967, deer became less numerous on the island because of wolf predation and the percentage of deer in the diet fell below 50 percent for the first time. In the subsequent years, the major food remains in scats shifted to birds, seals, marine invertebrates, and small mammals. As deer declined on Coronation Island, the wolf population dropped from a maximum of 13 wolves in 1964 to two wolves in 1967. With declining deer numbers, wolves even resorted to cannibalism. To the best of our knowledge, this is the only study that indicates an inability of Alexander Archipelago wolves to maintain high densities in response to a declining deer herd.

From 2012–2018, wolf scats were opportunistically collected from 12 study sites across the three Analysis Units in Southeast Alaska. DNA metabarcoding was used to identify and quantify geographic variability in the consumption of prey species across systems with distinct ungulate species composition and abundance. DNA metabarcoding allows for identification of prey to the genus or species level and has become a powerful method for characterizing carnivore diets (Massey et al. 2019, p. 14).

Alexander Archipelago wolves increased the number and diversity of prey species consumed as the proportion of ungulates in their diet declined (Roffler et al. 2021, p. 9). Ungulates were the most prevalent diet item, confirming previous coastal wolf diet research (Fox and Streveler 1986, entire; Kohira and Rexstad 1997, entire; Darimont et al. 2004, entire; and Lafferty et al. 2014, entire), and the proportion of ungulates in wolf diets followed regional patterns of prey distribution and abundance (Roffler et al. 2021, pp. 9–10). On islands where black-tailed deer (*Odocoileus hemionus)* were sympatric with moose or mountain goats, deer were generally consumed at a higher rate. Conversely, moose and mountain goats were the most consumed ungulate species on mainland study sites (Roffler et al. 2021, p. 12). Across all study sites, wolf diets most frequently consisted of ungulates, followed by beavers, marine mammals (particularly sea otters), and then black bears (Roffler et al. 2021, p. 8).

Scat analyses match observations from Indigenous experts across Southeast Alaska, who report that wolves will eat anything, with ungulates (deer and moose) as the primary prey and opportunistic predation of beavers, porcupines, bears, birds, marine mammal carcasses, salmon, mink, marten, and spawning needle fish (Brooks et al. 2022, p. 31, 41, 60, 73). Two Indigenous experts suggested that wolves may actively hunt bears (Brooks et al. 2022, pp. 59–60, 73).

Considering all scat analyses conducted across the range of the Alexander Archipelago wolf, deer had the highest frequency of occurrence in scats found in Southeast Alaska and coastal B.C., except for the Northern Southeast Alaska Analysis Unit where deer are scarce. In this Analysis Unit, mountain goats and especially moose had the highest frequency of occurrence (Table 4). After ungulates, black bear (*Ursus americanus*) had the highest frequency of occurrence in scats found in the POW Complex and Coastal B.C. Analysis Units, and beaver had the highest non-ungulate frequency in scats found in the Southern Southeast Alaska Analysis Unit. Indigenous experts also indicate that beavers are commonly consumed on the islands within this unit (Brooks et al. 2022, p. 41). Alexander Archipelago wolves also feed on marine mammals, especially sea otters and harbor seals (*Phoca vitulina*), mustelids, birds, fish, and shellfish. Spawning salmon are consumed during the summer and fall by some wolf packs in Southeast Alaska and coastal B.C. and salmon were especially common in scats from wolves in the POW Complex Analysis Unit. Thus, consistent with their opportunistic food habits and lack of specialization, Alexander Archipelago wolves seem to eat most available prey items within a habitat type or area provided that the cost-to-benefit ratio requirements are met (e.g., prey availability, capture efficiency, nutritional gain, and potential for injury) (Table 4; Appendix B).

2.5.2 Habitat and Space Use

Because wolves occupy a variety of habitats across their range in North America, they are considered to be habitat generalists (Mech and Boitani 2003, p. xv). The presence or absence of wolves in an area is considered a function of the availability of their prey and the intensity of human-caused mortality (Mech 1995, p. 273; Mladenoff et al. 1995, p. 286).

On POW Island and Kosciusko Island, wolves used young-growth habitat significantly less than expected based on availability of this habitat type. Wolves were found in old-growth habitats the majority of the time and they appeared to be selecting for unharvested forests, likely due to the high cost of movement and low visibility resulting in poor hunting conditions found in young-growth habitat (Person and Ingle 1995, p. 30). Old-growth habitats can be further separated based on the forest structure and ecosystem diversity associated with timber volume, with low volume old-growth forests having smaller trees and smaller tree densities than high-volume old-growth forests (USDA 2016c, pp. 3-189–3-191). Based on aerial telemetry surveys of three wolf packs, wolves were found in young-growth habitat 7.2 percent of the time, low volume old-growth 46.8 percent of the time, high-volume old-growth 9.5 percent of the time, and non-commercial forest (U.S. Forest Service volume classes less than or equal to 3 and muskegs) 34.7 percent of the time (Person and Ingle 1995, p. 30). Use of various habitat types differed significantly from availability for all three packs except for high-volume forest which all three packs used in proportion to its availability (Person and Ingle 1995, p. 30). Two packs used low volume old-growth stands (U.S. Forest Service volume classes 4 and 5) significantly more than expected and one pack used noncommercial habitat more than expected (Person and Ingle 1995, p. 30).

Home range size of wolves was strongly related to the proportion of “critical winter habitat for deer” (Person 2001, p. 66), defined as productive old-growth forest less than 250 meters (820 feet) in elevation with southern exposure. Critical winter habitat for deer is likely a good measure of habitat quality for wolves (Person 2001, p. 66). Indigenous experts report Alexander Archipelago wolves using different elevations as the snow depth changes and wolves coming down from the mountains in winter to follow ungulates (Brookes et al. 2022, p. 22, 29). In general, wolves spent most of their time at low elevation, especially during the denning period, with a majority (95 percent) of radio-collared wolves below 400 meters (1,312 feet) and 50 percent of radio-collared wolves below 82 meters (269 feet; Person 2001, p. 62).

A more recent study on POW Island employed spread-spectrum GPS radio collars with a VHF component for radiotelemetry (Roffler et al. 2018, entire). This allowed for higher resolution data to be collected. Results from this study generally corroborated previous habitat use studies on POW Island but provided additional detail about the seasonal use of habitat types. Wolves in this study showed a strong preference for certain critical winter deer habitat (southern aspects, low elevation, old-growth forest; Roffler et al. 2018, pp. 195–196), and avoided low-quality deer habitat (old clearcuts), especially during winter. Old-growth forest made up the majority of wolf home range areas, and other cover types (non-forest, clearcuts, treated forest, and open vegetation) occurred in declining quantities within home range areas (Roffler and Gregovich 2018, p. 8). However, wolves did select young clear-cut forests in the fall and winter (although less than low-volume old-growth) (Roffler et al. 2018, p. 197). Wolves also selected for areas near anadromous streams during late summer, when salmon are spawning (Roffler et al. 2018, p. 196).

Habitat Use of Primary Prey

Alexander Archipelago wolves consume black-tailed deer more than any other single prey species throughout most of their range (see *Chapter 2.5.1 Prey*). Thus, maintaining a viable, well-distributed wolf population likely depends on maintaining habitat to support a viable, well distributed, and available population of deer (Person et al. 1996, pp. 15–16).

Several studies document the importance of geomorphometric variables (i.e., elevation, slope, southing) in predicting winter habitat selection by black-tailed deer (Shanley et al. 2021, pp. 8–9; Schoen and Kirchhoff 1990, pp. 375–376; Doerr et al. 2005, pp. 327–329). Deer tend to select for elevations less than 250 meters (820 feet), where precipitation primarily falls as rain during the winter (Shanley et al. 2021, p. 9). Forest structure (e.g. tree height) is also commonly detected as an important predictor of resource selection for black-tailed deer on POW Island (Shanley et al. 2021, p. 10), and is discussed in more detail below.

Most studies of deer in Southeast Alaska have found that deer use old-growth forests significantly more than young-growth forests, especially in winter (Bloom 1978, p. 110; Wallmo and Schoen 1980, p. 453; Rose 1982, p. 287; Schoen and Kirchhoff 1990, p. 374; Kirchhoff 1994, p. 34). Several characteristics of old-growth forest make it valuable winter habitat for deer. High-volume old-growth forest stands with multi-layered overstories intercept snow and moderate temperature and wind, creating a microclimate favorable for deer (Bloom 1978, p. 108; Kirchhoff and Schoen, 1987, p. 31). Owing to the complex canopy structure of old-growth forest types, light penetrates to the forest floor, facilitating production of a diverse understory of shrubs and forbs, including several nutritious forage species for deer (Bloom 1978, pp. 110–111;

Hanley, 1984, p. 10; Parker et al. 1999, pp. 25–26; Hanley et al., 2014, pp. 6–7). In addition, arboreal lichen, which is nutritious deer forage, is available in significant quantities only in old-growth stands (Parker et al. 1984, p. 8).

However, some studies have reported that deer use of clearcuts less than 10 years old was similar to that of old-growth (Brinkman et al. 2011, p. 239), even in winter (Yeo and Peek 1992, p. 257; Doerr et al. 2005, p. 326). Deer have been found to select for young clearcuts over old clearcuts, and over high-volume old-growth at lower snow levels (Gilbert 2015, p. 129). As snow depth increased, deer decreased selection for young clearcuts and increased selection for old clearcuts and high-volume old-growth. In addition, as local availability of young and old clearcuts increased for individual deer, deer increasingly selected for those habitats (i.e., a functional response), but deer decreased selection for clearcuts of all ages when old-growth was more available to them as an alternative (Gilbert 2015, p. 130).

Deer have also been found to select strongly for edge habitat (Shanley et al. 2021, p. 10). Deer may choose locations with shorter distances to openings to increase forage productivity (since light penetrates to the forest floor along edges) and still remain under cover. They can also move more easily along edges compared to within clearcuts, especially in deep snow conditions (Shanley et al. 2021, p. 10).

In general, deer have non-linear patterns of habitat selection, and traditional resource selection function (RSF) modeling techniques may fail to capture important habitat variability in old-growth and young-growth stands. New techniques that combine Random Forest and traditional RSF models will allow for deeper insights and more confidence in data (Shanley et al. 2021, p. 10).

Home Range and Core Use Areas
In portions of the Northern and Southern Southeast Alaska Analysis Units (i.e., Yakutat, Excursion Inlet, Kupreanof Island, and Kuiu Island), Alexander Archipelago wolf packs appear to be organized into territories that correspond to watersheds, and pack trails are often associated with stream beds (Brooks et al. 2022, p. 39, 42). In contrast, within the POW Complex Analysis Unit, packs seem to be organized by islands, although packs will move between islands in response to prey availability (Brooks et al. 2022, pp. 80-81, 98-99).

In Southeast Alaska, minimum convex polygon home ranges of wolf packs on Revillagigedo Island averaged 279 square kilometers (108 square miles) and ranged from 79–447 square kilometers (31–173 square miles; n is equal to 7; Smith et al. 1987, p. 15). In the mid-1990s on POW Island and Kosciusko Island, pack home ranges of radio-collared wolves averaged 280 square kilometers (108 square miles) with a range of 101–419 square kilometers (39–162 square miles; n is equal to 7); core areas, where wolf activity was concentrated were about 55–60 percent smaller than total home ranges (Person et al. 1996, p. 7). Similarly, during denning and pup-rearing periods, pack home ranges were about 50 percent smaller than during other times of year (Person 2001, p. 55). For example, summer home ranges of five packs on POW Island averaged 100 square kilometers (39 square miles), where winter home ranges for the same packs averaged 240 square kilometers (93 square miles) (Person et al. 1996, p. 7). Summer home ranges for wolves on POW Island were similar to summer home ranges reported for Minnesota where wolves primarily rely on deer for food; however, winter home ranges of POW Island were substantially larger (Person et al. 1996, p. 7).

In recent years, researchers have equipped wolves with downloadable GPS collars resulting in more locations at finer spatial and temporal resolution, which can lead to larger estimates of home range size. Roffler and Gregovich (2018, p. 6) estimated the mean home range size of wolf packs on POW Island Complex to be 376 square kilometers (145 square miles). Wolf pack membership was the most important variable explaining individual wolf home range size, across all seasons (Roffler and Gregovich 2018, p. 6). During the denning season, breeding wolves had significantly smaller core use area sizes compared to wolves not associated with an active den (Roffler and Gregovich 2018, p. 5). The mean denning season core use area was 107 square kilometers (41 square miles) (Roffler and Gregovich 2018, p. 5). Breeding wolves also had a smaller mean home range area (57 square kilometers (22 square miles)) compared to wolves not associated with an active den (Roffler and Gregovich, 2018 pp. 5–6).

Denning and Rearing Habitat

Indigenous experts have observed wolves locating their dens under trees near reliable food sources (Brooks et al. 2022, p. 43, 58) and close to water bodies, particularly ones with beavers (Brooks et al. 2022, p. 82). Alexander Archipelago wolves often den in root wads of large living or dead trees in old-growth forests and near fresh water (Person and Russell 2009, p. 211). A study of 25 active wolf dens on POW Island indicated that wolves select for relatively flat areas near lakes and streams at low elevations, and wolves never located dens in clearcuts or young-growth forests (Person and Russell 2009, p. 221). Seventeen of 25 active dens (67 percent) were adjacent to ponds or streams with active beaver colonies (Person and Russell 2009, p. 216). Most den sites were located farther from logged stands and roads than unused locations, although some wolves used areas near clearcuts and roads for denning probably because suitable alternatives were not available (Person and Russell 2009, p. 220).

More recent data from POW Island also showed that den sites were generally located in old-growth forest, but old clearcut forests sometimes occurred in close proximity to den sites (0.1–1 kilometers; Roffler and Gregovich 2018, p. 8). Breeding wolves and non-breeding wolves differed in the proportion of old clearcut forest used in their home range, which may be explained by variation in movement patterns. Breeding wolves, due to their restricted mobility, may be unable to use more old-growth forested habitat because it would necessitate greater travel distances from the den site (Roffler and Gregovich 2018, p. 8). In contrast, non-breeding wolves had home ranges areas approximately 8 times larger than breeding wolves and therefore a greater ability to incorporate more old-growth forest into their home ranges despite the proximity of unfavorable habitat (i.e., clearcuts; Roffler and Gregovich 2018, p. 8).

In B.C., wolves may select homesites in forest stands of uniform age and away from roads which may cause disturbance (Rozalska 2007, pp. 73–74). Salmon presence and deer availability have been shown to increase the probability of coastal wolf homesites in B.C. (defined as areas occupied by dens and rendezvous sites; Rozalska 2007, p. 61). Meanwhile, increased percent road cover and standard deviation of wetness (a metric for forest structural complexity) decreased the probability of homesite presence (Rozalska 2007, p. 61).

2.5.3 Remoteness (Space from Human Activity)

Road density and human accessibility are important determinants of wolf persistence. In Wisconsin during the 1980s, areas with road densities greater than 0.58 kilometer/square kilometer failed to support gray wolves (Thiel 1985, p. 405). In Upper Peninsula Michigan, wolf occupancy declined at higher road densities, with a predicted threshold of 0.7 kilometer/square kilometer (Potvin et al. 2005, p. 7). In the Northern Rocky Mountains, gray wolves in larger core areas and in areas with less agriculture and less private land had higher survival (Smith et al. 2010, pp. 630–631). Further, in and around Banff National Park, Canada, wolves outside the park had a much lower annual survival rate (44 percent) than park wolves (84 percent), where trapping and hunting were prohibited (Hebblewhite and Whittington 2020, p. 6). Modeling of wolf presence in B.C. indicated that human disturbance (primarily from logging) was one of the primary factors affecting coastal wolf presence at an island level (Swan 2005, p. 47). Most recently, wolves in wilderness areas were found to have higher survival and less anthropogenic mortality than wolves found outside wilderness areas, highlighting the importance of core protected areas (Barber-Meyer et al. 2021, p. 9).

Motorized Vehicle Access

Generally, most studies have found that gray wolf populations do not survive when road densities exceed 1.00 kilometer/square kilometer (Fuller et al. 2003, p. 181 and references therein), although densities of about 0.60 kilometer/square kilometer have been recommended as a threshold for wolf persistence (Thiel 1985, p. 405). In some cases, these studies were conducted in areas where legal hunting was not permitted because wolves were protected, but nonetheless, the thresholds are informative and applicable in areas where wolves are not protected. In recent years, as attitudes toward wolves have improved, gray wolves are occupying areas successfully where road and human densities were thought previously to be too high. Merrill (2000, pp. 312–313) reported wolves breeding in an area where road density was greater than 1.40 kilometers/square kilometer. On POW Island, road density was an important predictor of Alexander Archipelago wolf harvest rates, but when densities exceeded 0.90 kilometer/square kilometer, the relationship deteriorated (Person and Russell 2008, p. 1548). This suggests a threshold beyond which further increases in road density had little detectable effect on wolf harvest rates (Person and Russell 2008, p. 1548).

Recent analyses of GPS-collared wolves on POW Island found that wolf habitat selection was negatively correlated with high road density during the denning season and late summer (Roffler et al. 2018, p. 196). Wolves used areas with a mean road density of 0.772 kilometer/square kilometer during denning season, 0.686 kilometer/square kilometer during late summer, and 0.406 kilometer/square kilometer in open habitats during late summer. In the fall, areas with high-quality deer habitat were avoided if they also had high road density. This could be a response to heavy deer hunter traffic at this time and the associated disturbance and/or risk avoidance (Roffler et al. 2018, p. 199). Alexander Archipelago wolf packs may also experience more conflicts in roaded areas, since roads allow wolves to enter other territories more easily (Brooks et al. 2022, p. 42).

While wolves avoided areas of high road density in the fall, the relationship switched in winter and wolves strongly selected highly roaded areas (Roffler et al. 2018, p. 196). In general, roads seem to present a trade-off for wolves. Although they may provide more access for humans to harvest wolves (as described above), they can also increase efficiency for wolves hunting prey and maintaining territories (Roffler et al. 2018, p. 199; Zimmerman et al. 2014). Seasonal differences in use of roads have been documented, typically with higher selection during fall and winter when wolves are hunting and dispersing (Roffler et al. 2018, p. 199) and avoidance during the summer when wolves are denning and rearing pups (Roffler et al. 2018, p. 199; Person and Russell 2009, pp. 216–217). Indigenous experts also report that wolves travel on and near road systems, and some have observed that road travel allows wolves to move quickly and effectively to access prey (Brooks et al. 2022, p. 114).

Marine Boat Access

Within the range of the Alexander Archipelago wolf, harvest rates of wolves decrease as the distance between human population centers and the ocean increase (Person and Russell 2008, p. 1546). Although, the relationship can be complicated because hunters and trappers likely choose the most efficient means of transportation to access a particular area. In some cases, a favored area for hunting or trapping could be accessible by road, boat, or more than one type of transportation (e.g., boat and all-terrain vehicle).

The many waterways in Southeast Alaska provide ample access to harvest wolves by boat, and most wolf harvest is achieved using boats for transportation (ADFG 2022a, p. 9). Table 5 below shows the number of Alexander Archipelago wolves harvested by boat versus motorized vehicle in each of the Southeast Alaska Analysis Units from the period of 2015–2020 (ADFG 2022b, pp. 9–10). During this 5-year period, hunters and trappers used boats to harvest wolves 72 percent of the time, whereas motorized vehicles were only used 24 percent of the time. Although POW Island has an extensive road system, the prevalence of boat-accessible beaches still allows hunters and trappers greater access to harvest wolves.

Table 5 Transportation methods used to harvest wolves in the three Southeast Alaska Analysis Units from 2015–2020.

Analysis Unit	Wolves Harvested by Boat	Wolves Harvested by Motorized Vehicle
Northern Southeast Alaska	96 (47 percent)	87 (42 percent)
Southern Southeast Alaska	467 (83 percent)	77 (14 percent)
POW Complex	258 (68 percent)	107 (28 percent)
Total	**821 (72 percent)**	**271 (24 percent)**

CHAPTER 3 – FACTORS INFLUENCING VIABILITY

The following discussion provides a summary of the factors that are affecting or could affect the current and future condition of the Alexander Archipelago wolf throughout some or all of its range.

3.1 Timber Harvest and Roads

Timber harvest and associated development has altered the landscape within the range of the Alexander Archipelago wolf more than any other human activity and can influence several aspects of its habitat (detailed in *Chapter 2.5.2 Habitat and Space Use*). In this section, we briefly review timber management and practices in Southeast Alaska and coastal B.C., past timber harvest and current conditions on the landscape, and roads on the landscape. Projections for future timber harvest are discussed in *Chapter 5 Future Conditions*.

3.1.1 Overview of Timber Management and Practices

In Southeast Alaska, approximately 75 percent (Table 6) of the land is managed by the U.S. Forest Service, Tongass National Forest (Tongass) via the 2016 Tongass Land and Resource Management Plan (Forest Plan; USDA 2016b, 508 pp.). Given the large percentage of land managed by the Tongass, the Forest Plan is the single most important regulatory/management framework influencing future habitat and resource conditions of the Alexander Archipelago wolf in Southeast Alaska. Under the current Forest Plan, timber harvest and other development have been identified as suitable on approximately 14,000 square kilometers (5,405 square miles) of the Tongass, equivalent to 21 percent of total Tongass land area.

Table 6 Area of land ownership and management (square kilometers; gray shaded values are percent) by Analysis Unit across Southeast Alaska and within the range of the Alexander Archipelago wolf.

Analysis Unit		Tongass National Forest	National Park Service	State of Alaska	Native Corporations	Other	Total
		Landowner or Manager					
Northern Southeast Alaska	Area (km²)	18,163	10,734	2,546	229	2,646	34,318
	Percent	53	31	7	1	8	
POW Island Complex	Area (km²)	7,262		312	1,613	231	9,418
	Percent	77	0	3	17	2	
Southern Southeast Alaska	Area (km²)	27,345		622	425	1,679	30,071
	Percent	91	0	2	1	6	
Other (Outside Wolf Range)	Area (km²)	14,191	1	121	355	742	15,411
	Percent	92	0	1	2	5	
Southeast Alaska Total	Area (km²)	66,961	10,735	3,602	2,622	5,298	89,218
	Percent	75	12	4	3	6	
Within the Range of the Wolf	Area (km²)	52,770	10,734	3,481	2,267	4,556	73,807
	Percent	71	15	5	3	6	

The current Forest Plan amends the 2008 Forest Plan (USDA 2008, 469 pp.) in response to recommendations for expediting the transition to young-growth management. When ready, most young-growth stands are projected to have up to twice the volume of existing old-growth stands. The Forest Plan identifies the Projected Timber Sale Quantity to be 46.0 million board feet (MMBF) per year for the first decade of the plan (2016–2026), followed by 71.8 MMBF per year as more young-growth reaches harvestable age (USDA 2016b, p. A-6). For comparison, previous versions of the Forest Plan allowed 267 MMBF per year, with earlier versions allowing as much as 450 MMBF per year.

While the Forest Plan is the management document for the Tongass, legislation and other direction, such as the 2001 Roadless Area Conservation Rule (Roadless Rule; 66 Federal Register [FR] 3244) and the Southeast Alaska Sustainability Strategy, place additional constraints on old-growth harvest on the Forest. The 2001 Roadless Rule prohibits road construction and timber harvest within inventoried roadless areas on National Forest lands, including some areas that would otherwise be suitable for timber harvest in the Forest Plan. The implementation of the 2001 Roadless Rule on the Tongass has been the subject of debate and litigation for two decades, with the 2020 Alaska Roadless Rule (85 FR 68688) being the most recent effort for a full exemption. The Alaska Roadless Rule removes restrictions on inventoried roadless areas on the Tongass and directs an administrative change to the timber suitability for lands that would otherwise be suitable in the Forest Plan. However, in 2021 the United States Department of Agriculture (USDA) began taking steps to repeal the Alaska Roadless Rule and maintain protections for inventoried roadless areas. With the 2001 Roadless Rule (66 FR 3244) in place, 919 square kilometers (355 square miles) of old-growth forest is suitable for timber production. With the full exemption under the Alaska Roadless Rule (85 FR 68688), the amount of old-growth forest suitable for timber production would increase to 1,599 square kilometers (617 square miles) (USDA 2020b, p. ES-11).

In addition to the Roadless Rule, in 2021 the Secretary of Agriculture issued a press release announcing the Southeast Alaska Sustainability Strategy, with direction to reduce the amount of old-growth harvest on the Tongass. Under this direction, only small sales (generally less than 10 MMBF (USDA 2016b, p.7-57) or micro-sales (salvage sales of dead or down timber approximately 50 thousand board feet (MBF) or less (USDA 2016b, p. 7–31)) can be offered for old-growth harvest. The Forest Plan would have had this transition occurring in 2033 (USDA 2016d, p .7), and the Southeast Alaska Sustainability Strategy moved that transition up to 2021.

Timber harvest on State, private (including Native Corporation), and municipal land is governed by the Alaska Forest Resources and Practices Act (Alaska Statute 41.17). This State law requires retention of unharvested buffers along anadromous fish-bearing water bodies and establishes standards to minimize erosion of soil. These regulations and their implementation are generally less restrictive than the Forest Plan which applies to National Forest System lands only. Therefore, on State and private lands that are managed for timber production, harvest is often more intensive than on the Tongass.

Across all land ownerships, clearcut logging has been the primary timber harvest method. Clearcutting removes all trees from a logged unit and results in regeneration of an even-aged young-growth stand. Logging costs for a given volume of wood are typically lowest with this method and regeneration of preferred tree species such as Sitka spruce is favored. In some cases, single trees or small groups of trees may be left to provide wildlife habitat or reduce visual impacts (USDA 2016c, p. 3-336).

In recent years, various forms of uneven-aged management have been used as alternatives to clearcutting in some areas. These approaches include group selections and diameter-limit harvests and are best suited for areas where helicopters can be used. Costs typically are higher with these “partial harvest” systems than with clearcutting, so higher-value trees often are targeted for harvest to help offset higher costs (USDA 2016c, pp. 3-336–3-337). Harvest is spread over a larger area to produce the same timber volume that clearcutting produces. While this methodology does not result in complete removal of tree cover from an area, considerable slash and debris can result at the site and persist for some time. This approach results in retention of forest canopy that captures some snowfall (reducing snow accumulation) and increases heterogeneity during stand development, which favors forage plants.

In B.C., approximately 50 percent of the timber volume is located on land suitable for harvesting (BCMF 2010, p. 127). About 220,000 square kilometers (84,942 square miles) of forest is in the Timber Harvesting Land Base (THLB), defined as the operationally feasible areas for timber harvesting where the government has expressed intent to have timber harvest. Timber harvest on Crown lands, or land owned by the provincial government, accounts for approximately 95 percent of the land base, is regulated by allowable annual cut quota (as determined by the provincial government) and is subject to the Forest and Range Practices Act. The B.C. government authorizes the rights to harvest Crown timber through forest agreements, also called tenures. All forest agreement holders must prepare a forest stewardship plan which identifies how the activities will be consistent with government objectives and natural resource values. Stewardship plans are subject to public review and must be approved by the B.C. government before any timber harvest or road building can occur.

Private land accounts for five percent of the land base, and timber harvest on these lands is subject to the Private Managed Forest Land Act. This legislation sets management objectives for landowners, with requirements for managing environmental values and provisions for critical wildlife habitat. Private landowners are also subject to provincial and federal environmental laws.

3.1.2 Past Timber Harvest and Current Conditions

In Southeast Alaska, commercial logging was initiated in Alaska in the late 1800s, primarily to encourage local economic growth and support development of mining, fishing, and local communities. In 1955, following completion of a major pulp mill in Ketchikan, industrial-scale logging began, dramatically increasing the rate of timber harvest. From 1909 to 1952, an average of 41 MMBF per year was harvested, increasing to 380 MMBF per year from 1955 to 1995 (Iverson et al. 1996, pp. 7–8; USDA 1997, p. 3-259). Timber harvest then declined to 91 MMBF per year from 1996 to 2004, further declined to 30 MMBF per year from 2008 to 2013, and then to 22 MMBF per year from 2016 to 2021 (USDA 2022b, unpaginated).

Across Southeast Alaska, nearly 3,000 square kilometers of forest has been logged. Timber harvest was near or above 500 square kilometers per decade during the 1960s through the 1990s, peaking in the 1980s when approximately 780 square kilometers of productive old-growth forest were logged (Figure 4). Recent declines in the rate of logging have been linked to several factors, including changes in market conditions, more restrictive standards and guidelines in the Forest Plan, and litigation (Brackley et al. 2006, pp. 4–5, 27; USDA 2012, p. 13). Additionally, vast amounts of the easily accessible productive forest has been logged, and the remaining productive forest is more expensive to access. As a result, there has been a lack of interest in some of the timber sales offered by the Tongass (USDA 2022b, unpaginated).

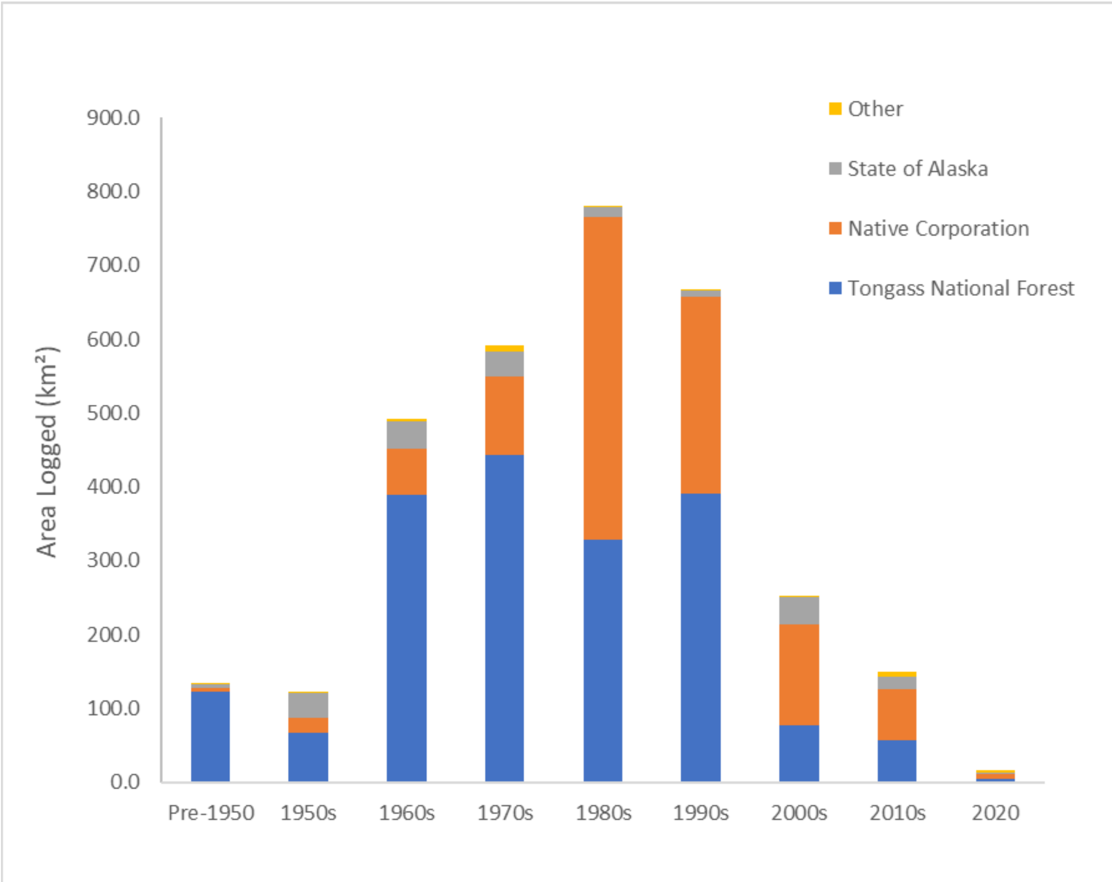


Figure 4 Age distribution of logged forest across all land ownerships in Southeast Alaska (Shanley 2015, updated since 2012 with data from Hansen et al. 2013).

Although most (59 percent) of the logging in Southeast Alaska has occurred on National Forest land, Native Corporations, which own only 3 percent of the land area, account for roughly one-third of the logging, based on total area harvested (Table 7, Figure 4). This reflects the higher rates of harvest on lands owned by Native Corporations (57 percent of their productive forest harvested to date) compared to National Forest land (9 percent of the productive forest harvested; Table 7). These data are based on current ownership of the land and may overestimate the amount of logging accomplished by Native Corporations if young-growth now in Native Corporation ownership was originally logged while managed by the Tongass or others. Additionally, in 2021, Sealaska Corporation announced it would discontinue logging and instead focus resources on generating sustainable value for their shareholders (Sealaska Corporation 2021, unpaginated). Since Sealaska Corporation owns 56 percent of all Native Corporation land (Table 8), this change means a substantial reduction in the amount of land being managed for high rates of timber harvest. Nonetheless, combined Tongass and Native Corporation lands currently account for over 93 percent of the area logged in Southeast Alaska (Figure 4).

Table 7 Current condition (square kilometers) of forest stands by land ownership and management, Southeast Alaska (Albert 2019; Hansen et al, 2013).

Landowner / Manager	Current Forest Condition (km²)			Percent of Forest Logged
	Productive Old-Growth	Young-Growth	Total Forest	
Tongass National Forest	19,745	2,067	21,812	9
National Park Service	796	5	801	1
State of Alaska	1,008	279	1,287	22
Native Corporations	917	1,229	2,146	57

Table 8 Area of Sealaska Corporation land ownership compared to other Native Corporations (km²; gray shaded values are percentages) by Analysis Unit across Southeast Alaska and within the range of the Alexander Archipelago wolf.

Analysis Unit		Landowner: Sealaska Corporation	Landowner: Other Native Corporations	Total
Northern Southeast Alaska	Area (km²)	3	226	229
	Percent	1	99	
POW Island Complex	Area (km²)	1,083	530	1,613
	Percent	67	33	
Southern Southeast Alaska	Area (km²)	172	253	425
	Percent	40	60	
Other (Outside Wolf Range)	Area (km²)	221	134	355
	Percent	62	38	
Southeast Alaska Total	Area (km²)	1,479	1,143	2,622
	Percent	56	44	
Within the Range of the Wolf	Area (km²)	1,258	1,008	2,267
	Percent	56	44	

Intensity of timber harvest has not occurred evenly across Southeast Alaska (Figure 5). Initially, harvest was concentrated along marine shorelines near mines and towns to support early industry (primarily mining and fishing) and community development. However, after mills were built in

Ketchikan, Sitka, and Wrangell in the 1950s, areas designated specifically for timber harvest were targeted in order to supply those mills. As a result, substantial timber harvest occurred on POW Island, Revillagigedo, and surrounding islands for delivery to the Ketchikan pulp mill, on northern Baranof and eastern Chichagof islands to support the Sitka pulp mill, and portions of Wrangell, Etolin, and Mitkof islands for the Wrangell sawmill. Native Corporations have logged on many islands including POW Island and surrounding islands, Revillagigedo, Kupreanof, Kuiu, Admiralty, Baranof, and Chichagof, as well as portions of the mainland (e.g., Hobart Bay, Port Houghton). In addition, logging has occurred on State lands on the northern mainland near Haines and Yakutat and on islands in the southern portion of the region, including POW Complex, Gravina, and Revillagigedo (Figure 5). This State land includes two State Forests (the Haines State Forest and Southeast State Forest) which are managed for timber production and other beneficial uses of public land and resources (AS 41.17.200), as well as Alaska Mental Health Trust and University of Alaska Trust lands which are managed to maximize revenue and generate funding for social and educational programs and have had relatively active timber programs in the last decade (Alaska Department of Commerce, Community, and Economic Development 2022, unpaginated).

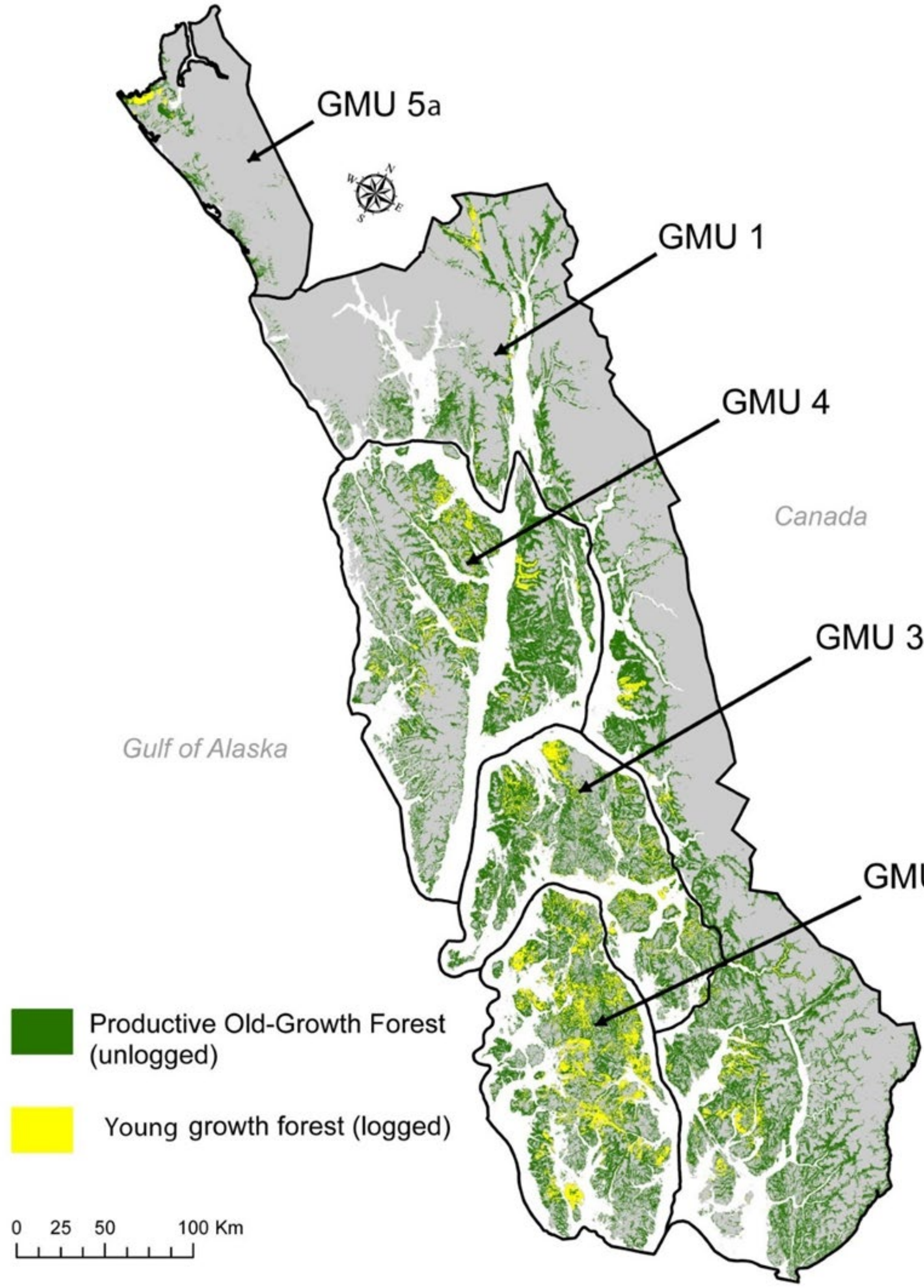


Figure 5 Distribution of (unlogged) productive old-growth forest and (logged) young-growth forest across Southeast Alaska with Game Management Unit (GMU) boundaries (Shanley 2015). Gray areas are unforested.

Across all of Southeast Alaska, the highest rates of logging (percent of productive forest harvested) have occurred in the POW Complex Analysis Unit (GMU 2) where about 30 percent of the productive old-growth forest has been logged (Figure 5, Table 9). POW Island was one of the primary sources of timber for the pulp mill in Ketchikan (which is now closed), as well as a sawmill in Klawock (which continues to operate), in addition to supporting most of the Native Corporation lands devoted to timber production. Overall, logging rates in GMU 2 are at least twice those in all other GMUs and over the range of the Alexander Archipelago wolf in Southeast Alaska (Table 9).

Table 9 Current condition (square kilometers) of forest stands by Game Management Unit (GMU) and within the range of the Alexander Archipelago wolf (i.e., minus GMU 4), Southeast Alaska (Albert 2019, Hansen et al. 2013).

Game Management Unit	Current Forest Condition (km^2)			Percent of Forest Logged
	Productive Old-Growth	Young-Growth	Total Forest	
GMU 1	9,407	672	10,079	7
GMU 2	3,929	1,693	5,622	30
GMU 3	3,661	638	4,300	15
GMU 4	5,838	603	6,441	9
GMU 5A	429	89	518	17
Total	23,265	3,695	26,960	14
Within the Range of the Wolf	17,426	3,093	20,519	4

The age distribution of logged stands is of particular importance to deer, the primary prey of the Alexander Archipelago wolf (see *Chapter 2.5.2 Habitat and Space Use*). Indigenous experts observe that large amounts of young-growth forest limit how many deer the landscape can support because of the reduced capacity of older young-growth stands in the stem exclusion phase, as well as the snow depths that can accumulate from lack of canopy cover (Brooks et al. 2022, p. 68). Generally, stands less than 25 years of age are used by deer because they produce abundant forage, but young-growth stands greater than 25 years of age provide little forage for deer due to canopy interception of sunlight and are avoided. These low-forage conditions can last for another 150 years, until natural disturbances or further timber harvest disrupt the uniform structure of the forest canopy (Alaback 1982, pp. 1936–1942).

In the POW Complex Analysis Unit, where most of the timber harvest occurred in Southeast Alaska, harvest rates were high from the 1960s to the 1990s with the highest harvest in the 1980s (Table D 1 in Appendix D). Most (84 percent) of the young-growth stands in the POW Complex Analysis Unit are older than 25 years and are in age classes that experience low-forage conditions for deer. Although other Analysis Units were logged over a similar time period (Table D 2 and

Table D 3 in Appendix D), the rates of harvest in those Analysis Units were considerably lower, underscoring the compromised current condition of the POW Complex Analysis Unit (GMU 2). Within the range of the Alexander Archipelago wolf in Southeast Alaska, nearly 2,700 square kilometers (1,042 square miles) have been harvested with 8 percent (206 square kilometers (80 square miles), Table D 2 in Appendix D) of the harvest occurring in the Northern Southeast Alaska Analysis Unit, 34 percent (924 square kilometers (357 square miles), Table D 3 in Appendix D) in the Southern Southeast Alaska Analysis Unit, and 58 percent (1,554 square kilometers (600 square miles), Table D 1 in Appendix D), in the POW Complex Analysis Unit.

Regeneration of a forest stand following logging typically results in dense stands of young trees that compete with each other for light and nutrients. Removal of some trees in these stands (i.e., precommercial thinning), is a common silvicultural practice used to encourage growth in fewer, larger trees, improving lumber quality and reducing time until subsequent harvest. Compared to no treatment, precommercial thinning increases understory biomass, changes forage species composition, and increases the forage available for deer, and these benefits can persist for several years post-treatment (studied 16 years post-treatment; Crotteau et al. 2019, p. 185). While precommercial thinning stimulates the growth of understory (i.e., shrub and forb) biomass, it produces dense slash as a byproduct, which may reduce use of thinned stands by deer and other wildlife. Preliminary findings suggest that slash volume was one of the best predictors of percent deer browse in recently thinned stands, with deer browse decreasing as slash biomass increases. However, slash volume became less of a factor around 3 years after treatment when slash decomposition was evident and understory regeneration increased (Brinkman 2022, pers. comm).

Since 1979, over 800 square kilometers (309 square miles) of young-growth on the Tongass has been pre-commercially thinned, primarily to promote timber production, but also with the intention of improving conditions for deer. In recent years, an average of 23 square kilometers (8.9 square miles) has been thinned annually (USDA 2016c, p. 3–334). Additionally, the Central POW Pre-Commercial Thinning project (USDA 2022a, p. 2) has authorized the treatments up to 54.6 square kilometers (21.1 square miles) on forested stands that had been harvested between 1974 and 2006 on POW.

In B.C., timber harvest on public and private lands increased 10-fold between the 1900s and 1990s, and then leveled off in the 1990s (BCMF 2010, p. 137). Since then, the provincial harvest had a high in 2005 with 90 million cubic meters per year (1120 million cubic yards per year), and a low in 2009 with 52 million cubic meters per year (68 million cubic yards per year) (Environmental Reporting BC 2018, p. 2). Beginning in 1949, the government set allowable annual cut limits in an attempt to regulate the growing timber industry on public lands and some private lands. Over the last 10 years, the average total timber harvest across the province was 74 million cubic meters per year (97 million cubic yards per year) and most (90 percent) came from forests that were regulated by allowable annual cut limits. On these forests, actual harvest typically is below the cut limit; over the last 10 years, average annual harvest was 67 million cubic meters per year (88 million cubic yards per year), but the allowable cut was 83 million cubic meters per year (109 cubic yards per year), roughly 19 percent below the permissible level (Environmental Reporting BC 2018, p. 3).

Using an integrated land cover developed for the transboundary area by the North Pacific Landscape Conservation Cooperative (NPLCC, available at http://www.nplcc.databasin.org) and updated based on recent provincial data (methods described in *Chapter 4.2.3 Availability of Old-Growth Forest*), we estimated percent of forest logged in each region of coastal B.C. Based on that data layer, we determined that across all of coastal B.C, 26 percent of the forest was harvested with a larger percentage harvested in the Southern Coastal B.C. Analysis Unit (41 percent harvest in Region 1 and 26 percent harvest in Region 2) compared to the Northern Coastal B.C. Analysis Unit (16 percent harvest in Region 5 and 18 percent harvest in Region 6) (Table 10). Most of the offshore islands adjacent to the mainland remain unharvested (Figure 6).

Table 10 Current condition (km²) of forest stands in coastal B.C., by Analysis Unit and Region (North Pacific Landscape Conservation Cooperative and B.C. (BC) VRI data, methods described in *Chapter 4.2.3 Availability of Old-Growth Forest*).

Alexander Archipelago wolf Analysis Unit	BC Region	Current forest condition (km²)			Percent of forest logged
		Old-growth	Logged stands	Total forest	
Southern Coastal BC	1 - Vancouver Island	7,707	5,388	13,095	41
	2 - Lower Mainland	2,074	719	2,793	26
Northern Coastal BC	5 - Caribou	4,123	783	4,906	16
	6 - Skeena	5,913	1,334	7,247	18
Total		19,817	8,224	28,041	29

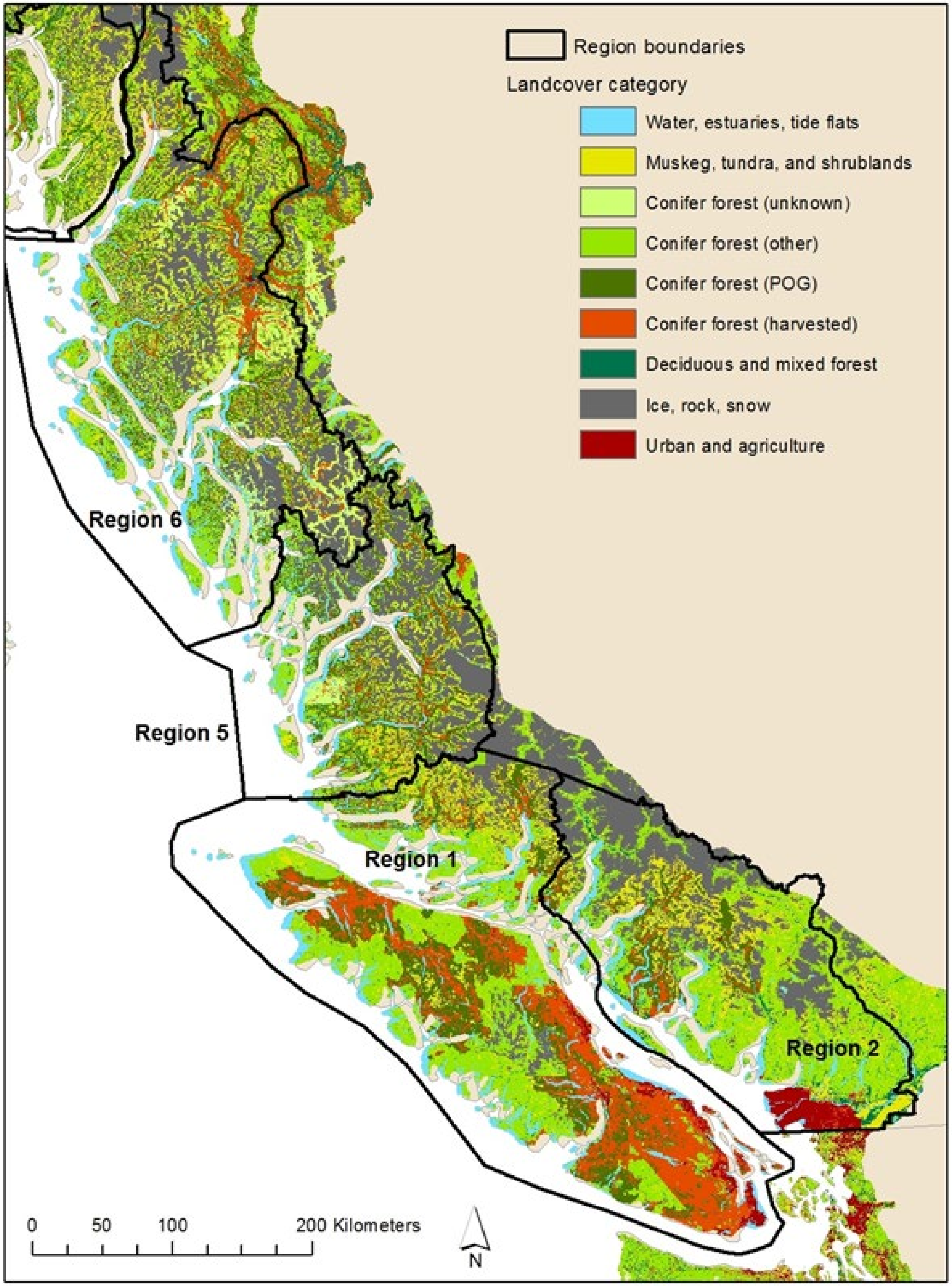


Figure 6 Map depicting land cover in coastal B.C. (available at: https://sciencebase.gov/catalog/item/558474dae4b023124e8f5969; accessed July 10, 2015).

3.1.3 Roads

Outside population centers in Southeast Alaska, nearly all roads were built to facilitate logging and forestry-related activities. Although roads occur on federal, state, and private lands, the majority are administered by the Tongass. Many of these roads remain, although their status, accessibility, ownership, and maintenance vary over time. Similarly, the Tongass authorizes construction of temporary roads by contract, permit, or lease for short-term operations, yet at the end of those operations, the road remains, and ownership or responsibility is often not clear. Oftentimes, roads are left open post-logging for community uses such as firewood gathering and hunting access, and restricting access by closing roads can be highly controversial. The Tongass and other transportation and land management agencies recognize the need to inventory and manage for the existing road system in Southeast Alaska (Service 2015, p. 68). It is important to note that mean road densities and the subsequent effects of roads on wolf viability vary by Analysis Unit, and consideration of road impacts within Southeast Alaska is most relevant for the POW Complex Analysis Unit where road densities are the highest (see Table 26 and Table 27 in *Chapter 4.2.4 Remoteness*).

In 2005, the United States Department of Agriculture revised regulations for travel management on National Forest System lands (2005 Travel Management Rule; 36 CFR 212). In 2009, the Tongass drafted the POW Access Travel Management Plan (ATM) in response to the Travel Management Rule, reduction in road maintenance budgets, changes in road use, and resource concerns. The ATM is the guiding document for road management on POW, and it outlines a schedule for re-categorizing 2,283 kilometers (1,419 miles; ~40 percent of all roads in GMU 2) of road, decommissioning roads (restoring to a more natural state, USDA 2016b, p. 7–51), and converting roads to trails (USDA 2009, p. 2). The ATM calls for decommissioning 129 kilometers (80 miles) of road, converting 16 kilometers (10 miles) to trail and 357 kilometers (222 miles) to motorized trail, and storing (closing to vehicular traffic and receiving basic custodial maintenance, USDA 2016b, p. 7–52) an additional 237 kilometers (147 miles) of road.

We expect some new road construction associated with Tongass timber sales that have been sold (but not cut yet), approved for sale after potential effects of proposed logging have been evaluated and disclosed under the authority of the National Environmental Policy Act (NEPA), or are in the planning stages. Since the 2015 Alexander Archipelago Wolf SSA, the biggest potential new road contributor continues to be the Big Thorne project in the POW Complex Analysis Unit, which requires 74 kilometers (46 miles) of new road construction and 59 kilometers (37 miles) of reconstruction of existing roads (USDA 2013, p. 1). The Kosciusko Vegetation Management Watershed Improvement Project, a young-growth timber project also in the POW Complex Analysis Unit, requires 10 miles of road reconstruction and 1 mile of temporary road construction (USDA 2016a, p. 1). Other smaller projects such as the Central Kupreanof project, the Navy Timber Sale project, and the Wrangell Island project, (USDA 2011, p. 3; USDA 2015b, p. R-1; USDA 2017, p. 1; all in the Southern Southeast Alaska Analysis Unit) would each require more than 4.0 kilometers (2.5 miles) of new road construction, over 2.4

kilometers (1.5 miles) of road reconstruction, and over 5 kilometers (3 miles) of temporary road construction. Most other current or upcoming projects are either small or are young-growth projects where a minimal amount of new road construction is needed. Two larger projects have been on hold since the Southeast Alaska Sustainability Strategy was released in 2021, and if they proceed as initially proposed they would require half the number of roads as the Big Thorne project. One on-hold project is the Twin Mountain II project (POW Complex Analysis Unit) which could require 5 kilometers (3 miles) of new road construction, 56 kilometers (35 miles of road reconstruction, and 17 kilometers (11 miles of temp road construction (USDA 2020d, p. 1)). The second on-hold project is the South Revilla project (Southern Southeast Alaska Analysis Unit), which could require 14.4 miles of new road construction and 34 miles of temporary road construction (USDA 2020c, p. 20).

As the Tongass transitions to young-growth harvest according to the 2016 Forest Plan, projects will be able to utilize existing roads from previous timber harvests and reduce the amount of new road construction needed. While we don't have specifics on planned road development amounts for other landownerships, we expect levels of road development to be proportional with the levels of timber harvest.

3.2 Wolf Harvest

Of the primary threats that affect Alexander Archipelago wolves, wolf harvest by humans is the only one that directly results in mortality. Wolves in Alaska are managed for long-term sustainable populations (ADFG 2015a, p. 6), while providing opportunities for hunting and trapping to the public (Alaska Board of Game 2011, p. 2). In B.C., objectives of wolf management are more varied, but include opportunities for cultural, economic, and recreational use (BCMF 2014, p. v).

Mortality of wolves due to human harvest may be compensated for via increases in survival, reproduction, or immigration (i.e., compensatory mortality) or harvest mortality may be additive, causing overall survival rates and population growth to decline. One study demonstrated that high rates of reproduction and immigration can compensate for human-caused mortality rates of up to 48 percent (Gude et al. 2012, p. 112). Another study showed that wolf population trends are not affected by annual human-caused mortality less than 30 percent (Adams et al. 2008, p. 170). However, results of other studies suggest that harvest of wolves by humans are at least partially additive (Murray et al. 2010, pp. 2519–2520), and therefore, sustainable mortality rates may be lower than expected (approximately 22–25 percent; Creel and Rotella 2010, p. 5, Sparkman et al. 2011, p. 5). Sustainable rates of human-caused mortality within a wolf population vary considerably based on population characteristics such as age and sex structure, but typically depend on productivity and immigration (Fuller et al. 2003, p. 185). In this regard, each population (or group of populations) is different, and a universal human-caused mortality rate does not exist.

3.2.1 Management Authorities, Regulations, and Guidelines

In Southeast Alaska, wolf harvest regulations are set by the Alaska Board of Game for all resident and non-resident hunters and trappers, and by the Federal Subsistence Board for federally-qualified subsistence users on Federal lands. ADFG implements regulations set by the Alaska Board of Game, whereas the USFS implements regulations set by the Federal Subsistence Board. These two management agencies work collaboratively to manage wolf populations and harvest, with public input from the Southeast Alaska Regional Advisory Council (Service 2015, p. 75). Additionally, Advisory Committees are local groups that develop and evaluate regulatory proposals, provide a local forum for wildlife and habitat conservation and use, and consult with individuals, organizations, and agencies, with the goal of making recommendations to the Alaska Board of Game.

Although hunting and trapping regulations vary across Analysis Units in Southeast Alaska (Table 11), generally the hunting season opens on August 1 followed by the trapping season on November 1, and both seasons conclude in late April or May. The bag limit for hunters under both State and Federal regulations is five wolves annually; no bag limit is set for trappers under either set of regulations. In addition, bag limits for hunters and trappers are tallied separately; for example, if a hunter reaches their bag limit of five wolves, the individual can still trap wolves with no bag limit. Across Analysis Units, all harvested wolves must be sealed, which involves the placement of an official marker or locking tag on the hide by an authorized representative of ADFG (Service 2015, pp. 75–76).

In the POW Complex Analysis Unit, wolf harvest is managed differently. Beginning in 1997, ADFG and USFS annually determined a combined maximum number of wolves that could be hunted or trapped under either set of regulations (i.e., State and Federal regulations); if the annual harvest guideline was exceeded, both agencies issued an emergency order closing the hunting and trapping seasons. Prior to 2013, ADFG and USFS did not estimate wolf populations in GMU 2 (or any other GMU) on an annual basis; therefore, annual wolf harvest caps were determined using the most recent estimate and knowledge of the local biologists, hunters, and trappers, while adhering to the guidelines established by the Board of Game (Service 2015, p. 76).

Between 1997 and 2000, the allowable wolf harvest in GMU 2 was set at 25 percent of the fall population estimate (90 wolves). In 2000, the harvest guideline level was increased to 30 percent of the fall estimate, although the total number of wolves that could be harvested remained at 90 wolves; in 2011, this number decreased to 60 wolves because of suspected declines in wolf abundance. Based on the fall 2013 wolf population estimate (221 wolves), wolf harvest for the 2014 season was capped at 25 wolves. In January 2015, the Board of Game lowered the harvest guideline level to 20 percent of the fall population estimate because of concerns about the status of wolves in GMU 2, which equates roughly to 18 wolves based on the 2014 population estimate of 89 wolves. However, owing to concerns about the GMU 2 wolf population, ADFG and USFS set the harvest cap for the 2015 season at 9 wolves, or 10 percent of the 2014 population estimate (Service 2015, p. 76).

Beginning in 2019, the wolf harvest management strategy on the POW Complex (GMU 2) changed from a harvest quota calculated as a percentage of the most recent population estimate to one where season length is annually adjusted to achieve a level of harvest that will maintain the wolf population within a sustainable fall population objective range of 150–200 wolves as established by the Alaska Board of Game (ADFG and USFS 2021, p. 1; Table 11). In fall 2020, ADFG, with support from the USFS and Hydaburg Cooperative Association (HCA), began using a DNA-based mark-recapture technique to estimate wolf abundance in GMU 2. Wolf DNA samples were collected within the same large, northern and central POW Island study area used in 2014–2019. In 2021 ADFG and HCA monitored an additional study area adjacent to the southern boundary of ADFG's original study area. This collaboration expanded the area sampled to nearly 80 percent of POW Island and over 60 percent of the land area of GMU 2. Since 2019, one emergency closure was issued in 2020 with 68 wolves harvested (ADFG and USFS 2021, p. 1).

Table 11 Current hunting and trapping regulations for wolves in Southeast Alaska implemented by the State of Alaska and U.S. Forest Service (with authority from the Federal Subsistence Board).

Analysis Unit	State regulations			Federal regulations		
	Hunting season	Trapping season	Sealing period	Hunting season	Trapping season	Sealing period
Southern Southeast Alaska	August 1–May 31	November 1–April 30	Within 30 days of season closure	August 1–April 30	November 10–April 30	Within 30 days of season closure
Northern Southeast Alaska	August 1–April 30	November 1–April 30	Within 30 days of season closure	August 1–April 30	November 10–April 30	Within 30 days of season closure
POW Island Complex	Adjusted Annually	Adjusted Annually	Within 15 days of harvest	Adjusted Annually	Adjusted Annually	Within 15 days of harvest

The 2019 wolf harvest strategy for GMU 2 also included numerical thresholds for when the population is 1) below the objective range but can still support some harvest and 2) too low to support harvest. Each threshold was also accompanied by an explicit change in harvest management (ADFG 2019, p. 3). Figure 7 below illustrates these thresholds and management modifications.

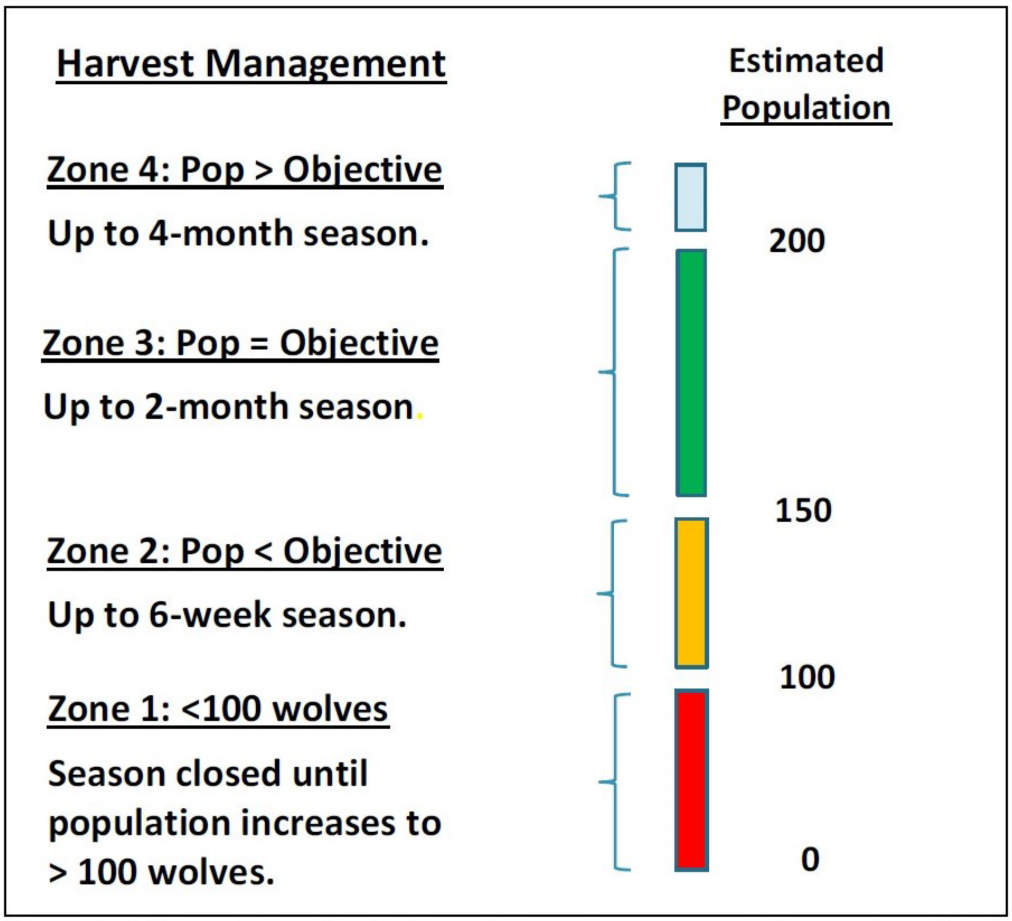


Figure 7 Fall population thresholds and harvest management changes to maintain the GMU 2 wolf population within the Alaska Board of Game-established objective range (ADFG 2019, p. 4).

In March 2021, the Alaska Board of Game changed state regulations for sealing wolves harvested in GMU 2, and those changes went into effect in July 2021. Hunters and trappers must sequentially number or mark wolves taken in GMU 2 and then report the date and location of take to ADFG within 7 days. All hides must be sealed within 15 days of take (ADFG and USFS 2021, p. 2; Table 11). These regulations were designed to provide more precise data for managers to use when calculating population estimates. Federally-qualified users harvesting wolves on Federally managed land in GMU 2 may also seal wolves under Federal subsistence regulations. Federal regulations also require wolves harvested in GMU 2 to be sealed within 15 days of harvest (50 CFR 100.26(n)(2); Table 11). Federal regulations do not apply to wolves harvested on municipal, private, or state lands, including tidelands. Trappers sealing wolves under Federal regulations are also encouraged to provide precise information on the date and location where each individual wolf was harvested (ADFG and USFS 2021, p. 2).

In coastal B.C., the provincial-based Ministry of Forests, Lands and Natural Resource Operations manages wolf harvest according to an established management plan (BCMF 2014, entire). Wolves can be hunted (designated as "big game") by residents and non-residents and trapped (designated as "furbearers") by residents. In the Southern Coastal B.C. Analysis Unit, the hunting season extends from September 10 to June 15, and reporting is required within 30 days of the kill (via online or mail-in reporting or in-person inspection); in the Northern Coastal B.C. Analysis Unit, the hunting season is from August 1 through June 15 and reporting is not required. Although reporting isn't required in the Northern Coastal B.C. Unit, wolf harvest may be reported using a voluntary mail-out survey (the B.C. Hunter Survey). The hunting bag limit is three wolves annually. Under trapping regulations, wolves are considered a Class III species, meaning that they generally are not vulnerable to over-trapping and trappers are encouraged to trap these species. In Southern Coastal B.C., the trapping season begins September 10 and ends June 30. In Northern Coastal B.C., the trapping season begins October 15 and ends March 31. Reporting is required in Southern Coastal B.C. only within 15 days of the end of the trapping season. Similar to Southeast Alaska, regulations set no limit on the number of wolves that can be trapped in a season (BCMF 2020, pp. 29, 36, 60, 67, 90, 92, 96).

3.2.2 Reported Wolf Harvest

In Southeast Alaska, reported annual wolf harvest ranged from 107 to 308 wolves (mean is equal to 176) between 1997 and 2021 (data summarized from ADFG 2012, pp. 1–52; ADFG 2015b, pp. 3–6; ADFG 2022b, p. 2) (Figure 8). Harvest varied substantially across years and Analysis Units. Variation may be attributed to a number of factors, including but not limited to: fur or fuel prices, weather, trapper interest, trapper demographics, changes in regulation or management, etc. Following patterns in wolf abundance, annual wolf harvest was lower on the mainland (GMU 1, including all subunits, and GMU 5A) compared to the islands (GMUs 2 and 3). Across all years, harvest on islands accounted for 63 percent of all reported harvest in Southeast Alaska.

Since 1997, annual reported wolf harvest in the Northern and Southern Southeast Alaska Analysis Units has generally remained steady or increased slightly (Figure 8). Annual population sizes in these units are not estimated; therefore, we cannot make comparisons between wolf harvest and abundance in these two units. In the POW Complex Analysis Unit, where abundance estimates have been calculated somewhat consistently since 2013, wolf harvest and population estimates have both been highly variable but have generally increased (Figure 9).

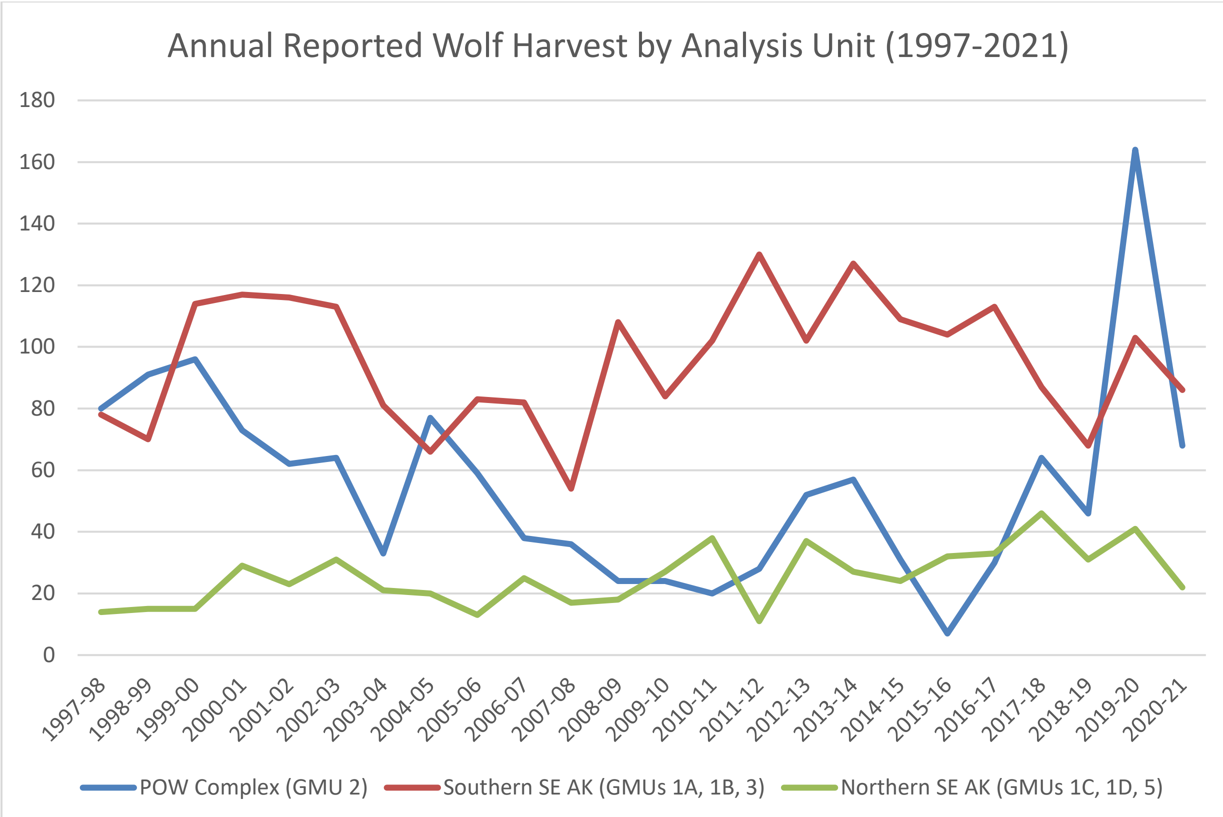


Figure 8 Number of Alexander Archipelago wolves harvested and reported by hunters and trappers by Analysis Unit between 1997 and 2021 in Southeast Alaska (ADFG 2012, pp. 1–52; ADFG 2015a, pp. 3–6; ADFG 2022b, p. 2).

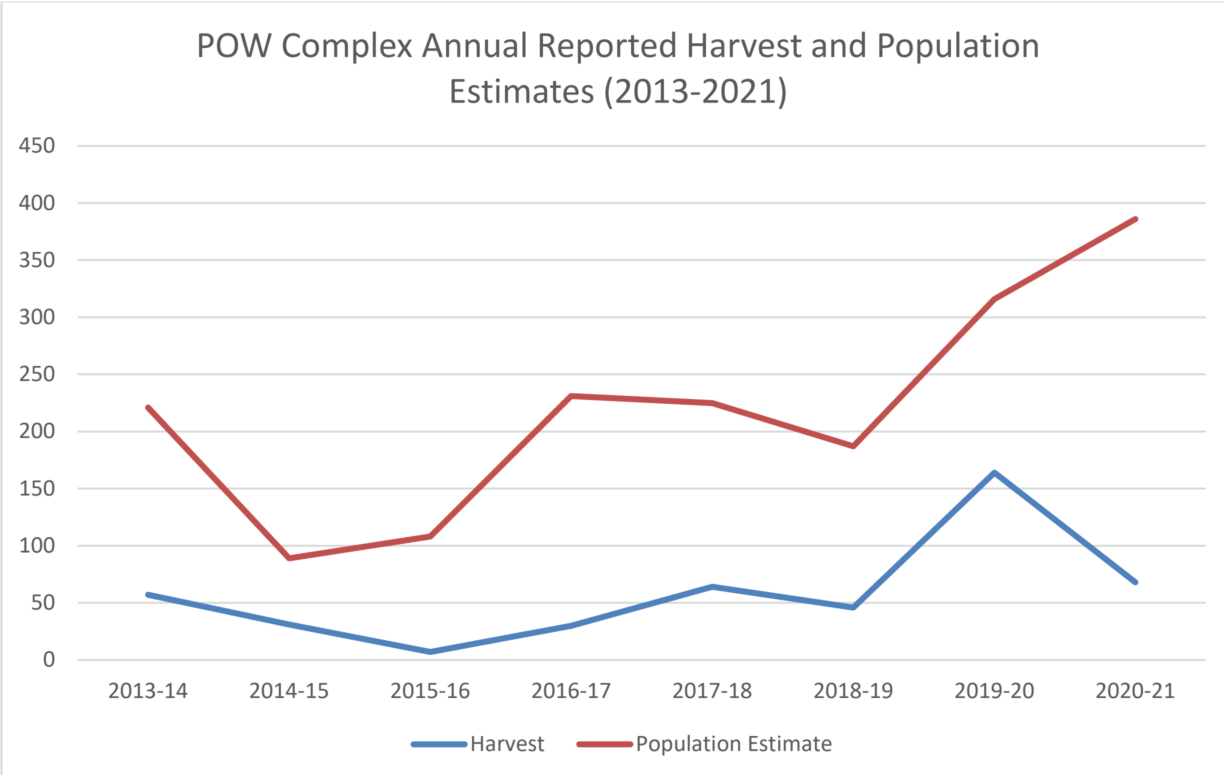


Figure 9 Comparison of reported wolf harvest of Alexander Archipelago wolves versus abundance estimates for the POW Complex Analysis Unit between 2013 and 2021 (ADFG 2012, pp. 1–52; ADFG 2015a, pp. 3–6; ADFG 2022b, p. 4).

Between 2000 and 2014, the number of wolf trappers in the POW Complex generally declined, while the average catch per trapper remained stable (ADFG 2018b, p. 11). However, between 2015 and 2020, the number of successful wolf harvesters in the POW Complex increased (ADFG 2022b, p. 5). Comparing annual reported wolf harvest in Southeast Alaska over the last seven years (Figure 8) with the percentage of successful wolf harvesters over approximately the same time period (Figure 10), some interesting patterns emerge. On the POW Complex, where reported annual harvest has generally increased, we see the opposite trend in the percentage of successful harvesters, indicating that fewer hunters and trappers are harvesting more wolves each year. The opposite seems to be true in Southern Southeast Alaska, where, over the last six years annual reported harvest has declined, but the percentage of successful harvesters has increased.

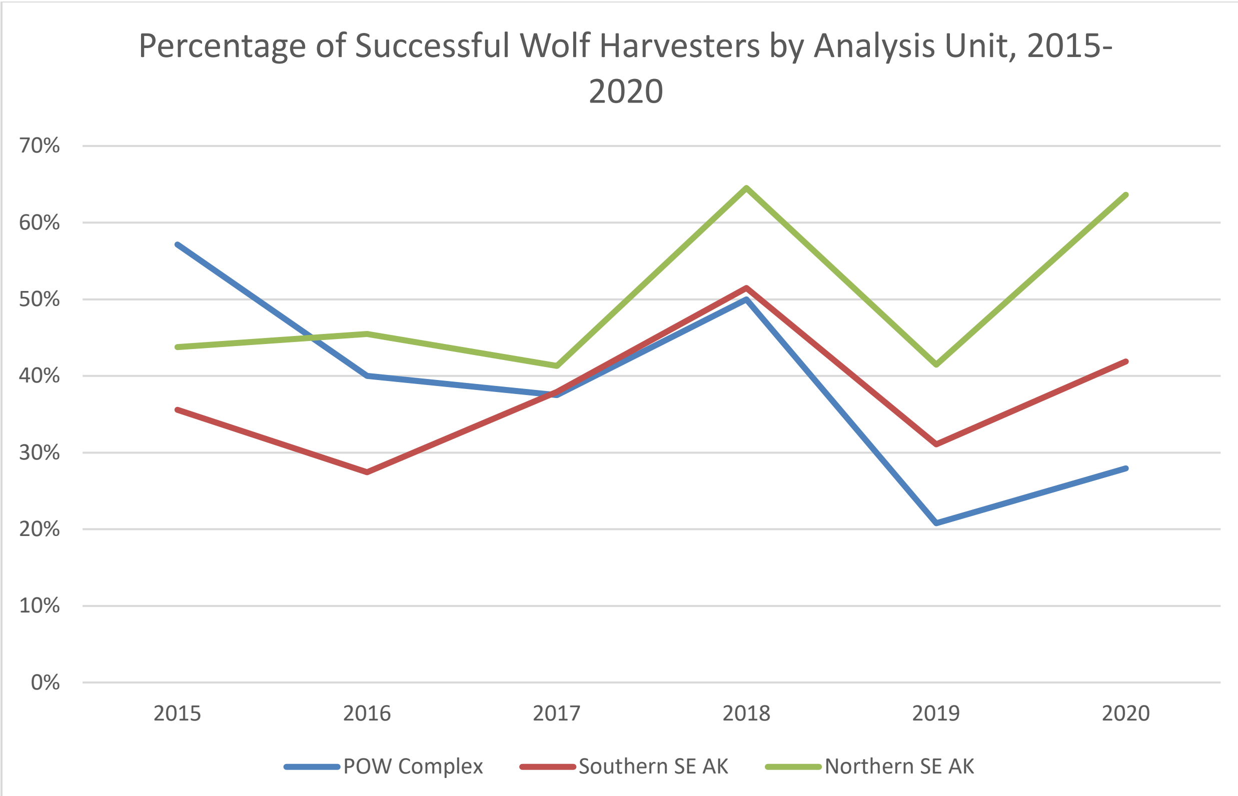


Figure 10 Percentage of successful wolf hunters and trappers by Analysis Unit (2015–2020).

Based on the best available maximum population estimates of Alexander Archipelago wolf, mean reported annual wolf harvest between 1997 and 2021 represented 9–19 percent of the GMU-specific wolf population (Table 12). In the Analysis Units with larger maximum population estimates (i.e., Southern Southeast Alaska and POW Island Complex) 16–19 percent of the population on average was harvested and reported annually. In Northern Southeast Alaska, which has a lower maximum population estimate (277 wolves), harvest rates relative to population size were also lower (8–9 percent). We emphasize that these values were based on reported harvest only; we address unreported harvest and other sources of human-caused mortality below in *Chapter 3.2.3 Unreported Harvest* (*and Other Human-Caused Mortality*).

Table 12 Mean annual reported harvest of Alexander Archipelago wolves by Game Management Unit (GMU) between 1997 and 2021 relative to estimated population size (ADFG 2012, pp. 1–52; ADFG 2015b, pp. 3–6). We combined values across all GMUs on mainland Southeast Alaska (i.e., GMUs).

Analysis Unit	Maximum population estimate[1]	Number of wolves harvested annually		Percent of population harvested annually	
		Mean	Range	Mean	Range
Southern Southeast Alaska	509	96	54–130	19 percent	11–26 percent
Northern Southeast Alaska	277	25	11–46	9 percent	4–17 percent
POW Complex	336	55	7–164	16 percent	2–49 percent

[1]Refer to Table 18 for derivation and citations related to maximum population estimates.

ADFG also collects information on residency status and federal qualification status from wolf hunters and trappers in Southeast Alaska. The following table shows the residency status of harvesters by Analysis Unit from 2015–2020 (Table 13). Most harvested wolves in Southeast Alaska are taken by residents. This is likely because non-residents tend to harvest wolves opportunistically while hunting for other big game species. Residents tend to harvest wolves in proximity to the community they live in (ADFG 2022a, p. 9; ADFG 2022b, p. 7).

Table 13 Wolf harvest in Southeast Alaska by Analysis Units and residency status, 2015–2020.

Regulatory Year	Northern Southeast Alaska			Southern Southeast Alaska			POW Complex		
	Resident	Non-Resident	Unknown	Resident	Non-Resident	Unknown	Resident	Non-Resident	Unknown
2015	28	4	0	99	5	0	7	0	0
2016	33	0	0	112	1	0	29	0	1
2017	43	2	1	82	2	3	60	0	4
2018	29	2	0	60	6	2	44	0	2
2019	38	2	1	99	4	0	153	1	0
2020	21	1	0	80	6	0	68	0	0
Total	**192**	**11**	**2**	**532**	**24**	**5**	**361**	**1**	**7**

We used the B.C. Big Game Harvest database (2019; https://kootenaywildlife.shinyapps.io/BCHarvestData_2019/) to estimate wolf harvest in Southern and Northern Coastal B.C. between 1976 and 2019. This database combines data from the various reporting sources described in *Chapter 3.2.1 Management Authorities, Regulations, and Guidelines* (online, mail-in, or in-person inspection). For Southern Coastal B.C., we looked at harvest data across all Wildlife Management Units (WMUs) in Administrative Regions (ARs) 1 and 2. For Northern Coastal B.C., we excluded our search to WMUs 7, 8, and 9 in AR 5 and WMUs 3, 11, and 14 in AR 6 because these WMUs capture the estimated range of Alexander Archipelago wolves in Northern Coastal B.C. As such, we were only able to glean the mean annual harvest in Northern Coastal B.C. using the maps in the database, rather than the tables, which we determined to be approximately 24 wolves. For Southern Coastal B.C., we determined that annual harvest of wolves between 1976 and 2018 from hunting and trapping ranged between 1 and 135 wolves (mean is equal to 41). We emphasize that these are minimum values because reporting is not required in all Regions.

In Southern Coastal B.C., where a compulsory reporting program is in place, annual wolf harvest has declined since 1976 (Figure 11). Based on the best available maximum population estimates of Alexander Archipelago wolf (Table 14), in Southern Coastal B.C., reported annual harvest between 1976 and 2018 represented 1–31 percent (mean is equal to 10 percent) of the maximum wolf population (Table 14). In Northern Coastal B.C., reported annual harvest from 1976–2018 averaged 6 percent of the estimated maximum wolf population. Therefore, across Coastal B.C., the mean minimum percent of the population that was harvested and reported annually was slightly less (6–10 percent) than in Southeast Alaska populations (9–19 percent), although we recognize that the harvest statistics presented here are incomplete because of the lack of reporting requirements in Northern Coastal B.C. Further, we note that the population estimates may be biased high and therefore, the minimum percent of population harvested may be biased low; however, these data represent the only available information, to the best of our knowledge.

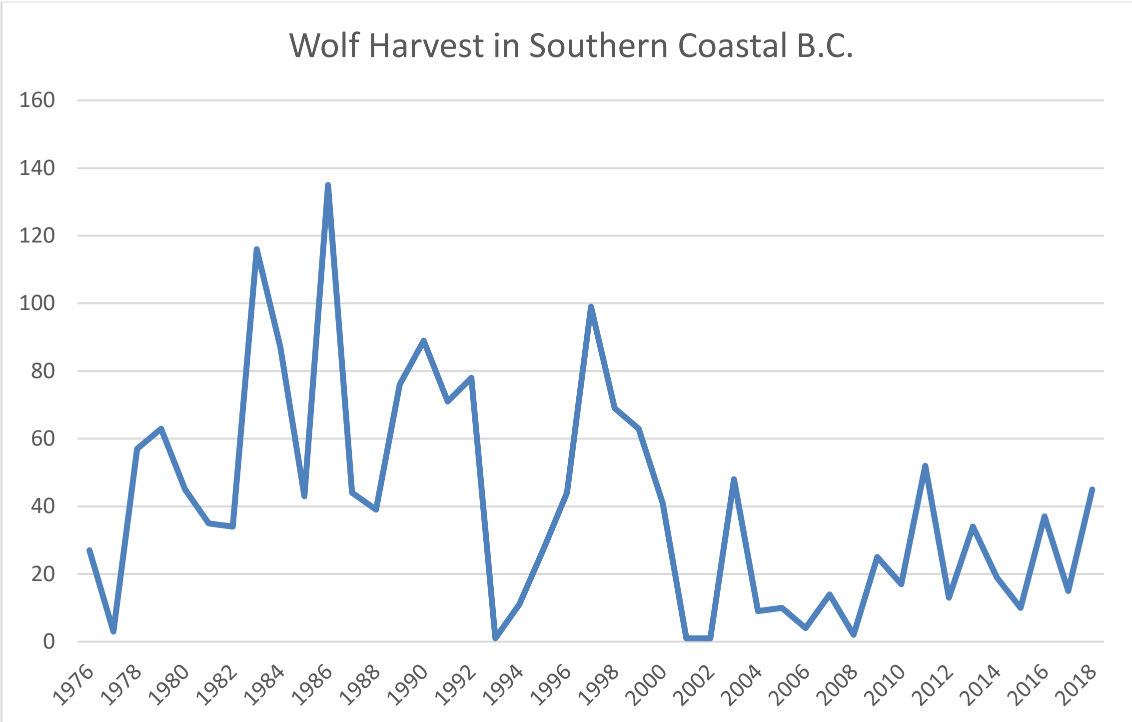


Figure 11 Annual wolf harvest in Southern Coastal B.C. (ARs 1 and 2) from 1976 to 2018.

Table 14 Coastal B.C. maximum wolf population and harvest estimates and percentage of the maximum population harvested annually.

Analysis Unit	Maximum population estimate	Number of wolves harvested annually		Percent of maximum population harvested annually	
		Mean	Range	Mean	Range
Southern Coastal B.C.	430	41	1–135	10 percent	0–31 percent
Northern Coastal B.C.	444	24	Unknown	6 percent	Unknown

3.2.3 Unreported Harvest (and Other Human-caused Mortality)

In Southeast Alaska and Southern Coastal B.C., hunters and trappers are required to report their wolf harvest, yet not all harvest is reported (Person and Russell 2008, p. 1545; ADFG 2012, pp. 3, 12, 19, 43). Unreported harvest can result from a hunter or trapper unknowingly harvesting a wolf (e.g., wounded animal that dies and is not recovered, often referred to as wounding loss) or from a hunter or trapper choosing not to report harvest for whatever reason (e.g., killed outside of open season, exceeded bag limit, etc.). If this situation is common, over-harvest of the population can occur, resulting in population decline (Liberg et al. 2011, p. 1). We cannot distinguish between wolves that were killed and purposefully not reported and those that were killed and unknowingly not reported. Therefore, for the purpose of this assessment, we consider unreported harvest to be a trapping or shooting harvest that was not reported or sealed, but was required to be, regardless of when it occurred (i.e., during open or closed seasons) and includes wounded animals that later died and were not recovered.

Unreported harvest is inherently difficult to document and quantify. Between 1993 and 2004, 16 of 34 (47 percent) radio-collared wolves harvested on POW Complex were not reported (Person and Russell 2008, p. 1545). Most of these wolves (13 of 16, 81 percent) were shot out of season or killed during legal season and not reported (Person and Russell 2008, p. 1545). Average annual rates of mortality attributed to legal harvest, unreported harvest, and natural mortality were 0.23 (SE is equal to 0.12), 0.19 (SE is equal to 0.11), and 0.04 (SE is equal to 0.05), respectively (Person and Russell 2008, p. 1545), indicating that unreported harvest on POW Island Complex can be substantial (i.e., 0.45 of total annual harvest).

Between 2012 and 2018, researchers captured and radio-collared 12 wolves on POW Island. Subsequent to collaring, ten of these wolves died as a result of human activities and two died from natural causes; five wolves were harvested and sealed, four were categorized as unreported harvest, and one was categorized as wounding loss (ADFG 2022b, p. 11). Assuming that the five wolves that were categorized as unreported harvest and wounding loss in fact were harvested and not reported and that harvest rates were equal across years, these data suggest that unreported harvest is similar (5 of 10; 50 percent) compared to data collected in the 1990s and 2000s by Person and Russell (2008, entire), although the sample size was small (n is equal to 10). Collectively across these two studies, unreported harvest of radio-collared wolves on POW Island constitutes an estimated 45–50 percent of total harvest. Importantly, these unreported harvest estimates represent cumulative harvest over a period of multiple years, and not an annual unreported harvest rate.

Outside of GMU 2 in Southeast Alaska, we found other reports of documented and suspected unreported harvest of wolves. In GMUs 1A and 1C, at least two wolves each have been taken illegally since 1996 (ADFG 2009, pp. 3, 19; ADFG 2012, pp. 3, 19). In GMUs 1B and 3, reported take of wolves is suspected to be below actual take due to poaching (i.e., unreported harvest; ADFG 2012, pp. 12, 43). In GMU 5A, wolves were found dead in snares after the trapping season ended on two occasions (ADFG 2000, p. 41; ADFG 2006, p. 47). Between 2018 and 2021, 12 wolves were radio-collared in GMUs 1A, 1C, and 4, and only one wolf was categorized as wounding loss (17 percent of total harvest) (ADFG 2022b, p. 11). We found no information on unreported harvest in Southern Coastal B.C. where reporting is also required.

In addition to unreported harvest, wolves may be killed accidentally by humans (e.g., vehicle collisions). Since 1996, eight Alexander Archipelago wolves were killed by vehicles in GMU 1A (ADFG 2000, p. 3; ADFG 2006, p. 3; ADFG 2009, p. 5), GMU 1C (ADFG 2006, p. 18), and GMU 5A (ADFG 2000, p. 41). In addition, on rare occasions, wolves can be aggressive, especially if conditioned to human food, and may be pursued by concerned homeowners or community members (ADFG 2012, p. 49); we found only one record of two Alexander Archipelago wolves being killed by humans because of increasingly aggressive behavior (Vargas

Island, coastal B.C.; summarized in McNay 2002, p. 5). If a wolf is killed accidentally (or in defense) and is not reported, we consider it to be an unreported human-caused mortality. It may be difficult to differentiate an unreported harvest event from an unreported human-caused mortality event, but given the documented high rate of unreported harvest presented by Person and Russell (2008, entire), we believe this distinction is important when assessing the status of the Alexander Archipelago wolf. The intent of these types of events is fundamentally different and should be acknowledged.

Intensive management of black-tailed deer, which includes the culling of wolves with the aim of increasing deer populations and deer harvest by humans, is authorized in the Southern Southeast Alaska Analysis Unit (GMU 1A (ADFG 2013a, entire) and GMU 3 (ADFG 2013b, entire)). Currently, these programs are inactive, but operational plans exist and could be implemented in the future. If activated, the treatment area in GMU 1A would be restricted to Gravina Island (about 2 percent of total land in GMU 1A) and all wolves would be eliminated from the treatment area over a 5-year period (ADFG 2013a, p. 6). In GMU 3, the treatment area constitutes 22 percent of the total land area and is located in the northern portion of the unit including Woewodski, Mitkof, and part of Kupreanof Island (ADFG 2013b, p. 6). Within the GMU 3 treatment area, up to 80 percent (or approximately 50 wolves in 5–6 packs) would be removed; the duration of the culling effort would be a minimum of five years (ADFG 2013b, pp. 8–9).

3.2.4 Effects of Wolf Harvest
Wolves can compensate for harvest through adjustments in dispersal, reproduction, survival, or a combination of these vital rates, although other factors such as prey availability also may be limiting the population. Evaluating the effect of harvest on wolves requires information about the dynamics of the population, including social structure (Rutledge et al. 2010, p. 332); for example, if harvest rates are high, wolf density may be lower, resulting in increased prey abundance, which may trigger higher reproduction rates. Therefore, when assessing whether or not rates of harvest, or human-caused mortality, are sustainable, it is useful to understand which factors may be limiting the population and the thresholds at which those limitations apply. In the absence of data on ecological limitations, population trend can be used to evaluate sustainable harvest limits.

The Alexander Archipelago wolf is harvested throughout most of its range (with the principal exception of Glacier Bay National Park in the Northern Southeast Alaska Analysis Unit), yet we do not understand fully the demographic mechanism by which populations may compensate for harvest. Although individual wolves are affected by harvest, few data exist to assess population- or subspecies-level response of Alexander Archipelago wolves to harvest. We found that, in most years, rates of reported harvest relative to estimated maximum population size (Table 15) were within the sustainable harvest guidelines for Alexander Archipelago wolf (approximately

34 percent; Person and Russell 2008, p. 1547) and gray wolf populations in continental North America (approximately 20–30 percent; Adams et al. 2008 [29 percent], p. 22; Creel and Rotella 2010 [22 percent], p. 5; Sparkman et al. 2011 [28 percent], p. 5; Gude et al. 2012 [25 percent], pp. 113–116). However, population sizes are challenging to estimate and have not been calculated consistently across time and space for most Alexander Archipelago wolf populations, increasing uncertainty in our estimates of percent of the population harvested. Further, unreported harvest in some areas may be substantial and may be having an undocumented impact on some populations, although outside of the POW Complex, we found few data to examine.

On the POW Complex, although reported annual harvest between 2013 and 2021 averaged 26 percent of the population (Table 15), when estimated unreported harvest is accounted for, total wolf harvest may exceed sustainable limits in some years (Table 15). We lack a clear understanding of the demographic compensation of the POW Complex population to wolf harvest, but we assume that the insularity of the population makes it more susceptible to over-harvest. Interestingly, however, even though the POW Complex wolf population declined after periods of relatively high reported harvest from 2013–2014 and 2017–2018, the population appeared to increase between 2019 and 2021 after the highest ever reported harvest on the POW Complex. (Table 15, Figure 12). This finding suggests: a) that population estimates are not accurate, b) unreported harvest declined significantly in the 2019–2020 season compared to previous seasons, or c) that wolf harvest is not a primary driver of population trend. One Indigenous expert on the POW Complex indicated that he alone harvested an average of 25 wolves annually for a number of years, and that it did not seem to adversely impact the population (Brooks et al. 2022, p. 68).

Table 15 Calculation of the estimated proportion of the POW Island Complex Alexander Archipelago wolf population that was harvested (legally or illegally) between 2013 and 2021 using a range of 0.17 to 0.47 as our estimate of the proportion of total harvest that was unreported.

	Reported Harvest	**Population Estimate**	**Estimated proportion of total harvest that was unreported**	**Total Estimated Harvest**	**Proportion of population Illegally harvested**	**Proportion of population harvested (legally or illegally)**
2013–14	57	221	0.17 – 0.47	69 – 108	0.05 – 0.23	0.31 – 0.49
2014–15	31	89	0.17 – 0.47	37 – 58	0.07 – 0.31	0.42 – 0.66
2015–16	7	108	0.17 – 0.47	8 – 13	0.01 – 0.06	0.08 – 0.12
2016–17	30	231	0.17 – 0.47	36 – 57	0.03 – 0.12	0.16 – 0.25
2017–18	64	225	0.17 – 0.47	77 – 121	0.06 – 0.25	0.34 – 0.54
2018–19	46	187	0.17 – 0.47	55 – 87	0.05 – 0.22	0.30 – 0.46
2019–20	164	316	0.17 – 0.47	198 – 309	0.11 – 0.46	0.63 – 0.98
2020–21	68	386	0.17 – 0.47	81 – 128	0.04 – 0.16	0.21 – 0.33

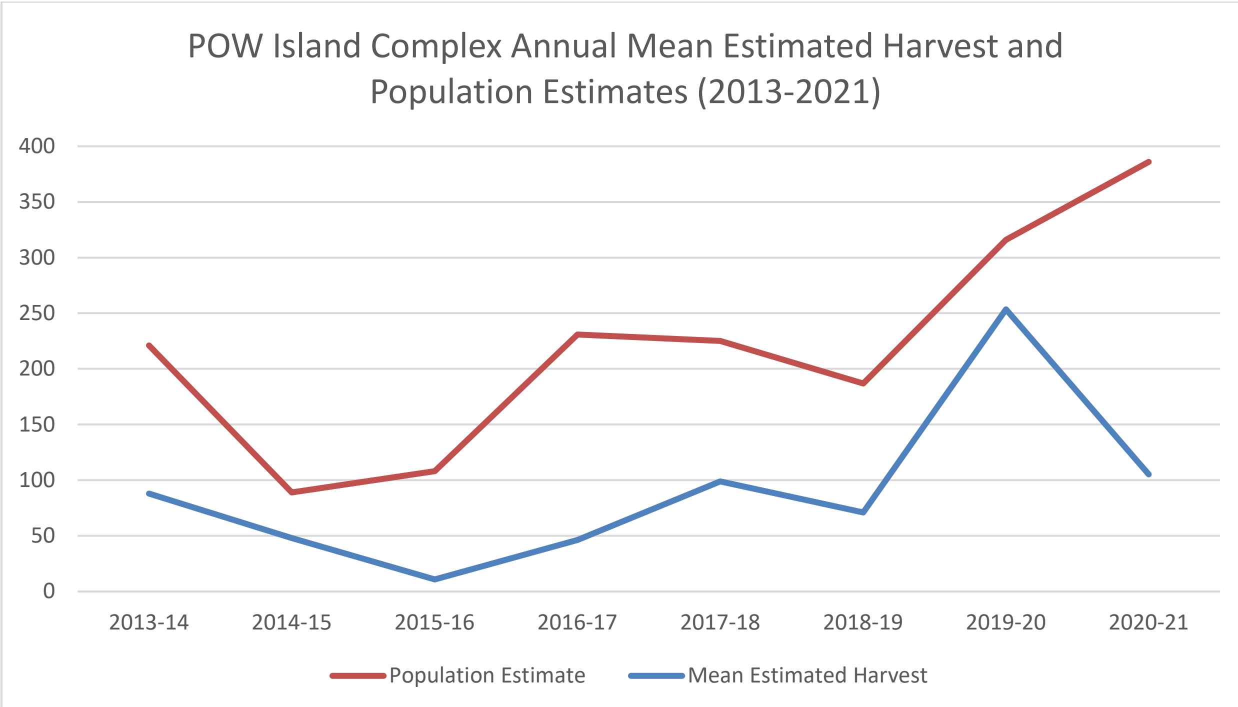


Figure 12 Illustration of population estimates and mean total estimated harvest on the POW Island Complex Island Complex between 2013 and 2021.

Traditional Ecological Knowledge (TEK) suggests that to have healthy wolf packs, wolves must be trapped and hunted on a three-year cycle in which a substantial portion of the pack is removed, but never the entire pack. If wolves have adequate prey and no other sources of mortality, packs that are not harvested for three to five years will increase in size. Additionally, TEK sources indicate that the health of a pack increases after it has been harvested for three years because there is more food per animal. Packs will also start to form in different locations because they become trap-shy and warier of people. This harvest approach therefore creates a balanced ecosystem optimal to deer and wolves and ensures the overall health of deer and wolves (Brooks et al. 2022, pp. 70-72, 114).

3.2.5 Human Access and Rates of Wolf Harvest

Harvest of wolves has been found to increase with increasing road access and open habitats (e.g., muskegs) (Person and Russell 2008, pp. 1546–1548) and decrease as the distance between population centers and the ocean increases. Other habitat features also seem to decrease harvest risk (e.g., increasing distance from lakes and streams [Person and Russell 2008, p. 1545], and increasing proportion of alpine habitat [Person and Logan 2012, p. 14]), but high road densities and human population centers near the ocean have the greatest effect on wolf harvest rates.

From 1985–2009, 19 of 32 study sites (59 percent) on POW Island were chronically over-harvested, and most (16 of 32; 50 percent) also met the criteria for risk of pack depletion with roads being a primary factor facilitating wolf harvest (Person and Logan 2012, pp. 12–13). In most study sites, closing of roads only had a modest effect on reducing wolf harvest because planned road closures represent a small percentage of the total road density in those locations, and therefore, access was not reduced by a meaningful amount. In some areas, however, rates of harvest decreased substantially (Person and Logan, pp. 22–23, 25). Therefore, the efficacy of road closures to mitigate for possible over-harvest of wolves on POW Island is dependent on the roads selected for closure, timing and duration of the closure, and method by which the road is closed.

Although roads increase risk of harvest to wolves, most wolves in Southeast Alaska, including POW Island, are harvested by hunters and trappers using boats for transportation. See *Chapter 2.5.3 Remoteness (Space from Human Activity)* for additional information on this topic.

3.3 Inbreeding

Small, isolated wolf populations may be subject to inbreeding (mating between related individuals) which increases homozygosity in offspring because they have alleles that are identical by descent (i.e., the alleles are copies of the same allele from a common ancestor). Inbreeding can expose deleterious, partially recessive alleles resulting in inbreeding depression, or a relative reduction in the fitness of offspring due to inbreeding. In wolves, inbreeding depression has been documented in several wild populations, manifested as decreased pup survival (Scandinavian gray wolf populations: Liberg et al. 2005, p. 18), congenital bone deformities (Scandinavian gray wolves: Räikkönen et al. 2006, entire and Isle Royale gray wolves: Räikkönen et al. 2009, entire), and reduced litter size and sperm quality (Mexican wolves: Fredrickson et al. 2007, p. 2368 and Asa et al. 2007, entire).

A recent study of Alexander Archipelago wolves used hundreds of thousands of single nucleotide polymorphism genotype likelihoods to infer individual inbreeding in wolves across Southeast Alaska by analyzing runs of homozygosity (ROH; Zarn 2019, entire). ROH are a genomic signature of individual inbreeding and represent continuously homozygous regions of the genome which are identical by descent (Keller et al. 2011, entire; Kardos et al. 2016, entire). Longer ROH reflect inbreeding among recent parental ancestors, while shorter ROH are more likely derived from distant ancestors (contributing to estimates of "total genomic inbreeding", Zarn 2019, p. 14) since ROH will be broken up during meiosis and recombination (Kardos et al. 2016, pp. 1206, 1210). Zarn 2019 (entire) identified elevated levels of ROH across all three ROH lengths analyzed (≥10Mb, ≥1Mb, and ≥100Kb) in POW Complex wolves, as well as elevated levels of intermediate and short length ROH in Southern Southeast Alaska individuals; Northern Southeast Alaska individuals showed the lowest levels of ROH at all three lengths. These results indicate that POW Complex wolves show the genomic effects of both recent and ancestral inbreeding, while Southern Southeast Alaska individuals show signatures of elevated total genomic inbreeding. Zarn (2019, pp. 13–15) also identified similar or higher ROH in POW Complex and Southern Southeast Alaska wolves when compared to a ROH analysis of highly inbred Isle Royale wolves (Robinson et al. 2019, entire), though limitations reported in Zarn (2019, p. 13) prevent a full evaluation of these comparative results with Isle Royale. Finally, there are no definitive data to date that link genomic signatures of inbreeding to inbreeding depression (i.e., fitness impacts) in Alexander Archipelago wolves, though Zarn (2019, pp. 16–17, 41–43) provides camera trap photos of three different POW Complex individuals with short tails, which may be due to injury/trauma (i.e., not linked to inbreeding depression) or skeletal deformities (i.e., potential signs of inbreeding depression). More generally, inbreeding has been shown to have overall negative impacts on individual fitness, population-level fitness, population viability, and adaptive capacity in mammalian species due to reduced genetic variation and increased genetic load (Lacy 1997, entire).

Previous information on inbreeding in Southeast Alaska wolves was limited to a microsatellite study by Breed (2007, pp. 27–28, 32–33) that used the inbreeding coefficient, F. After removing individuals identified as migrants (which can skew population allele frequencies), this study identified the highest F values in the “mainland coastal Alaskan” unit (corresponding to the Southern Southeast Alaska Analysis Unit), followed by POW Complex. Breed qualified these results, however, due to substructure identified within their mainland coastal Alaska unit, which can artificially increase F due to the Wahlund effect (i.e., a deficit of heterozygotes compared to expected Hardy-Weinberg proportions due to the presence of multiple populations). Unlike calculation of F, ROH are not dependent on reference to subpopulation allele frequencies, a strength of the Zarn (2019) analysis. Finally, Breed (2007, p.18) did not find strong signatures of inbreeding based on F in populations in B.C. (corresponding to the Northern Coastal B.C. Analysis Unit); unlike their analysis of POW Complex and the mainland coastal Alaska units, Breed did not identify significant heterozygote deficiencies, indicating that these results for B.C. are not likely to have been impacted by population substructure (i.e., no Wahlund effect).

Inbreeding has recently been documented in Alexander Archipelago wolves at the larger Southeast Alaska scale as well (Pacheco et al. 2022, entire). Researchers compared inbreeding coefficients (through evaluation of homozygosity-by-descent (HBD), obtained from ROH) among five gray wolf populations (two from Russia, one in Southeast Alaska, one from inland Alaska, and one from inland B.C.). Southeast Alaska wolves showed the highest average inbreeding coefficients (F_{HBD}), significantly different from all other populations (Wilcoxon-Mann-Whitney test, p is less than .05) (Pacheco et al. 2022, pp. 5–6). The Russian and inland Alaska and B.C. populations exhibited heterozygosity and inbreeding coefficients comparable with previously described values for other extant populations in Eastern Europe and North America. In contrast, the lower levels of genetic diversity and higher inbreeding coefficients exhibited by Southeast Alaska wolves revealed a genetic signature of persistent decline in effective population size, particularly over the last 280 years (Pacheco et al. 2022, p. 10).

In summary, a genomic assessment of individual inbreeding (using ROH) identified high levels of recent and ancestral inbreeding in POW Complex and elevated total genomic inbreeding in Southern Southeast Alaska wolf populations (Zarn 2019, entire). While not definitely linked to inbreeding depression in these populations, it is plausible that these levels of inbreeding are negatively impacting population fitness and viability due to exposure of deleterious alleles as well as reducing overall genetic diversity and evolutionary adaptive capacity (ability to respond to shifting selection pressures; Lacy 1997, entire). By comparison, wolves in the Northern Southeast Alaska unit showed lower levels of total genomic inbreeding than POW Complex and Southern Southeast Alaska, which should reflect reduced fitness and viability impacts relative to other Alaska populations (Zarn 2019, entire). When comparing all wolves in Southeast Alaska with inland Alaska and B.C. wolves, a recent study found significantly lower heterozygosity and inbreeding coefficients in Southeast Alaska wolves. Finally, a microsatellite study in the Northern Coastal B.C. unit did not identify strong signatures of inbreeding based on the inbreeding coefficient, F (Breed 2007, entire); to our knowledge there are no genetic studies of inbreeding in the Southern Coastal B.C. unit.

3.4 Disease

Gray wolves are susceptible to numerous diseases and parasites, some of which may alter wolf population dynamics by affecting reproduction, mortality, or dispersal (Brand et al. 1995, p. 428). Many of these diseases impact individual wolves, and the social structure of wolves may facilitate rapid spread of some diseases within packs. Of the numerous diseases that can affect gray wolf populations, rabies, canine distemper virus, canine parvovirus, and sarcoptic mange have been classified as having medium risk to wolves (CDFW 2016, pp. 38–41). Canine distemper virus and canine parvovirus can have population consequences categorized as severe and moderate, respectively (Brandell et al. 2021, p. 3). While numerous other diseases could infect wolves, their impacts to wolf population dynamics are not known to be significant and are considered low to no risk for wolves (Fuller et al. 2003, pp. 276–278; CDFW 2016, pp. 38–41).

3.4.1 Rabies

Rabies is caused by Rhabdovirid virus and infects all warm-blooded animals, including Alexander Archipelago wolves. Rabies is a fatal viral disease that infects the central nervous system (Centers for Disease Control (CDC) 2022, p.1). Verified cases of rabies have been documented in wild wolves in other parts of Alaska, and rabies has been linked to declines in wolf abundance in Alaska (Johnson et al. 1994, pp. 436–437; Weiler et al. 1995, p. 80; Ballard and Krausman 1997, p. 243). In northwestern Alaska, the wolf population growth rate in the two years prior to a rabies outbreak was 1.43 and 1.05, while in the two-year monitoring period during the rabies outbreak, the growth rate declined to 0.64 and 0.62 (Ballard and Krausman 1997, p. 243).

Other species in Southeast Alaska may be vectors of rabies to wolves. Potential vector species of rabies in Southeast Alaska are red fox (*Vulpes vulpes*) and bats (Hueffer and Murphy 2018, pp. 4–5). Domestic dogs are also a likely vector for rabies in Southeast Alaska. Prior to 1993, there were no documented cases of rabies in any terrestrial animal from Southeast Alaska (Alaska Section of Epidemiology 2021, p. 4). Since then, four individual bats tested positive for rabies in 1993 (Revillagigedo Island), 2006 (POW Island), 2014 (POW Island), and 2022 (Juneau), respectively (ADFG 2015c, p. 1; Schumacher 2022, pers. comm). Likewise, bats are reported to carry rabies in B.C. (B.C. Ministry of Environment 2003), but no documented cases of rabies have been found in wolves from coastal B.C.

3.4.2 Canine Parvovirus

Canine parvovirus has been detected in nearly every wolf population in North America, including in Alaska (Johnson et al. 1994, pp. 270–272; Bailey et al. 1995, p. 441; Brand et al. 1995, p. 420; Kreeger 2003, pp. 210–211; ODFW 2014, p. 7), and exposure in wolves is thought to be almost universal. Canine parvovirus was discovered during the late 1970s in both domestic dogs and wild wolves. Death of captive and free-ranging wolves from parvovirus has been documented (Goyal et al. 1986, p. 1093; Johnson et al. 1994, p. 271; Mech and Goyal 1995, p. 567; Mech et al. 1997, p. 322; Mech et al. 2008, pp. 827–828). A controlled study of the effect of parvovirus on wolves revealed that 30 percent of the wolves developed clinical disease symptoms, and 10 percent would likely have died without supportive care (Brand et al. 1995, p. 421). For gray wolves in northeastern Minnesota, in the 30 years (1973–2004) following canine parvovirus detection, the disease reduced gray wolf pup survival, subsequent dispersal, and population growth rate (Mech et al. 2008, p. 824). A follow-up study 35 years after detection indicated that once the virus became endemic (after 1993), the population developed enough immunity to withstand population-level effects of the disease (Mech and Goyal 2011, pp. 28–30).

Although documented cases are rare, the transmission of parvovirus from domestic dogs to wild wolves is a conservation concern in Southeast Alaska and coastal B.C. Canine parvovirus occurs regularly in domestic dogs throughout Alaska and even with intensive care, high mortality still results. Within Southeast Alaska, canine parvovirus is not common, but some outbreaks have occurred, especially in remote villages that do not have immediate access to veterinarian care (New 2015, pers. comm.). Additionally, parvovirus outbreaks in B.C. have been reported in domestic dogs (Bryan et al. 2011, pp. 14–15).

3.4.3 Canine Distemper

Canine distemper is a viral disease usually affecting gray wolf pups between the age of three and nine weeks of age. Outbreaks of canine distemper virus are particularly lethal for young wolves and have resulted in reduced pup survivorship to as low as 13 percent (Almberg et al., 2010, p.

2072). Adults are less affected, but among those adults exposed to canine distemper virus for the first time, survival is roughly half of what it is normally (Almberg et al. 2016, p. 2). Once an individual survives a canine distemper infection, it is thought to be immune for life (Almberg et al. 2016, p. 2). As a result, it may take several years before an area has enough susceptible individuals to support another outbreak (Almberg et al. 2016, p. 2). While distemper can cause localized population decreases in the short term, its effects are acute, and wolf populations usually rebound shortly after disease outbreaks (Brand et al. 1995, p 420; Almberg et al. 2009, p. 9; Almberg et al. 2010, p. 2072; Almberg et al. 2012, p. 2847).

In northwestern and interior Alaska, gray wolves tested seropositive (positive result in a test of blood serum) for distemper at a low rate (Stephenson et al. 1982, p. 421). The low seropositive rate suggests either rare exposure or a high fatality rate. In 1978 and 1980, two yearling wolves were found dead on the Kenai Peninsula, and canine distemper was the reported cause of death (Peterson et al. 1984, p. 31; Brand et al., 1995, p. 420). Although distemper has largely disappeared in domestic dogs as a result of vaccination, rare cases do occur in Southeast Alaska. In 1996, canine distemper was confirmed in a domestic dog treated at the Juneau Veterinary Hospital (New 2015, pers. comm.). There have been no reported cases of canine distemper from coastal wolves within B.C.

3.4.4 Mange

Sarcoptic mange is caused by the ectoparasitic mite, *Sarcoptes scabei.* Wolves with mange usually have severe hair loss, and severe infestations result in crusted lesions and hairless, thickened, slate-gray skin over much of the body (Brand et al. 1995, entire). Infested animals generally suffer from alopecia, hyperkeratosis, seborrhea, scabs, ulcerations, and lesions (Jimenez et al. 2010, p. 1120). Severe mange infestations can result in wolf mortality, especially in pups, and may play a role in regulating wild canid populations, with the number of cases increasing when wolf populations increase (Todd et al. 1981, p. 727). In a long-term study of wolves in Alberta, higher wolf densities were correlated with an increased incidence of mange, and pup survival decreased as the incidence of mange increased (Brand et al. 1995, pp. 427–428). In Montana and Wyoming, packs with the most severe mange infestations had low pup survival, and some adults died, suggesting that wolf populations can be affected by mange at local scales (Jimenez et al. 2010, pp. 331–332).

While the effects of most outbreaks of mange are short-lived, the combined effect of an outbreak of mange and canine distemper virus in 2007 and 2008, respectively, caused the wolf population to become regulated at lower population sizes in Yellowstone National Park (DeCandia et al. 2021, p. 430). The ultimate impact of mange on wolves may partially depend on their genetic diversity. In a study of wolves in Yellowstone National Park, individual genomic diversity in gray wolves was inversely correlated with mange severity, meaning that wolf genomic variation can buffer against the risk of severe mange (DeCandia et al. 2021, p. 441); however, this also means that a decline in genome-wide variation at the population-level has the potential to increase the prevalence of severe manage in wolves (DeCandia et al. 2021, p. 440).

3.4.5 Pathogen Seroprevalence Within Alexander Archipelago Wolves

Seroprevalence, or the level of a pathogen in a population as measured in blood serum, was analyzed for seven Alexander Archipelago wolves captured from POW, Berners Bay, and near Gustavus between 2015–2018 (Table 16; Brandell 2020, p. 1). Overall, Alexander Archipelago wolves have high exposure to canine adenovirus, canine herpes virus, and the parasite *Neospora caninum* (Brandell 2020, p. 7). These three diseases are considered low risk to gray wolves (CDFW 2016, pp. 38–41). When compared to 16 wolf populations sampled across North America, Alexander Archipelago wolves have moderate pathogen burdens (Brandell 2020, p. 7).

Table 16 Mean pathogen prevalence and standard error for seven Alexander Archipelago wolves captured between 2015–2018 (Brandell 2020, p. 3).

Pathogen	Number positive/ total tested	Prevalence	Standard Error
Canine distemper virus	0/7	0.0 percent	0.0
Canine parvovirus	1/7	14.3 percent	14.3
Canine adenovirus	5/7	71.4 percent	18.4
Canine herpesvirus	7/7	100 percent	0.0
Neospora caninum	3/5	60.0 percent	24.5
Toxoplasma gondii	1/5	20.0 percent	20.0

Based on these limited data, Alexander Archipelago wolves appear to be fairly naïve to both canine distemper virus and canine parvovirus. Canine distemper virus may not be detected in wolf populations because it leads to high mortality and is thus difficult to detect because a recent epidemic has not occurred, or it is not maintained because the greater carnivore community is too sparse (Brandell 2020, p. 5). In most North American gray wolf populations, canine parvovirus is an endemic pathogen infecting greater than 65 percent of wolves, compared to 14.3 percent in Alexander Archipelago wolves (Brandell 2020, p. 5). Canine distemper virus and canine parvovirus pose the largest known threat to Alexander Archipelago wolves because, when introduced to a naïve population, they have very high mortality rates (Brandell 2020, p. 7). If either pathogen enters the population it may result in a large-scale epidemic. This concern is heightened by the high prevalence of canine herpesvirus in Alexander Archipelago wolves (found in 100 percent of wolves sampled), because coinfection with parvovirus or distemper virus would be highly detrimental to pup survival (Brandell 2020, p. 7).

3.4.6 Summary

The role of disease in limiting Alexander Archipelago wolf populations remains largely unknown. If populations of Alexander Archipelago wolves decline to small numbers or become highly localized, then their vulnerability to disease may increase. The introduction of new diseases, disease variants, and parasites into wolf populations in the western United States is likely to continue (see Canuti et al. 2022, pp. 12–14), and it is difficult to predict the consequences of novel pathogens. Further, changes in climate and increased economic activities could increase the potential for introduction of new pathogens and susceptibility of wolf populations to existing pathogens, especially in coastal wolf populations (Bryan et al. 2011, p. 12).

3.5 Climate Change

Climate change refers to the change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (Intergovernmental Panel on Climate Change (IPCC) 2014, p. 120). There is increasing evidence that climate change is impacting species and populations in a variety of ways, and the expected consequences of future changes will vary by region, species, and ecosystem type (U.S. Global Change Research Program (USGCRP) 2018, pp. 270, 273). Climate change may have direct or indirect effects on Alexander Archipelago wolves, their prey, and their habitats.

Impacts of climate change are challenging to predict for several reasons. First, although some factors will likely change linearly and gradually (e.g., average temperature), many will not, instead exhibiting threshold responses (e.g., average water temperature in glacier-fed streams). Second, averages do not reflect the increased variability and extreme events that are the signature of climate change and that reflect the day-to-day experience of organisms and ecosystems. Third, climate impacts will interact with each other and with non-climate pressures in complex, non-linear, and often unpredictable ways. Similarly, multiple pressures will combine to impact Alexander Archipelago wolf health in suites of cascading effects: for example, individuals stressed by changing abiotic conditions (e.g., changes to temperature, precipitation, snowpack) will be more susceptible to disease and less able to disperse or reproduce, limiting adaptive capacity. At a species scale, changes in disease prevalence or in timing of critical processes may tip species over a threshold. (Price and Daust 2016, p. 2).

The influence of climate on Alexander Archipelago wolves includes abiotic factors, biotic factors (i.e., changed interactions with other species), and the complex system of interactions among factors that result in emergent patterns of habitat on the landscape (Price and Daust 2016, p. 12). In this section, we consider the most up-to-date climate projections for Southeast Alaska and coastal B.C. and discuss the potential effects of climate change on Alexander Archipelago wolves across their range.

3.5.1 Climate Projections for Southeast Alaska

The following list summarizes the predicted climate changes for Southeast Alaska over the next century (Haufler et al. 2010, p. 8):

- Temperatures will increase, with winter temperatures increasing at a greater rate than summer temperatures.

- Length of growing seasons and frost-free days will increase.
- Temperatures in seasonal transition months in many locations will shift from below freezing to above freezing.
- Precipitation will increase.
- More precipitation will fall as rain rather than snow.
- Evapotranspiration rates will increase.
- P-PET ratios (precipitation minus potential evapotranspiration) will decrease in summer, causing dryer conditions in summer for many locations.
- Storm intensities will increase.

Projected changes for Alaska indicate a universal decrease in the length of the snow season, with larger decreases in southern Alaska and at lower elevations and some coastal regions. Historically, most of Alaska was snow-dominated, but the area of Alaska considered snow-dominated decreases into the future under all scenarios, while transitional and rain-dominated watersheds increase (Littell et al. 2018, pp. 667–668). Areas of Alaska with maritime climates are expected to see a decreased incidence of extreme accumulated snowfall in the future, while more northerly, continental, and high-elevation locations are likely to see an increased incidence of extreme accumulated snowfall (Lader et al. 2018, pp. 182–184).

There are conflicting data regarding the rate of climate change impacts in different areas within Southeast Alaska. One source projects that changes in climate variables will generally follow a high to low pattern along two gradients, from north to south and from mainland to the outer coast; with northern mainland areas showing the greatest change in temperature and precipitation and southern island provinces exhibiting the least (Shanley et al. 2015, p. 5; Figure 13). Similarly, climate monitoring data from the National Oceanic and Atmospheric Administration (NOAA 2022, website) project the most extreme decreases in summer precipitation around Yakutat and Glacier Bay and the most extreme increases in both summer and winter precipitation around Juneau and Admiralty Island, all of which are found in Northern Southeast Alaska (NOAA 2022, website). However, NOAA (2022, website) and Littell et al. (2018, pp. 7–8) also indicate that average summer and winter temperatures and precipitation will increase at greater rates in the southern regions of Southeast Alaska compared with the northern regions.

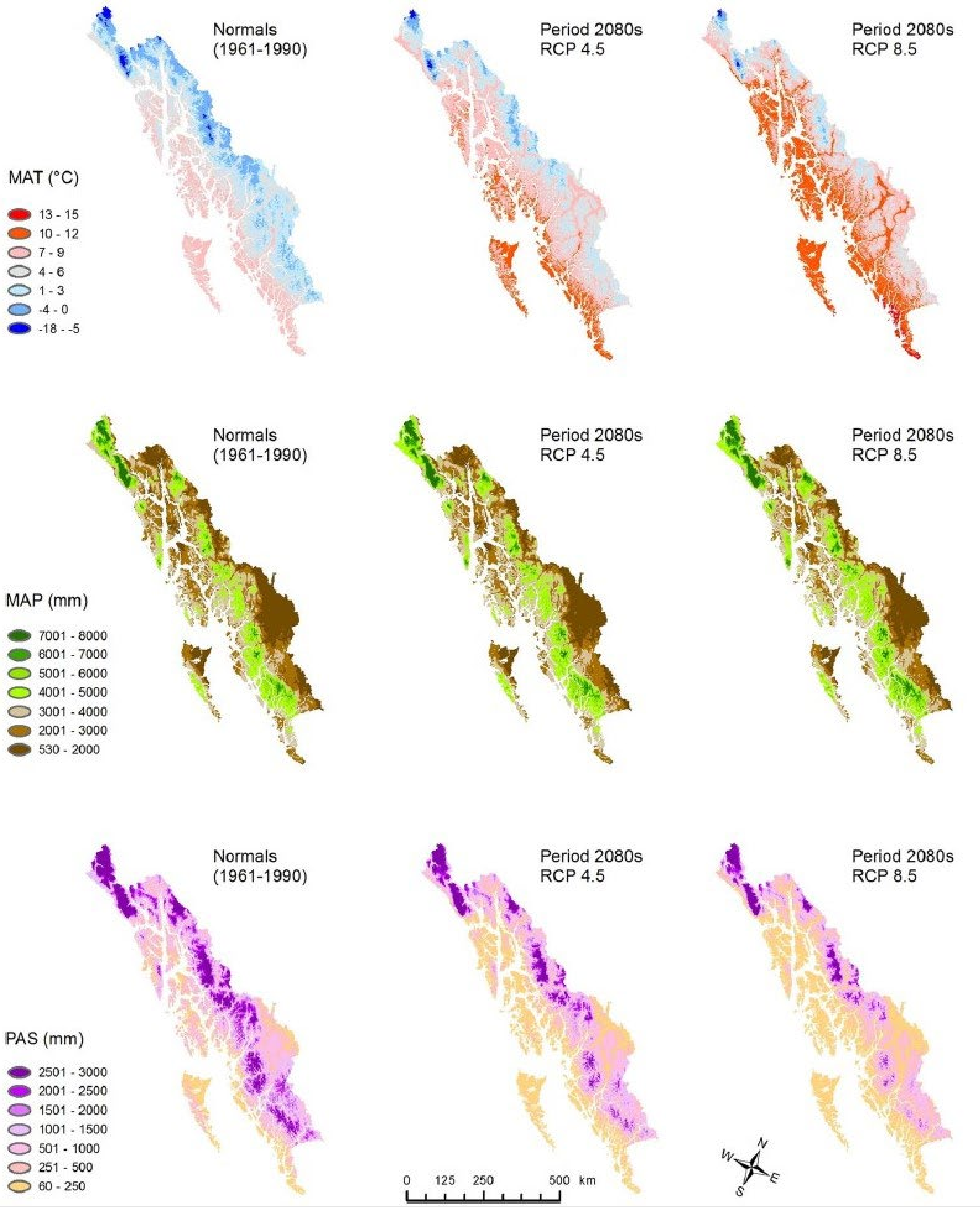


Figure 13 A map series of potential climate change showing the current mean annual temp (MAT), mean annual precipitation (MAP), and precipitation as snow as water equivalent (PAS) compared to corresponding projections for the 2080s (2071–2100; 30-year normal period) using a five global climate model ensemble average (CCSM4, GFDL-CM3, GISS-E2-H, IPSL-CM5B-LR, and MRI-CGCM3) from the IPCC CMIP5 scenarios RCP 4.5 and RCP 8.5 (Shanley et al. 2015, p. 6).

3.5.2 Changes to Snowpack

Precipitation as snow has been projected to decrease up to 58 percent in Southeast Alaska and northern B.C. over the next 80 years (Shanley et al. 2015, pp. 5–6). B.C. has become warmer and wetter over the last century, and extreme rainfall and dry conditions have increased. These trends are expected to continue, with variation over shorter time periods, and among regions. More winter precipitation is expected to fall as rain, and spring snowfall will decrease, resulting in lower snowpacks, earlier snowmelt, and longer fire seasons in many regions (Price and Daust 2016, p. 2). Most changes in snow will occur in February and March, resulting in an earlier onset of spring conditions and longer growing season (McAfee and Rupp 2014, p. 3944).

Annual snowpack can strongly affect black-tailed deer populations, which in turn impacts wolves by reducing available prey. Therefore, it is important to attempt to understand the frequency and influence of severe winters on wolf and deer population dynamics. A severe winter primarily affects deer in two ways: (1) by reducing availability of forage (i.e., snow covers browse) and (2) by increasing energy expenditure associated with movement (i.e., deep snow is difficult to move through) (Parker et al. 1984, p. 474; Parker et al. 1999, p. 5). Future projections suggest that deep snow may no longer be a limiting factor for deer in certain parts of Southeast Alaska and coastal B.C., and projected declines in snow accumulation and persistence may alleviate winter stress. A longer growing season may also increase food availability in the spring when energy demand of winter-stressed individuals is high (Shanley et al. 2015, p. 10). However, other studies suggest that more rapid green-up in the spring can also result in an overall reduction in the availability of high-quality forages across alpine landscapes and a corresponding reduction in juvenile ungulate growth and survival (White et al. 2018, pp. 1144-1145).

In the Northern Southeast Alaska Analysis Unit, where moose are the primary prey of wolves rather than black-tailed deer, we see similar responses to severe winters. Winter snow accumulation not only affects moose populations by increasing physiological costs associated with locomotion but also through burial of important forages. Winter diet composition of moose in Gustavus includes high proportions of low-growing *Equisetum* sp. that, although widely available during snow-free winters, are especially prone to burial under only modest amounts of snow. Thus, for the Gustavus moose population, snow accumulation is likely to result in nonlinear, or greatly accelerated, decreases in functional habitat carrying capacity that are triggered at much lower snow depth thresholds than would occur for populations such as Yakutat, that feed predominantly on taller, woody browse species (White et al. 2004, p. 27).

3.5.3 Changes to Habitat Composition and Structure

Other climate-related changes that are occurring or are expected to occur within the range of the Alexander Archipelago wolf include reduction or loss of yellow cedar as a result of warmer winters and reduced snow cover over the next 50 years (Hennon et al. 2012, p. 156; Service 2018, entire). We also expect biotic disturbance dynamics to change. Warming conditions and wetter springs in many regions may lead to more frequent and extensive tree mortality due to insects and diseases (as already seen with mountain pine beetle, spruce beetle and *Dothistroma* in B.C.), although some fungal diseases may decrease with drier conditions. In general, insects and disease organisms have high adaptive capacity and can respond to changing conditions faster than their hosts (Price and Daust 2016, p. 14).

Models project that Southeast Alaska and B.C.'s biogeoclimatic ecosystem climate envelopes will move up to 300 meters (984 feet) higher in elevation and 170 kilometers (106 miles) farther north within the next 30–60 years (Shanley et al. 2015, p. 9; Price and Daust 2016, p. 14). In response, ecological communities will disassemble and reassemble—sometimes into novel combinations—as populations decline, move, or adapt. Many species, including trees, will not be able to migrate quickly enough to keep pace with shifting climate. During this transition, ecosystems will be strongly influenced by disturbances and invasive plants. Additionally, alpine and subalpine ecosystems are expected to shrink since high-elevation ecosystems are vulnerable to encroachment by lower-elevation ecosystems and cannot migrate (Price and Daust 2016, pp. 14–15). Forested subalpine communities may become shrublands in some areas, because shrubs migrate faster than trees (a conversion that is already happening in Alaska) (Price and Daust 2016, p. 34).

Although forest extent appears to be exhibiting a slight decline in the southern portion of the Alexander Archipelago wolf range, it appears to be expanding in the north, at least on northerly-facing, low-angle, sheltered slopes. For example, the Glacier Bay region has seen extensive glacial retreat and forest establishment. Yellow cedar mortality, which is primarily occurring in southerly locations within the range of the Alexander Archipelago wolf, may be driving some of this spatial pattern. USFS Inventory and Analysis data indicate that biomass increases for yellow cedar are highest on steeper, north facing slopes and nonexistent on south facing, shallow slopes, contrary to the other major tree species and the overall trends of higher mortality at higher slopes (Buma and Barrett 2015, pp. 7–8).

Although these changes on the landscape have been observed, we do not know their impact to the Alexander Archipelago wolf. We hypothesize, however, that effects (negative or positive) will be negligible because the wolf is a habitat generalist and an opportunistic predator. Further, yellow cedar is a minor component of the temperate rainforest, which is dominated by Sitka spruce and western hemlock, and neither of these tree species appears to be impacted negatively by reduced snow cover (Schaberg et al. 2005, p. 2065). We are not aware of research that has measured changes in deer abundance with regard to loss of yellow cedar in forests of Southeast Alaska or coastal B.C.

Wolves in the Northern Southeast Alaska Analysis Unit are likely to face a different set of climate change effects because of their diet, which is primarily composed of moose rather than black-tailed deer. Therefore, the habitat that wolves are using in the Northern Southeast Alaska unit is also different, as moose tend to select for both young forests and shrublands for browse and mature forests for shelter and cover from extreme weather and predators. An increase in the freeze-free season, increased precipitation in spring and winter, and decreased precipitation in summer is predicted to be beneficial to deer, whereas moose and mountain goats may become physiologically stressed in response to warming (Weiskopf et al. 2019, p. 775; White et al. 2018, entire).

3.5.4 Changes to Hydrology and Marine Systems

Climate change may also contribute to hydrologic changes that reduce salmon productivity within the range of the Alexander Archipelago wolf (Edwards et al. 2013, p. 43; Shanley and Albert 2014, p. 2). As the rain-snow transition zone increases in elevation in response to increased mean annual temperature, less precipitation as snow will be stored in seasonal snowfields or ice. Therefore, runoff patterns are expected to transition toward lower-elevation watershed types, shifting from glacial to snow melt and from snow melt to rainfall-dominated. In Southeast Alaska, snow melt-dominated watersheds have already shifted towards higher winter stream flows and lower summer stream flows during the warm phase of the Pacific Decadal Oscillation; based on modeling results, we anticipate this trend will be more prevalent in the future (Shanley et al. 2015, p. 7). Warmer winter temperatures and extreme flow events are predicted to reduce egg-to-fry survival of salmon, resulting in lower overall productivity (Shanley et al. 2015, p. 8).

Current projections of warmer stream temperatures and increased extreme flow events indicate that salmon abundance and availability may decline in the future. Additionally, marine mammals and invertebrates are likely to be adversely impacted by ocean acidification and warming. However, as discussed in *Chapter 2.5.1 Prey,* salmon do not contribute substantially to wolf diet across the wolf's range (less than 1 percent), nor do marine mammals (less than 2 percent) or invertebrates (less than 2 percent) and therefore, we do not expect climate-induced hydrological or marine changes to have a significant impact on wolf resiliency within any of the Analysis Units.

3.5.5 Wolf Adaptability

Alexander Archipelago wolves are habitat generalists, which tend to be resilient to climate change, since they already survive in a variety of habitats and conditions. Wolves are also capable learners with extreme behavioral plasticity and have the potential to disperse long distances (Price and Daust 2016, p. 22; McKelvey and Buotte 2018, p. 360; Barber-Meyer et al. 2021, pp. 1, 11). However, climate change may influence prey availability for wolves over the long-term (via changes in snowfall, disease dynamics, and heat stress) and expected future wolf survival, reproduction, and dispersal could be affected by lagged adjustments to their prey populations (Barber-Meyer et al. 2021, p. 11).

There is no current evidence that climate change is causing negative effects to the viability of gray wolves in the western United States or Alexander Archipelago wolves in any portion of their range. While uncertainty remains as to how climate change may affect wolf populations in the future, we do not expect that the flexible and adaptive nature of wolves will change.

3.6. Existing Conservation Mechanisms

We reviewed relevant existing conservation mechanisms that directly or indirectly benefit, or are intended to benefit, the Alexander Archipelago wolf in Southeast Alaska and coastal B.C. We did not evaluate the efficacy of these mechanisms, but instead briefly review their intended purpose and any pertinent limitations to them.

3.6.1 Southeast Alaska

Land Management

National Forest Land

The Tongass Forest Plan (USDA 2016, entire) incorporates several conservation mechanisms for old-growth forest and wildlife habitat in its delineation of lands unsuitable for timber harvest. Appendix A of the Forest Plan explains the considerations for suitability, which include legal or technical reasons, or the desired conditions of the land use designation (LUD). Designated areas where timber harvest is prohibited include Wilderness, National Monuments, LUD II areas, Tongass Timber Reform Act stream buffers, Research Natural Areas, Municipal Watersheds, Experimental Forests, and Inventoried Roadless Areas. The 2001 Roadless Rule, which directs protections of Inventoried Roadless Areas, is discussed in *Chapter 3.1.1 Overview of Timber Management and Practices* and *Chapter 5.2.2 Future Resiliency Methods, Timber Harvest*.

The desired conditions and objectives for different LUDs also determine the suitability for timber harvest. Forest-wide and LUD-specific standards and guidelines specify resource protections and restrictions on timber harvest. Several conservation considerations were factored into the Forest Plan, including the Tongass Conservation Strategy, and the Tongass 77 (T77) Watersheds and The Nature Conservancy (TNC) / Audubon conservation priority areas, which are described below.

Tongass Conservation Strategy - The Tongass Conservation Strategy was designed during development of the 1997 Forest Plan and helped shape standards and guidelines that are part of the 2016 Forest Plan. Some of these standards and guidelines include conservation of Riparian Management Areas (USDA 2016b, p. 4-48–4-52, 5-6–5-7, and Appendix D) and Beach and Estuary Fringe (USDA 2016b, p. 4-4–4-5 and 5-5–5-6), and others are more generally applicable to habitat and species conservation needs including those for Alexander Archipelago wolves, Sitka black-tailed deer, and other wolf prey species (USDA 2016b, p. 4-85–4-94). The Tongass Conservation Strategy was also key to the development of the Old-Growth Habitat LUD (USDA 2016b, p. 3-63). Specifically, the Conservation Strategy creates a forest-wide reserve network and connective corridors of intact old-growth habitat, and it specifies how old-growth habitat should be managed to protect its integrity.

T77 Watersheds and The Nature Conservancy (TNC) / Audubon conservation priority areas - Tongass 77 (T77) Watersheds and The Nature Conservancy (TNC) / Audubon conservation priority areas are also conservation considerations of the 2016 Forest Plan. The T77 Watersheds are value comparison units that Trout Unlimited, Alaska Program identifies as priority salmon watersheds. The TNC / Audubon conservation priority areas are watersheds with the highest concentrations of ecological values with global importance for conservation (Smith 2016, pp. 211–214). In the T77 and TNC / Audubon conservation priority areas, young-growth timber harvest is allowed, but old-growth timber harvest is not (USDA 2016b, Appendix A and Appendix B).

Southeast Alaska Sustainability Strategy - The Southeast Alaska Sustainability strategy was issued by the Secretary of Agriculture in 2021, and it reduces the amount of old-growth timber that can be sold across the forest by ending large-scale old-growth timber sales and focusing resources to support restoration, recreation, and resilience. The sustainability strategy is further discussed in *Chapter 3.1.1 Overview of Timber Management and Practices* and *Chapter 5.2.2 Future Resiliency Methods, Timber Harvest*.

Tongass Timber Reform Act – The Tongass Timber Reform Act amended the Alaska National Interest Lands Conservation Act (ANILCA) to protect certain lands in the Tongass. The Act prohibits timber harvest within 30.5m (100ft) of anadromous fish streams, and resident fish streams that flow directly into anadromous fish streams. Stream buffers function as corridors for wildlife and can facilitate movement between areas of habitat (USDA 2016c, p. 3-198).

National Park Service Land

The National Park Service manages approximately 15 percent of the land within the range of the Alexander Archipelago Wolf in Southeast Alaska (see Table 6 in *Chapter 3.1.1 Overview of Timber Management and Practices*). The mission of the National Park Service is "to preserve unimpaired the natural and cultural resources of the park for the enjoyment, education, and inspiration of this and future generations" (https://www.nps.gov/aboutus/index.htm). While hunting on National Park Service land is permitted in National Preserves and for subsistence uses (16 U.S.C. § 410hh-2), timber harvest is not.

Lands Managed by the State of Alaska

Alaska Forest Resources and Practices Act – The Alaska Forest Resources and Practices Act (Alaska Statute 41.17) governs timber harvest activities on state, private, and municipal land. It specifies protections for natural resources while providing for a healthy timber industry (see *Chapter 3.1.1 Overview of Timber Management and Practices* and *Chapter 5.2.2 Timber Harvest*).

Wildlife Management

Maintaining sustainable populations is a shared policy for both State and Federal wildlife managers. Wolf harvest regulations for resident and non-resident hunters and trappers are set by the Alaska Board of Game and implemented by ADFG. ADFG manages wolf populations according to the State's constitutional mandate that all wildlife and other replenishable resources be maintained on the sustained yield principle (Alaska Const. art. VIII, § 4). ADFG prepares wolf management reports and plans by species and GMU, and the plans detail the department's goals and objectives for maintaining sustainable harvest and viewing opportunities of wolves.

Wolf harvest regulations for federally-qualified subsistence users are set by the Federal Subsistence Board. While the FWS Office of Subsistence Management is the lead administrative office for the Federal Subsistence Program, the federal subsistence harvest regulations are implemented by the USFS on National Forest land. ANILCA establishes a subsistence priority for the taking of fish and wildlife on federal lands. In accordance with ANILCA, it is the policy of the USFS to provide a meaningful subsistence priority and to cooperate with the State of Alaska, adjacent landowners, and land managers in managing subsistence activities and in maintaining the continued sustainability of all wild renewable resources on National Forest lands (USFS 2016b, p. 4–65).

Alaska Wildlife Troopers enforce state laws, and USFS Law Enforcement Officers enforce federal laws. The large area and extensive road system on POW Island make law enforcement difficult. Enhanced patrols of Alaska Wildlife Troopers and coordination with USFS Law Enforcement Officers have been helpful for enforcing wolf hunting and trapping laws (Hasbrouck 2022, p. 12).

For more information, see *Chapter 3.2 Wolf Harvest*.

3.6.2 Coastal B.C.

Land Management

<u>*Forest and Range Practices Act*</u> - The Forest and Range Practices Act and its regulations govern the activities of forest and range licensees in B.C. (see *Chapter 3.1.1 Overview of Timber Management and Practices* and *Chapter 5.2.2 Timber Harvest*). The statutes set the requirements for planning, road building, logging, reforestation, and grazing. The Act does not include provisions specifically for Alexander Archipelago wolves.

<u>*Regional Land Use and Management Plans*</u> - We found over 20 regional- and watershed-based land use and management plans active within the range of the Alexander Archipelago wolf (e.g., Central Coast Land and Resource Management Plan; Vancouver Island Land Use Plan). These land use plans are developed with public and stakeholder input and are considered in decisions pertaining to timber harvest. These plans can be found at https://www2.gov.bc.ca/gov/content/industry/crown-land-water/land-use-planning.

Wildlife Management

<u>*Wildlife Act of B.C.*</u> - The Wildlife Act of B.C. is the legislative foundation for the interaction of people and wildlife in B.C. This Act authorizes the government to declare a species as threatened or endangered. Wildlife is defined as all native and some non-native amphibians, birds, and mammals that live in B.C.; the gray wolf (which includes the Alexander Archipelago wolf) is included under this Act where it is classified as "big game." It was amended with the

Environmental Amendment Act in 2008, authorizing management of alien species and increasing fines for wildlife violations, among other minor changes.

Convention on International Trade in Endangered Species - The gray wolf is listed as a furbearer and protected under the Convention on International Trade in Endangered Species. Therefore, a permit is required before exporting wolf pelts across international boundaries. For a permit to be issued authorities must determine that such export will not be detrimental to the survival of the species and that specimens to be exported have not been obtained by violation of the laws for their protection.

CHAPTER 4 – POPULATION AND SPECIES NEEDS AND CURRENT CONDITION

In this chapter, we describe the current condition of the Alexander Archipelago wolf in terms of the 3Rs. For purposes of this SSA, we defined "current" as the next six years, which is the average lifespan of an Alexander Archipelago wolf (Service 2022, p. 1). We describe current condition by evaluating the existing state of habitat and demographic factors that we identified as Alexander Archipelago wolf needs in *Chapter 2 Species Biology and Individual Needs*. In *Chapter 3 Factors Influencing Viability*, we summarized our evaluation of potential stressors and conservation efforts that influence the condition for each population.

We begin our evaluation of current condition with an overview of the available information on Alexander Archipelago wolf abundance within each of the Analysis Units. We then describe the methodology used to assess resiliency across the range of the wolf.

4.1 Population Abundance and Distribution

Estimating wolf abundance and densities in the temperate rainforests of Southeast Alaska and B.C. is challenging. Researchers have attempted to generate population estimates using direct methods such as radio-collaring wolves (Person 2001, pp. 33, 55–70; Roffler et al. 2016 and 2019, entire), non-invasive methods such as genetic analysis of hair samples (ADFG 2014, entire; Roffler et al. 2016 and 2019, entire), and habitat- or prey-based methods (BCMF 2014, pp. 5–6). Wolf abundance is generally limited by prey availability, except where populations are expanding, recovering, or reintroduced (Fuller et al. 2003, pp. 164, 171, 189; Kuzyk and Hatter 2014, p. 878). However, there is some nuance to this relationship, and maximum densities may be limited by intraspecific competition as well as prey abundance (Peterson et al. 1998, pp. 831–832; Cubaynes et al. 2014, pp. 1350–1353).

In the following narratives, we describe the available information for estimating abundance and distribution of Alexander Archipelago wolves within each of the five Analysis Units in Southeast Alaska and coastal B.C. (information from the Northern and Southern Coastal B.C. Analysis Units are summarized together.)

4.1.1 POW Complex Analysis Unit

In Southeast Alaska, the only field-derived, empirical population estimates for wolves exist for POW Island and the surrounding islands (i.e., GMU 2). Person and Ingle (1995, p. 11) tracked Very High Frequency (VHF) radio-collared wolves regularly on POW Island to estimate number of packs, pack size and home range size. As part of the same study and using similar methods, in fall 2003, the wolf population in nearly all of POW Complex was estimated as 326 wolves (SE is equal to 75; ADFG 2009, p. 32).

Because of the expense and effort required to maintain a sufficient sample of radio-collared wolves on the POW Complex, population estimates were not repeated in subsequent years until 2013. From 2013 through 2020, ADFG used DNA from hair snares to identify individual wolves on POW Complex using the methods described in Roffler et al. (2016, pp. 3–14; 2019, pp. 33–35), and employed a spatially explicit capture-recapture (SECR) framework to annually estimate fall wolf density and predict wolf population abundance. A comparison of this noninvasive method to the estimation method used in the 1990s showed the noninvasive method to be more reliable and efficient, and population estimates had higher precision (Roffler et al. 2016, pp. 37–38; Roffler et al. 2019, p. 38). The radio-collar method was also found to be less robust to violations of model assumptions (ADFG 2022a, p. 5).

Following a pilot year in 2012, the wolf population in the POW Complex (9,069 square kilometers (3,502 square miles)) was estimated using genetic capture-recapture methods from a sample on a portion of POW Island. To better understand the spatial variability of wolf population dynamics, the study area was expanded during the fall of 2014 and again during the fall of 2016. The area of non-invasive DNA-based sampling currently encompasses 6,843 square kilometers (2,642 square miles) (representing approximately 60 percent of the POW Complex) (Schumacher 2022, pers. comm).

Based on the results of the genetic capture-recapture study on POW Island, Roffler et al. (2016, p. 38) concluded there was a decline in wolf population abundance on the northcentral portion of POW Island from 1995–2015. This apparent decline could be due to a variety of factors, such as increased wolf harvest (reported and unreported), reduced reproduction, changes in prey vulnerability, increased disease rates, or a combination of these. Between 2012 and 2018, researchers captured and radio-collared 12 wolves on POW Island. Subsequent to collaring, ten of these wolves died as a result of human activities and two died from natural causes; five wolves were harvested and sealed, four were categorized as unreported harvest, and one was categorized as wounding loss (ADFG 2022b, p. 11). Assuming that the five wolves that were categorized as unreported harvest and wounding loss were in fact harvested and not reported, and that harvest rates were equal across years, these data suggest that unreported harvest is similar (5 of 10; 50 percent) to data collected in the 1990s and 2000s by Person and Russell (2008, entire), although the sample size was small (n is equal to 10) (See *Chapter 3.2.3 Unreported Harvest* (*and Other Human-Caused Mortality*) for additional information).

Another potential factor that could contribute to a decline in the wolf population is a decrease in prey abundance. Wolf abundance is believed to be largely limited by the availability of vulnerable ungulate prey (Fuller and Murray, 1998, pp. 155–156; Fuller et al. 2003, entire), and therefore, a decline in black-tailed deer could affect wolf abundance. Because availability of vulnerable ungulate prey is difficult to measure, an ungulate biomass index may be used as a proxy (Fuller et al. 2003, p. 171). Roffler et al. (2016, entire) compared wolf population estimates from methods implemented in this study and wolf abundance predicted by ungulate biomass regression models. The 2013 fall wolf population estimate from the study ($\hat{N}$ is equal to 221.1, plus or minus 61.4 wolves (95 percent confidence interval (CI) is equal to 130.0–378.1)) was comparable to the 2015 ungulate biomass regression model prediction ($\hat{N}$ is equal to 239) suggesting that wolf populations are responding to availability of ungulate biomass. However, the 2014 wolf population estimate was substantially lower (89 plus or minus 27.1 (95 percent CI of 49.8–159.4) wolves), suggesting some other factor may be more influential to wolf abundance. TEK also indicated that 89 wolves was a low number, and that the estimates in 2019 and 2020 were more in line with their expectation regarding wolf numbers on POW Complex (Brooks et al. 2022, p. 77). The following table (Table 17) (ADFG 2022b, p. 2) shows fall (September-October) Alexander Archipelago wolf population estimates during 2013–2020 for POW Complex.

Table 17 Fall wolf population estimates and 95 percent confidence intervals (CIs) during 2013–2020 for the POW Complex Analysis Unit (GMU 2).

Year	Population Estimate	95 percent CIs
2013	221	130–378
2014	89	50–159
2015	108	69–167
2016	231	192–285
2017	225	198–264
2018	187	147–236
2019	316	250–398
2020	386	321–472

Although ADFG's POW Complex wolf population estimates have been consistent with the DNA samples collected, analysis of data from 2019 and 2020 suggests that earlier estimates (e.g., the 2018 estimate of 187 wolves) may have been biased low. Along with incremental improvements in capturing DNA from hair samples, 2019 and 2020 were the first years for which ADFG had access to DNA from relatively large numbers of wolves harvested within the study area during the October-December study period. The DNA collected at sealing contributed to larger datasets for the 2019 and 2020 population estimates and, in part, may be responsible for higher estimates in those years. Fewer samples from harvested wolves available for earlier estimates may have biased those estimates low (ADFG 2022a, p. 6). TEK indicated that the study failed to estimate an adequate number of wolves during the early years due to placement of hair traps near roads and wolf avoidance of traps (Brooks et al. 2022, p. 76). It is possible that a portion of the population harvested on POW Complex was not adequately sampled at hair boards and therefore was not included in the estimate, which would bias the estimate low. A harvest of the magnitude reported in 2019 (154 wolves) might be expected to result in a decrease in population size, yet only a minimal decrease in the estimated number of individually identified wolves occurred in 2020. (See also *Chapter 3.2.2 Reported Wolf Harvest*.) The estimated wolf population range in 2019 was 250–398 wolves, and despite the high harvest in 2019, the population estimate was higher (321–472 wolves) in 2020 (ADFG 2022a, p. 6).

TEK indicates that wolf populations on POW Island are likely between 300–400 (Brooks et al. 2022, p. 78), which is consistent with recent estimates from ADFG, and corresponds to estimates based on models of prey availability (i.e., 179–493; Suring et al. 1993, entire). One Indigenous expert reported that there is generally one wolf pack per island, and the largest pack he has seen was 12 wolves on Noyes Island (Brooks et al. 2022, pp. 73–74). TEK also suggests that wolf populations in the POW Complex are healthy, but that deer populations are declining (Brooks et al. 2022, pp. 67–68, 85). One Indigenous expert stated that deer numbers will continue to decrease if the wolf population is not maintained at 100–150 individuals. This source also indicated that stem exclusion from historical timber harvest is contributing to deer declines (Brooks et al. 2022, pp. 67–68). In the most recent (2011–2016) Deer Management Report for GMU 2, ADFG (2020, p. 5) concluded that despite abundant deer populations, historically high deer harvests, and liberal seasons and bag limits, there are continued concerns from subsistence users about the inability to meet their subsistence needs. One concern is increased deer hunting pressure (ADFG 2020, p. 5; Brooks et al. 2022, pp. 84–85). Additionally, ADFG suggests that as clearcuts advance past seral stages, deer are less visible and sightability leads to a misperception that there are fewer deer available on the landscape (ADFG 2020, p. 5).

4.1.2 Northern Southeast Alaska Analysis Unit

Little fine-scale information is available for Northern Southeast Alaska wolf populations. This Analysis Unit is composed of three GMUs: 1C, 1D, and 5. ADFG has opportunistically logged information on wolf distributions in GMU 1C, and no formal studies of wolf populations have been conducted in GMU 1D or 5. TEK collected recently (Brooks et al. 2022, pp. 21–31) also provides insight into wolf abundance and pack sizes within this Analysis Unit.

In GMU 1C, anecdotal evidence suggests that though wolves appear to be distributed widely, they primarily concentrate within major mainland river drainages such as the Taku River and Berners Bay, which support moose populations. Exceptions include the Chilkat Range and the Gustavus Forelands, where wolves may be more uniformly distributed, probably due to the presence of moose throughout those areas. Several wolves were collared in Gustavus since 2017, indicating that wolves use the Gustavus Forelands, eastern Glacier Bay, and the southern portion of the Chilkat Peninsula (ADFG 2021b, pp. 2–3). From 2015–2020, ADFG received reports of packs in the Gustavus Forelands, Endicott River, St. James Bay, Point Couverden, Berners Bay, Nugget Creek, Taku River, Snettisham Inlet, and Endicott Arm areas. An Indigenous expert from the Excursion Inlet area has noted two packs, one which is composed of 12 to 13 wolves and travels between the Haines area and down the Chilkat Peninsula, and another which is larger (more than 40 individuals) and travels across the bay from Haines and around Glacier Bay National Park (Brooks et al. 2022, p. 52).

Wolves were absent from Douglas Island adjacent to Juneau for several decades but recolonized the island during the late 1990s. Anecdotal information indicates that wolves recolonized Douglas Island by 2012, and wolves were photo documented in 2014. During 2015, several people reported seeing or hearing wolves, and ADFG estimates that 5–7 wolves have inhabited Douglas Island since 2014. Pleasant Island near Gustavus also has a small pack of 3–4 wolves. The first wolf was harvested on Pleasant Island in 2015, and a small pack still inhabits the island. TEK indicates that wolves have been depleting the deer population on Pleasant Island for the last 25 years, which has caused deer hunters to stop harvesting on the island (Brooks et al. 2022, pp. 53–54). Analysis of wolf scat indicates that the wolves on the island are also utilizing marine food resources for their survival (ADFG 2021b, p. 9).

No formal studies of wolf populations have been conducted in GMU 1D. Most information about wolf abundance and distribution in GMU 1D has come from fur sealing records, anecdotal reports, and observations recorded during aerial surveys for moose and mountain goats. Wolf distribution is likely influenced by the distribution of moose, which occur in highest abundance in the Chilkat and Katzehin river valleys (Koch 2017, p. 6). Wolves were observed during four separate ADFG moose surveys from 2010–2015. One wolf was counted during each of three moose surveys (1 December 2010, 7 December 2012, and 16 March 2015) in the Chilkat Valley. Two wolves were counted on 7 January 2011 during the only moose survey of the Katzehin River Valley conducted during this report period (ADFG 2018c, pp. 3–4).

Similarly, there has not been an ADFG scientific study of wolves in GMU 5. Wolf harvest data, along with anecdotal information, suggest that wolf numbers and distribution have been consistent for the last 3 decades. Wolf numbers may fluctuate with increasing and decreasing moose numbers; however, wolves probably subsisted mostly on mountain goats and salmon before the arrival of moose in the area (circa 1920s and 1930s). Salmon are considered a seasonally important component of wolf diet, especially as a late summer and early fall food source. The abundance and availability of salmon may sustain wolves in GMU 5 during declines in moose numbers (ADFG 2021b, p. 2; Brooks et al. 2022, p. 31).

Indigenous experts indicate that although wolves were present in the 1950s, they were not present across the Yakutat region in GMU 5. One expert stated that at that time, wolves were only found in the Ahrnklen mountains when her grandfather trapped there in the winter. In later years, wolves were documented moving down from the mountains to the beaches around Yakutat in the winter (Brooks et al. 2022, pp. 21–22). Another Indigenous expert stated that moose were also not present in the area until the 1940s, when they were building the Alaska Highway (Brooks et al. 2022, p. 22). An Indigenous expert also suggested that wolves are currently abundant on the east side of the Dangerous River, where he has encountered a large pack of more than 25 wolves and frequently observes wolf sign. He has also encountered packs along the Ahrnklen, Situk, and Lost Rivers, as well as Tawah Creek, and knows of packs in Russell Fjord and around Chicago Harbor and Knight Island (Brooks et al. 2022, p. 24).

Evidence from discussions with local hunters and trappers, hunting guides, pilots, and local ADFG personnel suggests that wolves remain common throughout GMU 5. ADFG personnel routinely see wolves during aerial moose surveys in both GMUs 5A and 5B. In conversations with ADFG biologists, trappers indicated that wolf numbers were high during the 2015–2020 report period with a large pack near Yakutat (ADFG 2021b, p.4).

4.1.3 Southern Southeast Alaska Analysis Unit

Across all GMUs in the Southern Southeast Alaska Analysis Unit (GMUs 1A, 1B, and 3), little research on wolf populations has been conducted, and while habitat conditions can be used to estimate carrying capacity, there is little robust data available that can be used to estimate population abundance.

Wolf abundance was monitored on Gravina Island in GMU 1A using trail cameras from 2016 through 2018. However, no wolves were detected on cameras during this time period, and cameras were removed. Wolves likely dispersed from Gravina; some may have been trapped or may have died from other causes. In 2019, a single wolf was detected on a Ketchikan resident's trail camera (ADFG 2021c, p. 4).

In GMUs 1B and 3, sealing records provide insufficient data to make a meaningful estimate of the wolf population. Current estimates of carrying capacity for these units are based on average territory and pack size from wolf research on POW Island (Person et al. 1996, entire). Because much of GMU 1B consists of high-elevation rock and ice, ADFG has conservatively estimated wolf carrying capacity in the unit based on the amount of habitat below 457 meters (1,500 feet) in elevation. With approximately 2,450 square kilometers (946 square miles) of habitat in elevations below 457 meters (1,500 feet), ADFG has estimated GMU 1B wolf carrying capacity to be approximately 85 wolves (range from 45 to 125) in 8 packs. It is estimated that GMU 3 can support approximately 250 wolves (range 125–385) in 23 packs. On Kupreanof and Kuiu Islands in GMU 3, Indigenous experts estimate that approximately 10–12 wolf packs are present and that wolves are abundant on the Lindenberg Peninsula on Kupreanof Island, where Petersburg hunters often hunt moose (Brooks et al. 2022, pp. 40–41). Pack sizes have been estimated to be approximately 15 wolves in this region (Brooks et al. 2022, p. 43).

Conversations with trappers, hunters, pilots, and other biologists, along with information from trapper questionnaires, indicate that wolf populations in these units increased during the 1990s in response to increases in deer and moose numbers. No wolf research has been conducted in GMU 1B and very little research has occurred in GMU 3; therefore, there is little to no information on the ecology, abundance, and population demographics of wolves in these GMUs. In response to mail-out questionnaires distributed by ADFG, individual trappers provided subjective assessments of wolf abundance in GMU 3. From 2010 to 2013 trappers characterized wolves as either "abundant" or "common" in the GMU (ADFG 2017, pp 4–5; ADFG 2018a, pp 5–6).

4.1.4 Northern and Southern Coastal B.C. Analysis Units

Wolf density varies greatly across B.C. and likely fluctuates with prey density (BCMF 2014, p. 10; Kuzyk and Hatter 2014, p. 882). In B.C. (as in many other populations globally), wolves have high reproductive rates and dispersal capacity; therefore, conservation concern for wolves has been low and relatively few wolf inventories have been done across B.C. (Mowat et al. 2022, p. 1). Inventories have rarely been repeated annually in the same place, but repeated inventories have been conducted where predation concerns have been ephemeral in space or time (Serrouya et al. 2017, entire; Bridger 2019, entire).

Harvest data from both trappers and hunters roughly document the increase in wolf numbers in southern B.C. during the 1990s and 2000s, although trapper kill data are less variable year to year than the hunter data. (It is important to note that this data includes both coastal and interior wolves in B.C., as the two subspecies were not separated out in the referenced Technical Report). The hunter and trapper harvest data suggest that a two- to three-fold increase in harvest indicates an increase in population abundance. Unlike overall harvest, hunter effort and success showed weak trends that were not correlated with the known changes in abundance in any part of the province (Mowat et al. 2022, pp. 14–15). Data from areas where wolves were eliminated demonstrate that a transition from no harvest to a measurable and somewhat consistent harvest suggests population recovery. Wolf harvest increased between 1978 and 2005 in the northern half of the province, suggesting wolves in northern B.C. may have been recovering from reduced numbers (Mowat et al. 2022, p. 14). A population increase beginning after 1987 seems likely, as wolf removals were conducted across Region 6 (which includes the Northern Coastal B.C. Analysis Unit) between 1982 and 1987 and across larger scales before that (Bergerud and Elliot, 1998, p. 1562).

While hunting and trapping kill data appear to document general trends, the precision of both data sets is low, and we suspect trends will often be obscured by among-year variation in the reported kill. This problem will be greater for regions or areas with fewer harvested wolves (Mowat et al. 2022, p. 15). BCMF is currently utilizing data collected through their voluntary B.C. Hunter Survey for the period 1976–2018 to estimate wolf harvest, hunter success (kills per hunter), and catch per unit effort (CPUE, or hunter days per kill) as possible predictors of wolf population trends.

4.2 Current Population Resiliency

As summarized in *Chapter 2.5 Resource Needs and Habitat*, we identified prey availability, denning habitat, and remoteness (space from human activity) as primary habitat needs for the Alexander Archipelago wolf. For demographic needs, we identified dispersal, reproduction, and survival as drivers of wolf abundance and ultimately, resiliency (See *Chapter 2.4 Life History*) (Figure 14).

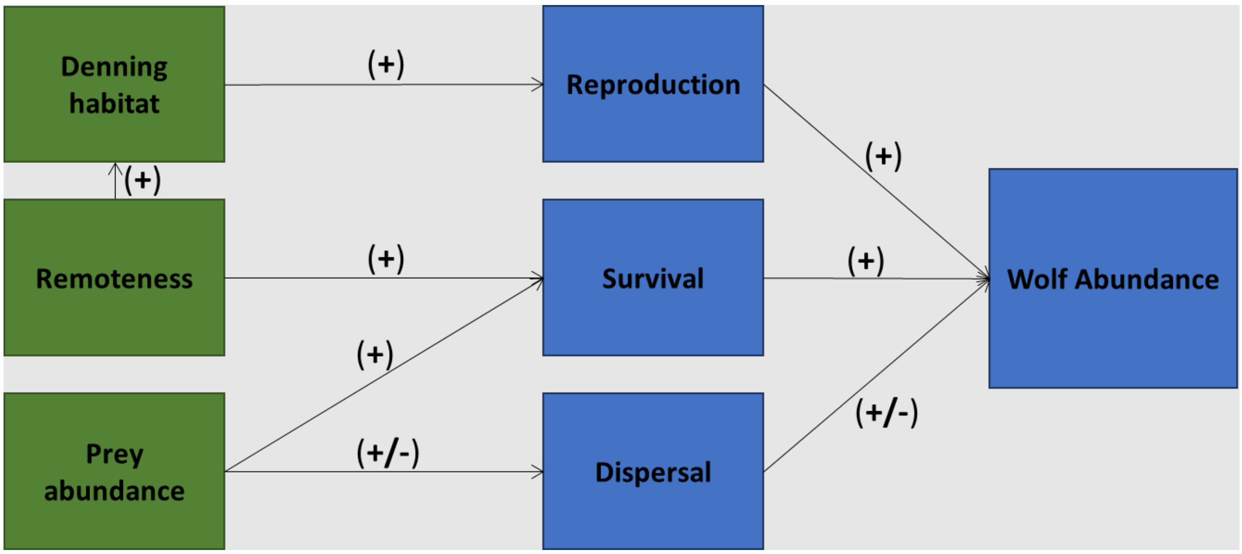


Figure 14 Conceptual model of the basic habitat and demographic needs of Alexander Archipelago wolves and how they influence population abundance and resiliency.

As described in *Chapter 4.1 Population Abundance and Distribution*, we do not have empirical abundance estimates for most of the Analysis Units. Therefore, to analyze current resiliency, we selected a subset of habitat and demographic factors that are influential to abundance and that we could measure relatively consistently across all five Analysis Units. Since we do not have recent empirical population estimates or other demographic data to provide a "snapshot in time" of the wolf's current status, we determined that the lifespan of a wolf was an appropriate short-term timeframe to evaluate population trend (as described in more detail below). The factors we used to assess current resiliency were:

1. **Population trend**, as measured by:
    - Alexander Archipelago wolf maximum population size estimates (derived from ungulate habitat capability and biomass models),
    - intrinsic rate of growth (from Montana gray wolf data),
    - wolf harvest estimates (reported and unreported) and estimates of harvest effect (compensatory vs. additive, from Montana gray wolf data), and
    - an estimate of inbreeding for populations with evidence that inbreeding is occurring.

This information contributed to a population growth model (Figure 15). Four of the Analysis Units lacked a time series of population estimates, from which we could estimate the intrinsic rate of growth and the effect of wolf harvest. POW Complex was the only Analysis Unit for which we had a time series of population estimates. However, POW Complex is likely not representative of other Analysis Units, and as described above there is much uncertainty associated with population estimates from POW Complex. Therefore, we used proxy data from Montana gray wolf populations because this data set allowed for the estimation of intrinsic rate of growth and wolf harvest effect over a long-time series (1995–2021).

Because the population growth model incorporated numerous drivers of resiliency (prey biomass and habitat, reproduction, mortality, dispersal, and abundance), it was the primary tool used to inform our assessment of population resiliency.

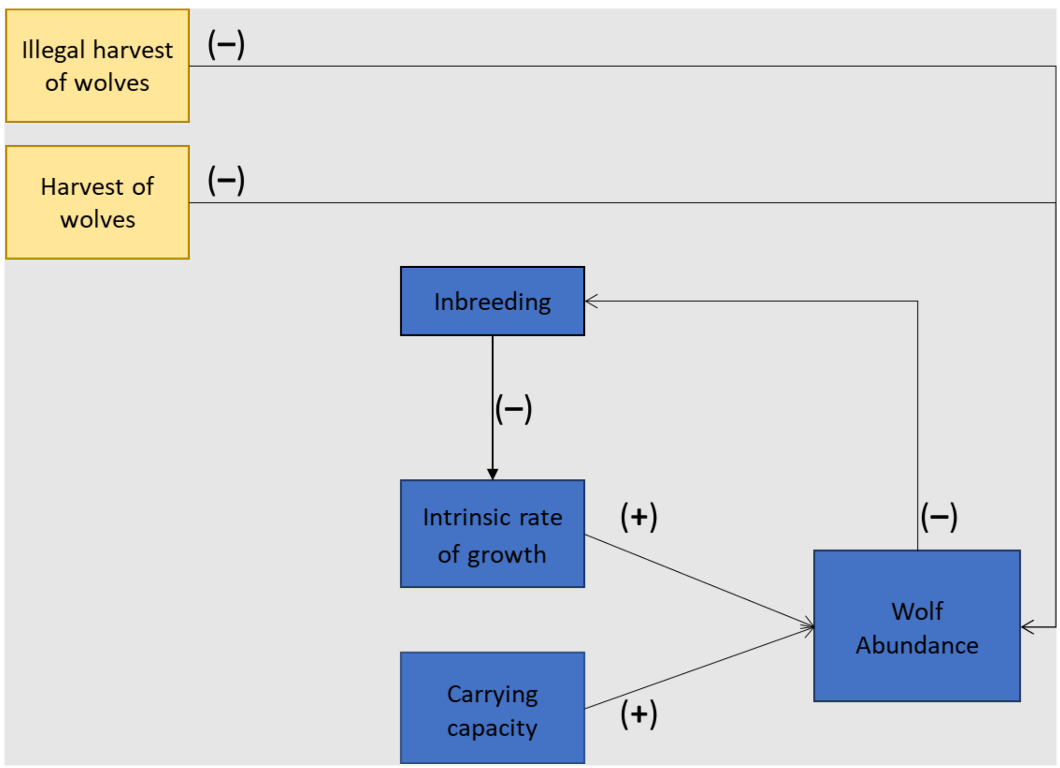


Figure 15 Diagram of the model used to assess population trend for Alexander Archipelago wolf Analysis Units. A (+) sign indicates a direct or positive correlation and a (-) sign indicates an inverse or negative correlation.

The following three habitat factors were also evaluated in more depth because we have recent data for each of them to help inform our understanding of resiliency.

1. **Prey**, as measured by the diversity of prey species that make up the Alexander Archipelago wolf's diet within each Analysis Unit.
2. **Preferred habitat type of primary prey (deer) and denning wolves**, as measured by productive old-growth forest, using spatial analyses to measure the total amount of this cover type available in sufficient patches within each Analysis Unit.
3. **Remoteness,** evaluated using two metrics: marine boat accessibility and road accessibility. Marine boat accessibility was calculated using spatial analyses to identify the ratio of shoreline to land area for each Analysis Unit, and road accessibility was measured using spatial analyses to identify the mean road density within each Analysis Unit.

As we considered the condition of each habitat and demographic factor, we used metrics that were available consistently for all Analysis Units, including compiled information from peer-reviewed literature, surveys and reports, and input from scientific experts. For most of the factors, data for other metrics exist (e.g., ungulate biomass or density to measure prey availability); however, we did not have accurate estimates of those metrics for all Analysis Units and therefore did not use these metrics to evaluate condition. Throughout our evaluation, we considered the life history and ecology of Alexander Archipelago wolves in Alaska and B.C., as summarized in *Chapter 2 Species Biology and Individual Needs*, data on current distribution and trends, as summarized in *Chapter 2 Species Biology and Individual Needs* and *Chapter 4.1 Population Abundance and Distribution*, and our cause-and-effect analysis of threats, as summarized in *Chapter 3 Factors Influencing Viability*. The following sections describe the methods used to evaluate the current condition of each demographic and habitat factor (population trend; prey, as indicated by dietary diversity; availability of preferred habitat, as indicated by old-growth forest; and remoteness (space from human activity)) within each Analysis Unit. For additional background on each factor, refer to *Chapter 2.5 Resource Needs and Habitat* and *Chapter 4.1 Population Abundance and Distribution*.

4.2.1 Population Trend
We developed one population model for all five of the Analysis Units (Model A), to assess population trend using estimates of maximum potential population size, intrinsic rate of growth (from Montana gray wolf data), wolf harvest estimates (reported and unreported), and an estimate of inbreeding (only for Southeast Alaska Analysis Units, where inbreeding has been documented). We also updated a population model developed by Gilbert et al. (2022) for the POW Complex only (Model B). The original Gilbert et al. (2015) population model was used for the previous version of this SSA (Service 2015, entire). The following sections outline the methods that were used to develop Model A and update Model B.

Model A (All Analysis Units)

<u>Estimates of Maximum Potential Population Size Using prey-based Estimates</u>
We are aware of only one effort to estimate the maximum potential population size of the Alexander Archipelago wolf population as a whole in Southeast Alaska. Using a model linking

wolf abundance to habitat capability for black-tailed deer and other prey (moose, mountain goat [*Oreamnos americanus*]), Suring et al. (1993, entire) estimated that wolves in GMU 2 represent about 37 percent of the total wolf population in Southeast Alaska, followed by GMU 1 (33 percent), GMU 3 (28 percent), and GMU 5A (2 percent) (Person et al. 1996, p. 13). Based on the GMU 2 proportion estimate and their own empirically derived estimates of wolf population size on GMU 2, Person et al. (1996, p. 12) estimated the fall 1994 population in Southeast Alaska to be 908 individuals (SE is equal to 216).

Using the Alexander Archipelago wolf population estimate of 908 wolves for Southeast Alaska, we further estimated the maximum population sizes of GMUs 1A, 1B, 2, and 3 based on the aforementioned allocations from Suring et al. (1993) and applied the overall coefficient of variation to individual estimates to calculate variance (Table 18). We urge caution in interpreting these numbers as absolute because they are based on outdated habitat capability of prey and do not take other factors into account (e.g., wolf density, territoriality; Cubaynes et al. 2014, entire).

Because wolves in the Northern Southeast Alaska Analysis Unit (GMUs 1C, 1D, and 5) rely significantly more on moose for prey than black-tailed deer, as discussed in *2.5.1 Prey,* it was determined that using the Suring model (which assumed a much higher percentage of deer was available to wolves compared to moose) to derive population estimates for wolves in this Analysis Unit was not the best available method. In discussions with experts, we also learned that moose populations have expanded and colonized new areas within the Northern Southeast Alaska Analysis Unit since the early 1990s (including the Chilkat and Chilkoot valleys, the Taku River, and Glacier Bay) (Roffler 2022, pers. comm.). Therefore, we estimated the number of Alexander Archipelago wolf packs within this Analysis Unit using home range estimates for three packs of wolves (Berners Bay, Chilkat, and Gustavus; average home range size is equal to 540 square kilometers) (Roffler 2022, unpublished data). We then divided the total area of suitable wolf habitat in the Northern Southeast Alaska Analysis Unit (i.e., elevations less than 4000 feet and no ice; 20,984 square kilometers) by the average home range size to estimate the number of wolf home ranges in the Analysis Unit (20,984/540, or 39 home ranges). Based on empirical observations of 16 wolf packs in the area provided by ADFG, we estimated mean pack size as 7.1 wolves (95 percent CI 5.6–8.6). Using this information, we calculated the maximum population size for Northern Southeast Alaska as 277 wolves (95 percent CI 220–336; Table 18).

Table 18 Estimated maximum potential population size by Analysis Unit derived from habitat capability models of deer, moose, and mountain goat developed in the early 1990s in Southeast Alaska (Suring et al. 1993, as presented in Person et al. 1996, p. 13), as well as home range estimates and estimated pack sizes for the Northern Southeast Alaska Analysis Unit.

Analysis Unit	Percent of Southeast Alaska wolf population	Derived maximum population estimate	Range of Estimates	
			Lower	Upper
POW Island Complex[1]	30	336	179	493
Southern Southeast Alaska	45	509	272	746
Northern Southeast Alaska	25	277	220	336

[1]More recent field-derived estimate available; see Table 17

Kuzyk and Hatter (2014, entire) also used ungulate biomass to estimate the maximum potential population size of wolves in B.C. Regional ungulate population surveys were used to estimate biomass, which then was included in a regression model to predict wolf abundance for 2000, 2003, 2008, and 2011 (Kuzyk and Hatter 2014, p. 879). The most recent provincial maximum population size estimate was 8,688 wolves (95 percent CI is equal to 5,898–11,760), indicating a slight but consistent trend upward since 2000 when the estimate was 7,213 wolves (95 percent CI is equal to 4,977–9,696) (Kuzyk and Hatter 2014, p. 881). We used these estimates in our assessment after making adjustments to reflect the coastal population of wolves only (i.e., Alexander Archipelago wolves).

By multiplying regional wolf maximum population size estimates by the proportion of the region that fell within the range of the Alexander Archipelago wolf, we generated maximum population size estimates for coastal B.C. (Table 19). Using the wolf density approach (BCMF 2014, entire), we estimated that 691–1,688 Alexander Archipelago wolves could occupy coastal B.C. and, using results from Kuzyk and Hatter (2014, p. 881), we calculated a mean maximum population size of 875 Alexander Archipelago wolves (range is equal to 597–1,183). We suspect that the latter estimate may be biased slightly high because wolves on the coast primarily eat deer, which have a lower biomass value (0.75) compared to moose (biomass value is equal to 6), the primary prey item of wolves in interior B.C. (Darimont et al. 2004, p. 1871; Kuzyk and Hatter 2014, p. 880). However, moose are expanding their range into coastal B.C. (Darimont et al. 2005, p. 235) and have been detected in wolf scats found on the coastal mainland and nearby islands (Darimont et al. 2004, p. 1871). Nonetheless, we urge caution in interpreting these numbers as absolute values, but present them here as general estimates of the maximum population size of the Alexander Archipelago wolf population in coastal B.C.

Table 19 Estimated maximum potential population sizes of the Alexander Archipelago wolf by Analysis Unit based on estimates of wolf density (BCMF 2014, entire) and ungulate biomass (Kuzyk and Hatter 2014, p. 881) and adjusted by the proportion of the Analysis Unit in the coastal portion of B.C.

Analysis Unit	Proportion of Analysis Unit Along Coast	Ungulate Biomass Method			Wolf Density Method	
		Mean	Low	High	Low	High
Southern Coastal B.C.	0.92	430	301	574	212	646
Northern Coastal B.C.	0.20	444	297	609	479	1,042

Wolf Harvest Effects
Given the maximum potential population size estimates described in the preceding paragraphs, we estimated the potential effects of current harvest (including unreported harvest) on population trend for the five Analysis Units.

To parameterize the model, given a lack of population-level data for Alexander Archipelago wolves, we used gray wolf data from the northern Rocky Mountains as surrogate data to estimate the intrinsic rate of growth *r* and the effects of harvest (*h*) on wolf populations:

Equation 1: $N_{t+1}=r_{max}N_t(1-N_t/K)-h(m)$ (Verhulst 1838, entire; Ricker 1954, entire),

where N is the population size at each time step; r_{max} is the per capita intrinsic rate of growth (which captures reproduction – natural mortality + immigration – emigration) at a small population size; *K* is the estimated maximum population for a particular Analysis Unit; and *h* is an estimate of the additive effect of harvested animals (*m*).

Understanding Maximum Potential Population Size, Intrinsic Growth, and Harvest Effects
Figure 16 below provides a graphical depiction of the density-dependent growth model we used to project wolf population size (*Equation 1* above). For current condition, we project the population forward 6 years to capture one generation of wolves and the current stressors on the population. Below we describe the parameters in this model in further detail.

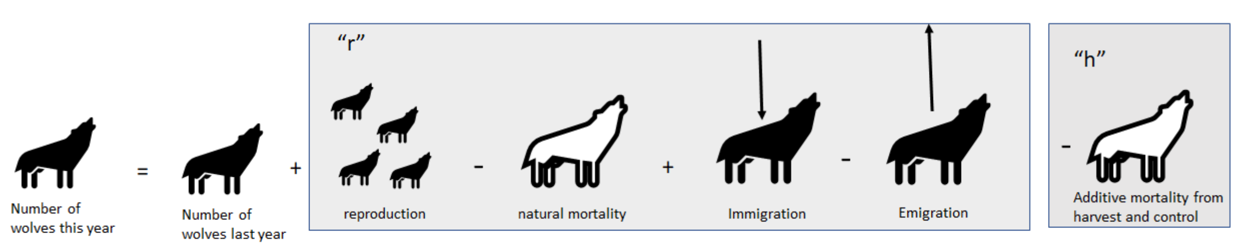


Figure 16 Schematic of density-dependent wolf population model

As described above, in the density-dependent growth model equation, r_{max} is the maximum per capita intrinsic rate of growth, which incorporates the effects of reproduction, natural mortality, immigration, and emigration (Figure 16). In density-dependent models, r_{max} is scaled by the term ($1–N_t/K$) which approaches zero as N_t increases and approaches one as N_t declines. In other words, the effective rate of growth approaches its maximum value when populations are small and approaches zero as populations reach their maximum size (K). In most population models, K is interpreted as a "carrying capacity", or the maximum number of animals an area can sustain due to factors such as prey density or habitat availability. Because wolf populations in the western United States are highly managed and influenced by human activities, here we chose to define K for Alexander Archipelago wolf as a maximum potential population size, likely limited by both environmental and societal factors.

Our density-dependent growth model also included a measure of the additive effect of wolf harvest (h) (Figure 16). In this density-dependent growth model, as the estimate of h approaches zero, harvest effects do not exceed losses that would have occurred through natural mortality and dispersal; in other words, as h approaches zero, any wolf killed by harvest or control measures would have died through natural causes in the absence of such human-caused mortality. As the estimate of h approaches one, harvest effects are completely additive and each wolf killed by harvest is subtracted from the population; in other words, as h approaches one, any wolf killed by harvest or control measures would not otherwise have died through natural causes.

Technical Details of Modeling to Estimate Parameters for Forecasting

We estimated r and h from population estimates and counts of animal removals (harvest and control) in Montana from 1999–2020. Models were run in a Bayesian framework using rjags (an interface between R and jags, Plummer 2021, R package) for 300,000 iterations with 100,000 burn-in, leaving 200,000 iterations to estimate the posterior distribution of the parameter estimates. Priors for h and r were diffuse (mean is equal to 0, precision is equal to 0.0001). Model priors for K were somewhat informative to assist with convergence and based on maximum observed values (i.e., priors for K were limited to be within a few hundred wolves below the maximum observed value to twice the maximum observed value). Posterior distributions were inspected visually to determine if priors were too restrictive (i.e., if values were highly skewed toward a limit of the prior distribution of K). $\hat{R}$ values were checked for values greater than 1.1 and trace plots were inspected for chain convergence.

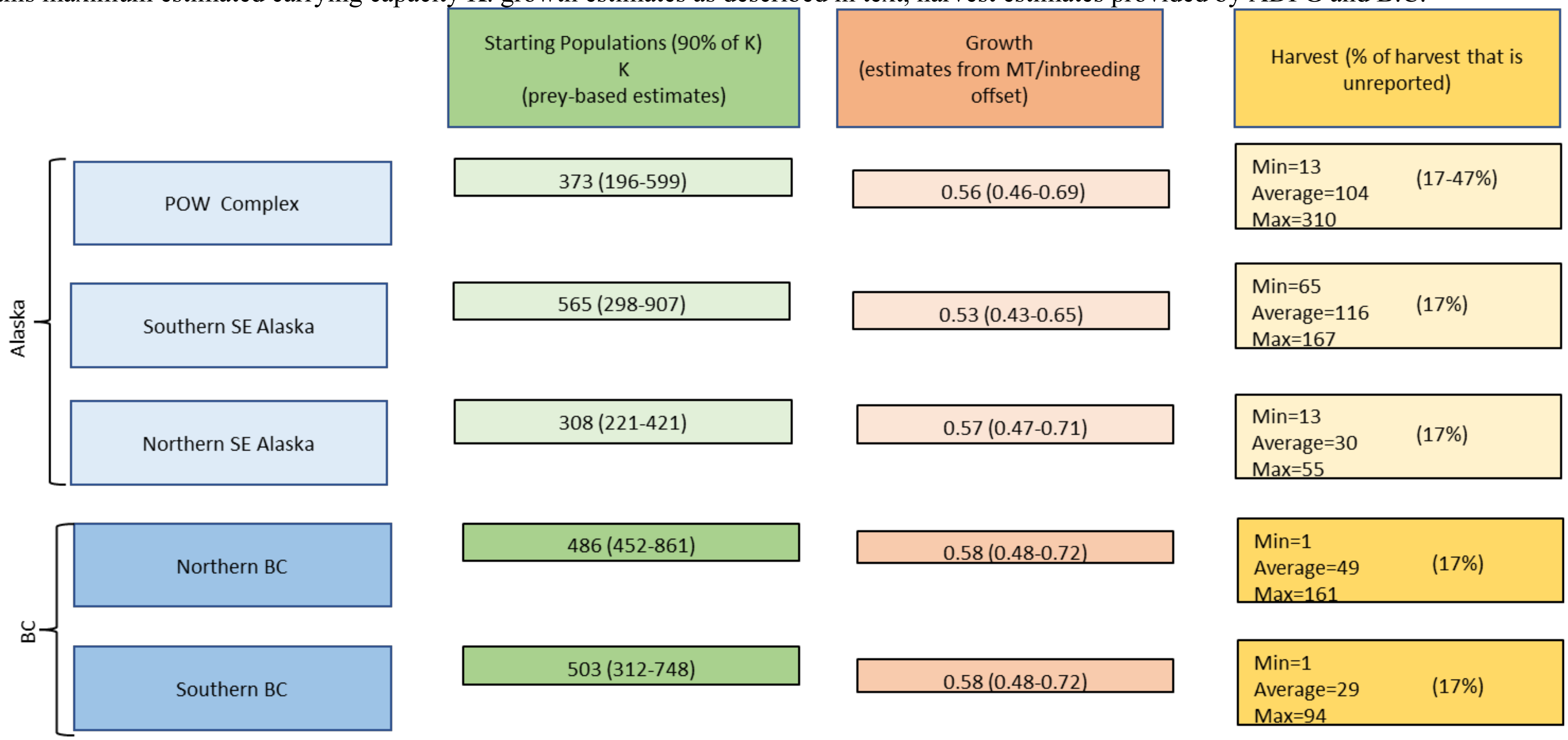
Assumptions Regarding Immigration, Emigration, Natural Mortality and Reproduction

Immigration, emigration, natural mortality, and reproduction are all processes that contribute to estimates of r. In density-dependent models, r is a function of population size (it increases at smaller population sizes and reaches zero as the population size approaches a maximum). However, we assume that the effects of wolf harvest (assessed by our estimates of h) are not density-dependent (i.e., whether harvest is compensatory or additive does not change with changes in populations size). Additionally, we assume no interaction between r and harvest rates (i.e., in our model, rates of immigration, emigration, natural mortality and reproduction do not increase or decrease with changes in harvest; they only change as population size changes). In addition, in our models we did not vary K. Uncertainty in all these parameters (h, r, and K) was included in the models through the use of a posterior distribution versus a single median or mean value for the parameter.

Estimating Current Population Trend

We used *Equation 1* to project the population forward one generation (6 years) and estimate the population size under current rates of wolf harvest. We ran 200,000 simulations to explore the effects of parameter uncertainty on wolf populations (Figure 17).

Figure 17 Schematic of current conditions assessment. Starting populations derived from Suring et al. 1993, as presented in Person et al. 1996, p. 13, for POW of Southern SE Alaska, Roffler, unpublished data for Northern SE Alaska, and from Kuzyk and Hatter 2014, p. 880, for British Columbia Population estimates were scaled by 1-1.5 to account for the potential that the estimates were low. We started the population at 0.90 * this maximum estimated carrying capacity K. growth estimates as described in text, harvest estimates provided by ADFG and B.C.



Maximum Population Size (K)

For Alexander Archipelago wolf populations, we used the estimates of maximum population size from Table 19 and Table 20 to provide a range of potential values of K. We started populations at 90 percent of K for each simulation in order to allow populations the potential to increase (otherwise all simulations would have indicated stable or declining populations). Due to a paucity of information from the Alexander Archipelago wolf populations, intrinsic rate of growth for these populations was estimated using data from the northern Rocky Mountains. We did not attempt to parse out the components of r (i.e., reproduction, natural mortality, immigration and emigration) due to a lack of information on these parameters.

Wolf Harvest

We estimated reported harvest for each analytical unit as the average of reported harvest over the last four years. We estimated the relative strength of compensatory versus additive harvest (h) using data from the northern Rocky Mountains. For current condition modeling we used the mean estimate of the percentage of the population harvested between the years 1997–2021 and included an estimate of unreported harvest. For the POW Complex Analysis Unit, we selected a random number between 17 and 47 percent to reflect year to year variation and uncertainty in this parameter (see *Chapter 3.2.3 Unreported Harvest*; estimates from Person and Russell 2008, p. 1545; ADFG 2022b, p. 11) and for the rest of the Analysis Units the estimate was 17 percent (see *Chapter 3.2.3 Unreported Harvest*; estimate from ADFG 2022b, p. 11). See Appendix C for a summary table of reported (empirical), unreported (estimated), and total (estimated) wolf harvest across all Analysis Units. Numbers are reported as the mean, minimum, and maximum a) number of wolves and b) percentage of the estimated population harvested annually between 1997 and 2021.

Inbreeding

To incorporate the effects of inbreeding identified in Alaska populations (Zarn 2019, entire), we applied offsets to the intrinsic rate of growth for the POW Complex, Southern Southeast Alaska, and Northern Southeast Alaska Analysis Units only. (Note: available genetic data do not indicate that the Northern Coastal B.C. Analysis Unit shows strong signatures of inbreeding based on the inbreeding coefficient (F is equal to 0.06, Breed 2007, p. 18). To our knowledge there are no genetic studies of inbreeding in the Southern Coastal B.C. unit). We focused on the longest runs of homozygosity (F_{ROH} is greater than or equal to 10 Mb) identified by Zarn (2019, p. 12), which are strongly correlated with pedigree inbreeding coefficients (Kardos et al. 2018, p. 126–127). We then use the results from Liberg et al. (2005, entire) to parametrize the relationship between inbreeding coefficients and the intrinsic rate of growth. We focus on the Liberg et al. study (2005, entire) because it is the only published study that links inbreeding coefficients to fitness effects and subsequent changes in population growth rates in gray wolves. Briefly, Liberg et al. (2005, entire) estimated pedigree inbreeding coefficients for a small, wild population of gray wolves in Scandinavia. They identified inbreeding depression in this population (i.e., fitness impacts due to inbreeding) based on the relationship between the number of surviving pups per litter and the pedigree inbreeding coefficients of the pups. They then used a Leslie matrix model with five age classes to model the impact of inbreeding-induced declines in pup survival on the population growth rate (details on the model available in Liberg et al. 2005, Electronic Appendix, p. 7). Using results from this model, we built a linear relationship between the pedigree inbreeding coefficient (F_p) and population growth rate (λ), where: λ is equal to -0.8(F_p) + 1.384. We then applied this equation to the mean F_{ROH} that was greater than or equal to 10 Mb for each population from Zarn (2019), substituting the mean F_{ROH} that was greater than or equal to 10 Mb for F_p to estimate λ for each population. We calculated the expected percent decline in λ and applied that rate to the intrinsic rate of growth (see Table 20). Because this approximation of inbreeding depression is limited to fitness effects related to fecundity and pup survival, it may underestimate total impacts of inbreeding (Liberg et al. 2005, p. 19). However, it provides the best quantitative estimate currently available to link inbreeding to potential fitness effects.

Table 20 Estimation of population growth rate (λ) based on mean $F_{ROH} \geq 10$ Mb for Alaska wolf populations (Zarn 2019, p. 12) and inbreeding depression relationships derived from Liberg et al. (2005)

Estimation of lambda based on Zarn F_{ROH}:			
Analysis Unit	mean $F_{ROH} \geq 10$ Mb	lambda	percent change from no inbreeding
POW Complex	0.16	1.256	-0.092
Southern Southeast Alaska	0.07	1.328	-0.040
Northern Southeast Alaska	0.04	1.352	-0.023
No inbreeding	*0.00*	*1.384*	

Model B (Updated Gilbert et al. (2022) model for the POW Complex)

Gilbert et al. (2022) developed a complex model of deer, wolf, and human interactions for the POW Complex. Starting wolf populations in the model were based on an assumed 31 packs occupying approximately 9,000 square kilometers (3,475 square miles) or 9.9 wolves per 1000 square kilometers, with a mean number of 6 wolves per pack and a maximum of 18 (max population size of 558). The models also assumed no variation in the starting population size, that wolf populations are limited by deer populations, and that wolf harvest is proportional to road and boat access. With new information from TEK and ADFG we made the following changes to the model:

1) Starting population size was 386 (Table 17; ADFG 2022b, p.2). Uncertainty in the Gilbert et al. (2022) model is incorporated through the estimates of pack sizes in Model B, with each pack size drawn from a distribution with a mean and standard deviation.

2) Home range sizes of wolves were roughly 20 percent larger, and subsequently, the number of deer in each territory increased by 20 percent.

3) Based on new home range sizes and TEK (which indicated fewer than 31 packs), we estimated 26 packs occupied GMU 2, for a maximum number of wolves of 468 (18 wolves per pack*26 packs). This pack size is somewhat larger than average pack sizes reported through TEK (6–12 wolves), but within the range of maximum pack sizes reported (30–40 wolves; Brooks et al. 2022, p. 28, 43, 44, 56, 58, 73). This estimate falls within the range of the estimates provided in Table 18 and is on the upper end of the 2020 population estimate of 386 (95 percent CI 321–472) provided by ADFG (Table 17).

4) Wolves eat approximately 22.5 deer per year based on a diet composition of 66 percent deer (Table 4) versus the 15 estimated by Gilbert et al. (2022, pp. 6–7).

5) We included harvest as a function of the number of days the season was open with a randomly generated number of wolves killed per day between 2.1 and 3. Total harvest was estimated as the number of days of the harvest season multiplied by the number of wolves killed per day. We used a 30-day harvest season (63–90 total wolves harvested) for our current condition analyses. Harvest for each pack was estimated as a function of coastal access and road access:

$$Ht = (1.010 - 0.010*(pack.ocean) + 0.103*(pack.roads/pack.areas))^2;$$

This equation was modified slightly from the Gilbert et al. (2022, p. 6) equation to double the effect of coastal access and halve the effect of roads (G. Roffler 2022, pers. comm.).

H=the sum of all Ht for each pack. Ht/H was multiplied by the total harvest to parse out the harvest proportionally across packs.

Metrics Used to Evaluate Current Condition

In addition to calculating the median population size (and a credible interval around this estimate) one to six years into the future, we also calculated the proportion of simulations that were below either a key viability threshold (quasi-extinction) or an effective population size (Ne) of 50 (Gilbert et al. 2015, entire). Because small populations can be disproportionately impacted by demographic or environmental fluctuations, and potentially subject to genetic effects (e.g., inbreeding), Allee effects, or demographic constraints (e.g., changes in sex-ratios) that are often not included in model parameterization, population viability analysis (PVA) practitioners typically do not rely solely on estimates of absolute extinction risk (Thomas 1990, entire; Reed et al. 2002, entire). Instead, relative measures of “quasi-extinction” risk or the risk of falling below specific management thresholds are often considered more useful (Reed et al. 2002, entire). We therefore examined multiple thresholds in our analysis of future condition:

1. **Quasi-Extinction (QE) Threshold (10 wolves):** Quasi-extinction is defined as a situation when extinction is inevitable despite the fact that individuals may still persist in the population (Legendre et al. 2008, entire). The concept derives from the fact that small populations are more likely to collapse due to inbreeding, lack of reproductive capacity, or catastrophic events. Therefore, for PVAs, biologists often select a value above zero

against which to compare the predicted population sizes to evaluate the risk of quasi-extinction (Otway et al. 2004, entire; Semmens et al. 2016, entire). We selected a QE threshold of 10 based on a previous PVA that used 10 wolves as the definition of "biological extinction" (Gilbert et al. 2022, entire) and because a population of only 10 wolves has a high likelihood of going extinct due to stochastic events including reproductive failure, human mortality, disease, catastrophes, Allee effects, genetic factors, or some combination of the above.

2. **Effective Population Size (Ne) (50 wolves):** We further evaluated a threshold based on the 50/500 rule (Franklin 1980, entire), which posits that an effective population size of 50 is needed for avoiding deleterious genetic effects such as inbreeding depression. Effective population size reflects the number of animals successfully reproducing in a population and represent one aspect of genetic health. Using calculations from Gilbert et al. (2022, p. 8), we further determined that an Ne of 50 equates to a total abundance estimate of approximately 120 wolves because only a fraction of the population breeds.

Key Uncertainties

We address uncertainty using distributions of parameter estimates versus point estimates (means or medians). However, there are several uncertainties we could not explicitly resolve in the model, including changes in parameter estimates over time, small population effects, and future management of populations. Our assumptions were designed to avoid making quantitative predictions for situations where uncertainty was unacceptably high and to increase transparency by explicitly stating our assumptions. Table 21 below details these uncertainties and elucidates the implications of our assumptions for the model output.

Table 21 Summary of key uncertainties for current and future projections.

Area of Uncertainty	Potential Effect on Model's Projection of Viability
Starting population sizes Best available science does not provide accurate estimates of population size for Alexander Archipelago wolves. We estimated maximum population sizes based on estimates of available prey biomass (Suring et al. 1993, entire; Kuzyk and Hatter 2014, entire) and home range/average pack sizes (Roffler 2022, unpublished data)	Model projections could ***overestimate*** population sizes if previous estimates were higher than actual populations Model projections could ***underestimate*** population sizes if previous estimates were lower than actual populations.
Small population effects We do not explicitly model changes in genetic diversity over time that could impact population fitness. Additionally, we do not explicitly model loss of connectivity (decreases in immigration or emigration). We include an estimate of inbreeding effects on the intrinsic rate of growth for some	Model projections could ***overestimate*** wolf viability if deleterious effects of small populations worsen over time. Model projections could ***underestimate*** wolf viability if immigration was sufficient to alleviate inbreeding depression.

populations, but do not model changes in that inbreeding effect over time.	
Choice of quasi-extinction threshold and changes in connectivity There is much uncertainty in the literature regarding what an appropriate quasi-extinction threshold is for gray wolves. Connectivity of populations is an important factor, and the connectivity of Alexander wolf populations is not well documented.	Model projections will ***overestimate*** viability (underestimate risk of quasi-extinction) if population sizes larger than 10 are needed to maintain population viability. Model projections will ***underestimate*** viability (overestimate risk of quasi-extinction or inbreeding depression) if populations always recover after falling below a threshold with no deleterious consequences.
Wolf Harvest Best available science indicates that there is uncertainty regarding the effects of harvest on wolf population dynamics. We estimated the effects of harvest from populations located in Montana, which gave us a long enough time series to estimate these effects	Model projections will ***overestimate*** viability if harvest effects are greater. Model projections will ***underestimate*** viability if harvest effects are less.
Management of Population The state of Alaska has set management objectives for GMU 2; however, other Analysis Units currently do not have population objectives. We model wolf harvest in our projections as either a constant proportion (Model A) or a fixed length of harvest season (Model B) to demonstrate the long-term effects of different levels of harvest. However, it is likely that ADFG will manage adaptively as they have in the past (i.e., adjust harvest levels to reflect changes in population sizes).	Model projections will ***overestimate*** viability if population monitoring is not accurate enough to allow for adaptive management of populations. Model projections will ***underestimate*** viability if ADFG manages for larger population sizes

<u>Starting populations in models</u>

The starting population sizes (from Table 18 and Table 19 in *Chapter 4.2.1 Population Trend*) were multiplied by 1–1.5 (drawn from a uniform distribution and applied to 200,000 estimates of the population size) to reflect uncertainty in population sizes and opinions of the expert panel indicating that the estimated population sizes from Suring et al. (1993) were potentially low. These scaled estimated are referred to as the maximum potential population size (K). Starting populations for the simulations were begun at 0.90*K in order to allow populations the potential to increase (otherwise all simulations would have indicated stable or declining populations) (Table 22).

Table 22 Maximum population sizes and starting population sizes after incorporating multiplier.

	Maximum Potential Population Size (K)	Starting Population Size (0.9*K)
Northern Southeast Alaska	342 (95 percent CI 246–465)	308 (95 percent CI 221–419)
Southern Southeast Alaska	627 (95 percent CI 331–1007)	565 (95 percent CI 298–907)
POW Complex	414 (95 percent CI 217–665)	373 (95 percent CI 196–599)
Northern B.C.	540 (95 percent CI 347–786)	486 (95 percent CI 312–707)
Southern B.C.	559 (95 percent CI 347–831)	503 (95 percent CI 312–748)

Results

Northern and Southern Southeast Alaska Analysis Units

Our model projections indicate that the median population size at 6 years is projected to be 476 (95 percent CI 245–797) for the Southern Southeast Alaska Analysis Unit (GMUs 3, 1A, and 1B), and 306 (95 percent CI 217–419) for the Northern Southeast Alaska Analysis Unit (GMUs 5, 1C, and 1D). Average harvest rates, including the 17 percent estimated unreported harvest, were 12 percent and 23 percent for the Northern and Southern populations, respectively. No simulations resulted in a population size below 120 for either population (Figure 18).

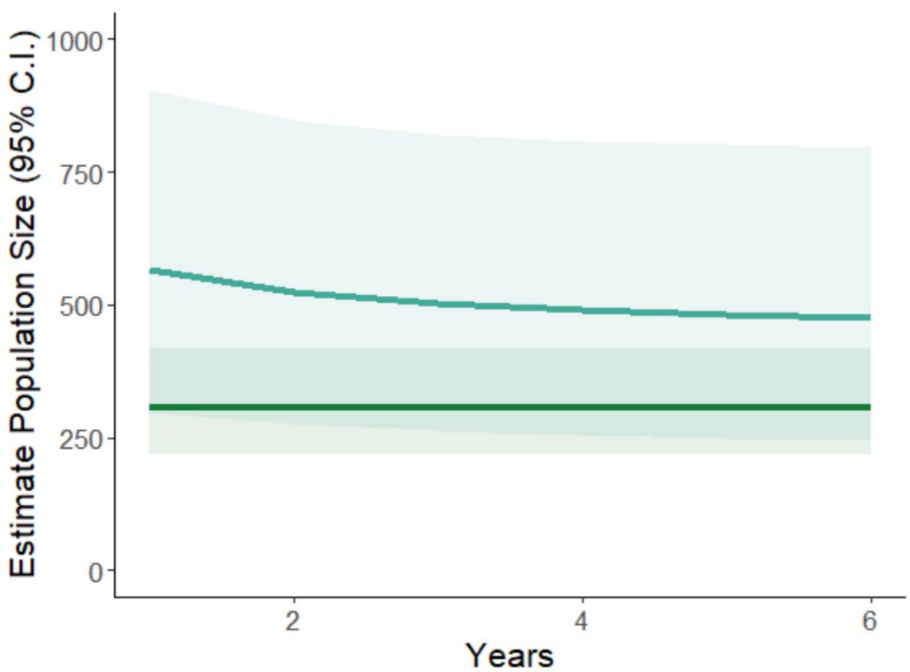


Figure 18 Estimated median and 95 percent Credible Interval (shaded areas) for projected population sizes over the next 6 years for Northern Southeast Alaska (green) and Southern Southeast Alaska (blue).

POW Complex Analysis Unit

Model A

The median projected population size for the POW Complex in 6 years (assuming current harvest rates continue) is 297 (95 percent CI 151–504) (Figure 19). This rate includes the estimated 17–47 percent unreported harvest rate (i.e., unreported harvest made up 17–47 percent of the total harvest). The estimated wolf populations are projected to remain above 120 wolves. Less than one percent of simulations result in a population size of less than or equal to 120 wolves (Figure 19).

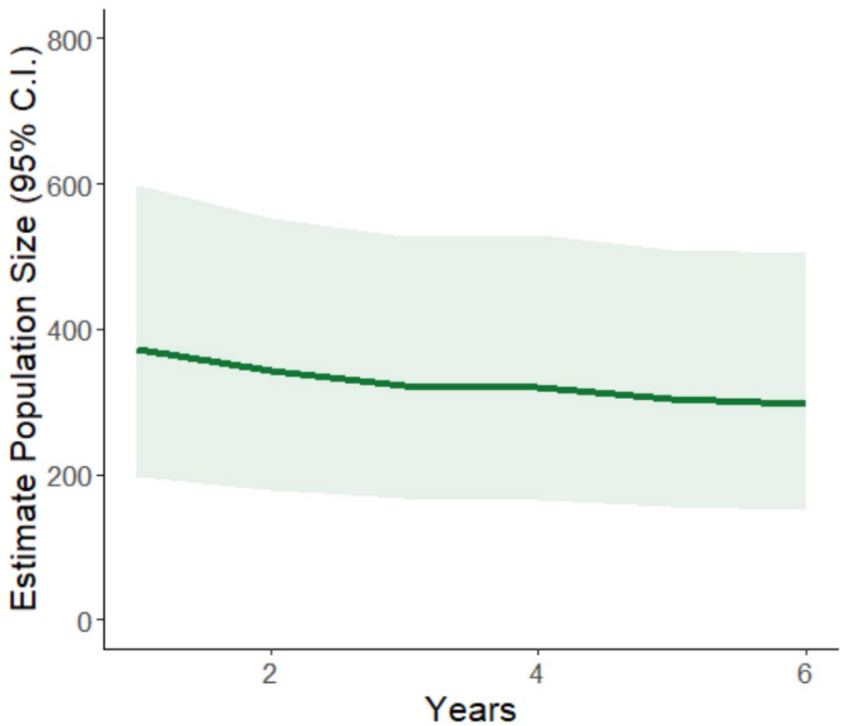


Figure 19 Estimated median and 95 percent Credible Interval (shaded area) for predicted populations sizes over the next 6 years for the POW Complex Analysis Unit.

Model B (updated Gilbert et al. (2022) population model)

We projected results using Scenario B from Gilbert et al. (2022, p. 7) (transition to young-growth harvest and planned decommission of roads). Results from the updated model indicate that the POW Complex wolf population will decline by approximately 70 percent in 6 years (Figure 20). The median population size at year 6 is approximately 134 (95 percent CI is equal to 101–167). Fifteen percent of simulated populations result in an estimated population size of 120 wolves at the end of the 6-year timeframe, and no simulations result in less than 10 wolves.

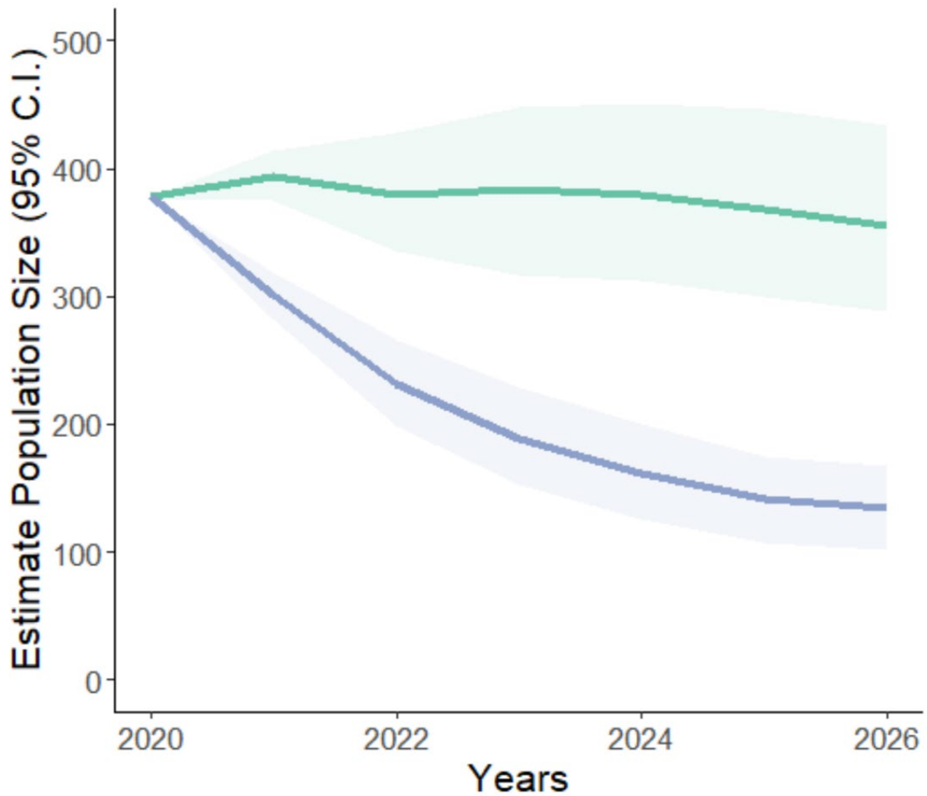


Figure 20 Estimated median population size of Alexander Archipelago wolves on the POW Complex using Scenario B from Gilbert et al. (2022, p. 7) and a 30-day harvest season (blue), and a no-harvest scenario (green) for comparison (shaded areas represent the 95 percent confidence intervals).

Interpreting differences between model results

The major difference between the updated Gilbert et al. (2022) model (Model B) and our simplified model of population dynamics (Model A) for the POW Complex Analysis Unit is that wolves in the Gilbert model are explicitly linked to deer populations and limited by the amount of prey available. Even under a no-wolf-harvest scenario, projected wolf populations using Gilbert et al. (2022, p. 9) decline to a median estimated population size of 355 wolves in 6 years from a starting population of 385. These models suggest that deer populations on the POW Complex are not capable of supporting 385 wolves; however, current and historical wolf population estimates on POW Complex have been higher than the lower 100s suggested by the Gilbert et al. (2022, p. 8) model. It is possible that the habitat on the POW Complex can support more deer than the Gilbert et al. model (2022, p. 6) indicates, which would explain some of the differences between the two model results as well. Additional information regarding deer habitat capability on the POW Complex is needed to fully explain these discrepancies.

<u>Coastal B.C. Analysis Units</u>

Our projections for B.C. indicate that the population size in both B.C. units will remain relatively stable over the next 6 years under current average wolf harvest conditions (6.5 percent for

Northern B.C. and 12 percent for Southern B.C.). The median projected population size for Northern B.C. is 506 (95 percent CI 325–738) and Southern B.C. is 493 (95 percent CI 304–740) (Figure 21). This rate includes the estimated 17 percent unreported harvest rate (i.e., total wolves harvested is 17 percent higher than reported). No simulations result in 120 wolves or less in either Analysis Unit.

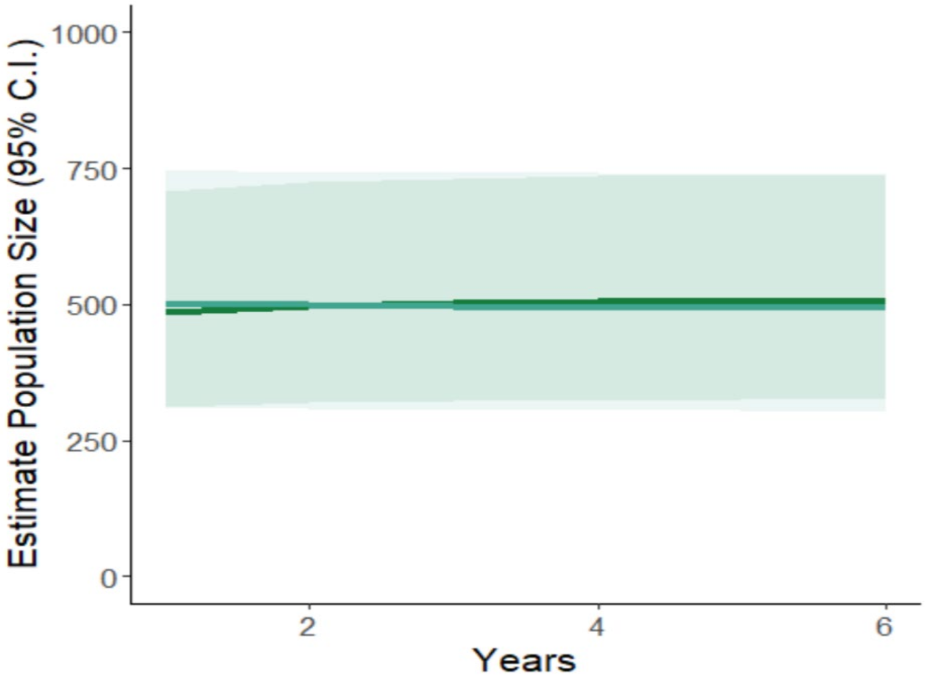


Figure 21 Estimated median and 95 percent CIs (shaded areas) for predicted Alexander Archipelago wolf populations sizes over the next 6 years for Northern B.C. (green) and Southern B.C. (blue).

Table 23 below provides a summary of the current population projections under Model A for all five Analysis Units across the range of the Alexander Archipelago wolf.

Table 23 Median, lower 95 percent credible intervals (LCIs), and upper 95 percent credible intervals (UCIs) for projected population sizes at 6 years under average observed harvest rates for each Analysis Unit. 120 Threshold is the percentage of simulations where the population size at year 6 was below 120, and 10 Threshold is the percentage of simulations where the population size at year 6 was below 10. Percent of maximum is the estimated population size as a percentage of the estimated maximum.

Analysis Unit	Median	LCI	UCI	120 Threshold	10 Threshold	Percent of maximum
Northern Southeast Alaska	306	217	419	0 percent	0 percent	89
Southern Southeast Alaska	476	245	797	0 percent	0 percent	76
POW Island Complex	297	151	504	1 percent	0 percent	72
Northern BC	506	325	738	0 percent	0 percent	94
Southern BC	493	304	740	0 percent	0 percent	88

4.2.2 Dietary Diversity

Understanding how Alexander Archipelago wolves respond to changes in prey abundance (especially ungulate abundance) is an important consideration for predicting the ability of wolves to persist in areas of variable ungulate occupancy and species composition across their range. Scat analyses conducted across the range of the Alexander Archipelago wolf demonstrate that ungulates, and primarily black-tailed deer, are the most frequently consumed prey item (See *Chapter 2.5.1 Prey*). Northern Southeast Alaska is the only Analysis Unit where moose is the most consumed species. It is also the only Analysis Unit where non-ungulate prey items (sea otters and marmots) are consumed more than deer. Indigenous experts have observed signs of wolves preying on deer in the Islands of Yakutat Bay and fishing for salmon in the upper reaches of the Ophir River (Brooks et al. 2022, p. 25). On the POW Complex Analysis Unit, where black-tailed deer are the only ungulate available, wolves consume black bear and beaver at much higher frequencies than, and at a similar rate to secondary ungulate prey in other Analysis Units. To emphasize this point, ungulates (deer) make up only 66 percent of wolves' diet on POW Complex, whereas, in all other Analysis Units, ungulates make up at least 81 percent of wolves' diet. In general, if ungulates are excluded from analyses, black bears and beavers (or sea otters in the case of the Northern Southeast Alaska Analysis Unit) are the most consumed species. Mustelids are also frequently consumed on POW Complex and in Coastal B.C.

To assess current dietary diversity in each Analysis Unit, we first determined the proportion of the diet composed of ungulate versus non-ungulate prey. We also calculated the number of ungulates and non-ungulates in the diet of wolves in each Analysis Unit (Table 24).

Table 24 Summary of ungulate and non-ungulate prey composition in Alexander Archipelago wolf scat analyses (summarized from Table 4 in *Chapter 2.5.1 Prey*).

Analysis Unit	Ungulate Proportion	# of Ungulate Species Consumed	Non-ungulate Proportion	# of Non-ungulate Species Consumed
Northern Southeast Alaska	89.15	3	10.84	17
Southern Southeast Alaska	85.19	3	14.81	14
POW Complex	65.84	1	34.17	12
Coastal B.C.	81.19	3	18.81	10

This table provides a clearer picture of dietary resiliency within each Analysis Unit. Within the Northern Southeast Alaska unit, the three available ungulates (deer, moose, and mountain goats) compose nearly 90 percent of the diet, and although numerous non-ungulates are consumed, they make up a much smaller proportion of the diet. The Southern Southeast Alaska unit is similar to the Northern Southeast Alaska unit, except that fewer non-ungulate species are consumed and make up a larger portion of the diet (primarily in the form of beavers and bears) in Southern Southeast Alaska. In Coastal B.C., only ten non-ungulate prey species have been detected in scat analyses, but they do make up a larger proportion of the diet overall compared with Northern and Southern Southeast Alaska. Black bears contribute quite a lot to the non-ungulate diet in Coastal B.C. (5.46 percent), as do mustelid species (5.52 percent).

The diet of wolves on the POW Complex Analysis Unit is the most different, with black-tailed deer being the only available ungulate. As a result, wolves on the POW Complex Analysis Unit consume approximately double the amount of non-ungulate prey compared to the other Analysis Units. That said, the number of non-ungulate species on the POW Complex diet is the lowest of the Southeast Alaska units. Black bears and beavers are the most significant non-ungulate contributors to wolf diet on the POW Complex, together making up over a quarter of the diet. The fact that only one ungulate occurs on the POW Complex and that few non-ungulate species contribute to wolf diet in the Analysis Unit, suggests that this population may be less resilient to stochastic events.

4.2.3 Availability of Old-Growth Forest

As discussed in *Chapters 2.5.1 Prey* and *2.5.2 Habitat and Space Use*, Alexander Archipelago wolf presence is closely-linked to a sufficient supply of prey (primarily ungulates), and the presence of the wolf's primary prey species (black-tailed deer) is tightly connected to availability of productive old-growth forest habitat. Additionally, Alexander Archipelago wolves have been shown to select for old-growth forest habitat during the denning and pup-rearing season. Therefore, we used spatial analyses in ArcGIS Pro to assess the area of old-growth forest present within each of the Analysis Units to better understand wolf habitat suitability across its range.

We compiled land cover data from a variety of sources to capture the current condition in Southeast Alaska and coastal B.C. For Southeast Alaska, the 2018 Southeast Alaska Forest Condition dataset, which was built for analyzing conservation significance of inventoried roadless areas (Albert 2019, entire), was the primary land cover layer we used because it is an updated version of what was used in the 2015 Alexander Archipelago Wolf SSA, and it was created using the best available information for all land ownership. We used high resolution maps of forest cover change (Hansen et al. 2013, accessed through www.globalforestwatch.org), which have been updated annually from 2001 through 2021, to identify land cover changes in Southeast Alaska since 2018.

For B.C., we primarily used an integrated land cover layer developed for the transboundary area by the NPLCC (accessed from https://www.sciencebase.gov/catalog/item/5306b12de4b0e59bb387a33f) because it was the same data used in the 2015 Alexander Archipelago Wolf SSA, and because it described land cover on all land ownership. However, this layer was created using B.C. Vegetation Resources Inventory (VRI) data up to October 2006 for information on public lands, so we used the VRI 2020 Forest Vegetation Composite Polygons (accessed from https://catalogue.data.gov.bc.ca/) to identify polygons with harvest dates after October 2006.

At the highest imaginable prey densities (e.g., 15 deer or 3 moose/square kilometer) an individual pack of four gray wolves probably requires a territory of about 75 square kilometers (30 square miles) to meet its nutritional requirements (Fuller et al. 2003, p. 163). Therefore, we limited our spatial analysis to only include patches of old-growth forest that were at least 75 square kilometers in area. We used ArcGIS Pro to identify patches of old-growth forest that were at least 75 square kilometers (29 square miles) throughout Southeast Alaska and coastal B.C. We categorized existing land cover categories as old-growth, young-growth, water, and other. We then identified contiguous patches of old-growth, calculated the area of each patch, and totaled the area of those old-growth patches by Analysis Unit (Table 25).

Table 25 Area (km²) within and outside of contiguous old-growth patches greater than or equal to 75 km², by Analysis Unit.

Analysis Unit	Area of old-growth in contiguous patches ≥ 75 km²	Area outside of old-growth patches	Total Area
Northern Southeast Alaska	1,511.0	32,754.8	34,265.8
Southern Southeast Alaska	5,354.2	24,452.6	29,806.8
POW Complex	1,564.2	8,186.9	9,751.2
Northern Coastal B.C.	1,427.0	64,112.0	65,538.9
Southern Coastal B.C.	4,428.8	71,893.8	76,322.5

We considered a total area of old-growth (composed of contiguous patches at least 75 square kilometers (29 square miles) of approximately 1,500 square kilometers (579 square miles) or larger to be sufficiently large to potentially support populations of Alexander Archipelago wolf within an Analysis Unit. This approximate threshold is based on observations that gray wolf populations can persist in reserves larger than 1,500 square kilometers (579 square miles) but tend to be unstable in smaller reserves (Smietana and Wajda 1997, entire; Lariviere et al. 2000, entire; Fuller et al 2003, p. 164). Applying this threshold, all Analysis Units likely provide either sufficiently large or nearly sufficiently large patches of old-growth forest to support populations of Alexander Archipelago wolves.

Old-growth forest is likely less important for wolf resiliency in the Northern Southeast Alaska Analysis Unit because black-tailed deer contribute very little to wolf diet in this Unit compared to the other Units (see *Chapter 2.5.1 Prey*). Instead, moose make up most of the diet in the Northern Southeast Alaska unit (78 percent; Table 4), and moose select for different habitat than black-tailed deer (young forests and shrublands for browse and mature forests for shelter and cover from extreme weather and predators). Therefore, availability of old-growth forest is not the most appropriate habitat type to evaluate resiliency in the Northern Southeast Alaska Analysis Unit.

In general, the Southern Southeast Alaska and Southern Coastal B.C. Analysis Units provide the largest amounts of contiguous old-growth forest across the range of the wolf. Sufficiently large patches of old-growth forest are less available on the POW Complex Analysis Unit and the Northern Coastal B.C. Analysis Unit, which may make these populations less resilient to stochastic events.

4.2.4 Remoteness

To understand current remoteness for Alexander Archipelago wolves we examined road and boat access across all Analysis Units. Between 2015 and 2020, motorized vehicles and boats were the most commonly used (96 percent; see Table 4 in *Chapter 2.5.3 Remoteness (Space From Human Activity)*) transportation types for hunters and trappers to harvest wolves in Southeast Alaska (where the only available data were collected). We did not find comparable data describing harvest transportation for coastal B.C., but we assume that most hunters and trappers use motorized vehicles given the extensive road system, and perhaps boats in the more isolated areas of Northern Coastal B.C.

Motorized vehicle access

We estimated road densities by Wildlife Analysis Area (WAA) in Southeast Alaska and by Wildlife Management Unit (WMU) in coastal B.C. and then summarized results by Analysis Unit. We considered all types of roads in the analysis (e.g., sealed, unsealed) as long as they allow for human access using any motorized vehicle (e.g., off-highway vehicle, all-terrain vehicle, snowmachine, passenger vehicle). We also reviewed plans for decommissioning of roads and new construction associated with current and planned timber sales. We urge the reader to be mindful of the fact that plans for road management (e.g., decommissioning, closure, new construction) are difficult to ascertain and are not certain to be implemented. We note here that the data used to conduct road density analyses is the same as that used in the 2015 Alexander Archipelago Wolf SSA. Although new data has been identified, its reliability and completeness is unknown. Please refer to *Chapter 3.1 Timber Harvest and Roads* for the most up-to-date information on road construction and decommissioning as a result of timber harvest activities.

Using data from the previous SSA, we determined that 10,975 kilometers (6,820 miles) of roads exist within the range of the Alexander Archipelago wolf (72,930 square kilometers (28,158 square miles)) in Southeast Alaska, resulting in an overall road density estimate of 0.23 kilometer/square kilometer (Albert 2015, entire; Table 26). Half of these roads are located in the Southern Southeast Alaska Analysis Unit, followed by the Northern Southeast Alaska and POW Complex Analysis Units (28 and 23 percent, respectively). However, estimates of road density, which are more meaningful and informative, are greatest on the POW Complex (0.62 kilometer/square kilometer) and are negligible in the Northern Southeast Alaska unit (0.04 kilometer/square kilometer; Table 26). Across all Analysis Units, road density estimates in WAAs ranged from 0.00 to 1.57 kilometers/square kilometer. Of 137 WAAs, 62 (45 percent) had no roads in them, 60 (44 percent) had estimated densities between 0.01 and 0.90 kilometer/square kilometer, and 15 (11 percent) exceeded the 0.90 kilometer/square kilometer threshold above which wolf harvest rates can be problematic (Person and Russell 2008, p. 1548; Figure 22). Not surprisingly, given the high road densities in the POW Complex Analysis Unit, most of the WAAs that exceed the 0.90 kilometer/square kilometer threshold (13 of 15; 87 percent), are located in the POW Complex Analysis Unit; the remaining two are located in the Southern Southeast Alaska Analysis Unit.

Table 26 Mean estimates of road density and ranges calculated by Wildlife Analysis Area (WAA) within each Analysis Unit (Albert 2015, entire).

Analysis Unit	Road density (kilometer/square kilometer)		WAAs	
	Mean	Range	Total number of WAAs	Percent with road density greater than 0.90 kilometer/square kilometer
Southern Southeast Alaska	0.14	0.00–1.25	68	3 percent
Northern Southeast Alaska	0.04	0.00–0.40	38	0 percent
POW Complex	0.62	0.00–1.57	31	42 percent
Total	0.23	0.00–1.57	137	11 percent

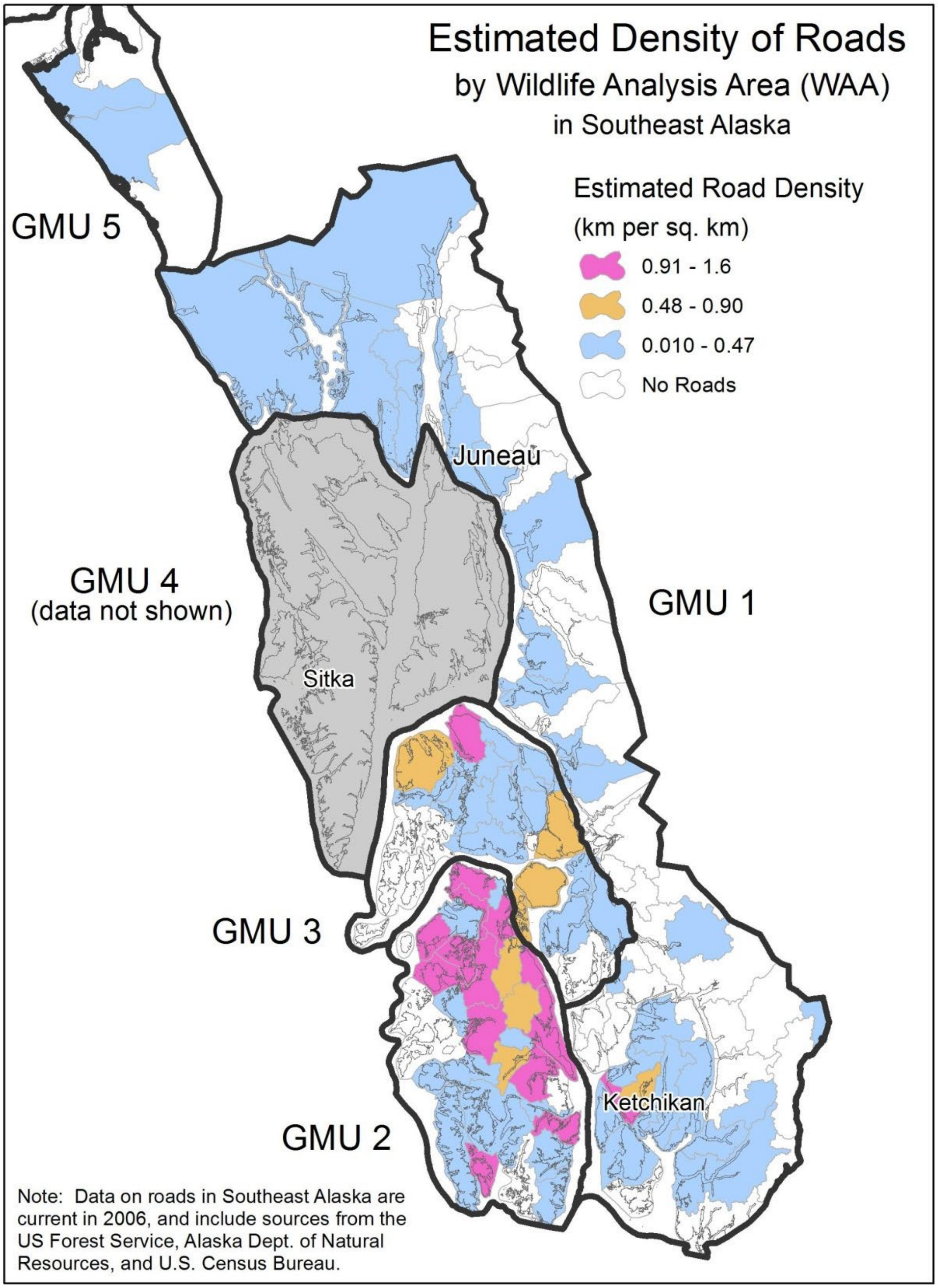


Figure 22 Map depicting road densities estimated by Wildlife Analysis Area (WAA) and presented by GMU within the range of the Alexander Archipelago wolf in Southeast Alaska (wolves have not been observed in GMU 4; Albert 2015). Estimated road densities greater than 0.90 kilometer/square kilometer are considered to be problematic for wolves due to high rates of wolf harvest by humans (Person and Russell 2008, p. 1548).

In coastal B.C., roads are often described as being “connected” or “unconnected” to the main road system. In total, 67,612 kilometers (42,012 miles) of road exist within the range of the Alexander Archipelago wolf in B.C., resulting in a mean road density of 0.47 kilometer/square kilometer (Albert 2015). The majority of roads are located in Southern Coastal B.C. (78 percent). Mean road density estimates follow a similar pattern, with the highest densities also in Southern Coastal B.C. (0.54; Table 27). Across Coastal B.C., estimated road densities range from 0.05 to 3.03 kilometers/square kilometer (Table 27). Six of 36 WMUs (17 percent) exceed the threshold of 0.90 kilometer/square kilometer presumed to be negative for wolves; all of these WMUs are located in Southern Coastal B.C. and surround the large cities of Victoria and Vancouver (Figure 23). One WMU in Northern Coastal B.C. has an estimated road density of 0.89 kilometer/square kilometer, which is high compared to the other WMUs in that unit. We did not find data indicating planned road construction or future road management in coastal B.C.

Table 27 Mean estimates of road density and ranges estimated by Wildlife Management Units and summarized by Analysis Unit in coastal B.C. (Albert 2015, entire).

Analysis Unit	Road density (kilometer/square kilometer)		WMUs	
	Mean	Range	Total number	Percent with road density greater than 0.90 kilometer/square kilometer
Southern Coastal B.C.	0.54	0.05 – 3.03	28	21 percent
Northern Coastal B.C.	0.22	0.07 – 0.89	8	0 percent
Total	0.47	0.05–3.03	36	17 percent

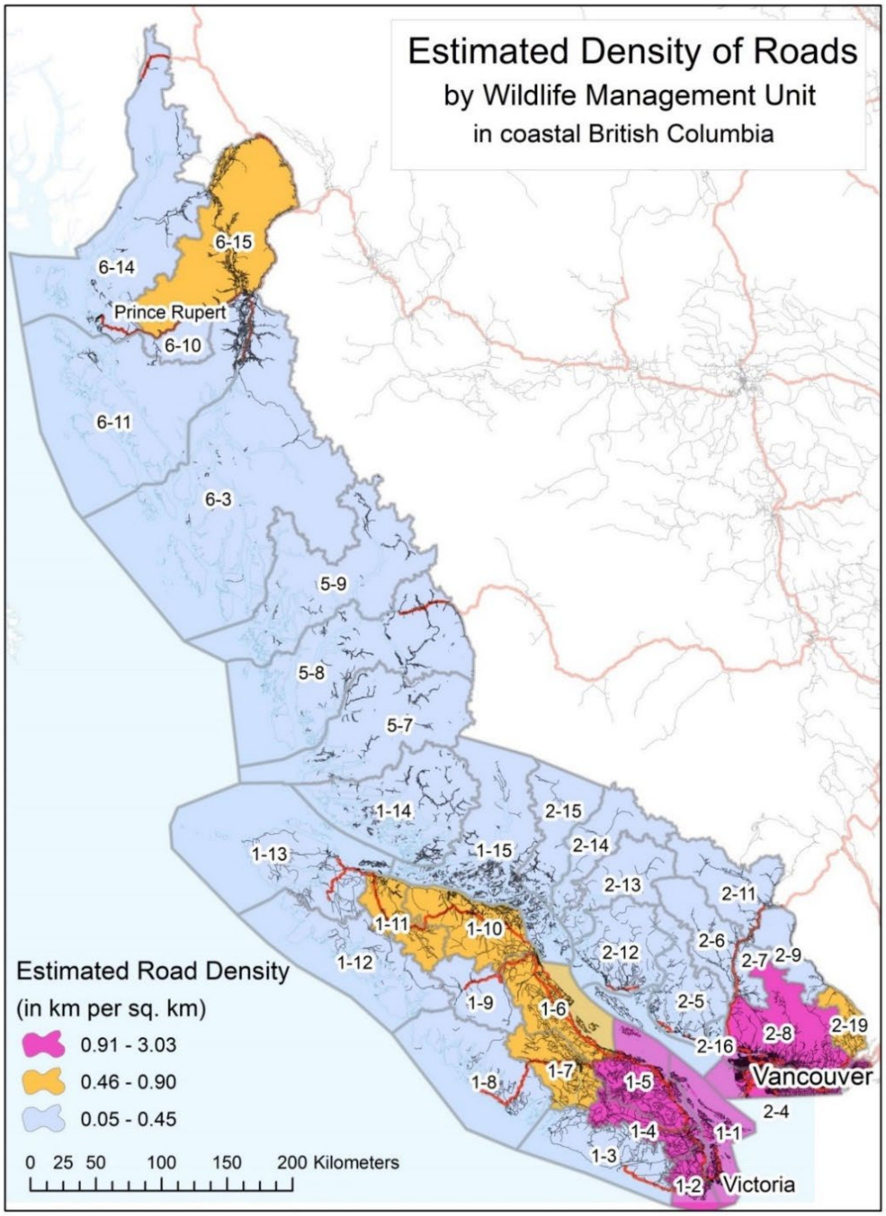


Figure 23 Map depicting road densities estimated by Wildlife Management Unit (identified on map with region preceding the hyphen) within the range of the Alexander Archipelago wolf in coastal B.C. (Albert 2015). Estimated road densities greater than 0.90 kilometer/square kilometer are considered to be problematic for wolves due to high rates of wolf harvest by humans (Person and Russell 2008, p. 1548).

In summary, road density is lowest in the Northern and Southern Southeast Alaska Analysis Units (mean is equal to 0.09 kilometer/square kilometer), followed by Northern Coastal B.C. (0.22 kilometer/square kilometer). In Southern Coastal B.C., mean road density is 0.54 kilometer/square kilometer, largely due to the urban areas of Victoria and Vancouver (Figure 23), and 21 percent of the WMUs have densities greater than 0.90 kilometer/square kilometer. The POW Complex Analysis Unit has the highest road density (mean is equal to 0.62

kilometer/square kilometer) and the highest percentage of WAAs over the threshold (42 percent). Therefore, road access for hunters and trappers is greatest in the rural POW Complex Analysis Unit, followed by the highly urban regions in Southern Coastal B.C.; elsewhere in the range of the Alexander Archipelago wolf, evaluation of road access is limited at the scale of our analysis (Figure 24).

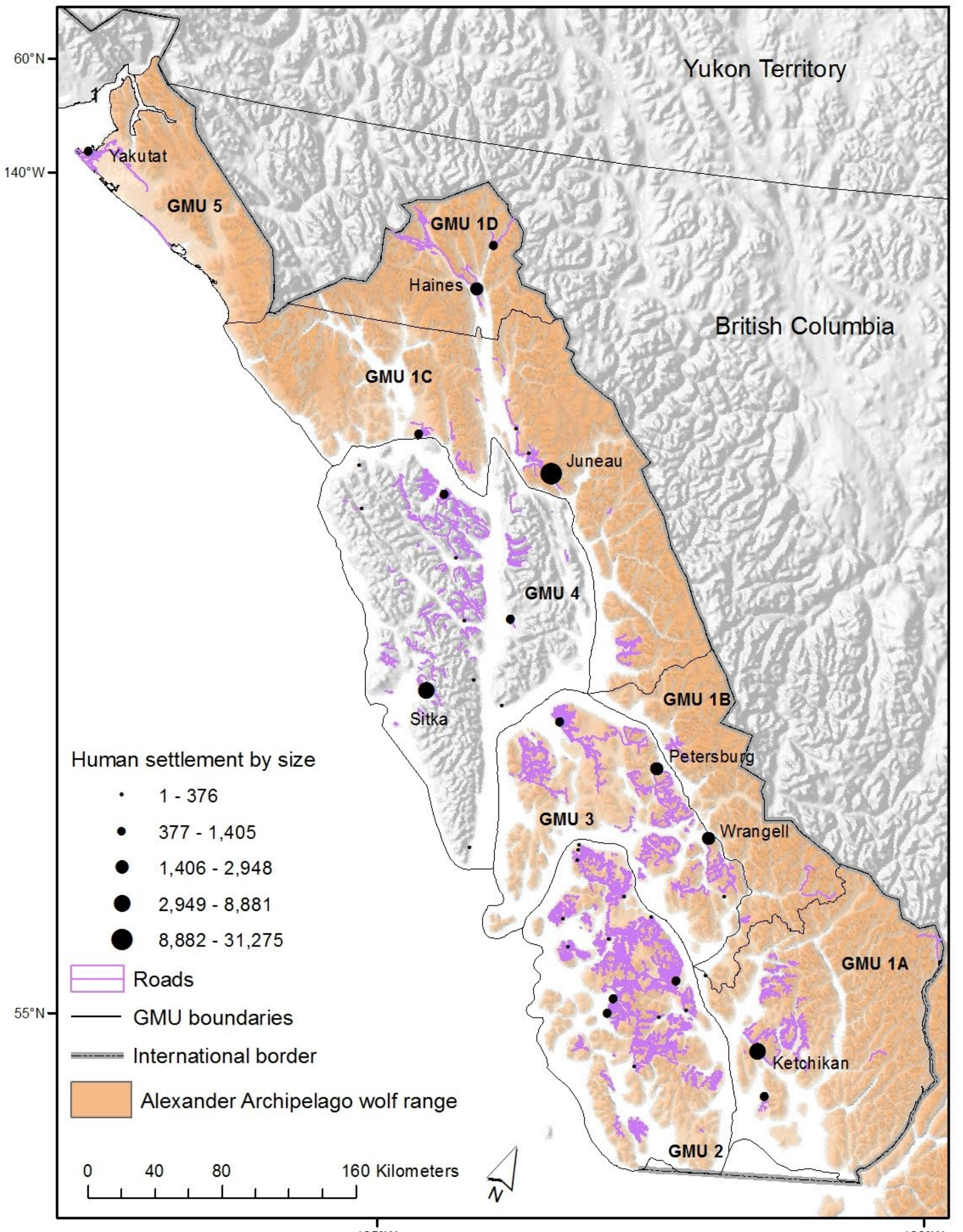


Figure 24 Map of human settlements by population size and roads to demonstrate variation in access (e.g., road, boat) for hunters and trappers within the range of the Alexander Archipelago wolf in Southeast Alaska.

Marine boat access
We examined boat access by calculating the ratio of shoreline to land area as a proxy of boat access for hunters and trappers of Alexander Archipelago wolves. The POW Complex Analysis Unit has the highest ratio of shoreline to land area (0.81) by far, followed by the Southern Southeast Alaska Analysis Unit (0.33) (Table 28). The remaining three units within the range of the Alexander Archipelago wolf have comparable ratios of shoreline to land area ranging from 0.16 to 0.20, suggesting lower overall boat access in Coastal B.C. and Northern Southeast Alaska (Table 28).

Table 28 Description of road and boat access for hunters and trappers by Analysis Unit in Southeast Alaska and coastal B.C. We summarized road access using mean road density (kilometer/square kilometer) and percent of Wildlife Analysis Areas (WAAs, Southeast Alaska) and Wildlife Management Units (WMUs, coastal B.C.) with densities greater than 0.90 kilometer/square kilometer. We summarized boat access using the ratio of shoreline to land area.

Analysis Unit	Mean road density (kilometer/square kilometer)	Percent of WAAs or WMUs with road density greater than 0.90 kilometer/square kilometer	Approximate ratio of shoreline to land area
Southern Southeast Alaska	0.14	3 percent	0.33
Northern Southeast Alaska	0.04	0 percent	0.16
POW Island Complex	0.62	42 percent	0.81
Southern Coastal B.C.	0.54	21 percent	0.17
Northern Coastal B.C.	0.22	0 percent	0.20

Considering road and boat access collectively, the POW Complex Analysis Unit provides the greatest access for hunters and trappers within the range of the Alexander Archipelago wolf. In the Southern Southeast Alaska Analysis Unit, boat access is somewhat high, but road access is comparatively low, and based on the low percent of WAAs exceeding the road density threshold, is also concentrated. Boat access and road access are both comparatively low in the Northern Southeast Alaska Analysis Unit. These results are reflective of the transportation used to harvest wolves; in the Southern Southeast Alaska Analysis Unit, which favors boat access, boats are the preferred transportation type for wolf harvest. In the Northern Southeast Alaska Analysis Unit, boats and motorized vehicles are used at a similar rate, but taken together, boats and motorized vehicles are used less than in the other two Southeast Alaska Analysis Units (Table 5). Although road access is high in Southern Coastal B.C., these roads primarily lie within the urban areas of Victoria and Vancouver; further, boat access is much lower than in the Southern Southeast Alaska and POW Complex Analysis Units.

4.2.5 Current Resiliency Summary
In the following summaries for each Analysis Unit, we use the terms “low”, “moderately-low”, “moderate”, “moderately-high”, and “high” to describe the condition of each habitat and

demographic factor that we used to evaluate current resiliency for each Analysis Unit. To categorize each factor, we developed definitions for “low”, “moderately-low”, “moderate”, “moderately-high”, and “high”. These definitions are provided in Table 29 below.

Table 29 Condition categories table for each of the habitat and demographic factors included in the current resiliency analysis.

Condition	Population Trend	Dietary Diversity	Area of Old-Growth Forest (in patches of at least 75 square kilometers)	Remoteness	
				Ratio of Shoreline to Land Area	Mean Road Density (kilometer/ square kilometer)
High	Increasing growth trend and large maximum population estimate	Three or more ungulate species and many non-ungulate species available; ungulates contribute significantly to diet	greater than 3,000 square kilometers	less than 0.20	less than 0.5
Moderately-high	Stable growth trend and large maximum population estimate, OR increasing growth trend and moderate maximum population estimate	Two ungulate species and many non-ungulate species available, OR three or more ungulate species available and few non-ungulate species available; ungulates contribute significantly to diet	2,500–3,000 square kilometers	0.20–0.40	0.5–0.65
Moderate	Decreasing growth trend and large maximum population estimate, OR stable growth trend and moderate maximum population estimate	One ungulate species and many non-ungulate species available, OR two ungulate species and few non-ungulate species available; ungulates contribute a moderate amount to diet	2,000–2,499 square kilometers	0.41–0.60	0.66–0.82
Moderately-low	Stable growth trend and small maximum population estimate, OR decreasing growth trend and moderate maximum population estimate	One ungulate species and few non-ungulate species available, OR two ungulate species available and very few non-ungulate species available; ungulates do not contribute significantly to the diet	1,500–1,999 square kilometers	0.61–0.80	0.83–1.0
Low	Decreasing growth trend and small maximum population estimate	Fewer than two ungulate species and very few non-ungulate species available; ungulates contribute little to the diet	less than 1,500 square kilometers	greater than 0.80	greater than 1.0
Functionally Extirpated	All simulations result in a population size less than or equal to 120 individuals	n/a	n/a	n/a	n/a

Northern Southeast Alaska Analysis Unit
The population trend for the Northern Southeast Alaska Analysis Unit is stable over the next 6 years resulting in a median population size of 306 wolves (95 percent CI 217–419). In general, the moderate to large population estimate at year 6 for the Northern Southeast Alaska unit, and the finding that no simulations fall below a population size of 120, indicate moderately-high resiliency in terms of population growth.

Regarding diet, wolves in the Northern Southeast Alaska Analysis Unit primarily consume moose, but also have access to mountain goats and a small population of deer. This has been documented in scat analyses (see *Chapter 2.5.1 Prey*), as well as reports from Indigenous experts (Brooks et al. 2022, p. 24). Of all the Analysis Units, the Northern Southeast Alaska Analysis Unit contains the largest number of non-ungulate prey species, although they make up a small proportion of the total diet given the strong preference for moose. In general, this Analysis Unit appears to exhibit high resiliency in terms of dietary diversity.

Because the availability of sufficient old-growth forest patches is likely not a good indicator of resiliency for prey in this moose-dominated rather than deer-dominated unit, we did not include the old-growth analysis in our resiliency assessment for the Northern Southeast Alaska Analysis Unit. The area of old-growth forest patches greater than or equal to 75 square kilometers (29 square miles) within the Analysis Unit is 1,511 square kilometers (583 square miles), which we would consider to be moderately-low for populations that rely on deer as prey.

The Northern Southeast Alaska Analysis Unit is the most remote of all Analysis Units, in terms of road and boat access. No WAAs exhibit road densities greater than 0.90 kilometer/square kilometer, and the mean road density within the unit is only 0.04 kilometer/square kilometer. Additionally, the ratio of shoreline to land area is only 0.16. Therefore, access to wolf harvest opportunities within this unit is low. This indicates high resiliency, in terms of remoteness for the Northern Southeast Alaska Analysis Unit.

Southern Southeast Alaska Analysis Unit
The population trend for the Southern Southeast Alaska unit indicates a median population size of 476 wolves (95 percent CI 245—797) at year 6. No simulations result in a population of less than 120 wolves over the next 6 years. The large population estimate at year 6 for the Southern Southeast Alaska Analysis Unit and the finding that no simulations result in a population of less than 120, indicate moderately-high resiliency in terms of population growth.

Regarding diet, wolves in the Southern Southeast Alaska Analysis Unit primarily consume deer and moose, but also have access to mountain goats. This Analysis Unit also contains a fairly large number of non-ungulate prey species, although the non-ungulate wolf diet in this Unit consists primarily of bears and beavers. In general, The Southern Southeast Alaska Analysis Unit appears to exhibit high resiliency in terms of dietary diversity.

The area of old-growth forest patches greater than or equal to 75 square kilometers (29 square miles) within the Southern Southeast Alaska Analysis Unit is 5,354 square kilometers (2,067 square miles) (the largest of all the Analysis Units). Therefore, we consider this unit to exhibit high resiliency in terms of availability of preferred habitat.

The Southern Southeast Alaska Analysis Unit has a low mean road density (0.14 kilometer/square kilometer), and only 3 percent of WAAs in the unit have road densities greater than 0.90 kilometer/square kilometer. The ratio of shoreline to land area (0.33) provides for moderately-low levels of marine boat access. Therefore, access to wolf harvest opportunities within this Analysis Unit is moderately-low. This indicates that resiliency, in terms of remoteness for the Southern Southeast Alaska Analysis Unit, is moderately-high.

POW Complex Analysis Unit
According to Model A, the population trend for the POW Complex Analysis Unit indicates that in 6 years the median estimated population size will be 297 wolves (95 percent CI 151–504). Less than one percent of simulations under Model A result in a population size of less than ten wolves. If we instead consider Model B, with an estimated current population size of 385 wolves, we also see a decline (albeit significantly larger at approximately 70 percent) over 6 years to a population of 134 wolves (95 percent CI 101–167). Approximately 15 percent of simulations result in a population size less than 120 wolves over the next 6 years, and no simulations result in a population size less than 10 wolves. The primary driver of this decline under Model B is the availability of deer on the POW Complex. Considering both models and the moderately-small to moderately-large population estimates at year 6 for the POW Complex unit, and the finding that approximately 15 percent of simulations result in population sizes below 120, indicates moderately-low resiliency in terms of population growth.

Regarding diet, wolves in the POW Complex Analysis Unit primarily consume deer and have no access to other ungulate prey species. The POW Complex Analysis Unit also contains a lower number of non-ungulate prey species compared to the other units, although the non-ungulate wolf diet makes up a large proportion of the overall diet, given the lack of ungulate species available. Twenty-six percent of the diet in the POW Complex is composed of bears and beavers. In general, the POW Complex Analysis Unit appears to exhibit moderate resiliency in terms of dietary diversity.

The area of old-growth forest patches greater than 74 square kilometers (29 square miles) within the POW Complex Analysis Unit is 1,564 square kilometers (604 square miles). This is on the low end of old-growth availability compared with the other Analysis Units, and may cause instability within the population, especially given the wolves' reliance on deer for prey. Therefore, we consider this unit to exhibit moderately-low resiliency in terms of availability of preferred habitat.

The POW Complex Analysis Unit has a moderate mean road density (0.62 kilometer/square kilometer) and almost half (42 percent) of WAAs in the unit have road densities greater than 0.90 kilometer/square kilometer. Additionally, the ratio of shoreline to land area is high at 0.81.

Therefore, access to wolf harvest opportunities within this Analysis Unit is high. This indicates that resiliency, in terms of remoteness for the POW Complex Analysis Unit, is moderately-low.

Northern Coastal B.C. Analysis Unit

The population trend for the Northern Coastal B.C. Analysis Unit indicates that over the next 6 years the median population size will be 506 wolves (95 percent CI 325–738). No simulations result in a population size less than 120 wolves over the next 6 years. The large population estimate at year 6 for the Northern Coastal B.C. Analysis Unit, and the finding that no simulated populations fall below 120, indicates high resiliency in terms of population growth.

Regarding diet, wolves in the Northern Coastal B.C. Analysis Unit primarily consume deer, but also consume moose, goats, bears, and mustelids in high quantities. Although wolf diets in this unit have been shown to consist of only 10 non-ungulate prey species, the proportion of the diet made up of non-ungulates is fairly high. In general, this unit appears to exhibit high resiliency in terms of dietary diversity.

The area of old-growth forest patches greater than or equal to 75 square kilometers (29 square miles) within the Northern Coastal B.C. Analysis Unit is 1,427 square kilometers (551 square miles) (the smallest of all the Analysis Units). The small amount of old-growth forest in sufficient patches may cause instability within the population. Therefore, we consider this unit to exhibit low resiliency in terms of availability of preferred habitat.

The Northern Coastal B.C. Analysis Unit has a low mean road density (0.22 kilometer/square kilometer), and none of the WMUs in the unit have road densities greater than 0.90 kilometer/square kilometer. Additionally, the ratio of shoreline to land area is moderately-low at 0.20. Therefore, access to wolf harvest opportunities within this unit is low. This indicates that resiliency, in terms of remoteness for the Northern Coastal B.C. Analysis Unit, is high.

Southern Coastal B.C. Analysis Unit

The population trend for the Southern Coastal B.C. Analysis Unit indicates a median population size of 493 (95 percent CI 304–740) at year 6. No simulations result in a population size less than 120 wolves over the next 6 years. The large population estimate at year 6 for the Southern Coastal B.C. Analysis Unit, and the finding that no simulations result in populations below 120, indicates high resiliency in terms of population growth.

Regarding diet, wolves in the Southern Coastal B.C. Analysis Unit primarily consume deer, but also consume moose, goats, bears, and mustelids in high amounts. Although wolf diets in this unit have been shown to consist of only 10 non-ungulate prey species, the proportion of the diet made up of non-ungulates is fairly high. In general, this unit appears to exhibit high resiliency in terms of dietary diversity.

The area of old-growth forest patches greater than or equal to 75 square kilometers (29 square miles) within the Southern Coastal B.C. Analysis Unit is 4,429 square kilometers (1,710 square miles), which is high in comparison to the other Analysis Units. Therefore, we consider this unit to exhibit high resiliency in terms of availability of preferred habitat.

The Southern Coastal B.C. Analysis Unit has a moderately-low mean road density (0.54 kilometer/square kilometer), although almost a quarter (21 percent) of the WMUs in the unit have road densities greater than 0.90 kilometer/square kilometer. The ratio of shoreline to land area is low at 0.17. Therefore, access to wolf harvest opportunities within this unit is moderately-low. This indicates that resiliency, in terms of remoteness for the Southern Coastal B.C. Analysis Unit, is moderately-high.

All Analysis Units
Table 30 and Figure 25 below summarize the narratives presented above regarding the current resiliency of each Analysis Unit across the range of the Alexander Archipelago wolf. As discussed at the beginning of *Chapter 4.2 Current Population Resiliency*, population trend is the primary factor we used to assess resiliency of each Analysis Unit, and therefore we weighted this factor times 3 compared to the other three factors. Overall resiliency for each Analysis Unit was assessed by "averaging" the condition of all four factors.

Table 30 Summary of the current condition of important habitat and demographic factors contributing to the resiliency of Alexander Archipelago wolf populations across the range of the subspecies.

Analysis Unit	Population Trend (x3)	Dietary Diversity	Preferred Habitat Availability	Remoteness	Overall Resiliency
Northern Southeast Alaska	Moderately-high	High	Unknown	High	High
Southern Southeast Alaska	Moderately-high	High	High	Moderately-high	Moderately-high
POW Complex	Moderately-low	Moderate	Moderately-low	Moderately-low	Moderately-low
Northern Coastal B.C.	High	High	Low	High	High
Southern Coastal B.C.	High	High	High	Moderately-high	High

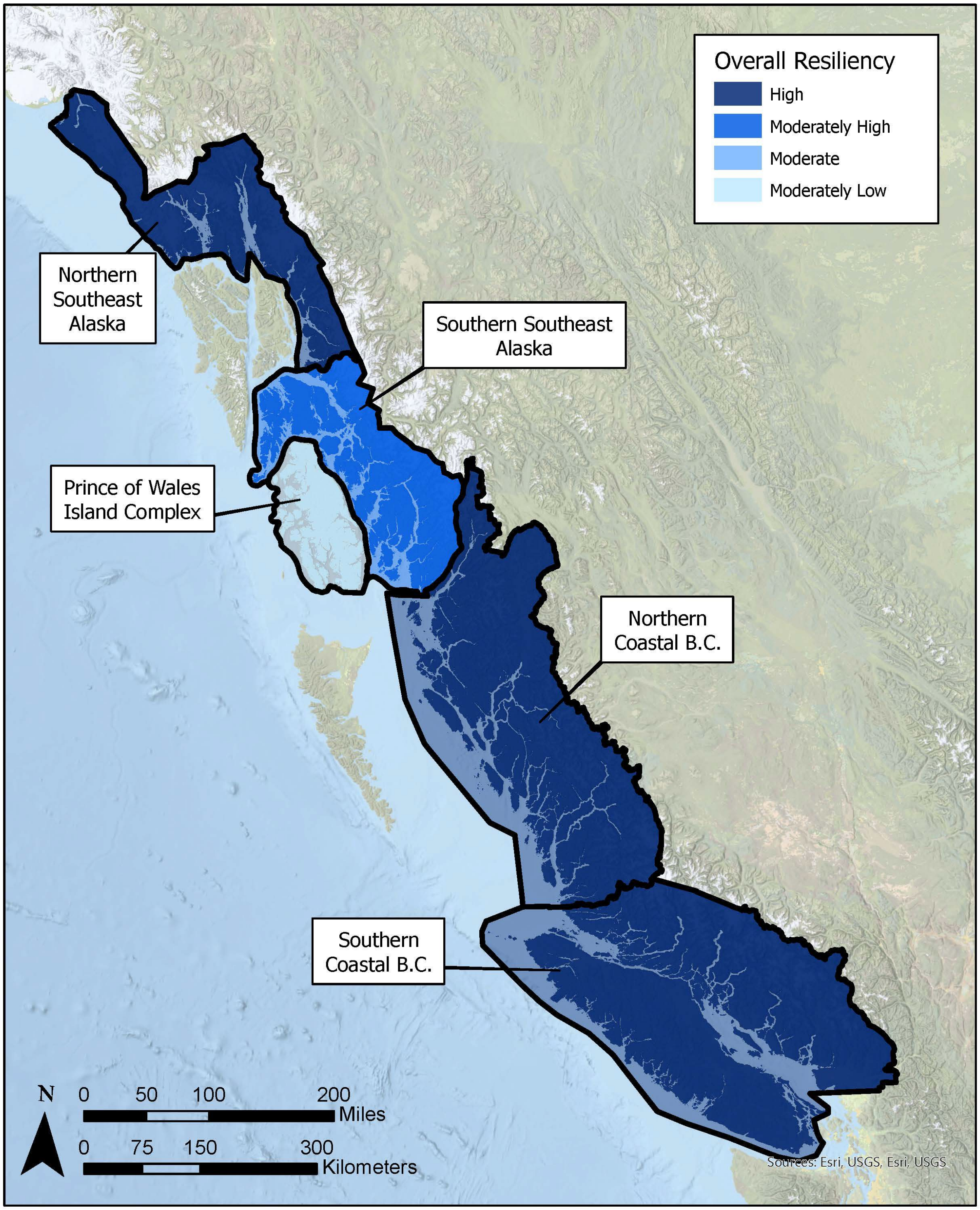


Figure 25 Map showing the overall resiliency for Alexander Archipelago wolves by Analysis Unit, based on the current condition of important habitat and demographic factors summarized in Table 30.

4.3 Current Species Representation

Representation describes the ability of a species to adapt to near-term and long-term changes in its physical and biological environments, also known as adaptive capacity. Adaptive capacity can include the ability to track changes in environmental conditions through dispersal, and capacity to alter behavioral or other traits to match changing conditions either through plasticity or evolutionary adaptation. In North American gray wolves, there are genetically distinct populations which correspond to differences in ecological factors such as prey type and habitat, indicative of local adaptation across the species complex. Suggested reasons for this pattern include dispersal by individuals to habitats similar to their natal environment (natal homing) and the presence of discrete habitat and prey relationships (Geffen et al. 2004, p. 2488; Musiani et al. 2007, pp. 4162–4163). As described in earlier sections of this SSA, Alexander Archipelago wolves in near-shore environments often specialize on fish and small deer, tend to be smaller and more slender than wolves elsewhere, and live in wet temperate rainforests. Although variation within the Alexander Archipelago wolf subspecies is more subtle than the variation between gray wolf subspecies, there is also evidence of ecological, genetic, and behavioral differences between Alexander Archipelago populations that would confer adaptive capacity across the subspecies range.

4.3.1 Ecological Variation

Maintaining populations across an array of environments ensures exposure to differing selective forces (Hoffmann and Sgrò 2011, p. 484; Lankau et al. 2011, p.320; Sgrò et al. 2010, p. 332), and thus, potentially increases a species' range-wide genetic variation and evolutionary potential (Service 2021, p. 5). One of the components of ecological variation that we discuss below is climatic niche breadth, which is a measure of the range of abiotic conditions to which a species is adapted, and the degree of flexibility the species has in responding to changing conditions potentially outside of that range. We also consider the physiological tolerances of Alexander Archipelago wolves by determining the degree to which the subspecies is restricted to a narrow range of abiotic conditions (e.g., temperature, hydrology, or snowpack conditions) (Thurman et al. 2021, entire). Please also refer to *Chapter 3.5 Climate Change* for an in-depth discussion of the potential effects of changing environmental conditions on Alexander Archipelago wolves. Schweizer et al. (2016a, p. 397) demonstrated that environmental influences dominate population structure in wolves, especially precipitation. Mean diurnal temperature range and maximum temperature of warmest month also appear to play an important role. This result is concordant with previous genetic analyses which suggest that vegetation (Geffen et al. 2004, p. 2481) and habitat type (Carmichael et al. 2007, p. 3466; Muñoz-Fuentes et al. 2009, p. 1) are the main drivers of wolf ecotype differentiation. Precipitation has also been shown to be a significant correlate of morphological variation in wolves (O'Keefe et al. 2013, p. 1235).

The climate in Southeast Alaska and coastal B.C. is generally wet and cool, but there is geographic variation. Average annual precipitation varies from 50 to 600 centimeters (20 to 236 inches) near sea-level, with more precipitation at higher elevations (Albert and Schoen 2007, p.

2; Tillmann and Glick 2013, p. 22). Summers tend to be drier than winters, when much of the precipitation falls as snow in northern portions of the region and at higher elevations (Tillmann and Glick 2013, pp. 21–22). Generally, temperatures are warmer in the southern portions of the range, and precipitation decreases from west to east (Shanley et al. 2015, p. 5; see Figure 13 in *Chapter 3.5 Climate Change*), often resulting in rainshadows on the eastern sides of some of the larger islands (MacKinnon 2003, p. 475).

In Southeast Alaska, the lowland forests are composed primarily of western hemlock and Sitka spruce (*Picea sitchensis*), whereas in coastal B.C., Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), and other fir species (*Abies* spp.) become increasingly common (Service 2015, p. 43). The dominant vegetation types not only vary with latitude, but also with elevation. With increasing elevation, forests grade into subalpine and alpine vegetation zones; treeline increases in elevation southward, ranging from about 700 to 900 meters (2,300–3,000 feet) (USDA 2016c, pp. 3–7; Albert and Schoen 2013, pp. 775–776). At the highest elevations, rock, snow, and ice dominate the land surface. The following sections summarize the primary ecological distinctions and provide insight about differences in selection pressures which could lead to local adaptation across the five Alexander Archipelago wolf Analysis Units.

Northern Southeast Alaska

The landscape of the Northern Southeast Alaska Analysis Unit is considerably different than the other four Analysis Units. Much of the region is covered in icefields and glaciers, and Glacier Bay National Park and Preserve protects a large chunk of the Unit, which also contains Southeast Alaska's highest and most steeply rising mountains. This portion of the Alexander Archipelago wolf's range also contains forelands consisting of surficial deposits, raised marine sands, and silts that support diverse forests and wetland ecosystems (Smith 2016, p. 34). As a result, the diet of the wolf within this unit is quite different than wolf diets across the rest of the range. Because few black-tailed deer occur in this unit, wolves consume moose and mountain goats at greater rates than in other parts of the range. The estimated population size within this unit also appears to be slightly smaller than the other Analysis Units, potentially because of the low availability of suitable habitat for deer (the preferred prey across the range).

POW Complex

The ecological dynamics of the POW Complex are also notably different when compared with the other Alexander Archipelago wolf Analysis Units. Although POW Island is the largest island in the Alexander Archipelago, and the northern portion of the island contains more productive forest land and rarer large-tree forests than any other unit in Southeast Alaska, it is also much more insular than the other units. Water barriers surround the island, creating a center of endemism and symbiotic ecological relationships among endemics (Smith 2016, pp. 36–37). As noted in *Chapter 2.5.1 Prey,* the only ungulate available to wolves in this unit are deer, resulting in different predator-prey dynamics compared with the Northern Southeast Alaska Analysis Unit.

In addition, the density of humans and anthropogenic impacts within this unit are higher than that of the other units in Southeast Alaska and the northern and central coasts of B.C.

Southern Southeast Alaska and Northern Coastal B.C.
These two units are probably the most ecologically similar of the five Analysis Units across the range of the wolf. The mainland portions of these units are partially comprised of steep-walled granitic fjords, narrow valleys, and fragmented sections of conifer forest. However, some areas also contain gentler topography, numerous estuaries, and large amounts of productive old-growth forest. Many of the islands within these units are characterized by fjords and large-tree old-growth (Smith 2016, pp. 34, 36). Wet coastal forests dominate but on the upper elevations there are extensive areas of alpine and often barren rock (Demarchi 2011, p. 29). Human presence is limited within both units, but especially on the southern mainland of Southeast Alaska. Deer, moose, and mountain goats are available, as are elk, which were introduced to one of the islands in Southern Southeast Alaska.

Southern Coastal B.C.
Although the topography and climate of the southern B.C. mainland is similar to that of the southern Southeast Alaska and northern B.C. mainland, the southernmost parts of this unit have the greatest amount of annual sunshine in B.C., and temperatures are moderated by the Pacific Ocean and inshore marine waters (Demarchi 2011, pp. 37, 48). This unit contains Vancouver Island, which is more accessible from the mainland compared to POW Island, and it also provides habitat for both deer and elk. Most of the human population in B.C. occurs in the Southern Coastal B.C. Analysis Unit (primarily in and around the cities of Vancouver and Victoria), and the environment has been greatly modified. Large portions have been converted to exclusive urban, industrial, and agricultural use (Demarchi 2011, p. 47).

4.3.2 Inter-Population Dispersal Capacity
The ability of Alexander Archipelago wolves to disperse between populations is important for tracking changing environmental conditions and increasing gene flow among populations. Gene flow supports evolutionary processes by introducing new alleles into a population, thereby increasing genetic variation (Service 2021, p. 5). Maintaining the natural network of genetic connections between populations minimizes the loss of genetic variation due to genetic drift (Crandall et al. 2000, p. 293). Dispersal capacity has a positive effect on genomic diversity and reduces inbreeding effects, ultimately increasing evolutionary potential in isolated populations (discussed below).

Given the naturally fragmented landscape within the range of the Alexander Archipelago wolf, connectivity among Analysis Units is of considerable relevance when assessing the status of the range-wide population. If a lot of interchange among Alexander Archipelago wolf populations occurs, especially between mainland and island populations, then reduction or loss of wolves for any island or island groups poses less risk to the overall population than if interchange of wolves is limited. One major limitation to our understanding of the Alexander Archipelago wolf is the lack of data on immigration and emigration rates between and among populations and other related processes such as colonization and recolonization.

Demographic connectivity depends on the relative contribution of immigration and emigration compared with within-population vital rates of birth and death; in other words, it does not depend on dispersal or movement alone, but instead considers how migration rates relative to local recruitment affects dynamics within and among populations (Lowe and Allendorf 2010, p. 3039; Mills 2013, p. 177). We are not aware of any field studies that have measured demographic connectivity explicitly or opportunistically, and therefore, in this section, we describe inter-population dispersal and movements of Alexander Archipelago wolves.

The fact that wolves have not established breeding populations on Admiralty, Baranof, and Chichagof Islands, even though those islands support high numbers of deer, indicates that wolf movements may be restricted by water barriers. Potential crossing distances to these islands at some locations are not greater than confirmed crossing points elsewhere in the Archipelago (Person et al. 1996, p. 4); however, recent glaciation, the shape and distribution of land masses, and tidal currents likely combine with over-water distances to impede successful wolf dispersal. Also, lower densities of wolves on the mainland, a potential source population, may influence chance dispersal events to these islands. In terms of distance, avenues of dispersal are limited, and most of the feasible dispersal routes involve multiple swims. Generally, as the larger straits between land masses become constricted into channels and passes, the greater the influence of tidal currents.

Movements of wolves among nearby islands probably are common. Yet, wolves that were radio-collared on POW Island and Kosciusko Island did not disperse out of the population, which would require at least five swims with the longest being only about 2 kilometers (1.2 mi) in length (see *Chapter 2.4.2 Intra-Population Dispersal*). Alexander Archipelago wolves in coastal B.C. apparently can swim as far as 13 kilometers (8 miles) (Darimont and Paquet 2002, p. 418), although we presume that this lengthy distance is on the extreme end. Nonetheless, we assume that wolves are capable of swimming the short distance (approximately 3.2 kilometers (2 miles)) from POW Island to West Island and onward to Zarembo Island (i.e., between the POW Complex and Southern Southeast Alaska Analysis Units). Using remote camera systems, a wolf was documented on Shrubby Island between POW Island and Zarembo Island (ADFG 2015d, p. 2), suggesting that wolves explore and occupy this route, although concrete evidence of successful dispersal is lacking.

In a recent study, one potential immigrant or offspring of an immigrant wolf was identified on POW Island using genomic data, which further supports the hypothesis that wolves can move between the mainland and POW Complex. However, the frequency of these immigration events is unknown, and the probability of these immigrants reproducing in the POW Complex Analysis Unit is also unknown (Zarn 2019, p. 15). The degree of insularity probably varies among island groups. Interchange between POW Complex and the mainland may be limited most, in part due to the time required to travel the distance and the low survival rates of dispersing wolves (see *Chapter 2.4.2 Intra-Population Dispersal*), and therefore could be inconsequential from a demographic perspective. Additionally, genomic assessments of inbreeding indicate that the number of successfully breeding migrants is not sufficient to alleviate high levels of recent inbreeding in the POW Complex (Zarn 2019, p. 15).

Genetic studies also inform our understanding of inter-population dispersal among mainland populations. For example, one study used genetic assignment tests to identify directional movement of wolves in coastal B.C. into mainland Southeast Alaska (Breed 2007, p. 34). Other studies support the overall assessment that Alexander Archipelago wolves are not genetically homogenous (or panmictic) across their range, though they do exhibit population genetic structuring reflecting both geographic distance and barriers to movement (e.g., Weckworth et al. 2005, pp. 919–920, 926–927; Cronin et al. 2015a, entire; Zarn 2019, entire), as delineated by our Analysis Units (discussed in *Chapter 1.2 Geographic Extent and Analysis Units*).

4.3.3 Evolutionary Potential (Genetic Diversity)

Evolutionary potential is the ability of populations to evolve genetically-based changes in traits in response to selection through evolutionary adaptation. It is dictated by traits and behaviors that influence fitness and determines the long-term persistence of the species in the face of environmental change. Conserving a species' evolutionary potential requires maintaining the existing genetic variation that natural selection acts upon, as well as the processes that generate variation across species' ranges (Service 2021, p. 4). Species with larger ranges (spread across variable environmental conditions/selective pressures), larger population sizes (to maintain genetic diversity and reduce the impact of genetic drift), and relatively continuously-distributed populations will generally have larger census and effective population sizes, reduced drift, and increased evolutionary potential. By contrast, species with smaller ranges and/or fewer or more isolated populations with smaller population sizes are more likely to have reduced evolutionary potential (Forester et al. 2022, p. 7–10).

As discussed above, Alexander Archipelago wolves occupy variable ecological and climatic conditions across their range, providing selective pressures that may drive local adaptation. Additionally, the subspecies has sufficiently constrained dispersal and gene flow to reflect population genetic substructure, which can indicate the presence of genetic lineages that may harbor locally adaptive traits (Hendry et al. 2011, p. 167). These conditions can increase overall adaptive capacity of the subspecies if populations harbor sufficiently large effective population sizes and genetic diversity to maintain the standing genetic variability necessary for current and ongoing adaptation. However, a recent study estimating individual-level genomic inbreeding in wolves across Southeast Alaska identified high levels of recent and ancestral inbreeding in wolves in the POW Complex and total genomic inbreeding in Southern Southeast Alaska and, to a lesser extent, Northern Southeast Alaska (Zarn 2019, entire; see *Chapter 3.3 Inbreeding*). Low genetic diversity and high levels of inbreeding compared to other gray wolf populations in northwestern North America have recently been documented in Alexander Archipelago wolves at the larger Southeast Alaska scale as well (Pacheco et al. 2022, entire; see *Chapter 3.3 Inbreeding*). The study found consistently smaller Ne values for the Southeast Alaska population compared with the other four inland populations evaluated (Pacheco et al. 2022, p. 7), and a reduction in genetic diversity across a geographical gradient from Russian populations towards northwestern North American populations, with Southeast Alaska wolves showing the lowest genetic diversity and highest genome-wide homozygosity, particularly over the past 64 generations (c. 280 years) (Pacheco et al. 2022, p. 10).

While inbreeding can result in direct fitness impacts (e.g., inbreeding depression), it also reduces genetic diversity and evolutionary potential, causing maladaptation and reduced population and species-level viability (Forester et al. 2022, p. 2–3). Based on these data, wolves in the POW Complex will have highly reduced evolutionary potential, decreasing their capacity to show an evolutionary response to changing environmental conditions. While signatures of recent inbreeding are lower in mainland Alaska, total genomic inbreeding will also contribute to reduced evolutionary potential throughout the Southeast Alaska Analysis Unit. Available data for the Northern Coastal B.C. Analysis Unit indicates that inbreeding is low (Breed 2007, p. 18); we have no available data to inform inbreeding metrics in the Southern Coastal B.C. Analysis Unit.

4.3.4 Behavioral Plasticity

Plasticity is the ability of one genotype to produce more than one phenotype when exposed to different environments and allows individuals to acclimate to new conditions within a lifetime, as rapidly as instantaneously (Hendry et al. 2011, p. 161). Plasticity is an important mechanism that some species possess to accommodate environmental variation and, like evolutionary (genetic) responses, can include changes in behavior (Beever et al. 2017, entire), morphology (Thurman and Garcia 2017, entire), phenology (Socolar et al. 2017, entire), and physiology (Coles et al. 2018, entire). Plasticity can also be considered a trait in-and-of-itself (in addition to being a mechanism of adaptive capacity) as it has the potential to evolve (Service 2021, p. 4).

As discussed in *Chapter 2.5 Resource Needs and Habitat* and *Chapter 3.5 Climate Change*, Alexander Archipelago wolves are habitat generalists, which tend to be resilient to changes in their environment, since they already survive in a variety of habitats and conditions. They also utilize a range of food resources and are flexible in prey preference. In general, wolves are capable learners that exhibit extreme behavioral plasticity (Zimmermann et al. 2014, pp. 1360–1362; Price and Daust 2016, p. 22; Barber-Meyer et al. 2021, pp. 1, 11).

Some wolf populations have also shown behavioral plasticity in response to human modification of natural landscapes. For example, wolves in Scandinavia have been documented adapting to and using roads for traveling, scent-marking, and territorial patrolling, but they have also developed cryptic behavioral responses to roads, likely driven by the increased risks associated with human presence. The high behavioral plasticity which allows such ambivalent responses of wolves toward infrastructure is a key factor in the recent wolf recovery in industrialized countries, many of which have higher densities of roads and humans than in Scandinavia (Zimmermann et al. 2014, p. 1362). Additionally, wolves across Southeast Alaska have been observed avoiding locations where traps have been set previously. Once a wolf has been caught, others in the pack will avoid the area, and catch success has been documented to decrease with duration of trapping effort in the same location. Wolves also avoid trapping locations if they recognize a human scent on the equipment (Brooks et al. 2022, pp. 34, 47–48, 53, 76–77).

4.3.5 Current Representation Summary

Environmental variability across the Alexander Archipelago wolf range contributes to the maintenance of evolutionary potential and adaptive capacity range-wide since diverse environments expose populations to heterogeneous selection pressures. Although much of the range is characterized by similar climatic, geologic, and vegetation regimes, there are notable differences that may result in some local adaptation between Analysis Units. Elevation plays a large role in these variations, as well as latitude. It is also important to take into account anthropogenic influences on the landscape and the climate when evaluating the ability of wolf populations to adapt to changing conditions and novel environments.

Moving north to south across the Alexander Archipelago wolf Analysis Units in Southeast Alaska, we notice a shift in climate, geology, and dominant vegetation types. The Northern Southeast Alaska Analysis Unit exhibits significantly different topography when compared with the POW Complex Analysis Unit, for example. Similarly, the influence of humans in the Northern Southeast Alaska Analysis Unit is small compared with the POW Complex Analysis Unit, where timber harvest and road development has historically been extensive, and also between the Northern Coastal B.C. Analysis Unit, where there are few population centers, and the Southern Coastal B.C. Analysis Unit, where most of the B.C. population exists in two large urban areas.

Wolf populations appear to be quite adaptable in terms of their ability to occupy different habitats in a variety of climatic conditions (see *Chapter 3.5 Climate Change*), and we expect that a range of novel conditions will generally be tolerable for Alexander Archipelago wolves across the range. However, the potential for adverse cumulative impacts of timber harvest, wolf harvest, and climate change should not be discounted in Analysis Units where these threats occur. Additionally, in insular populations, such as the POW Complex Analysis Unit, where shifts in behavior are limited, changing environmental conditions could be more detrimental.

In general, wolves have substantial movement capability and can travel long distances to achieve their resource needs. However, compared with other gray wolf populations in interior Alaska, Canada, and the lower 48 of the United States, Alexander Archipelago wolves face challenging geographic barriers to movement in the form of steep fjords and tidally influenced and sometimes lengthy marine water barriers. Although Alexander Archipelago wolves have been documented swimming long distances, there is evidence that some islands in the Archipelago are significantly more difficult to access (POW Island, Admiralty, Baranof, and Chichagof Islands). Therefore, connectivity between islands and between the mainland and islands is restricted and may result in increased insularity and decreased gene flow for some island populations.

These characteristics are reflected in studies of genetic differentiation and admixture across the subspecies range, with higher differentiation primarily between mainland and island wolves, likely due to geographic barriers and potentially natal habitat-biased dispersal rather than isolation-by-distance. Where population sizes are large enough to maintain adaptive genetic diversity and reduce the impact of genetic drift, this interplay of differentiation and gene flow across the range may provide conditions that foster the maintenance of evolutionary potential range-wide. For example, Northern Coastal B.C. may serve as a source population for Southern Southeast Alaska (Breed 2007 p. 19–22), increasing population size and genetic diversity, despite signatures of historical inbreeding, potentially due to historical barriers to movement (Zarn 2019 p. 14). Within Southeast Alaska, the Northern Analysis Unit exhibits the most heterozygosity and lowest levels of genomic inbreeding, which may result from high genetic connectivity with interior wolves. By contrast, where populations are small and isolated, evolutionary potential will be at risk due to loss of genetic variation from genetic drift and inbreeding. For example, the POW Complex Analysis Unit is more differentiated than other units in Southeast Alaska in addition to exhibiting signs of recent, historical, and ancestral inbreeding. This could pose a significant threat to POW Complex wolves because of their isolation, and it will be important to closely monitor abundance to avoid the potential for the population to enter an extinction vortex. Evolutionary potential in this Analysis Unit has possibly declined as a result of hunting pressure and impacts to primary prey (deer) from timber harvest, which have caused fluctuations in population sizes (e.g., bottleneck effects), reductions in effective population sizes, and increased inbreeding.

Like many other gray wolf subspecies, the Alexander Archipelago wolf exhibits high behavioral plasticity, both in terms of dietary breadth and habitat generalization. Across most of the Analysis Units, Alexander Archipelago wolves are flexible in their prey consumption, and during much of the year, are readily able to switch among multiple food sources based on their availability. Most populations are not strongly dependent on one or a few species; however, there is one notable example where this is not the case – the POW Complex– where deer are the only available ungulates. This may put pressure on wolves in years when deer populations are low, but wolves within this unit also appear to frequently utilize other non-ungulate prey species such as bears and beavers.

Alexander Archipelago wolves are also habitat generalists, primarily because of their varied diets. Depending on the food they are targeting, wolves will utilize whatever habitats are preferred by their prey. However, Alexander Archipelago wolves are more selective when it comes to denning and rearing habitat, preferring old-growth stands in close proximity to fresh water and away from roads (see *Chapter 2.5.2 Habitat and Space Use*). Availability of fresh water is not a concern across the range of the subspecies, but there are Analysis Units where old-growth is more limited (POW Complex and Northern Coastal B.C.) and roads are more dense (POW Complex and Southern Coastal B.C.). The ability of Alexander Archipelago wolves to cope with limited availability of their preferred denning habitat is unknown. However, in other subspecies (e.g., Scandinavia), wolves have exhibited a great deal of adaptability in terms of their response to roads.

Generally, Alexander Archipelago wolves appear to have high adaptive capacity, and most populations will likely be able to adapt to near-term changes in their physical and biological environments. An exception is the POW Complex Analysis Unit, which exhibits high levels of inbreeding and high prey specificity, characteristics that limit this population's adaptive capacity; signatures of historical and ancestral inbreeding in the Southern Southeast Alaska Analysis Unit may also limit evolutionary adaptive capacity in this population. It will be important to monitor more insular populations and those exposed to significant threats (i.e., timber and wolf harvest), as these populations face greater challenges when it comes to dispersal capacity and gene flow, as well as the ability to occupy different niches within their environment.

4.4 Current Species Redundancy

Redundancy describes the number and distribution of populations, such that the greater the number and the wider the distribution of resilient populations, the better Alexander Archipelago wolves will be at withstanding catastrophic natural or anthropogenic events. The catastrophic event with the highest potential to impact Alexander Archipelago wolf redundancy is disease. Canine distemper virus and canine parvovirus pose the largest known disease threat to Alexander Archipelago wolves because, when introduced to naïve populations, they have very high mortality rates. If either pathogen enters a population it may result in a large-scale epidemic. This concern is heightened by the high prevalence of canine herpesvirus in Alexander Archipelago wolves, because coinfection with parvovirus or distemper virus would be highly detrimental to pup survival. We are not aware of any significant disease outbreaks within Alexander Archipelago wolf populations currently.

Alexander Archipelago wolves currently occupy five Analysis Units that span the historical range of the subspecies, three of which exhibit high resiliency (Northern and Southern Coastal B.C. and Northern Southeast Alaska), one with moderately-high resiliency (Southern Southeast Alaska), and one with moderately-low resiliency (POW Complex). Given the wide distribution of populations across the historical range, and the moderately-high to high resiliency exhibited by most of the populations, we consider the Alexander Archipelago wolf subspecies to have high redundancy in the face of potential catastrophic events.

CHAPTER 5 – FUTURE CONDITIONS

We have considered what the Alexander Archipelago wolf needs for viability and the current condition of those needs (*Chapter 2 Species Biology and Individual Needs* and *Chapter 4 Population and Species Needs and Current Condition*), and we reviewed the factors that are driving the current and future conditions of the subspecies (*Chapter 3 Factors Influencing Viability*). We now consider the subspecies' future condition. We apply our future forecasts to the concepts of resiliency, representation, and redundancy to describe the future viability of the Alexander Archipelago wolf.

To evaluate future condition, we used the same models to project the population forward that we used to evaluate current condition, and we considered the future condition of habitat and demographic needs under a range of plausible scenarios. For these scenarios we included an effect of potential stochastic disease events (described below). We developed future scenarios to capture the range of uncertainty associated with how threats could influence viability in the future.

We evaluated future condition for the Alexander Archipelago wolf 30 years into the future. We selected this timeframe because it captures approximately five generation intervals (i.e., the approximate time that it takes a female wolf to replace herself in the population). Given the longevity of Alexander Archipelago wolves, five-generation intervals represent a time period during which a complete turnover of the population would have occurred, and any positive or adverse changes in the status of the population would be evident. Additionally, this timeframe considers the possibility that USFS land management plans, which may provide important conservation measures to reduce potential threats, could go through at least one revision.

Below we discuss the plausible future scenarios that were selected for each threat, followed by a discussion of the methods used to model the effects of the threats into the future. Finally, we provide a summary of the results for each Analysis Unit and discuss future representation and redundancy for the Alexander Archipelago wolf subspecies.

5.1 Future Scenarios and Models

The following figure (Figure 26) provides a visual representation of the core Alexander Archipelago wolf habitat and demographic factors (green and blue boxes; see *Chapter 4.2 Current Population Resiliency* for additional context), along with the primary influences on viability (yellow, orange, and gray boxes; see *Chapter 3 Factors Influencing Viability* for in-depth descriptions of each one). This conceptual diagram formed the basis for our future condition modeling; in the following sections we break out each influence pathway and discuss the methods used to evaluate the impact of each one on Alexander Archipelago wolf resiliency, representation, and redundancy. The two climate change variables with dashed boxes were considered for our assessment of future condition; however, they were ultimately excluded due to a lack of information about their effects on Alexander Archipelago wolf resiliency and because of the widely cited adaptability of Alexander Archipelago wolves to changing environments.

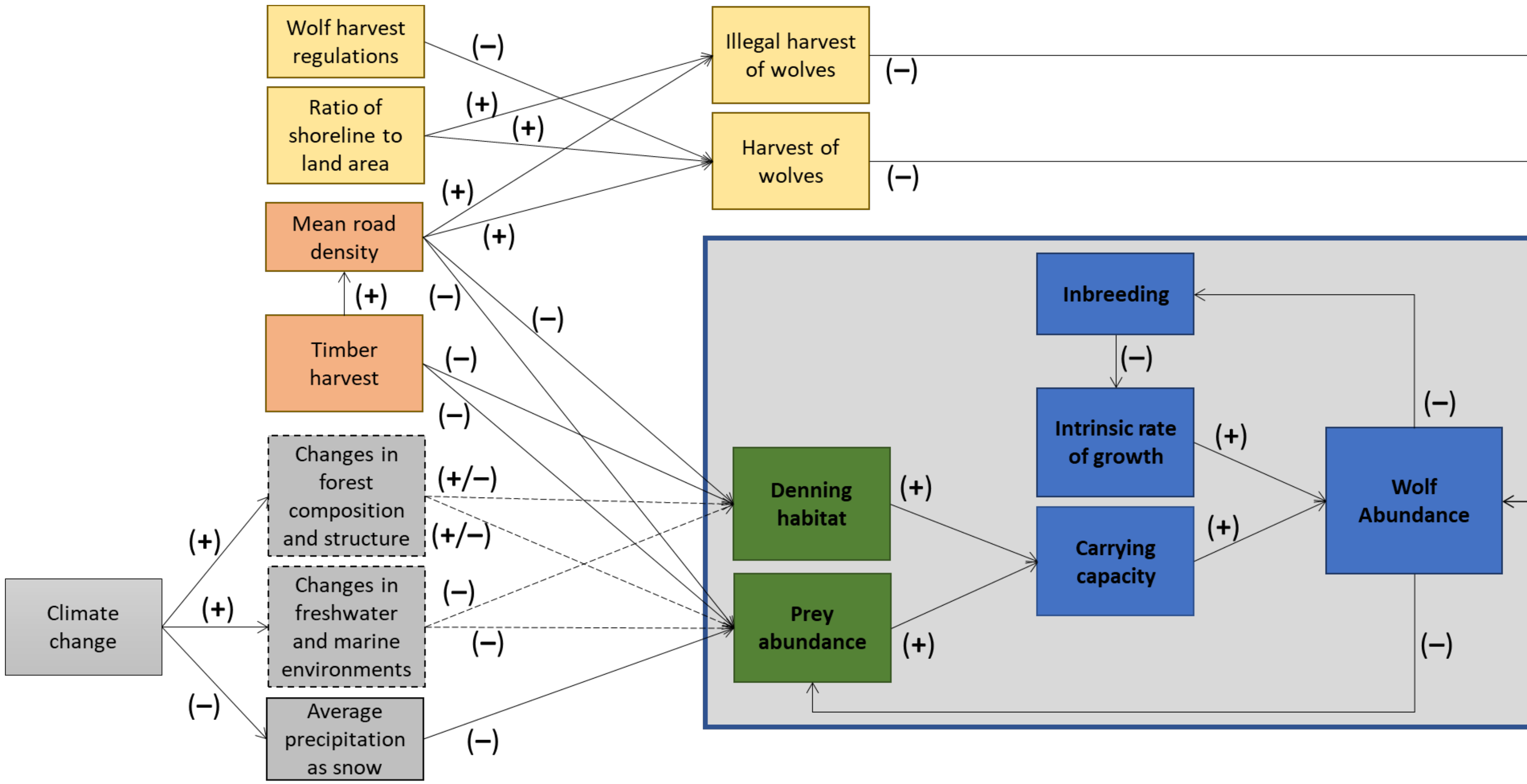


Figure 26 Diagram of Alexander Archipelago wolf needs and the primary influences on wolf resiliency. The pluses and minuses denote the directionality of the relationship. Pluses indicate a positive or direct relationship, and minuses indicate a negative or inverse relationship.

The core models that were used to evaluate current resiliency within each of the Alexander Archipelago wolf Analysis Units were also used to evaluate future resiliency but were updated to include additional potential threats that populations may be exposed to in the future. We developed one model for all five of the Analysis Units, "Model A" (Table 31), that helped us assess potential future effects of wolf harvest, inbreeding, and disease. We also updated the POW Complex model, "Model B" (Table 32), that was developed during the previous version of the Alexander Archipelago wolf SSA (Service 2015, entire; Gilbert et al. 2022, entire). Model B does not include inbreeding effects, but it does include climate change, timber harvest, and wolf harvest effects (for additional information about this model, see *Chapter 4.2.1 Population Trend*). We added the potential effect of disease as described below.

We developed different scenarios for the various threats to explore a range of possible future conditions for the Alexander Archipelago wolf, given the uncertainty with future threats, the potential response to those threats, and the potential for possible conservation efforts to improve future conditions. For this assessment, we developed three scenarios that capture the range of plausible, future possibilities for the Alexander Archipelago wolf and its habitats. Scenarios are qualitative in nature, include a high level of uncertainty, and are intended to evaluate general impacts of the range of potential future threats and conservation actions.

The future scenarios that we used to evaluate condition for the Alexander Archipelago wolf are:

Future Scenarios A1 and B1: Under these scenarios, primary threats are at the lowest plausible levels.

Future Scenarios A2 and B2: Under these scenarios, primary threats continue as currently observed.

Future Scenarios A3 and B3: Under these scenarios, primary threats are at the highest plausible levels.

Table 31 and Table 32 summarize the two future condition models (Model A and Model B) and include brief descriptions of the three scenarios that were evaluated for each stressor included in the model. Disease was analyzed differently in that we ran all other scenarios in each of the models under a "Disease Scenario" and a "No-Disease Scenario".

Table 31 Summary of the future scenarios included in Model A. Inbreeding reduces the overall population growth rate and is included in all scenarios. YNP= Yellowstone National Park.

Future Scenarios for Model A		
NO-DISEASE		
	Wolf Harvest	
Scenario A1	Minimum harvest rate	
Scenario A2	Average harvest rate	
Scenario A3	Maximum harvest rate	
DISEASE (based on observed rates in YNP)		
	Wolf Harvest	**Disease**
Scenario A1	Minimum harvest rate	Disease event once every 7 years (25 percent reduction in population)
Scenario A2	Average harvest rate	
Scenario A3	Maximum harvest rate	

Table 32 Summary of the future scenarios included in Model B, which is an updated version of the POW Complex population model that was used in 2015 Alexander Archipelago wolf SSA. YNP= Yellowstone National Park.

Future Scenarios for Model B				
NO-DISEASE				
	Wolf Harvest	**Climate (Ave. Precip. As Snow)**	**Timber Harvest**	
Scenario B1	low harvest - short season (20 days)	SSP5-8.5 (180 mm)	transition to young-growth	
Scenario B2	moderate harvest - medium season (30 days)	SSP3-7.0 (192 mm)	harvest of old-growth at rates observed from 2008-present	
Scenario B3	high harvest - long season (40 days)	SSP2-4.5 (200 mm)	maximum harvest of old-growth	
DISEASE (based on observed rates in YNP)				
	Wolf Harvest	**Climate (Ave Precip. As Snow)**	**Timber Harvest**	**Disease**
Scenario B1	low harvest - short season (20 days)	SSP5-8.5 (180 mm)	transition to young-growth	Disease event once every 7 years (25 percent reduction in population)
Scenario B2	moderate harvest - medium season (30 days)	SSP3-7.0 (192 mm)	harvest of old-growth at rates observed from 2008-present	Disease event once every 7 years (25 percent reduction in population)
Scenario B3	high harvest - long season (40 days)	SSP2-4.5 (200 mm)	maximum harvest of old-growth	Disease event once every 7 years (25 percent reduction in population)

The following sections outline the methods and justifications that were used to develop the different scenarios for each threat that was included in the models.

5.2 Future Resiliency Methods

5.2.1 Wolf Harvest

As described in *Chapter 4.2.1 Population Trend*, for Model A we used current reported harvest and included estimates of unreported harvest to estimate total current harvest. Although there will always be uncertainty regarding future management of wolf populations in Alaska and B.C., based on the best available information, we assume that harvest regulations will remain similar to the existing regulations within each Analysis Unit. For the units in B.C., we don't anticipate changes to the hunting bag limit of three wolves and unlimited trapping throughout the season. Outside of the POW Complex in Alaska, we also expect the bag limit for hunters to remain at five wolves annually and for no bag limit to be set for trappers. Historically, wolf harvest regulations have fluctuated the most on the POW Complex, and we expect fluctuations to continue.

To capture the range of plausible wolf harvest scenarios for Model A, we first calculated the mean, maximum, and minimum total harvest (reported and unreported) for each Analysis Unit between the years 1997–2021 (see Appendix C for a summary of these calculations). We then estimated the difference in the percentage of the population harvested between the mean harvest and the maximum and minimum and divided this difference in half to estimate a plausible maximum and minimum harvest rate for each Analysis Unit. Scenario A1 represents the minimum plausible harvest rate, Scenario A2 represents the mean harvest rate, and Scenario A3 represents the maximum plausible harvest rate (Table 33).

Table 33 Percentage of total population harvested per Analysis Unit under Scenarios A1, A2, and A3.

	POW[1]	Northern SE Alaska	Southern SE Alaska	Northern B.C.	Southern B.C.
Scenario A1	11–17 percent	8 percent	18 percent	3 percent	6 percent
Scenario A2	20–31 percent	11 percent	23 percent	6.5 percent	12 percent
Scenario A3	43–62 percent	15 percent	27 percent	14 percent	24 percent

[1]For the POW scenarios, rather than using a fixed unreported harvest rate, we used a lower unreported harvest bound of 17 percent and an upper unreported harvest bound of 47 percent to reflect year to year variation and uncertainty in this parameter (as we did for current condition modeling (see *Chapter 4.2.1 Population Trend*). This explains total harvest being represented as a range of values rather than a fixed value for POW.

To demonstrate the long-term effects of different harvest season lengths, we evaluated wolf population projections under three different harvest scenarios for Model B. We estimated moderate harvest as a 30-day season (60–90 wolves), reflecting average harvest totals over previous years, low harvest as a 20-day season (40–60 wolves), and high harvest as a 40-day season (80–120 wolves). Our models hold the number of days in the season constant and select a number of wolves harvested per day from a distribution (provided by ADFG). These models assume that harvest does not change as a function of population size, and that there is no population-level threshold at which harvest ceases. This results in a fixed number of wolves being harvested from the population yearly rather than adjusted adaptively according to the population size.

5.2.2 Timber Harvest

In Southeast Alaska, the Tongass is seeking to accelerate the transition from old-growth to young-growth harvest while also providing a timber supply that meets the annual market demand for timber on the Tongass (USDA 2016b, p. 5–13). The current Five-Year Sale Schedule and Contract Plan produced by the Tongass anticipates 22.4 MMBF of old-growth timber and 64.75 MMBF of young-growth timber to be sold between 2022 and 2026 (USDA 2021, entire). Most of this timber is scheduled to be sourced from the POW Complex and the Southern Southeast Alaska Analysis Units, and no timber is scheduled for sale from the Northern Southeast Alaska Analysis Unit (Table D 4 in Appendix D, USDA 2021, entire).

As of June 2022, at least 47.6 MMBF of old-growth timber and 14 MMBF of young-growth timber from 7 different NEPA project decisions remained unsold (Table D 5 in Appendix D; Sever 2022, pers. comm.). There are 5 additional NEPA project decisions that authorize commercial firewood and individual tree sales (up to 0.3 square kilometers [0.1 square miles]), and salvage sales (up to 50 MBF). There are 7 projects still under development that could clear an estimated 83.3 MMBF of old-growth timber, 103 MMBF of young-growth timber, and 2 projects that could clear small sales or microsales (Table D 5 in Appendix D; Sever 2022, pers. comm). All 83.3 MMBF of the old-growth timber volume is associated with projects that were on-hold as of June 2022. It is difficult to accurately convert NEPA volumes of wood to an area that will likely be logged because many of these projects involve partial harvest. Additionally, NEPA-cleared volume is a rough estimate of volume per acre, and the actual volume sold is based on statistically valid timber cruises, or the process of measuring forested stands for timber sale preparation. While NEPA clearing authorizes which areas could have timber harvest, the Southeast Alaska Sustainability Strategy currently limits the amount of old-growth timber that can be offered to around 5 MMBF per year across the whole Forest.

After the timber is sold, it is considered “under contract” and may be cut by the purchaser. As of April 2022, the Tongass had 35 contracts in place with approximately 14 MMBF of old-growth timber and 18 MMBF of young-growth timber remaining that was not yet cut (Table D 6 in Appendix D, USDA 2022c, unpaginated).

Most of the projected old-growth timber harvest (including scheduled volume, NEPA-cleared and NEPA-in-development volume, and volume under contract, summarized in Table 34) is located in the POW Complex Analysis Unit where roughly 58 percent of past harvest occurred within the range of the wolf in Southeast Alaska (Figure 5). For all Analysis Units, old-growth timber harvest on the Tongass is projected to contribute less to the total future harvest compared to past harvest.

Table 34 Summary of projected old-growth timber harvest volume (MMBF) on the Tongass National Forest from the Five-Year Sale Schedule and Contract Plan (Table D 4 in Appendix D), uncut volume currently under contract (Table D 6 in Appendix D), and NEPA-cleared timber and NEPA-in-development timber projects (Table D 5 in Appendix D).

Analysis Unit	Volume (MMBF) of Old-Growth Timber			
	Five Year sale schedule	Under contract (sold)	NEPA-cleared (unsold)	NEPA-in-development, but on-hold
Northern Southeast Alaska	-	-	22	-
Southern Southeast Alaska	10.55	3.9	10.3	53
POW Complex	9.85	8.8	15.5	30.3
Other (outside wolf range)	2	1.5	-	-
Total	22.4	64.75	47.8	83.3

We acknowledge a large degree of uncertainty associated with planning, selling, and cutting timber on the Tongass. Between 2016 and 2021, an average of 11 MMBF of timber was sold, roughly 24 percent of the annual Projected Timber Sale Quantity under the current Forest Plan (46 MMBF) (USDA 2022b, unpaginated). Timber sales on the Tongass have often been delayed during the planning process and due to litigation surrounding individual project decisions. In some cases, timber is offered for sale, but not sold due to a lack of bidders. Thus, with respect to future timber harvest on the Tongass, it is likely that the projected harvest described in this section will not be implemented fully or on schedule; alternatively, sales and projects currently not on the schedule could be prioritized in the future.

Though the Forest Plan and Southeast Alaska Sustainability Strategy provide current direction on the amount of old-growth timber volume that can be offered, the fate of the 2001 Roadless Rule on the Tongass could change where that volume comes from on the Forest. Gray wolf packs have been documented to require a territory of at least 75 square kilometers (29 square miles) in order to meet their nutritional requirements (Fuller et al. 2003, p. 163). Under a full exemption, an additional 16 square kilometers (6 square miles), 152 square kilometers (59 square miles), and 70 square kilometers (27 square miles) of old-growth in contiguous large (greater than or equal to 75 square kilometers) patches could become suitable for timber harvest in the Northern Southeast Alaska, Southern Southeast Alaska, and POW Complex Analysis Units, respectively (Table D 7 in Appendix D). While a full exemption would provide more options for offering economically viable timber sales, most of the areas that would be made suitable for timber harvest are distant from roads, and accessing timber in those areas could be cost prohibitive

(USDA 2020a, p. 7). In 2021, USDA began taking steps to repeal the 2020 Alaska Roadless Rule to maintain protections of inventoried roadless areas on the Tongass.

While the Tongass is dialing back on old-growth timber harvests, land transfers and exchanges could bring some productive old-growth stands from the Tongass into ownership that harvests timber more aggressively under the Alaska Forest Practices Act. Active land transfers include the Alaska Mental Health Trust Land Exchange (transfers nearly complete) and the Unrecognized Southeast Alaska Native Communities Recognition and Compensation Act (SB3269, introduced to the Senate in November 2021). The State National Forest Management Act, which was introduced in 2017 as HR232 and again in 2021 as HR633, is currently inactive, but we are including it to show how land management within the range of the wolf could change if transfers like this ever passed (Table D 8 in Appendix D).

The Alaska Mental Health Trust Land Exchange transfers 72.5 square kilometers (27.9 square miles) of Alaska Mental Health Trust land for 74.6 square kilometers (28.8 square miles) of Tongass National Forest, and the transfer is mostly complete. Within the range of the wolf, approximately 12.5 square kilometers (4.83 square miles) of productive old-growth from the Southern Southeast Alaska Analysis Unit and 16.8 square kilometers (6.49 square miles) of productive old-growth from the POW Complex Analysis Unit are being transferred to the Alaska Mental Health Trust (Table D 8 in Appendix D) in exchange for 3.5 square kilometers (1.35 square miles) of productive old-growth from the Northern Southeast Alaska Analysis Unit and 55.8 square kilometers of productive old-growth (21.5 square miles) from the Southern Southeast Alaska Analysis Unit (Table D 9 in Appendix D).

The Unrecognized Communities Land Transfer (SB 3269) would allow five Alaska Native communities (Haines, Ketchikan, Petersburg, Tenakee, and Wrangell) in Southeast Alaska to form urban corporations and receive land entitlements. Within the range of the wolf, this legislation would transfer 249 square kilometers (96.1 square miles) of productive old-growth from the Tongass to Alaska Native communities (Table D 8 in Appendix D).

Another land transfer that has been proposed but is currently inactive is the State National Forest Management Act (HR232 in 2017, HR 633 in 2021). Within Southeast Alaska, the State National Forest Management Act would transfer around 8,000 square kilometers (3,089 square miles) of the Tongass to the State of Alaska. Within the range of the wolf, this legislation would transfer 3,018 square kilometers (287,939 square miles) of productive old-growth (Table D 8 in Appendix D) to the State of Alaska.

Harvest schedules are available for some state and private lands, with allowable harvest generally declining in recent decades. Haines State Forest in the Northern Southeast Alaska Analysis Unit has an allowable harvest of 5.88 MMBF per year (ADNR 2022, p. 6), with the Five-Year Forest Management Schedule showing 50.7 MMBF of sale volume from 2016 to 2022 (ADNR 2022, p. 9). Similarly, the Southeast Alaska State Forest, which is in the Southern

Southeast Alaska and POW Complex Analysis Units, has an allowable cut of 9.147 MMBF (ADNR 2021, p. 8), with the Five-Year Forest Management Schedule showing 76.9 MMBF (ADNR 2021, p. 15) of sale volume from 2021 to 2025. Based on the descriptions of the planned sales (ADNR 2021, p. 10–14), most of the sales would come from the POW Complex Analysis Unit (52.1 MMBF over 5 years, covering up to 13.3 square kilometers [5.14 square miles]), with the rest coming from the Southern Southeast Analysis Unit (24.8 MMBF over 5 years, covering up to 5.3 square kilometers [2.0 square miles]). With the exemption of one sale in the POW Complex Analysis Unit (Heceta area; ADNR 2021, p. 12), all the planned volume on State Forest is coming from old-growth timber. While the total annual volumes listed in the Five-Year Forest Management Schedule exceed the allowable cut on a yearly basis, it is done so for planning purposes and to allow leeway for reacting to unknown project constraints and market fluctuations. The Five-Year Forest Management schedules show approximately where harvest could be directed, but the annual allowable cut for each forest won't be exceeded. We could not find harvest schedules for other state and private lands. The Alaska Mental Health Trust manages timber lands to maximize revenue over time (AMHT 2022, website) and will likely harvest lands recently received in the land exchange for that purpose. However, Sealaska Corporation, who owns 56 percent of all Native Corporation land (Table 8), announced they would discontinue logging (Sealaska Corporation 2021), which would mean a substantial reduction in the amount of Native Corporation Land being managed for timber harvest. Generally, area logged from state and private landowners has been decreasing in recent decades (Table D 1, Table D 2, and Table D 3 in Appendix D), and with Sealaska Corporation's exit from the industry that trend may continue.

Additionally, many rural residents in Southeast Alaska have expressed interest in transitioning away from old-growth logging, which could influence future land management decisions. During the scoping period for the Alaska Roadless Rule, responses generally opposed Tongass timber harvest for a variety of reasons including opposition to subsidizing the timber industry as well as timber harvest being a minor economic contributor to the Southeast Alaska economy (USDA 2019, pp. 6–9). There were also concerns that increases in timber harvest and road construction resulting from the Alaska Roadless Rule could harm the cultural livelihood and spiritual well-being of Alaska Native Tribes, communities, and individuals (USDA 2019, p. 4). Additionally, there has been opposition to timber harvest on state lands on POW Island. Naukati residents, many of whom have worked in the forest products industry and support forestry, are opposed to logging activities that are happening near their community after a land exchange transferred forest ownership from the Tongass to the Alaska Mental Health Trust (Stone 2022, unpaginated). Similarly, Whale Pass residents have expressed concerns with logging practices on state land near their community including the potential for impacts on recreation and tourism, fish and streams, property values, and others (Greely 2022, unpaginated). Furthermore, Native Corporations may begin focusing more resources on other ways of generating sustainable value for their shareholders. Prior to Sealaska Corporation's 2021 announcement to cease logging (Sealaska Corporation 2021, unpaginated), in 2018 they initiated a carbon offset project through

California's cap-and-trade program (Jenkins 2018, unpaginated) where they agreed to keep 668 square kilometers (258 square miles), nearly half of their forestland, unharvested. Forest carbon offset projects like this may present an alternate path forward for other Native Corporations in the region for generating revenue from their lands while preserving habitat for important subsistence species.

For B.C., the provincial timber supply forecast projects a 25 percent decrease in timber supply by the year 2025 resulting from tree mortality caused by the mountain pine beetle (*Dendroctonus ponderosae*) epidemic. Most of that change is expected to come from interior B.C. while harvest volumes from coastal B.C., where approximately 30 percent of B.C. timber harvest occurs, are expected to remain relatively steady. The timber supply is expected to return to recent harvest levels by year 2075 (Environmental Reporting BC 2018, p. 4), in part because young-growth timber will have reached harvestable age (BCMF 2003, p. 14).

The Province of B.C. defines old-growth based on age and regional climate, with coastal forests considered old-growth at 250 years, and dry interior forests considered old-growth at 140 years (BCMF 2022b, website). Based on this definition, approximately 26 percent of B.C.'s forested area is considered old-growth. However, this definition doesn't account for site-productivity, and includes forests in less productive habitats like bogs and the subalpine. Based on site-productivity, less than 1 percent of B.C.'s forests support high productivity old-growth, and less than 0.1 percent supports very high productivity old-growth (Price et al. 2021, p. 744). When considering the amount of productive old forests remaining in B.C. there are concerns that current policy and practices present very high levels of risk to productive old forests and their ability to maintain biodiversity and carbon storage (Price et al. 2020, p. 8).

In response to concerns about remaining old forests, the provincial government and First Nations across B.C. have deferred logging of 17,000 square kilometers (1.7 million hectares) of old-growth, including 10,500 square kilometers (1.05 million hectares) of forest considered most at risk of irreversible loss (BCMF 2022a, website). This deferral comes after the B.C. government commissioned an independent panel to engage residents about their views on the management of old-growth forests. After near-unanimous agreement about the importance of old forests, the panel recommended deferring development in old forests with high risk of biodiversity loss until a new management strategy could be implemented (Gorley and Merkel 2020, p. 15). With a new management strategy in development, completely phasing out old-growth timber harvest could take time and may still be 10-20 years out (Egan-Elliott 2021, website). Based on the information we found, the timber industry in B.C. is faced with substantial uncertainty in the near future due to market conditions, insect infestations, and future changes in management strategies.

We used the Gilbert et al. (2022) model (Model B) for incorporating future timber harvest scenarios and making population projections for wolves in the POW Complex Analysis Unit, but we did not include effects of timber harvest when making population projections for wolves in the other Analysis Units. Effects of timber harvest on prey populations are complex, and for all Analysis Units except for POW Complex, wolves prey on a range of forest-dependent species. Gilbert et al. (2022, Supplement 2, Table A1) updates the 2015 model (Gilbert et al. 2015, entire) but uses the same five scenarios developed in 2015 for timber harvest on the POW Complex based on land management information available at the time: No new harvest, transition to young-growth, continued old-growth harvest, increased old-growth harvest, and maximum old-growth harvest. While the Forest Plan and landownership have changed since then, we are adopting three of these scenarios because the relative consequences on forest composition and the landscape are still applicable. Scenario B1 represents the transition to young-growth timber harvest, Scenario B2 represents a continuation of old-growth timber harvest at rates observed from 2008 to present, and Scenario B3 represents the maximum harvest of old-growth (Table 35).

Table 35 Future timber harvest scenarios for the POW Complex Analysis Unit.

Variables Influencing Timber Harvest	**Scenario B1** Transition to young-growth timber harvest	**Scenario B2** Harvest of old-growth timber at rates observed from 2008-present	**Scenario B3** Maximum harvest of old-growth timber
Southeast Alaska Sustainability Strategy	Strategy remains in-place; old-growth timber harvest is restricted to 5 MMBF per year across the Tongass National Forest	Strategy is reversed; old-growth timber harvest resumes to recent levels allowed by the Forest Plan (forestwide PTSQ of 46 MMBF per year) with a transition to 5 MMBF per year by 2033	Strategy is reversed; old-growth timber harvest resumes to recent levels allowed by the Forest Plan (forestwide PTSQ of 46 MMBF per year) with a transition to 5 MMBF per year by 2033
2001 Roadless Rule	Rule remains in-place; timber harvest in Inventoried Roadless Areas is restricted	Rule remains in-place; timber harvest in Inventoried Roadless Areas is restricted	Rule is repealed for the Tongass National Forest; Inventoried Roadless Areas become eligible for timber harvest where they are otherwise suitable in the Forest Plan
Land Transfers	No additional transfers of Tongass National Forest land to other ownership; timber harvest continues to be managed by the Tongass National Forest	Some additional transfers of Tongass National Forest land to other ownership; timber harvest on transferred land is governed by the Alaska Forest Resources and Practices Act	Large transfers of Tongass National Forest land to other ownership; timber harvest on transferred land is governed by the Alaska Forest Resources and Practices Act

Scenario B1 - In the 2015 Alexander Archipelago Wolf SSA, the "transition to young-growth harvest" scenario considered the Tongass schedule of activities at the time, which were focused on a young-growth transition, and harvest volumes on other landownership were assumed to be similar to Scenario B in Gilbert et al. (2015, p. 40).

Similar harvest levels could be achieved if the Southeast Sustainability Strategy continues to restrict the amount of old-growth timber harvest on the Tongass, inventoried roadless areas continue to be protected by the 2001 Roadless Rule, there are no large land transfers, and other landowners continue to manage their lands as they have since 2008 (Table 35).

Scenario B2 - In the 2015 Alexander Archipelago Wolf SSA, the "continued old-growth harvest" scenario assumed approximately 34 MMBF/year of timber would continue to be harvested on the Tongass with 37 percent of that coming from the POW Complex, and that inventoried roadless areas would continue to be protected by the 2001 Roadless Rule. It assumed that Sealaska Corporation would harvest their lands at a rate of 28 MMBF per year, the state would harvest at a rate of 11 MMBF per year, and that other Native Corporations would harvest at 14 MMBF per year.

Based on current information, average harvest volumes from 2008 to present could be maintained if the Southeast Sustainability Strategy were reversed; this would allow the Tongass to return to recent old-growth harvest levels if other landowners continue to manage their lands as they have since 2008, and if smaller land transfers were passed (Table 35).

Scenario B3 - In the 2015 Alexander Archipelago Wolf SSA, the "maximum old-growth harvest" scenario assumed the maximum Allowable Sale Quantity (267 MMBF per year in 2008 FP) allowed in the 2008 Forest Plan would be met, with 25 percent of the volume coming from the POW Complex. It assumed that the 2001 Roadless Rule would be repealed on the Tongass, and inventoried roadless areas in suitable land use designations would become eligible for timber harvest. It also assumed that Sealaska Corporation would continue to log their lands at a steady rate of 84 MMBF per year for 10 years across 10 square kilometers (970 square miles), including lands transferred to them under the Sealaska Land Entitlement Finalization Act of 2014. It also assumed an even pace of logging from state lands at 33 MMBF per year for 10 years across 4.5 square kilometers (425 square miles), and that other Native Corporation lands would harvest 5.2 square kilometers (2.0 square miles) at 42 MMBF per year over 10 years.

The 2016 Forest Plan has a Projected Timber Sale Quantity of 46 MMBF per year, transitioning to 79 MMBF (5 MMBF as old-growth) as more young-growth reaches harvestable age. Additionally, the Southeast Alaska Sustainability Strategy limits the amount of old-growth harvest to 5 MMBF per year across the whole Forest. Furthermore, Sealaska Corporation announced they will discontinue logging on their lands. However, we believe relative amounts of harvest are still appropriate for a "maximum old-growth harvest" scenario given the potential for land transfers to move large portions of the Tongass to state or private ownership (Table D 8 in

Appendix D). Additionally, if the Southeast Sustainability Strategy were reversed, the Tongass National Forest could resume old-growth harvest levels according to the Projected Timber Sale Quantity in the Forest Plan (Table 35). Given the existing road network on POW Island, the Tongass could focus more of the Projected Timber Sale Quantity on POW Island, especially if the Tongass received an exemption to the 2001 Roadless Rule.

5.2.3 Climate Change

Climate change impacts on deer populations (and subsequent effects on carrying capacity for wolves) are only included in Model B for the POW Complex Analysis Unit. Climate change effects were incorporated in the Gilbert et al. (2022, p. 6 and Supplementary Appendix A) model based on the frequency of extreme snow years. This parameterization used historical snowfall data from Annette Island to define extreme snow years combined with unpublished CMIP5 projections of future snow conditions from five global climate models (GCMs) for 2030–2059 (Gilbert et al. 2022, Appendix A, pp. 3–4, 7). We conducted an evaluation of the most recent (CMIP6) climate data to determine if and how the climate change model parameters for extreme snow years should be modified for the future model scenarios used here.

We evaluated snowfall on the POW Complex using downscaled data from the ClimateNA tool, version 7.30 (Wang et al. 2016, entire). We pulled a random sample of 1500 pixels from the ClimateNA elevation raster for POW Complex, representing approximately 14 percent of pixels in POW Complex. We averaged precipitation as snow (PAS, in mm) for these 1500 pixels in winter (November-March) for historical (1992–2020), current (2022–2028), and future (2029–2057) time periods. We used the 13-model ensemble from CMIP6 developed by Mahony et al. (2022, entire) for current and future time periods, including three CMIP6 Shared Socioeconomic Pathway (SSP) scenarios: SSP2-4.5, SSP3-7.0, and SSP5-8.5. We calculated the percent change in PAS between the historical and current/future time periods.

Historical average PAS from interpolated ClimateNA data sampled across POW Complex did not reflect weather station data used by Gilbert et al. (2022, Supplementary Material 1) from Annette Island. For example, “extreme snow years” as defined by Gilbert et al. (2022, Supplementary Appendix A) were not identified as the highest PAS years in the ClimateNA data. However, trends over time in PAS were similar between Gilbert et al. and this analysis, with a decrease in average PAS of 18.7–27.0 percent between historical and future periods (Table 36). By comparison, Gilbert et al. (2022, Supplementary Appendix A) identified a decrease in PAS of 0–28.6 percent (average of 19.2 percent decrease) across five GCMs for the CMIP5 A2 emissions scenario. We note that ClimateNA and Gilbert et al. (2022, pp. 8–10) results are not directly comparable for multiple reasons including: differences in GCM selection (this analysis uses an ensemble of 13 CMIP6 GCMs while Gilbert et al. [2022, Supplementary Table A1] used five separate CMIP5 GCMs); differences in scenarios (this analysis uses three SSP scenarios while Gilbert et al. 2022, Supplementary Appendix A) uses a single RCP scenario); differences in time ranges (Gilbert et al. [2022, Supplementary Appendix A] used

1970–1999 as their historical time range and 2030–2059 as the future time range); and difference in location and data type (this analysis uses a sample of 1500 points across POW Complex and CMIP6 ClimateNA interpolated data while Gilbert et al. (2022, Supplemetary Appendix A) used weather station data from Annette Island and unpublished CMIP5 climate data). Because of these discrepancies, we are not able to directly replicate and update the Gilbert et al. (2022, Supplementary Table A1) snow projections using CMIP6 forecasts. However, our analysis indicates that the projected decreases in PAS used by Gilbert et al. (2022, Supplementary Appendix A) are (with one exception) within the range forecasted by the CMIP6 data. The exception is the 0 percent change found by Gilbert et al. (2022, Supplementary Table A1) using the UKMO-HadCM3 CMIP5 GCM. We have chosen to retain this scenario as a plausible “no change” (worst case) scenario since GCM projections can vary widely (Mahony et al. 2022, pp. 8–12), and our analysis uses an ensemble of 13 GCMs, which averages variation across projections.

Table 36 Average precipitation as snow (mm) and percent change from historical conditions across 1500 randomly sampled points on POW Island for three time periods, historical, current, and future using CMIP6 climate projections. Current and future periods show results from three Shared Socioeconomic Pathway (SSP) scenarios.

Time period	Scenario	Average precipitation as snow (mm)	Percent change
Historical	-	246	-
Current	SSP2-4.5	249	1.0 percent
	SSP3-7.0	264	7.3 percent
	SSP5-8.5	253	2.8 percent
Future	SSP2-4.5	200	-18.7 percent
	SSP3-7.0	192	-22.0 percent
	SSP5-8.5	180	-27.0 percent

5.2.4 Inbreeding

Future effects of inbreeding were only factored into the three Southeast Alaska Analysis Units in Model A because we don’t currently have evidence of inbreeding in the B.C. units. Inbreeding was incorporated into the model in the same way it was incorporated in our current resiliency analysis and was held constant over the modeled time period (see *Chapter 4.2.1 Population Trend;* Figure 17). We did not develop different future scenarios for inbreeding because inbreeding levels are unlikely to shift significantly under the 30-year time frame (5–6 generations) considered here without targeted interventions such as genetic rescue. Both the loss and recovery of genetic diversity in small populations and their respective increases and reductions in inbreeding would occur over longer time frames than are modeled here (Kardos et al. 2021, pp. 2–3). For additional information about how the effects of inbreeding were incorporated into the model, please see the full description in *Chapter 4.2.1: Estimating Current Population Trend: Inbreeding*.

5.2.5 Disease

Detections of disease events in wolves are relatively infrequent and require close monitoring of populations; there are few studies that accurately evaluate the frequency and severity of disease events in wolves. Therefore, we based our estimates of the frequency and severity of disease events on observed rates of canine distemper in Yellowstone National Park, where three instances of canine distemper virus resulting in 20 to 30 percent mortality in the population were observed over 25 years (Brandell et al. 2020, entire; Smith et al. 2020, p. 126). Disease dynamics are complex and difficult to predict and there is little data available regarding the spatial scale of disease events in wolves. In our models a disease event affects all wolves within an Analysis Unit. We included disease in both Model A and Model B as a stochastic event. Each year had a 0.15 probability of being a disease year (1 disease year approximately every 7–8 years). If a year was a disease year, the population in the entire analytical unit was reduced by 25 percent.

5.3 Future Resiliency Results

5.3.1 Northern Southeast Alaska Analysis Unit

Our projections indicate that wolf populations in Northern Southeast Alaska are not expected to drop below the quasi-extinction threshold of 10 within the next 30 years. The median population size at year 30 ranges from 279–316 under all three scenarios in Model A, both with and without disease. No simulations without disease result in projected population sizes of less than 120. With disease, 9–13 percent of simulations fall below 120 at year 30 (Figure 27, Table 37).

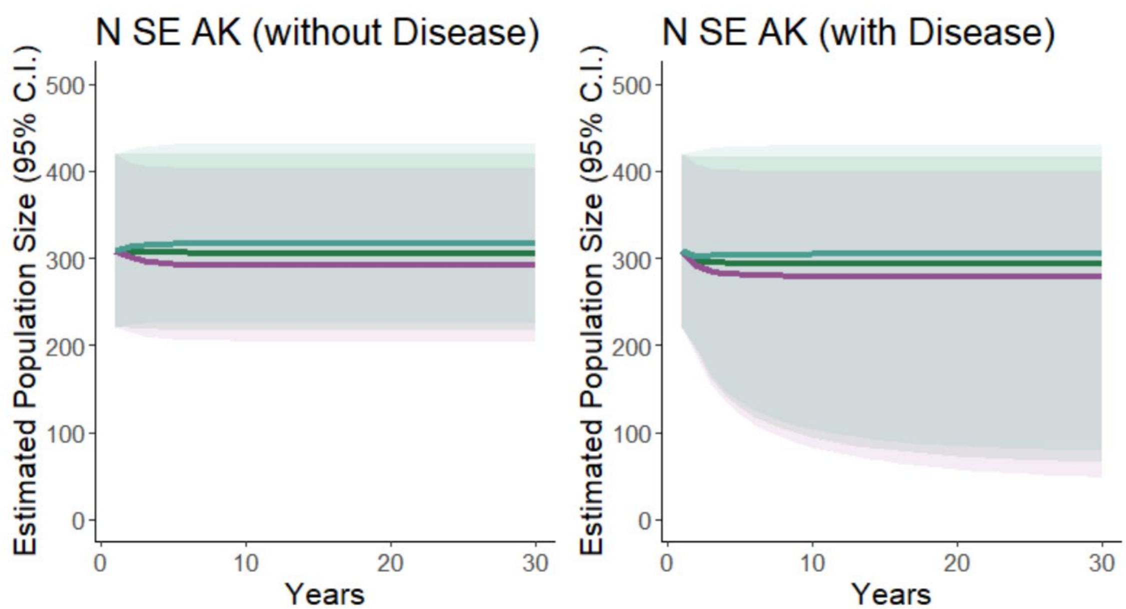


Figure 27 Projected median population size and 95 percent Credible Intervals (shaded areas) for populations in Northern Southeast Alaska, with and without observed YNP disease rates. Blue is Scenario A1, green is Scenario A2, and pink is Scenario A3.

Table 37 Projected median population sizes and 95 percent Credible Intervals at year 30 for populations in Northern Southeast Alaska (LCI is lower 95 percent Credible Interval, UCI is upper 95 percent Credible Interval), with and without disease. The 120 Threshold indicates the percentage of simulations in which the population is below 120 at year 30, and the 10 Threshold indicates the percentage of simulations in which the population is below 10 at year 30. Percent of maximum is the estimated population size as a percentage of the estimated maximum of 342 wolves.

	Scenario	Population at Year 30	LCI	UCI	120 Threshold	10 Threshold	Percent of Maximum
No Disease	Scenario A1	316	225	431	0 percent	0 percent	93 percent
	Scenario A2	306	217	415	0 percent	0 percent	90 percent
	Scenario A3	291	204	395	0 percent	0 percent	85 percent
Disease	Scenario A1	304	79	429	9 percent	0 percent	89 percent
	Scenario A2	294	65	416	11 percent	0 percent	86 percent
	Scenario A3	279	48	400	13 percent	0 percent	82 percent

5.3.2 Southern Southeast Alaska Analysis Unit

Overall projections for the Southern Southeast Alaska Analysis Unit indicate that the median population size will be 431–506 wolves at year 30 under all Model A scenarios and no disease. The addition of disease events results in approximately 40 fewer wolves overall, and 6,7, and 11 percent of simulations fall below the threshold of 120 respectively, but no simulation falls below population size of 10 wolves at 30 years (Table 38, Figure 28). The resulting population size is 19-32 percent lower than the maximum estimated population size.

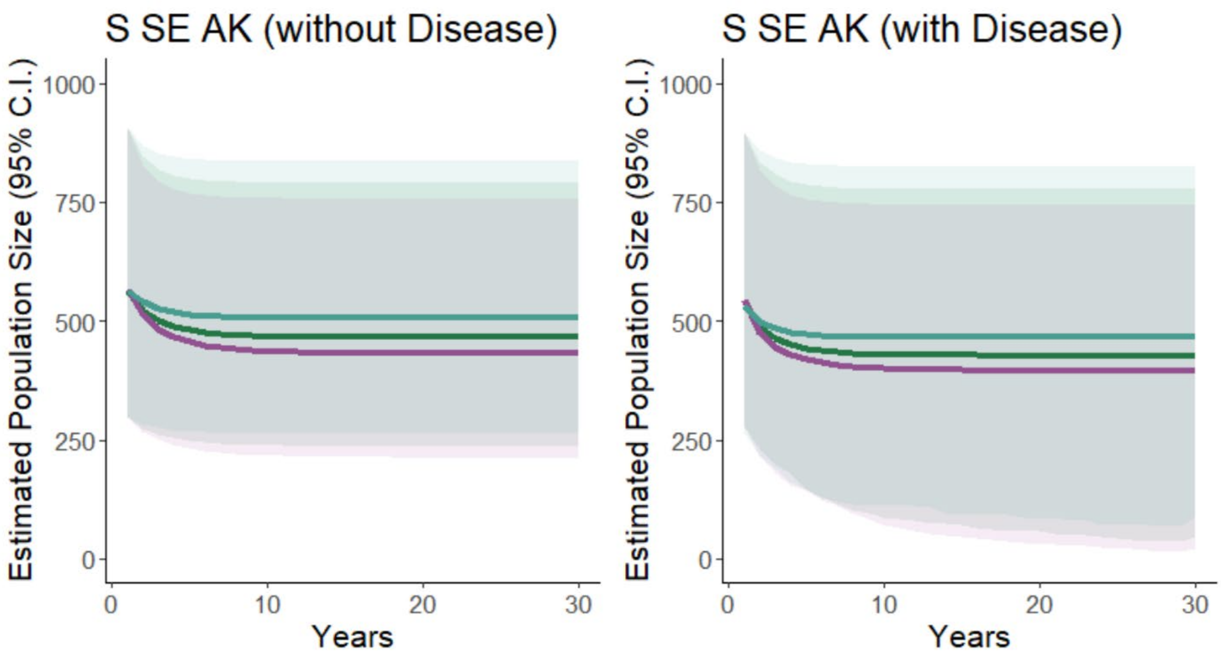


Figure 28 Projected median population size and 95 percent Credible Intervals (shaded areas) for populations in Southern Southeast Alaska, with and without observed YNP disease rates. Blue is Scenario A1, green is Scenario A2, and pink is Scenario A3.

Table 38 Projected median population size and 95 percent Credible Intervals at year 30 (LCI is lower 95 percent Credible Interval, UCI is upper 95 percent Credible Interval) for populations in Southern SE Alaska, with and without disease. The 120 Threshold indicates the percentage of simulations in which the population is below 120 at year 30, and the 10 Threshold indicates the percentage of simulations in which the population is below 10 at year 30. Percent of maximum is the projected population size as a percentage of the estimated maximum of 627 wolves.

	Scenario	Population at Year 30	LCI	UCI	120 Threshold	10 Threshold	Percent of Maximum
No Disease	Scenario A1	506	263	835	0 percent	0 percent	81 percent
	Scenario A2	465	236	790	0 percent	0 percent	74 percent
	Scenario A3	431	212	757	0 percent	0 percent	69 percent
Disease	Scenario A1	466	70	824	6 percent	0 percent	74 percent
	Scenario A2	428	43	777	7 percent	0 percent	68 percent
	Scenario A3	396	21	743	11 percent	0 percent	63 percent

5.3.3 POW Complex Analysis Unit

Model A

Overall, our Model A projections indicate that under Scenario A1 (minimum wolf harvest rates), the median wolf population size on POW Complex at year 30 is projected to be between 98–354 wolves. Without disease, no projection under Scenario A1 results in wolf populations of less than 120. Projections under Scenarios A2 and A3 (without disease) result in wolf populations of less than 120, but under Scenario A2 these results only occur 1 percent of the time. With disease, all scenarios result in greater than 1 percent of simulations having population sizes of less than 120. Scenario A3 results in more than 50 percent of simulations with projected populations sizes of less than 120 at year 30 (Table 39, Figure 30).

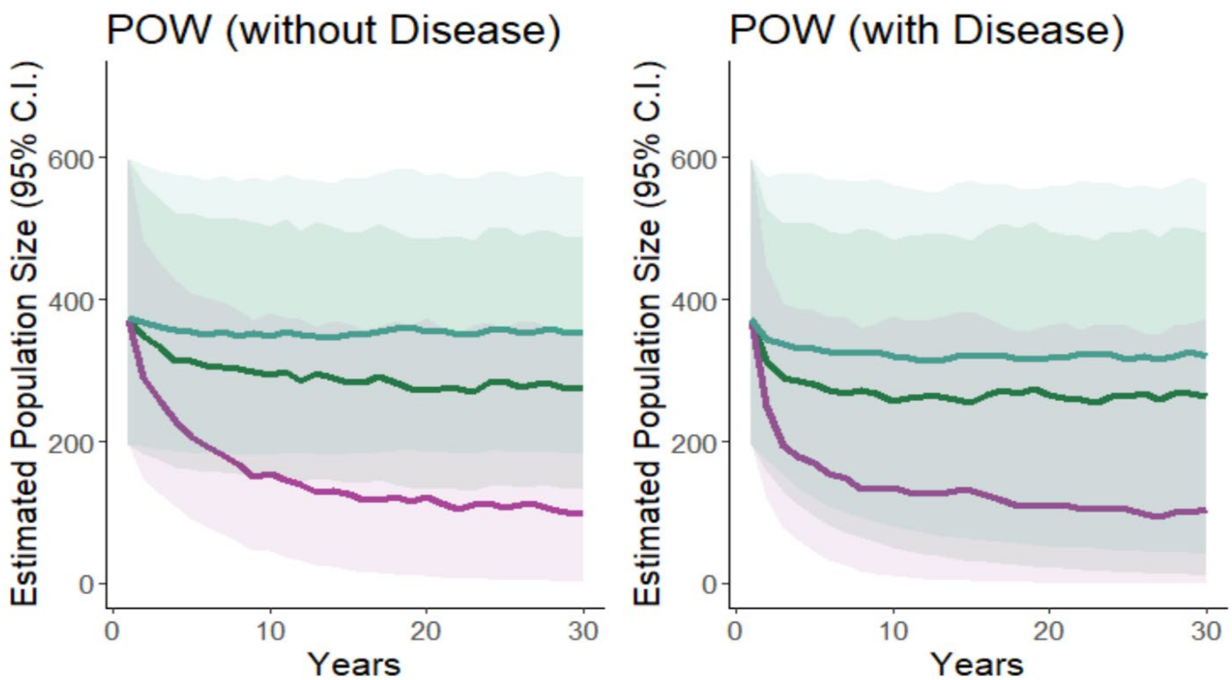


Figure 29 Projected median population sizes and 95 percent Credible Intervals (shaded areas) for populations on POW Complex, with and without observed YNP disease rates. Blue is Scenario A1, green is Scenario A2, and pink is Scenario A3.

Table 39 Projected median population sizes and 95 percent Credible Intervals (LCI is lower 95 percent Credible Interval, UCI is upper 95 percent Credible Interval) at year 30, for populations on POW Complex, with and without disease. The 120 Threshold indicates the percentage of simulations in which the population is below 120 at year 30, and the 10 Threshold indicates the percentage of simulations in which the population is below 10 at year 30. Percent of maximum is the projected population size as a percentage of the estimated maximum of 414 wolves.

	Scenario	Population at year 30	LCI	UCI	120 Threshold	10 Threshold	Percent of Maximum
No Disease	Scenario A1	354	185	575	0 percent	0 percent	86 percent
	Scenario A2	275	133	489	1 percent	0 percent	66 percent
	Scenario A3	104	2	352	58 percent	8 percent	25 percent
Disease	Scenario A1	320	41	563	12 percent	0 percent	77 percent
	Scenario A2	262	11	493	14 percent	3 percent	63 percent
	Scenario A3	98	0	372	56 percent	17 percent	24 percent

Model B (updated Gilbert et al. (2022) population model)
Gilbert et al. (2022, entire) projected wolf populations from a starting population size of 89 (the 2015 estimate) and predicted that wolf populations would generally persist over the next 30 years on POW Complex. However, their model results indicated that there was a greater than 10 percent chance that populations would drop below a census size of 120 or an effective population size (Ne) of 50 during those years, leading to potential deleterious genetic effects (Table 40).

Please see *Chapter 4.2.1 Population Trend: Model B* for a description of the updates that were made to the Gilbert et al. (2022) model for this SSA. For Model B, under all scenarios without disease, projected POW Complex population sizes at year 30 range from 20–152, with declines of 61–95 percent. Under Scenarios B2 and B3, more than 95 percent of simulations drop below 120 wolves at year 30. Trajectories for all scenarios with disease are similar, but median population sizes are lower overall. Scenarios B1 and B2 result in less than 2 percent of simulations with a total population size of less than 10 wolves at year 30, while Scenario B3 results in more than 25 percent of simulations with a total population size of less than 10 wolves at year 30 (Table 40, Figure 30).

Table 40 Projected median population size at year 30, and 95 percent Credible Intervals (LCI is lower 95 percent Credible Interval, UCI is upper 95 percent Credible Interval) for the POW Complex Analysis Unit, with and without disease. The 120 Threshold indicates the percentage of simulations in which the population is below 120 at year 30, and the 10 Threshold indicates the percentage of simulations in which the population is below 10 at year 30. Percent of Starting is the estimated population size as a percentage of the estimated starting population of 386 wolves.

	Scenario	Population at Year 30	LCI	UCI	120 Threshold	10 Threshold	Percent of Starting
No Disease	Scenario B1	152	116	186	5 percent	0 percent	39 percent
	Scenario B2	72	39	109	96 percent	0 percent	19 percent
	Scenario B3	20	4	43	100 percent	10 percent	5 percent
Disease	Scenario B1	136	93	182	23 percent	0 percent	35 percent
	Scenario B2	54	23	93	99 percent	1 percent	14 percent
	Scenario B3	17	3	38	100 percent	17 percent	4 percent

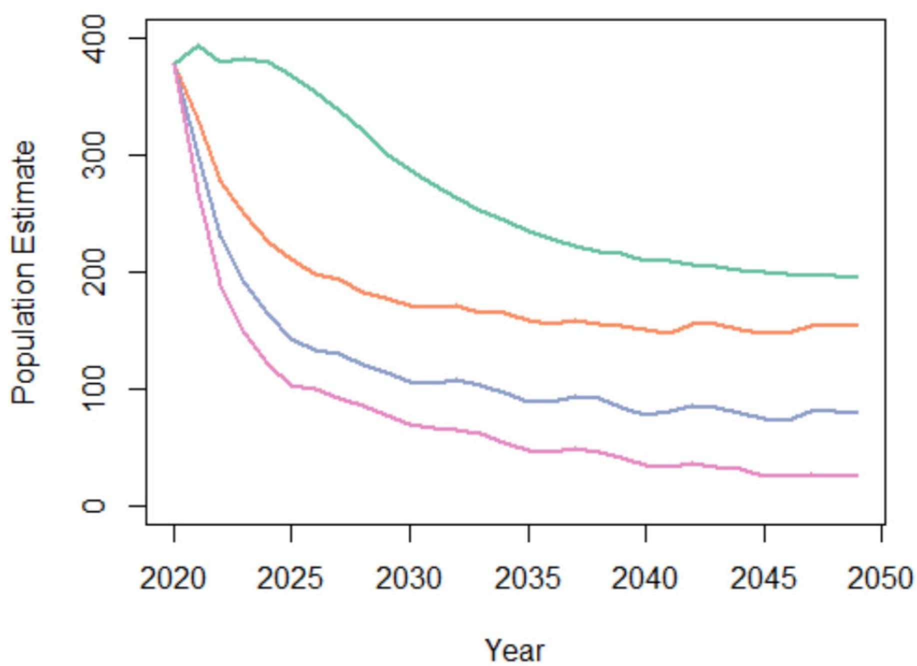


Figure 30 Projected population size over a 30-year time span for wolves in the POW Complex Analysis Unit under Scenarios B1 (orange), B2 (blue), and B3 (pink), without disease. A no-harvest scenario (green) is depicted for comparison purposes.

The precipitous declines are driven by the estimated carrying capacity of deer from Gilbert et al. (2022, p. 6, Supplementary Material 1). Even a no-harvest scenario results in a median population size of 193 wolves, which is an approximately 50 percent decline from the starting population size (Figure 30). As discussed in *Chapter 4 Population and Species Needs and Current Condition*, it is not known whether this estimate is accurate and wolf populations of approximately 150 represent a maximum sustainable population of wolves on the POW Complex, or whether the carrying capacity of deer on POW Complex is higher than estimated and capable of sustaining more wolves. Because of this, harvesting a fixed number of wolves (i.e., a set 20-, 30-, or 40-day harvest) that does not adjust for declining population sizes results in low population numbers. The State of Alaska has set a population objective for POW Complex at between 150–200 wolves; these models demonstrate that goal can be feasibly achieved. Continuing to implement adaptive management practices once that goal is reached will be necessary for maintaining a stable population.

5.3.4 Northern Coastal B.C. Analysis Unit

Overall, our Model A projections indicate that the Northern Coastal B.C. wolf populations will be at or above 85 percent of the maximum population size at year 30 under all scenarios. Populations drop below 120 wolves only in 4 percent of Scenario A3 simulations with disease (Table 41, Figure 31).

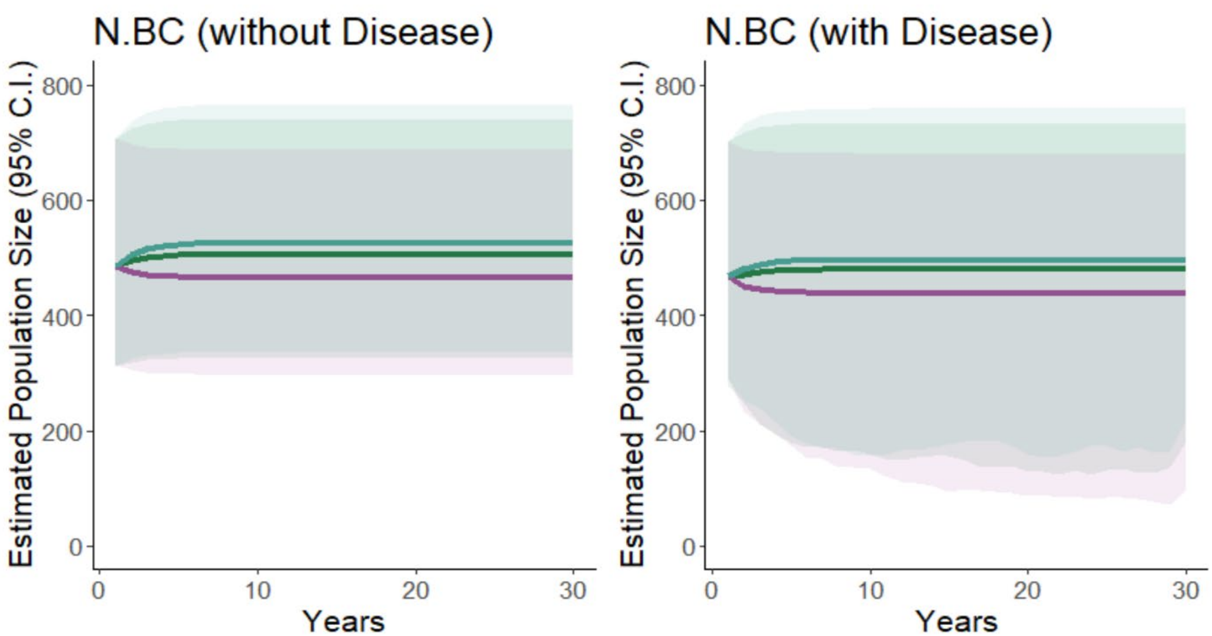


Figure 31 Projected median population sizes and 95 percent Credible Intervals (shaded areas) for populations in Northern Coastal B.C., with and without observed YNP disease rates. Blue is Scenario A1, Green is Scenario A2, and Pink is Scenario A3.

Table 41 Projected median population sizes at 30 years and 95 percent Credible Intervals (LCI is lower 95 percent Credible Interval, UCI is upper 95 percent Credible Interval) for populations in Northern Coastal B.C., with and without disease. The 120 Threshold indicates the percentage of simulations in which the population is below 120 at year 30, and the 10 Threshold indicates the percentage of simulations in which the population is below 10 at year 30. Percent of maximum is the estimated population size as a percentage of the estimated maximum of 540 wolves.

	Scenario	Population at Year 30	LCI	UCI	120 Threshold	10 Threshold	Percent of Maximum
No Disease	Scenario A1	525	337	764	0 percent	0 percent	97 percent
	Scenario A2	506	326	739	0 percent	0 percent	94 percent
	Scenario A3	464	296	687	0 percent	0 percent	86 percent
Disease	Scenario A1	497	219	758	0 percent	0 percent	92 percent
	Scenario A2	480	181	733	0 percent	0 percent	89 percent
	Scenario A3	438	96	680	4 percent	0 percent	81 percent

5.3.5 Southern Coastal B.C. Analysis Unit

Overall, our Model A projections indicate that under Scenarios A1 and A2, wolf populations in Southern Coastal B.C. will be between 87 and 95 percent of the maximum estimated population size at year 30. Under Scenario A3 (with and without disease) populations are projected to decline 24–26 percent below the maximum population size. Under Scenario A3 with disease, 10 percent of simulated populations fall below 120 wolves (Table 42, Figure 32).

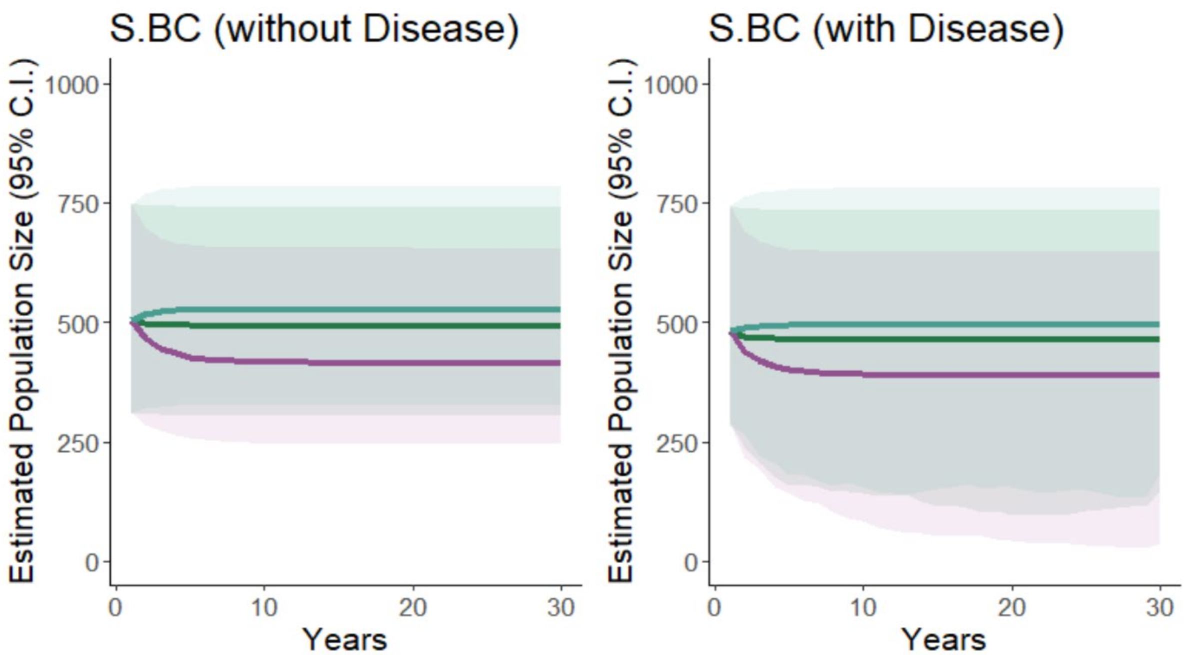


Figure 32 Projected median population sizes and 95 percent Confidence Intervals (shaded aread) for populations in Southern Coastal B.C., with and without observed YNP disease rates. Pink is Scenario A3, green is Scenario A2, and blue is Scenario A1.

Table 42 Projected median population sizes at year 30 and 95 percent Credible Intervals (LCI is lower 95 percent Credible Interval, UCI is upper 95 percent Credible Interval) for populations in Southern Coastal B.C., with and without disease. The 120 Threshold indicates the percentage of simulations in which the population is below 120 at year 30, and the 10 Threshold indicates the percentage of simulations in which the population is below 10 at year 30. Percent of maximum is the estimated population size as a percentage of the estimated maximum of 559 wolves.

	Scenario	Population at year 30	LCI	UCI	120 Threshold	10 Threshold	Percent of Maximum
No Disease	Scenario A1	527	327	785	0 percent	0 percent	95 percent
	Scenario A2	492	303	741	0 percent	0 percent	88 percent
	Scenario A3	415	244	655	0 percent	0 percent	74 percent
Disease	Scenario A1	495	183	779	0 percent	0 percent	88 percent
	Scenario A2	464	149	734	1 percent	0 percent	83 percent
	Scenario A3	389	36	647	10 percent	0 percent	70 percent

5.3.6 Future Resiliency Summary

Before providing a summary of future resiliency for the five Alexander Archipelago wolf Analysis Units, it is important to point out a few considerations when interpreting the model results. First, our uncertainty in the starting population sizes is high. We used a prey habitat model (Suring et al. 1993, pp. 11-12) and an ungulate biomass model (Kuzyk and Hatter 2014, entire) that have not been recently updated, as well as unpublished home range estimates to derive our maximum population estimates for each of the Analysis Units. Additionally, wolf harvest rates are likely to fluctuate year to year, rather than be sustained at the same rates annually, as we are projecting for all Analysis Units except the POW Complex. ADFG has set a management objective of 150–200 wolves for POW Complex; if ADFG achieves this goal, our estimates of resiliency for POW Complex will be underestimates. ADFG has also set numerical thresholds and accompanying management changes for when the population is: 1) below the objective range but can still support some wolf harvest and 2) too low to support wolf harvest. It is also important to note that the true spatial extent of disease events is difficult to evaluate, and under high wolf harvest conditions, populations are not likely to be resilient to catastrophic events. These real-world conditions are difficult to capture in models, and therefore, results should be interpreted with caution and with these nuances in mind.

Scenarios A1 and B1

Under Scenario A1 (low wolf harvest), resiliency in the Northern Southeast Alaska Analysis Unit is expected to remain high. Both the no-disease and disease models project a median population size between 304 and 316 wolves in 30 years. Under this "low wolf harvest" scenario, no simulations under the no-disease model resulted in populations less than or equal to 120 wolves, and only 9 percent of simulations under the Disease model resulted in a population of less than or equal to 120 wolves.

Under Scenario A1, resiliency of the Southern Southeast Alaska Analysis Unit is anticipated to remain the same at a moderately-high level. The median population size at year 30 is expected to remain high, between 466 and 506 wolves. Additionally, only 6 percent of simulations under the disease model result in a population size less than 120 wolves after 30 years.

The results from Model A project that the POW Complex Analysis Unit will remain stable, and resiliency may even increase under Scenario A1. Resiliency is projected to increase from moderately-low to moderate. The future estimated median population size on the POW Complex Unit is projected to be between 320 and 354 wolves. Additionally, only 12 percent of simulations under the disease model result in a population less than 120 wolves.

However, when projecting 30 years into the future under Model B for the POW Complex, resiliency is projected to stay the same (moderately-low) under Scenario B1 (low wolf harvest, lowest amount of precipitation as snow, and conservative old-growth harvest). Using this model, we still expect a median population size between 93 and 186 wolves under both the "disease and "no-disease" models. Some simulations (5–23 percent) also result in a population size less than 120 wolves over the next 30 years.

The Northern and Southern Coastal B.C. Analysis Units exhibit a similar trend in population growth under Scenario A1, with overall resiliency in both units projected to remain high. The median estimated population size in the Northern Coastal B.C. Analysis Unit is estimated to be 497–525 wolves at year 30, and the Southern Coastal B.C. Analysis Unit is 495–527 wolves under both the disease and no-disease models. Neither unit drops below the 120-wolf threshold in any simulations.

Table 43 shows the current resiliency of each Analysis Unit alongside the projected future resiliency under Scenarios A1 and B1. Figure 33 shows the future resiliency of each Analysis Unit under Scenarios A1 and B1.

Table 43 Summary of current resiliency and future resiliency under Scenarios A1 and B1.

Analysis Unit	**Current Resiliency**	**Future Resiliency**	
		Scenario A1	**Scenario B1**
Northern Southeast Alaska	High	High	
Southern Southeast Alaska	Moderately-high	Moderately-high	
POW Island Complex	Moderately-low	Moderate	Moderately-low
Northern Coastal B.C.	High	High	
Southern Coastal B.C.	High	High	

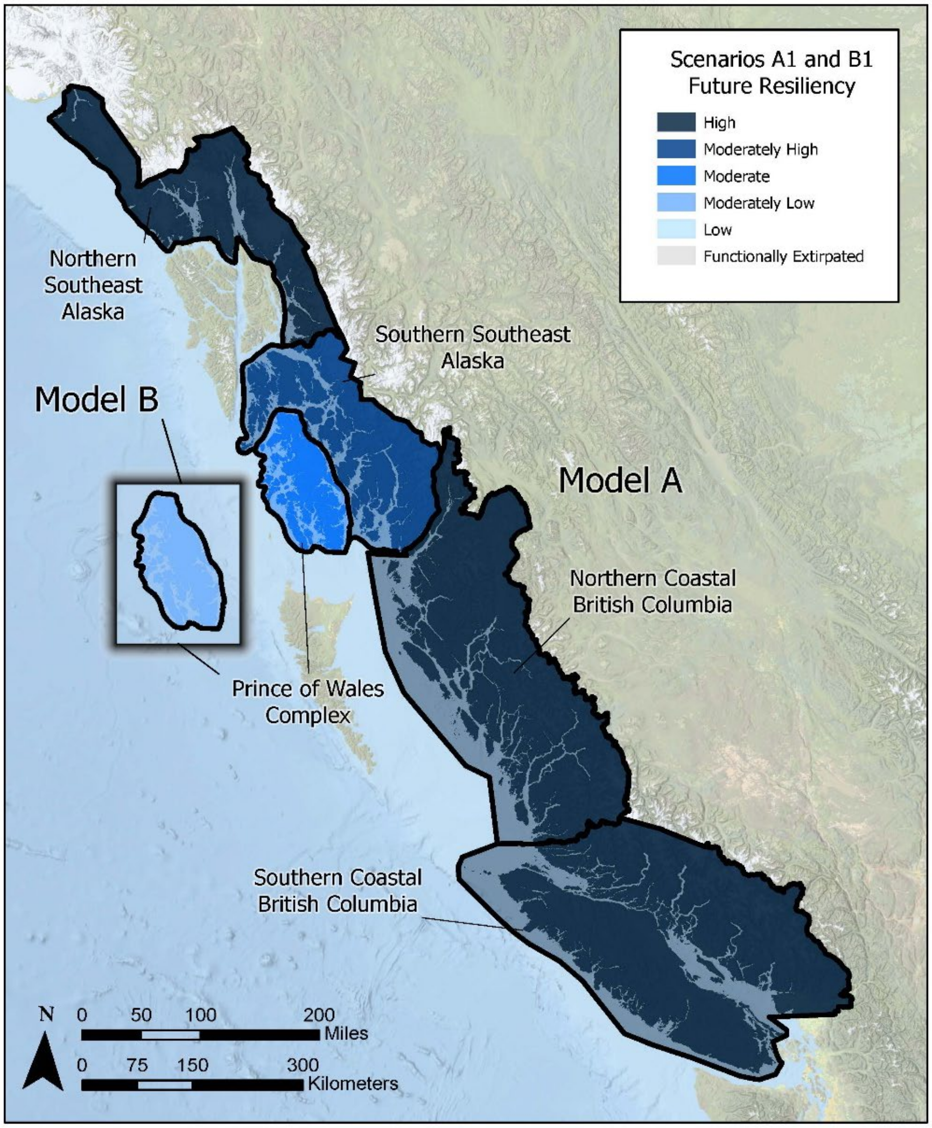


Figure 33 Map of future resiliency across all Analysis Units under Scenarios A1 and B1.

Scenarios A2 and B2

Under Scenario A2 (using derived maximum population estimates from Suring et al. (1993)) (average wolf harvest), resiliency in the Northern Southeast Alaska Analysis Unit is projected to decrease slightly from high to moderately-high. Both the no-disease and disease models project a median population between 294 and 306 wolves at year 30. Under "average" wolf harvest conditions, 0–11 percent of simulations under both the disease and no-disease models result in a population projection of less than or equal to 120 wolves.

Resiliency of the Southern Southeast Alaska Analysis Unit is anticipated to remain moderately-high under Scenario A2. The median population size is projected to be between 428 and 465 wolves at year 30. Additionally, only 7 percent of simulations under the disease model result in a population size less than 120 wolves.

Resiliency of the POW Complex Analysis Unit is projected to remain moderately-low under Scenario A2. Under this scenario the future estimated median population size in the POW Complex Unit is still between 262 and 275 wolves. Under the disease model, 14 percent of simulations result in a population size less than 120, and 3 percent of simulations result in a population smaller than 10 wolves.

When projecting 30 years into the future under Model B for the POW Complex, resiliency is expected to decrease to low under Scenario B2 (moderate wolf harvest, moderate amounts of precipitation as snow, and current timber harvest conditions). Using this model, we expect a median population size between 54 and 72 wolves under both the “disease” and “no- disease” models. One percent of simulations result in a population size less than 10 wolves over the next 30 years.

The Northern and Southern Coastal B.C. Analysis Units exhibit a similar trend in population growth under Scenario A2, with overall resiliency in both units projected to remain high. A median population size of 480–506 wolves is projected for the Northern Coastal B.C. Analysis Unit at year 30, while the Southern B.C. Analysis Unit is projected to have 465–492 wolves under both the disease and no-disease models at year 30. In only one percent of simulations for the Southern B.C. Analysis Unit did the population drop below 120 wolves. The Northern B.C. Analysis Unit did not drop below the 120-wolf threshold in any simulations.

Table 44 below shows the current resiliency of each Analysis Unit alongside the projected future resiliency under Scenarios A2 and B2. Figure 34 shows the future resiliency of each Analysis Unit under Scenarios A2 and B2.

Table 44 Summary of current resiliency and future resiliency under Scenarios A2 and B2

Analysis Unit	**Current Resiliency**	**Future Resiliency**	
		Scenario A2	**Scenario B2**
Northern Southeast Alaska	High	Moderately-high	
Southern Southeast Alaska	Moderately-high	Moderately-high	
POW Island Complex	Moderately-low	Moderately-low	Low
Northern Coastal B.C.	High	High	
Southern Coastal B.C.	High	High	

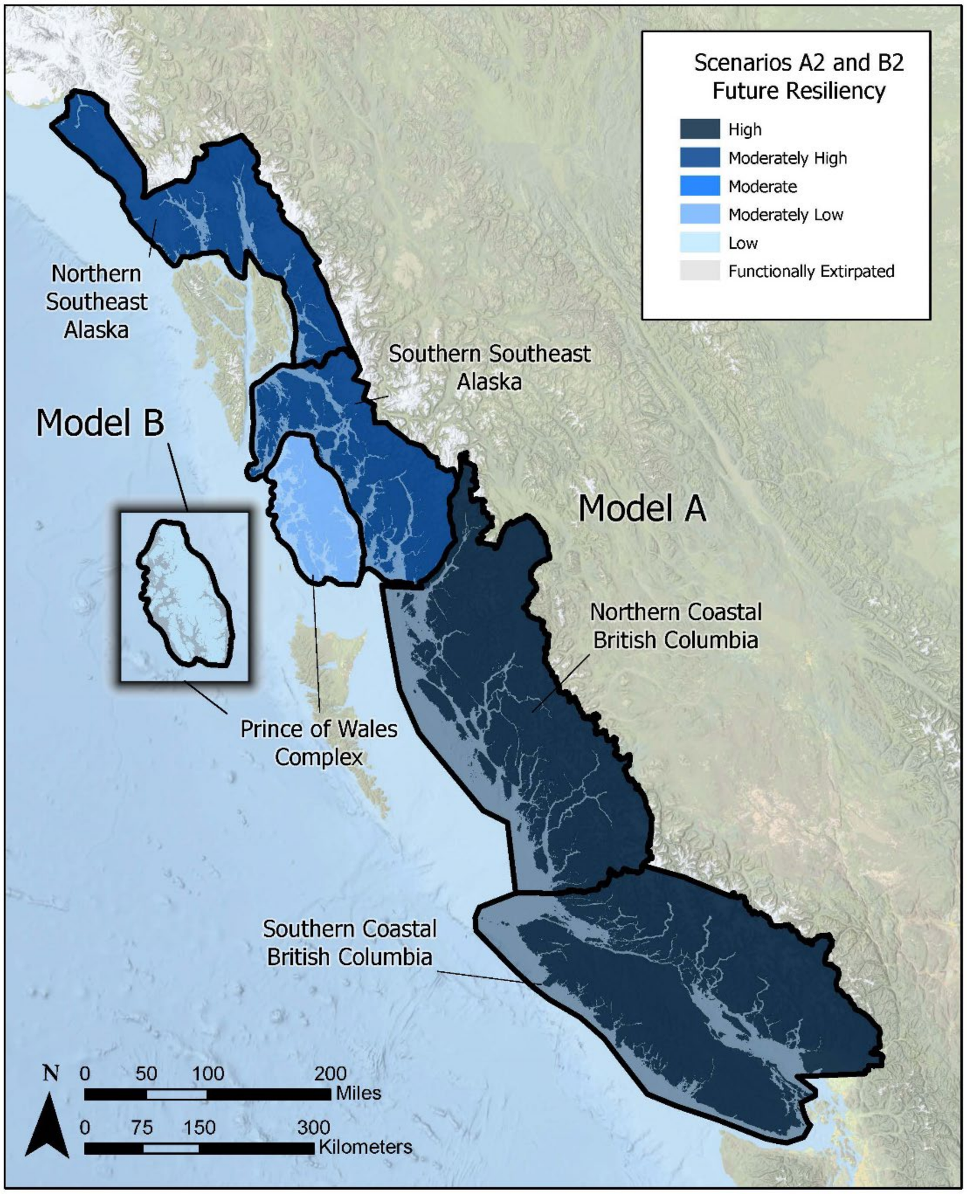


Figure 34 Map of future resiliency across all Analysis Units under Scenarios A2 and B2.

Scenarios A3 and B3

Similar to Scenario A2, under Scenario A3 (high wolf harvest), resiliency in the Northern Southeast Alaska Analysis Unit is expected to decrease from the current high level to a moderately-high level. Both the no-disease and disease models project a median population between 279 and 291 wolves at year 30. Under "high" wolf harvest conditions, 0–11 percent of simulations under both the disease and no-disease models result in a population less than or equal to 120 wolves.

Resiliency of the Southern Southeast Alaska Analysis Unit is anticipated to remain at a moderately-high level under Scenario A3. The median population size is expected to remain high, between 396 and 431 wolves at year 30. Additionally, only 11 percent of simulations under the disease model result in a population size less than or equal to 120 wolves.

Resiliency of the POW Complex Analysis Unit is expected to decrease to low under Scenario A3. Under Scenario A3 the estimated median population size in the POW Complex Unit at year 30 drops to 98–104 wolves, and under both the disease and no-disease models, between 8 and 17 percent of simulations result in a population smaller than 10 wolves.

When projecting 30 years into the future under Model B for the POW Complex Analysis Unit, the population is expected to drop to a functionally extirpated state under Scenario B3 (high wolf harvest, highest amounts of precipitation as snow, and liberal timber harvest conditions). Using this model, we expect a median population size between 17 and 20 wolves under both the disease and no-disease models. Between 10 and 17 percent of simulations result in a population size less than 10 wolves over the next 30 years.

Again, the Northern and Southern Coastal B.C. Analysis Units exhibit a similar trend in population growth under Scenario A3, with overall resiliency in both units declining from high to moderately-high. Projections for the Northern B.C. Analysis Unit result in a median population size of 438–464 wolves over the next 30 years, while projections for the Southern B.C. Analysis Unit result in a median population size of 389–415 wolves under both the disease and no-disease models. In four percent of simulations for the Northern B.C. Analysis Unit and ten percent of simulations for the Southern B.C. Analysis Unit, the populations drop below 120 wolves.

Table 45 below shows the current resiliency of each Analysis Unit alongside the projected future resiliency under Scenarios A3 and B3. Figure 35 shows the future resiliency of each Analysis Unit under Scenarios A3 and B3.

Table 45 Summary of current resiliency and future resiliency under Scenario 3/C.

Analysis Unit	**Current Resiliency**	**Future Resiliency**	
		Scenario A3	**Scenario B3**
Northern Southeast Alaska	High	Moderately-high	
Southern Southeast Alaska	Moderately-high	Moderately-high	
POW Island Complex	Moderately-low	Low	Functionally Extirpated
Northern Coastal B.C.	High	Moderately-high	
Southern Coastal B.C.	High	Moderately-high	

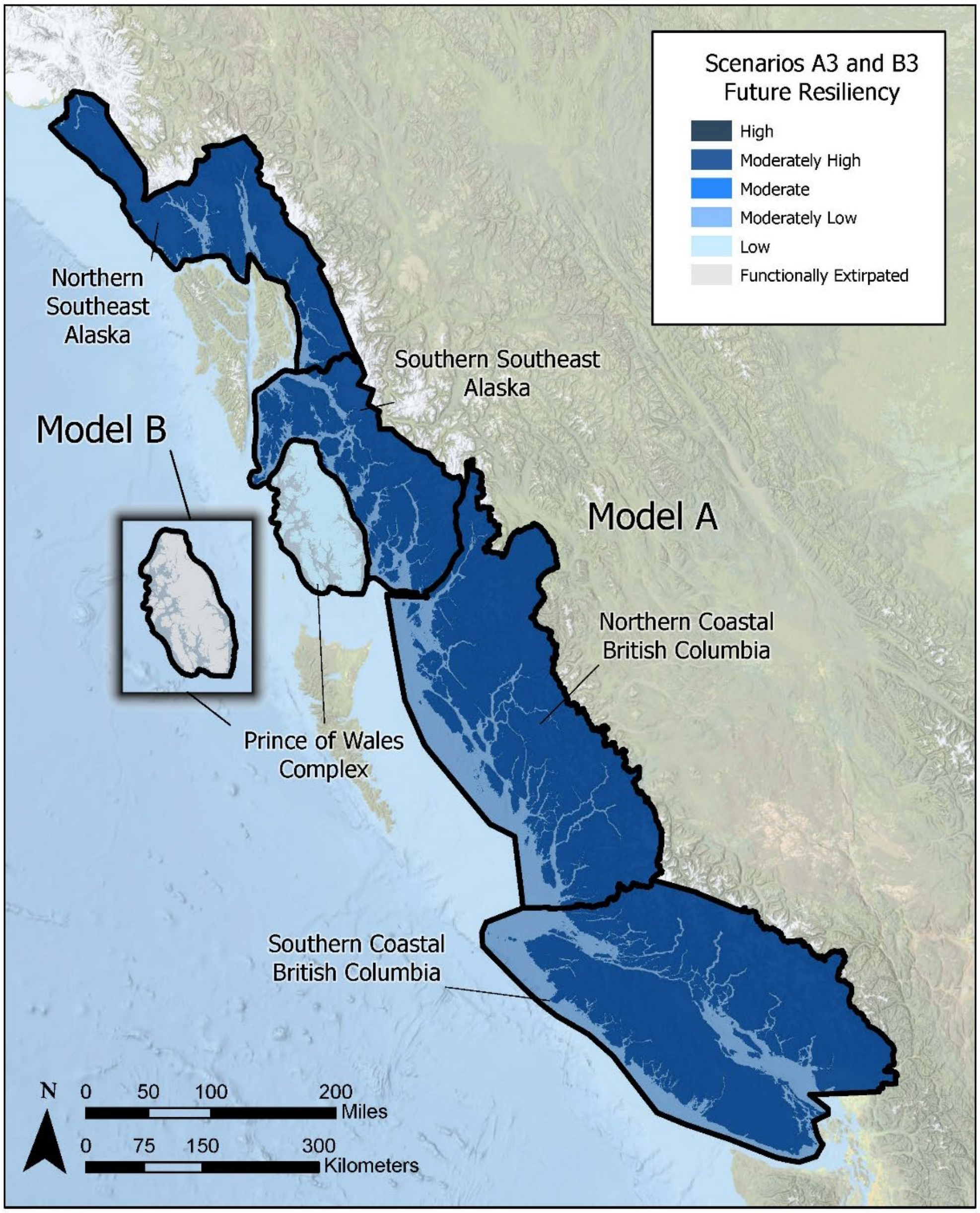


Figure 35 Map of future resiliency across all Analysis Units under Scenarios A3 and B3.

All Analysis Units

The following table summarizes the narratives presented above regarding the current and future resiliency of all Analysis Units under the three plausible future scenarios (Table 46).

Table 46 Summary of current resiliency and future resiliency under all scenarios.

Analysis Unit	Current Resiliency	Future Resiliency					
		Scenario A1	Scenario B1	Scenario A2	Scenario B2	Scenario A3	Scenario B3
Northern Southeast Alaska	High	High		Moderately -high		Moderately -high	
Southern Southeast Alaska	Moderately -high	Moderately -high		Moderately -high		Moderately -high	
POW Island Complex	Moderately -low	Moderate	Moderately -low	Moderately -low	Low	Low	Functionally Extirpated
Northern Coastal B.C.	High	High		High		Moderately -high	
Southern Coastal B.C.	High	High		High		Moderately -high	

5.4 Future Representation

As summarized in *Chapter 4.3 Current Species Representation*, Alexander Archipelago wolves currently exhibit high adaptive capacity across most of their range. However, we also noted that the POW Complex Analysis Unit shows high levels of inbreeding and is limited in terms of prey availability, since deer are the only ungulate in the Analysis Unit. Additionally, there is evidence of historical and ancestral inbreeding in the Southern Southeast Alaska Analysis Unit. These characteristics limit evolutionary potential within the subspecies.

Importantly, evolutionary potential cannot be restored on ecological time scales without gene flow and cannot be maintained within small populations due to the influence of genetic drift and potential inbreeding (Forester et al. 2022, p. 2–4). Although we know that wolves have exceptional movement capability, the geographic barriers that contribute to isolation within the Alexander Archipelago wolf range will not change within the next 30 years. Available genetic data indicates that the Northern Coastal B.C. Analysis Unit serves as a source population for Southern Southeast Alaska (Breed 2007, p. 34), which should continue to increase population size and genetic diversity within the Analysis Unit. There is also evidence of admixture occurring between Northern Rocky Mountain gray wolf populations and Alexander Archipelago wolves in the Southern Coastal B.C. Analysis Unit. Sightings of interior Canadian gray wolves within the range of Northern Southeast Alaska Alexander Archipelago wolves, combined with high levels of heterozygosity within the Northern Southeast Alaska Analysis Unit indicate that admixture is likely occurring along the northern boundary of the Alexander Archipelago wolf range as well. However, we also know that wolves within the POW Complex Analysis Unit are more isolated than mainland populations, and evidence of gene flow between the POW Complex and other Analysis Units is scant. These conditions are unlikely to change in the future, and therefore, managing for increased population sizes will be one of the only ways to proactively improve evolutionary potential in these populations. This will both reduce inbreeding and help restore genome-wide genetic variation, which is essential for maintaining evolutionary potential for known and novel stressors in the future.

It will also be important to consider anthropogenic influences on the landscape and the climate when evaluating the ability of wolf populations to adapt to changing conditions and novel environments. It is likely that evolutionary potential has already declined as a result of hunting pressure and impacts to primary prey (deer) from timber harvest within some Alexander Archipelago wolf populations, and as outlined in our three plausible future scenarios, we expect legacy impacts and ongoing timber harvest activities to continue to impact these populations into the future.

Although Alexander Archipelago wolves are quite adaptable in terms of their ability to occupy different habitats in a variety of climatic conditions, the potential for adverse cumulative impacts of timber harvest and wolf harvest could be high, especially in insular populations, where shifts in behavior are limited. Future condition modeling results indicate that wolves in the POW Complex Analysis Unit could be especially limited in the niches they occupy given their isolation and the potential for historic and ongoing impacts of timber harvest to reduce their only ungulate prey and the availability of preferred denning habitat. However, there is also extensive documentation of behavioral plasticity in wolf populations worldwide when it comes to flexibility in prey consumption and the use of a variety of habitat types to fulfill life history needs. Wolves in the POW Complex eat several prey items in addition to deer, and they also utilize roaded and non-roaded habitats at different times of the year to maximize their hunting capabilities and minimize contact with humans. However, if old-growth becomes increasingly limited and roads become more dense, it will be more difficult for wolves in the POW Complex to adaptively respond in a way that sustains the population.

Under Scenarios A1 and B1 (decreased-threats scenario), it appears that adaptive capacity within the subspecies will largely remain intact and may even increase slightly over the next 30 years. Under Scenarios A2 and B2, where threats continue at current levels, we anticipate that adaptive capacity will be maintained or decline slightly, specifically in the Southeast Alaska Analysis Units. As we move into a scenario where threats increase over the next 30 years (Scenarios A3 and B3), we expect adaptive capacity to decline slightly across the range, and the POW Complex Analysis Unit, which is already experiencing isolation and threats to prey availability from habitat destruction, may reach a point where adaptive capacity cannot be sustained without intensive conservation (e.g., translocations, reintroductions).

5.5 Future Redundancy

Given the wide distribution of populations across the historical range, and the moderately-high to high resiliency exhibited by most of the populations, we consider the Alexander Archipelago wolf subspecies to currently have high redundancy in the face of potential catastrophic events.

As described in *Chapter 4.4 Current Species Redundancy*, the catastrophic event of highest concern for Alexander Archipelago wolves is disease, which has the potential to alter population dynamics by affecting reproduction, mortality, or dispersal.

In our future condition models, we included a disease and a no-disease scenario to evaluate the potential impacts to redundancy from a simulated disease event. We based our disease scenario on observed rates of canine distemper in Yellowstone National Park, where three instances of canine distemper virus resulting in 20 to 30 percent mortality in the population were observed over 25 years. Comparing the resulting impacts of disease versus no-disease scenarios on Alexander Archipelago wolf populations, we found that disease generally had a small negative effect on population growth.

Under a low threat scenario, we expect Alexander Archipelago wolf redundancy to remain high, with most Analysis Units continuing to exhibit moderately-high to high resiliency. In a scenario where threats continue at current rates, we anticipate a slight decline in resiliency in the Northern Southeast Alaska Analysis Unit and the POW Complex Analysis Unit. Since resiliency is projected to decline within these Analysis Units, we also anticipate an overall reduction in subspecies redundancy.

Under a scenario where threats are high, resiliency is expected to decline for all Analysis Units except the Southern Southeast Alaska Analysis Unit. Resiliency in all Analysis Units except the POW Complex Analysis Unit is expected to be moderately-high. However, resiliency of the POW Complex is projected to decline to a very low level under a "high" threat scenario. Thus, under this scenario, we expect overall subspecies redundancy to be reduced further.

It is important to note that the true spatial extent of disease events is difficult to evaluate. Additionally, if populations of Alexander Archipelago wolves decline to small numbers or become highly localized, their vulnerability to disease may increase, and changes in climate and increased economic activities also have the potential to influence introductions of new pathogens and susceptibility of wolf populations to existing pathogens. On the other hand, the naturally fragmented landscape within which Alexander Archipelago wolves reside, could confer some protection against parasites and disease. We were not able to incorporate these cumulative effects into our models, so it is imperative that we take them into consideration when interpreting results.

CHAPTER 6 – SUMMARY OF VIABILITY

We considered what the Alexander Archipelago wolf needs to maintain viability by characterizing the status of the subspecies in terms of its resiliency, redundancy, and representation. Resiliency describes risk associated with stochastic events, redundancy with catastrophic events, and representation describes risk associated with long-term environmental change. We generally define viability as the ability of the subspecies to sustain populations across the current range within a biologically meaningful timeframe: in this case, 30 years (2053). Based on the life history and habitat needs of the Alexander Archipelago wolf, and in consultation with experts, we identified the potential threats and the contributing sources of those threats that are likely to affect the subspecies' future condition and overall viability. Future scenarios were developed to capture a range of plausible futures and associated uncertainty.

Alexander Archipelago wolves currently occupy five Analysis Units that span the historical range of the subspecies, three of which currently exhibit high resiliency (Northern and Southern Coastal B.C. and Northern Southeast Alaska), one with moderately-high resiliency (Southern Southeast Alaska), and one with moderately-low resiliency (POW Complex) (Table 30). Alexander Archipelago wolves appear to have high adaptive capacity, and we expect most populations to be able to adapt to near-term changes in their physical and biological environments. An exception is the POW Complex where high levels of inbreeding have been documented and ungulate prey is limited compared to the rest of the range. These characteristics limit the adaptive capacity of this Analysis Unit.

Given the wide distribution of populations across the historical range, and the moderately-high to high resiliency exhibited by most of the populations, we consider the Alexander Archipelago wolf subspecies to currently have high redundancy in the face of potential catastrophic events. The catastrophic event with the highest potential to impact Alexander Archipelago wolf redundancy is disease, and we are not aware of any significant disease outbreaks within Alexander Archipelago wolf populations currently.

We identified the most significant and plausible factors that could affect the viability of the Alexander Archipelago wolf 30 years into the future. Across the range of the subspecies, we evaluated the potential effects of wolf harvest and disease. Within the Southeast Alaska Analysis Units, we also considered how inbreeding could continue to impact population growth, and within the POW Complex Analysis Unit, we analyzed how different precipitation regimes and historical and ongoing timber harvest activities could alter land cover and the availability of deer for Alexander Archipelago wolves.

Under the low wolf harvest scenario (Scenario A1), we anticipate resiliency to remain similar to current conditions across most of the subspecies' range, and resiliency within the POW Complex Analysis Unit is expected to increase to moderate levels. If we look at Model B for the POW Complex under Scenario B1 (low wolf harvest, least amount of precipitation as snow, conservative old-growth harvest), we expect resiliency to remain at the current moderately-low level. All other Analysis Units exhibit moderately-high to high resiliency. Therefore, we also anticipate redundancy for the subspecies to remain high. Under this decreased-threats scenario it also appears that adaptive capacity within the subspecies will remain intact.

Under the average wolf harvest scenario (Scenario A2), we anticipate resiliency to decrease only in the Northern Southeast Alaska Analysis Unit. However, if we look at Model B for the POW Complex under Scenario B2 (moderate wolf harvest, moderate amount of precipitation as snow, and current timber harvest conditions), we also expect resiliency to decrease in this Analysis Unit. The POW Complex Analysis Unit exhibits moderately-low to low resiliency under these scenarios. All other Analysis Units continue to exhibit moderately-high to high resiliency. Therefore, if threats continue at current rates, we expect redundancy and adaptive capacity to remain stable or decrease slightly, specifically in the northern portion of the range (Southeast Alaska Analysis Units).

Under the high wolf harvest scenario (Scenario A3), we anticipate resiliency to decrease across all Analysis Units except the Southern Southeast Alaska Analysis Unit. Resiliency in the POW Complex under this scenario is low, and Model B (high wolf harvest, highest amount of precipitation as snow, liberal timber harvest) projects this population to be functionally extirpated in 30 years under Scenario B3. All other units exhibit moderately-high resiliency. Under this scenario, where threats are high, we expect overall subspecies redundancy to be reduced, and we also expect adaptive capacity to decline across the range. The POW Complex may reach a point where adaptive capacity cannot be sustained without intensive conservation (e.g., translocations, reintroductions).

Overall, the threat to viability of the subspecies is low across most of its range. However, in one Analysis Unit - POW Island Complex - human activities (specifically wolf harvest and timber harvest) have the potential to threaten population stability. Maintaining a resilient population will require careful monitoring and management. Based on our assessment of the 3Rs, currently and 30 years into the future, viability for the Alexander Archipelago wolf will remain relatively high if threats are reduced. However, even if threats continue at current levels, we suspect that viability will decline slightly, specifically in Southeast Alaska populations. If threats increase, viability is anticipated to decline further, and we may reach a point where it is difficult to recover the POW Complex population.

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APPENDIX A: INDIGENOUS ENGAGEMENT WITH THE ALEXANDER ARCHIPELAGO WOLF: AN APPLIED STUDY OF TRADITIONAL ECOLOGICAL KNOWLEDGE

Indigenous Engagement with the Alexander Archipelago Wolf: An Applied Study of Culture and Traditional Ecological Knowledge

Jeffrey J. Brooks, Stephen J. Langdon, Devlin *Shaagaw Éesh* Anderstrom, Michael *Gitwaayne* Douville, Thomas Allen George, Michael Arne Jackson, Scott Jackson, Thomas Mills, Judith *Dax̱ootsú* Ramos, Jon Rowan, Tony Sanderson, and Sid Edenshaw

Uwashag̱i G̱ooch Gáas' (Panting Wolf House Post)*

Interim Report Published with the Species Status Assessment

Submitted to the United States Fish and Wildlife Service by Sealaska Heritage Institute

Cooperative Agreement Number F22AC00887

August 15, 2022

NOTE:

The interim report is appended to the final Species Status Assessment for the petition of the Alexander Archipelago wolf. An earlier version dated July 12, 2022 was appended to the draft Species Status Assessment for peer and partner review. A final report will be submitted in December 2023.

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*Cover photo: Courtesy of the National Park Service, Sitka National Historical Park, SITK 163, *Kaagwaantaan* Panting Wolf house post, NPS Photo (SITK 00000163 09/01/2007)

Executive Summary

The U.S. Fish and Wildlife Service in Alaska is conducting a Species Status Assessment in response to a petition to list the Alexander Archipelago wolf under the Endangered Species Act. This federal undertaking could not be adequately prepared without including the voices of the Indigenous people who have a deep connection with the species. The Indigenous knowledge presented in this report is the cultural and intellectual property of those who have shared it. The purpose of the report is to communicate the knowledge shared with us to the U.S. Fish and Wildlife Service to help inform the Species Status Assessment.

Due to limited time, we employed rapid appraisal research to expeditiously develop a preliminary understanding of Indigenous people's ecological knowledge of wolves. We applied the social scientific methods of ethnographic interviewing and inductive coding from grounded theory for text analysis. We conducted a literature review to supplement the interviews focused on the cultural significance of wolves in Tlingit society and social organization. The study was informed by tribal consultation (Appendix A).

Our Indigenous research partners consist of knowledge holders, living in Southeast Alaska. Their interviews represent six large geographic areas and communities, including Yakutat, Excursion Inlet, Kake, Klawock, Craig, and Hydaburg (Figure 2). Five Indigenous research partners provided information about cultural connections to Wolf, and nine provided traditional ecological knowledge about wolves. We interviewed a total of nine knowledge holders (Appendix D).

We primarily analyzed the data within geographic area and within interviews. The insights we learned are specific to the areas where the knowledge holders with whom we spoke have engaged with Wolf. There were differences and similarities in findings across areas. Some findings and insights apply for more than one area or social context in Southeast Alaska.

We report extensive traditional ecological knowledge about wolf health and abundance, distribution, territories, travel patterns, reproductive behaviors, and wolf habitat and prey needs and conditions. For the Yakutat and Excursion Inlet areas, two types of wolves were identified. The smaller of the two is known as the southeast wolf or the Alexander Archipelago wolf; the larger one was identified as the Yukon wolf. Our Indigenous research partners have not observed the two types intermixing.

The Alexander Archipelago wolves are organized into packs of about six to twelve animals on average, and sometimes packs are larger (i.e., ~20 to 30 plus). While there are discrete packs, they subdivide in various ways at various times. In the fall they join together into the largest units of the year. Related packs may merge to form larger packs. It is not entirely clear if these larger packs are one pack operating in one territory or two or more related packs joined together for hunting an area with abundant prey.

There was agreement that packs break up during the mating season as one or more breeding pairs begin denning and caring for pups. The other members of the pack continue to hunt as a smaller group and usually do not mate. There are usually five to eight pups in a litter. The dens are multigenerational and located between 1,000 and 1,500 feet elevation in the Kake area. Packs reunite when the pups are big enough to travel and learn to hunt.

Wolf pack territories are bounded by watersheds or stream drainages in Yakutat, Excursion Inlet, and Kuiu and Kupreanof islands. Packs will normally travel on well-established and marked trails. For the Excursion Inlet area, wolf packs tend to move through the forest as a group, not necessarily following established trails, in similar fashion to a pod of orcas. Wolves tend to aggressively defend their territories, but some territories may overlap, and minor intrusions may be tolerated. We learned there are approximately 10-12 wolf packs in the Kuiu and Kupreanof islands area (Figure 17).

The wolf packs in coastal Southeast use habitats at all elevations from the beaches and islands to the mountain passes. Muskegs appear to be important habitat for wolves. Wolves tend to follow ungulates up and down the mountains in a seasonal pattern limited by snow depth. Large islands may be occupied by one or more packs, and packs tend to swim from island to island in pursuit of deer. Wolves travel on and near the road system, and road travel allows wolves to move quickly and effectively access prey.

The primary prey for the Alexander Archipelago wolves is ungulates supplemented with beaver and salmon, but wolves consume whatever they can catch or find, including birds, small mammals, and beached carcasses of marine mammals. There is evidence of more than one pack driving deer and moose into bottleneck or dead end areas to facilitate capture and kill. Three specific kill sites were identified by substantial accumulations of bones.

Results include detailed information on the cultural importance of wolves, Indigenous understandings of wolves, relationships between humans and wolves, and the position of Wolf in Tlingit social organization. The Indigenous peoples of Southeast Alaska possess an understanding of wolves that differs from the western scientific understanding of wolves. They have a profound and ancient relationship with wolves embedded in their language, culture, society, and homelands. Their understandings of Wolf and their engagements with wolves on the landscape are based in a rich blend of history in place, ecological observations, sociocultural knowledge, and cosmological beliefs (Figure 15). In this perspective, wolves are viewed as nonhuman beings that desire respect and are the relatives of people who belong to the Wolf moiety and clans.

We found evidence that some of the Indigenous wolf experts we talked with also have western scientific knowledge of and experience with wolves learned from agency biologists through direct conversations, sharing and reading reports of scientific research, or participation in the mark-recapture studies conducted in parts of Prince of Wales Island.

The primary motive for wolf trapping and hunting is to achieve balanced populations of deer and wolves. The local objective is to ensure adequate deer abundance and deer proximity to communities for subsistence harvests. There are two dimensions to consider: low abundance of deer from predation by wolves and deer becoming too wary, or skittish, and therefore difficult to harvest in the presence of active wolf packs. The preferred means of maintaining balance is by subsistence hunting and trapping in places where communities normally access and hunt deer and other ungulates for subsistence purposes.

To ensure healthy wolf packs, they have to be trapped and hunted on a three-year cycle in which a substantial portion of the pack is removed. The packs will regrow their numbers larger than original size when left alone for three to four years if they have adequate prey and no other sources of mortality. This approach creates a balance optimal to humans, deer, and wolves where wolf and deer harvests improve wolf and deer health while ensuring freezers full of venison and healthy Indigenous Peoples and cultures.

The agencies are seeking good estimates of wolf abundance. Indigenous experts in this study possess knowledge and skills that would help the agencies improve their population estimates. Local wolf trappers have years of experience with attracting wolves and making close contact. These skills are invaluable for the hair board mark-recapture technique. Expert wolf trappers know how to effectively mask foreign scents that may repel wolves, and they can estimate wolf abundance in an area by counting tracks and scat piles and studying features of wolf trails and markings. Indigenous wolf experts can effectively design and conduct studies with the agencies to estimate wolf abundance.

The analysis points to several important next steps, including more agency investment in Indigenous knowledge studies; wolf research that uses a coproduction of knowledge approach; enhanced collaborative management of wolves; and discussions of the potential for cooperative management of wolves in Southeast Alaska.

List of Key Words and Topics

Alaska Native Peoples; *At.óow*; Collaborative management; Co-production of knowledge; Culture; Endangered Species Act; Existencescape; Haida; Human-Wolf relationship; Indigenous worldview and ontology; *K̲u.éex'*; Predator-prey dynamics; Prince of Wales Island; Southeast Alaska; Social science; Subsistence harvest; Tlingit; Social organization; Wolf-Dog hybridity

Table of Contents

1. Introduction

> "Like when you see the wolves up in the woods, they come around, you yell, put your hand together [cups his mouth with his hands] '*Táanaa! Táanaa haat tán*!' That means, 'Bring the spears!'[1] And those wolves would take off, didn't want anything to do with it. Yeah, that's true fact, because there were a lot of wolves around the mainland. The mainland is where the wolves were at. And there used to be, before we moved into there, when we first come down, after that ice age melted down, that's before the great rain. And there were mammoths up there, on the mainland. Old timers call them, *lugeitl*', 'Snotty nose,' because it looked like a snotty nose because they have that big nose."
>
> Mr. Thomas Jack, *Wooshkeetaan* (Interviewed by Chuck Smythe, 2017)

The U.S. Fish and Wildlife Service in Alaska is preparing a Species Status Assessment[2] in response to a petition to list the Alexander Archipelago Wolf under the Endangered Species Act. The petition and the assessment have a direct and important connection to the Indigenous subsistence way of life in Southeast Alaska. People and wolves depend on the same land base and many of the same food sources in this part of Alaska. According to Presidential Directive (Lander and Mallory, 2021), this federal undertaking cannot be considered complete or adequate without including the voices of the Indigenous people who have the deepest connections with the species. Accordingly, the U.S. Fish and Wildlife Service made a major decision to include traditional ecological knowledge in this Species Status Assessment.

It is highly appropriate to include traditional ecological knowledge because the agency is required to incorporate available information about wolves into its assessment, and part of that information is held by Indigenous residents of Southeast Alaska. This information includes, among others, wolf health and abundance, wolf distribution within its ecological setting, wolf behaviors and traits, and wolf habitat and prey needs and conditions, both current and future (U.S. Fish and Wildlife Service, 2016). The people who live everyday with wolves on the land and hunt, trap, and gather the same foods in the same places as wolves know a lot about the ecological and biophysical information needed for the Species Status Assessment.

The Indigenous ecological knowledge presented in this report is the cultural and intellectual property of those who have shared it with us. The purpose of this report is to compile, organize, and communicate the knowledge we have so graciously received. The primary audience is the U.S. Fish and Wildlife Service, and the objective is to inform the agency's Species Status Assessment for the Alexander Archipelago wolf.

As Mr. Thomas Jack indicates in the epigraph, the Indigenous Peoples of Southeast Alaska have an ancient relationship with Wolf. Wolves mean much more to them than the subject of a petition to list the subspecies under the Endangered Species Act. Every analyst, project manager, scientist, and decision maker involved with this listing process has something to learn from those who have coexisted with Wolf[3] in this place for millennia.

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[1] Mr. Thomas Jack references a type of short spear easily carried on one's back.

[2] We purposively avoided the use of most acronyms such as SSA and TEK throughout the report.

[3] We capitalize Wolf when referring to the nonhuman being Wolf and the Wolf People to acknowledge the Tlingit perspective and understanding of wolves and to highlight this aspect of the Tlingit relationship with the species.

1.1 Background: Archaeology, History, and Culture

Although this report focuses on ecological and biophysical knowledge about the Alexander Archipelago wolf, it is necessary for the reader to understand at the outset the rich cultural and historic contexts and origins of this knowledge as it relates to Tlingit and Haida societies, ways of life, traditions, and cultural practices.

1.1.1 Indigenous Peoples and wolves in Southeast Alaska

Southeast Alaska consists of the mainland from Cape Yakataga in the north to Dixon Entrance in the south including the islands of the Alexander Archipelago (Smith, 2016). Wolves occur in much of this area but are absent in some places (Section 3.5). Archeological evidence of stone tools indicates humans arrived in the region approximately 11,000 years ago at a time of deglaciation and substantial coastal change (Moss et al., 2016). Human remains from Prince of Wales Island have been dated to 10,600 years ago (Dixon, 2000). The Tlingit and Haida were the Indigenous occupants in the region when European explorers arrived in the late 18th century. Tsimshian people live today on Annette Island near Dixon Entrance on the Metlakatla Indian Reserve created by federal action in 1915. Figure 1 shows Tlingit *K̲wáans, Kaigani Haida, and* Tsimshian territories in Southeast Alaska.

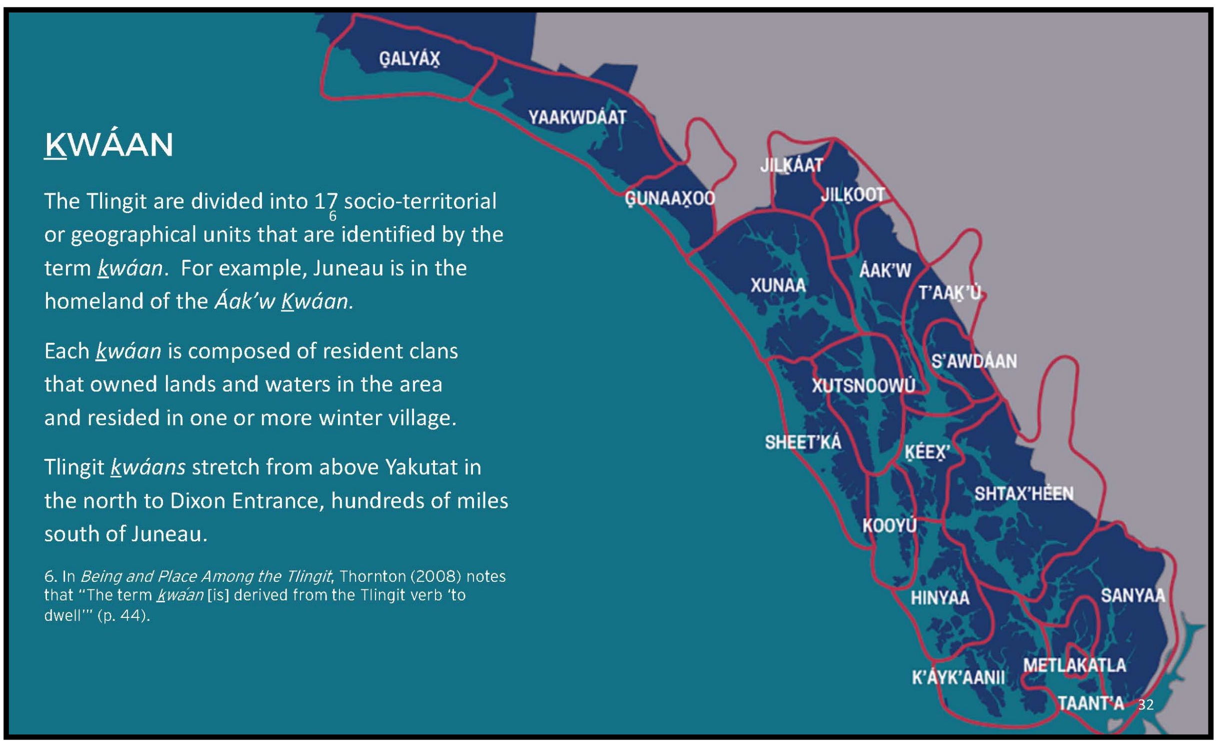

Figure 1. Tlingit *K̲wáans, Kaigani Haida* (i.e., *K'áyk'aanii*), and Tsimshian territories (i.e., Metlakatla). Source: Sealaska Heritage Institute

Archeological and linguistic evidence suggest that Tlingit have been in the region for at least 6,000 years (Langdon, 2020a). The Haida emigrated to the southern part of the Prince of Wales Archipelago from Haida Gwaii in several waves approximately 100-150 years prior to European appearance (Blackman, 1990). The Tsimshian moved to Annette Island in 1887 from the vicinity of the mouth of the Skeena River in northern British Columbia, following authorization by the

United States Government of a request made by William Duncan, an English missionary, and Tsimshian leaders. Ironically, they sought a new home to escape the jurisdiction of British Columbia that refused to recognize their claim of aboriginal occupancy and sovereignty.

1.1.2 Archeological evidence of wolves and dogs

While the amount of archeological research in Southeast Alaska to date has been meager, there are several studies of relevance to this research. There is a substantial excavation covering about 3,000 years of human occupation at Coffman Cove on the east coast of Prince of Wales Island (Moss et al., 2016). Remains of dogs are first identified at 3,800 years before present, but no remains of wolves are reported from any strata excavated. Skeletal evidence is presented identifying two discrete dogs that are classified as "village dogs." Moss et al. (2016:176) note:

> "The gray wolf is the wild canid inhabiting the islands of the Alexander Archipelago. The bones found at 49-Pet-O67 [Coffman Cove] all are coyote-sized or smaller, indicating they are the remains of dog not wolf."

Moss et al. (2016) do not appear to recognize the distinction between Alexander Archipelago and timber wolves, and that Alexander Archipelago wolves are smaller than timber wolves.

Archeological evidence of the appearance, presence, and characteristics of dog remains from four sites on Prince of Wales Island are analyzed in Crockford et al. (2011). The authors claim there is no evidence of wolf in any of the remains. They further assert, "While wolves do inhabit these islands, wolf (*Canis lupus*) skeletal elements are considerably larger than aboriginal dogs of any kind …" (Crockford et al., 2011:56). They use as a comparative indicator, the lower jawbone of a wolf from the continental United States, as the basis for this assertion (Crockford et al., 2011).

It is important to note that while we have not consulted any anatomical studies comparing the Alexander Archipelago wolf with the timber or "Yukon wolf" for size, physiology, and morphology, it was pointed out by interviewees Thomas Mills in Excursion Inlet and Devlin Anderstrom in Yakutat that the solitary timber wolves they observed were significantly larger than the Alexander Archipelago wolves (Sections 3.5.1.3 and 3.5.2.1).

1.1.3 Historical accounts of wolves and dogs

In the late 1700s and early 1800s, a number of European countries sent voyages of exploration to the north Pacific Ocean. Great Britain, Spain, and France were the primary sponsors of those voyages. The Spanish explorers produced substantial descriptions of the people and their way of life along with aspects of land and sea more extensive than those of explorers from other countries.

Spanish explorers came to the west coast of Prince of Wales Island on three occasions: 1775, 1779, and 1792. On each occasion they entered Bucareli Bay. The 1779 expedition commanded by Arteaga and Bodega y Quadra came with two large 100 foot sailing vessels and a number of longboats for survey work. The party was in the area for about six weeks. Tlingit and Haida visited the main vessels anchored in Port Santa Cruz on Suemez Island where brisk trade between the Indigenous People and the Spaniards took place. A survey party explored the nearby islands and waterways for 26 days taking soundings and making charts. During those travels, they had several encounters with Indigenous People. The Spanish journals include substantial descriptions of the landscape and various aspects of Indigenous culture and practices.

In the journal of Bodega y Quadra, one of the leaders of the 1779 expedition, he reported:

> "… they continually brought well-woven mats of various colors, pelts from land wolves, sea lions, seals, sea otters, deer, bear and other small animals, well-tanned, others prepared with the hair on them" (Olson, 2002:109).

In 1791, Malaspina led a Spanish voyage of exploration that visited Yakutat Bay at the opposite end of Southeast Alaska. The area was occupied by Tlingit. As with the Spanish accounts of visits to Bucareli Bay, Malaspina and other members of the party produced descriptions and observations of people in Yakutat they encountered. Malaspina wrote:

> "The clothing of the men is regularly a cape of nutria (sea otter) pelts, of wolves or of martens over the body, with a band (sash) on the lower part of the abdomen" (Malaspina quoted in de Laguna, 1972:434).

In 1792 Jacinto Caamano, captaining a single large vessel, returned to continue exploring portions of Bucareli Bay not completely surveyed in 1779. The vessel anchored in Port San Antonio on the southwest side of Baker Island. The survey took 11 days. One purpose was to continue to pursue waterways to the east to see if they could find a Northwest Passage. This was part of the charge given to Caamano. In fulfilling this aim, the long boat party went east and then south from the anchorage to Ulloa Channel that led them westward back to the Pacific Ocean. Eventually, they circumnavigated Suemez Island arriving back at Port San Antonio. Josef Maldonado, a botanist, was charged with documenting the fauna encountered in this survey and reported that "wolves" were observed as well as "Indian dogs" (Olson, 2002:503).

The Spanish journals documented there were wolves on the landscapes they explored, and the Tlingit were taking wolves, tanning their skins, trading them, and wearing the skins.

Some intriguing comments about dogs observed in Sitka were provided by a member of Captain Marchand's crew who visited there in 1791. The surgeon Roblet noted:

> "His feet are extremely large; the tail is bushy, the muzzle long and pointed, the ear erect, the eye sharp, the body thick and his height may be about eighteen inches. He barks little and appears timid with strangers. He welcomes and caresses his master, but caresses him alone" (Fleurieu, 1801:306).

Descriptions of hybrid wolf-dogs given by several interviewees strongly resemble this observation of both physical and behavioral traits (Sections 3.5 and 4.6). Mike Jackson of Kake made the following observations on hybrid wolf-dogs.

> MJ: "…they [hybrids] were super protective of the owner. They would hardly bark or anything. They would just watch from out in the bushes, just like a real wolf … but if there was somebody that was gonna do harm, they could sense it. And they'd come sit right next to 'em and watch that person."

De Laguna made a distinction between “small, quick, terrier like animals, quite different from the larger wolflike dogs used for ordinary hunting and carrying packs” (Emmons, 1990:139). This comment could be interpreted as referencing wolf-dog hybrids.

British explorer George Vancouver had numerous encounters with Tlingit and Haida when sailing in southeast Alaska between 1792-94. Just north of modern day Ketchikan, a party of Vancouver’s men had an intense, violent engagement with a party of Tlingit in several large canoes. During the confrontation:

> “… a young man, appearing to be the chief of the party, seated himself in the bow of the yawl, and put on a mask resembling a wolf’s face, compounded with the human countenance…”

It is likely the mask was part of the armor that Tlingit leaders wore into hand to hand combat (Emmons, 1991:350).

In 1867, the United States purchased Russian claims to Alaska and assumed jurisdiction. In 1879, John Muir traveled to Southeast Alaska to explore the territory. Arriving in Wrangell, Muir joined with missionary S. Hall Young and arranged with Tlingit leaders to take a canoe trip into the northern part of southeast Alaska. One of the Tlingit was the young Christian leader Kadashan. The party was camped one evening along Chatham Strait when “the howling of a wolf on the opposite side of the strait was heard” (Muir, 1915:124). Kadashan asked the missionary S. Hall Young if wolves had souls. An exchange concerning wolves followed that Muir documented.

> “The Indians believe that they have [souls], giving as foundation for their belief that they are wise creatures who know how to catch seals and salmon by swimming slyly upon them with their heads hidden in a mouthful of grass, hunt deer in company, and always bring forth their young at the same and most favorable time of the year.”

Clearly Tlingit were aware that wolf packs engaged in complex communication skills during deer hunts. Tlingit held wolves in high regard due to their combination of speed, strength, intelligence, and cooperation allowing them to consistently provide food for themselves.

Muir further inquired:

> “... how it was that with enemies so wise and powerful the deer were not all killed. Kadashan replied that wolves knew better than to kill them all and thus cut off their most important food supply. He said they were numerous on all the large islands, more so than on the mainland, that Indian hunters were afraid of them and never ventured into the woods alone for these large gray and black wolves attacked man whether they were hungry or not. When attacked, the Indian hunter, he said, climbed a tree or stood with his back against a tree or rock as a wolf never attacks face to face. Wolves, and not bears, Indians regard as masters of the woods, for they sometimes attack and kill bears, but the wolverine they never attack …” (Muir, 1915:124).

While we have identified little commentary on wolf abundance and distribution in the historic records thus far examined, one noteworthy comment from Emmons (1991:136) is as follows:

> “Within the last 30 years [~1900-1937] it [wolf] has increased greatly in numbers and has crossed some broader channels to islands where many deer formerly lived, [and the latter, in consequence] have become extinct.”

Tlingit were no doubt aware of this phenomenon particularly those living in areas into which wolves expanded.

1.1.4 Cultural overview

Although they are not linguistically related and display distinct cultural identities, the three Indigenous groups share many cultural values, beliefs, and customary practices that allowed for significant, but not necessarily peaceful, interactions among the groups. Tlingit, Haida, and Tsimshian share matrilineal descent, corporate kin groups, key ontological assumptions about being and existential processes, and central ceremonial forms and ritual practices. The following cultural synopsis is based on Tlingit society as they are the predominant Indigenous group in Southeast Alaska before and following contact with Euro-American society. Haida and Tsimshian variations from this pattern are minor.

Culture is the general term covering all aspects of the way of life practiced by a human society in which members share understandings that enable the group to live collectively. For purposes of this discussion, Tlingit culture is divided into two subcategories: existencescape and social organization. The former is employed to frame the Tlingit relationship with Wolf from their perspectives and experiences on the land, while the latter is used to help the reader understand Tlingit relationships among individuals, social groups, and within their society as a whole.

1.1.4.1 Existencescape

An existencescape comprises the realm of possible understandings, behaviors, and creative responses given a set of cosmological and ontological principles. These are experienced and expressed in the embodied habitus among members of a cultural group that allows them to share orientations and understand experiences. Habitus constitutes the cognitive structures through which sensory experiences are processed into meaningful understandings; it is the physical embodiment of cultural capital, the deeply ingrained habits, skills, and dispositions that people have due to life experiences and position in a society (Bourdieu, 1977). In the rich temperate rain forest of their homeland, the Tlingit created an existencescape premised on shared similarities of being with other entities with whom they lived and now live (Langdon, 2019; 2020b). By being, is meant person—a form equivalent in essence to a human being, including an invisible spirit that is found in all existing entities. A key element of all persons, both human and nonhuman, is the spirit or existential essence that has the capacity to live, die, and return (i.e., be reborn) a process termed cosmological cycling (Fienup-Riordan, 1983).

Orientations of the Tlingit existencescape are based on core beliefs expressed in cosmological myths and mythic charters and covenants.[4] Through the Raven cycle of myths, Tlingit acquire understandings of the nature of existence: domains, entities, processes, interactions, time, and space. They learn that the living forms around them are persons essentially like themselves in

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[4]In this context, a myth is a traditional story, especially one concerning the early history of a people or explaining some natural or social phenomenon and typically involving supernatural beings or events.

that they are perceptive, sentient, attentive, volitional, and desirous of respect (Langdon, 2019). They learn that movements between domains of existence can occur (e.g., between living and dead or visible and invisible). They learn that movements between forms of existence can occur (e.g., transformation, hybridization). An implicit message in these accounts made explicit when taught is one must be observant, attentive, open to new knowledge, and respectful at all times. Finally, they learn that through appropriate respectful treatment and ritual action, fulfilling the moral obligations stipulated in the charters and covenants will meet their obligation to sustain existence. Anthropologist Julie Cruikshank has observed the Tlingit occupy "a moral universe inhabited by a community of beings in constant communication and exchange" (quoted in Thornton 2012). This fundamental orientation to existence is termed relational sustainability (Langdon 2019, 2020b).

1.1.4.2 Social organization

Social organization includes many components, but for the purposes of this discussion, it comprises the kinship structure that establishes identity and relationships among people, patterns of marriage, leadership principles, and ceremonial practices that sustain and reproduce the society. Everyday social life among humans in Tlingit society is organized around principles of membership and engagement at multiple levels. The first principle is matrilineal descent. Every person born in Tlingit society takes on a primary identity from their mother. That identity operates at multiple levels. The first level is the dual division known as moiety. There are two sides or "tribes," Ravens on one side and Wolf/Eagles on the other. At the next level in each moiety there are approximately 35 clans that are named, corporate transgenerational entities whose members recognize and subscribe to a joint identity. The third level is the house group. Tlingit houses are named and recognized social units in Tlingit cultural processes. A person is then at birth a member of moiety, clan, and house.

A fundamental principle of social process and organization is a person must marry someone from the opposite side or moiety. In the past, a violation of this principle would constitute incest and could lead to banishment. The marriages create relationships between the two clans that can be characterized as obligatory reciprocity. That is especially apparent on key occasions, such as following a death, during house building, and totem raising. The side pursuing the event arranges with their opposites who carry out much of the related activity necessary to complete the task. For example, at death, the opposites come in and take care of the deceased body, prepare it for observation, and provide services such as food and solace to their relatives. Subsequently, those receiving the services stage a ceremony a year or more after to honor the deceased termed a *k̲u.éex'* (i.e., potlatch). Acting as host, they invite their opposite relatives who supported them as honored guests. At the formal ceremony among other activities, recognition, thanks, and gifts are given by the hosts to the opposites. This is a pivotal event in Tlingit social structure as it reinforces and recreates bonds while establishing new leaders and freeing the spirit of the deceased for reincarnation.

The Tlingit *K̲wáan* is a socio-geographic organizing unit of intermarrying clans who occupy a discrete territory defined by clan territorial ownership within the area (Figure 1). It is not a political entity but is recognized as a unit in which peace generally prevails among the resident clans. Clans, the sovereign political units in Tlingit society, may be in conflict with clans in other Tlingit *Ḵwáans*.

2. Study Design and Methodology

This type of study requires a substantial amount of time, community outreach, review, and discussions between the research partners and the agency analysts who seek to apply traditional ecological knowledge. The unfortunate reality is we did not have enough time to complete a comprehensive data collection and analysis. We developed a hybrid research approach that combined principles and methods from three well-established and compatible approaches in anthropology. These included rapid appraisal, ethnography, and grounded theory. Rapid appraisal is used to expeditiously develop an initial, preliminary, and qualitative understanding of a situation; in this case, Indigenous people's understandings and knowledge of wolves to inform the agency's Species Status Assessment (Beebe, 1995; Carruthers and Chambers, 1981).

To develop initial analytical categories and concepts for the sociocultural and ecological relationships between Indigenous knowledge holders and wolves, we applied ethnographic interviewing and inductive coding from grounded theory for text analysis (Bernard, 2006). Because traditional ecological knowledge is primarily specific to individuals and places, we conducted a within-transcript and within area analysis. Due to time constraints, we did not conduct extensive across-transcript analyses normally associated with studies of Indigenous knowledge such as regional comparison and contrast for commonalities and variations, missing data, and unique materials (Langdon, 2006).

We combined several methods and sources of information, including literature review, notes from tribal consultation (Appendix A), informal conversations with local wolf experts, a mapping exercise, and personal history narratives for long-time wolf trappers and hunters. We used open ended conversations and semi-directed interviews to construct the personal narratives (Huntington, 1998). The conversations focused on biophysical and ecological aspects of wolves, wolf behaviors, wolf characteristics, and interactions between people and wolves (Appendix B). Some Indigenous knowledge holders were asked about cultural connections and significance of wolves and how Wolf is used and displayed in names, clan crests, ceremonies, performance, sacred *at.óow*, everyday objects, *ḵu.éex'*, and other types of material culture (Appendix C).

Our Indigenous research partners are wolf experts and cultural experts, living in Southeast Alaska (Appendix D). These partners represent six large geographic areas and communities, including Yakutat, Excursion Inlet, Kake, Klawock, Craig, and Hydaburg (Figure 2). Five Indigenous research partners provided information about cultural connections to Wolf, and nine provided traditional ecological knowledge about wolves. We did not ask everyone the same questions and encouraged open-ended conversations. Some personal narratives about Wolf contained both types of information, and others contained one type or the other. Some partners provided extensive geographic information about wolf distribution, range, and locations of specific wolf packs. We attempted to map these locations when enough geographical and place name data were shared. Mr. Scott Jackson from Kake sketched a map showing wolf packs for Kuiu and Kupreanof islands (Figure 17).

Nine audio recordings were made and transcribed, resulting in approximately ten hours of dialog. The audio recorded interviews were proofed and corrected. The primary analyst carefully listened to the recordings while reading through the transcripts. Then, during a second read he used the comment function in Microsoft Word, Track Changes to apply coding labels to sections of text. The coding labels represent both questions we asked and some emergent and unexpected categories. The analyst wrote memos under the codes in the comment bubbles. The memos were the analyst's summary impressions and interpretations of cultural understandings and traditional ecological knowledge of wolves and how these related to our purpose.

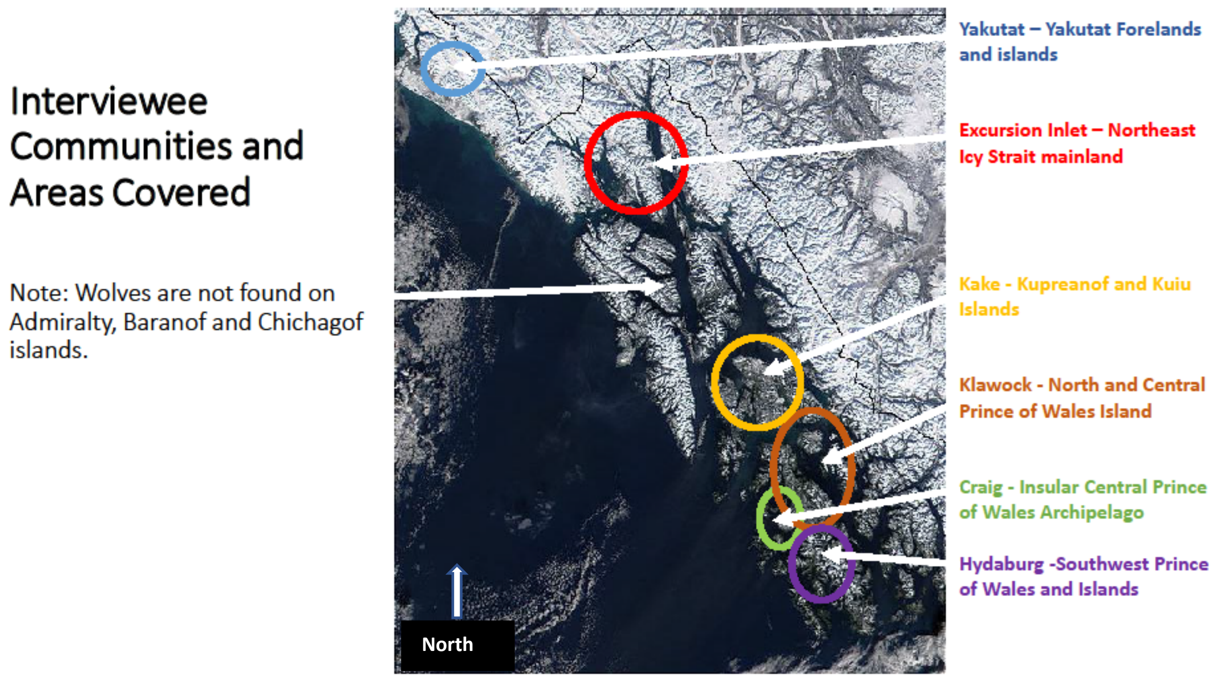

Figure 2. Map of study area, subregions, and communities covered by our Indigenous research partners. Source: Steve Langdon

Our Indigenous research partners voiced and shared a substantial body of knowledge about wolf behaviors and characteristics, trapper experience and insights, and sociocultural meanings of Wolf. Several interviewees reported over 50 years of active engagement with wolves. The results and discussions are largely descriptive syntheses with our interpretations and insights provided where appropriate. The presentation of results consists of analytical categories, narrative characterization and description, extensive direct quotations from the interviews and literature to support categories, and an interview theme used as a subtitle for each geographic area.

Each interviewee was given an informed consent form to read and sign beforehand, which was also signed by the interviewer (Appendix E). Each Indigenous research partner was compensated with an honorarium, and all agreed to the use of their names in the report. The interviewer, Steve Langdon, is designated SL, while the interviewees are designated by their initials (e.g., DA).

3. Results and Discussion

3.1 *G̱ooch*: Centrality in Tlingit Culture, Society, and Symbolism

3.1.1 Origins of Wolf crest and position in moiety structure

For the Tlingit, like western science, wolves existentially are the source of dogs.

> "The origin of the dog is attributed to the wolf. Native tradition goes back to the taking of a wolf's nest in the interior and the training of the young to hunt. From this beginning was developed the dog. The young wolf learned to talk, and so today the dog understands everything he is told to do" (Emmons, 1991:139).

As noted previously, Tlingit society is organized into two matrilineal moieties (i.e., social divisions) into which all Tlingit are born and assigned membership based on their mother's status. Wolves stand with Raven as the symbolic crest representatives of the two moieties but there are no evident oral traditions that explain duality or the two chosen moiety crests (Emmons, 1991:23). While Raven, as one moiety crest, can be attributed to dominance in Tlingit cosmology and is so claimed by human Raven moiety members, there is no oral tradition that can be interpreted to raise Wolf to an equivalent level (Emmons, 1991:23). A Tlingit account from Yakutat stipulated:

> "Raven … tried to create a 'brotherhood' of all the creatures of the world, assigning major crest animals to one moiety or the other. But the Wolf was against him, and destroyed this harmonious scheme, so Raven doomed the latter to wander, howling for help" (Emmons, 1991:23).

While there are no oral traditions that speak to the pairing of Raven and Wolf as moiety crests, Tlingit are well aware of the symbiotic relationship between ravens and wolves in the environment. One perspective is that they are linked as ravens help wolves find prey animals and then after the animals are harvested by Wolf, ravens are able to get bits of food from those animals after the wolves have finished. Devlin Anderstrom provided his view on this relationship.

> DA: "We see everything else as being people too. And especially the wolves because they're so similar to us. And they have this symbiotic relationship with ravens and crows, just like we do. And that's pretty interesting for us. And I think that's actually where that moiety comes from. That's my guess, my own personal guess. Well, you see them when you're out there, moose hunting. I'm a moose hunter myself. And you watch the animals, the way that they act when they're out there. And the ravens know that if they can help a wolf pack kill a moose, then they're going to get to eat the scraps, because the wolves can't pick every single bit of flesh off the bone and then the ravens will get the, you know, peck at the eyes and all the stuff that they like to eat. So, they'll lead them, they'll lead the [wolf] pack to a moose."

3.1.2 Overview of *at.óow* and Wolf clans and houses

G̱ooch (Wolf) and wolves are at the center of Tlingit cultural construction and practice. Most critically they appear many times in the foundational *at.óow* accounts of virtually all of the clans of the Wolf moiety, under which fall approximately 30 clans. Scholars of Tlingit life state that *at.óow* is the "single most important spiritual and cultural concept" among Tlingit and exemplifies the "two main features [that] characterize Tlingit culture and oral tradition—ownership and reciprocity" (Dauenhauer and Dauenhauer, 1990:13-14). Indeed, the objects and practices associated with *at.óow* are treated with great reverence by Tlingit in such a manner as to approach the sacred (White and White, 2000). Objects such as hats, tunics, blankets and other items typically had symbols or images associated with the events, locations, and spirits that were collectively owned by the matrilineal clan or house group and memorialized the central claims associated with a specific *at.óow* (Dauenhauer and Dauenhauer, 1990:15).

At.óow can be acquired only through some form of sacrifice, usually the loss of life of an ancestor who had acted to protect or advance the interests of the group, that establishes the ultimate foundational claim of the group (White and White, 2000). The associated objects, songs, and dances that are created to memorialize the event are handed down and placed on display or performed by subsequent generations only on ceremonial occasions of great significance. Dauenhauer (1995:21) described the significant connection of *at.óow* to a group and the power of *at.óow* to invoke the presence of their ancestors.

> “The traditional art pieces called *at.óow* are brought out only on special occasions, usually in a ceremonial context, the most widely known of which is called "potlatch” in English. In Tlingit tradition, the ceremonial is called *k̲u.éex’,* and means ‘invitation.’ It begins with a ritual called *Ls’aatisháa G̲aax̲ée* (the Widow's Cry), during which the guests bring out the *at.óow* of their clan to wipe away the tears of the hosts. Each piece of ceremonial wear, whether elaborately decorated or plain, is important. This ritual display of visual art is accompanied by oratory delivered by selected individuals who are genealogically related to the deceased and by the performance of appropriate songs. When we put the *at.óow* on our grandchildren, we wrap them in our care; when we wear the *at.óow*, we know that our ancestors are present. When we do this, we are doing what the art was designed and created to do. We are also imitating our ancestors. This is the greatest honor we can give to them and to our relatives among the hosting clan as well.”

Wolf *at.óow* are found in Tlingit clans across the regional sweep of Tlingit occupation and across time from the immediate post-glacial to the early 20th century (de Laguna, 1972; Thornton et al., 2019). Noted Tlingit ethnographer George Emmons (1991:22) wrote about clan houses named for Wolf.

> “In the principal Wolf families, the chief’s [highest ranking leader] house at *Kax’noowú* [Female Grouse Fort] of the Hoonah was named Wolf House; the chief’s house in Sitka was likewise named Wolf House, with the front painted in a Wolf figure, while a minor chief’s house was painted in the Eagle design. At Chilkat [Klukwan] the principal houses were named for the Wolf or Brown Bear.”

An example of a prominent wolf clan *at.óow* is the Panting Wolf of the *Kaagwaantaan* found primarily in the northern communities of Southeast Alaska (Section 3.1.3.1; Figure 10). Numerous wolf *at.óow* are found among Wolf clans from the *Taant’ak̲wáan* on the southern boundary to the *G̲alyax̲ Kaagwaantaan*, the most northwesterly of the Tlingit groups (Figure 1).

Wolf symbolic presence permeates Tlingit culture in all of its domains, including clan houses that have wolf names (Table 1; Figure 3).

Table 1. Tlingit houses associated with Wolf: *K̲wáan*, village, clan, and house names.

K̲wáan	Village	Clan	House
Sheet'ká	Sitka (*Sheet'ká*)	*Kaagwaantaan*	*Kaawashagi G̲ooch Hít* (Panting Wolf House) *G̲ooch Hít* (Wolf House) *Déix̲ X̲'awool Hít* (Two Door [Wolf] House) *Aanyádi Hít* Noble [Wolf] House) *Wudzix̲eedi G̲ooch Hít* (Multiplying Wolf House)
Laax̲aayík	Yakutat (*Yaakwdáat*)	*Kaagwaantaan*	*G̲ooch X̲aay Hít* (Wolf Steam Bath House)
Hinyaa	Tuxekan (*Tax̲jik'.àan)*	*Shangukeidi*	*G̲ooch Hít* (Wolf House)
Saanyaa	Cape Fox Village (*G̲àash*)	*Teik̲weidí*	*G̲ooch Hít* (Wolf House)
Taant'ak̲wáan	Village Island (*Dàasaxakw.àan*)	*Dak̲l'aweidí*	*G̲ooch Hít* (Wolf House) *Yeisk̲ú Hít* (Forrester Island/Wolf)
Taant'ak̲wáan	Tongass Village (*Naduk̲x̲uka*)	*Dak̲l'aweidí*	*G̲ooch Hít* (Wolf House)
Jilk̲áat (Chilkat)	Klukwan (*Tlákw.aan*)	*Kaagwaantaan*	*G̲ooch Hít* (Wolf House)

Sources: Hope (2009); Monteith (1998); Thomas Thornton, personal communication, March 18, 2022

Figure 3 portrays Chief Annahootz of the Wolf House of the *Kaagwaantaan* clan standing in front of the Multiplying Wolf house in Sitka (Griffin, 2000:2). The painted artwork at the top of the house front is called a house screen. This crest *at.óow* is on loan from the Wolf House and displayed at the Sitka National Historical Park Visitor Center.

> "The *Wudzix̲eedi G̲ooch* 'Multiplying Wolf' house screen, now seen indoors, was originally installed outside above the entrance, in keeping with Tlingit tradition. Customarily house screens are displayed outside to identify the clan within. ... The

elements began to take their toll, and the screen was brought inside, protecting it from further damage. This painted crest tells of a time when the Wolf Clan outgrew its clan house and had to establish a new house” (NPS, 2022).

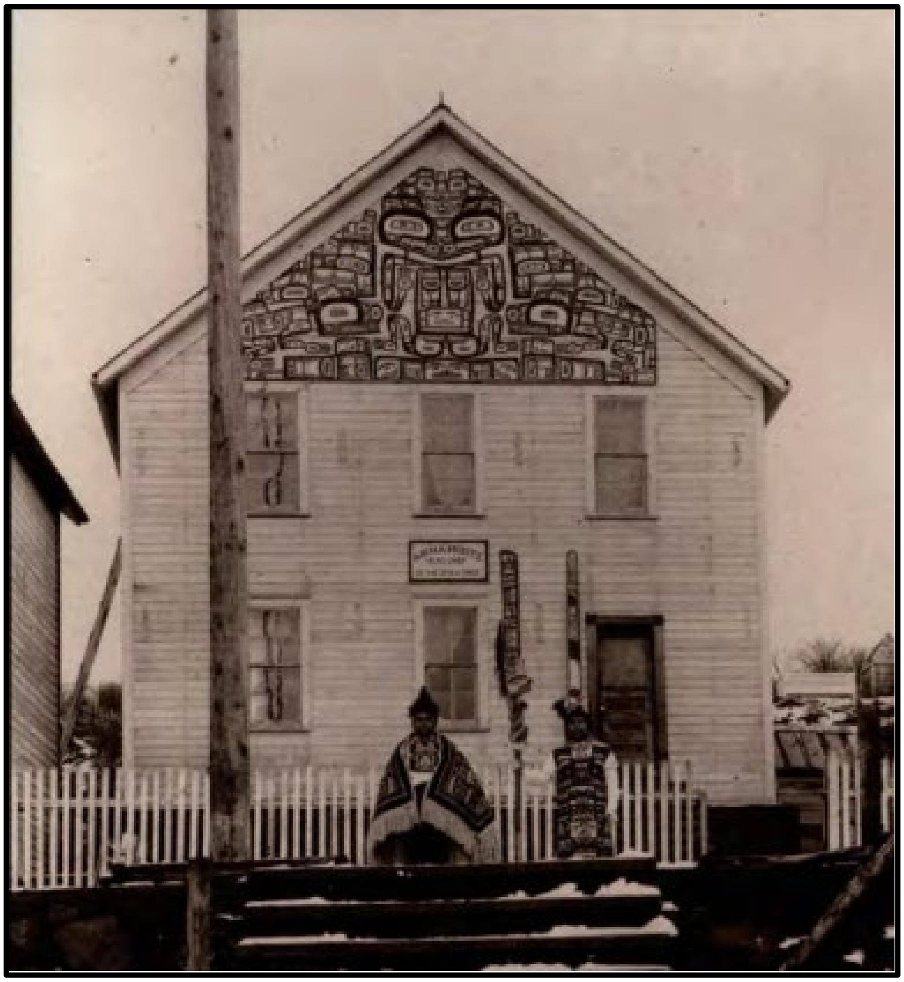

Figure 3. Multiplying Wolf house screen in Sitka with Chief Annahootz (*Anaxóots*) standing and wearing regalia. Photographer: E. W. Merrill; Source: Griffin (2000:2)

3.1.3 *G̱ooch* presence in Tlingit *at.óow* and clan oral traditions

At.óow are clan property. Tlingit clans derived their crests from past events or situations involving monumental interactions between clan ancestors and animal persons. These events have been recorded in oral traditions handed down through generations and comprise the historical heritage of a clan. Any clan or member of a clan of the Wolf moiety can use Wolf as a crest in some form or other on their personal regalia, but *at.óow* are under the control of clan leaders who make decisions about their use. Wolf crests may be of an individual or lineage nature derived from other oral traditions. Important clan traditions and objects exist that are neither *at.óow* nor commemorated in various regalia. There are significant oral traditions involving Wolf that are not manifest in crests or other forms of clan symbolism.

3.1.3.1 *Kaagwaantaan*

The Panting Wolf is a crest of the Sitka *Kaagwaantaan* generally recognized as the most powerful of the Wolf clans (Figure 10). The oral tradition that is the basis for this relationship recounts an occurrence of an ancestral encounter with a wolf while the group was migrating northward back home during the retreat of the ice sheets. The oral tradition of the Panting Wolf was recently presented in a lecture by David Kanosh (2018).

> "While he was out hunting he saw this wolf out in the distance. He thought the wolf was going to attack him, but as the wolf got nearer, he could see that the tongue was hanging out. And then as the wolf got even closer, he could see that there was a bone stuck in between its teeth, and it punctured the lip, so the tongue was hanging out, probably trying to fight off an infection and a fever. The hunter said, 'If you don't harm me, I will remove that bone.' The wolf came down gently and opened his mouth wide, and the hunter removed it. And then the hunter said, 'Now tell me the secrets of hunting deer.' ... but the wolf didn't do anything. He ran away. Later on that night, the hunter was setting up camp. He built the fire. He was getting ready for bed, but then he saw that wolf again. And the wolf came running down, and then when he got by the fire, he stood up like a man. He started showing that hunter the secrets of how to use the deer call. ... And then he became quite good at hunting deer. He was able to provide not only for his family, but also for the entire village. That Wolf was no ordinary wolf. There was a young lady in that village who got sick, and that Wolf came up, that same Wolf, and he licked the wound of this young lady, licked it clean, and she became well. From this came a name: *K̲'ayéil'i*, 'Saliva Mouth', one you can still hear today, one being used by the *Teik̲weidí* people, and that young hunter, he built a house pole with a panting Wolf, one of the first emblems to be used by the Tlingit people in the migration north."

There is also a *Kaagwaantaan* clan segment located in Klukwan of the *Jilk̲áat K̲wáan.* In this community, Wolf *at.óow* is associated with the Wolf House and based on the Crying Wolf oral tradition. Jennie Thlunaut, revered *naaxein* weaver, gave this account of the tradition in association with her weaving of a *naaxein* for her daughter depicting the Crying Wolf (Figures 4 and 9).[5] The clan's origin story is *at.óow*.

> "Their ancestor *K̲aa.ushtí* was at a place called *K̲aak'wx̲anseiyí*. He saw a wolf crying while running ahead of him. *K̲aa.ushtí* believed the wolf was trying to tell him about a death back in his home village. All the time it was trying to tell him about his own death" (Thlunaut, 1988).

The *at.óow* associated with this oral tradition was memorialized by the Chilkat *Kaagwaantaan* of the Wolf House in another way. In 1904 a wolf house post was commissioned by *K̲'axook Éesh*, Jennie's grandfather, also a *Kaagwaantaan*. The post was made to stand in front of the Wolf House. The wolf post is now located at the visitor's center in Sitka.

[5] The information provided by Jennie Thlunaut is from the film, *In Memory of Jennie Thlunaut* (1988), narrated by Nora Dauenhauer and transcribed by Chuck Smythe. Source: Sealaska Heritage Institute Archives

Figure 4. *Yaa Kandagax̱ G̱ooch Naaxein* (Crying Wolf robe) woven by Jennie Thlunaut, *Kaagwaantaan*. Source: Sealaska Heritage Institute, SCC.1975.001.024

3.1.3.2 *Teiḵweidí*

The *Teiḵweidí* are a Wolf moiety clan with segments located in a number of *Ḵwáans* including *Taant'aḵwáan*, *Saanyaa*, and *Yaakwdáat*. Oral traditions indicate they are related to the *Kaagwaantaan*. Oral traditions converted to *at.óow* are found in *Taant'aḵwáan* and *Yaakwdáat Ḵwáan*. The *Teiḵweidí* oral tradition from the *Taant'aḵwáan* comes from an encounter with a wolf in the last 200-300 years. The oral tradition that is the basis for their wolf *at.óow* is called The Tired Wolf (Garfield and Forrest, 1961:18-19). Wolf and Brown Bear are crests of the *Teiḵweidí*.

A Tlingit party was traveling by canoe in the waters of southern Southeast Alaska. They noticed a wolf swimming who was so tired his tongue was hanging out of his mouth. They picked up the wolf and put it in the canoe.

> "They took him back to the village, where he stayed with his rescuers. When the men went hunting, the wolf hunted with them and, as he was always successful, they had plenty of meat. He lived among them until his death many years later and came to be treated almost as a member of the clan. Not long after his death a dream came to one of the men of Forest Island House in the form of a song. The Wolf People were singing for their dead relative in this dream, and they appeared as human beings just like himself. … Because this was a lament for their deceased relative, the people of Forest Island House sing it only as a dirge or mourning song" (Garfield and Forrest, 1961:18-19).

Two carved poles memorialized these events and the relationship. Both are unusual in that they are profile carvings rather than the standard frontal view. In both, the tongue is hanging out of the wolf's mouth (Figure 5).

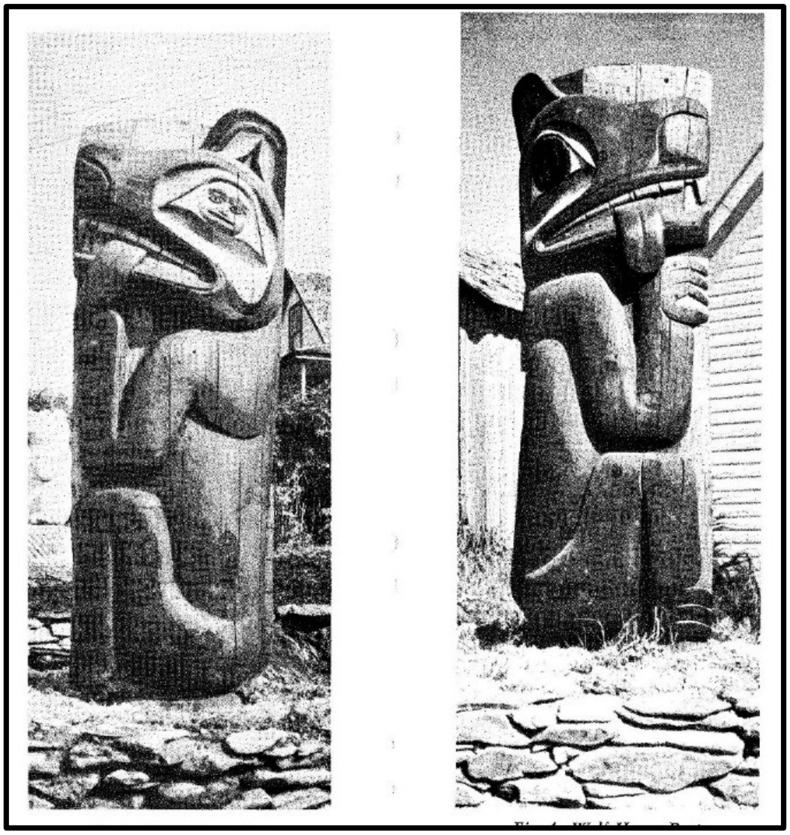

Figure 5. House posts of Wolf of the *Teik̲weidí* clan. Source: Garfield and Forrest (1961)

The *Teik̲weidí* also have clan presence in *Yaakwdáat K̲wáan*. The incident that is the basis of their wolf *at.óow* is a little over 120 years old. The oral tradition might be termed the guarding wolves based on the wolf behavior described.

> "A *Teik̲weidí* man drowned attempting to cross the Ahrnklin River when the water was high. His body was found at the mouth of the river on a sandbar by relatives several days later. The men had nothing to carry the body with and so had to go back for a stretcher. Before they left they spoke to the four winds and to the wolves, mostly, to guard the body. The wolves did hear and came to guard the body. When they came back with a stretcher to get the body, they saw a lot of wolves take off. And they could see the places where a wolf had been sleeping at the head and another one at his feet. They prayed to the wolves because they 'had the Wolf' [meaning it was their crest animal]" (de Laguna, 1972:872).

The two wolves that guarded the body are shown near the bottom of the Ahrnklin River blanket, a clan *at.óow* object. It was evident in the sand that one wolf had laid down at the head of the man and another below his feet. This oral tradition and associated *at.óow* recounts events that occurred around 1900 (Figure 6).

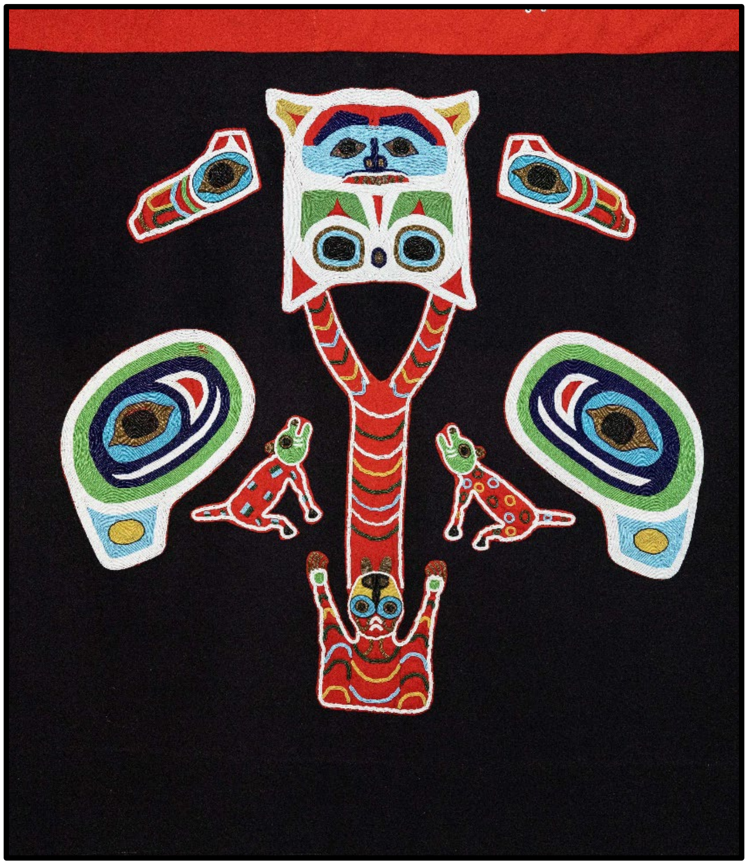

Figure 6. Yakutat *Teiḵweidí* blanket depicting Ahrnklin River event of drowned man's body protected by wolves. Courtesy of the Alaska State Museum.

3.1.3.3 *Yanyeidí*

The *Yanyeidí* are a Wolf clan of the *T'aaḵú Ḵwáan*. Wolf is a crest and *at.óow* of the *Yanyeidí* clan (Figure 13). They have an oral tradition that establishes their *at.óow* relationship with Wolf.

> "The people of Taku used to make trips to the interior to trade with the *G̱unanaa*. … On one such trip there were three men and one woman. One night the woman went outside to urinate. She saw a 'man' like a *G̱unanaa* [Athabascan Indian]. When the 'man' saw her he ran away howling like a wolf, for he was really a wolf-man. Then she was sorry. She told her husband what had happened. The wolf-man did not return. That night her husband dreamed of the wolf-man who said, 'Your wife made a mistake. I wanted to help you to bring you whatever I caught. But I cannot because of what your wife did.' The party went home to the coast. There the husband called the *Yanyeidí* together and related what had happened. The chief said, 'We should use the wolf for a crest.' The people agreed" (Olson, 1967:44).

3.1.3.4 *Wooshkeetaan*

The *Wooshkeetaan* are a Wolf clan whose oral tradition describes their migration from the interior to the coast down the Taku River. Along the way, an important interaction between an ancestor and Wolf became the basis for a crest story. George Jim (1982) gave this account of the encounter and interaction between the two parties.

> "This other one though, the head of the Taku, everybody who came down through the head of the Taku knows this story. At the head of the Taku a wolf approached a person. He kept going up to the place where he saw it up above towards the evening. A large house stood there, a *Shangukeidí* house. Then he searched for a moose, for something to kill. He was walking up toward there and this big dog was following him up. Eventually he figured it out. Oh, so it was a wolf. He had his ears laid back. He looked inside its mouth. They would lay down a leather hole punch; it is a bone with a sharp point. When he saw it he was speaking words of encouragement to it. It was foaming at the mouth. Then he pried the bone splinter out from between its teeth. After he pried it free from between its teeth [the wolf] moved its tongue around in its mouth. He wrapped the bone in leaves [and put it] inside his coat. After that it just sat by him. At this point it walked away from him. He was speaking words of encouragement to it for good luck. When he came home he went to bed; he didn't eat. That night I dreamed, 'I know you are my friend, which is why I came to you. I was suffering.' The wolf was just emaciated; that's what I dreamed. So he was the one who laid it down. So when they came out through the Taku the Wolf Spirit ran to my grandfather. They used to have two houses standing in the shelter of the point and the songs about them; alongside the other one where his ancestors went forth to speak. That's how it is known by whoever came down along the Taku."

A number of *Wooshkeetaan* clan members use the wolf as a crest on clan regalia. According to *Wooshkeetaan* clan member Thomas Jack, "Our wolf has a tongue hanging out of the right-side of the mouth" (Jack, 2022). He stated that any clan member was able to use the wolf as a crest on their regalia.

3.1.3.5 ***Shangukeidí***

Wolf is a crest and *at.óow* of the *Hinyaa Shangukeidí*. Wolf behavior in the foundational oral tradition of the clan can be characterized as nurturing. Jon Rowan tells the oral tradition he learned as a child that is the basis for that relationship.

> JR: "I've been agonizing over it. There was a people that went to this area and this boy's parents got killed. And so it was the grandparents that were taking care of him, and he was crying, and he wouldn't stop. And the clan leader, after a while, said, 'That's enough of that. Leave him on the flats. We're gonna leave, we're gonna—on this muddy beach.' It was a muddy flat. Leave him there because they didn't want to be burdened with that. And the grandparents were sad, but they couldn't care for him, so they left him, and they went away. The whole village left him. And he sat on that muddy beach there and he cried, and he cried. Well, up in the hills, the wolves had heard him, and they came down and they took him. The grandparents, you know, after a while—I don't know how long, you know, but they felt bad, so they went back to go look for him. And they looked in the mud on the flats and they could see his prints and all of this wolf prints all around him and where they went. And they were really sad then, so they went back. They—my aunt said probably a year of grieving

> for him, and they went back to look again, and they camped out. And that night they heard all these wolves howling. Next morning they came down with him, and he was talking and telling them not to be afraid of them. He said, ‘They took me in, and they took care of me, and they fed me.’ And he said, ‘And I get to come back with you guys, and here is what they’re [giving us].’ And they came with tons of food: deer meat, every kind of food that they could think of. And they loaded up the canoes and they took him back, and he was brought up with great status after that, that particular household. And that’s all I remember from that because I was really [young]—I was probably about six or seven, and I had heard that so long ago.”

Mr. Rowan’s account is similar to the one the Klawock Tlingit leader John Darrow told to Olson in 1934 (Olson, 1967:106). In Darrow’s account, the boy shows his kinsmen the den where the wolves lived and informed them they could always come there to get food as long as they did not kill any wolves. In the account, the *Shangukeidí* clan continued to use the cave as a source of food at mortuary rituals (Olson, 1967:106).

As a crest of the *Hinyaa Shangukeidí*, Wolf appears on various types of regalia. Jon Rowan wears a headdress made of wolfskin on ceremonial occasions. Wolf is also a crest on the staff of the leader who leads the clan during ceremonials (Figure 7).

Figure 7. *Hinyaa Shangukeidí* clan leader Sam Williams carries staff with Wolf when leading clan members into ceremonies. Courtesy of Steve Langdon

3.1.3.6 *K̲aax̲'oos.hittaan*

The *K̲aax̲'oos.hittaan* are closely related to the *Hinyaa Shangukeidí*. The original oral tradition describing their journey and arrival at their primary territory, Sarkar Lake, includes the wolf as a significant actor in the events. Steve Langdon recounts the version of the origin story told to him by Clara Peratrovitch.

> "The people were starving and decided to move to find a better place with more food. Their shaman and leaders told them pack their things and load the canoes. They started out but didn't know which way to go. As they were paddling out from the shore, the shaman spotted a killer whale in the channel. It seemed to be waiting for them. The shaman directed the paddlers to move behind the killer whale. Then the killer whale headed up the channel and the people in the canoes followed behind at a distance. The killer whale stopped at one location and the canoes did as well. Then he started up the channel again and the canoes followed. The killer whale travelled a long distance with the people following. The killer whale stopped again as did the canoes but started up again and they followed. He kept traveling and the people began to wonder, where are they going to end up? After some time, the killer whale slowed again. The people thought maybe this was the place. But after a short time the whale moved on. Soon the people saw the killer whale come to a complete stop. And the canoes stopped as well. The shaman and leaders looked around. On the shore they saw a hairy man [*kooshdaak̲áa* (land otter man)] on the shore waving them to come in. The shaman hesitated but the killer whale was still, not moving. Then the people began rowing their canoes toward their shore where the hairy man was. When the hairy man saw the people coming ashore, he started up the bank and across the flats at low tide of Sarkar Cove. He moved rapidly ahead but looked back. The shaman and leaders decided to follow him. As they followed, the hairy man turned inland and began to walk up the bank of a river. The people were able to follow him because they saw his footprints in the mud. When they rounded the first bend in the river, they saw the hairy man far ahead. He was waiting to see if they were following. When he saw them, he headed further up until he came to a lake. Then they saw him go around the shore of the lake. They continued to follow. At the head of the lake, they saw the hairy man approach a stream. He looked back again to see if they were following. Then he continued up the stream and never looked back. The people followed his route to the stream where they discovered an abundance of sockeye. They were red and preparing to go up the stream to spawn. As the people came up to the river, the leaders noticed a wolf laying down on the opposite shore. As the people arrived, the wolf remained. The shaman knew that they had found their new home. They built new houses on the river and named themselves the *K̲aax̲'oos.hittaan* after the hairy man's footprint which led them to their new home."

While Killerwhale is an important crest and *at.óow* of the *K̲aax̲'oos.hittaan* clan, Wolf also is an important crest. The wolf appears as *at.óow* on the Sarkar pole originally located in the village of *Tak̲jik'.àan*, and now a replica of it is found in the Klawock totem park (Figure 8). The pole represents the ownership of the Sarkar system at the northern end of Prince of Wales Island by the *K̲aax̲'oos.hittaan*. The figures on the pole are the crests related to the clan story of discovery and occupation of the area along with the valued sockeye salmon of the system. This Tlingit *at.óow* tells the clan story about ownership of the stream and demonstrates respect for salmon (SASAP, 2019). Wolf is the third figure from the top of the pole and plays a central role in the clan's story of coming to Sarkar. Wolf is depicted in the descending wolf fashion with its tail being held by a human figure. Cultural informants told Garfield that it represents the head of the clan "holding back his clansmen, symbolized by the wolf, so that they will not be greedy with the fish which it is their good fortune to possess" (Garfield and Forest, 1961:119-121).

Figure 8. *K̲aax̲'oos.hittaan kootéeyaa* (totem pole) is *at.óow* associated with clan origin tradition and demonstrates ownership of a sockeye salmon stream on Prince of Wales Island by the *K̲aax̲'oos.hittaan* clan. Courtesy of Steve Langdon

3.1.3.7 *Chookaneidí*

The *Chookaneidí* are a Wolf clan found primarily among the *Xunaa K̲áawu*. Their original homeland was Glacier Bay. They were forced to move from their ancestral village there due to a glacial advance that followed an insult to the glacier by a young girl. *Chookaneidí* returned following the retreat of the glaciers in the 19th century and re-established sites. They visited resource sites regularly until most subsistence uses in Glacier Bay were banned by the National Park Service in the late 1900s.

The Tlingit of Alaska and Canada use songs as important means for communicating and aligning relationships, knowledges, and emotions among humans, non-human persons, and ancestral lands. As potent expressions of individual and collective identity, heritage, and destiny, songs encapsulate and evoke special events and emotions. A particular ancestral or communal context, such as a potlatch or *ḵu.éex'*, may call for a spiritual, mournful, or happy song to help effect a transition, for example, from mourning to celebration or death to rebirth. Ceremonial songs are typically owned as property and performed by particular Tlingit matrilineal groups (i.e., clans or their house groups).

Although property of the clan, songs are in the first instance composed by individuals, typically in response to other unique events, such as extraordinary encounters with wildlife, disasters, or other remarkable circumstances. Mary Sheakley *(Lx̱ooḵ*) is one such figure. Mrs. Sheakley accompanied by relatives journeyed from Hoonah to a traditional berry picking site in Dundas Bay on the north shore of Icy Straits. She composed the song in response to a group of wolves that came to the beach and howled as she and her fellow paddler left their subsistence camp in what is now Glacier Bay National Park and Preserve around the turn of the twentieth century. In 1996, the song was spontaneously remembered by a contemporary elder and younger *Chookaneidí* clan sister to Mary Sheakley, Amy Marvin, who, in turn, taught it to her younger clan daughter during a berry picking trip to Glacier Bay. Later, during that same trip, Amy Marvin deployed the song to cap an impromptu ritual of commemoration for Tlingit relatives that had died in a tragic boating accident in the Park in the late twentieth century.

The song was revived and become a clan song, which is now considered sacred clan property (i.e., *at.óow)* and performed during *ḵu.éex'* (Thornton et al., 2019:392). Mary Sheakley's song is plaintive in tone because it conveys feelings of longing or love for members of the opposite moiety (Thornton et al., 2019:393). The account of the inspiration for the song interprets the wolves' howling at the departure of the party as "crying." Crying might be for any number of reasons, but no further commentary is provided on why the wolves are crying.

3.2 Wolf in Material Culture

3.2.1 Tlingit

The centrality of Wolf to Tlingit cultural practice is demonstrated in the artistic domain of material culture. There are innumerable objects of regalia worn only at significant ceremonial events that display Wolf. We provide examples involving dance, regalia, house posts, and totem poles. Dance performance is part of material culture in Southeast Alaska. Mr. Michael Arne Jackson from Kake describes an entrance dance in which the participants ritualized wolf howling and physical motions in the performance. Mike shares an account from his youth about the first time he heard the performers howl at a *ḵu.éex'*. In the story, the Wolf clans are the *Wooshkeetaan* and *Shangukeidí*. He describes the dance motions and postures of Wolf used to communicate messages.

> MJ: "I remember being small enough to remember the sound of the wolves that sent chills up my spine when I was standing by my mom and dad, and I heard them outside. They weren't yelling or the wolf call wasn't really loud, but it was loud enough to hear them outside the building, the old Alaska Native Brotherhood Hall.

> And then you heard the box drum, and they started getting louder, and it was their coming-in song or announcement they were out there. And then pretty soon the doors swung open. There were helpers, the Raven helpers opened the door for them, and they were all dressed to the tees because they made their regalia for them. And then these wolves started coming in with the headdresses. There were three of them ... SL: When they entered—I assume it's howling … Did they make any body motions to try to imitate the Wolf? MJ: They came in real low and backwards. ... [This] signaled they were in peace. They weren't prone. And that's how the young wolves act around the big alpha. And Dad said, 'You see, they're real low. They're coming in peace.' ... but the language isn't said, but the motions say it all. ... *Teik̲weidí* are the same way. They came in backwards meaning that you could attack them if you wanted to, and then they turned around real slow."

The motions, gestures, and postures used in the dance performance mimic communication among wolves while at the same time symbolize and communicate information to the audience about human relations between Tlingit social groups.

In Figure 9, a woman wears regalia and dances at a ceremonial event to represent the Wolf House of the *Kaagwaantaan* in Klukwan. It is called *Yaa Kandagax̲ G̲ooch Naaxein* (Wolf Going Along Crying or Mourning, also known as the Crying Wolf Chilkat robe).

Figure 9. Ms. Agnes Bellinger wears and dances the Crying Wolf *Naaxein* (Chilkat robe). Courtesy of Sheldon Museum.

Kaagwaantaan clan members stand in front of the Panting Wolf House, which is the first and leading house of the Sitka *Kaagwaantaan.* The object on the house front is a depiction of the Panting Wolf, which is a *Kaagwaantaan* crest and *at.óow* based on the oral tradition of an encounter between a wolf and *Kaagwaantaan* ancestors (Figure 10).

Figure 10. *Kaagwaantaan* clan members gathered in regalia for a major ceremony in 1904 (Alaska State Library William Norton Photo Collection ASL-P226-369).

The extended tongue of the *Uwashag̱i G̱ooch Gáas'* (Panting Wolf post) represents the passing of knowledge to future generations (Figure 11). The house owners are wearing associated regalia. This is the same house post as the one depicted in Figure 10 and on the front cover.

Figure 11. *Kagwaantaan* Panting Wolf House post from Sitka, Alaska (Courtesy of National Park Service, Sitka National Historical Park).

Pole carving is an important sociocultural practice and means of communication in Southeast Alaska. Depictions of Wolf and other crests are common features in carved poles in the region. In Figure 12, Wolf is the lower figure in what is likely a mortuary pole housing the cremated remains of a person of the *Shangukeidí* or *K̲aax̲'oos.hittaan* clan for both of whom Wolf is a crest.

Figure 12. Wolf is depicted in this *kootéeyaa* in *Tak̲jik'.àan* (Tuxekan), Prince of Wales Island in 1903 (Courtesy of National Park Service, Sitka National Historical Park; SITK 3825).

A member of the *Yanyeidí* clan wears a headdress depicting Wolf while making an offering during a ceremonial event. The regalia is made from carved and painted wood with wolf fur attached (Figure 13).

Figure 13. Mr. Ben Coronell, *Yanyeidí* clan, makes an offering of food for the Thanking and Feeding the Spirits of the Trees portion of the Sealaska Heritage Arts Campus Grand Opening Ceremony, June 8, 2022 (Courtesy of Sealaska Heritage Institute).

3.2.2 Haida

The Haida are recent emigres to Southeast Alaska traveling from their homeland in Haida Gwaii, formerly Queen Charlotte Islands, across Dixon Entrance and now primarily residing in previously occupied Tlingit settlements in the Prince of Wales Archipelago. There are no wolves in Haida Gwaii and perhaps consequently they have no presence in Haida social organization, which is similarly constructed to Tlingit. The Haida were aware of wolves from their interactions with their Tlingit and Tsimshian neighbors. The Haida name for Wolf living on the land is *ruuji*.

While Wolf per se does not appear in Haida oral traditions, their mythology includes a hybrid known as *'Waasguu*, which combines characteristics of Wolf and Killerwhale (Figure 14). This bronze cast of the post, carved by Haida artist T. J. Young of Hydaburg, depicts *'Waasguu* (Seawolf), a supernatural figure in the Haida culture known for possessing the size and strength to hunt whales. Mr. Young said, "I've illustrated *'Waasg̱uu* mid-hunt with two Killerwhales clenched in his teeth. The third Killerwhale has temporarily eluded *'Waasg̱uu* and rests on top with his pectoral fins tucked inside *'Waasg̱uu*'s ears" (Sealaska Heritage Institute, 2019:1).

'Waasg̱uu's arms and legs are adorned with classical relief carved Haida form line.

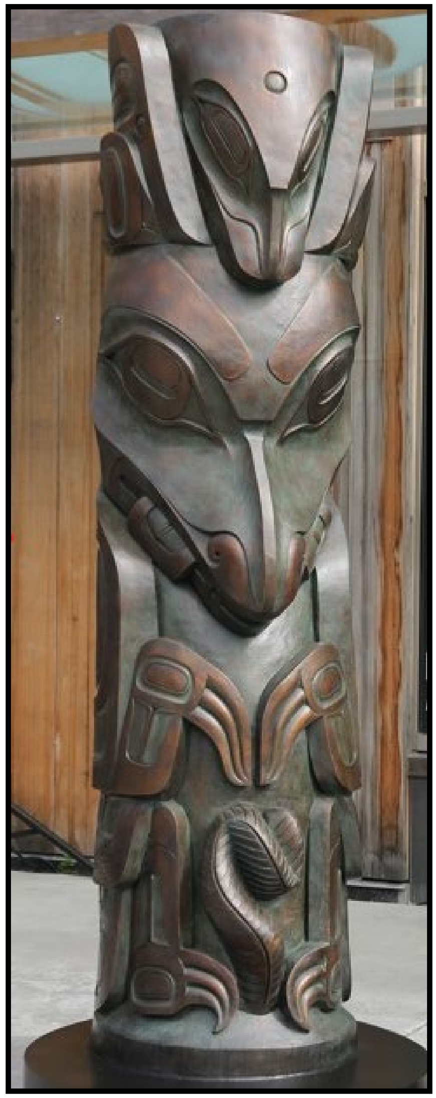

Figure 14. *'Waasg̱uu* hunting two Killerwhales: A bronze cast of a Haida post depicting *'Waasg̱uu* carved by T. J. Young (Courtesy of Sealaska Heritage Institute, 2019).

In the 19th century following contact with Europeans, Haida monumental architecture in the form of various types of carved poles boomed. Crests derived from cultural practice made up the images carved into the poles. MacDonald (1995) reports *'Waasg̱uu* is one of the most frequent images in carved poles among the Haida in their homelands. Wright (2001) reports only one image of *'Waasg̱uu* on a pole in the Kaigani Haida settlements. It was located in Koinglas*,* the only Kaigani Haida village not built on the same site as a previous Tlingit village. The oral tradition explaining the origins of *'Waasg̱uu* and its ability to bring wealth and prosperity is found in all three groups of Alaska Native Peoples living in Southeast Alaska.

3.3 Tlingit Relations with *G̱ooch Ḵwáani*: The Wolf People

The way that many Alaska Native People in Southeast Alaska understand and relate to wolves is by living closely with them in their homelands, practicing their culture through ceremony and ritual, affirming their Indigenous identity, and continuing their way of life on the land and sea. Stories and experiences of Tlingit-Wolf relations are passed down through the generations. This relational sustainability is part of Tlingit existencescape, which merges time, ontology, spirituality, sociocultural meanings, ecology, and place (Cooper, 2019; Langdon, 2019, 2020b; Figure 15).

3.3.1 Wolf as nonhuman relative: Tlingit understanding and respect

As Mr. Thomas Jack indicates in the epigraph of this report, the Tlingit of Southeast Alaska have an ancient relationship with wolves or as they say, with Wolf the nonhuman person and with the Wolf People. Wolf means much more to the Indigenous people in Southeast than a subspecies of interest for biological conservation. They have an actively vibrant relationship with Wolf. Mr. Devlin Anderstrom from Yakutat articulately explains that Tlingit and Wolf are similar beings with profound connections.

> DA: "... we also have a lot of respect for them, because we think about them as like another type of people. I was just having this conversation with somebody the other day about what the difference is between a real Tlingit worldview and then the modern worldview, and one of the things is that in school, we go there, and we learned that humans are animals, we're part of the animal kingdom and for us, when we talk about things in Tlingit, like every type of species, we call it the people, so the wolf species, that's *G̱ooch Ḵwáani*, the Wolf People. So, to us, it's the other way around. We see everything else as being people too. And especially the wolves because they're so similar to us. … they [the Wolf People] have this symbiotic relationship with ravens ... like we do. ... I think that's actually where that moiety comes from."

Mr. Anderstrom shares an ancient and deep cultural connection to Wolf. In a more modern sense, Mr. Mike Douville shares an Indigenous view of wolves based in a deep respect for the hunting prowess of Wolf that contrasts with the majority western European ethos of wolves, which is based in hatred, fear, and perceptions of cruelty.

> SL: " ... in terms of the [wolf] kills that are not consumed, leading to this rabid hatred of wolves ... in the western ethos ... so they [wolves] will be labeled as cruel or unrestrained. Do you have any thoughts about that? MD: I don't have any hatred for them. They're really probably the best at what they do. I mean they're really good at it. But I think the hate comes from competing for food, tempts the Wolf, and they're so much better at hunting than any human. They are absolutely the peak deer predator. So they can get deer where you can't, and it frustrates a lot of people, and they've developed this hatred, if you will, I guess, for them. But they're just good at what they do. They have a good nose; they have good ears; they can move fast; they're—I mean, if they get after a deer, it doesn't stand a chance. I mean, they will get them. And you can hunt in a place where you can hardly even get a deer, and a

wolf will be fat, seriously, fat as deer! I can show you pictures of a St. John wolf from a year before that is just fat as deer, and no one's hunting on there because they can't get any [deer]. But there's enough deer to keep the Wolf fat."

Mike's statements, similar to Devlin's, demonstrate the Indigenous view that Wolf is a nonhuman being or person with perhaps the same temptations as humans. Wolf is capable of being tempted to misuse his ability as a great hunter. Wolf is not being cruel but has succumbed to the temptation to take more deer than he needs because he can; he has this ability because he is the best hunter. In the Indigenous perspective, Wolf may occasionally have similar weaknesses as humans. That is a profound understanding based in an Indigenous existencescape, sociocultural meanings, and extensive observations and experiences on the land with wolves in their ecological setting (Figure 15).

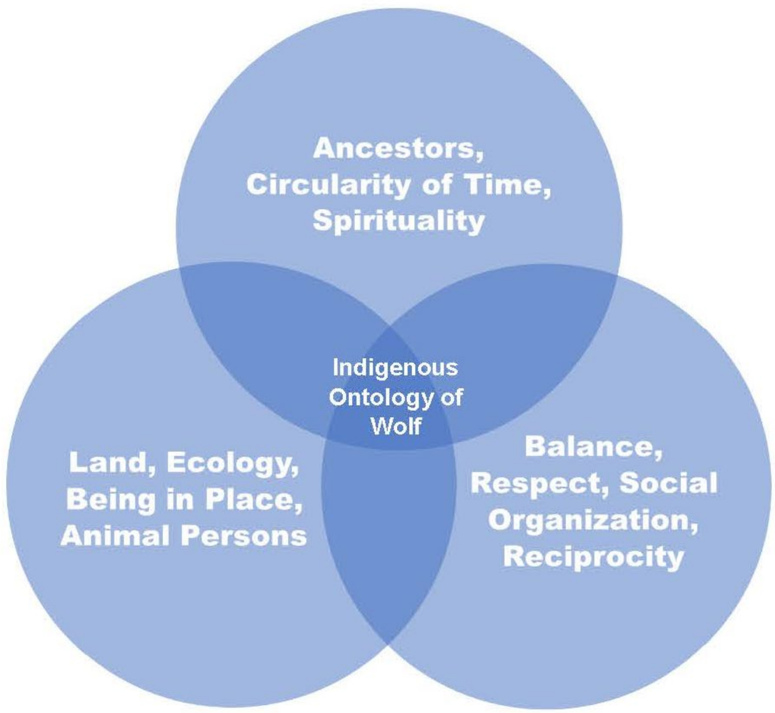

Figure 15. Aspects of culture, nature, and spirit overlap to reveal an Indigenous existencescape and conceptual understanding of Wolf (Cooper, 2019; Langdon, 2019, 2020b).

Mr. Michael Jackson from Kake further demonstrates Tlingit existencescape in a description of how hunters engage with the animals they harvest during a hunt. The Tlingit do not simply kill animals. There is a deep and respectful relationship and interaction that is ritualized in specific actions directed towards animals by the hunter.

MJ: "And they didn't just go out to kill it. If they saw a wolf, they just didn't kill it. They had to ... get ready, and they had a ritual to do, and then when they killed it there was a ritual to put it to rest. ... And it wasn't just going out to get the wolves to say, 'Ha, I'm a sports hunter.' ... And put it up on the wall. No. It was—when they killed—even today, when Shawaan goes hunting—I told him right from the beginning, and he was wondering why I put water in the mouth or go down and drink water out of the stream and come back and share it with the Deer or the Wolf. The Mink, the Otter. Same as the Seal. You can put saltwater in your mouth and not swallow it and go over and share it with [the animal being for its] the last drink. That's part of the ritual, laying to rest. ... and closing the eyes."

The Tlingit relationship with Wolf and other animals runs deep with elements of ritual, respect, thankfulness, and spirituality. Mike explains what hunters do before and after killing an animal as a ritualized sharing of a drink of water with the animal and closing its eyes.

Devlin Anderstrom continues by explaining why he is never worried or fearful about being approached or threatened by wolves when he has made a moose kill. He practices what his Grandmother taught him when he is out on the land.

> SL: "Now, have you ever heard a story or had the experiences of wolves closing on you after you've made a moose kill? DA: I've never had them really come up to me like that. I've heard some interesting stories about that. But I've never had that or really even had that as a worry or a fear. And I talk to them when we're out there. We call it *x̱'alaḵáns'*. And my Gram taught me that the animals will hear you and understand you if you talk to them and explain what you're doing there. Like we saw *Wooshjix̱oo Éesh* [George Ramos] doing in that video that was *x̱'alaḵáns'* too, when he was talking to the seal. So, I'll talk to the wolves and the bears and explain to them what I'm doing out there. And I'll ask them to not let any harm come to me. And, even to protect me because that pack out there, those are the same wolves that protected my *Gaawhittaan* [Drum House clan] ancestor when he got hurt. So, they're kind of like relatives, that's the way that we see them."

Devlin talks to the animals and asks them for help and protection. He is reminded of the story of his injured ancestor being protected by Wolf. He is literally related to Wolf, so he is not afraid. Judith Ramos also speaks of talking to Wolf as if speaking to one's relatives.

> SL: "Can you tell me as a child, what you were taught or learned about wolves? JR: So most of the stories I learned about was through my mother. And she would accompany her father Olaf, and whenever they would encounter a wolf, they would talk to the Wolf because he, his people, the *Teiḵweidí* have a relationship with the Wolf. So, I grew up hearing stories about the Wolf, they would come down mostly in the winter down from the mountains down to the Yakutat area. ... come down nearer to the community, ... they would only kind of encounter them occasionally on the beach ... SL: Do you remember what your grandfather might have said to the wolves? JR: He would just talk to them like they were his brothers. Greet them, and mom would talk to them. And she loved the wolves, she would also tell stories about talking to the wolves, when they would sort of accompany her and her father as they were doing things [out on the land]. ... She would talk about how the Wolf would just be there. And she always loved talking about her Wolf, it was her Wolf, of course. ... So she had a real love for the wolves. ... I think there was a sense that the Wolf had a

kind of relationship with them through Olaf's family, that they were his, like his brothers."

3.3.2 Time and ancestors: ***Haa Shuká***, ***Haa Shagóon***, and ***Haa K̲usteeyí***

Tlingit clans have relationships with their ancestors. The discussion of Indigenous knowledge of wolves would not be complete without acknowledging time and clan ancestors (Figure 15). The concept *Haa Shuká* refers to "our ancestors," especially those who made significant, contributions to the clan heritage. The ancestors have a continuing presence that is most manifest when their names are called out at the beginning of the *k̲u.éex'*. When donning regalia worn only on the occasion of a *k̲u.éex'*, living clan members experience the presence of their ancestors. Regalia play a critical role as donning and presenting them at a *k̲u.éex'* invokes the presence of the deceased elders.

A more encompassing concept is *Haa Shagóon.* Dauenhauer and Dauenhauer (1990:19) characterize this deep concept as "those born ahead of us who are now behind us and those unborn who await ahead of us." Thus the term references the past and the future and the total clan membership in those temporal domains. It is a primary Tlingit concept that sits at the core of the existencescape and defines how Tlingit think of the social interactions among the generations that are essential for the continuity of the human spirits of the clan.

Haa Shagóon is the embodied Tlingit construct that culturally defines cosmological cycling through its direct connection of one's ancestral relatives with one's descendants. The concept is always invoked at critical moments in Tlingit ceremonial and ritual events such as the mortuary *k̲u.éex'.* While primarily intended to recognize and honor recently deceased persons, this ceremony is a pivotal social ritual for the clan and larger society because it is formally structured to honor and recognize all the ancestors, those who have gone before, and to celebrate and embrace the positioning of young people in their social stations, envisioning their active roles to ensure continuity of the clan and its members into the future.

The third concept is *Haa K̲usteeyí* that refers to the totality of Tlingit culture and historical existence. It is used when discussing "our way of life" as what is valued and practiced from time immemorial. We learned about Tlingit concepts of time, ancestors, and *at.óow*. The Tlingit view of time is demonstrated by their beliefs in wearing and displaying sacred objects at *k̲u.éex'*. Mr. Jon Rowan from Klawock explains when the *at.óow* come out for the people to see during a ceremony, the clan's ancestors are present with them.

> SL: "When you are in an occasion where those garments are worn, what sort of impact does wearing them have on you? JR: Well, like when our *at.óow* comes out we believe that's our ancestors that goes—that's all our ancestors being represented. They're with us. That's our uncles, they're standing with us when they're brought out. SL: When those objects of *at.óow* are brought out, all of the ancestors are present? JR: They're with us. SL: Does that produce any special sensations or feelings for you when you start dancing? JR: Well, it's like say you went to Ireland and you guys had a special doing [or ceremonies] that said your ancestors are here now. How would you feel? I would feel pretty darn good that they're here with me. SL: Yeah, for sure. JR: And that's represented in this item here, this sacred item.

That's that kind of power. SL: ... when you start dancing and singing, what are the feelings that go along with that? JR: It's like we're with them [our ancestors] ... because they did the same things. And where we practice it was almost darn near within a quarter mile of where they [practiced it]—you know, especially like the *G̱aanax̱.ádi* were doing it. You know, living it."

All the generations are together when the *at.óow* come out, invoking *Haa Shuká* and *Haa Shagóon*. When clan members enact *ḵu.éex'* and the same or very similar rituals their ancestors had enacted, the entire clan is united across time. This is a powerful experience tied to sacred objects, place, and an ancient way of life. The power of the sacred objects displaying Wolf lies in their capacity to invoke the ancestors and bring the past and future into the present. The continuity of the clan is maintained through the power of *at.óow* when *ḵu.éex'* are held in the same place or nearby where their ancestors had held *ḵu.éex'*.

3.3.3 The *ḵu.éex'* and presentation of *at.óow*

The *ḵu.éex'* accomplishes multiple objectives including, honoring deceased clan members, thanking the clan members of the opposite moiety who took care of the body of the deceased at the time of death, freeing the spirit of the deceased so it can return, giving new names, and creating the conditions for the spirits of deceased clan ancestors to be present. At the beginning of the *ḵu.éex'* is the period of grieving at which time clan leaders of the opposite moiety approach the host clan members who are positioned facing members of the opposite moiety wearing their appropriate regalia. During this stage of grieving, members of the opposite clans walk up and approach the hosts carrying their *at.óow*, typically crest blankets. They may provide a short account of the *at.óow* tradition and then metaphorically speak of how the wolf crest will protect, aid, comfort, and otherwise support the opposites in their difficult time. *Kaagwaantaan* women hold tunics with their wolf crest as they speak to their Raven opposites seated in front of them (Figure 16).

Figure 16. *Kaagwaantaan* clan members present Wolf crest regalia to Raven hosts at *ḵu.éex'* while providing condolences and support. Courtesy of Steve Langdon

3.3.4 Tlingit place names and personal names using Wolf

Tlingit people have a complex relationship with places. The place names given to locations derive from many themes and often experiences on the land (Thornton, 2008). Wolf, as both physical being and totemic crest, is a component of a variety of place names that are found across the span of Tlingit geography from the *Taant'ak̲wáan/Saanyaa K̲wáan* in the south to the *Yaakwdáat K̲wáan* in the north (Table 2). There are no Tlingit place names using Wolf on the islands where wolves are not found, namely Admiralty, Baranof, and Chicagof.

Table 2. Tlingit place names with Wolf.

Place name	Translation	*K̲wáan*	Location	Notes
G̲ooch Tatóogu	Wolf Cave	*Yaakwdáat*	Ahrnklen River	
G̲uchhéeni	Wolf Creek	*Xunaa*	Wolf Creek in Spokane Cove	Glacier Bay
G̲ooch Gúgu	Wolf's Ear	*Sheet'ká*	Reef near Biorka Island	
G̲òoch Te	Wolf Rock	*Hinyaa*	Wolf Rock	
G̲òoch Héeni	Wolf Stream	*Taant'ak̲wáan/Saanyaa*	Creek from Yellow Hill	
G̲òoch Làakanòow	Inside Wolf's Mouth Fort	*Taant'ak̲wáan/Saanyaa*	Inside Kasaan Bay	
G̲òoch Héenak'u	Wolf Little Stream	*Taant'ak̲wáan/Saanyaa*	West shore of Princess Bay	"Wolf Streamlet" would be a better translation.
G̲òoch Héeni	Wolf Stream	*Taant'ak̲wáan/Saanyaa*	Creek at head of Tamgas Harbor	
G̲òoch Héenak'u	Wolf Little Stream	*Taant'ak̲wáan/Saanyaa*	Near Annette Point	"Wolf Streamlet" would be a better translation.
G̲òoch Héenak'u	Wolf Little Stream	*Taant'ak̲wáan/Saanyaa*	South of Davison Mountain	"Wolf Streamlet" would be a better translation.
G̲òoch Héeni	Wolf Stream	*Taant'ak̲wáan/Saanyaa*	Shore near Snip Island	
G̲ooch X̲'akanòow	Wolf Mouth Fort	*Taant'ak̲wáan/Saanyaa*	Cape Northumberland	More literally "On-Wolf's-Mouth Fort."

Source: Thornton (2010)

Tlingit personal names can be based on a number of elements in the culture. The crest animal itself can be the basis for names. "Wolf on the Mainland" and "Wolf's Nose" have *G̲ooch* in the name itself. Names may derive from aspects of oral traditions about wolves. For example, *K̲'ayéil'i*, (Saliva Mouth) is derived from the *Kaagwaantaan* oral tradition of the Panting Wolf. *Asx̲'áak,* (Between Two Trees) is based on the *Kaagwaantaan* oral tradition of acquiring the wolf post from the Athabascan woman because the house posts were between two trees. *Yaanjiyeetgaax̲* (Crying from Hunger) is the name given by the wolves to the Athabascan man who followed the wolves into the interior looking for food but eventually collapsed due to starvation. It is likely personal names implicating Wolf or oral traditions involving wolves are more numerous in Wolf moiety clans, but Raven clan persons are not precluded from having wolf names.

3.4 Tribal Consultation

The U.S. Fish and Wildlife Service arranged for a Government-to-Government tribal consultation on March 2, 2022. The proceedings of the tribal consultation are an important source of information for this study. Seven tribal leaders, other tribal representatives, and staff were in attendance. The Craig Tribal Association was the primary participant with the Organized Villages of Kake and Kasaan also in attendance but with less representation. Mr. Mike Douville represented the Craig Tribal Association. Mr. Joel Jackson, President of the Organized Village of Kake also spoke on the record. The reader is directed to Appendix A for the full record.

The tribal leaders thanked the federal agency for asking them to contribute to the discussion of the petition to list the Alexander Archipelago wolf and the development of the Species Status Assessment. One of the issues raised by the tribes was there was not enough time allowed for the work to be properly accomplished, which caused frustration. They asked for several more consultations during this important process.

Most of the discussion focused on the need to provide adequate subsistence harvest of deer and other ungulates for the many communities in the region. Mr. Jackson said, "It's important to echo our reliance on deer and moose populations." Experienced hunters and trappers explained that when wolf numbers are too high on the islands, deer numbers decrease dramatically and there is inadequate subsistence harvest to fill freezers. Harvest of old growth forest was also implicated in the decrease in deer abundance. Two tribal participants recounted a story about having to go outside to Juneau to buy meat during the COVID-19 pandemic because the local stores were empty, and there were no deer to harvest. This occurred outside the regular hunting season.

Another theme of the consultation was the need for state and federal managers to obtain better wolf population estimates so that proper and correct quotas can be set for wolf hunting and trapping. The local trappers need to remove enough wolves to ensure adequate subsistence harvest of deer. It was unanimous that the wolves in Southeast Alaska are healthy and abundant and as such are not endangered. It was stated that the local people who rely on deer will suffer if the subspecies is listed. Residents practice a subsistence way of life and harvest deer meat for important cultural reasons. There was frustration with the fact that outsiders, who had never been there, were trying to make decisions for them about their homelands. Mr. Douville explained,

> MD: "Outsiders do not know what is going on in our place, they are trying to make local decisions, and that is not right. Wolves adversely affect deer harvest success. Deer are in decline within past years, Alaska Department of Fish and Game reports

also indicate that. The geography we have will support a lot of deer, but we need to keep predators in check, so it's devastating to deer, it's from high predation. You also need to stop harvest of old growth [forest] to have a place for deer to overwinter."

3.5 Traditional Ecological Knowledge by Geographic Area

The Alexander Archipelago wolf occupies most of Southeast Alaska from Yakutat Bay to Dixon Entrance. Wolves are not present on Admiralty, Baranof, and Chichagof islands or in Haida Gwaii. We discuss traditional ecological knowledge for the Yakutat area, Excursion Inlet area, the Kuiu and Kupreanof islands, and three areas of Prince of Wales Island (Figure 2).

Results are primarily organized by geographic subareas, north to south, for two reasons. First, Southeast Alaska is vast with a total land area of 35,138 square miles (91,010 km^2) (U.S. Census Bureau, 2020). Southeast is a physically diverse area with more than 18,000 miles of coastline (29,000 km) and thousands of islands; the Alexander Archipelago has about 5,000 islands, over 1,000 of which are named on maps (Smith, 2016). Second, traditional ecological knowledge is closely tied to places, or locales in the landscape where Indigenous knowledge holders have lived their lives and gained extensive experience through being on the land. Our Indigenous partners spoke about Wolf and wolves in the context of their places and life experiences.

Traditional ecological knowledge is a smaller subset of a much larger body of Indigenous ways of knowing (i.e., Indigenous science; Cajete, 2020). The people in Southeast Alaska we partnered with for this study apply their own models of coexistence with wolves in their homelands.

3.5.1 Yakutat area: "And I talk to them when we're out there."

Two Tlingit interviewees familiar with the Yakutat region provided information on their experiences with wolves. Ms. Judith Ramos was born in 1959 and was raised in Yakutat where she spent most of her life. She, like her mother, Elaine Abraham, is of the Raven, *Kwaashk'ik̲wáan* clan, Owl House. She is the granddaughter of Olaf Abraham of the *Teik̲weidí* clan. Mr. Devlin Anderstrom was born in 1999 and has lived in Yakutat off and on during his life, but continuously since 2013. He has extensive hunting experience for moose with his father and by himself over that period. He is a member of the Raven, *Kwaashk'ik̲wáan* clan, Moon House. He carries the name and spirit of his great-great grandfather as foretold in a dream to a clan member prior to his birth. Both Judith and Devlin describe the practice of talking to Wolf.

3.5.1.1 Environmental context, presence of wolves, and historical abundance

The Yakutat forelands are located at the northern end of Southeast Alaska. The region is bordered on the west and north by extensive ice fields and mountains and to the east by heavily glaciated mountains. To the south, the region is connected by a narrow coastal strip of rain forest to the Icy Strait region of northern Southeast Alaska. Yakutat Bay was covered with a large ice sheet extending into the Pacific Ocean at the end of the last Ice Age and became available for occupation by wildlife, fish, and humans beginning around 9,000 years ago.

Connections between the Yakutat region into the interior and southeast regions have varied through time. Pathways into the Yakutat region appear to be primarily down the Alsek River to its mouth at Dry Bay and along the coastal strip from the Icy Strait region. A less likely route is along the shore to the west where ice sheets closely abut the coast. The Alsek River is considered to be the corridor through which moose enter the region from the proximate interior region. Deer, on the other hand, are thought to have entered the region by traveling up the coastal strip. Both local interviewees, however, stated their belief that deer were "released" or "introduced" into the area.

While wolves were present in the 1950s, they were not present across the Yakutat region.

> JR: "Only up, way up in the Ahrnklin mountains way up there when my grandfather trapped up there in winter. That's mainly when he would encounter the wolves way up there."

The presence of wolves is likely related to the presence and abundance of moose and deer, the two primary prey for wolves in the Yakutat region. The status of these two species likely has had a major impact on wolf presence and abundance in the Yakutat region.

> JR: "Moose did come in [until] the 40s, maybe 1940s. They suspect it came down from when they were building the highway, the Alaska Highway or something did come down the rivers or something. SL: So neither deer nor moose were there in the 19th century? JR: Not till the recent centuries, yeah. SL: Really? JR: Deer or moose, neither them nor deer; my grandfather has a story when he encountered the first moose."

3.5.1.2 Teachings about Wolf, interactions with humans, and seasonal movements

Growing up in Tlingit families in Yakutat, Ms. Ramos and Mr. Anderstrom were taught about wolves from their families and observed wolves while out on the land. Ms. Ramos traveled with her mother and grandfather on many trips as a child and young person when they encountered wolves. Judith was taught wolves were her grandfather's relatives. She also learned that wolves would move down from the mountains in winter, and people would see then on the beaches. Devlin was taught to respect wolves and speak to them as people.

> JR: "And so, a lot of the Wolf *G̱ooch* ... information comes from Olaf Abraham's lineage. So, he even had a *G̱ooch Yaakw* a wolf boat. My mom used to tell stories about the *G̱ooch Yaakw* … she would accompany her father Olaf, and whenever they would encounter a wolf, they would talk to the Wolf because he, his people, the *Teiḵweidí* have a relationship with the Wolf. So, I grew up hearing stories about the Wolf, they would come down mostly in the winter down from the mountains down to the Yakutat area. And people would know when the wolves would occasionally be on the beach."

> DA: "I was taught that I have to have a lot of respect for them in different ways, because for one, they can be dangerous. But they also don't really mess with us. I've never had it happen to me. I've never even heard of many people getting messed with

> by wolves in Yakutat. … my Gram taught me that the animals will hear you and understand you if you talk to them and explain what you're doing there.”

3.5.1.3 Two types of wolves

Two kinds of wolves are recognized in the Yakutat region. Southeast wolves and Yukon wolves are perceived as distinct species and populations. Yukon wolves are thought to enter the region via the Alsek River valley and Southeast wolves along the coastal strip. Tlingit sources in the first half of the 20th century recognized two types of wolves in the region, larger and smaller wolves. Sources reported to Frederica de Laguna in the first half of the 20th century the smaller wolves were found in the southern part of the Yakutat region (de Laguna, 1972). The recognition of two types of wolves in the Yakutat region continues to this day.

> DA: “I might not have even noticed myself if my dad didn't point it out to me that there seem to be the Southeast wolves. That's what he called them, … that are the small ones. And then there's the Yukon wolves that's what he called the Southeast and Yukon wolves. … SL: He made that distinction, too. DA: Yeah, those [Yukon wolves] are the big. … there's the really big ones and then there's the smaller ones, which are like the ones that I think of as being like from Southeast maybe. Both of those two loners that I was telling you about were bigger than most of the well, actually, there was this one really big one that I could just tell by his tracks. Out at that spot where I like to go hunting, there was a pretty massive one out there. There's the really big ones and then there's the smaller ones, which are like the ones that I think of as being like from Southeast.”

Mr. Anderstrom has never seen any mixing of the two kinds of wolves. He has seen packs of southeast (i.e., Alexander Archipelago) wolves but only solitary Yukon wolves.

3.5.1.4 Wolf health

Mr. Anderstrom has noticed differences in health among wolves. He suggests how those health differences may arise. This comment raises the interesting issue of how wolves adapt if the resources of their customary territory falter.

> DA: “I've seen real skinny ones before. I've seen the ones it looks like they're kind of emaciated, and they have more of like a ratty hide. It's not so nice and full. And then I've seen really strong, big healthy ones. SL: What do you think is the cause for the unhealthy ones ... Not enough food, maybe? DA: Yeah, I don't know it might be. I'm wondering if it has something to do with the way that their territories are, are lined up. If this one, like something happened, where if there was too much rain or something like that, and they couldn't get to the fish and there weren't as many deer over there or the deer moved into some other pack’s territory or something? My guess something like that, or it was just sick.”

3.5.1.5 Wolf distribution and abundance, pack size, and location of territories

While Mr. Anderstrom primarily hunts for moose and has had his closest encounters with wolves in the Ahrnklin and Dangerous River valleys, he is familiar with their presence in other parts of the Yakutat region.

> DA: "I hunt on the east side of *Kulijigi Héen*, Dangerous River. And that's wolf country over there. There's a lot of wolves there. There's a really huge pack that lives right there. SL: Could you estimate when you say huge numbers of a pack? DA: My guess, maybe 25 of them or more? … Maybe 30. I had heard that there were a lot of wolves out there. You see the sign all over the place. And you know that there's wolves there. I think they have really well-established territories. And I'd be surprised to find if there was much overlap, but I know that they do like to move around, for sure. But it seems like the different packs have different food sources that they're used to hunting. Because the wolves in the islands, I'm pretty sure they primarily eat deer. There are fewer salmon streams and things on the islands. So, I don't think they're fishing as much. And then these wolves out by Dangerous River, that area back there floods all the time. And you can walk back there, you can walk around and pick up red fish with your hands. Yakutat area is huge. And there's a lot of places there that I haven't been to, but of the places that I'm familiar with, Dangerous River has that huge one, a huge pack there. And I think they've got that little area claimed between Dangerous River and Italio River. And they run that whole area; I think it's the same pack that goes up to Harlequin Lake too, and I think they hunt around there. Yeah, I've seen them. I've seen their sign in the forested area back there, too. And there's the Ahrnklin River pack, and I think they're a pretty big one too. But I don't spend as much time over there. There are some out by Situk. And I don't know where their den is or anything like that. I just know that there seems to be another group there. There's more by Lost River. And then I think there might be a pack that likes to hang out by Tawah Creek and run that creek. … and then there's the ones that are in the islands. And I don't know if those are ... SL: Discrete or not right, where they're their own group? DA: Yeah, I think they might be, and I think they might go from island to island and hunt deer. ... I know that for sure there are some in Russell Fjord, and then there's another pack in Chicago Harbor, Knight Island."

Mr. Anderstrom lists six apparent packs in the Yakutat area, two of whom he considers quite large: Dangerous River, Ahrnklin River, Situk River, Lost River, Tawah Creek, Ophir River, and the islands. In addition, he states there were wolves in Russel Fjord located at the northern end of the Yakutat area. He suggests pack territories in the Yakutat area are organized by stream drainages with the exception of the packs on the islands.

3.5.1.6 Hunting behavior, diet, and movement patterns

In the Yakutat region, wolves primarily hunt and consume moose and to a lesser extent, deer and salmon seasonally.

> DA: "… this last year when I was moose hunting. And I had already gotten a moose, but I was taking my friend out to try to get him one. And first I could hear this cow

and calf. And I figured if there's a cow and a calf over there, maybe there's a bull nearby. So, we started walking across this meadow and then there's these big stands of cottonwoods and willows. And they're kind of blocking off the next meadow, which is where I was hearing them from. So, as we're going around them, it starts to blow and rain. And it's getting harder to hear. And I'm still hearing a sound, but the sound changed. And it's something else now. And it took me a minute to identify it and finally got close enough and realized that I was hearing wolves yipping. Yeah. So, there was a cow and a calf. And I could see their tracks, I could see where they ran away. And I know this area pretty well. So, I'm pretty sure I know what the wolves did. Because I could hear where they ended up. And they weren't very far from me, but I just couldn't see them. And I didn't want to step back there because it's a really closed off little area. And it would have put me right on top of them to be able to see them. But there's a finger meadow that ends, like it's surrounded by really dense thickets; it would even be hard for a moose to run through. And actually, in a similar spot, I've seen a moose break its own leg, trying to run through a thicket. And this pack chased them back there. And I guess they must have got that calf or something because I was crouched down in a short little stand of willows and just listening to them. And then they all started to howl at the same time. And that's when I realized how many of them there were. Because even being that distance away from them, when they all went off at the same time, it was so loud that I could feel it. I could feel the vibrations in the air. And that's when I realized that day was for the wolves. So, I told my buddy, they're hunting here today. We got to get out of here, man."

Devlin shares an account about observing a wolf hunting strategy of driving moose to a place where they may be able to make an easy kill near Harlequin Lake.

> DA: "And this was pretty interesting because they were hunting moose at the same time as my dad and I were, and we went up by the lake, by Harlequin Lake, and then we came back down. And apparently in the time that we had gone to the lake and then come back, a moose had ended up on the trail, and the pack got behind it and started chasing it. And they did something that I thought was pretty interesting. You could see the tracks right in the parking lot where the trail comes out. They pushed that moose onto the bridge. And I think they must have started attacking it on the bridge and then killed it on the other side of the river."

Wolves have successfully hunted deer in islands of Yakutat Bay.

> DA: "They [wolves] move around, and you'll see them on Khantaak there used to be a lot, used to be a lot of them. And well, I guess there is again now. ... so they move around. And there weren't hardly any. There was no wolf sign really on Khantaak for a long time. So, I think maybe there just weren't any wolves there. But the deer population got pretty big on Khantaak. And I just heard from my dad recently that when he went deer hunting there this last winter where we usually go to there, there's tons of deer. There's so much deer sign in this this little crossing. And it was just

> filled with piles and piles of wolf shit, he said. They were deer killing, yeah. Killing those deer. Yeah, he [father] was pretty sad about that because that was our spot."

Mr. Anderstrom has observed that wolves catch red salmon in upper reaches of the Ophir River.

> DA: "One of the things that I learned is that they like to fish, and I learned some of the spots where the wolves like to go get fish because they're really close to where we spear fish. I used to go out and spear fish … the really red time of year that we go get them, … we'll get them even sometimes in November, cohos."

He went on to note that wolves are particular, use the same spot, and appear to recognize stream conditions.

> DA: "... this is one of their fishing spots. Because I think it's just set up the right way for them to, to go down. And it's just there's a spot where there's kind of a bank that they stand on. And they look down into the water and wait till they see a fish come underneath them. Right where, they must know where the eddies are and stuff."

3.5.1.7 Communication and vocalization

Wolves utilized different kinds of vocalizations to communicate and share information. Mr. Anderstrom observed and describes a pattern of wolf communication. The howling he believes was an announcement or celebration of having killed the moose.

> DA: "I think that's how they talk to each other. When they're hunting and when they were, I think they pushed those moose right where they wanted them to go. SL: Telling each other how to coordinate their movements? DA: Yeah. Because that's what I started to hear was like, 'yip,' like this, the sound over here and this unit over here, and hearing it over there. And then I heard them, like, kind of like concentrated in one area. And I think that was them pushing it into that little finger meadow back there. And then that's where that's where it got quiet all of a sudden. And then, and then one started to howl and then they all howled together."

3.5.1.8 Motivations for and impacts of hunting wolves

Tlingit subsistence harvesters in Yakutat harvest wolves for various reason. The impacts of those harvests on the wolf population are small according to Mr. Anderstrom.

> SL: "Is there a conscious effort within the Yakutat hunting and trapping community to control wolves, to keep wolf populations at some level. DA: A little bit, I think. There are people that would like to see less wolves sometimes because there are a lot. We have quite a few of them. But I only know of a few guys that really trap them. And they don't do enough to really put a dent in the numbers. I haven't seen or noticed them fluctuate myself very much, but I'm pretty young, you know, I've only been out there [a few years]. SL: Well their motivations for trapping them would be economic or for regalia or what would be their motivations for trapping them? DA: Mostly … economic so they can sell the hides, yeah. And sometimes to make regalia out of them."

3.5.1.9 Ecological balance

At present, the relationship among humans, wolves, and ungulates in the Yakutat area is one of balance according to Mr. Anderstrom. Humans are satisfied with their opportunities to obtain moose and deer. Moose and deer populations are healthy. Mr. Anderstrom is puzzled by the one deer limit because the deer population is so healthy at present. Wolves are numerous and found throughout the region.

> SL: "... in your experience, the dynamics between wolves, moose, deer, and humans. People have not complained about their subsistence areas or subsistence catches of those animals, moose or deer in a way that has led them to try to cull wolves? DA: No, nobody really doing that. People have talked about it a little bit, wanting to get out and start trapping. And I myself wanted to. I want to go and start trapping for regalia mostly. Yeah. SL: So it's generally ... not any great anxieties about them. DA: No. More bears than wolves. ... SL: So do people have any concerns about the size of the moose population for subsistence purposes or hunting? DA: No, our moose population is pretty strong, I think."

People are not actively targeting wolves for removal to increase ungulates in the Yakutat area. It should be noted that unlike the Prince of Wales Archipelago discussed below, very little clear cut logging has been done in the Yakutat area to date. The unaltered condition of the forest habitat may be a benefit to wolves and ungulates in the area, supporting high numbers of each.

3.5.1.10 Wolf-Dog hybrids

Judith Ramos reported her uncle actively sought wolf-dog hybrids and describes how he pursued that end. The offspring were larger than other Yakutat dogs and were used as pack dogs.

> JR: "So yeah, he was trying to breed a hybrid wolf mix. So he would take a female dog in heat and kind of stake it out, you know, where he knew the wolves would be. And so either the wolf would impregnate that female dog, and they'd have a hybrid, or they would kill that dog. So anyway, that's the way he would breed hybrid dogs. SL: And what was his purpose in doing that? JR: [H]e always had, this was Harry, Great Uncle Harry Bremner. There was always a dog that he used, and there was a big dog he would always use that was trained. Mom would always laugh that was trained to be a packing dog, you know, and that was always in the competition to see how big, how much it could pull things. And it was smart enough to go out and wash its own dish. Yeah. So I don't know if this is from when he lived up in the Cordova area, when this big dog he had that was trained. So he had a great interest in training dogs and things like that. I don't know why."

3.5.2 Excursion Inlet area: "There are advantages of having wolves around."

Mr. Thomas Mills is an elder and long-time resident of Excursion Inlet, located on the north shore of Icy Strait. Excursion Inlet is on the mainland. He was interviewed April 21, 2022. Mr. Mills is 76 years old. He lived a traditional Native subsistence lifestyle and attended boarding school in Hoonah, starting at age nine. Mr. Mills is a veteran of the U.S. military, serving six years in the Vietnam War. He trapped wolves with his father when he was young. He has been inside wolf and bear dens, and he once raised a wolf pup as a family pet and pack animal, which he and his siblings rode to boarding school. Mr. Mills has a deep connection to the land and Wolf. He was taught by his elders, and his knowledge and experience are rooted in and represent the Excursion Inlet area.

> TM: "I am Raven. My brothers and sisters are on the *K̲aashaayí Hít* and *Tax̲'hít* in Hoonah. It's a Head House being the biggest Raven house in Hoonah and Snail House being the second ... My father's clan is the *Wooshkeetaan* from *Noow Hít* [Fort House] in Angoon. I don't remember his Tlingit name, but his English name was Gilbert Albert Mills, Sr. ... I spent my whole life over there [Excursion Inlet] except for six years in the military, when I had to go over to Vietnam for a little bit. … My first nine years in Excursion Inlet and growing up over there, we just lived the Native lifestyle of hunting, trapping, and fishing. We always gathered our foods, early, from the very first time. We never, ever played with toys or anything like that. It was nonexistent. … when we were just old enough to start participating in the hunting and gathering, we did it. And it started off going out with our great uncles, and in the wintertime we used that for when we were running out of food ... we used to go find bear dens and being I was small enough and smart enough and strong enough, my great uncles and my grandmother's brothers used to give me a rope, and I'd crawl into a black bear den and tie a rope around it, and they would pull it out. … and then after that we'd take the meat downtown; we'd share the meat with the whole village. ... SL: Who were your older relatives that were involved with you? … TM: It's Alexander Wilson. His nickname was Shorty. And his brother was Frank Wilson. My grandmother's (Mary Wilson) brothers … At one time the Wilson family used to own Excursion Inlet. SL: … So they were *T'ak̲deintaan* as well? TM: Yes."

3.5.2.1 Two types of wolves

Mr. Mills states there are Alexander Archipelago wolves and larger timber wolves in the Excursion Inlet area. He can tell the two apart by judging body size and coat color. The big timber wolf is gray or brown, and the Alexander Archipelago wolf is black, or brown with black guard hairs, and he has seen white ones, too. He has only observed single timber wolves but packs of Alexander Archipelago wolves. He indicated that the two types never intermix.

> SL: "Now you mentioned earlier to me about the different types of wolves that you've seen. Can you explain that? TM: Yes, we have different—two different kinds of wolves that were in Excursion Inlet. We have the Alexander Archipelago wolf, which is a smaller species of the—what we refer to as a timber wolf or tundra wolf or whatever they call it, but the timber wolf is a great, big thing. It weighs around 200, 250 pounds. And an Archipelago wolf is much smaller than that. I don't think they get over 60 pounds. SL: Now you've seen them both in the vicinity of Excursion Inlet in your life? TM: Yes, but they were always present, but they never, ever mix. SL: ... they're always present, but they never intermix? TM: Yes."

3.5.2.2 Territories and travel patterns

Mr. Mills describes two different packs in the Excursion Inlet area with separate territories. He describes the location and geography of each territory. He describes wolf movements, travel patterns, and the time a wolf pack takes to travel a circuit around its territory. One pack takes 42 days to make its circle, and the other one takes about 73 days to make its circle. These packs have maintained this same travel pattern during Thomas' lifetime (~80 years.) He says they can hear the two packs communicating with each other but indicates little to no intermixing.

> SL: "Which are the predominant ones that you've experienced? TM: Most of the wolves that we have experience with is the Alexander Archipelago wolf. I think that they are most common there. Over in Excursion Inlet we have two packs of them. One of them comes down, and it goes up towards Haines area, comes down around the Chilkat Peninsula side. They think it's every 42 days. And then there's another pack that goes across the bay and National Park Service, and those ones go up a different trail but head up towards Haines area and make their way down into Glacier Bay hunting. And those ones take 72 days, 73 days, to make their circle. SL: ... they have separate circuits so that they don't interact. TM: Yes. SL: And over your life, have those groups maintained in that kind of pattern? TM: Yes. And we can hear them communicating with each other, but we never, ever saw them mix. If they mix, they probably did it up at the head of the bay in Excursion Inlet, where it just goes for miles up there in the valley. SL: But you think they head on the outside of the peninsula, on up the peninsula, and then they head back down. TM: Yes. SL: And how do those cycles operate the same throughout the year, or do they change between the warmer season and the colder season? TM: They pretty much operate separate all year long."

3.5.2.3 Pack size and hierarchy

Thomas says the one pack is smaller at 12 to 13 wolves, and the other pack on the National Park Service side is greater than 40 individuals. Thomas says the alpha female is the leader of the pack and all wolf packs are led by females.

> SL: " ... And so in those other two packs, do you have any way of estimating the approximate number of animals that might be in them? TM: The first one had, I think, twelve, thirteen wolves. ... And then on the one across the way in National Park over there are about 40, 47 wolves. ... SL: So in your view, the head of the pack could be male or female? TM; It's female—this one was female. Or it seems like it. The leader[s] of all the packs are female."

3.5.2.4 Seasonal habitat use

In the Excursion Inlet area, Mr. Mills says Wolf follows its prey, using different elevations as snow depth changes. A pack will follow the ungulates up and down the mountain as conditions change.

> SL: "I think this area up in the mountains has heavy snowfall. TM: Yes. SL: How do wolves deal? Do they stay out of heavy snowfall? TM: They stay in the forest. They

> don't run into the snowfall areas; they stay in the forest. Yes, and they don't—they're not so high up. They're not so high up, either. They follow the game and if there's too much snow the game—drive the mountain goats and deer and stuff will come down lower. SL: So in terms of their zone might be halfway up the mountains? TM: Yes. Three-quarters way up the mountains, halfway, or on top of the mountain, and then when the snow starts getting too deep and the deer and stuff can't move around, they take them into the forest for shelter and food, too. And the wolves just keep following them."

3.5.2.5 Hunting behaviors and diet

People were taught to be very careful with wolves because they were vicious predators and highly intelligent. Mr. Mills says one needs to be cautious when Wolf is feeding; do not disturb Wolf. Wolves are not fearful of guns. Wolf will come into the community and take food if it is left out. Dogs in the community are afraid of wolves. People were taught to be careful when harvesting game because wolves could be attracted to the animal blood. People learn from wolves; they always watched wolves to see how they behave and hunt.

> TM: "But we've always watched wolves. They were always very intelligent. We would watch how they would surround an animal and take it down for food. And we'd watch 'em when they were out hunting over there. They would have a couple of wolves, adult wolves, standing by to watch the immature wolves while the rest of 'em were out hunting. ... and we also saw it—my children also saw it over there by our cabin by Gustavus when we were watching the children videotape wolves takin' down a cow moose, and they were able to see the whole thing that we explained to them. We'd had two adult wolves takin' care of the babies while the other adults went after an adult moose to bring it down. And when we saw those wolves take down that moose, I think there was two different packs that joined together to help. Because there was one pack in the brush across the river from my cabin were howling all night long, and then there was another pack further on towards Gustavus that was howling."

Mr. Mills says the wolves in this area do not use trails; they spread out and follow their noses while they hunt. They do not follow each other on a trail. He compares them to orcas.

> SL: "Now do the wolves have their own trails. Do they use the river corridor? TM: They just follow their noses. They're just like orcas. They just spread out. They just don't follow each other on one trail. ... They just bust through that whole area just like you will see on those killer whales. They will just close off a whole bay and just swim up there and harvest everything in its path. SL: That's the way they move. TM: That's how the wolves go through the forest. And when they pick up on wounded game or everything, that's when they all bunch together and team up."

Mr. Mills describes how wolves got to Pleasant Island and reduced the deer numbers by driving them to the beach; he said there is one particular beach littered with deer bones. He said he is not sure how the wolves got to the island, but he thinks they came over on the ice. He explained that these islands were where his people would go to hunt deer because they tasted really good. Now, the deer are scarce, and people cannot harvest on Pleasant Island. People are not actively harvesting wolves from Pleasant Island; once some deer hunters got a wolf there with a bow and arrow. Thomas says that wolves are not on Lemesurier or Inian islands. There are bears on these islands, black, brown, or both.

> SL: "... you mentioned an occasion in which there's hunting for deer done on Pleasant Island. TM: Yes. … Pleasant Island is that big island by Gustavus, and it is always, always loaded with deer. The best-tasting deer came from Pleasant Island, Lemesurier Island, and the Inian Islands. Those were three places where we went hunting for our deer. But somehow wolves got onto the islands, and I think it got on from the ice floe. When the wolves went out on the ice, it broke off on the shoreline and floated out and it hit the beach over there on Pleasant Island. And I think there's a pregnant female wolf out there with 'em, because those wolves multiplied out there and now there's no deer out there. There's just one beach where they drove all the deer down to the beach and killed 'em down there and ate 'em. You just see how that one beach is just littered with deer bones. SL: Was that a single event, the killing of those deer? TM: It's going on today. It's been going on the last 25 years now. SL: So the deer have been able to maintain reproductive population. They haven't disappeared from Pleasant Island. TM: Well, they're becoming very scarce. There's some other people in Gustavus that I know have told me he hasn't gotten a deer on Pleasant Island in the last five years. SL: So I want to make sure that you we're not talking about a single event in which the pack drives deer, a bunch of deer, onto the beach. That is—did that occur or not? TM: Well, they would run the deer, and the deer would run to the beach, trying to get away, but the Wolf would trap 'em on the beach. SL: How many deer, usually? Is that a one deer or two deer? TM: Well, you could see one or two deer where they drag 'em down, but where they trap 'em on the beach over there you could see all their deer bones … SL: That's a recurring pattern, then? TM: Yes. They keep driving' the deer down on that one beach more than any other beach. SL: So you think that if we were to go to that beach today, we would see the deer bones? TM: Yes."

Thomas Mills says wolves will eat birds, porcupines, bears, in addition to salmon, goats, deer, and moose; they eat whatever they can find. They will go after bears, especially if the bear is sick or injured. Thomas gives an account about a wolf pack chasing a small black bear in a coordinated effort.

> SL: " ... do you have any other indications of what wolves eat? You said mountain goat, moose, deer obviously, and you've seen 'em eat salmon. TM: Yes. Well, they're pretty much—hunt whatever they can find. They know how to kill porcupine and eat 'em without getting quills in 'em. Most of the porcupine carcasses that I've seen, the head would be gone and there would be no insides. You'd just see a hole where the neck was at. And the rest of the body with the quills on it would still be laying' there. SL: Wolves don't try to take bear, do they? ... TM: If the bear is wounded or sick, they'll go after it. They'll go after just about anything. Out at the cabin there was people in Gustavus were using great big snares to catch a moose, but there was one incident where this one bear had a snare around its neck so tight that it didn't have

any hair on it except for the head, the front paws and the back paws. It looked like it had fur slippers on. The rest of it didn't have any hair. But it was sick, and it walked out on a sandbar in front of the cabin and sat on the grass a little bit, and then it staggered back into the bushes. And a smaller bear came out, a healthy one, and then a pack of wolves came out and they smelled that sick bear. So they thought that little healthy bear was the sick one, and they tried and tried and tried to take it down but it—for almost four miles of fighting, that they never, ever brought that little black bear down. They would just go to try to attack it over there, and when it didn't work, the wolves would break off and go back by their leader, which is the mother, and they would—just like they had—were having' a little conversation, and they would try something new again."

According to Mr. Mills, wolves in the Excursion Inlet area will eat sockeye and pink salmon. Wolf will sometimes feed on the beach and shore for invertebrates, shellfish, octopus but do not dig deep for clams. Wolves hunt and eat ermine but do not eat sea otter carcasses. He says wolves are frequently seen when going to the mountains to hunt mountain goats; when the moose started coming into the Excursion Inlet, they started to see both species of wolf, and the wolves would follow the moose.

> SL: "... how frequently did you see wolves? TM: We would—when we went out moose hunting—mountain goat hunting, we would see the wolves just about every time we went up in the mountains to go get a goat. ... And later on, when moose start showing up in Excursion Inlet, we start seeing both species, the Alexander Archipelago wolf and the great big gray timber wolf, and they would follow the moose around."

Earlier, Thomas Mills said wolves would come into the village to eat ducks that were hung up aging, but they never bothered their fish smoke houses. However, he has observed wolves feeding on fish in the Neva River.

> SL: "Now you mentioned that the wolves came to the village for the geese [ducks], but you folks are smoking fish there. Have you ever had wolves around your fish—salmon that's processing? TM: No, we never, ever had wolves bothering the smokehouse or trying to get the fish we have already caught. But up there in that Neva Creek over there, at one time I came across I think three sockeye all in one big pile. And I thought … it was the work of a bear pulling them out of the river. And then I looked at 'em a little bit closer and you could see the tooth marks, canine teeth marks from a wolf, where they just bit 'em in the back and sheered the backbone and put it up on the beach and they let the—let it ferment a little bit to break down, and then they went down there and ate everyone them up. You couldn't even see any scales over there anymore where all the wolves—where all that salmon were. SL: You've only seen that happen once, though, huh? TM: No, it's the only time I've ever noticed that. ... I would see places where there was a lot of fish over there, but I never really examined it. I always just assumed that it was the work of a bear. But then after we started realizing it, we started looking a little bit harder and we could see wolf tracks up and down the river just like bear. SL: That's on the river proper. TM: Yes.

SL: That's not on the tributary creek up above—coming out of the lake, then, where they went … TM: Yes, it's the one that comes out of the lake."

3.5.2.6 Mating, denning, and dispersal

Wolf mating season begins in February in the Excursion Inlet area. Wolf is vulnerable to trapping during the mating season. Thomas and his Dad trapped in February when they started to breed because the wolves become distracted and careless during the mating season.

> TM: "We would just get ready for February, because February is when the wolves and the coyotes start mating [in this area] … and that's when they become careless. SL: How would you know that they're mating at that time? TM: We would hear them howling. They have a whole different activity, and you would see tracks all over, lone tracks. ... You'll see a lone female or a lone male track over there, where one of 'em, usually a male, would break off from the pack over there and try to start its own—find a female and start its own pack."

Thomas described a time they found an active wolf den under stumps and extracted a pup. He explained how to identify the alpha wolf in the litter by allowing it to bite the hand.

> SL: "Did you ever encounter a den, a wolf den? ... TM: Yes. ... We used to watch this one wolf go over there, keep going into these bunch of stumps the military stacked up over there, and we'd hide away and just keep watching 'em from different angles, and pretty soon we found out where it's den was. And then we found out that there's a mother there that had pups already, so we just took some of Grandmother's dish cloths and small towels and wrapped it around our arms and stuff and we stuck it into the wolf den, and the first one that bit our arms and stuff, we pulled it out and kept it, thinking that was the alpha. That was the alpha and the pups over there. SL: ... Your sense is that the one that would bite would be the alpha ... TM: Yes. That's to protect—protecting the rest of the pups."

Thomas observed a litter of seven pups inside this den. He says there is only one breeding pair in a pack—the alpha male and the alpha female. The alpha male will not allow the younger males to breed. He indicated that dispersal of pack members, and possibly new pack formation, will occur when the leader or alpha wolf dies. When left without a leader, the other members of the pack are vulnerable to attack by an intact pack, so they have to disperse and form a new pack(s) to avoid the threat of attack by a stronger pack in the area.

> SL: "So the time that you went in and got the wolf pup [from its den] ... do you have any idea of how many pups were present? TM: I think there were seven; seven pups in there. SL: In the litter. TM: Mm-hm. SL: Well, given the size of some of those packs, you must have multiple breeding pairs in them? TM: No, there was—in a wolf pack there's just the alpha male will breed with the female, the alpha female. The rest of 'em won't breed. And if they try, the alpha male will fight 'em and tear 'em down. SL: ... they obviously have to have a pattern because the leader is gonna die at some point, so there's probably some kind of way in which a new leader has to come into existence. TM: I think they break apart when the alpha leader dies, and then the herd

> [pack], the [pack] doesn't have a leader anymore because it's all the female's children. So they all have to scatter off and go start their own herds [packs] again or else the other wolves around will hunt them down and kill 'em. Wolves don't—wolves are predators, and they won't like—they don't like other predators around 'em, so they'll go after the other predators and try to kill 'em to eliminate the competition for food."

Mr. Mills has observed a group of wolves by Neva Lake and river that may be a recently formed wolf pack.

> TM: "... Yes, it's the one [river] that comes out of the [Neva] lake. ... Then, I think there's one new wolf pack that just hangs out up there by that lake. SL: This is recent, then. TM: Yes, this was in the last five years. Because every year, every winter, we have our own little march out there where we drill holes into the ice in the lake and see who can catch the biggest Dolly Varden. And sometimes when we're real quiet over there we can hear them wolves making little noises in the bushes around us over there, and the wolves won't even hear us walking on the ice. Most of the time the wolves will stay off of the lake or frozen water because they know it's dangerous and when all that methane gas and stuff that's coming up underneath the ice over there, the ice starts vibrating over there and the wolves can pick it up in their feet ... SL: So it sounds like you think there's another pack coming into existence? TM: Yes, I think there's a new pack that's started off over there, because the female is pure white."

3.5.2.7 Communication and vocalization

Thomas Mills says wolves howl to communicate with one another, and their howls do not have an echo. Mr. Mills shares an account about encountering wolves in the forest as a child. Wolves will respond to humans howling at them. Wolves will kill intruders they find in their territory, and they do not tolerate coyotes. Thomas has never heard a wolf bark.

> SL: " ... what you said about that pattern of wolf howling. What's going on with the howling? TM: Well, the howling is their—first of all, the wolves' howling doesn't have an echo. Coyote doesn't have an echo. And the wolf howl is used to send messages to the other wolves that broke up from the pack to hunt, to either let 'em know that there's danger or they got—or they took something down for food or killed a—it's kind of like a beacon to let the other wolves know where they're at. If somebody who is smart enough that was hunting wolves and knew all this information, they could just pick up on a wolf howl and just head right straight toward it and chances are they'll see the wolf. And when the wolves start howling, one will start—one will start it, and all the other ones will join in like a big serenade. That's when they're feeding. SL: And so if they see you, have you ever heard wolves howl or make other noises when they observe you? TM: No, ... they just become quiet and all you see is little flashes of shadow. ... SL: Have you ever tried to communicate with wolves using howling? TM: Well, we would howl over there, and I don't know, they were probably laughing at us. But they would answer us. SL: They would? TM: Yes. We'd howl like a wolf, and then they would answer."

3.5.2.8 Intelligence, sense of smell, and response to trapping

In the Excursion Inlet area, wolves travel in a consistent pattern but will change their ways if someone sets a trap line. Mr. Mills says wolves will avoid an area that has been set. Once a wolf is caught, others in the pack will avoid the area; wolves become wise to trapping and become trap shy or avoidant. Catch success decreases with duration of trapping effort in the same location. Wolves are hard to trap, and success is low in this area. Thomas states that his father's take of wolves did not affect wolf numbers because wolves leave an area that is being trapped and do not return for a long time. Trappers and hunters would have to actively travel and search for wolves after the pack left the area, which is not efficient. Even the really good trappers have low success. He says you have to have a lot of knowledge about wolves to catch high numbers, and it is critical to remove all human scent from one's trapping equipment to be successful.

> TM: "And this other guy trapped two Archipelago wolves that—last year, and I called him, and I said, 'You're not gonna get anymore wolves,' and he didn't believe me. He's been tryin' now for the last couple years to trap an Archipelago wolf, and he won't do it. ... So I just told Dan he's not going to—he's going to be very, very lucky if he ever traps another Alexander Archipelago wolf, because they're wise to him already. SL: ... those traps that you use—your father used, what kinds of traps were they? TM: They were double spring with big teeth on 'em. ... we used snares, too. And it was—both with snares and traps you have to be really careful that you don't leave any human scent on it. SL: Is there any difference in their effectiveness? TM: Well, you leave human scent on any of 'em, they won't catch—you won't catch anything. So normally we would get our traps and boil 'em in either spruce boughs or something that would kill the smell of it. SL: How would you transport them? TM: Oh, just put 'em in a burlap bag ... we'd have to boil the burlap bag in the water, too, when they're over there, sort of to get rid of all the human scent, yeah, and just carry the bag."

Thomas explained how to best anchor or weight a trap so that the wolf would not chew its foot off. Wolf can see your traps, so you need to use several decoys and one hidden out of sight to trick Wolf. Thomas and his Father did not target a specific number of wolves. He says what you got by chance is what you got. He says they primarily caught immature wolves. Wolf is too hard to trap, so you do not get enough to make a difference.

> SL: "Have you trapped or hunted wolves specifically? TM: Yes, we trapped—I went out with my dad when I was a child. But most of the time we would be trapping 'em, marking up there in the mountains. But when we did go for traps we always used three or four different traps over there because of the wolves' intelligence, if they would—we'd set one trap and hide it away really good so the wolf can't see it, and then another trap we'd set it there just so the wolf can spot it and avoid it, and another trap, we'd just leave it out in the open so the wolf would know it's there. So while it's looking at both of the other traps, it steps into the one it's not seeing. And then they always have to attach the trap to a weight that the wolf can drag, but not too far, because if the wolf can't drag the weight or move the trap, it'll chew its foot off. SL: Now this trapping, what part of the area did you do

that in? TM: We trapped in Excursion Inlet up in the mountains. SL: What approximate elevation, would you say? TM: Um, about halfway to three-quarter. We stayed in the timberline. SL: ... any difference in terms of whether they're large or smaller wolves that you would be catching in the traps? TM: Normally you would catch the immature wolves because the older wolves are wiser and smarter. And once a wolf is trapped, all the other wolves are wise to that area, and you'll never catch another wolf in a trap."

3.5.2.9 Wolf health and status

Mr. Thomas Mills observes that the wolves in his area are healthy. He uses the condition of the wolves' hides as an indicator of wolf health. He says wolves are not endangered. The narrative indicates people have been harvesting wolves in Southeast Alaska for a very long time, and the wolves are still there.

> TM: "... when the Wolf starts eating a, say a moose or a deer, they eat the hair, hide, everything. It's a—that's why you see all the hair inside their droppings. Yeah, if you just observe what comes out of a wolf over there, you can just about tell how healthy the pack is, too. Okay, yeah, when you're going' after wolves and stuff, you probably going' after the hide, and you want the hide to be in prime condition over there. Well, if a wolf isn't eating very good, the hide isn't a very good condition. So the indicators are what comes out of the wolf and its stool. If it has good, healthy stool and it's a nice—it's nice and solid over there, chances are that wolf is a real healthy wolf and the hide is really good because those hides are beautiful. They're real thick. You can't imagine how—you can't imagine the beauty of one of those wolves, and you can't explain it until you have it in your hands, and then you just really can't believe it. You just can't believe you can just feel the—how insulated that wolf hair is over there, because your hands automatically warm up, just from your own body heat being insulated from the hair on the wolf hide. SL: are wolves endangered in your view? TM: No, I don't think wolves are endangered. I think the wolves are pretty healthy. Because all the wolf hides that I—when somebody traps a wolf or shoots a wolf and they mention it to me, I just go over there and look at it, just glance at it and see what condition the hide is in, and that's where I can tell whether those guys have a good hide [health] or whether the wolves are having trouble feeding."

3.5.2.10 Conservation, regulation, and hunting

Based in his knowledge and experience, Mr. Mills shared a conservation message for agency regulators and decision makers. He implies that hunting may be more successful than trapping in the Excursion inlet area. He says it is easier to hunt wolves today with modern long range rifles, and hunters can locate the pack by walking toward the direction of the howling because wolf howls make no echoes. Thomas says that there are not as many people going after wolves today as compared to the 1930s through the 1950s because there is far less economic incentive.

> TM: "And then hunting them, too, it'll be—it's easy if you're going after a wolf to hunt, because like I said earlier, the wolf howl doesn't give an echo. So when ... you're after a wolf, and you hear a pack of wolves howl, you just go right over to that

direction over there and you're going to find 'em. And with the modern rifles now, like, um, say, for an example, on Prince of Wales Island, where they've clear cut [the forest]. So you're destroying the Wolf's habitat, although you're building up a browsing area for the deer. So the wolves are confused because there's no more trees around anymore that used to give them shelter. And when they start hunting over there and start howling, with their success on hunting 'em, and then the other people over there have these modern rifles over here and they can kill wolves at a thousand yards with no problem. And that's how come most of the wolves don't go further south and around cities and stuff, start losing their big ... packs of wolves, because they're people with modern, long-range shooting rifles over there. The wolves just don't have a chance. The way [to] protect the wolves over there would be to have an open and closed season and a limit on them. They should, before they try to put anything on endangered species, they should try everything else first before they just shut the door on everybody. Because there's very few people that hunt wolves now for a profit like they used to back in the '50s, '40s and '30s. They don't hunt them as much as they used to. ... The Wolf is just a magnificent animal if you just really look at it and see what it does and how it helps nature. It doesn't just go out there and slaughter the other animals. The Wolf is just like coyotes and stuff: they'll prey on the weak and the sick. And that's thinning 'em out. So there's a lot of advantages of having wolves around, and like I said before, not very many people go after 'em, and the people that do go after 'em, they're not very successful. The Wolf is just far too intelligent, once they understand what's happening, because they know where to go to stay away from the area."

In Excursion Inlet today, people equate the presence of wolves with lower deer harvest success, but they have accepted it and do not desire to go after the wolves to lower competition for deer. Thomas says that it is important to conserve wolves, but the agencies should try everything possible before making it an endangered species, which he thinks would shut everybody down. He recommends limits on seasons and amount of harvest for wolves before listing. He thinks clear cutting has been bad for wolves as well.

3.5.2.11 Wolf-Dog hybrids

Thomas Mills reports on what he learned about wolf-dog hybrids.

TM: "I've heard about them, too, but they said they're pretty much useless for a work dog because they have a tendency to go back into the wild. And when they have a dispute with the other dogs, like say that they're using 'em on a sled dog [team], well, the wolf-dog will kill the other dogs really quick. And even before the guy can stop it, the owner can stop one, the wolf-dog will kill 'em."

3.5.3 Kuiu/Kupreanof Islands: "We are trying to enhance our subsistence way of life."

Mr. Michael *K̠'a.óosh* Jackson and Mr. Scott Jackson from Kake, Alaska were interviewed April 26, 2022. They are distant relatives who grew up in Kake. The information they shared about Wolf pertains to the Kupreanof and Kuiu Islands. Scott and Michael both shared traditional ecological knowledge of Wolf, and Michael shared cultural knowledge of Wolf. Michael is an elder and culture bearer who has lived in Kake for 71 years, and Scott is an expert wolf trapper.

One of the main themes of this section and these interviews is the desire to maintain a balanced subsistence way of life. Trappers such as Scott Jackson continue to work very hard in a coordinated effort with a small group of trappers to control wolf numbers to ensure their subsistence way of life in perpetuity. Feeding the elders and the community wild foods such as deer and moose meat is the overriding motivation for trapping and hunting wolves.

3.5.3.1 Motives for wolf harvest and control

The reasons people trapped and hunted wolves in the 1950s are similar to their motives today, including the economics of trade and the mixed subsistence-cash economy; wolf management and control to ensure enough deer to feed the people; and protection of life and property, especially to keep wolves from entering communities to eat dogs or threaten people.

> SL: "Now, your father and the rest of the people's motivations for taking wolves back in the 1950s say, were primarily for economic … MJ: Yeah, yeah. SL: … economic motivations. It was not related to excessive predation by wolves or impact on deer or anything like that. MJ: It was all of the above because if the wolves got too plentiful, they came right in the village and took their dogs. SL: Even at that time. MJ: Yes, even at that time. Like it says, you don't ever kick anybody's dog."

Michael explains when he was young his dad and most of the town trapped furbearers in the winter for a source of cash. It was an important community and family activity. He explains that his dad would be out on the islands for long periods, and they used to take the entire family trapping before the kids were made to attend school. The missionaries convinced the town fathers to fine parents when they did not send kids to school, which changed this winter subsistence activity.

> SL: "What did you learn or were you taught about wolves as a child? MJ: ... growing up around my father and my uncles ... and my grandfather, then, the whole town were trappers. That's how they earned money during the winter. It was so serious that my dad would disappear for two or three months on end. So would the whole town, the guys. SL: They'd be out in the islands? MJ: Yeah. Before that, they would take the families out. Back in 1912, the city wanted to be an organized village in the western way, and the only way that—see, missionaries, they wanted the kids to go to school. So they convinced the city fathers to fine the parents fifty cents to five dollars, and back in the day that was big money. And if they took their kids out in the winter, they'd stay in just these canvas tents with a stove in there. And they did everything outside, all the activity. But even then my dad remembered how they were trained to trap. They trapped everything from the ermine to the mink to the otter to the marten to the wolves, and so they were pretty busy. We would be helping 'em disinfect the traps, so they had no smell."

Wolf pelts were coveted because of the thick fur and warmth and waterproofing. These were decorative and may have been used in certain regalia and donated to elders in times of need. Getting a wolf was a status symbol for the hunter or trapper, not just a valuable fur.

> SL: "Did you think Wolf were ever used in regalia? MJ: Yeah. If somebody they knew of needed something, they'd donate freely. They'd just give it to the elders if they needed something. And a lot of times, back in the day, dad said that they [wolf pelts] were coveted because the thick fur that would be waterproof and snow proof. They would look [like] a big, well, for the current word, Sasquatch, walking through the forest with this … besides seal pelt and sea otter, the wolf pelt was really decorative. ... the wolf pelts, they just didn't get them for the pelt. They were admired when they got them."

The people in the Kake area know by experience that controlling wolf numbers allows for enough deer to sustain the human population. From a subsistence perspective, there are two dimensions to the wolf-deer dynamic: Michael Jackson indicates that when wolves are present in the community's deer hunting areas, the deer become spooked and skittish or "scared," making them difficult to hunt, and after the wolves successfully kill and eat a large number of deer in an area, deer become too scarce for adequate subsistence harvest. Mr. Douville of Craig also described the same dimensions of the problem in his interview. It is not only lower abundance of deer from predation, but just as important, the deer become too difficult for people to harvest in the presence of an active wolf pack.

> MJ: "Yeah, because then, too, they [the people] noticed the impact of the wolf because the wolves would eat the deer. And the deer would get scared. ... And they knew it because there were some places and villages that didn't trap the wolves. They didn't have trappers, and people that went out of their way to go get the wolves. And here they were—they'd been almost starving. And I remember my father telling me those different places he'd go where that was happening. But when he'd tell stories and, you know, the meaning of the story was that you had to control them. SL: It was about the classic Tlingit concept of balance. MJ: Right."

Scott Jackson articulates that trappers' motivations are to ensure the people's subsistence way of life in perpetuity. Good subsistence equates with wealth and good health for the community and the Tlingit people.

> SJ: " ... that's the bottom line is where we're subsistence trappers not trying to overdo our boundaries and just trying to respect ... Yeah, we're just trying to respectfully get something back that you know, pays dividends into our family of, this is how a lot of us are rich. You know, if we can keep our subsistence rich, our community remains rich. And it keeps us from having to hit the liquor store. I mean, the Hardware, the SOS, the Value Marts so often. ... I keep reiterating, like, why we do this, it's we're trying to enhance our subsistence way of life. And if we're gonna allow outsiders to come in and throw a wedge in there, you know, they got to at least come in and say, well, this place really needs, a place like Kake, a place like, you know, we need stuff like that [wild foods]. We don't always have; we don't always have [store bought foods and other commodities]."

Scott reiterates that people from outside his area need to understand that they need deer and moose to survive in a place like Kake, Alaska.

Another motivation is protection of life and property. A direct threat to the community exists when wolves become hungry in the absence of their normal prey. Michael shares an account when wolves came into town and killed a German shepherd dog for food. The loggers in the area had killed off the deer, and the wolves were hungry. The wolves came into town and killed the dog and dragged it off to eat, leaving only the head on the chain.

> MJ: "They [wolves] come so—they've came in here when the loggers chased them out of the woods, and the loggers killed a lot of the deer, so the wolves came into town. Me and Edna stayed just right down the beach there with two elderly people, and they said, 'You hear that last night?' And—because we'd always take 'em either a pie, or we'd go share something like seal, because they were very elderly. And they said, 'You hear the wolves?' And I said, 'Yeah, they were right above the house here on the road, running.' And they said, 'You guys don't go out. Don't let your little dog out.' We had a little foo-foo dog. Here, Gilly Williams—did you ever meet him? He was like with Calvin's age, senior, Clarence age ... But he had a big German shepherd *because* of those wolves. And one night when that was going on, all he heard was a whimper from his dog outside. He had him chained up on an alder tree. He jumped up, grabbed his gun—because he knew what happened. And all he could see were these blinking eyes and disappearing. They ripped that dog right off his chain. All that was left of his dog was the head. They just—all of them got together and just ripped it off because they were hungry."

3.5.3.2 Number and location of pack territories, movement patterns, and abundance

In the Kake area, Scott Jackson says wolf pack territories are organized by watersheds, and pack trails are associated with stream beds. He explains there are many wolf packs that most people never see running the creek beds, valleys, and beaver beds.

> SL: "... do you have any idea of what organizes a pack's territory? ... SJ: And I've seen it several times where I've been in the Hamilton area, and where I came into an area, and they got really territorial. You can see when they're on the road, when two packs come together, they get really territorial, because they'll start pooping and peeing really bad. Right on the border. And you'll think it's just the one pack, but you know what, there's another pack down by the creek bed that's barking and peeing and pooping in that area, too. And that's the thing that a lot of people don't realize is, if there's one pack here doing that, then that means there's another pack over here, keeping the range. ... [looking at a map] This is the North pack. And I would call this the Portage. And then there is a Mid pack like in here. I mean, it's just because people aren't seeing them, don't mean they're [not] there. There's so many hidden roads back here that they're running on. Then they run valleys. They'll run creek beds; they'll run beaver beds. You know, everywhere you see a creek on this [map], that's where they're running. That's their travel path."

Scott draws on a map where each pack has its territory as he names and counts the number of packs. He estimated about 10-12 wolf packs on Kuiu and Kupreanof islands. The packs have local names given by the trappers (Figure 17).

> SL: "... how many packs would you think exist ... organize it spatially for me whether you can do it the whole island or half the island or whatever? SJ: I would say, like how many packs do we have throughout Kupreanof Island? ... I would say we have a north end pack. Yeah, north. That's in Portage Bay and tip of Schooner. I think we have a mid-pack by the Alpines to White Rock, which is Petersburg Borough. And then we even have another pack that developed out here. And I only say that because right now, if you see them consistently, that means they're by a den. ... So, this is just our area. Yeah, so then you can include Kuiu [Island], and there's one, two, three, just on this side. Probably four [packs] that are on that side. So, I would say a dozen packs, just to be realistic."

Scott shows the locations of the various wolf packs and some dens in the area. He explains how wolves start to become more common when people start hunting moose; they come around to feed on the leftovers from subsistence harvests.

> SL: "You think you could quickly sketch that in? SJ: Yeah. Let's see, what do we have, where's Kake on this thing? Kake access [road]. So, this is Portage right here. This is because there's a spot here. And this isn't even covering our whole island. I heard the peninsula down here. Down here, this is just covered with wolves. Lindenberg? ... So Lindenberg, like, I heard this is where a majority of Petersburg people, the majority, of the hunters, I'll say complain about wolves is on this peninsula. But see what, what they do if you're ever around, so there won't be no wolves around, they'll stay hidden. But once all the moose, so everyone start shooting moose in here and this is a peninsula. I call it the Salt Lake Peninsula. Salt Lake and once people start slaughtering moose, the wolves start congregating out here. And you'll hear him [Wolf] all the time. Because they're going after the carcasses and ... you'll see them start moving. Like, that's how you get a good grasp. And what I do is, in the wintertime, I can go out and I can see what is going on out here. But down here by Devil's Elbow, right here, they cross heavily. So they cross here heavily. ... this is Devil's Elbow, I believe, right? Because I spent so much time out. So it's like a cross path and then down here is Three Mile, and that is loaded. And then we have No Name. And then we have Affleck lower down that way."

> SL: "So those names, you're referencing packs and those locations? SJ: Yeah. ... So, this is the mid Saginaw. So this is the Kadak pack up here. Yep, and then if we go farther up here, you're talking about Saginaw, so. SL: Are you over on Kuiu? SJ: Yeah. So, we'll call this Saginaw pack. And then if you go farther this way, there's a Saginaw/Security pack. So just to reference this, 1, 2, 3, 4, 5, 6 just on that side of Kuiu. And then down here we have Totem Bay. This is the Totem pack, which is the south end of our island. And then there's another pack. But this is where it gets tricky, right. So up here, you see what road it is. Here's the 45-38 [roads], the 45. I wish they had the lake on here. There's a trail that runs this way, to here. And a lot of times the

> wolves run up this side. Wolves are up here, wolves around this way. But I've known there to be a steady pack there. There's also a pack right here. I want to say their den is right here. So, every time we can think of a den Yeah, so there's a, they've been seeing, and Josh, one of his workers said they saw a female track with blood in it. So, you know the den is close. So I want to say in this timing area, but I think it's around here. The den there, I've seen a den down here, I've seen a den over here. This is Irish area. So, this area is really flooded with about 10, a pack of 10 runs a circle right here. So from here to there. ... But if I can continue on this [map], I have a pack here. Right? So a den, I heard there's a den right here. So right in the middle between Seal Point and Kake, there's a den right here."

There is a high abundance of wolves on the Lindenberg Peninsula.

> SJ: "... I heard the [Lindenberg] peninsula down here is just covered with wolves. Have you ever heard of Lindenberg Peninsula? SL: Yeah, sure. SJ: So Lindenberg, like, I heard this is where a majority of the Petersburg people, the [deer] hunters, I'll say complain [about wolves]."

Figure 17. Wolf packs on Kuiu and Kupreanof Islands (Mapped by Mr. Scott Jackson; Source: Steve Langdon).

3.5.3.3 Hunting, feeding, travelling, and territoriality

Michael describes why sometimes you may find a deer kill left before it is completely consumed by Wolf. During travel between watersheds, if a wolf intrudes on the territory of a different pack and kills a deer, they will not have time to finish eating it. They have to leave it partially uneaten to avoid a conflict with the pack in whose territory they entered to make the kill.

> SL: " ... periodically, there are accounts of wolves killing large numbers of deer and not consuming them. Have you heard stories or see any events like that? MJ: I've never seen any, but I've seen where they left … and the way dad explained it to me, and grandpa, was that they were going. They [wolves] were traveling. And they travel from watershed to watershed. And that's very territorial. But if there was a visiting wolf and they got a deer, most likely a deer, they would eat as much as they can as fast as they can and get out of that territory and leave it. And that was an intruder. The other ones, if they had got it, a pack of them, they'd howl and the other packs would come in, and if they're in their same watershed, they'd come and eat it."

Scott Jackson describes in more detail wolf diet and prey types. Scott says the wolves primarily eat deer, moose, and beaver, and their diet is seasonal. After the moose and deer rut, in winter, the wolves will prey on the male ungulates because they are weak and vulnerable from the mating season (i.e., rutting). Wolves will prey on deer fawns and moose calves during spring.

> SL: "Now what have you seen wolves eat besides the ungulates? SJ: What have I seen them eat on the island? SL: ... there are two things: What have you seen? And what are you aware of them eating through looking at their feces or their stomachs? SJ: Oh, feces? I think I see a lot of beaver in there. Lots this year, this spring, I noticed a lot of deer hair, moose hair. I guess it goes on winters too. ... It really depends on the time of year, you know, because after the ruts, and after the big, when after the bulls, moose and everything, you know, rut and everything. And same with deer. They're weaker. And that's, I think that's a time of year that you'll see them more vulnerable. SL: What about at fawning time? SJ: In fawning time? I think usually you see quite a bit of deer fur, tending to, [wolves] really focusing on them [fawns]."

3.5.3.4 Watersheds, roads, conflicts, and assimilation

Wolf packs in the Kake area are organized into territories that correspond to watersheds. Michael did not know the specific time it takes a pack to travel its territory, but he says it is faster now because the watersheds are connected by roads. He indicates that the roads have led to more conflicts between wolf packs because the roads allow the wolves to easily enter more watersheds and another pack's territory.

> SL: "So the underlying principle—the wolves are organized by drainages and watersheds into their territories? MJ: Yeah, yeah. SL: And what kind of timeframe do they use to make their circuit? MJ: Today it has sped up, and Scott might talk about it. It is because roads connect those territories, those watersheds now. … [wolves] got into more watersheds, into one another [pack's territory], so there were conflicts. SL: So there are conflicts over territories? MJ: Oh, yeah. And the only ones that were

> brave enough were young, strong ones to be integrated into another one, they took ‘em in because they knew he was going to be tough… where he gave up a big fight with the alpha. SL: So there will be assimilation? MJ: Yeah, and that’s how they kept their blood lines different. But they were always looking for another female on the other side. SL: Oh, yeah. Recruiting, or… MJ: Right.”

Conflicts with intruding individuals may lead to outside wolves being assimilated into a pack. If an intruder could survive a fight with the alpha male, it would be integrated. Also, a pack is always looking for females from a different pack. Michael says a wolf pack will do this to “keep their blood lines different.”

3.5.3.5 Reading wolf sign, pack boundaries, abundance, and harvest amount

Scott shares an account about finding himself between two packs; he was on the boundary of two wolf territories. At a place called Hamilton, he found a wolf he had snared to be torn apart by a rival pack in defense of territory.

> SJ: “Well, I will say this one time. So when I was trapping, this is where I knew I was between two packs. So I checked my traps every three days, and I was trapping the road system. And right here by Hamilton, there's a den here. But see, there's a creek right here called Hamilton. So I trapped two wolves in the snare. I came back on the third day, it was icy, came on my four-wheeler, and I came up to the snare and they're ripped apart by another pack of wolves. You can see the one pack on this side ran this way, and the other pack stayed on the road, marking their territories, and they turn around there and went back towards Petersburg. So that right there just tells me you're dealing with probably 30 wolves together. Yeah, and just me. Yeah, I'm gonna have a good season. I think I'm doing good for 20 years if I can catch 20 a year, and I've done pretty close to that. But that's nothing because you're talking about pack after pack after pack.”

He explains how he reads wolf sign that marks the boundary to estimate number of wolves. Scott determines that the two packs together probably comprise about 30 wolves, so roughly, 15 in each pack. He also estimates that he may take 20 wolves per year which is not a lot considering all the packs in the area and the size of the packs.

3.5.3.6 Denning, den location, litter size, and movement patterns

Michael describes how to locate a wolf den and at what elevation he has seen dens. He says the reason Wolf has its den at 1,500 feet elevation is because here the area would not become snowbound; the wolves at the den could still travel in and out of the area to hunt in the valleys and still go back to the den to protect and care for the pups. The parents need to be able to come and go quickly and easily to and from the den site.

> SL: “… Well, what about wolf dens? … MJ: Yes. You really start seeing where a den was because of the activity at—when you’re walking through the forest there’s certain vegetation scattered around, and at different levels [elevation]. So most common wolf dens I have run into were maybe around the 1,500-foot level. So that it wasn’t snowbound enough, they couldn’t get around; they could get down into the

> valleys, but they go back [to the den] … because the most important part was the protection of the cubs. And then when you got closer to them [dens], you'd start smelling decaying matter. But they didn't have the decaying matter by the entrances and the play area of the den. It was off to the sides … That was there to warn the other wolves to stay away. You know, they came up and did their business at the way fringe, but they also got rid of what they didn't want at the fringe. So when you start coming upon a den, it was pretty clean. It was pretty well worn because if it was an established pack, you know, that's where they'd had all their social interaction, but all the little ones would run around, too, into—and you can see very clear—into their dens, where they went in. It was always down and up. Because the weather would come, it'd go down, but it'd never go up, because up here would be the heat."

One can smell a den when you are close to it due to decaying matter at the perimeter of the den site used to warn other wolves to stay away. Near the den entrance it is clean and well-worn from social interactions and pups playing. The den entrance is clearly evident, and the entrance to the den is constructed with a cold sink.

Wolf dens are multigenerational, but they just don't use one den, they use multiple den sites. Michael explains wolves will move up and down the island depending on temperature; they move from the south end of Kupreanof Island, if it is too cold, all the way to the end of Kuiu Island. They will make their dens on the south side facing the sun for warmth. Michael's dad saw seven pups in a litter one time. Michael thinks seven is a lot.

> SL: "… those dens, do you think they're transgenerational? I mean multiple generations that keep using the same locations. MJ: Yeah. They just didn't use one den, though. ... just like us when we went after halibut, we went to a different place. When we went after sockeye, we went to that—the lake area. SL: So they have multiple sites like that? MJ: Yeah. They'll go up and down the island. Like up here it gets too cold, and they'll go to the south end of Kupreanof or all the way to the end of Kuiu and sit on the south side, their dens, facing the sun. And the other animals would, too—the deer. SL: Have you ever been on Kuiu to see them out there? MJ: Yeah ... SL: How many pups in a litter? Do you have a sense? MJ: Once we saw because my dad came across one and he said there were seven [pups]. That's a lot. SL: ... would be their ability to replenish is pretty high. MJ: Yeah."

Michael describes how wolves use trails and travel the same trails over the decades, moving along in places where deer are located and spend time. He repeats how wolves use different elevations during the season. Wolves come down off the mountains in fall, and they go back up to about 1,000 feet elevation to their den sites in winter. Earlier, Michael said the dens were at about 1,500 feet, so perhaps the dens are 1000-1500 feet elevation.

> MJ: "… the river comes down like here, and the river also used to connect to there, to Big John's Bay. So there was a trail that they [wolves] used, too, but most of the time we'd go on his little rowboat that had an 8-horse. SL: You can see wolf trails? MJ: Yeah. SL: And how do these trails manifest themselves in these areas? MJ: They were just used over decades. You could see where they traveled. They move along, where the deer might hang out and at different elevations during the season. But

mostly at fall time, they were coming down off the mountains, eating ... So they're around about the thousand feet, and that's why the dens were about a thousand feet. So in the wintertime everybody came down. But the wolves would go back to their dens up there."

3.5.3.7 Age, pack size, and vulnerability to Bear

Scott and Michael share information about wolf age and pack size. Wolf is in its prime at ages eight to ten, and pack size can be from six to twelve animals.

> SL: "When we say old-timer, what are we talking about in terms of the longevity for a wolf? Same as dogs? MJ: Yeah. Their prime is around about eight or nine years old … ten years old. Then you start going downhill. SL: What do you think the, well, a general pack size is? SJ: General pack sizes here? What I've noticed is anywhere from six to 12. ... SL: I mean would bears look to predate on them at the den—on the cubs, do you think? MJ: Yeah. They'd always—but they knew better not to. Because they knew the business of—if you—if they went into the territory, they're [a wolf pack] so organized they can take down any kind of bear."

Michael indicates that bears may like to eat wolf pups, but they avoid doing so if they know there is an organized pack in that territory.

3.5.3.8 Vocalization and Human-Wolf communication

Michael said he heard a wolf moan right before his father killed it (he had caught it in a trap) because it was scared and knew it was at the end of its time. His father was talking to the Wolf in Tlingit. At the end of this section, Michael says it may have made a whine not a moan. Michael indicates that Wolf is aware of its own death when eminent. He also shares an account of a group of people calling to wolves at a particular location and wolves responding. He says people are cautious when doing this because they are fearful to be approached by a wolf pack when far away from town.

> SL: "What about wolves' communications? The sounds that they make and the purpose of their sounds. MJ: I was close enough to hear one when it was scared. And it was almost like a moaning, real deep. Because he knew he was at the end of his time when my dad caught him. And my dad was talking to him in Tlingit and [speaks Tlingit]. SL: And when they howl, are you able to howl back and get a response? MJ: Yeah, but it's not real, but on the other hand, they can't take a chance of another group coming into its territory. ... We were just talking about this the other night with Don and Cal ... There's a place we—they're clearing now, I have them clearing so people can gather all kinds of things. And we call it Skyline Mountain. I just printed it off [a map]. And right here, this real small branch right here, it goes up, and it goes up a mountain, and then one goes off to one side, the other one comes back this way. And that place, you can go up to the top and there's this big valley right here. Goes over toward Petersburg, Duncan Canal. You can howl and you can hear it echo, then pretty soon you'll start hearing [wolves howling back at you]. Cal and they were out there kind of toward the evening, and they did that, and they were right close, just

> right around below there. They said, 'Well, let's go.' And when you're out there by yourself, you want to go because you don't want to get a flat close to them. ... SL: ... Do they bark? MJ: Yeah, when they're running, mostly. Most of their growling was either in contact with you [makes deep growling sound] … or growling at the smaller ones."

Michael has heard wolves howl, moan, bark, and whine. They will howl back to you if you howl at them, but they know it is not real. However, they have a strong urge to protect and defend their territory so they may come to your location because they can't take a chance of letting another group of wolves into their territory. Michael says they growl when they have contact or interactions with people or when they are correcting their young, and they may bark when they are running.

3.5.3.9 Coordinated trapping to maintain balance and wolf health

Mr. Scott Jackson explains how to maintain a balance among subsistence, wolf numbers, and deer numbers, which if achieved can allow for the health of all. Subsistence harvest is dangerous the farther from home you must travel to find deer. He reminds the reader there is a subsistence priority in Alaska, so there is a need to trap wolves in places where people subsistence hunt for deer near their communities.

> SJ: "I became involved [in wolf trapping], as you know, it was a long time ago, we lost my uncle and my cousin and a family friend on the north side of the island. And by then we had already started trapping and what we started realizing is every area that we did trap, the abundance of deer and moose that you'd see in that certain area, but the whole bottom line is, at one point after we lost our family members and family friends, we come to the realization that we shouldn't have to travel a waterway to go across that strait to harvest our deer. SL: So that's why they drowned in the water going across to do subsistence. SJ: Yes, on the very last day of the season. And that's to me, traditionally, our subsistence gatherers, we shouldn't have had to do that, day one. And this is one of the reasons why I set out to catch as many [wolves] as I can in certain areas, because I only trapped the areas that I hunt."

When there are too many wolves, they are not healthy. Scott trapped an area for 10 years before he could save a hide that had market value. He advises the best or correct way to manage wolves is through subsistence trapping and hunting. The subsistence deer hunters who harvest wolves are not out there to decimate or kill all the wolves. They are trying to preserve their subsistence way of life by ensuring adequate deer abundance and health by removing the proper number of wolves to maintain balanced wolf-deer populations.

> SJ: "... it's just been like the whole ideal on this is for the first 10 years we couldn't even save a [wolf] hide, and to me, it seemed like they had eaten themselves out of [house and home]... SL: The hides were so, of such poor quality. SJ: Yeah, they were really poor quality. Yeah, for 10 years, I couldn't even save a hide. It was like, we'd catch wolf after wolf after wolf, and they'd be like mangy and the bugs on them, and their fur would be coming off and their tails wouldn't have any fur on them, type deal. But I think ... there's such a separation of what the right way is to go about managing,

> and I think the right way to manage them is just allow subsistence trappers to keep it subsistence trapping, because they're not out there to decimate. We're out there to help increase the subsistence way of life. We're just not all killers who are just up [to no good]. You know, and that has been the perception of the whole thing."

Trappers in the Kupreanof and Kuiu area cooperate in an organized fashion and on a set timeline for wolf harvest.

> SL: "Now, after you had trapped, how quickly did you begin to see deer replenishing? SJ: For me, it took about three to five years because you'll start seeing fawns, you know there's that, because it's not gonna happen right away. I mean, you're looking at three to five years, maybe ... but I ... have friends that I asked to come and show me how to, you know, Winrods and Peters. I asked them, 'Can you come help me because this place is overrun.' Yeah. So, they go down on the south end, and we work together. I work the north side, and then we'll meet together, and we'll check stuff. Yeah, work down because you can't do it by yourself. It's too much area. SL: What about Kuiu? SJ: Yeah. Oh, that's the worst place. And what we're realizing is a majority of the Kuiu [wolves] are the ones that are flooding onto our island and wiping our game clean. Because I've been all over the island, but it wasn't, see once we started talking about how long it takes, see, so Winrod came up this must have been 10 years ago, and he said it's gonna take like five years. So about five I'd say, and you can look at the reports for the moose and the deer and I just got a call earlier that said, we were the highest moose-take-area again, in Southeast Alaska. It's been like that for if you look at the moose reports, it's been going like this in a steady uphill ever since those guys started coming up and helping me. But they don't come up every year or every third year, they'll come up. SL: Third year, it's your own sense of rotation? SJ: That's our own rotation. Because I asked them. I respect everything and out of respect you need a balance. You know, so what our balance is every third year that we have those guys come up, and that's because I keep in close contact with the biologists in Petersburg."

After three years of trapping an area, the wolves there start to get healthier due to more food per animal. Scott explains if there are too many wolves at one time, the younger ones are not allowed to eat because the older dominant wolves consume all the food. There needs to be balance, so there is enough food to go around. When the wolves become healthier, they start to form new packs in different areas because as they become trap shy and warier of people, they relocate.

> SL: "How long did it take for you to begin to see the improvement in their health and the quality of the wolf [pelts]. SJ: Once they [other trappers] started coming up, it took probably, I would say, three years, and right away, you started seeing healthier? Because it's, it's gonna be healthy because you want to take out ... the old ones, because they always end up taking all the food from the younger ones. You see, so there's got to be that balance on where they come in, and they got to be shared. SL: Okay, so you think the older ones are going to be trapped and there's going to be better food for the younger ones? Do you think that's the dynamic process? SJ: I think it's a good dynamic. I mean, what you have now and what I've noticed, just on my

> own, is, you have packs splitting up to make, like, when they're healthiest, and it's the same thing they used to notice on the POWs when they're trapping really good, is you'll see the, the older, like, usually a male and female will split off. And they'll start their own little packs. Yeah, and that's what they'll do. But see, what we have now is, and what I've learned is that I keep looking at the old spots where I caught wolves. So alright, so the wolves aren't gonna go there. They're too smart. So just the last couple of years, it's been like, oh, nothing's here. Nothing's here. And I kept telling my friends that and two weeks ago, my friend was filming a *Life Below Zero* deal, and he said 11 wolves ran onto the flats. So, there is no shortage. They're just getting smarter."

The concept of balance is the appropriate Indigenous model for wolf-deer management and ensuring a continued subsistence way of life. The whole point of the coordinated trapping effort is to have and maintain a Native diet in perpetuity.

> SJ: "Yeah, like I said, there's gonna be balance. But I think if we can keep from outside interference, we can keep it positive for this island. ... I grew up out here. When I had to go to college, I was living in the grocery store. And you know, you have pork chops and steaks and chicken. You know me, I'm used to my Native diet. SL: And it's much better for people I believe you're absolutely right in that contention. SJ: Yeah. And so then after this process, the [wolf] hides improve. SL: And so the hides become marketable? SJ: They're very marketable once they improve."

There is an economic incentive to having healthy wolves. The wolf hides become marketable when wolf numbers are kept under control and maintained at a level that allows for balance. When there is balance, Wolf and Deer are healthy, and there are successful deer hunters and adequate amounts of venison in the communities.

> SJ: "... we have a guy that works on the north end and what we communicate, I go work to the north, like right next to him, and he'll go back to Petersburg, and I'll come back this way. SL: So Petersburg works on that side. SJ: Yeah, from Schooner Island, towards Portage Bay and back from Portage ... to Petersburg. SL: What do you think of their efforts? SJ: They've done a good job. SL: So that's their hunting territory. SJ: Yeah, he hunts. He traps the areas he hunts. And it's kind of like me [trapping wolves where I hunt deer]. ... And I like it's really been a cooler deal to see so many successful hunters the last couple of years. Yeah, cause that's moose and deer. We grew up on deer. And it's cool to be able to see the elders at least be able to keep on doing what they're doing. So in a sense, it keeps a lot of them kicking, including my father."

Scott estimates he can catch five to seven wolves in a certain area in three years, and that amount of harvest does not result in more deer and moose. Trapping becomes more difficult as time passes. Wolves move out of an area when they are consistently trapped to avoid losing more pack members, and deer and moose move in when the wolves leave because they do not have to stress over predators.

> SL: "When you trap an area, how many do you usually get out on the three-year cycle? SJ: If I'm trapping this area, I'm lucky to pull five to seven out in three years. SL: And what is your feeling about that number? SJ: I feel like it hasn't done anything. Because it's still .. I went back there this year and that's still a pack of 10 [wolves] because I can see it in the tracks. And then I have people that call and tell me, 'Hey, I saw about 10 wolves in that bay right there.' SL: And so then what that means is that's not going to give you the benefit with regard to moose or deer. SJ: No, now I think the consistency on trapping an area, you'll start to see them push out of their area and that will make the deer comfortable and the moose comfortable to come into an area. SL: Okay, so if you're trapping it consistently, they [wolves] get uncomfortable and spatially relocate? SJ: Yeah, they'll spatially relocate and stay out of the area where their friends got picked off."

The key to effective wolf trapping is maintaining a consistent effort. However, the wolf population outnumbers the active local trappers. Despite their coordinated efforts, it is difficult to control wolf numbers to the extent there is a noticeable increase in ungulate abundance.

> SJ: "I did a lot of work when you saw the moose come back. So let's just say about eight years ago, I trapped back here. And you saw the moose, just, and deer. You can just, and not only, like I said, I went in there. I knew the pack was strong and heavy, because my friend said he saw about 15 wolves. And I said, 'Well, I'm gonna concentrate there this year.' Because a lot of the things I do, somebody calls me and says, 'Hey, you need to concentrate here. I saw 12 to 15 wolves.' And go take about five or six out and harvest those because they're really, because the pilots will see if they're raising Cain on an area, they can see when the pilots are flying they'll see blood or, you know, just a massacre stuff. And they'll be like, 'You really need to go take care of that pack.' ... a lot of times I've tried to sit back and say, 'Oh, we don't have a problem.' But we do have a problem because the wolves, like even if I trapped, I'm just gonna throw a number out there. Okay, let's say I trap 60 wolves in the last 7 years. Okay, that's only, you know, that's nothing. ... even if I came in and I say I trapped 57 in the season. Okay, but the following season, the following three seasons, we got like, maybe five to 10 every trapping season. I mean, once you get on them, I mean, you can't stop. I mean you can stay consistent. I'm not gonna be able to do many. Like, I don't have 100 trappers here. There's just me on the side covering from here. So my friends cover [this area]. ... I'll cover down to this area. This is our line here. And, and they try to cover in here and all through here."

Trapping success tends to decreases in the second and third seasons as wolves become trap shy, fewer in number, or leave the area.

3.5.3.10 Duration and timing of wolf trapping

A one-month wolf trapping season is not long enough for trappers to adjust to conditions like bad weather; they feel pressured to go out in dangerous weather conditions. Trappers need more time to implement contingency plans, adapt to changing weather conditions, and sit out days that are not safe to travel. Also, law enforcement could force them to pull all their gear on the last day of the season, and that day could be bad weather with unsafe travel conditions.

SJ: "... if they have a deal or let's just say we're Prince of Wales and they just came in here and said, 'All right, you're only get to trap for a month.' Well, guess what, I don't have that month to sit here and trap those ones right here. And, and realistically when they give you a month, it's dangerous for the subsistence trapper. SL: You got to confront weather. SJ: Yeah, and friends going out in 20-25-foot seas. I mean, I can understand them, an outside group, but they got to see the perspective of, 'Okay, I'm gonna give you a month to trap.' Okay, but one it's blowing and it's 20-25-foot seas. This guy sitting out here is the State Trooper right now. They're going to expect you to pull your stuff [traps/snares] no matter what. So how many lives are going to be lost just trying to help out one community?"

If the wolf trapping season is going to be for one-month, Scott says the best time for it is December 15 to January 15. He prefers not to set traps or snares in November during the deer rut because the rutting deer move a lot and may be unintentionally caught.

SJ: "... if you trap late in the season you're looking at unprime [fur], ... and in November I try not to trap, you know, I'm really, I watch what they do on Prince of Wales, that kind of mixes with the rutting season. And that's probably not good. You know, it really affects me, I don't want people to set traps and snares and have them catch all the rutting deer because they're running through that area. That's why we've always, that's why I always questioned my friends who were trapping in November. I said why are you guys trapping in November? They said, that's the timeline they give them. You know, I said, end of December. If they went from December 15 to January 15, that'd be a good season."

3.5.3.11 Wolf-Dog hybrids

Mike Jackson comments that wolf-dog hybrids were sought by the Tlingit through specific procedures. Further, they had special qualities that were valued. They sought to continue the line, but gradually desired qualities disappeared. In some cases the hybrids returned to the wolf packs but were killed.

MJ: "They took a dog in heat out in—trapping with them … when they knew the pack was around. And they put it out there at night. This was a long time ago. But they built a fire big enough, and they used torches, where they would tie rope real tight that was soaked in water but also with the oil, and then they covered the torch with pitch. And they lit it afire, and they put it out there kind of close to the dog in heat, and they'd tie it up there. They'd load up their bows all set, and they'd just see these eyes turn up, you know, the glowing fire … in the [eyes], and if the fire was small enough, they weren't afraid of it. So as the dog in heat—they'd whistle because, you know, they trained it, and it'd look toward 'em [the hunters], and they knew that was the dog they tied there. The other ones that were—they'd turn away, you wouldn't see 'em before, but just as they turned they knew which—where the body was facing … and they'd shoot 'em. SL: That's really interesting about using the female dog to draw them in. MJ: Because they'd just go nuts. SL: … do you think—well, did they produce hybrids from that? MJ: Yeah."

Hybrids had a number of characteristics that made them useful to Tlingit people as Mike Jackson points out.

> MJ: "The hybrids were easier trained. And they were super protective of the owner. They would hardly bark or anything. They would just watch from out in the bushes, just like a real wolf … but if there was somebody that was gonna do harm, they could sense it. And they'd come sit right next to 'em and watch that person. And the people would look for them, because, you know, their dog looked like this. A lot of little dogs—they were little—but the ones that they trained in that order were getting bigger. But my dad said one of the *ix̲t'*, the spiritually trained, think it came—they looked a lot different from wolves after like the third generation. SL: So you could keep breeding them? MJ: Yeah. And they became more vocal. SL: So they didn't bark at the outset? MJ: Yeah, but there were also—they knew where the big wolves were. They could smell the trail. And they'd start—they'd light up and that's where they would set traps and stuff. Yeah, so they … had enough of what they knew [as wolves] … in their head to show their owners where the trails were. But sometimes they'd go back to the wild and most of the time they were killed just like that."

Mike Jackson's account of how Tlingit proactively sought hybrids is similar to Judy Ramos' account from Yakutat though valued hybrid traits differed between the two areas. He also states that when hybrids went away from human settlements they were often killed by wolves.

3.5.4 Prince of Wales Archipelago

The Prince of Wales Archipelago is located on the southwestern corner of southeast Alaska. It consists of Prince of Wales Island proper, the second largest island in the United States, and a group of islands to the west extending from Kosciusko Island in the north to Dall Island in the south. Interviews with Indigenous experts on the island are organized geographically as follows: Klawock (Northern and Central Area), Craig (Central Islands), and Hydaburg (Southern Prince of Wales).

3.5.4.1 Northern and Central area (Klawock): "Wolf has to eat, and we have to eat."

Mr. Jon Rowan and Mr. Thomas Allen George were interviewed in Klawock, Alaska on April 25 and April 22, 2022, respectively. Mr. Rowan is the Cultural Education Teacher at the Klawock School District. Jon is 58 years old and has lived in Klawock for most of his life except for a short period of military service. Mr. Rowan is a culture bearer and an experienced wood carver. He also has experience hunting and trapping wolves. His Tlingit clan is *Shangukeidí*. Jon started trapping later in life after he got out of the military. He decided to learn how to trap, and he taught himself and was mentored by Mr. Thomas George and others. When he watched Thomas working on his wolf traps, he thought it was cool.

3.5.4.2 Early trapping activity and experience

Mr. George is an elder who has lived in Klawock for 67 years. His Tlingit name in English means "Before the Raven Rises." He is a Raven and is an expert wolf hunter and trapper. He practices both wolf trapping and hunting, which use different methods and require different skills. His Father's name is Robert William George, Sr. from the Tlingit Wolf Moiety. Thomas started trapping around age nine.

> SL: "When did you first start your experience of trapping or hunting wolves? TG: I caught my very first one when I was nine years old. I got a bunch of otter traps and used a C-clamp to set 'em because I was too squirrely, too light. Had to use a clamp and stick a nail under the jaw and set 'em open and—but I put like ten traps around a deer head, there, and—buried a rotten deer head. SL: Where? TG: On Wadleigh Island across here at Flounder Bay. Yeah, just across the bay. I couldn't go far ... all I had was a six-horse Johnson. And it was a learning experience. I kept checkin' it, checkin' it, and they would always steal my bait. But I finally got that deer head and put a rockpile on it because they knew there was gonna be bait there all the time, so they kept coming back. I buried the traps in gravel, and some of them didn't close all the way but when I finally got that one big female ... She was tangled up all over the top of that rockpile there."

3.5.4.3 Wolf abundance, amount of harvest, and motives for harvest

Jon Rowan says that wolves are abundant in his area. Even when they trap a lot, or "hit it hard," the wolves come back the next season. They are seeing more wolves now than they ever have before.

> SL: "Now you've been at this a while, and not so much recently, but during the time in which you were trapping, did the number of wolves out there change, do you think? JR: [silence while he thinks] Let me put it this way. We went to this one area, and we would hit it hard, up on the road system. We'd go to this island. There were a lot of wolves there. A lot of deer there, too, but they would—they would be really skittish. So the cousin, he would trap the bays. That was his territory. But we'd go up inside. And they'd get a lot, and we'd get a lot. But the next season, [they'd] be back just like cockroaches, man. I mean, just like we haven't—just like they reproduce to bring it back even more, and we would hit it hard again. SL: So it's hard to make a dent in them. JR: Seems—it seemed like it. And then now, we're seeing more Wolf everywhere than we ever have before."

Jon shares a different view where in past years it seems wolf and deer numbers have been decreasing.

> SL: "... so you don't have an experience of saying that we've knocked the wolves down and then we can see the deer come back? JR: You know, I personally never noticed. I wasn't aware of that; I didn't think about it. But just in the past years it seems like there's been a lot of wolves and a lot of deer disappearing, and it can't just [be blamed] laid that on the Wolf, either, because you've got black bear that'll go through a unit with a bunch of fawns and eat every one of them. SL: There's supposed to be more black bears now because they're not being hunted as much anymore. JR: Yeah. SL: There's secondary growth, there's the predators, they're around wanting his food. JR: Yeah."

He indicates wolves and black bears compete for deer. Lower deer numbers are not just caused by wolves; black bears eat a lot of deer fawns in some areas. The dialog indicates black bear numbers are up due to less black bear hunting, and secondary growth plays a role in deer and wolf abundance.

Jon said that in their preferred trapping area, he and his partner would take 8-10 wolves out of the pack based on the wolf sign they would see in that area, implying that they judge or estimate the number of wolves in an area by studying the wolf sign they find there.

> SL: "Would you have any set number of wolves that you wish to take, either a ceiling or a target, when you were working? JR: This one area we really liked to hunt. We would take at least—just us, me and my partner alone, we would probably take eight to ten out of the pack. SL: ... why was that number chosen? JR: I don't know. We just look at the sign—see we weren't there to wipe them out. Because you need that. Otherwise, if you take and wipe all of them out, these guys [deer] suffer because you got sick and weak animals. SL: You meant the deer. JR: Yeah ... [They] need to be culled out. SL: ... so much deer they're gonna damage the browse ... JR: And get a disease which you see a lot happening, it seems like."

Jon said they had no intention of wiping the wolves out in that area, because that would upset the predator-prey balance. Jon indicates the wolves maintain balance in the deer population.

Thomas traps and hunts wolves in areas where people deer hunt to allow them to fill freezers with venison. He has trapped in many places and in the service of many communities.

> TG: "... I used to trap Noyes, Baker, and Lulu for the longest time, and that was always good for 30 plus wolves every year, and then I hit Heceta and the peninsula between Naukati and Shinaku. I'd target all those bays and stuff there, and the entire Thorne/Staney Valley. I'd target that because there is a lot of [deer] hunting activity from locals in that area. ... I trapped all the way to Lab Bay. Because a lot of our Native people were driving the roads up there for deer hunting to get away from the Ketchikan hunters that were clustered in the middle, and we'd go all the way—they'd go all the way up there deer hunting, camping overnight and such, and so we went up there. My god, it was anywhere from five to ten wolves every visit. SL: So how often have you trapped that far up, or up that north? TG: I did it for about ten years. But it was never ten years in a row. It was like every other year or every third year. SL: Did you move it around to different areas up there? TG: All the way from Collar Bay all the way around to Red Bay, Lab Bay, all the way out by—I developed the—a dry land set, and I got pretty effective at it to where I actually set five traps on the Kasaan Peninsula and checked 'em six hours later and had five wolves. ... I've trapped Coffman. The mayor, she asked if—what's the chances of me coming over and working on that pack, because they're—she says everybody's freezer's been empty for several years. I went and drove through there and checked it out, and my god, she was not kidding. So I went back into town after doing an assessment of what the hell is going on around there. I told her, 'Well, I'm ready to do it ..."

His expertise is in demand. The mayor of Coffman asked Thomas if he would come trap wolves in their deer hunting area. Where there are a lot of wolves and no wolf trapping, there are no deer for subsistence harvest. Thomas insists that consistent wolf removal will allow for enough deer for subsistence harvest.

> TG: " ... I quickly found out that, *wow*, it fills the freezers by takin' down this pack and this pack and this pack, and you go back there couple years later, the place is just loaded with deer. ... I had it figured out. I needed deer here, I got all the Haidas deer, I got all the Thorne Bay deer, I got all of Kasaan deer, Naukati—I had deer overrunning Naukati and Coffman Cove, Craig and Klawock. I didn't have to go but across the bridge to go get my deer, because I took care of that pack back there. I hammered on 'em for 20 years. And then all of a sudden, my god, I've got deer on my back doorstep. I take a five-minute walk up the hill right there, and I had all the deer I wanted. ... Wolf has to eat, and we have to eat. ... I was targeting the Thorne River, built a deer herd up in there when you're comin' back from a ballgame in Thorne Bay at night in the dark, you'd count over a hundred deer in your headlights."

3.5.4.4 How to find Wolf by reading sign

Active trails are the primary indicator of Wolf. Jon says the active trails are worn down, wider than inactive trails, and have marking posts where wolves habitually urinate.

> SL: "... what indicators would you use to locate wolves? JR: First thing is if I was heading out into an island or wherever, If I'm gonna look for Wolf, I'm gonna look for sign. I'm gonna look for tracks, I'm gonna look for scat, I'll look for trails, active trails. SL: "... you distinguish between active and—what difference would that be in terms of the use? JR: Worn down, wide, piss posts. You know, where they're always marking their territory, wherever they're going."

After Thomas agreed to the mayor's request to trap the Coffman Cove area, he went there to assess where to set traps. Trappers locate wolves and estimate wolf abundance by the sign they observe. Thomas stops when he sees wolf sign to investigate the area; if he finds a pack's trail with fresh sign, he makes sets.

> [Driving Coffman Creek Road] TG: "... after you get out to the first straightaway there was a little curve in the road and there were several piles of wolf crap right there on the road. So I got out to investigate and I got to lookin' and I could see a wolf trail in the rocks, goin' down and goin' through a little tunnel of saplings. When I poked my head through that tunnel, there was a wolf trail carved in the muskeg that deep. You can't see the muskeg from there, but it was carved that deep into that muskeg. So I followed it on, and I found a sapling and tied a snare off and hiked out onto that muskeg. Oh, my god, the wolf trail across that muskeg was unreal. I just snared all the way down to Grassy Lake and came back up. The very first snare I set I had a wolf in it already. Ha! Two hours! Two hours I was gone, and I came back, I had a wolf, and it was still alive. It was a female."

This story provides more evidence that when wolves are not trapped, they are not trap shy and can be caught more easily and more rapidly than wolves that have experienced being trapped and are warier.

3.5.4.5 Travel circuit, movements, territories, and habitat use

Jon Rowan from Klawock explains the amount of time it takes a wolf pack to travel around its territory is one month.

> JR: "I was going up above the dam, across the river. Because you listen for them, you know, and then you start learning where they're going and like those guys, the older guys, are saying, if—when you're up there and you get one, remember the day, remember the week. Because in a month they're gonna be right back through again."

Thomas George says it takes a wolf pack seven to eleven days to make a circuit, or roughly every week to ten days they complete travel of their territories.

> SL: "... so that pack that had developed in the back of Sunnahe, what would be their territory up there? TG: That pack used to run from Sunnahe all the way to Klawock, all the way down to the bottom of the Harris to 12-Mile Arm to Trocadero Bay, and then back. SL: That's their circuit? TG: Yeah, yeah. SL: Now is there a time frame in which they move around? ... TG: It is seven to eleven days they move through there."

Thomas says wolves follow the deer up the mountain during summer as the deer migrate to higher elevations. The wolves are not down in the valleys and on the islands in summer unless they run out of deer and are hunting beavers at lower elevations.

> SL: "... I want you to talk a little bit about these trails and how wolves move across the landscape. They mostly use their trails, or do they move through the forest to hunt? TG: They've got summer trails, and they've got winter trails. In the summertime they're usually up high because the deer migrate up with the snowline, so the wolves are up and about way up high. So when these guys are doing their wolf studies to assess how many wolves are on the island, they're all looking through the bottom of the valleys and ... you know, like the only time you're going to find them down low like that is around beaver ponds and stuff when they're dammed up. SL: So they will eat beaver? TG: Oh, yeah. It [Wolf] totally devastated the beaver population on this island because they ran out of deer."

Mr. George shares an account about when he sat down with a biologist. They did a mylar mapping exercise together, and Thomas' map matched the biologist's map; there was clear corroboration between traditional ecological knowledge and the telemetry data. Thomas says that wolves go over the saddle to the other side of the mountain, and wolves use the muskegs at elevation in the mountains for sunning and resting. He says that sometimes pack territories overlap.

> SL: "... so there are gonna be wolf trails up high in the summer in the warmer periods because that's where the deer are, but they're gonna use these trails, whether they're low elevation or mid elevation or high up? They establish their customary routes;

> they just don't move through the landscape ... or both? TG: They occupy territories and in some cases they overlap territory boundaries. I've found two different packs occupying at the same ridge line ... And actually I had a chance to sit down and talk with the biologist, and he had this map like this here of Prince of Wales, and he put a mylar over the top of it and handed me a marker. And he marked off islands and so forth, a boundary around there, and he says, 'In your idea, could you show me what you know about boundary lines of the different packs on the island?' I says, 'Sure.' I went and I drew it in, and I was explaining to him how the wolves moved around there, and I said, 'Now this pack occupies this territory here, and this one and this one here, but they occasionally cross over each other's boundary line here. Why that is I don't know. I don't know if they're related to one another, but they seem to allow it. And he says, 'Okay,' and I kept on drawing it. SL: Do you remember how many different packs that you drew at that time? Approximate? TG: No, but I probably know 'em all yet, but he brought another piece of mylar out on his—all his research on following the radio transmitters and everything to establish, and he put that over the top of mine, and he says, 'How did you figure all this out?' I says, 'Well, I've been chasing 'em my entire life.' You know, I says, 'You've been only out here for a few years.' And he says, 'That's interesting about this pack sharing this territory on this ridge line,' he says, because he monitored that happening. And that saddle trail that I was telling him about, way up in the top end of Shinaku. And he says yeah, he's got transmitter recordings that he followed all the way up through there where they [wolves] did go over that saddle more than once, through those mountains. SL: ... do any 'em go over the main mountain line? TG: I've shot 'em up in the mountains over and over, and sometimes you come out there and my god, there are fifteen wolves laying on the muskeg right out in the middle, just lying there in the sun. SL: Way up high. TG: Yeah, way on top the mountains ... it's crazy!"

Mr. George describes wolf movements among islands. He says a pack will leave an island sometimes for up to six weeks to hunt on other islands before returning to hunt the island they left. A pack will island hop by swimming to find deer and other prey.

> SL: "... how did you know that there were wolves on Wadleigh? TG: You could hear 'em. Yeah, you could hear 'em. You can hear 'em on Peratrovich and Wadleigh, you know. There was wolves all over there, howling all the time. Yeah, it's only a couple minutes to 'em across the channel for them. They are swimming all the time. SL: What distance can they swim? TG: They swim out to St. John all the time. SL: The closest to get to St. John is actually probably from Amagura, right? TG: Yeah, Amagura or Fern Point. Yeah, and they also will swim off of Wadleigh onto Fish Egg and across Fox Islands out to St. John that way. ... They swim Bocas de Finas all the time out to Anguilla islands there."

Thomas listed a number of islands used by wolves, including Wadleigh, Peratrovich, St. John, Amagura, Fern Point, Fish Egg, Fox Islands, Anguilla Island, and Heceta Island. He shares a story about his experience trapping on Heceta Island in which the pack had left the island for six weeks. A large pack came back, and Thomas caught over twenty wolves on Heceta.

> TG: "I set up the bay, and I went out by the old cannery site, and I found a hell of a wolf trail, so I set all the snares and it was fresh wolf tracks, everywhere I was lookin' there was wolf tracks, and all fresh. And dang, there was—the beach trail was carved into the beach like I've never seen before. And I trapped that place for years and left it alone because they were doing that study. But they [the pack] were gone for six weeks. Not one wolf. I had so much time on my hands setting that place up, I had so much gear in there, traps, snares, you name it, I had everything—where did they go, you know? Then all of a sudden they came back. My first encounter with them was by the cannery. Boom, I picked up five. They killed a doe right smack in the middle of all my snares. They chased it in there and killed it, and they tore it up, tearing, runnin' in different directions. I got five of them. ... SL: You mean the cannery site at the head of Warm Chuck, is that what you're talking about? TG: The cannery. It's on the left side of Warm Chuck as you're going in. Just above Bay Point, by those—inside those little islands. But up the head of the bay there on the left side I had so much gear in there, yeah, after they passed through there they went up in there, and I pulled in there with a boat and we sat there looking with the binoculars, and just looking I could count seven on the beach that were fighting in traps. Yeah, so we went ashore and started walking into trails and checking my hardware, and it turns out we wound up with 17 on one visit. And I had so much gear in there I told my brother, I says, 'I don't want to kill them off because that wouldn't be good for the deer.' I said, 'You gotta leave at least one breeding pair to go, and they will take care of the sick deer so that the disease doesn't spread through the rest of the deer herd.' So I says, 'We've gotta pull the—start pulling the gear.' It took me three days to get all my gear out of there, and by the time I got all my gear pulled, I had 23 wolves out of there. SL: Those were all Heceta Island wolf? TG: Yeah. SL: When you said they went away, you said six weeks there was no evidence. TG: Yes, no sign, no tracks, no fresh tracks, nothing. They swam onto the Anguilla Islands. SL: So that's part of their circuit, then? TG: Yeah."

Jon indicates wolves use the beaches all the way to the mountains, and they follow the deer up high, and they will come back down to the coast when the deer move down. Jon has also seen wolf sign at lower elevations in the summertime, indicating that they do not stay at elevation all the time in summer.

> JR: "Because they're going where the deer are. They're going up high. SL: At what elevation do the wolves operate? JR: And that's not to say they're gonna stay up there because I've seen sign way down low in the summertime, too. But for the most part … when the activity is—because the snows up there is deep there's nothing up there to eat. All—everything is pushed down. So that's where they're going, where the refrigerator is."

3.5.4.6 Pack size

Jon Rowan from Klawock says, on average, pack sizes are six to ten wolves. Thomas George described the largest wolf pack he has seen to be 30-45 wolves; he indicated that he and his deer hunting partners could not get a count; there were so many wolves. His story is set in the Port Bazan area of Dall Island.

> SL: “What size do you think the packs are normally? Numbers of animals. JR: I think probably they’re averaging between six and ten.” TG: “The most I’ve ever seen was just a few years ago in one pack. It was right above Port Bazan. I was deer hunting down there with ATVs, a friend of mine and my son, … SL: Dall Island. TG: Dall Island, yeah. ... and we had a weather change. It quit raining and then started clearing up and then the temperature dropped 20, 25 degrees, just boom, really quick. And I’m wet underneath my raingear, and it’s starting to get cold. I still got 20 miles of road back to the boat. I told those guys, I says, ‘I’m gonna have to get dried out and warmed up here. We gotta build a fire before we continue.’ So I was sitting on the four-wheeler because the heat from the engine was keeping me warm, and they started gathering sticks and stuff to build a fire, and the sun starts shining way out past where they took the bridge out above Port Bazan there, and I was looking and I says, ‘Hey, look, there’s something running on the road coming this way.’ And I had a two-point buck on my four-wheeler and the wind was blowing right at them and they could smell all that blood. And I don’t know, ten to fifteen wolves ran around, and they were in behind a bunch of trees where the road curved around behind it before it came to where they took the bridge out, and they were all looking down where they took the bridge. ... [We] looked over [to see] two more rows of ten to fifteen wolves coming around that corner. Ten to fifteen went by already, and ten to fifteen more coming around the—it was so many of them we couldn’t count ‘em. ... I’ve never, ever seen a pack of that magnitude.”

Mr. George was very successful trapping the Coffman Road area. TG: “And in two and a half weeks, trapping that Coffman Road, I took 27 wolves out of there. And I said that pack can’t be very much bigger than that.” Mr. George shared his knowledge of the average pack size. “SL: What is your general sense of the size of these packs that move around? TG: On the average, it’s 7 to 11, the average size packs.”

3.5.4.7 Fluctuations in wolf-deer abundance related to logging and roads

Thomas explains why they saw such a large group of wolves in the Dall Island area. He indicates that packs generally do not join together to form larger packs, at least not in this context or situation. Pack size tends to increase when there is lots of prey. Thomas explained that all the logging activity in that area kept the wolf pack off the roads, so they could not access and kill deer. In the absence of wolves, deer abundance went up. As a result subsistence deer harvest was exceptionally good.

> SL: “Could that be packs joining for some reason? Do they ever join together? TG: No, this is what happened. Because of all the logging activities that were going on down there, it kept those wolves off of that road system, and the deer population flourished around it. I mean, you could go down there and tag out in three hours of hunting with a four-wheeler. You’d fill every tag you have on the boat. We went up for two hours, the three of us just went to take a look to see what it was like when we first tied up, and in two hours we got seven bucks. It wasn’t even hunting. It was like

> shopping. And that was our very first time we ever went up there, and they were still logging there, Sealaska was, and when they pulled out, the wolves utilized the roads and because of the ungulate populations was so huge like that, they had it so easy to get 'em and everything, their [wolf] population just exploded on there. When we were drivin' down there, we were actually choice-selecting what we were taking, and we'd have almost all four-pointers [bucks]. SL: But you didn't take any of those wolves that you saw? TG: No, we didn't see them back then. [He described hearing reports of other hunting parties in that area only harvesting bucks.] ... But that last trip when we were down there, we saw all those wolves, before we saw the wolves, I asked, ... 'where's all the does?' We've been hunting this for five days hard, and all we saw is five does. No fawns. I said, 'Every time we were down here before we'd see 80-100 does, and we couldn't even begin to count how many fawns.' So what happened? Mike says, 'Well, maybe those Tsimshians shot 'em all. Or those Wrangell boys might have got 'em.' I says, 'No, from what I hear they were takin' nothing but bucks.' Then when we saw that big pack of wolves, we put two and three together and decided that was the culprit, you know. They [the large group of wolves] were just totally devastating that herd of deer."

When the logging operation ceased, the wolves began to use the roads again to access and successfully hunt the large deer population. Thomas says that all the deer hunters in the area were getting bucks at the time logging ceased, and nobody was seeing many does or fawns. They wondered if other people had harvested all the does before they arrived, but everyone else was only harvesting bucks. In the end they determined that the large pack of wolves had eaten the female deer and fawns after the logging operations stopped.

There was no evidence in the conversation whether this large wolf pack was a result of quick and successful reproduction in the presence of high deer numbers or if it formed from two or more smaller packs joining together to hunt. In a subsequent follow up conversation with Mr. George, we learned apparently on occasion related packs can join into groups as big as 35 wolves. Thomas called these "super packs" and indicated they can engage in massive deer kills.

3.5.4.8 Denning behaviors

Wolf dens can be found under trees and thick brush. Thomas says you find the surrounding area tore up and littered with bones and feces at a den site. Dens are located near a reliable food source and are used year after year; dens are multigenerational.

> TG: "They just had it [den] under a couple bull pines and a cedar tree. There were actually no den [excavated], they just had…yeah, they just had the pups under the protection of the bushes. And there—it was no doubt about it. There was small scat and bones all over the place there. Beaver bones. Because all the way around that muskeg is beaver ponds, pond after pond after pond after pond… The site location depends on the available food source that's there. And this particular situation, it was all those beaver ponds and beaver lodges all the way around. So it was obvious they were—they picked that location just because of the food source available."

Thomas shares an account about locating a den site at Gucki Lake.

> TG: "Gucki Lake has a den site. ... Yeah, on the south side of the lake there's a little, tiny little peninsula like that sticks out part onto the lake, just a little—maybe the size of this building. And up in the middle there's a den, and I crawled into that one—had my nephew crawl in there, Duane, Jr. And we had to grab him by the ankles and pull him back out, but he was able to get in there okay and he was just a young guy, then, and through a breather hole up there, 'Here, grab it.' He handed us a little pup. Eyes weren't open yet or anything, you know. What a cute little—plays around with it a little while ..."

He also shares an observation of a pack denning up near town on the back side of Mary Jackson, which is a housing development.

> TG: "I was up walking my dog at 4:00 in the morning. She wanted to go out, so I got up and was walking around the streets in my PJs and ... there was a whole pack of wolves lit up [howling] on Klawock Flats and a whole pack of wolves lit up on the back side of Mary Jackson, there, howling at each other. I says, ... they denned up right here again."

3.5.4.9 Pack dynamics, litter size, pup size, and pup growth rate

Wolf pups are taught how to hunt during their first year with the pack. Within six months of age, pups are almost as big as adult wolves. They grow fast, especially when they have a lot to eat; growth rate of pups is related to the amount of food available.

> SL: "... what happens to the pups ... there's some adults, then, left there to feed the pups, or at what age do you think they start eating? TG: They're taught how to hunt on their first year with the pack. And they're actually almost as big as the adult wolves on their—within six months of age. They grow fast. And they grow faster if there's a lot for them to eat."

Jon says he has seen a group of pups numbering eight running down a road. Thomas also thought eight was about the right number for a wolf litter size.

> SL: "How many pups will a mature mating pair produce in the litter? JR: Hm, I couldn't tell you for sure, but I've seen a pack of pups running down the road and there was like about eight of them. SL: Yeah, I've heard that's in the neighborhood. Tom said that, too."

3.5.4.10 Pack formation and reproductive behavior

Thomas describes the conditions in which wolves will purposively have a population boom. This may indicate the formation of new packs or growth of a single related pack.

> SL: "... you talk about seeing singles, small groups, and large groups. ... in your encounters with wolves, how does it break up in terms of I saw a single wolf, a small group, or a large group? TG: When trapping through the month of January and you start seein' groups of three wolves instead of big pack sizes, and there's a lot of ungulates around, you've gotta take caution because there's gonna be a boom in the wolf population the following year. I've seen it happen over and over and over again.

> They split up with a female and drive her into goin' into heat and developing packs all around when there's a lot for them to eat. That's where the population boom comes."

3.5.4.11 Wolf diet, body weight, and coat color

Jon explains wolves eat deer and salmon and whatever they can get. He has heard that the wolves will feed on salmon in the rivers and streams in the fall, and they mostly eat the heads where it is fatty and nutritious. Jon imagines that wolves eat bears; he tells a story about encountering a black bear at the edge of a muskeg that was crawling low to the ground. During this observation, Jon made a wolf call, and the bear quickly turned and ran into the forest as if fearful of the wolves. Jon imagines that wolves will eat marine foods and whatever they find on the beach such as marine mammal carcasses.

> SL: "What do they eat? Besides deer. JR: Deer, salmon, they eat whatever they can get ... SL: Have you seen them at a stream in Southeast? JR: I've never seen them myself, but I've heard of them eating [fish] … especially in the fall when the salmon are in the rivers. And I heard there was a—mostly the head, where it was really fatty, good, nutritious stuff. SL: Do you think they eat bear? JR: I imagine they do. I mean, when I was out hunting in the fall, and I was blowing the call, and this happened to Sambo one time, too. And I saw these two little—looked like two little birds at the edge of the muskeg. And I was like *what the heck?* So I was ready and I kind of tiptoed up and looked. Here it was a black bear, low, crawling. ... So I started howling, and that sucker jumped up, took off, and boy I just kept it going and I could hear him going through the woods. ... SL: Do you think they eat marine foods? JR: Clams and stuff like that? I imagine so. ... Anything [they can get]."

Thomas George shared details about what wolves eat. Wolves prey on several types of birds, marine mammals washed up on the beach, beavers, and beavers out of people's traps. Thomas talked about wolves eating the carcasses of sea lions, sea otters, and pilot whales and shared an account of catching a large alpha female that had been feeding on a beached carcass. The alpha female he caught weighed 97 pounds, and she had been feeding on blubber from a dead pilot whale washed up on the beach.

> SL: "What's your comment about the kind of food that you have seen them eating? TG: Well, I've found geese, swans, seagulls, ravens, eagles, you know, all torn up. You know it's wolves that've done it. And sea lions, I've seen them down on the beach munching on a sea lion. They didn't kill it, the sea lion washed up on the beach. But they could smell it, and I've even encountered them munching on a pilot whale on a beach. And I was trapping beaver and right up here where that big Salt Lake subdivision is down there, there's that one pond they call Mallard Pond. We set that up for beaver, and the wolves kept stealing our beavers. So I set up a snare and a trap, and I got two. And the next day I had two more. And the next day I had three more. I thought what the hell is going on. So I set it all up, and I wound up catching a total of seven, but the one that really caught my attention was this big female. I mean she was huge! So I said, 'well, I'm gonna have to weigh this'. I've never seen a female wolf this big. Ninety-seven pounds. And when I went to skin her ... she was

all bloated. I took the skin off and she had canines on her like that. Long, sharp. I mean, and she was the alpha. And I went and opened her up because I wanted her glands in the worst way [for making lures]. ... and her stomach was so full I had to see what was in it. And all it was shreds of fat. So low tide that evening I jumped in my skiff, and I ran the beach back up toward Small Salt Lake and just across from where the Winrods have their boat parked there, there was a pilot whale dead on the beach there they had been eating on."

The largest alpha male Thomas remembers harvesting weighed 143 pounds on Sukkwan Island. When he first trapped there, the alpha male was only 87 pounds, which is the size of a big female. Wolf body weights are positively related to the amount of food and inversely related to pack size, or wolf abundance in a territory, which determines the amount of food available per individual.

SL: "What about the difference in size? What kind of variations are there in terms of the size that you see? What was your biggest? ... TG: That was 143 pounds, and that—on Sukkwan Island, the alpha male, when we first trapped it, was 87 pounds, and that's the size of a big female. But only because there was little or nothing for them to eat on that island. SL: So that's what [food] affects the variation in size. Now what about their color, or color phase? What kind of differences? TG: No, I don't know what triggers the color, but I came across a couple different packs that produced darker ones, and I actually targeted them pretty extensively that one winter. And I wound up with 19 black ones. SL: From one pack? TG: No, multiple packs. I just come across them. I'd call 'em in, and I'd shoot one or two of them, and '*Oh, shoot, there goes a couple black ones!'* and I shot too soon, and so I'd set it all up [with traps] and target them, and I wound up getting all of 'em, and they finally started getting a few dark ones showing up. I got a couple last year, or a couple years ago. But I think Sam Peters might have got one, too."

Thomas says getting black wolves is desirable. He has harvested a substantial amount of black wolves from multiple packs.

3.5.4.12 Hunting and feeding behaviors

Thomas shared an account in which he observed a place where wolves had killed several deer and had been using the same place to feed for a number of years. He described how certain wolves play certain roles in an organized manner when hunting deer. In this case the wolves were driving deer to a kill site.

SL: "... have you ever seen evidence of the wolves driving deer and then killing a whole bunch of them at once? TG: On the north side of Sunnahe there was a little cul-de-sac below the knob on that ridge. There's a muskeg on top of the ridge, and the road goes all the way up around to the top of the ridge and the muskeg is right below the cul-de-sac on that road, and there's a cedar lead strip that's all through there that the deer hold up in. But there's that little road on the bottom of that knob down below a little stretch of clear cut. One or two wolves—you could see it in the snow actually what happened, they'd send a couple wolves up that road and drive those cedar strips,

> and I would see the hunters, man, I mean, when I first pulled in there I think there was seven deer dead on that cul-de-sac. ... the way I found it was seeing all that raven activity. ... something's going on up there. So I drove up there and my god, in that fresh snow, there was blood everywhere. And I ... opened my box and started setting hardware all over the place in there, and I got to lookin' around. When the snow melted, they'd been utilizing that spot for maybe two or three years, or when they first started logging. SL: Oh, so you saw bones there? TG: Yeah, when they quit logging it, you know, because a lot of those bones had been there for a couple of years. SL: So that's a site where they have historically been able to successfully harvest lots of deer. TG: Yeah, they just didn't have anywhere else to go. They'd just stay there and eat ..."

Thomas indicates a wolf pack will use an area for a number of years for getting multiple deer at once. Thomas has seen deer bones in this place that were from multiple kills over 2-3 years. He referred to this place as a "buffet."

A large pack will split into smaller sized "hunting packs" as a function of food scarcity Thomas says the two smaller groups are from the same large family or pack and will join back together when food becomes more plentiful, and a large kill is made.

> TG: "But what got me is I think there was seven to eleven wolves that was goin' around in that area [Heceta Island], but ahead of them and adjacent to them there was probably seven to eleven more other wolves goin' around that same area. They were all the same family. But they were all split up into hunting packs occupying it, because the way it looked, when they got held up somewhere from a good feast, good kill, all of a sudden, you'd have a space between when they'd show up again. Sometimes it would be only three days later, sometimes it would be fifteen days later. And when they'd come back, it seemed like the pack size would have doubled because there would be a lot more tracks. They'd bump up into each other before splitting up equally again, you know. So that's why I asked Mike Douville for help, and he set up Trocadero, and he started pulling twenty a year out of there."

Thomas asked Mike Douville to help him trap this large pack.

Thomas shares an account about a severe winter of 1968 where he and a group of fishers saw a pack of about 29 wolves that were staying near Klawock Lake "a wolf pack on ice all winter." Thomas returned to the area a month or so later, and he found a large number of dead deer that had been killed by wolves and left uneaten. Thomas says the wolves killed them just for the kill. We heard about reasons for this type of wolf behavior in other interviews (e.g., Mike Douville from Craig). He also describes how wolves catch and kill deer.

> TG: "No, they actually kill just for the kill. Yeah, because I've seen it. The winter of 1968 was an extreme one. There was the ice in Klawock Lake got so thick that it is expanding out and pushing the banks, uprooting the trees inward. And there was a wolf pack on ice there all winter, and there were—we counted 29 in that pack as we walked the ice up to the mouth of 3 Mile. Henry McNeil, William Charles, Raymond McNeil, and I went up to get some cherry cohos. They wanted cherry cohos for

> boiled fish. So we went up and the mouth of that creek to a spot where the water kept it from freezing. ... So we hiked up there and it was a long walk, but boy, there were good cohos. And across the lake there by Hatchery Creek there was a pack of wolves there. ... there was like 29 in the pack, and I started yelping and howling at 'em. They come running halfway across to us and then got nervous around by [us], and my uncle Henry got mad at me. 'Don't do that, I've only got seven bullets!' ... and he had the only rifle among us, and so I quit. But I went back up there in February because it never got warm and all those trees were uprooted away from the lake and the ice was so thick, and all over that lake there was dead deer. And a lot of them were just hamstrung and left. They were just doin' it to take em' down. SL: ... typically how do they kill deer? TG: Well, they will hamstring 'em to slow 'em down. And bite a chunk of meat right out of the back of the leg and flip 'em over and then *thoomp*. And it—but a lot of 'em their throat wasn't even crushed, they were just hamstrung and left, and one was still sitting upright, and I said, '... there's a live one!' and went over there and the was dead. SL: Sitting up on his haunches. TG ; Yeah. ... Yeah, they were just killing for the kill."

3.5.4.13 Vocalization and communication

Mr. George says wolves talk to one another when they have a kill and when driving prey; they make a short howl, which means they are moving fast. When they are on a kill, they make a lot of noise while they fight over who gets to eat first. Wolf whistles when he breathes. And barks on rare occasions. A wolf bark is an omen of death.

> SL: "... if you hear them howling before you've tried to bring them by howling, why are they howling? TG: Just a means of communication amongst themselves. Sometimes they're saying, 'Hey, dinner's on.' They've got a kill. Sometimes they use it to drive their prey. They have a different howl then. [mimics the howl]. SL: Would you still call it a howl? TG: It's kind of a howl, a short howl the way they do it. When you hear that, they're moving fast. I usually just try to keep up with them until they make the kill. You know because they're on the chase. Once they're on the kill, it's [mimics the sound they make]. SL: Would you call that barking? TG: No, they're fighting amongst each other on who's gonna get the first bite. ... Yeah, and when that's all goin' on, there's usually ravens [makes raven noises] and with all that ruckus you could walk right up on 'em ... They make like a whistling noise. [mimics the whistling noise] It's just the way they breathe. It sounds like a whistle. ... SL: Do they bark like a dog? TG: *Very* rarely, and amongst our Native people, that's—my grandma [would] say, 'When you hear a wolf bark, you go the other way and hope that it's not intended for you.' Because when you hear wolves bark like a dog, that means you've got death coming in your family. SL ... so that's cultural knowledge. TG: Yeah. Well, it turned out to be true. My brother Bobby and I were hunting wolves in Salt Lake, and the wolves came down. They wouldn't show themself. They started barking at us [mimics the barking sound]. ... We'd howl at 'em, and they'd just bark. They'd never howl back at us, and they would not come out. They would not howl. They [were] just barking at us. And the whole pack, barking all different areas. And that winter, a month later, my dad died right on my mom's birthday."

3.5.4.14 Wolf-Dog hybrids

Wolves and dogs are able to interbreed and produce hybrid offspring (Lescureux, 2018). Those offspring are fertile and can continue to breed with dogs in human settlements. The flow of genetic material is usually from a male wolf to a female dog. An oral tradition from Klawock, told to Steve Langdon when he was young, states that village leader John Darrow in the 1910s and 1920s patrolled the outskirts of the village with three wolf-dog hybrids, presumably to keep wolves away from the community. Thomas George once acquired a female wolf-dog puppy, which he used as a source of urine to mask his scent and make lures to attract wolves for hunting and trapping. Thomas tells a story about how he raised the animal and how he manufactured a "passion lure" from its urine when she was in heat.

> SL: "Now one of the things that I heard when I was younger here was that John Darrow, the man had three hybrid wolf dogs that he used to go out and patrol the community for wolves' presence. Have you ever experienced hybrid wolf dogs? TG: I had one. I named her Shadow Girl, and she came from Fairbanks when she was a puppy, and Sylvia Montero's sister or brother-in-law gave her the pup. And Sylvia was living in Hydaburg, and I was working down there at the time, and I kept eyeballing it, and it was just a small, little thing ... I've been around wolves my entire life, and I could see the resemblance of a wolf immediately. Soon as I saw that dog running on the side of the road [expletives] ... there's a wolf, you know. So I did some inquiries around as to whose dog it was, and I knew Sylvia, and I told her, god, you know, I'd love to have a pup and if she ever breeds it. Well, make a long story short, a month later she calls me up, says, 'You want my wolf dog?' I said, 'What's goin' on, Sylvia?' She says, 'Tommy, [she explained she was seriously ill] ... I just need her to go to a good home, and I know you'll take care of her.' I said, 'Sylvia, I'd love to keep your dog.' So I raised her, and I actually used her urine on a lot of my sets, and when she'd go into heat, I'd collect it and stabilize it with sodium benzoate, so I could have it in a spray bottle and spray my boots and walk through my sets. And I'd set up Polk Inlet, and I had those wolves so in love in there, they would not leave the bay. I took seventeen male wolves out of that bay, all males, big males."

Thomas George has had extensive contact with hybrids, raising a hybrid female who had numerous litters of offspring. His commentary reveals a number of significant aspects of the behavior of the female hybrid. He recounts that another Klawock resident also had a hybrid wolf-dog and discusses events that occurred when the two animals came together.

> TG: "That Shadow Girl ... even though she was a hybrid, ... she had that strong [will]; she'd never bark. Once in a while you'd hear her howl just the most beautiful sound you ever heard, and this one day, our neighbor down the street there—he got this hybrid dog, and it was a big monster. And he had it for about a year, and my Shadow Girl was on a twist-link chain. Boom, boom, and she was snapping at the chain. What the heck is goin' on? I ran out to see what all the ruckus was about, and here that big dog got over in front of her and into her… [territory]. And she's punching at the chain, and pretty soon, *pow*, she broke it. That big hybrid wolf dog took off running and as small as she was, she caught him up in just a flash and she nipped him on the

> back of the leg, flipped him over, and just went [makes a sound]. And she started running back, you know, coming back to me—I was calling her. And that other dog got up and took off running, running like hell, and the owner was looking out there. It was Shanky Peratrovich. He goes, 'Hey, you better keep that [expletive] animal chained up!' I says, 'She was chained up, and she broke her chain because your dog wasn't chained up, coming over [to] her.' And the dog dropped dead right at his feet, *whump*. When I saw what she could do, ho, man, my blood turned cold, and I could not tolerate the thought of her doing that to some little child, you know. So I took her out and put her down … because I didn't want the responsibility of some little kid getting their throat torn out."

Shadow Girl was friendly with the family but untrainable. They bred her with a dog, and she had eight pups of which she was highly protective. Mr. George shared an account of how Shadow Girl interacted with his wife and himself while she was caring for the pups. They determined that the hybrid female had eaten the female pups, and Thomas thought she did this to eliminate competition in the pack.

> TG: "Yeah, and she was just a hybrid, and I couldn't train her, couldn't do anything with her. And she loved the hell out of us. She had eight pups. Yeah. And on the second morning, my wife was the only one that could go in and play with—and handle the pups and look at 'em, and she'd just lick my wife's hands, you know. If I tried to do it, *wham*! I mean I had holes on my hands. I had holes—see? Yeah, she [makes growling noise] ferociously ripped me up, wouldn't let me touch 'em. But my wife can hold 'em and play with 'em, and she determined there were four males and four females. On the second morning, she went down there, and I says, 'Hey, come here. Check this out.' I says, 'I could only see four.' She says, 'No, there's eight.' I says, 'No, there's not, there's only four.' She went down there and looked. Only four. Four males. During the night, she ate the other four females. She didn't want the competition in the pack. Yeah, you talk about a cruel, cruel world. I mean. We bred her with a big husky and my god, those pups got *huge*. Skip Warren had one of 'em, and he was like 190 pounds. Yeah, I mean, got forearms on 'em like this big around and just—although you couldn't train 'em or anything, you just strictly to a chain, you know, and just as friendly as you could possibly imagine."

Thomas George's account describes a longer time of living with hybrids and therefore a variety of experiences. His female hybrid provided protection and was the source of a successful wolf lure, but she was essentially untrainable and dangerous to other dogs and potentially people. The disappearance of the female pups from one of her litters and Thomas' interpretation that she consumed them is a unique observation made in this study.

3.5.4.15 Predator-prey dynamics, trapping cycle, model of wolf health

Thomas George explains when there are too many wolves, they run out of food and become unhealthy. There needs to be a balance through wolf management. Thomas shows Steve two photos, one of a healthy wolf, after substantial trapping on the island, and one of a skinny underweight wolf in the absence of trapping (Figure 18).

Figure 18. Photos to illustrate wolf health. The top is Wolf with good body condition, and the bottom photo is Wolf with poor body condition. Courtesy of Mr. Thomas George

> TG: "It's a good example of conservation does not work. You see how big that dog [wolf in the photo] was? Hundred and 43 pounds. That is one year after we had that 168-wolf harvest on the island here. He did not have the competition to go after food. SL: For game ... So the size—the ones that are there increase in size? TG: Yeah. Here's what conservation does. Look how skinny that is. SL: I'm not seeing it right. You'll have to explain that to me. Oh, there's no fat in that gut, is that what you're saying? TG: Um, that's a shoulder blade. There's no meat on it. And those ribs, there's nothing' on it. This is a full-grown adult female wolf, wet. She weighed 50— or 30 pounds. SL: What, oh, now what accounts for her condition? Why is she like that? Because she can't eat? TG: There was no food out there for her. She's still retaining that hunting area as her domain. But there's nothing for her to eat out there."

Thomas traps a wolf pack on a three year rotation, and he leaves at least one breeding pair to rebuild the pack to ensure the deer stay healthy. He says if you stop trapping for more than three years, the pack may substantially increase to larger than its original size. He says that a 3-year trapping cycle ensures a healthy mature wolf pack.

> SL: "... How do you choose a site in the sense of why did you decide that you were going to be working Heceta, or when you decide to work any area, what is your thinking about picking it? TG: I used to do a three-year rotation because the—after the third year, if you leave it alone for more than three years you're gonna wind up with a wolf pack that's more than 200 percent of the original pack size when you first went in there. SL: Within three years. TG: Yeah. So I targeted the packs on a three-year rotation. Anywhere I trapped I'd really work on taking that pack down, but I always made sure that I tried to leave at least part of a breeding pair, if not a breeding pair, behind. And going with a three-year rotation, you wind up with more mature wolves than you would catching a whole bunch of pups."

Based on his experience, Mr. George reiterates if not trapped or hunted for three years, with a good food source, a pack can potentially increase by 200 percent. His estimate was corroborated by western science after discussing it with a wolf biologist.

> SL: "... in your three-year cycle, ... you knocked them down to some relatively low level and within three years their reproduction rate allows them to get back to that same level or more. TG: In three years, in my experience, if left alone, they can come back 200 percent better than the original pack size. And I brought that to the area biologists attention, and ... He says, 'Are you sure?' I says, 'Yeah, absolutely positive.' And he pulled out some paperwork for me to read. It's exactly the same findings that he came across. SL: they have enormous reproductive capabilities? TG: Yeah. Well, if the food source is available, and you've got a low mortality on them."

Thomas gives a caveat on pack-size growth: there has to be a good food source for them and low mortality in the pack. Mr. George's estimate of a potential 200 percent increase in pack size in three years is corroborated in the case of the Honker Divide pack. Four years after trapping ceased, the wolf pack at Honker Divide grew from 11 animals to 36, which is a 227 percent increase. Trapper access to the pack ceased when the road was gated for the purposes of continuing research on the pack.

Thomas says trapping a large pack that has not been trapped for more than three years results in catching a lot of young wolves and pups for which there is no fur market. Other interviewees have explained that when you first start trapping a pack, you first catch the younger wolves that have little experience with traps, and they are not trap shy or wary.

> TG: "I worked that Hydaburg area for a couple of years and built up a hell of a deer herd on Sukkwan Island to where I couldn't hang a snare anymore. And the wolves that I initially took off of there the first time settin' it up, only one was worth any value. Because they didn't have the nourishment to put hair on 'em. There was no fur, and the fur on the rest were all dull and kinky and, you know, from being undernourished. And they were all skinny little runts, every one of 'em. And I let

> them alone for three years and went back and set it all up. I caught nine again, and only two of them were not marketable. The rest of them were big and plush, just silky hides on 'em, you know. It's amazing what a turnaround. And they had so many deer on that island, they had plenty to eat, and they flourished. But I could see, because of leaving 'em alone for three years, if I left 'em alone for four years, boom, they'd kill that deer herd off overnight, and so… Oh, it makes a healthy wolf—overnight. ... SL: So they have enormous reproductive capabilities, then. TG: Yeah. Well, if the food source is available, and you've got a low mortality on them."

Mr. George explains how wolf health and fur marketability are a factor of removing enough individual wolves during a three-year cycle of subsistence trapping.

Thomas uses deer abundance and difficulty in deer harvest as indicators to determine where he is going to concentrate on wolf harvest. He understands the relationship between predator and prey abundance, and he uses this knowledge to guide his wolf trapping and hunting behaviors.

> SL: "... do you have any sense of its impact [on] next year in terms of the population numbers, or on deer harvests? TG: I'd always determine where I'm going to be concentrating on harvesting [wolves] while I'm deer hunting. How much effort do I have to put into deer hunting in this area versus this area, and why doesn't this area [produce deer]? ... it's been a better environment for deer than this one, and there's more deer over here, so you put two and two together and there's got to be a problem or something developing over here. So that's when I'd concentrate on [trapping]. SL: That's how your indicators are that you use. TG: Yeah."

One experienced wolf trapper and hunter with high success can affect subsistence harvest over a large geographical area, benefitting many communities.

> TG: "Well, the truth of the matter is, when I was hard at it, I had every freezer on the island here full of venison, including Ketchikan, Saxman, Metlakatla, Wrangell, and Petersburg. ... Yeah. Everybody was happy, everybody was a great hunter."

3.5.5 Central Islands (Craig): "But we do have a good population of Wolf."

Mr. Mike Douville is an elder and long-time resident of Craig, Alaska. He was interviewed April 23, 2022. Mr. Douville is 73 years old, and his Tlingit name is *Gitwaayne*. Mr. Douville is a Crow (Raven) Beaver (*Deisheetaan)*. He is an expert on wolves and has been hunting and trapping on the land in the Craig area since he was 15 years old. He started hunting with an old friend and mentor named, Bud Thomas. Mike was also taught how to trap by Claude Hanson and Lester Nelson. Mike describes his first year of trapping and how he got started. There was a bounty on wolves at the time, so there was economic incentive to learn to trap. Up-and-coming trappers got support (e.g., credit, seed money) from others in the community who wished to invest in the trapping venture.

> SL: "... And do you recall your first sighting or interaction with the wolves? MD: No, I cannot remember. I remember we used to hear Wolf ... Oh, I was like fourteen or

> fifteen years old. I used to go hunting with an old friend of mine, Bud Thomas. Yeah, we had contact with Claude Hanson, he made his living trapping and wolf hunting, seal hunting and at that time, actually, hunting eagles. There was a bounty on eagles as well as seals and wolf. And Bud was also a wolf trapper, him and Lester Nelson, they used to trap together in the winter, and he would always tell me stories about it. And Claude also [would] tell me stories and actually how to trap, how to make sets, so that perked an interest, but not only that, there was a $50 bounty, which made it kind of attractive, too. So when I was like 15 years old I build a skiff. I didn't have a boat of my own to get around, so I built one and then started with the instruction I got from Bud and Claude, I started to trap Wolf. But my first year I just had some otter traps and they're not really what you need to catch Wolf with. You will catch some, but you'll also miss them, and they can get away from you with a smaller trap. So when I was 16 I bought a dozen real wolf traps from Tex Yates for $150, and he actually fronted me, trusted me to give me credit, and I bought a dozen traps and then started more serious trapping. But I could only put two traps with the one set, and I could only have six sets, so you would catch two wolves and then they'd steal your bait, and they'd all go away. So it wasn't near enough."

3.5.5.1 Historic abundance and habitat changes through time

Mr. Douville says in the early days of his trapping career he took far too few wolves to affect the population. The areas where Mike trapped when he was young were pristine before logging became more expansive. Mike says wolves were widespread and deer abundance was good decades ago when the feds were using poison to remove wolves and collecting bounties. The bounty on wolves helped residents purchase fuel. He says even with the incentive of the bounty and increased local trapping effort the wolf population did not decrease. This may imply that after the federal government stopped using poison, the wolf population increased, or they moved back to territory they had abandoned as a result of poisoning efforts.

> SL: "... in what locations did you begin with your trapping? MD: Well, in reality, looking back, I didn't harm the wolves back then because I only had just a few traps, and I had them up at Big Harbor [Trocadero Inlet south of Craig]. I had a couple sets. I had a couple sets on San Fernando [Island] and sometimes I'd put some in Port Estrella, but that was about the extent of it. They [wolves] were really widespread, and I was catching Wolf, but in reality it wasn't harming the population at all, didn't make a dent in them. SL: Well, in the time frame you're talking about and in the areas that you're talking about there had been no logging ... oh, there's Jim Sprague logging at the mouth of some, what do they call it, A-frame? MD: Well, he did Cat logging. There was a little bit of Cat logging in Big Harbor, which is which is Trocadero Bay. Local name is Big Harbor. There was a little bit up at the head of Port Estrella and Port Dolores, but those were just Cat logging. It was pretty much pristine. SL: Exactly, not like what followed afterwards. So in those years you were also providing food by hunting deer. MD: Correct. SL: And what was your sense of the deer? What did people talk about in terms of deer abundances through time, as you recall? MD: The deer abundance was actually pretty good. ... in the '50s, they [attempted to] eradicate Wolf by the federal fish and game, and they used a poison called strychnine.

> ... up until about the mid-’60s or maybe even close to 1970 there was quite a bit of deer. And then when I was about 16, which would be, ’66 or ’65 I started trapping. The Wolf started making its presence again, and there was still a bounty on them, so Wolf was quite valuable because a barrel of gas cost $35, so you could—if you got a wolf you could buy a 50-gallon barrel of gas. So it was really quite valuable, really, for me. But by the early ‘70s we had a really strong wolf population. It just rebounded, just—it was just amazing to see how much Wolf—the population grew. SL: ... let’s talk about the late ‘50s and ‘60s, then. Claude Hanson is out there, Lester’s out there, and then you come along. There’s a pretty big incentive, so do you think there was enough effort across you guys to knock the wolf population down? MD: No. SL: There was not. ... so what accounts for their rebound ... What might account for why the increase of wolves at that time? MD: Well, when the federal fish and game quit trapping [poisoning] them, there was some effort, but the effort that I saw was they’d go out—Bud and Lester would go out in a big boat every week or ten days to check their sets. ... it was just kind of a thing to do. They were younger and didn’t mind doing it. But they didn’t catch enough of them.”

3.5.5.2 Current population status, habitat condition, and trapper response

When Mr. Douville talks about wolf abundance and population health, it is always in the context of deer abundance and population health and also deer availability for subsistence harvest. For Mike, discussions of predator-prey dynamics include humans harvesting both deer and wolves to achieve and maintain balance. In this case, he integrates the current condition of forest habitat into his explanation. He says the population of wolves is good and healthy. If trappers can remove just enough wolves, the deer should be okay. As it is now, the deer numbers and subsistence deer harvest are going down.

> MD: “But we do have a good population of Wolf. I mean, our population is high enough to where our deer population is—the deer harvest numbers are still going down, and they will continue to go down because we’re not able to keep the wolf population at 100, 150. I would think we could probably maintain, but we’re not going to build a deer population like we had in the 2000s because all through the ‘90s and 2000s, up to 2010, we were able to trap like hell. ... So we have two things: you have stem exclusion and a high wolf population, and we’re still trending down.”

The secondary forest conditions are negatively affecting the deer population. The deer population has at least three interrelated things against it. Mike says deer are at high risk due to secondary growth, deep snows in winter, and wolf predation. Stem exclusion in secondary growth forest limits the ability of deer to utilize that habitat. There is no cover for the deer in winter in secondary growth; the snow gets too deep. They try to keep the wolf population down to a manageable level.

> SL: “... You had made a comment about the impact of the secondary forest having on the ability of the deer population. What are your feelings about that? MD: I think it’s high risk—we’re at a high-risk time because we have so much secondary growth that doesn’t support deer. Geographically we have enough ground to have deer, a good population, but then you have predation. So we’re at high risk because of snow. It

could decimate the deer population, which it probably did this winter some. But in the short term, if you keep the wolves at a manageable level, then you'd have deer. But for quite a few years we were able to trap all winter, and we kept the population down, significantly down."

Mike says the most he has taken while wolf trapping is 31 animals and he averaged about 25 per year for a number of years. He said this did not seem to adversely affect the wolf population by any means.

> SL: "... what is the most that you have taken in a year, in numbers? MD: I believe 31. I was averaging close to 25 a year for several years. SL: ... what is your sense about that number in terms of the relation to the wolf population? MD: Well, at the time I was doing it every year. I mean it was okay. There seemed to be plenty of wolves."

Mike now focuses his trapping efforts on the nearby islands to keep a small area that's got a good enough deer population so the community can get meat. When trapping stops or is not seriously and consistently pursued, the wolf population increases quickly.

> MD: "So the only thing I can do is trap on the islands here and keep a small area that's got a decent deer population so we can get meat. SL: ... in your experience, there've always been wolves on those islands, even when you're trapping? ... MD: There are some. Yeah, there's still Wolf. Not as many as there were before because I've been working on 'em for several years. But soon as you let your thumb off of it, they'll regroup, and you'll have a pretty good population. It doesn't take too long."

Decreasing deer abundance is an indicator that wolves are doing well, and their population is at a viable level. There are plenty of wolves, and they need to be managed to improve deer abundance.

> MD: "We've got plenty of wolves. I mean, they're not a problem. The deer population would totally indicate that. The deer population is going down, which means you've got so many wolves that you can't even level either one of them off. And try to keep it at a sort of a level. They'll never be a level, but you can hope for sort of one. ... you don't have to kill them off. It's never been my desire to do that. Well, maybe on a couple small islands. But for the rest of it—to me, I'm getting older, it's not worth the effort, you know, so long as I have a smaller place to hunt that can produce quite a few deer, but the local population gets onto it, too, and it's really kinda hard because they're as bad as the wolf, too"

Mike has no desire to kill all the wolves, he seeks balance. He is getting too old to put in the required effort, so he tries to have just enough deer to get meat, but the local demand for deer is going to exceed his ability to produce enough through the local management system, using subsistence wolf trapping. He indicates during times of low deer numbers competition among local subsistence hunters and perhaps non-subsistence deer hunters can be a problem.

3.5.5.3 Predator-prey dynamics, threats and vulnerabilities, and trapper response

Mike took a break from trapping wolves in the mid-1990s because the quota was so low, and he switched to steelhead fishing until the harvest was restricted. He was having trouble getting deer at the time he stopped steelhead fishing. Mike had to start trapping wolves again to allow for the deer to return. He says there was a pack of wolves on each side of Trocadero Inlet, howling during deer season in the early 2000s. This made the deer skittish and wild, and deer hunting was difficult. He started seriously trapping again and harvested 30-31 wolves that season. Mike has observed that trapping wolves can increase deer numbers unless the deer population goes too low. Then, it takes about a decade for the deer to return; this is for St. John Island.

> SL: "So as a result of your efforts out in the islands, of taking those wolves, can you see, when the wolves come back up, how that affects the deer population as compared to when you've taken the wolves down? MD: For a while I didn't trap wolves as heavy as like in the mid-'90s, '94, '95. I used to like to go steelhead fishing. And I was pretty busy [with fishing and working] ... I was having trouble getting deer. I'd go to Big Harbor and there was a pack of wolves on each side of the bay howling, and you're trying to get deer. So I said we're gonna have to do something about this. So I got all my gear together and really started. We were struggling. But when the wolves are howling, the deer are so wild, and they're really hard to get. So I started trapping seriously again. I think I had 30, 31 wolves that season. And I was trapping up at Trocadero, Suemez, and on the outside islands. And it took twelve years to get the wolves on the outside islands down to where we had deer again, twelve years of hard effort. So it takes quite a while to do that. But we had a real blossom of deer for a while, and then ... I didn't quit trapping, but kinda slacked off, and we had deer for a while. And then the wolves repopulated again and so now we're repeating the cycle. So the population is not real strong out there now, and last couple of years we've had good success hunting there, as opposed to what's going on Prince of Wales. But part of that was because the [wolf] quota was so low I focused my effort on where we'd get our meat. ... So it has made a difference with the exception of St. John where the deer population got knocked down so bad it's gonna take ten years for it to come back if you keep the wolf off or at least to a lower level."

He indicates deer can be healthy, and winter culls deer when they become overpopulated. Deer also will avoid wolves by moving to places where it is harder for wolves to catch them like brush piles or steep country. Deer are pretty good at dealing with predators, but wolf will eventually win out.

> SL: " ... Does the presence of deer predation affect the quality of the deer? I mean, are the deer healthier ...? MD: ... the deer can be pretty healthy. They just go to live in places where it's harder for a wolf to get them or sneak up on them. So they're pretty good at dealing with predators, too, but in the end they will lose. But they hide in brush piles where you can't sneak on them or things like that, steep country ... SL: What would happen to a deer population if there was no predation, no—either humans or wolves, say, on one of the islands? MD: The deer population would go up, sure. SL: You never had the experience, but when it reached its peak, what would

> happen to it? MD: I guess in the past you'd have tough winters and stuff, … when the deer population overpopulates, they're not as fat and as healthy to withstand the winter, and that will thin them out because they're not as good a shape. You don't get as fat because the browse is all gone."

Mike indicates in the absences of subsistence hunting and predation by wolves, deer can become overpopulated and succumb to hard winters and deep snow. This will bring things back into balance. Deer do not necessarily need a predator to stay healthy.

3.5.5.4 Territory size, movements, and travel patterns

Mr. Douville says heavy snows and hard freezes shut wolf trapping down. These conditions render trappers' equipment useless, and the wolves do not travel in deep snow, especially in mountain passes. He says wolves will isolate in an area during heavy snows and move when conditions improve.

Wolves cover a 30-mile area in one to two weeks in the Craig area. Wolves generally use trails but will scatter away from trails from time to time. Mr. Douville says wolves travel across muskegs using trails; bears use these too, but deer do not like to go across a muskeg in the open. Wolves and bears use the same trails, but the bears do not make trails. Wolves make the trails, and Wolf is the primary user of the trails. Wolves have pee posts in the muskegs that they use to mark territory just like a dog will pee in the same place.

> SL "... in terms of winter or other kinds of climate conditions, do those affect your success? MD: It does. Heavy snow and a hard freeze will just about shut things down. ... the wolf doesn't travel, either. They won't go over the mountain passes and stuff. The valleys and stuff get too snowed in, and they don't like to go through deep snow here. So that keeps them isolated in an area until conditions get better, and then they'll come across again and start their normal travel. They seem to travel in about a 30-mile area. SL: Circuit, kind of? MD: Yeah. SL: Is there a time period that they cover that area? MD: One to two weeks, generally. SL: And how do they travel? Do they have trails that they stay on? MD: Absolutely. SL: In a single line, or do they spread out? MD: No, they have a trail. They'll scatter off of it, but as a general rule they go down a trail. SL: ... do they go around muskegs, across muskegs? MD: No, they'll go across a muskeg. They like to go across muskegs. Deer don't, particularly, like ... whenever I was flying in an airplane you can see these lines going across the muskegs, you know, and I always, before I knew better, I thought those were deer trails. They're not. They're wolf and bear. SL: Bear ... do they use the same trails? MD: They do. A bear doesn't make the trail, but he uses it. The wolf is the primary user. But they get out in these muskegs, and they have their pee posts and places where they scratch and stuff like that. It's important. They do it. Just like a dog."

Mike has experience observing wolf sign since he was a teenager, which allows him to know where Wolf goes. He describes Wolf as a creature of habit, and their habits are as reliable as clockwork. Wolves have travelled around the islands in a similar way several times in the past three years. Mike says the wolves will island hop and stay until the deer are gone before moving to another island.

> SL: "So let's talk a little bit about Lulu Island in terms of your deciding to make sets there. ... how would you select your site?... MD: There are three or four places that they [wolves] like to frequent, really, like clockwork. SL: How do you know that? ... I've trapped there since I was a kid … since I was a teenager. And I know where they go. The Wolf is a real creature of habit. And they all go the same way. SL: Do you think that those island wolves, then, they're different on different islands, but they can swim, do they constitute one kind of population? MD: They can move around. They—the last few years they've been coming from like Heceta Island and coming across the Hole in the Wall islands, and then they go to Noyes, and then they cross from Noyes over to Lulu and San Fernando or any of the other islands. They've done that several times in the past three years or so. SL: ... to get to Noyes is actually closer if you go down to Kelly Cove. That's a much closer. MD: So when they're crossing, they don't just make a beeline. They live on Anguilla's for a while. I was there three years ago. I went into a hole there. It's a good place to get deer. The beach is kinda like mud and stuff, and there were no deer tracks. The wolves had come across there, and they've lived on there long enough, they've got all the deer, and then they moved across to Hole in the Wall and hunt there, and they worked their way across. So the only tracks in there were honker tracks. There were no deer tracks, and there were no wolf tracks, either. And it used to be, in the '70s and early '80s there was pretty good deer hunting out there. We used to make special trips there to get deer. SL: To Anguilla? MD: Yeah, it was good. SL: And so those wolves came from Heceta. MD: Yeah."

Mr. Douville says when food is scarce or difficult to get, Wolf will move. There may be a few deer left in the place the wolves left, but it will take years for them to build up their population. Regarding wolves moving from island to island, Mike says some wolves do not like to swim, so they will be left on the island to continue to hunt. Sometimes the entire pack will move.

> SL: "Now is it possible that in the cycle that you're discussing that St. John's could end up with virtually no deer and virtually no wolves at a low point in the cycle? MD: They [wolves] will move. When the food gets too hard to get, they will move, and there are generally a few deer left. But it takes years to—for them to build back up again. SL: So the cycle is that the wolves will continue until they can't get any, and then they will move on. MD: Yeah. SL: So we know that they're out on other islands, and they can get to other places. MD: But the problem is, a wolf is sorta like—they're just like a dog. Some of them don't like to swim. So most of them will leave, but sometimes they'll leave one or two behind, so that keeps the [deer] population down even longer. And that's what I see. So I guess sometimes they can all move."

3.5.5.5 Hunting behaviors, prey, and diet

Mike says when deer have no experience with wolves, they are easy for Wolf to kill, and Wolf may take more than he can consume. He does not know for sure but thinks it may be the younger inexperienced wolves that do this. He offers these observations on an occasion where wolves killed and did not consume multiple deer on St. John Island near Craig.

> MD: "I went over there and here's a dead deer, and geez, there's the wolf tracks, and so those deer had not had a predator for many years and the wolf is like a dog in a chicken coop. If the deer—if it can catch the deer, they kill way more than what they eat. So they'll decimate a population like that. And that's what happened there. We saw several kills that weren't even eaten. They were dead deer that the wolves could catch easy, and mostly smaller ones, but they killed them and didn't really even eat them. I mean, that's what happens when there's a good deer population and, they don't have a fear of a predator like they should. SL: ... do you think they're using those events to train the younger wolves to learn how to make a kill? MD: I don't know. It's hard to tell. I would think that might be the younger, inexperienced ones that would go and kill and not eat them. Because it's just there, and they're younger and more susceptible to do that sort of thing."

Mike explains that wolves catch smaller younger deer and fawns in winter because these deer cannot get away as easily and are inexperienced with predators. He says wolves primarily use stalking to catch deer, not driving. People used to drive deer as a successful hunting method, but wolves do not.

> MD: "And trust me, the Wolf can take any deer that he wants, but they mostly eat small ones. When I've cut these wolves open and looked at their stomachs, a lot of the—most of the time the hooves in there are little guys. They eat—especially if there's a pack, they will start eating down a leg, like a pretzel if you will, a straight pretzel. They eat the hooves and everything. I've seen them with whole ears in their stomach, a whole deer ear, swallowed whole, you know. SL: ... so now the deer fawn when, in May or June ... MD: Yeah, May and June. SL: ... is that a time when the wolves would be particularly after those fawns at that age? MD: They do catch a lot of 'em then, but they catch 'em over the winter, also, because they're easier to catch. ... they're just not as smart. They're just not as worried, can't get away so easy, so the younger deer predation is much higher on small ones than it is big ones." SL: ... there's two accounts I've heard of wolves driving deer to particular sites for kills. Do you have any experience like that? MD: No, I don't think so. They can catch deer. I don't know if it's easy, but they don't have any trouble getting deer. They can smell 'em, they can sneak up on 'em, and get 'em. SL: ... but in your sense there's no reason for a wolf to do that, to be driving deer … MD: No, they can get 'em without doing that. But people used to do that."

Mr. Douville says wolves are opportunists in the Craig area and eat a wide variety of foods, including deer, beaver, swans, mink, marten, salmon in streams in the fall, spawning needle fish in the intertidal and beaches, and wolves will scavenge carcasses on the beach. Wolves' preference is deer, and beaver is a delicacy to Wolf. Mike also explains the difference between bears and wolves in the fall feeding at salmon streams; the bears stay until the food is gone, while Wolf eats for a day or two and moves on. "They're [wolves are] always moving."

> SL: "... what do wolves eat, besides of course deer and how do you determine that by looking at their stool or something inside their stomachs? MD: They eat mostly deer. I've cut open lots of wolves and most of the time they're eating deer. They will eat

beaver also, is a real delicacy for them. If they can get beaver, they will certainly go after them. I've seen them eat these big swans. But I think it just—it's not something they target. They just will go after them if the—like they're opportunist, you know? They'll eat mink and marten out of your traps. They'll scavenge off the beach, also—Anything that dies and drifts ashore … they actually will even eat these needlefish when they come ashore to spawn, you know? They bury in the sand; when the tide's down, they eat those. They eat fish in the creek in the fall. They're not like a bear; they don't live there and keep doing that and live there until there's no more. They keep cruising. They never stay in one place for a day or two or whatever, and they keep moving. They're always moving. So they'll eat fish for a day or two and then they're off to go somewhere else. SL: Well, that's a—that's a pretty wide range of diet. Do you think they'll try to eat shellfish or anything, like bears? MD: No, I've never seen them do that. I've never seen any evidence. I suppose they—if push came to shove they would."

Mike says wolves like to eat bear if they can. Mike told a brief story about accidently snaring a bear that was eaten by wolves. It was totally gone except for the bones. Mike is not sure if wolves actually hunt bears, but he thinks they probably would if they had a chance to take a cub.

SL: "... what about their interactions with bear? Have you ever seen any evidence? MD: They will eat a bear if they can. They do like to eat bear. I've accidentally snared bear, and you come back and there's nothing left except the bone that was the snare's around, and the bear is totally eaten up, totally gone. They eat it. They like to eat bear. I don't know if they actually hunt them; they probably would if they have a chance to get a cub or whatever, but they will certainly eat them. Nothing left."

3.5.5.6 Pack size and dynamics, hierarchy, mating, denning, and feeding pups

Mike says there is generally one pack per island. The largest group Mike has seen is 12 wolves on Noyes Island. He said there were more wolves there at the time, but only 12 in the group he observed. He says the breeding season is February when one starts to see single males cruising around looking for females. During the breeding season, the pack will break up into one to two mating pairs to den up and have pups, and the other nonbreeders in that pack will run and hunt together but will not be mating or denning. The entire pack does not live together in the same place raising pups during the breeding season. Mike says in the fall, the pack members will come back together to form a larger group.

SL: " ... in your mind, how are they organized in terms of their packs and the territory for those packs? How do you see that organization out there? MD: Generally, there's just one pack on an island. There may be some that are not with the pack at any particular time, but as a general rule they're all together. SL: Now, when you've seen wolves, do you see them as single individuals, small group, or a pack-size grouping? MD: You'll see singles in February when they're—when they have their breeding season. You see more singles then, big dogs, looking for females. ... a lot of people would like to believe that they mate for life, but you see these singles looking for females during the breeding season. They're on their own, and they're cruising. SL: Do you ever see small groups, by which I mean five or less together? MD: You do. It

> depends on how big the pack is on an island. You see them as many as a dozen, you know. SL: What's the largest grouping that you might have seen? MD: I've seen like twelve on Noyes Island at one time. But that wasn't all of them. That was that pack. There was more than that on there. SL: On that island. But so when they divided in those units, is that for purposes of hunting or for looking for food, or how is that? MD: I think that what it looks like to me is a couple pairs of that pack will pair off and have dens and stuff, and then the others are running kind of on their own. So they're not breeding or anything [the ones running on their own]. So they don't all live in the same place, you know raising a bunch of puppies. It doesn't look like that to me. But a couple pairs of them will have den sites and the rest of them are just kind of cruising and hunting, you know. And they seem to regroup come fall. SL: Oh, okay. By that you mean there is a larger group that comes together then. MD: Yes. SL: Oh, and that's cyclical, or seasonal. It happens during certain seasons, they come—they will get into bigger groups. MD: Yeah. SL: And then they will occupy a single den area, I mean, they'll all be in the same den area? MD: Not the whole pack. I don't think they do that. But I think that pair will raise a batch and then they'll rejoin the group."

Mike has observed bone yards near den sites. He says prey is brought back to the den site for the pups until they are big enough to go hunt with the parents. This is evident by the presence of bone yards.

> SL: "Oh, okay. So have you seen den sites? MD: I've seen a couple on camera, and I've been close to den sites, but I have never looked for it exactly. There was no one interested in doing so. But there was just like a bone yard. Deer bones everywhere in a little muskeg. SL: So that implies that they can pack the food or the animals back to the den site. MD: They absolutely do. SL: That's what—they pack it back and that's how they feed the pups, then. MD: Until the younger ones are big enough to follow them. But that's why the boneyards."

Mike has observed that female wolves are fatter and most likely are allowed to eat more, so they probably have a special status in the pack.

> MD: "The females seem to be the fattest. They have the—a status that is a little higher than the rest of them. ... when you catch females they're generally fatter than the males. ... So they have—at least some of them have a status that allows them to eat more."

3.5.5.7 Reproduction, litter size, and aggressive competition among males

Mike Douville says the number of pups in a litter is a function of the female's experience and age. A young female may only have and raise three pups. Generally, you see five to seven pups in a litter. Mike says it was a first-year mom that only raised three pups. He reiterates that mating pairs pair off—"they branch off." There could be more than one mating pair in a pack, and they will have pups in different places. Mike indicates that the larger group will come back together after the pups are old enough.

> SL "... do you have any idea of how many pups there are in a litter? MD: Usually, depending on how experienced the female is, like last year on St. John there was three [pups]. But that was—I know that female was inexperienced, a young female, so she raised three. But generally you see five to seven [pups]. SL: But only maybe three will survive out of there, huh? MD: Well, that was an inexperienced mom, and I know that she was just a first-year mom. So I've been watching these wolves on St. John's cameras and stuff. SL: So now, when they mate, she's gonna have a separate—the alpha male doesn't try to control all of the females in terms of impregnating … MD: They seem to pair off. SL: Okay, they pair off. So that's a new mating pair? MD: Yeah. SL: That's a unit that Person uses, right, when they [biologists] talk about wolves, they talk about mating pairs and total population. So how does that sound to you as an assessment? MD: They pair off. ... SL: Will they start their own pack, then, or will—can you have two mating pairs in a pack? MD: I think you absolutely could, but they branch off. They don't all have puppies in the same place. They pair off. SL: But then for other purposes they could all come together. MD: They do."

Mike says that he see males in a group that are not alphas. He can tell alpha males from younger non-alphas by the size of their testicles/external sex characteristics. The alphas' reproductive organs are noticeably larger. When male wolves fight, they try to castrate one another; this has led to the males not having long hanging scrotums. This is due to internal competition among males.

> MD: "You'll see males in a group that aren't alphas. You can tell the alpha male because they, for lack of a better term, they got great big balls on 'em, with the ones almost as big as him have little peanut nuts on 'em. Yeah, you can tell alphas. They got a big pair of nuts on 'em. But you can get a wolf that's almost as big as that guy and they're just peanuts, you know? And they don't have a nut sack like dogs. It's kind of in. They don't hang down like that because what they do, when they fight with each other, is they try to castrate the other one. I think that's something that's developed over eons of time is that they don't have a nut sack quite like a dog. But you see evidence of where they tried to take the other ones' balls off or … the sexual organs even was missing. SL: Then you think that's part of their internal competition, then. MD: It is."

3.5.5.8 Communication and vocalization

Wolves can distinguish a male howling from a female howling. Mike describes an observation of a lone female wolf calling to other wolves at a different place to group up with her at her location. There is variability in wolf vocalizations. Mike shares a story where a wolf heard his boat motor and responded in a real deep voice to let Mike know he knew that Mike was there. Pups make different sounds for different occasions.

> SL "... so tell me about your use of how wolves are communicating ... MD: They can tell from a howl, if one's howling, if it's a male or female. I don't know how they do it, but they can. They know. Because there was a female on Lulu that I could almost get all the wolves off there and then she would regroup them from the other islands,

> because they could hear her across on Baker, and they could hear [on] Noyes, San Fernando, and they'd regroup. She could call them together. SL: ... Do you ever hear them howling as a unit? MD: Oh yeah. Yeah … SL: Is there any patterning to that in terms of season or time of day? MD: No, I don't know what sets them off. On Lulu, for a few years, there was one old big one on there, and he could hear my speed boat, and you could hear them back in the woods, wooooo. He was letting me know that he knew I was there. He knew. I heard them several times. He could hear my speed boat and when I shut it off and was doing what I was doing, you could hear them back there. He was a big old dog, wooooo, real deep voice, you know. He knew what was going on. SL: What other kinds of noises have you heard them make? MD: When the puppies—they make quite a—they've got their regular howls and then you have the intermediate gang kind of thing. [Mike makes a different sound, rowrowrowrow.]"

3.5.5.9 Sense of smell, response to trapping, and hair boards

Mike Douville describes trapper practices used to cover human scent and trap scent using both modern and traditional materials. There is a basic principle of removing as much scent as possible from equipment to increase trapping success. Mr. Douville's narrative is a foreshadowing of what he says later about why the hair boards were not working. He explains that the field researchers conducting the study did not put enough effort into removing the scents from their hair boards. Therefore, they calculated an estimate of wolf abundance that was biased low.

Mr. Douville states Wolf can smell metal traps, and the hair board traps used metal barbed wire.

> SL: "... And what is the labor investment in preparing a wolf set as compared to mink or marten set? MD: You boil it in the same way; I use bark and stuff like that and boil them. And then I wax them to preserve them and keep the scent down. I add pitch and various things in there to keep the metal smell away because a wolf gets onto that and they… SL: On the metal smell, they can distinguish that? MD: Oh yeah, absolutely. MD: So if you don't put the effort to try to keep them scentless, your sets really just don't work very well. But still I don't think the hair board system is working very well because these guys [wolves] are too smart for that. For me to catch them, I can't leave any smell, I do everything I can to not even know that I have been there, you know what I mean? Biologists do not want to listen to Indigenous knowledge. You don't even want 'em to even suspect that you were there. But here you have a biology group that they can even smell your boots, where you walk with XtraTufs. They can smell you for days if it doesn't rain. And if it's frozen out, it just like preserves it in a freezer. It doesn't go away. But I think they have a lot to learn about even what they're trying to do. See, their—one of the things that I said you need to boil your stuff and take the scent away, but when you boil plywood, it's got all this glues and stuff and then it makes even a worse smell. And they can smell metal. If you take a piece of metal, he [Wolf] can smell it. Even with our nose, and a wolf nose is so much better. So they'll get a few samples like that, but it's not going to work very well. It's just plain and simple, a wolf will rear back—because they're putting it in the same place. I've had wolves bust my trap and it'll never work again because he'll

go there and he knows what it was, and he'll go there and check to see if it's there again. … for as long as that wolf lives, he never forgets that spot and he'll come and look to see if you did it again. ... So it's never gonna work because he [Wolf] knew what it was. And that's the same situation, but how do you teach somebody that? ... a biologist doesn't like to listen to Indigenous knowledge. And I've been doing this for 65 years or so. I've had a lot of experience with these guys. But when I see what they're doing, I know that they're not gonna be really successful because they leave their smell all over. They probably throw these things in the back of their truck and who knows what's in there and people smell; it's not gonna work that well. So you have to take that into consideration when you're doing your formulas because you're not getting a really good sample. Because he's [Wolf] really smart. And they don't forget. They remember everything down their trail. They might have a hundred-mile trail that they've circumference, and they know when something's screwed up on it. If you put a stick across there that wasn't there before, they know it."

Mike indicates the hair boards have too much scent, and Wolf figures out what they are and will not go near them, so the researchers get a low count. The method is conducted the same way each year, so the wolves remember what they have seen and smelled in the past. His assessment is based on extensive years of trapper experience covering up scent to increase trapping success. He says wolves never forget and will go back to a place and check to see if the trap or foreign object is still in its territory.

3.5.5.10 Wolf abundance, Indigenous science, and western science

Mike discusses the hair board study in depth. The biologists and traditional knowledge holders did not agree on the wolf population estimates. The biologists estimated a population of 89, while the trappers estimated 220. The quota was lowered to 10% of 89, so the trappers stopped trapping because it was not worth it. Then, the biologists figured a new estimate at 171 wolves, and the trappers caught 164 wolves. Mike says that you have to be very successful to get half the wolves in an area, so he is saying that there are at least twice as many as the trappers got, so that estimate would be 328 wolves; last year, the biologists came back with another estimate of 323 that is much closer to what the local experts figured.

MD: "So they put these hair boards out, and they were getting some samples of Wolf—they did this mostly in the central part of Prince of Wales. There's an area there that they like to do research on because they have a closed, gated road, they can drive in there, and after they did this study they collected some hair and decided that there was 89 wolves on Prince of Wales, so—in Unit 2. We thought there was—we got conversation with each other, the trappers, and we thought there was 220 based on what we see, how many tracks, all kinds of different stuff we observe. We know what's going on. So, then the quota got cut to I think ten percent of that population, so that made it like ten or eleven or whatever it was for a quota. But I'm saying that you're not getting a true test, depending on what formula you're using to extrapolate that across the whole of Unit 2. And we disputed that number. I've always disputed that number. So by keeping the quota way down, only taking ten or eleven wolves a year, there was no wolf trapping being done on Prince of Wales. I was trapping on the outside islands. So the wolf population was growing really fast. But the DNA hair samples was not showing that, and one of the things that you have to remember about Wolf is they're [he is] scared of people. So you have these—this biologist, and I consider them amateurs, setting these things out, people smell all over 'em, close to the road, using barbed wire and plywood that has totally foreign smell, and they use the same scent every year. And in my opinion it would work less and less every year. They're just too smart. So you might be able to get a sample out of that, but the real thing that happened is they decided, well, we're gonna open it for two months, and they said the population—the mid-level population we estimate is 171. So we caught 164 in 2019. So always in the past I felt that if you could catch half, which would be a high number, you were doing pretty good, so that meant to me that the population was close to 400. But they're still using the hair boards, and it's still not working very well. You're not getting a good handle on how many wolves there are unless you have the proper math to do it. So when we caught the 164, a certain amount of those were DNA catalog wolves. But that gave you a whole, great-big population that they did have DNA on, so then you have two numbers to work on. So then they calculated last year that there were 323. Somehow the number—they figured out how many that they were missing that they weren't getting DNA on, as opposed to the ones that they did. So you have two different numbers to work with, then, and it gives you a more accurate estimate of the wolf population."

3.5.5.11 Indigenous knowledge, cooperation, and balance

Mike indicates a combination of local hire and application of Indigenous knowledge is needed to resolve this problem. Traditional ecological knowledge of wolf behavior is needed to make the hair board population estimate studies successful. Hiring nonlocal biologists who have not lived in the place and do not know how wolves behave is a mistake. They need the agency employees to listen to them and learn the local perspectives. It seems to Mike the agency is trying to take the easy way out when in reality it is very difficult to get close to Wolf.

MD: " I think one of the biggest flaws is having biologists that have not lived here, and really understand the dynamics of how Wolf operates here. And they don't like to listen to you. You know, they don't—because I don't have a doctorate, they're not gonna listen to me. But I have decades of experience. In order to get a good hair sample like what they're trying to do, you're trying to contact a wolf. And in order to do that you have to be really careful how you do it. You don't want them to even know you've been there. So how you integrate that into what they're trying to do and teach them is very difficult. I don't think they listen to you. And they're doing it the easiest way they possibly can, which is drive on the road and walk off 20 feet and put a hair board there, that type of thing. Real easy. When you're trying to catch Wolf or have contact with 'em, it's not always that easy; it's best to go places where you have to go back a way [off the roads]; you have to work at it, here's [locate] their best trail on the island, right here. You're not even close to it. It takes an effort, and from what I see, it's not there. They're doing it the easy way and saturating the road system with hair boards, but they're not getting the whole picture."

Mike wants to work with the agency biologists and regulators to ensure they get an accurate wolf population estimate so a proper trapping quota can be set. When the quota is set at the correct level, the trappers have an incentive to do the work. This in turn allows for the proper amount of deer for both subsistence and wolf prey. The goal is to achieve and maintain balance.

3.5.6 Southern Prince of Wales (Hydaburg): "They're denning out there, so that pack took over that island."

The community of Hydaburg was founded in 1912 consolidating most of the Haida population from four villages on the west side of the Prince of Wales Archipelago. Kasaan, located on the eastern side of Prince of Wales Island, continues today as a separate community. Tony Sanderson was the primary interviewee in Hydaburg with a brief contribution by Sid Edenshaw. They are both of the same lineage, Eagle moiety and the Haida *Sgajuuga.ahl* clan, ancestrally originating in Masset, British Columbia. They both reside in Hydaburg and spent their entire lives there. Mr. Sanderson is 60 years old, and he grew up trapping. He has been working with the agencies and the Hydaburg Cooperative Association conducting population estimates using hair boards as a mark-recapture method.

3.5.6.1 Historic presence and engagement with Wolf

Wolves were known to be present in the forest surrounding Hydaburg when they were growing up but neither Mr. Sanderson nor Mr. Edenshaw recall any stories or teachings about wolves.

> TS: "Not in the village. They'd be behind the village, behind town here. ... this next street up. That used to be all muskeg that would run down towards Saltery. Because we used to play around there when we were kids. That's how close the wolves come. So you're talking like 300 yards behind the village, about 300 yards from here. My brother, when he was hunting down in Saltery one time there was about eight or ten of them that surrounded him down there."

In the 1950s and later, wolf trapping was a significant activity for many in the community, and wolves were one of a number of species trapped. The take of wolves was limited and not thought to have had any major impact on their numbers.

3.5.6.2 Presence of wolves in the islands in 1960s

Tony began engaging with wolves while trapping with his uncle in the 1960s. They trapped for a number of animals including wolves. He notes that roads have increased the mobility of wolves.

> TS: "... because they do travel the islands. You know, so, like I said, we did catch some wolves and like in the late 60s when I was seven, eight years old, I mean, there were a lot of people that would trap in wintertime. And they would trap wolves, but they would, they never caught them all. You know, like growing up, before the road system got put in. I think I've seen wolves three times on the beach. You'd hear them at nighttime. You know, and a lot of times, you'd hear them when you're hunting, but you wouldn't, actually see them that much. You'd see their scat and stuff, but you wouldn't see the actual wolves that much. At least I never did until the road system

> went in, and it's like you start seeing them more and more as time went on, and the road system I think has just made it easier for them to travel and hunt."

3.5.6.3 Other trappers in the 1960-70s

The area around Hydaburg was divided up into recognized trapping areas for different groups in earlier days.

> TS: "It was just the area that we were trapping and like I said, we weren't the only ones trapping. So they had their area where they trapped and there was other people that trap. Like I know that Cliff Durgan, he would trap the wolf outside of Dall Island."

3.5.6.4 Impact of the road coming to Hydaburg and predator-prey dynamics

Deer were abundant at the time the road to Hydaburg connected the community to the island road system.

> SE: "As I grew older, the road between Hydaburg and the Hollis Cutoff was connected in 1983. Right around there. So we started driving the road and seen a lot of deer in those days when I was younger. And as we got older, the deer became more and more scarce. And we know the wolves were multiplying because we would see them on the road here and there. And pretty soon as the years went on, we never seen any deer at all between Hydaburg and the cutoff. But when the wolves started getting hunted in the1990s, I think, by some hunters, we started seeing a lot of deer again, probably about ... The wolves started being hunted, and then we started seeing about probably upwards of 80 to 90 to 100 deer. We'd count them between Hydaburg and the cutoff. And in the later 1990s, they put a limit on hunting the wolves. And the numbers that we saw dropped back down to probably anywhere from five to 10 that we would see compared to the 100 we seen the 10 years before that. And now it's still low that we would only see probably close to 10, nowadays, that was anywhere from one to 10."

The number of deer observed on the road between Hydaburg, and the Hollis Cutoff is an index of deer abundance for Hydaburg residents. On his drive to Hydaburg from Klawock in March 2022, the interviewer (SL) saw one deer along the road.

3.5.6.5 Wolf health

Tony explains the difference in appearance between healthy and unhealthy wolves.

> TS: "I've only seen one wolf that looked really scraggly. You know and I don't know if it was an older wolf that might have been a little bit sick or something because it was by himself. He looked real scruffy compared to like, say the 10 that we saw down in in Soda Bay last fall. I mean, every one of those groups were healthy looking, and it was really weird because they were almost all identical in color."

3.5.6.6 Travel circuit, movement patterns, and trails

Wolves in the Hydaburg area travel from island to island presumably swimming. They also use trails and the roads. A pack in this area takes two weeks to make a circuit of its territory.

> SL: "How do you think they are organized? Maybe one pack on Sukkwan, but what about the other islands? TS: Oh they travel through the islands. SL: They travel through the islands? They don't just stay on one; they are moving? TS: Yeah. They're not like Sukkwan, they're not local to Sukkwan. They'll travel through there. You know and usually a wolf will take a couple of weeks to make a circuit. One's from Natzuhini, I think, because we've had pictures of them out in Canoe Pass, you know, because we had hair-boards on Canoe Pass. That wasn't on the road system. And we had pictures of them coming through, and they go over to Goat Island. You know, and like I say, there's trails on this and Goat Island by Lone Tree where they come across there. At some point they used I think they would travel across there because they can go through by Tlevak Narrows. ... SL: ... you mentioned the trails. How do you choose a site to set a trap? TS: You just look for their trails, they're pretty well worn where they run. Wolves are like dogs, so they'll tend to take the same trail, you know. SL: ... that's their standard, they never spread out, even in the forest and move sort of individually, they're following a line along these trails ... That's what they do? TS: Well, one thing I noticed when I was, a few years ago, because I started doing that wolf survey for the Tribe. And one thing I noticed was up towards Kasaan. We were going up towards Tolstoi, and we saw a wolf kill on the road. But one thing I noticed is they would run down the middle of the road, straight down the middle, but then every once in a while, the wolves would break off and then come back. SL: Some people talk about them as they're being the scouts or they're doing scouting. TS: Either that or they're chasing whatever they see."

Tony says working on the hair board project has confirmed a wolf pack travel circuit of two weeks.

> SL: "But on this mainland over here, south here, going down towards Eek and Heceta you don't know what the wolf situation or do people hunt that way? ... TS: Oh, yeah. And down in Nutkwa there, after Sealaska logged down there. ... you see the deer and wolf scat on the roads back in there. So they [wolves and/or people] do go down in there and hunt. Back in Chomly when we were doing the surveys because we could only drive to Chomly. So we'd have hair-boards back in there. And we got pictures of the wolves back in there. And that's why I say it probably takes a couple of weeks because they'll travel through. Like you'll get some hair samples and then it'll be nothing, nothing, nothing. And then pretty soon, they must come back this way, because then you get their hair samples again."

3.5.6.7 Wolves and trails on Dall Island

Dall Island is west of Hydaburg and lies on the coast of the Pacific Ocean. Tony trapped Dall Island for wolves as a young person. He recalls Cliff Durgan trapping the outer exposed inlets and bays of Dall Island for wolves in the earlier days.

> TS: "All over in the islands here, up in Natzuhini Islands, used to go all the way up towards the Tlevak Narrows and down Dall Island shore. Because it wasn't just the wolves we were trapping. ... my dad used to tell me about when they would trap wolves all the time. ... because when I first started trapping by myself, he told me, okay, out by Lone Tree, there's a trail, a real good wolf trail. So they knew where the wolf trails were across here by the graveyard. The next cove over there's trails back in there, and him and my Uncle Matt used to trap wolves all the time, him and my Uncle Oozie."

Tony Sanderson discusses seeing wolves and a den on Dall Island. The pack in this encounter also numbered about seven animals, corroborating Sid's observation.

> TS: "Five years ago, and I've seen that pack was, you know, six or seven. I didn't see the whole, I didn't see the [entire] pack, but I saw the tracks and I saw the den. And so that means they're denning out there, so that probably means that pack probably pretty much took over that island."

3.5.6.8 Wolf den on Dall Island and estimating abundance from tracks

During another field research project on Dall Island, Mr. Sanderson encountered a wolf den near Manhattan Lake. He comments on the location of the den in association with a salmon stream and lake. The lake supported beaver as well.

> TS: "And where we were doing the wolf survey back in there behind the lake and behind Manhattan Lake and when we were coming back out of the creek up there, we were on the opposite side of the stream. But when we were coming down, I was looking across, and I could see where the hole [den entrance] wasn't very big, like, maybe three feet around or something. You know, land otters have sort of the same size holes when they dig out a lot of areas. They [otters] will make the hole a little bit bigger. But this one here, the trail came out and they went up the hill. It didn't go down the hill. Land otters will go to the creek. This one came up and around. And there was actually three of us out there doing that survey: me and Jeff Peele and Melanie Kadake. Well, Jeff had left us, and he'd walked down. And so he was probably half a mile ahead of us, I guess. And so we looked at that, checked out that den a little bit. And then we kept walking, well in the meantime, the wolves ended up between me and Jeff and Minnie (Melanie). Jeff was down and he had the gun and here he went all the way to the edge of the lake, and he sat out on a big rock out there and he wouldn't move because he didn't know where they were at. But we could hear them following in between us. By looking at the tracks, there was probably five or six wolves in there in that area and there's some smaller ones because there was smaller tracks in there."

3.5.6.9 Location of dens

Tony describes the location of a wolf den.

> TS: “Probably a couple 100 feet up, you know, and it's probably yeah, cause that's sort of a steep stream going in there. And gradually, it goes back and then we were all the way out the back end of the lake and then there's another stream back there. So we were all the way in the back end that. I don't think they go up. I don't think they'd den too high up because of the snow and stuff. I think they tend to stay down. But there was a lot of tracks in that valley back there, so they liked that area.”

3.5.6.10 Pack size, body size, coat color, diet, and hunting behavior

Sid describes seeing a pack of about seven or eight wolves running and playing in a muskeg. He shared an account about his cousin seeing wolves kill a deer and kept running without stopping to feed.

> SE: “Also in 1981, I was logging. And we were logging up on the hillside behind Hydaburg here by the dam. And it was early in the morning, and I saw a pack of wolves run through that first muskeg by the dam, a wolf pack, there must have been about seven or eight of them just running straight through. And I watched them, they played around in the muskeg, and they took off. But I've heard about hunters. I think it was my cousin Robert Carle might have been Robert that was up on Heda Mountain, seen a pack and it was below him running and they were chasing a deer, and they killed the deer and just kept going, just left the deer. Yeah, surprised that they didn't stay and eat it. They just killed it and then kept going.”

Mr. Sanderson has seen a group of ten wolves while hunting on Soda Bay.

> SL: “... have you seen them as singles in small groups or large groups are all of the above? TS: All of them ... Usually, I don't know, it's hard to say, because sometimes you'll see just one and then sometimes, you'll see a couple like and then last fall when we were down on Soda Bay hunting, we went down there, and we saw ten in a bunch. SL: ... the largest grouping you've ever seen is ten? TS: Ten, yes. SL: Have you observed a variation in the wolf size or the color phase? TS: No, I don't think so. I at least I haven't noticed anything in the size. You know, you've got the males that are big and then females are smaller and then there are pups.”

He describes variation in coat color he has seen for wolves.

> SL: “What variation in color have you seen? TS: That was a gray and black color. I think the gray and black is the most popular. Every once in a while you'll see one that has blacker color and will still have some of that gray in there. I've never seen any real light-colored ones.”

Tony is aware of wolves eating fish, beaver, and deer.

> SL: “What do wolves eat? TS: ... sure they eat fish and deer. SL: ... Have you ever seen them on a stream? TS: I’ve seen the scat around the streams. I've never seen the

> wolves along the stream but they're no different than a dog. A dog will go eat salmon. ... they eat beaver. ... Yeah, they like beaver. So usually around beaver dams and stuff, you'll see their tracks."

3.5.6.11 Hair-board locations, issues, and impacts

Tony Sanderson has been involved in wolf hair board research with the agencies and his Tribe, the Hydaburg Cooperative Association, for several years. He has a great deal of experience with these studies and makes several observations based on that experience.

> TS: "Yes on Sukkwan. They do it [put out hair boards] let's see where they have done that, they have one out in [Audrey] Bay, one down by Klakas, have one over in Dunbar. And then you come down on this side and you have one down by Blanket Island. But they're not doing Dall Island, which I think they should be if they want to see if they're the same wolves or not. Because the hair samples will tell them, so you got to [try] to see if it's the same pack of wolves or not there. You know, there could possibly be more wolves out there than they think because they don't test that, you know. And when we're talking about when we're talking about Chomly down, I mean, that's what 20, 20-30 miles down. Yeah, big area down there. It's not being tested to see if there's more packs down that way."

Tony explains the hair board researchers are placing the traps along the roads, which only represents part of the wolf habitat. He implies this practice may lead to samples that are biased low. We heard this observation from Mr. Douville about these studies in the Craig area.

There may be a perception of multiple or different purposes of the hair board technique. That is, Tony indicates the goal is to identify different packs in different places, while the usual purpose of the technique is to calculate mark recapture ratios to estimate abundance.

> TS: "They're doing all the surveys just right on the route, actually. Some of them were maybe 20 yards off the road. Some of them are right on the side of the road, where they put them. SL: What is your sense about that strategy? TS: I think that there's a lot of area down here that [should] be checked for it. I think another thing and I talked to him, I talked to the Forest Service about that, because they asked me that same question. And I said I think that the hair-boarding is drawing the wolves towards the road. So that's pushing the deer away from the road system."

Interestingly, Mr. Sanderson further observes the hair board traps may be attracting wolves to the road system, which moves the deer away from it due to predator avoidance. The implication is deer hunting becomes more difficult for the community because they must travel further from home to access deer.

3.5.6.12 Competition for deer

Mr. Sanderson describes sources of competition for local deer hunters from outside hunters, wolves, and bears.

> SL: "... Do you think that wolves are ... a problem because of their impact on deer? TS: The impact right now is that sure they eat deer and stuff. But that's not the only

> factor, you know, to the declining deer population. You got, I mean, the amount of hunters from [outside]. When I was a kid and hunting here, we used to get deer whenever we wanted it. I mean, we'd never go out and come back home without a deer when we wanted to go get deer. But now you have so many people hunting, the wolves are competing with all the people. They're competing with all the bears ... they cut them off from, bear hunters used to be able to come here and hunt without having a registered guide. Now I think they're required to have a guide. You know, so our bear population has skyrocketed. And I think bears probably killed more [deer] than wolves do. SL: Interesting, then you have the impact of the clear cuts ... the secondary growth on ... how that limits the deer's abundance. ... you guys have to endure the ferry system bringing all the additional hunters ... TS: Yeah, a lot of them do because Sealaska's roads are open to the public. They [nonlocal hunters] do come down, and boats, I mean, they're all over the place. I went hunting up by Tlevak Narrows last year, two years ago. If I go back to the spot where I go hunt, we used to hunt all the time I hunted since I was a kid in that area. I go around this lake, and I get back on the backside of this lake. And then I'm sitting there taking a break and here comes these two guys walking up. So I got up and I hollered at them and waved at them, and they came over by me. I didn't want them to start shooting at me. The guy said, 'Yeah, there's four more guys back there. Over there, back over on the other side.' And I was like, okay, well, that's good to know. So, I'm gonna get out of here. Yeah, so I started walking along the lake. And I could hear these guys, and they're quite a way away from me, but I could hear them talking. ... Yeah, so I made a beeline for my boat and got the hell out of there. But just about anywhere you go now, you gotta be careful. I never know if there's gonna be people around me now. That island gets a lot of pressure."

Wolves are considered abundant at present, and the indicator is that deer numbers are low. However, Mr. Sanderson believes that wolves are only partly responsible for a decline in deer abundance.

3.5.6.13 Impacts of wolf trapping on deer and current trapping by Hydaburg

Sukkwan Island lies immediately to the west of Hydaburg. Hydaburg residents can easily cruise the coastline so availability of deer on Sukkwan Island is a priority to Hydaburg subsistence hunters. A family of non-Native hunters and trappers, the Winrods, who lived near Hydaburg used to harvest a substantial number of wolves, but they have moved out of the area.

> SL: "... do you have any sense of what affects your success in trapping or hunting them? TS: ... not really, because I haven't trapped in quite a while, especially wolves. I mean, there's enough people that do the trapping now. Compared to when I was younger when I trapped all the time. SL: (clarifying) Do you have active trappers now in the community? TS: Not here now. Yeah, the Winrods were the last ones that actively trapped here. I know he [former resident trapper], he pretty much took care of Sukkwan for us and kept the wolf population down. So the deer population was up, and then after he moved, the wolves move back in again and start multiplying and

> now the deer population is down again. Elijah caught a lot of wolves off Sukkwan. And after he did that for a few years after that the deer rebounded really heavy."

There are no active wolf trappers in Hydaburg now. Tony feels it would be helpful to have a coordinated effort by Hydaburg trappers to reduce the number of wolves. However, he says it is a cost prohibitive endeavor. It is not clear if this is due to startup costs being too high, the fur market too low, or the quota on take being too low. It is most likely a combination of factors.

> SL: "Do you think that the community needs to have an effort to limit the wolves?
> TS: No, it would be nice, but the cost of actually going and catching the wolves, tanning the wolves, you know, there's a lot of costs in it. It's not a cheap thing to do."

There used to be systematic trapping of wolves on Sukkwan Island, a key subsistence area, that kept wolf numbers down. Deer flourished at that time. Now with no trapping, the wolf numbers have increased, and deer numbers declined.

4. Key Findings and Insights

We primarily analyzed the data within geographic area and within interviews. This is an appropriate approach given the vast size of Southeast Alaska and the place-based nature of Indigenous knowledge. The insights we learned are, for the most part, specific to the areas where the knowledge holders with whom we spoke have engaged with Wolf. These are discussed in Section 3.5 for each geographic area. There are, however, some common findings and insights that appear to apply across the diverse geographies and social contexts of Southeast Alaska.

4.1 Relationships, Existencescape, and Science

In Southeast, the Tlingit have a profound and ancient relationship with Wolf and the Wolf People embedded in their language, culture, and society. Their understandings of Wolf and their engagements with wolves on the landscape are based in a rich blend of ecological observations and sociocultural and cosmological knowledge and beliefs (Figure 15). The Indigenous peoples of Southeast Alaska have an existencescape, or ontological understanding, of wolves that differs substantially from the Euro-American, western scientific understanding of wolves. They have their Indigenous science regarding wolves, which is "that body of traditional environmental and cultural knowledge unique to a group of people which has served to sustain that people through generations of living within a distinct bioregion" (Cajete, 2020:2).

Having said that, we found evidence that some of the Indigenous wolf experts we talked with also have western scientific knowledge of and experience with wolves they have learned from agency biologists through direct conversations, reading reports of scientific research, or participating in the hair board studies conducted in the central and southern parts of Prince of Wales Island. For example, Mr. Douville and Mr. George understand the mark-recapture technique and ratios applied in the hair board studies, and Mr. Sanderson has worked with the agencies and his tribe as a field technician on the studies. These Indigenous research partners discussed limitations and areas of improvement regarding the hair board studies.

4.2 Balance: Subsistence Priority and Motivation to Manage Wolf

A common motive for wolf trapping and hunting emerged. Across several knowledge holders and in the record of tribal consultation, we learned the primary motive for reducing wolf numbers is to ensure adequate deer abundance and proximity to communities for subsistence harvest. There are two dimensions to the problem: lower abundance of deer from predation and deer become wary, or skittish, and therefore difficult for people to harvest in the presence of an active wolf pack. The preferred means of keeping wolves in check is by subsistence hunting and trapping near communities and in places where communities normally access and hunt deer for subsistence purposes. These motives and desires are based in the Tlingit perspective of balance. In a simple statement, Mr. George explained, "Wolf has to eat, and we have to eat."

As evidenced in the record of tribal consultation (Appendix A) and the interview transcripts, nobody thinks the wolves in Southeast Alaska are threatened or endangered. Our Indigenous research partners have told us there are abundant wolves in their areas and in some places, there are not enough deer as a result. We also learned that to have healthy wolf packs, they have to be trapped and hunted on a three-year cycle in which a substantial portion of the pack is removed, but never the entire pack. The packs will regrow their numbers larger than original size when left alone for three to four years if they have adequate prey and no other sources of mortality. The path to balance is consistent and coordinated subsistence trapping and hunting of wolves in places where people harvest deer. In their view, this approach creates a balanced ecosystem optimal to humans, deer, and wolves in which human harvesting works to enhance the health of the wolves and deer, while at the same time, ensuring healthy Indigenous Peoples and cultures.

At least two of our Indigenous research partners reminded us of the subsistence priority on federal lands under the Alaska National Interest Lands Conservation Act (ANILCA). To maintain the subsistence way of life in Southeast, there has to be an optimal number of wolves and deer relative to a community's subsistence need. A balance must be reached among the three factors. One cannot be studied and understood outside the context of the other two. When the quota on take of wolves is properly set, there is incentive for subsistence trappers and hunters to pursue wolves for economic gain, community status and recognition, and most importantly, to ensure plenty of deer nearby communities that are not spooked by the presence of wolves. If the limit on wolves is too small, their trapping efforts have no positive effect on deer abundance and subsistence harvest.

4.3 Local Experts and Abundance Estimates

To set the correct bag limit on wolves for subsistence harvest, the agencies must have good estimates of wolf abundance. Some of the Indigenous experts in this study possess knowledge and skills that would help the agencies improve their population estimates. For example, the hair board technique relies on attracting wolves in close proximity to the hair traps. Local wolf trappers have years of experience with attracting wolves and making close contact. These skills are invaluable for this mark-recapture technique. Moreover, the expert trappers with whom we spoke know how to effectively mask human and other foreign scents that may repel wolves. Long-time wolf hunters and trappers have the ability to estimate wolf abundance in an area by counting tracks and scat piles and studying features of wolf trails and how wolves mark their territories. These skills could be adapted for use in other types of abundance estimation studies.

Local wolf experts have formally and informally contributed to the studies, and the agency's estimates of wolf abundance have improved as a result. This needs to be recognized.

4.4 Common Ecological Knowledge

Traditional ecological knowledge of wolves appears to converge in general agreement for several topics. For the Yakutat and Excursion Inlet areas, two types of wolves were identified. The smaller of the two is known as the "southeast wolf" or the Alexander Archipelago wolf; the larger one was identified as the "timber wolf" or the "Yukon wolf." Our Indigenous research partners have not observed the two types intermixing.

The Alexander Archipelago wolves are organized into packs of about six to twelve animals on average, and sometimes packs are larger (i.e., ~20 to 30 plus). While there are discrete packs, they subdivide in various ways at various times. In the fall they join together into the largest units of the year. Related packs may merge to form larger packs. It is not entirely clear if these "super packs" are one pack operating in one territory or two or more related packs joined together for some reason such as hunting an area with abundant deer.

There was agreement that packs break up during the mating season as one or more breeding pairs begin denning to birth and care for pups. The other members of the pack continue to hunt as a smaller group and usually do not mate. Often lone males will be seen moving around looking for females during this time. There are usually five to eight pups in a litter. The dens are multigenerational and located between 1,000 and 1,500 feet elevation in the Kake area. When the pups are big enough to travel with the pack, the pack reunites.

Wolf pack territories are bounded by watersheds or stream drainages in Yakutat, Excursion Inlet, and the Kuiu and Kupreanof islands. Packs will normally travel on well-established and marked trails. For the Excursion Inlet area, Mr. Mills described wolves moving through the forest using their noses to hunt, not necessarily following established trails; he spoke of a wolf pack hunting in similar fashion to a pod of orcas. Wolves tend to aggressively defend their territories, but some territories may overlap to some extent, and minor intrusions may be tolerated. We learned there are approximately 10-12 wolf packs in the Kuiu and Kupreanof islands area (Figure 17).

The wolf packs in coastal Southeast use habitats at all elevations from the beaches and islands to the mountain passes. Muskegs appear to be important habitat for wolves. They tend to follow ungulates up and down the mountains in a seasonal pattern limited by snow depth. Large islands may be occupied by one or more wolf pack(s), and packs tend to move around from island to island in pursuit of deer. Wolves also travel on and near the road system, and some interviewees have observed road travel allows wolves to move quickly and effectively access prey.

The primary prey for the Alexander Archipelago wolves is ungulates supplemented with beaver and salmon. However, the Indigenous knowledge holders in this study have seen them consume whatever they can catch or find, including birds, small mammals, and beached carcasses of marine mammals. There is evidence of more than one pack driving deer and moose into bottleneck or dead end areas to facilitate capture and kill. Specific kill sites were identified by large amounts of bones accumulating over time in the same place. These "bone yards" may also be found at den sites as the parent wolves bring food for the pups over multiple years.

4.5 Human-Wolf Interactions

Wolves are often observed or heard howling near communities, but normally do not enter town except on rare occasion to take a dog for food when they are extremely hungry. Wolves are attracted to female dogs in heat and have approached people on the land when accompanied by a dog in heat. We did not learn of any cases of wolves injuring people, but accounts were shared about close interactions between humans and wolves. Some of these are contemporary and others based in oral history. Subsistence wolf hunters who "howl up Wolf" are often closely approached by wolves in defense of their territory. A hunter would call the wolves to his location by howling. When a wolf or wolves arrive to confront the intruder, the hunter may have an opportunity to harvest.

4.6 Wolf-Dog Hybrids

Humans have an ancient and complex relationship with dogs, wolves, and wolf-dog hybrids (Lescureux, 2018). Dogs and wolves have been co-occupants of the Alexander Archipelago for thousands of years, and most likely both have interacted with humans over that time period. Interviewees' accounts and statements indicate a variety of different patterns of hybrid behavior and their relative utility in aiding the Tlingit. Tlingit people endeavored to obtain hybrids by placing female dogs in heat in proximity to wolf packs in the hope they would be impregnated. Hybrids have been used as pack animals, for protection from wolves, and for general protection and assistance in hunting. For example, Mr. Thomas George valued the urine from female hybrids for making scent lures used for trapping and hunting wolves. Interviewees felt that some hybrids did return to the wild but would likely not be accepted back into a wolf pack but rather killed.

5. Recommendations

The insights and knowledge learned from doing this study with our Indigenous partners has led to five recommendations.

1. The agencies should support expanding the current study.
2. The agencies should design, support, and fund future research on Indigenous knowledge for the Alexander Archipelago wolf and other wildlife species.
3. We recommend all wolf research in Southeast Alaska moving forward use a coproduction of knowledge approach.
4. The agencies should actively increase the meaningful participation of Indigenous wolf experts in existing collaborative management and regulatory processes.
5. We encourage the agencies and local leaders, including Tribes and wolf experts, to consider holding preliminary discussions to explore interest in and potential for a co-management arrangement for the Alexander Archipelago wolf.

5.1 Extend and Expand the Current Study

This type of study requires a substantial amount of time, outreach, review, and discussions between the Indigenous knowledge holders, the consultants, and the agency analysts who want to apply traditional ecological knowledge. The Indigenous research participants are part of the study team and coauthors of the report, so there needs to be ample time allocated for substantial interaction, feedback, and trust building. We had approximately four to five months to complete a study that normally would take two years or more.

Although this report is rich in information, the unfortunate reality is we did not have enough time to complete comprehensive data collection and analyses. This interim report should be expanded to include additional information from the interviews and better integrate the cultural significance sections with the traditional ecological knowledge sections. We recommend the agencies commit to continued financial support to expand this Indigenous knowledge project.

Future work for this study includes consideration and analyses of commonalities and variations in findings across geographic areas. There are data gaps, limitations, and uncertainties to consider, analyze, and report. This would involve follow up travel and conversations with our Indigenous research partners to fill gaps and clarify outstanding questions. It is advisable to obtain two to four additional interviews to represent Indigenous knowledge of wolves for the mainland areas of Haines and Klukwan and Ketchikan and Saxman.

Specific topics to further flesh out are pack movements; two types of wolves in the north; trappers' specific skills, techniques, and practices and how these could be harnessed to improve wolf research; the ecological and social importance of having wolves on the landscape; understanding the effects of logging and secondary growth on deer and wolf population dynamics; and further mapping of wolf pack territories by expert trappers and hunters.

The interviewees provided many place names and identified locations where wolves are known to exist and use specific habitats; we recommend more analysis and follow up to develop a mapping component for this study to capture the geospatial aspects of wolves and Indigenous knowledge in Southeast Alaska. This would add a valuable component to this study. It may also be planned as a second project focusing on the geospatial components of traditional ecological knowledge.

5.2 Invest More Time and Funds on Indigenous Knowledge

We recommend the agencies begin to have serious discussions with their Indigenous partners and tribal leaders in Southeast Alaska to explore what they consider to be needs and priorities for fisheries and wildlife research and management in their homelands. Once you discover who the local experts are for the research questions of interest, you should invite them to co-develop agency-sponsored studies that apply Indigenous science and traditional ecological knowledge alongside contemporary wildlife science, research, and decision making. The ultimate objective is to apply a complementary Indigenous knowledge system to agency decision making processes, not perfectly integrate Indigenous science and western science (Kendall et al., 2017).

As the agencies pursue expanding wildlife research that applies traditional ecological knowledge, they should work under the provisions of ANILCA, Title VIII to ensure the research is focused on a subsistence way of life and the subsistence priority. The agencies should encourage and support more Indigenous knowledge studies through the existing Fisheries Resource Monitoring Program administered by the Office of Subsistence Management. This is a small but effective federal research program authorized under the ANILCA focused on subsistence fisheries. We recommend the U.S. Fish and Wildlife Service in Alaska expand this research program beyond fisheries into wildlife research and monitoring to include subsistence hunting and trapping of wolves and other species.

5.3 Coproduction of Knowledge for Wolf Research Moving Forward

Based on the record of tribal consultation (Appendix A) and past and present frustrations among local experts, tribal leaders, and agency scientists, we recommend substantially more local outreach and local hire for agency-sponsored wolf research. Our Indigenous research partner in Hydaburg has been directly involved in the DNA-based mark-recapture research (i.e., hair board studies) conducted by the Alaska Department of Fish and Game with support from the Hydaburg Cooperative Association and the U.S. Forest Service (Shumacher and Moore, 2021). We applaud this case of local hire because it provides some opportunity to apply Indigenous knowledge. We recommend a substantial increase in such partnerships to foster trust and build stronger relationships among the agencies and the Indigenous residents of Southeast.

Above and beyond local hire, we recommend these partners deepen their relationships by making a substantial shift toward a coproduction of knowledge approach for all wolf research moving forward in Southeast Alaska, especially for studies designed to estimate wolf abundance. Coproduction of knowledge is a popular topic among Indigenous peoples as they discuss how to engage with federal agencies and best account for Indigenous knowledge and values (Brooks, 2020:5; Inuit Circumpolar Council, 2020; Wheeler et al., 2020; Wong et al., 2020).

"Coproduction of knowledge between Indigenous peoples' understandings and scientific understandings is the creation of new information by working together to understand the world. It involves mutual understanding, interaction, and respect, as well as the recognition that each party brings something important to the discussion" (Isaac, 2015:45). Coproduction acknowledges and accounts for Indigenous expertise, values, and ways of knowing through interactions that are respectful and mutually beneficial.

In coproduction, the outcomes of engagements between the agencies and the Indigenous experts include shared information, common understanding, and new knowledge. Coproduction takes the principles of formal tribal consultation a step further by adding equality of information, equality of knowledge, and equality of intellectual authority (Isaac, 2015). It is a way to better understand the interface of Indigenous knowledge and scientific knowledge used by biologists and managers. Coproduction allows Indigenous experts and agencies to create new knowledge and capitalize on the complementary nature of Indigenous peoples' understandings and scientific understandings of wolves and their ecology.

In the context of wolf research and management, coproduction of knowledge occurs when agency scientists, managers, and Indigenous wolf experts develop a mutual understanding of a research problem before the research proposal is written. Both contribute to a shared meaning of the research question, and their individual contributions support and often fuse into a new and distinct understanding of how to best conduct wolf research, analyze data, and interpret results to inform decision-making, wolf management, and harvest regulations (e.g., BOEM, 2019). Successful coproduction is verified by discussing and arriving at consensus on the credibility, usefulness, and mutual benefits of the results, implications, and final products.

In a coproduction model of wolf research, Indigenous peoples' understandings and scientific understandings of wolves, predator-prey dynamics, and other ecological concepts inform each other, and both partners benefit equally from the results (Isaac, 2015). Out of respect, the agencies should bring Indigenous experts into projects as early as possible so they may make real contributions (Johnston, 2020). The idea is for both sets of values and knowledge systems to contribute to the research goals. By engaging at the earliest stages of research, Indigenous wolf experts and wolf biologists can ensure equality in determining choice of research design and methodology.

Long-time wolf trappers and hunters have years of experience estimating wolf numbers by carefully studying the wolf sign they observe in an area. A coproduction approach would harness these skills for use in future studies and benefit wolves and all stakeholders in wolf research and management. Local wolf experts should be directly involved alongside agency biologists on an equal playing field to design, implement, and interpret studies on wolf abundance and other population parameters.

We recommend the agencies, with their Indigenous partners, work to develop viable and effective frameworks and methods for implementing coproduction of knowledge in wolf research using special arrangements, cooperative agreements, or memoranda of understanding. Open and transparent communication, frequent interactions, and trusting relationships are prerequisites (Brooks, 2020; Jacobs and Brooks, 2011).

5.4 Enhance Participation by Indigenous Experts in Regulatory Processes

There is a need to strengthen trust and relationships among agency scientists, agency regulators, Indigenous leaders, and local wolf experts in Southeast Alaska. More frequent and meaningful Indigenous engagement with, involvement in, and influence on the federal and state regulatory processes for subsistence wolf harvest would be beneficial for building trust, improving working relationships, and applying traditional ecological knowledge. However, the systems in place in Alaska used to manage subsistence harvest are not easy to navigate.

There are currently two separate regulatory bodies and processes in use for setting wolf harvest limits and restrictions, determining timing of trapping and hunting seasons, and deciding means and methods of harvest for wolves. These are the State of Alaska Board of Game and the Federal Subsistence Board. Each have different jurisdictions, and each promulgates separate state and federal regulations, respectively.

The state process is authorized under the Alaska Constitution and state law [Alaska Statute 16.05.221 (a) and (b)]. The purpose of the State Board of Game is for conservation and development (e.g., access to and allocation) of fisheries and wildlife resources in the interest of Alaska residents. The Alaska Department of Fish and Game and its Commissioner work in support of the Board of Game.

The Federal Subsistence Board is authorized and directed by ANILCA (Title VIII). The Secretaries of the Interior and Agriculture are responsible for implementing the federal law. The Federal Subsistence Board consists of the regional directors of five federal agencies, two members of the public, and a Chairperson. The chair and the public members are appointed by the Secretaries. One primary purpose of the Federal Subsistence Board is to ensure a subsistence priority on federal lands such as the Tongass National Forest. The Office of Subsistence Management, which is part of the U.S. Fish and Wildlife Service, and staff analysts from other federal agencies support the work of the Federal Subsistence Board to set subsistence harvest regulations on federal lands in Alaska.

Both regulatory processes use a complex and lengthy public process in which regulatory proposals are submitted by public individuals and entities and evaluated by the boards and their supporting staff, with input from the public. Both processes use advisory councils or committees to support the boards as they deliberate decisions on proposed regulations. The advisory bodies are made up of various stakeholders chosen to represent geographic areas and public interests. In Southeast Alaska, the advisory council for the Federal Subsistence Board is the Southeast Alaska Regional Advisory Council (Department of the Interior, 2022). This advisory body assists and advises the Federal Subsistence Board in decision making for the region.

The process is highly structured and organized, but confusing, and it is often difficult for most rural residents of Alaska to understand and get involved. In addition, the bureaucratic procedures and operations involved in the regulatory processes are not amenable to the cultural practices and ways of knowing used by Indigenous peoples (Brooks and Bartley, 2016; Jacobs and Brooks, 2011). We recommend the agencies work closely with the regulatory bodies and their Indigenous partners to improve the processes to be more user friendly and adapt procedures to better accommodate participation by Indigenous experts.

Indigenous people in Alaska have opportunities to participate in the regulatory processes as members of the public by attending and speaking at government meetings and by serving on the advisory councils. Mr. Michael A. Douville currently serves on the advisory council for Southeast. More Indigenous wolf experts should be sought out and encouraged by the agencies to get directly involved in the process and consider membership on the Southeast Alaska Regional Advisory Council.

5.5 Explore Potential Co-management for the Alexander Archipelago Wolf

The existing management and regulatory regimes under the State Board of Game and the Federal Subsistence Board have produced successful outcomes and are public processes that are highly collaborative. Indigenous experts are involved in these processes and should continue participating to the extent practicable.

In Alaska, the existing systems of governance for fish and wildlife and other natural resources only allow for an advisory role for Indigenous experts and members of the public. The Boards may defer to their advisory councils and committees in a large number of cases, but they are not obligated by formal arrangement or law to defer to their advisors. All decision making authority lies in the hands of the state and federal governments.

There is a notable amount of locally coordinated wolf management occurring in certain places where people hunt deer in the study area via subsistence trapping and hunting. Some of our Indigenous research partners are in regular communication with agency biologists and have a good understanding of wolf abundance and population dynamics from both the Indigenous and biological perspectives. There is also a notable amount of frustration among Indigenous wolf experts with current agency research, regulation, and management, especially for parts of Prince of Wales Island.

"Co-management (also called cooperative management) has been highly effective in some cases where neither local management nor exclusive government control provides for sustainable and equitable common property management" (Spaeder, 2005:165). Based on our observations, the current situation and context surrounding the Alexander Archipelago wolf appears amenable to and ripe for consideration of a co-management arrangement or pilot/demonstration project on co-management. We did not speak in depth with tribal leaders or agency officials about this topic, so our suggestion is preliminary and solely intended to bring the potential of co-management into awareness and discussion. We suggest and encourage the agencies; local leaders, including Tribes; and local wolf experts to consider holding preliminary discussions to explore interest in and potential for a co-management arrangement for the Alexander Archipelago wolf.

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Appendix A. Record of Tribal Consultation

Alexander Archipelago Wolf Species Status Assessment Tribal Information Briefing and Government-to-Government Consultation

Wednesday, March 2, 2022

9:00 to 10:48 AM

Participants List

<u>Tribal representation</u>:

Clinton Cook, Craig Tribal President
Dennis Nickerson, Organized Village of Kasaan
Joel Jackson, President, Organized Village of Kake
Michael Douville, Craig, AK
Millie Schoonover, Craig Tribal Association
Rudy Bean, Tribal Administrator, Craig Tribal Association
Shannon Isaacs, Craig Tribal Association

<u>Research consultants</u>:

Stephen J. Langdon, Ph.D., Sea Alaska Heritage Institute
Jeffrey J. Brooks, Ph.D., Bureau of Ocean Energy Management, Anchorage
Chuck Smythe, Ph.D., Sea Alaska Heritage Institute

<u>U.S. Fish and Wildlife Service</u>:

Bohling, Justin H.
Cogswell, Stewart
Eakin, Carly J.
Farmer, Sabrina J.
Kenney, Leah A.
Leonetti, Crystal
Mahara, Carol J.
Markegard, Sarah I.
Russell, Robin E.
Spegon, Jennifer
Knoll, Erin

<u>Transcript of discussion</u>

Crystal Leonetti: [Welcomes the group and kicks-off the call.]

Clinton Cook, Tribal President with Craig Tribal Association in Craig, AK: Looking at map slide, it looks like there's a line east of Vancouver. I don't think this wolf is special to the area since this map shows the wolf is on the mainland. It's interesting that you have Prince of Wales Island, but you are including the mainland in your range. Mr. Cook said that the map in the slide show was incorrectly including the mainland; he was questioning if the subspecies exists on the mainland.

Sarah Markegard: Yes, we'd like more information outside of Prince of Wales Island on the mainland. We do think that coastal wolf/AA wolf is on the mainland based on some information on genetics, diet preferences, and other biological information.

Joel Jackson, President of organized village of Kake, AK: I've been following this wolf/Endangered Species Act conversation. I'm 65, and we've hunted in our area, Tongass NF, and we've seen the wolves go up and go down because the food wasn't there anymore, meaning deer, moose, etc. When prey come back the wolf rebound. Over past couple decades, deer populations have dropped, ever since logging started in our area, and after the past couple years, we've seen a decrease in deer and moose population. We only have one trapper in our area, and he's set an area around us to keep the wolves out of our hunting area, and we've seen the difference: more deer. This trapper is taking some wolves out of the population to protect the deer hunting; this trapper has told Mr. Jackson that he only takes a number of wolves that the wolf population can support. This is my experience of living in the Tongass. Thank you for including tribal leaders, because nobody usually comes to us about what we know about our areas. We do see healthy wolf populations on the ground. We hear them. The only thing we see adversely affected is when we try to use science to explain what's going on, but I believe in science. I've seen the cycle of these wolves over 65 years, and I believe they have the right to live, but we know for a fact that they are healthy around us. Mr. Jackson does not agree with the map either; it is too big of an area; I don't think everything should be included in your map. I have friends on POW sending photos of wolves in their community, and my experience is when food is scarce wolves come into our communities; they take our dogs; they just drag them off; wolves will come into the community because they are hungry.

Thank you for including us tribal leaders. We do have local knowledge, and it's time the agency starts listening to us. Sorry if I'm rattling on, but this has been on my mind for a long time, and I'm trying to be respectful. I just want to share my experience.

Crystal: Our scientists are excited to learn from you and this is a first for us to try to learn as much traditional ecological knowledge as possible. I want to note Dr. Steve Langdon and Dr. Jeffrey Brooks, and Chuck Smythe from Sealaska Heritage Institute, so we have many ears listening in. [Asks them to ask questions if they need clarification.]

Steve Langdon: I want to acknowledge and thank you for noting our participation for bringing Indigenous Knowledge into this process. I want to support that this is the first time in U.S. Fish and Wildlife Service to include Indigenous Knowledge and hopefully this will be the practice moving forward. Wanted to underline that dimension of that.

Michael Douville, Authorized to represent Craig tribal association and represents the Kake tribe on issues of wolf and sea otter: I've lived on POW for 73 yrs. I've done a lot of harvesting since I was a teenager and am active today, but POW wolves are the most studied wolves in USA. Since early 1990s we've been dealing with ESA. Most of this is conservation groups aimed at stopping timber harvest. We also oppose timber harvest because it stops our ability to get deer; secondary growth acts as an exclusion zone; we cannot hunt deer in it. There's 100,000s of acres of secondary growth, but using Wolf to stop timber harvest isn't the way to do it. With the last pop growth of 6-7 years ago, Alaska Department of Fish and Game did a hair board study and decided there were 89 wolves in Unit2, and we disagreed. Mr. Douville said they thought that 89 was a low estimate. We thought it was more like ~220 wolves. But we were stuck with this number, and trapping/hunting quotas were adjusted accordingly [low], meanwhile, the wolf population was exploding. The low quota in the last years means we focus our harvest on other islands. This led to a population increase. When Alaska Department of Fish and Game opened the season for 2 months, we had a harvest of 64 wolves in three weeks (close to their pop estimate), which made it look bad. In a season if you could get 50% it was a big deal. The numbers made it made it look like 6 wolves were left, but I think it was double what was hunted. The wolves learn about trapping, and they haven't been trapped on POW for several years because of the low quota. Mr. Douville said the hair boards do not provide a representative sample for a good estimate of abundance, and he recommended the agencies use cameras. Wolves are too smart; they avoid hair boards. They are really shy and you're only going to get a small percentage of wolves on the hair boards. You need to know how many you're not getting. The 2019 high harvest gave us two numbers: those with and without DNA samples. Those percentages can give the department [Alaska Department of Fish and Game] an idea about how much they're missing. I encourage camera use to count wolves and understand how they interact. Last year came out with a more realistic number, 323 wolves. Now they think that 3 weeks is adequate. It might have been, but the last 10 days of season was too cold for our equipment to be operable. We still caught 64; gives an idea of the high number. You don't see the Department off the road system, and I don't think they have a good handle on what's going on off the road system. In other words, there is no endangered species here. I've seen the population go up and down. In the 1950s, fish and game decided to eradicate wolve in Unit 2, but by the 70s were starting to see wolf again, until a population high in the mid-1990s. When wolf population is high, deer population is down. If listed, the people who suffer are those who rely on deer for meat. We culturally harvest our own meat, which is becoming difficult, not because of old growth harvest, but maybe due to lots of snow, and we've had a high population of wolves recently, but no one wants to believe that's causing low deer numbers. If Wolf is listed, we will suffer because we cannot get deer. If there was no wolf, we'd have an abundance of deer. The wolf population is having biggest effect on deer. Old growth harvest has some but a lesser effect. We don't want to see wolf go away. I've done this for years. I don't care about hunting on POW, but I also hunt on the islands to the west. To list Wolf would be devastating to the people who live here and harvest their meat.

Sarah: [Thanking him for information and let him know that DIP letter response was received, while noting timeline/goals and process. We are considering all available information. Noting potential RTM outcomes: NW, T, E, CH.] The final rule making is scheduled to be completed by September 2022. There could be three outcomes: listed in its entire range, listed in only a portion of its range, or no listing.

Leah: We'll have a draft in July of Species Status Assessment that we'll send to tribes for review.

Clinton Cook: Wanted to remind U.S. Fish and Wildlife Service that it's March and the assessment is roughly ½ way over at end of the month, and there has been little consultation with tribes at this point. Any government-to-government should be with elected officials of the tribe, not with staff and non-elected tribal members, [and with higher ups at U.S. Fish and Wildlife Service, not just staff biologists]. This is frustrating to tribal leaders. I want to thank Mike Douville – he has a wealth of wolf knowledge. Government-to-government consultations are very important and should be at the forefront before the July status assessment is put out.

Crystal: Thank you for the reminder. I facilitate but also relay information back to the Regional Director at U.S. Fish and Wildlife Service.

Joel Jackson, President of the Organized Village of Kake: It's important to echo our reliance on deer and moose populations. The pandemic brought that to light. Stores couldn't get any meat. I got worried so I went to Alaska Department of Fish and Game about out of season deer and moose hunt and was denied; went to district ranger and they said they were not authorized to make that decision; went to Juneau to the regional ranger and got somewhere. At some point, Mr. Jackson was directed to the Federal Subsistence Board where a special action could be evaluated to provide an out-of-season hunt. I went to Forest Service, after 4 day discussion, my request went to DOI and then back down to district ranger office [?]. Three months had passed since I started to pursue this. They said they put a call out to Kake to see if we had a meat shortage, but I checked around with people locally and nobody heard from them. Went to the federal subsistence board who authorized a district ranger; he asked me how much deer and moose I'd need. I said 2 moose and 5 deer. We only used 1 of 2 approved hunts because the deer season opened before we could do the second hunt. That stood out in my mind; I wasn't asking permission, I was checking boxes to try to keep it legal, but if I'm denied I'm going to do what I need to do to feed my people. If we can't go to the store, what are we going to do?

Also, regarding roads, years ago, Alaska Department of Fish and Game or U.S. Fish and Wildlife Service were talking about logging roads being stretched across islands and how it makes traveling for wolves easier. That was concerning to us. We still see that; wolves quickly traversing the islands using the roads to travel. They don't stay on the road, but they use it when they need to move fast. Forest Service has been tearing up the roads, making it impossible for us to pass but not for wolves. It's important for U.S. Fish and Wildlife Service to talk with us. Up to this point, we hadn't heard anything from anybody. I heard about this meeting from social media.

Crystal: President Jackson, thank you for the touching and illuminating story how pandemic highlighted need for local foods and what you had to do to accomplish that legally.

Michael Douville: To have deer, we must harvest wolf as well; we have a healthy wolf population. We have wolf on other islands. St. Johns was only island without wolf; that's where we went to harvest deer, but then wolf got on and then the deer were wiped out. In the 70s, one island provided Craig (Kake?) with deer. Humans are part of this ecosystem. A lot of this stuff is coming from outside and people are trying to make decisions form us from outside. Mr. Douville explained that outsiders do not know what is going on in our place, they are trying to make local decisions, and that is not right. Wolves adversely affect deer harvest success. Deer are in decline within past years, Alaska Department of Fish and Game reports also indicate that. The geography we have will support a lot of deer, but we need to keep predators in check, so it's devastating to deer, it's from high predation. You also need to stop harvest of old growth to have a place for deer to overwinter. But Wolf knows that too, so they hunt in those places in the winter. In the 2nd growth areas there's no way for deer to eat during the winter. I recommend harvest of 2nd growth to open up forage, but no one is interested in harvesting 2nd growth. To catch wolves, you have to study them well. I've tried to help the department [Alaska Department of Fish and Game], but it's like they don't trust outside help. I'm not interested in wiping out the wolf population, but to list them would be unnecessary at this point in time.

Chuck Smythe, working with Sealaska Heritage Institute: Want to explain our role: facilitate research by Dr. Langdon and the report to be written by Jeff Brooks. I want to explain that SAI is supportive of both consultations and collection of TEK. We've done a lot of work on herring and the Sitka harvest. We're writing more proposals to continue that work. We're testifying at board of fish in support of subsistence fishermen in Sitka. We view this research as significant as a first by U.S. Fish and Wildlife Service to integrate TEK into their Species Status Assessment process and documenting what is not well known about wolves in the communities in this area. Want to address meaningful consultation. It needs to be early and meaningful. This is the first consultation, but really there should've been earlier consultation; consultation was needed to plan and design this TEK/IK study we are talking about. We've been in communication with Yakutat. It might be useful for Dr. Langdon to describe the scope of this project and how it will be carried out. We're currently finalizing the grant agreement. I hope this is a successful effort.

Steve Langdon: I told U.S. Fish and Wildlife Service that normally projects of this kind are multi-year processes, so this is a very limited timeframe. We had to weigh whether to do something or not at all. The research design is guided by needs of the assessment process and the wolf itself. We are planning 10 interviews across SE AK with Tlingit people, with some interviews on POW and some on mainland with Kake people and Haida people. In addition to interviews, will be assessed and included in a report. We'll also touch on cultural significance; ethnographic and the position of the Wolf in Tlingit culture and how the Wolf is incorporated into the cultural processes. Respect and balance are core values also will be recognized in the report. I wish this was not such a short-term process. We would want people's review of the report before any inclusion of report and materials in the Species Status Assessment.

Jeff Brooks: I really wanted to listen to tribal leaders today. I'm a social scientist for BOEM and doing a detail with U.S. Fish and Wildlife Service. I used to work in the Subsistence Program with U.S. Fish and Wildlife Service. I will help Dr. Steve Langdon analyze results and analyze and apply TEK about wolf, deer, people relations, and whatever else we learn. It's important to look at TEK in the ESA listing process, so I want to be involved in this important study, but I need to really learn from all of you at this point.

Crystal: [Thanks all and recognizes this is a learning moment for U.S. Fish and Wildlife Service and we're limited by when someone is going to petition a species. She is grateful to tribal leaders and those who will continue to participate.]

Rudy Bean, Tribal administrator for Craig Tribal Association on POW: Kake is also my hometown. I wanted to talk about what Joel was talking about and the lack of meat in the store during the pandemic. [Thanks Joel for his comments and leadership.] During that time, I had to fly to Juneau to buy meat for the family. Regarding agency trying to protect wolf; we ask ourselves if wolf or humans are more important to the agency. We can't wrap our head around why the wolf would be protected.

[Chat from Chuck Smythe: It may be helpful to explain that the origin of this project was a petition filed by some entity. ... and as Crystal said the agency is required to address in a short time frame.]

Erin Knoll: This is a learning process for the U.S. Fish and Wildlife Service, and we want to do better in the future, for wolf, ES, and communication. We were petitioned in 2020 by CBD to list the wolf. Once that happens it kicks off a timeline that we're beholden to in our regulations. We have learned that the minute we got the petition, we should've started this and tried to share that experience with other regions.

Crystal: Can you speak to the agency's role in the petition?

Erin: U.S. Fish and Wildlife Service is charged with the ESA and maintaining the list of listed species. Our job, once petitioned, is to gather all information on the species to make an unbiased decision based the best available scientific information. This is not supposed to be based on politics, economics; it should be what is best for the species. The listing decision is a longer process, and a decision will be reached December 2023. This is the first step in the decision-making process, with Species Status Assessment being the information collecting phase.

Clinton Cook: Comment regarding Erin's comment. Seems like you are getting pushed around by environmental groups and leaving us a very short window to testify. We understand the wolf more than any environmentalist will. We're starting our gathering season very soon: the herring are coming and with the herring comes life and squeezing this assessment into 6 months is too short of a timeframe. (Mr. Cook indicated that they would have to attend to their subsistence calendar (e.g., herring harvest) which takes time away from working with the agency on this effort.) You must have input from tribes since tribal members are affected most by this listing. This timeframe is very short for gathering the tribal input that is needed.

Dennis Nickerson: Wanted tribal leaders to speak before me. When we became aware of the petitioned listing, our department started researching this. At this time Alaska Department of Fish and Game came to advisory meetings and they only wanted to talk about the wolf. Some things were left out of our discussion with them, one thing being Section 10 of the ESA. Hearing that wasn't divulged by State of AK made the tribal committee feel like we were being cornered. We need to be notified. CBD is huge and has funding to do this. If we knew ahead of time, we'd have a better chance to address this. I think all agencies should yearly be contacting us to find out who are tribal leader, president, and any other people representing the tribe. I keep hearing about TEK/IK. What we're dealing with is Indigenous Science and Local Science. People go to college to do the same sort of studies we do in the field here. I think we need to coin what we do as Indigenous Science.

Crystal: U.S. Fish and Wildlife Service, any response to Section 10?

Erin: I can speak to Section 10 of ESA speaks to AK Natives and the relationship to T/E wildlife. Essentially, subsistence harvest by AK Natives and non-natives of AK Native village and doing so for subsistence in a non-wasteful manner, is exempt from the ESA. What this looks like moving forward – we'd need to talk to our Solicitor and with you to understand how wolf fits into the subsistence picture, should the species be listed. It's hard to speculate if the species were listed.

Millie Schoonover, with Craig Tribe: On just to learn.

Shannon Isaacs, Craig Tribal Association: Just here as staff to listen.

[Chat from Joel Jackson: could I have a full report on this meeting sent to ed@kake-nsn.gov]

Joel Jackson, President of Organized Village of Kake: What struck me at beginning of meeting, there are a lot of unknowns about the wolf population: how they move, numbers. If you've been out in the forest, how do you calculate what is there. Just look at the picture (on the slide), you can only see a limited amount of the landscape. If would take years to find out where all the deer and moose are, they are constantly evolving and adjusting to their environment. It can be weeks or months before they come back through a certain area. A lot of unknowns about these wolves. I'm out on the road and my boat and I don't go through the woods often, but I listen to our younger hunters and trappers and guide them to go check these areas. These are a lot of unknowns to respond to within 6 months by us or any agency or organization. This is ridiculous.

Sarah: I agree. We are lacking a lot of information. I'm not on the ground, so we are reliant on people like you and others who are on the ground and other scientists. My hope is that we can have these conversations in future years regardless of whether we are petitioned to list them. Really appreciate you pointing that out.

Jeff Brooks: The U.S. Fish and Wildlife Service seems interested in incorporating TEK in this process. Other than guidelines in ESA regulations, when did U.S. Fish and Wildlife Service decide to go the route of gaining the knowledge of Tribal people on the ground. I recognize we can't add time to the situation, but how can we make this work best in the time we have. Maybe you can give some context about how important the people's knowledge is to this project to help us to do the best we can for this project. I sense a great deal of frustration on part of the tribal leaders on the call today regarding the short timeframe.

Crystal: I will try to address from high level. There have been a couple species in AK where TEK or IK has been incorporated as part of the process but not as part of the Species Status Assessment process. [References polar bear and walrus in part of listing decision making process.] When the agency has been doing something in a structured way for a long time, it's hard to insert a new piece into that structure. Right now, we have a lot of people in the agency who are supportive and excited to learn TEK. We recognize that knowledge is limited but there are a lot of people are working to advance this. We are hoping that we can gain critical information about the process to advance the process.

Jenny Spegon, branch chief of Ecological Services: As branch chief I review documents, and I appreciate TEK. We can't get this anywhere else, and this needs to be considered when we're listing species.

Stewart Cogswell, U.S. Fish and Wildlife Service Field Supervisor of the Southern AK Field Office: I hear what tribal leaders are saying and unfortunately this is not unique. This feels frustrating to me, and how can we translate local concerns to national policy. This is tough but the good thing is that we're talking about it. TEK is picking up steam and our current administration is supportive, which is exciting. The timing isn't good for the wolf, and I apologize. We can work on getting staff and making future efforts better. I appreciate your comments and growing up as a hunter and gatherer myself it's tough to hear. Please continue to share your voice and keep the conversation going beyond this call so we can have the best outcome.

Michael Douville: Really appreciate the opportunity we have today. It's encouraging and down the road we can have more conversations. I'd be happy to answer questions later. I appreciate the opportunity and the effort you put forth.

[Chat from Clinton Cook (to request meeting notes): Clintoncooksr@craigtribe.org]

Clinton Cook: I echo Mike's thoughts and hopefully this is the first of quite a few Gov-2-Gov meetings. You can see the outpour from Craig tribe: we have staff and leaders here today. It's important to us to protect this resource. I'll continue to put the stress on Gov-2-Gov throughout the process. The use of TK is a factor. Glad that Sea AK is involved, and we consider Dr. Langdon as member of our community. Mr. Cook indicated they would be glad to see U.S. Fish and Wildlife Service in Craig for further consultation.

Jeff Brooks: I feel there is a substantial amount of knowledge on the ground that will help us do right by the species. Local managers are doing a great job managing the species on the ground. There is a lot we can learn from the people.

Steve Langdon: As a matter of commitment, the U.S. Fish and Wildlife Service should look into how budget and process makes a lot of sense, and this should be part of your consultation process moving forward.

Joel Jackson: Thanks to everyone on this call. This is an important first step in this process. I can't remember the last time we were asked to the table on anything concerning our resources in our area other than people just listening and going away and doing what they were going to do anyway. I hope this is different. U.S. Fish and Wildlife Service people here today, take our comments to higher ups who can make decisions and I hope they consider it.

[Chat From Chuck Smythe to Everyone 02:46 PM

I was thinking along these lines as well ... about the need to plan for continuing study including funding for it.]

--End of call at 10:48 AM---

Appendix B. Conversation Guide for Traditional Ecological Knowledge

Alexander Archipelago Wolf Traditional Ecological Knowledge Project:

Wolf Characteristics and Behavior Protocol

INTRODUCTION – The USFWS is conducting an Endangered Species Status Assessment (SSA) for the Alexander Archipelago wolf. They intend to include Tlingit and Haida traditional knowledge and cultural information in their assessment. To meet those needs, a limited research project is being conducted to acquire, analyze and prepare a report on wolf topics that will be submitted by the USFWS to use in their SSA. The information provided through this interview will assist in the preparation of the report on these topics that will be submitted to the USFWS.

BACKGROUND INFORMATION

Full name	Maiden name
Date of birth	Location of birth
Tlingit clan	Tlingit name(s) (translation)
House name	
Mother's clan	Mother's name
Father's clan	Father's name
Years resident in communities	

BACKGROUND INFORMATION

What did you learn or were taught about wolves as a child?

From whom did you learn that information?

Do you recall your first sighting of or interaction with wolves?

Have your elders told you stories about wolves?

PERSONAL EXPERIENCE

When did you first trap or hunt wolves?

When did you start trapping wolves? Why did you decide to do so?

Where did you begin trapping wolves?

How are traps set up? How do you choose a site? Describe how you distribute wolf traps/ snares.

Narrative – Where, how, outcomes, observation

Through time – Locations, time periods, experiences

Please describe your experience in seeing the large number of deer killed by wolves – one or more occasions?

WOLF CHARACTERISTICS

What kind of wolves have you seen – single, small group, large group?

Have you observed variation in wolf size, color phase? Any patterning?

Can you distinguish male from female wolves?

Have you seen wolf dens? Locations. How they re-use them?

Population – how do population numbers change? What indicators do you have?

WOLF BEHAVIORS

What indicators do you use to locate wolves? How do wolves respond to seeing you? What do wolves eat? Do you check their stomachs when you harvest them?

What size are wolf groups/packs?

Do they have territories?

How do they move seasonally?

How many pups appear in a litter?

WOLF COMMUNICATIONS

In what ways do wolves communicate?

When do wolves make noises?

Do wolves make noises when they encounter you?

Wolves howling – individual, group, response - discuss

Do wolves bark? Do wolves growl? Do wolves whine? Are there other noises?

Do you communicate with wolves? How do they respond?

WOLF HARVESTING

Have you ever hunted wolves?

Have you ever snared wolves? How does it differ from trapping?

If yes, how do you decide when and where to trap/hunt wolves?

Do you have a goal or general idea about the number of wolves you take? What goes into that decision?

What factors affect your success in trapping/hunting wolves?

Do you see impact of your wolf harvesting on deer populations?

WOLVES AND DOGS

Have you heard of hybrid wolf-dog animals?

Have you seen them?

What are they like – characteristics, behaviors etc.

Do you know any stories about hybrids? Hunting, searching, etc.

OTHER INFORMATION

Have you observed wolves in your community?

Have you heard stories or experienced wolves threatening people?

Have you seen wolves on beaches or in the water when you have been traveling for other activities?

Appendix C. Conversation Guide for Cultural Knowledge

Alexander Archipelago Wolf Traditional Ecological Knowledge Project:

Cultural Information Protocol

INTRODUCTION – The USFWS is conducting an Endangered Species Status Assessment (SSA) for the Alexander Archipelago wolf. They intend to include Tlingit and Haida traditional knowledge and cultural information in their assessment. To meet those needs, a limited research project is being conducted to acquire, analyze and prepare a report on wolf topics that will be submitted by the USFWS to use in their SSA. The information provided through this interview will assist in the preparation of the report on these topics that will be submitted to the USFWS.

BACKGROUND INFORMATION

Full name

Maiden name

Date of birth

Location of birth

Tlingit clan

Tlingit name(s) (translation)

House name

Mother's clan

Mother's name

Father's clan

Father's name

Years resident in communities

CULTURAL INFORMATION

Are you aware of a story about how the *Kaagwaantaan* or Klukwan Wolf House acquired the wolf as a crest?

Are you aware of a story about how the *Kaagwaantaan* Wolf House acquired that name?

Are there wolf crests or images that Wolf moiety/clan members use?

Are there wolf regalia – headdresses, tunics, blankets, dance boards etc. – that are the property of the house?

How are those regalia used (*ku'eex* etc.) by Wolf House clan members on ritual occasions?

Are there *at.óow* associated with wolf of the Wolf House?

How were/was the *at.óow* acquired or created?

Have you worn *at.óow* regalia? If so what is that experience like?

Do you know of any personal names used by Wolf clans that include reference to the wolf, wolf characteristics, or wolf behavior?

Do you know of any songs concerning the wolf sung by Wolf House members on ritual occasions?

Do you know of any dances concerning the wolf that are performed by Wolf House members on ritual occasions? Is there a name for the dance?

Are there any other aspects about the wolf that Wolf House members practice or perform (like howling)?

PERSONAL EXPERIENCES

Have you ever seen or encountered wolves?

Have you heard stories from other people about seeing or encountering wolves in the community?

Are you aware of any tribal member in Klukwan who trapped or hunted wolves? If so, when was that activity taking place? Why was it undertaken if you know.

Appendix D. Indigenous Research Partners

Name	Community	Age	Moiety	Clan	House	Trapper	Hunter
Judith *Dax̱ootsú* Ramos	Yakutat	63	Raven	*X̱waashk'ik̲wáan*	Owl	No	No
Devlin *Shaag̲aw Éesh* Anderstrom	Yakutat	25	Raven	*X̱waashk'ik̲wáan*	Moon	No	No
Thomas Mills	Excursion Inlet/Hoonah	77	Raven	*T'ak̲deintaan*	Head	Yes	Yes
Michael *K̲'a.óosh* Jackson	Kake	71	Raven	*K̲aach.ádi*		No	No
Scott Jackson	Kake			*Was'eeneidí*		Yes	Yes
Jon Rowan	Klawock	58	Wolf	*Shangukeidí*	Wolf *G̲ooch*	Yes	Yes
Thomas George	Klawock	67	Raven			Yes	Yes
Mike *Gitwaayne* Douville	Craig	73	Raven (Crow)	Beaver *Deisheetaan*		Yes	No
Tony Sanderson	Hydaburg	60	Eagle	*Sgajuuga.ahl*		Yes	No

Appendix E. Informed Consent

SEALASKA HERITAGE

Wolf Traditional Knowledge Research Interview Consent Form

TEK Gathering for Alexander Archipelago Wolf Species Status Assessment
Chuck Smythe, Ph.D. (Sealaska Heritage Institute), Steve J. Langdon, Ph.D. (University of Alaska-Anchorage), Jeffrey Brooks, Ph.D. (Bureau of Ocean Energy Management)

Researcher
Steve J. Langdon, Ph.D.
(907)-227-3126
sjlangdon@alaska.edu

Project Description
You are being asked to participate in a research project about Alexander Archipelago wolves that is being funded by the U.S. Fish and Wildlife Service through a cooperative agreement with Sealaska Heritage Institute. This research will be aimed at identifying traditional ecological knowledge (TEK) and other cultural knowledge related to the Alexander Archipelago wolf. Information from this interview will be used in a species status assessment (SSA) for the wolf as a potential endangered species following the provisions of the Endangered Species Act.

If you would be willing to participate, I would like to interview you on your knowledge and experiences concerning the Alexander Archipelago wolf and its position in Tlingit and Haida culture and society. Your perspective is of great importance and would greatly help to assess the status of this species. I will be recording this discussion and taking handwritten notes during the interview. This should take about an hour to complete. Information from this interview will be stored at SHI. We will share the results of this study with the communities involved through written materials.

Voluntary Nature of Participation
Your participation in this research is voluntary. At any time prior to the publication of this research you may contact me and withdrawal your consent.

Confidentiality
The protection of your identity is my primary concern. Under no circumstances will your identity or participation in this study be compromised. The study report to US Fish and Wildlife Service will use fake names for all participants to protect your identity. If you would prefer to be identified by name as one of the interviewees, please provide your consent here:

___ Yes, I give my permission to be identified by name as a participant in this research (Optional).

Signature__________________________________ Date _______________________________

Potential Benefits and Risks:
By participating in this interview neither you nor any groups you are affiliated with are at risk. You will receive $250 for each hour of interview you provide. Longer term benefits for participating in this collaborative research may be possible as a result of the analysis, results, and implications of this research.

Contact People
If you have any questions about this study, please contact Chuck Smythe, Ph.D., at (907)-586-9282 or chuck.smythe@sealaska.com. If you have any questions or concerns about your rights as a research participant please do not hesitate to contact Adam Kersch, Culture & History Manager at Sealaska Heritage Institute, (907)-586-9180 or adam.kersch@sealasa.com.

Consent
Please provide your informed consent to participate by signing below.

Participant's signature__________________________________ Date __________________________

I have informed the participant about the information described in this form by providing a written summary of the research goals and objectives, how the results will be used, and answering any questions by the participant.

Researcher's signature__________________________________ Date __________________________

NON-DISCRIMINATION STATEMENT

The U.S. Fish and Wildlife Service conducts all programs and activities free from discrimination on the basis of sex, color, race, religion, national origin, age, marital status, pregnancy, parenthood, or disability. For information on alternative formats available for this publication please contact the Ecological Services Office to make necessary arrangements. Any person who believes she or he has been discriminated against should write to U.S. Fish and Wildlife Service, 1011 East Tudor Road, Anchorage, Alaska 99503 or O. E. O., U.S. Department of Interior, Washington, D.C. 20240.

APPENDIX B: ALEXANDER ARCHIPELAGO WOLF DIET BY ANALYSIS UNIT

Table B-1 Wolf Diet in Northern Southeast Alaska. FOC and Weighted FOC came from Fox and Streveler 1986, Lafferty et al. 2014, Roffler et al. 2021; Roffler pers. comm.

NORTHERN SOUTHEAST ALASKA																
Citation			Fox and Streveler 1986, pp. 192–193		Lafferty et al. 2014, p. 145		Roffler et al. 2021; Roffler, pers comm									
Location			Northern Mainland		Glacier Bay		Northern Southeast Alaska									
Predominant time of year scat was collected			Summer		May–July		Year-round									
Number of scats			78		55		240									
Weight[1]			1.58		2.24		0.51									
Common name	Scientific name	Ave. Adult Weight (X)	Frequency of Occurrence (FOC)	Weighted FOC	FOC	Weighted FOC	FOC	Weighted FOC	Average FOC	Average Weighted FOC	Prey "weight" per scat (Y^)[2]	Corrected Average FOC[3]	Weighted Corrected Average FOC[4]	Proportion of Diet	Weighted Proportion of Diet	
Rodents																
Hoary marmot	*Marmota caligata*	12.00	42.6	67.2	0.0	0.0	6.25	3.2	16.3	23.5	0.5350	8.7130	12.5626	2.14	1.87	
American beaver	*Castor canadensis*	47.00	0.0	0.0	0.5	1.1	3.33	1.7	1.3	0.9	0.8150	1.0405	0.7680	0.26	0.11	
Microtine	*Microtus spp.*	0.06	0.0	0.0	9.0	20.1	2.08	1.1	3.7	7.1	0.4395	1.6231	3.1069	0.40	0.46	
North American porcupine	*Erethizon dorsatum*	20.00	0.0	0.0	7.0	15.7	0.42	0.2	2.5	5.3	0.5990	1.4815	3.1710	0.36	0.47	
Squirrel	*Tamiasciurus hudsonicus*	0.75					2.50	1.3	2.5	1.3	0.4450	1.1125	0.5706	0.27	0.09	
Unidentified rodent	*Rodentia spp.*	20.00	10.0	15.8					10.0	15.8	0.5990	5.9900	9.4527	1.47	1.41	
Total			**52.6**	**83.0**	**16.5**	**36.9**	**14.6**	**7.5**	**36.2**	**53.9**	**3.4325**	**19.9607**	**29.6317**	**4.91**	**4.42**	
Lagomorphs																

Snowshoe hare	*Lepus americanus*	3.50	0.0	0.0	7.0	15.7	0.83	0.4	2.6	5.4	0.4670	**1.2189**	**2.5049**	**0.30**	**0.37**
Carnivores															
American black bear	*Ursus americanus*	320.00	0.0	0.0	0.0	0.0	6.25	3.2	2.1	1.1	2.9990	6.2479	3.2044	1.54	0.48
Harbor seal	*Phoca vitulina*	190.00	1.0	1.6	0.5	1.1	4.17	2.1	1.9	1.6	1.9590	3.7025	3.1578	0.91	0.47
Sea otter	*Enhydra lutris kenyoni*	75.00					37.08	19.0	37.1	19.0	1.0390	38.5261	19.7591	9.48	2.95
North American river otter	*Lontra canadensis*	18.00	0.0	0.0	0.5	1.1	0.42	0.2	0.3	0.4	0.5830	0.1788	0.2593	0.04	0.04
Pacific marten	*Martes caurina*	2.00	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.4550	0.0000	0.0000	0.00	0.00
Ermine	*Mustela erminea*	0.57	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.4436	0.0000	0.0000	0.00	0.00
American mink	*Neovison vison*	2.00	0.0	0.0	0.0	0.0	0.00	0.0	0.0	0.0	0.4550	0.0000	0.0000	0.00	0.00
Wolverine	*Gulo gulo*	36.00					2.08	1.1	2.1	1.1	0.7270	1.5122	0.7755	0.37	0.12
Unidentified mustelid	*Mustelidae spp.*	6.00	9.0	14.2	0.0	0.0			4.5	7.1	0.4870	2.1915	3.4584	0.54	0.52
Unidentified marine mammal		132.50					3.33	1.7	3.3	1.7	1.4990	4.9917	2.5601	1.23	0.38
Total			**10.0**	**15.8**	**1.0**	**2.2**	**50.0**	**25.6**	**47.9**	**30.3**	**9.1476**	**52.3590**	**30.6145**	**12.88**	**4.57**
Ungulates															
Moose	*Alces americanus*	1000.00	0.0	0.0	80.0	179.0	12.92	6.6	31.0	61.9	8.4390	261.3840	522.2794	64.31	77.92
Black-tailed deer	*Odocoileus hemionus*	150.00	0.0	0.0	0.0	0.0	24.58	12.6	8.2	4.2	1.6390	13.4289	6.8873	3.30	1.03
Mountain goat	*Oreamnos americanus*	230.00	53.0	83.6	0.0	0.0	12.50	6.4	21.8	30.0	2.2790	49.7582	68.4072	12.24	10.21
Total			**53.0**	**83.6**	**80.0**	**179.0**	**50.0**	**25.6**	**61.0**	**96.1**	**12.3570**	**324.5710**	**597.5740**	**79.86**	**89.15**
Other															
Salmon		10.00					3.75	1.9	3.8	1.9	0.5190	1.9463	0.9982	0.48	0.15
Other fish and shellfish		10.00	4.0	6.3	4.0	9.0	5.83	3.0	4.6	6.1	0.5190	2.3926	3.1580	0.59	0.47
Unidentified amphibian		0.02												0.00	0.00

Unidentified bird	0.50	6.0	9.5	11.0	24.6	10.00	5.1	9.0	13.1	0.4430	3.9870	5.7908	0.98	0.86
Total		**10.0**	**15.8**	**15.0**	**33.6**	**19.6**	**10.0**	**17.4**	**21.1**	**1.4810**	**8.3258**	**9.9470**	**2.05**	**1.48**

[1]Used to balance the scat sample sizes for each study. The formula used is: W = T / A, where "T" represents the "Target" proportion, "A" represents the "Actual"
sample proportions and "W" is the "Weight" value.
[2]Determined by using the Weaver Correction Factor. Percent frequency of occurrence of a particular species in wolf scats does not always equate to percent consumed because smaller prey have a larger proportion of indigestible material than larger prey. The Weaver Correction Factor (Weaver 1993) has been used to correct for this bias and convert percent frequency of occurrence to percent consumed: Y^ = 0.439 + 0.008 x X where X is the average weight of a prey species and Y^ is the prey "weight" per scat.
[3]Y^ x the average FOC

Table B-2 Wolf Diet in Southern Southeast Alaska

SOUTHERN SOUTHEAST ALASKA													
Citation			**(Smith et al. 1987, pp. 9–11, 16)**		**Roffler et al. 2021; Roffler, pers comm**		**Average FOC**	**Average Weighted FOC**	**Prey "weight" per scat (Y^)[2]**	**Corrected Average FOC[3]**	**Weighted Corrected Average FOC[4]**	**Proportion of Diet**	**Weighted Proportion of Diet**
Location			Revillagigedo Island		Southern Inside Islands								
Predominant time of year scat was collected			Year-round		Year-round								
Number of scats			329		295								
Weight[1]			0.9		1.1								
Common name	**Scientific name**	**Ave. Adult Weight (X)**	**Frequency of Occurrence (FOC)**	**Weighted FOC**	**FOC**	**Weighted FOC**							
Rodents													
Hoary marmot	*Marmota caligata*	12.00	0.0	0.0	0.00	0.0	0.0	0.0	0.5350	0.0000	0.0000	0.00	0.00
American beaver	*Castor canadensis*	47.00	20.0	19.0	11.53	12.2	15.8	15.6	0.8150	12.8485	12.6981	6.13	5.94
Microtine	*Microtus spp.*	0.06	0.0	0.0	1.36	1.4	0.7	0.7	0.4395	0.2988	0.3161	0.14	0.15
North American porcupine	*Erethizon dorsatum*	20.00	0.0	0.0	0.00	0.0	0.0	0.0	0.5990	0.0000	0.0000	0.00	0.00
Squirrel	*Tamiasciurus hudsonicus*	0.75			0.00	0.0	0.0	0.0	0.4450	0.0000	0.0000	0.00	0.00
Unidentified rodent	*Rodentia spp.*	20.00	0.0	0.0			0.0	0.0	0.5990	0.0000	0.0000	0.00	0.00
Total			**20.0**	**19.0**	**12.89**	**13.63**	**16.45**	**16.30**	**3.4325**	**13.1473**	**13.0142**	**6.28**	**6.08**
Lagomorphs													
Snowshoe hare	*Lepus americanus*	3.50	0.0	0.0	0.00	0.0	0.0	0.0	0.4670	**0.0000**	**0.0000**	**0.00**	**0.00**
Carnivores													
American black bear	*Ursus americanus*	320.00	0.5	0.5	5.42	5.7	3.0	3.1	2.9990	8.8770	9.3067	4.24	4.35
Harbor seal	*Phoca vitulina*	190.00	0.0	0.0	0.34	0.4	0.2	0.2	1.9590	0.3330	0.3522	0.16	0.16
Sea otter	*Enhydra lutris kenyoni*	75.00			4.75	5.0	4.8	5.0	1.0390	4.9353	5.2197	2.36	2.44
North American river otter	*Lontra canadensis*	18.00	0.0	0.0	0.34	0.4	0.2	0.2	0.5830	0.0991	0.1048	0.05	0.05

Pacific marten	*Martes caurina*	2.00	0.0	0.0	1.02	1.1	0.5	0.5	0.4550	0.2321	0.2454	0.11	0.11
Ermine	*Mustela erminea*	0.57	0.0	0.0	0.34	0.4	0.2	0.2	0.4436	0.0754	0.0798	0.04	0.04
American mink	*Neovison vison*	2.00	0.0	0.0	2.03	2.1	1.0	1.1	0.4550	0.4618	0.4884	0.22	0.23
Wolverine	*Gulo gulo*	36.00			0.34	0.4	0.3	0.4	0.7270	0.2472	0.2614	0.12	0.12
Unidentified mustelid	*Mustelidae spp.*	6.00	0.0	0.0			0.0	0.0	0.4870	0.0000	0.0000	0.00	0.00
Unidentified marine mammal		132.50			0.00	0.0	0.0	0.0	1.4990	0.0000	0.0000	0.00	0.00
Total			**0.0**	**0.0**	**14.58**	**15.42**	**10.09**	**10.64**	**3.1506**	**15.2609**	**16.0584**	**7.29**	**7.51**
Ungulates													
Moose	*Alces americanus*	1000.00	0.0	0.0	16.27	17.2	8.1	8.6	8.4390	68.6513	72.6074	32.77	33.94
Black-tailed deer	*Odocoileus hemionus*	150.00	74.0	70.2	59.66	63.1	66.8	66.6	1.6390	109.5344	109.2183	52.29	51.06
Mountain goat	*Oreamnos americanus*	230.00	0.0	0.0	0.34	0.4	0.2	0.2	2.2790	0.3874	0.4098	0.18	0.19
Total			**74.0**	**70.2**	**76.27**	**80.67**	**75.14**	**75.42**	**12.3570**	**178.5731**	**182.2355**	**85.25**	**85.19**
Other													
Salmon		10.00			1.36	1.4	1.4	1.4	0.5190	0.7058	0.7465	0.34	0.35
Other fish and shellfish		10.00	0.5	0.5	0.34	0.4	0.4	0.4	0.5190	0.2180	0.2164	0.10	0.10
Unidentified amphibian		0.02			0.34	0.4	0.3	0.4	0.4391	0.1493	0.1579	0.07	0.07
Unidentified bird		0.50	1.0	0.9	5.42	5.7	3.2	3.3	0.4430	1.4220	1.4798	0.68	0.69
Total			**1.5**	**1.4**	**7.46**	**7.89**	**5.33**	**5.56**	**1.9201**	**2.4952**	**2.6006**	**1.19**	**1.22**

[1]Used to balance the scat sample sizes for each study. The formula used is: W = T / A, where "T" represents the "Target" proportion, "A" represents the "Actual"sample proportions and "W" is the "Weight" value.

[2]Determined by using the Weaver Correction Factor. Percent frequency of occurrence of a particular species in wolf scats does not always equate to percent consumed because smaller prey have a larger proportion of indigestible material than larger prey. The Weaver Correction Factor (Weaver 1993) has been used to correct for this bias and convert percent frequency of occurrence to percent consumed: Y^ = 0.439 + 0.008 x X where X is the average weight of a prey species and Y^ is the prey "weight" per scat.

[3]Y^ x the average FOC

[4]Y^ x the weighted average FOC

Table B-3 Wolf Diet in the POW Island Complex

POW Island Complex													
Citation			**Kohira and Rexstad 1997, pp. 429–430**		**Roffler et al. 2021; Roffler, pers comm**		Average FOC	Average Weighted FOC	Prey "weight" per scat (Y^)[2]	Corrected Average FOC[3]	Weighted Corrected Average FOC[4]	Proportion of Diet	Weighted Proportion of Diet
Location			Prince of Wales Island Complex Island		Prince of Wales Island Complex and Heceta Island								
Predominant time of year scat was collected			November - July		Year-round								
Number of scats			182		304								
Weight[1]			1.34		0.80								
Common name	Scientific name	Ave. Adult Weight (X)	Frequency of Occurrence (FOC)	Weighted FOC	FOC	Weighted FOC							
Rodents													
Hoary marmot	*Marmota caligata*	12.00	0.0	0.0	0.00	0.0	0.0	0.0	0.5350	0.0000	0.0000	0.00	0.00
American beaver	*Castor canadensis*	47.00	31.0	41.4	34.21	27.3	32.6	34.4	0.8150	26.5731	28.0098	11.71	11.71
Microtine	*Microtus spp.*	0.06	0.0	0.0	2.30	1.8	1.2	0.9	0.4395	0.5054	0.4040	0.22	0.17
North American porcupine	*Erethizon dorsatum*	20.00	0.0	0.0	0.00	0.0	0.0	0.0	0.5990	0.0000	0.0000	0.00	0.00
Squirrel	*Tamiasciurus hudsonicus*	0.75			0.00	0.0	0.0	0.0	0.4450	0.0000	0.0000	0.00	0.00
Unidentified rodent	*Rodentia spp.*	20.00	0.0	0.0			0.0	0.0	0.5990	0.0000	0.0000	0.00	0.00
Total			**31.0**	**41.4**	**36.5**	**29.2**	**33.8**	**35.3**	**3.4325**	**27.0785**	**28.4137**	**11.93**	**11.88**
Lagomorphs													
Snowshoe hare	*Lepus americanus*	3.50	0.0	0.0	0.33	0.3	0.2	0.1	0.4670	**0.0771**	**0.0616**	**0.03**	**0.03**
Carnivores													
American black bear	*Ursus americanus*	320.00	8.0	10.7	15.46	12.4	11.7	11.5	2.9990	35.1783	34.5472	15.50	14.44
Harbor seal	*Phoca vitulina*	190.00	0.0	0.0	0.33	0.3	0.2	0.1	1.9590	0.3232	0.2584	0.14	0.11
Sea otter	*Enhydra lutris kenyoni*	75.00			0.66	0.5	0.7	0.5	1.0390	0.6857	0.5481	0.30	0.23

North American river otter	*Lontra canadensis*	18.00	0.0	0.0	3.29	2.6	1.6	1.3	0.5830	0.9590	0.7666	0.42	0.32
Pacific marten	*Martes caurina*	2.00	0.0	0.0	0.66	0.5	0.3	0.3	0.4550	0.1502	0.1200	0.07	0.05
Ermine	*Mustela erminea*	0.57	0.0	0.0	0.00	0.0	0.0	0.0	0.4436	0.0000	0.0000	0.00	0.00
American mink	*Neovison vison*	2.00	0.0	0.0	0.00	0.0	0.0	0.0	0.4550	0.0000	0.0000	0.00	0.00
Wolverine	*Gulo gulo*	36.00			0.00	0.0	0.0	0.0	0.7270	0.0000	0.0000	0.00	0.00
Unidentified mustelid	*Mustelidae spp.*	6.00	17.0	22.7			17.0	22.7	0.4870	8.2790	11.0538	3.65	4.62
Unidentified marine mammal		132.50			0.00	0.0	0.0	0.0	1.4990	0.0000	0.0000	0.00	0.00
Total			**17.0**	**22.7**	**20.4**	**16.3**	**31.5**	**36.5**	**3.1506**	**45.5754**	**47.2942**	**20.08**	**19.77**
Ungulates													
Moose	*Alces americanus*	1000.00	0.0	0.0	0.00	0.0	0.0	0.0	8.4390	0.0000	0.0000	0.00	0.00
Black-tailed deer	*Odocoileus hemionus*	150.00	90.0	120.2	90.13	72.0	90.1	96.1	1.6390	147.6165	157.5157	65.05	65.84
Mountain goat	*Oreamnos americanus*	230.00	0.0	0.0	0.00	0.0	0.0	0.0	2.2790	0.0000	0.0000	0.00	0.00
Total			**90.0**	**120.2**	**90.1**	**72.0**	**90.1**	**96.1**	**12.3570**	**147.6165**	**157.5157**	**65.05**	**65.84**
Other													
Salmon		10.00			7.24	5.8	7.2	5.8	0.5190	3.7576	3.0036	1.66	1.26
Other fish and shellfish		10.00	5.0	6.7	0.00	0.0	2.5	3.3	0.5190	1.2975	1.7324	0.57	0.72
Unidentified amphibian		0.02			0.33	0.3	0.3	0.3	0.4391	0.1449	0.1158	0.06	0.05
Unidentified bird		0.50	0.0	0.0	6.25	5.0	3.1	2.5	0.4430	1.3844	1.1066	0.61	0.46
Total			**5.0**	**6.7**	**13.8**	**11.0**	**13.2**	**11.9**	**1.9201**	**6.5844**	**5.9584**	**2.90**	**2.49**

[1]Used to balance the scat sample sizes for each study. The formula used is: W = T / A, where "T" represents the "Target" proportion, "A" represents the "Actual"sample proportions and "W" is the "Weight" value.

[2]Determined by using the Weaver Correction Factor. Percent frequency of occurrence of a particular species in wolf scats does not always equate to percent consumed because smaller prey have a larger proportion of indigestible material than larger prey. The Weaver Correction Factor (Weaver 1993) has been used to correct for this bias and convert percent frequency of occurrence to percent consumed: Y^ = 0.439 + 0.008 x X where X is the average weight of a prey species and Y^ is the prey "weight" per scat.

[3]Y^ x the average FOC

Table B-4 Wolf Diet in Coastal B.C.

COASTAL B.C.						
Citation		**Darimont et al. 2004, p. 1871**	**Frequency of Occurrence (FOC)**	**Prey "weight" per scat (Y^)[1]**	**Corrected FOC[2]**	**Proportion of Diet**
Location		Coastal B.C.				
Predominant time of year scat was collected		Summer				
Number of scats		595				
Common name	**Scientific name**	**Ave. Adult Weight (X)**				
Rodents						
Hoary marmot	*Marmota caligata*	12.00	0.0	0.5350	0.0000	0.00
American beaver	*Castor canadensis*	47.00	3.0	0.8150	2.4450	1.48
Microtine	*Microtus spp.*	0.06	0.0	0.4395	0.0000	0.00
North American porcupine	*Erethizon dorsatum*	20.00	0.0	0.5990	0.0000	0.00
Squirrel	*Tamiasciurus hudsonicus*	0.75		0.4450	0.0000	0.00
Unidentified rodent	*Rodentia spp.*	20.00	1.0	0.5990	0.5990	0.36
Total			**4.0**	**3.4325**	**3.0440**	**1.85**
Lagomorphs						
Snowshoe hare	*Lepus americanus*	3.50	0.0	0.4670	**0.0000**	**0.00**
Carnivores						
American black bear	*Ursus americanus*	320.00	3.0	2.9990	8.9970	5.46
Harbor seal	*Phoca vitulina*	190.00	0.5	1.9590	0.9795	0.59
Sea otter	*Enhydra lutris kenyoni*	75.00		1.0390	0.0000	0.00
North American river otter	*Lontra canadensis*	18.00	4.0	0.5830	2.3320	1.42
Pacific marten	*Martes caurina*	2.00	6.0	0.4550	2.7300	1.66
Ermine	*Mustela erminea*	0.57	6.0	0.4436	2.6614	1.61
American mink	*Neovison vison*	2.00	3.0	0.4550	1.3650	0.83
Wolverine	*Gulo gulo*	36.00		0.7270	0.0000	0.00
Unidentified mustelid	*Mustelidae spp.*	6.00	0.0	0.4870	0.0000	0.00
Unidentified marine mammal		132.50		1.4990	0.0000	0.00

Total			**19.0**	**3.1506**	**19.0649**	**11.57**
Ungulates						
Moose	*Alces americanus*	1000.00	2.0	8.4390	16.8780	10.24
Black-tailed deer	*Odocoileus hemionus*	150.00	63.0	1.6390	103.2570	62.65
Mountain goat	*Oreamnos americanus*	230.00	6.0	2.2790	13.6740	8.30
Total			**71.0**	**12.3570**	**133.8090**	**81.19**
Other						
Salmon		10.00		0.5190	0.0000	0.00
Other fish and shellfish		10.00	12.0	0.5190	6.2280	3.78
Unidentified amphibian		0.02		0.4391	0.0000	0.00
Unidentified bird		0.50	6.0	0.4430	2.6580	1.61
Total			**18.0**	**1.9201**	**8.8860**	**5.39**

[1]Determined by using the Weaver Correction Factor. Percent frequency of occurrence of a particular species in wolf scats does not always equate to percent consumed because smaller prey have a larger proportion of indigestible material than larger prey. The Weaver Correction Factor (Weaver 1993) has been used to correct for this bias and convert percent frequency of occurrence to percent consumed: Y^ = 0.439 + 0.008 x X where X is the average weight of a prey species and Y^ is the prey "weight" per scat.

[2]Y^ x the FOC

APPENDIX C: RANGE-WIDE ALEXANDER ARCHIPELAGO WOLF HARVEST SUMMARY (1997-2021)

Analysis Unit	**Population estimate**	**ANNUAL REPORTED HARVEST (EMPIRICAL)**				**Estimated percent of total harvest that was unreported**	**Estimated percent of total harvest that was reported**	**ANNUAL TOTAL HARVEST (ESTIMATED)**				**ANNUAL UNREPORTED HARVEST (ESTIMATED)**			
		# of wolves		percent of population				# of wolves		percent of population		# of wolves		percent of population	
		Mean	Range	Mean	Range			Mean	Range	Mean	Range	Mean	Range	Mean	Range
Southern Southeast Alaska	509	96	54-130	19 percent	11-26 percent	17 percent	83 percent	116	65-157	22.72 percent	13-31 percent	20	11-27	3.86 percent	2-5 percent
Northern Southeast Alaska	255	25	11-46	10 percent	8-13 percent	17 percent	83 percent	30	13-55	11.81 percent	5-22 percent	5	2-9	2.01 percent	1-4 percent
Southern Coastal B.C.	430	41	1-135	10 percent	0-31 percent	17 percent	83 percent	49	1-161	11.49 percent	0-37 percent	8	0-26	1.95 percent	0-6 percent
Northern Coastal B.C.	444	24	1-78	6 percent	0-18 percent	17 percent	83 percent	29	1-94	6.51 percent	0-22 percent	5	0-16	1.11 percent	0-4 percent
POW Island Complex Island Complex	336	55	7-164	16 percent	2–49 percent	17-47 percent	53-83 percent	66-104	9-310	19.72-30.88 percent	3-92 percent	18-49	2-146	5.25-14.52 percent	1-43 percent

APPENDIX D: TIMBER HARVEST TABLES

Table D 1. Area of logged forest by decade and land ownership in the POW Complex Analysis Unit (GMU 2). Shaded cells represent totals for timber harvest before year 2000.

	Area of Logged Forest (km²), POW Analysis Unit				
Decade of Harvest	Tongass National Forest	State of Alaska	Native Corporation	Other	Total
Pre-1950	20	5	5	0	29
1950s	32	6	19	0	57
1960s	188	16	54	1	260
1970s	185	24	46	3	258
1980s	156	9	260	1	425
1990s	139	6	136	1	282
2000s	29	22	91	1	142
2010s	26	13	52	0	91
2020	1	1	7	0	10
Total	775	101	669	9	1,554
				Total Pre-2000	1,311
				Percent Pre-2000	84

Table D 2. Area of logged forest by decade and land ownership in the Northern Southeast Alaska Analysis Unit (GMUs 1C, 1D and 5A). Shaded cells represent totals for timber harvest before year 2000.

Decade of Harvest	Area of Logged Forest (km²), Northern Southeast Alaska Analysis Unit				
	Tongass National Forest	State of Alaska	Native Corporation	Other	Total
Pre-1950s	33	less than 1	less than 1	less than 1	33
1950s	less than 1	less than 1		less than 1	1
1960s	8	less than 1			9
1970s	7	less than 1	21	2	30
1980s	11		91	less than 1	103
1990s	8		less than 1		8
2000s	6	less than 1	6	less than 1	12
2010s	2	1	less than 1	2	5
2,020	1	less than 1	less than 1	4	5
Total	77	2	118	9	206
				Total Pre-2000	184
				Percent Pre-2000	89

Table D 3. Area of logged forest by decade and land ownership in the Southern Southeast Alaska Analysis Unit (GMUs 1A, 1B and 3). Shaded cells represent totals for timber harvest before year 2000.

	Area of Logged Forest (km²), Southern Southeast Alaska Analysis Unit				
Decade of Harvest	Tongass National Forest	State of Alaska	Native Corporation	Other	Total
Pre-1950s	43	less than 1	1	1	45
1950s	29	27	less than 1	1	58
1960s	97	17	5	1	119
1970s	164	7	33	4	208
1980s	121	4	58	1	184
1990s	118	3	67	1	188
2000s	35	15	22	less than 1	72
2010s	24	4	16	3	49
2020	2	less than 1	less than 1	less than 1	2
Total	633	76	202	12	924
				Total Pre-2000	802
				Percent Pre-2000	87

Table D 4. Timber volume in million board feet (MMBF) for old-growth (OG) and young-growth (YG) scheduled to be for sale on the Tongass National Forest between 2022 and 2026 by Analysis Unit, Southeast Alaska (USDA 2021, unpaginated).

Analysis Unit	2022		2023		2024		2025		2026		Total	
	OG	YG	OG	YG	OG	YG	OG	YG	OG	YG	OG	YG
POW Island Complex	1.70	0.15	2.30	14.20	1.95	0.20	1.95	0.20	1.95	26.00	9.85	40.75
Southern Southeast Alaska	2.90	24.00	2.30		2.65		1.40		1.30		10.55	24.00
Other (Outside Wolf Range)	0.40		0.40		0.40		0.40		0.40		2.00	0.00
Total	5.00	24.15	5.00	14.20	5.00	0.20	3.75	0.20	3.65	26.00	22.40	64.75

Table D 5. Timber volume (MMBF) and number of small sale and microsale projects by NEPA status and Analysis Unit in Southeast Alaska as of June 2022 (Sever 2022, pers. comm.). Timber cleared under the National Environmental Policy Act (NEPA) has been reviewed and approved, but not sold. Timber estimates for NEPA projects in development are subject to change.

	Analysis Unit	Old-Growth (MMBF)	Young-Growth (MMBF)	Number of Small Sale or Microsale Projects
NEPA-cleared timber (unsold)	Northern Southeast Alaska	22	-	-
	Southern Southeast Alaska	10.3	-	3
	POW Island Complex	15.5	14	2
	Other (Outside Wolf Range)	-	-	-
	Total NEPA-cleared	**47.8**	**14**	**5**
NEPA in development for timber projects	Northern Southeast Alaska	-	-	-
	Southern Southeast Alaska	53	33	-
	POW Island Complex	30.3	70	1
	Other (Outside Wolf Range)	-	-	1
	Total NEPA in development	**83.3**	**103**	**2**

Table D 6. Sold and uncut timber volume (MMBF) by Analysis Unit on the Tongass National Forest as of April 2022 (USDA 2022c, unpaginated). Uncut timber under contract has been sold and may be cut at any time.

Analysis Unit	Uncut volume of timber under contract (sold)		
	OG	YG	Total
Southern Southeast Alaska	3.9	2.7	6.6
POW Island Complex	8.8	15.0	23.7
Other (Outside Wolf Range)	1.5	0.0	1.5
Total	14.1	17.7	31.9

Table D 7. Change in area (km²) suitable for timber harvest on the Tongass National Forest and within the range of the wolf depending on status of 2001 Roadless Rule, by Analysis Unit and forest cover type. Old-growth and young-growth values came from suitability data from the Tongass National Forest, and contiguous old-growth patch values (in parenthesis) were estimated using updated forest cover data described in *Chapter 4.2.3 Availability of Old-Growth Forest*.

		Suitable area (km²)		
Analysis Unit	**Forest cover type**	**2001 Roadless Rule**	**Full exemption to 2001 Roadless Rule**	**Change**
Northern Southeast Alaska	Old-growth	25	43	18
	(Old-growth in contiguous patches)	(23)	(39)	(16)
	Young-growth	36	39	3
	Total suitable area	*61*	*81*	*20*
Southern Southeast Alaska	Old-growth	430	805	375
	(Old-growth in contiguous patches)	(228)	(380)	(152)
	Young-growth	471	492	21
	Total suitable area	*901*	*1,297*	*396*
POW Island Complex	Old-growth	298	445	147
	(Old-growth in contiguous patches)	(81)	(151)	(70)
	Young-growth	559	575	16
	Total suitable area	*857*	*1,019*	*163*

Table D 8. Area (km²) of Tongass National Forest that has been proposed for transfer to other ownership, by Analysis Unit, land transfer legislation (both active and inactive), and forest cover.

Analysis Unit	Land Transfers from Tongass National Forest	Productive Old-Growth			Young-Growth	Other	Total
		In Contiguous Patches (≥ 75 km²)	All Other Old-Growth	Total Old-Growth			
Northern Southeast Alaska	Active						
	SB3269 Unrecognized Communities	58.4	9.2	67.6	7.8	19.7	95.1
	Inactive						
	HR232 State National Forest Mgt Act	305.4	69.2	374.6	28.3	252.3	655.2
	Total for Northern Southeast Alaska	**363.7**	**78.4**	**442.2**	**36.0**	**272.0**	**750.2**
Southern Southeast Alaska	Active						
	AK Mental Health Trust	8.4	4.1	12.5	5.3	8.9	26.6
	SB3269 Unrecognized Communities	107.2	59.6	166.8	40.0	49.9	256.8
	Active Total	*115.6*	*63.7*	*179.3*	*45.3*	*58.8*	283.4
	Inactive						
	HR232 State National Forest Mgt Act	914.2	670.8	1,585.1	419.3	1,429.8	3,434.2
	Total for Southern Southeast Alaska	**1,029.8**	**734.6**	**1,764.4**	**464.6**	**1,488.6**	**3,717.6**
POW Complex	Active						
	AK Mental Health Trust	10.0	6.9	16.8	24.6	5.0	46.4
	SB3269 Unrecognized Communities	0.0	14.6	14.6	6.2	2.8	23.5
	Active Total	*10.0*	*21.5*	31.4	*30.7*	*7.8*	*70.0*
	Inactive						
	HR232 State National Forest Mgt Act	462.5	595.8	1,058.3	658.8	934.3	2,651.5
	Total for POW Complex	**472.5**	**617.3**	**1,089.8**	**689.6**	**942.1**	**2,721.4**

Table D 9. Area (km²) of land transferring to the Tongass National Forest from the Alaska Mental Health Trust, by Analysis Unit and forest cover.

Analysis Unit	Productive Old-Growth			Young-Growth	Other	Total
	In Contiguous Patches (≥ 75 km²)	All Other Old-Growth	Total Old-Growth			
Northern Southeast Alaska	2.2	1.2	3.5	-	7.4	10.9
Southern Southeast Alaska	42.6	13.2	55.8	3.6	28.4	87.8
Total	**44.8**	**14.4**	**59.2**	**3.6**	**35.8**	**98.6**

APPENDIX E: ANNOTATED CODE FOR POPULATION MODELS

Estimate future population size for Alexander Archipelago Wolves

Harvest is an n by 5 matrix with the harvest rates for each analytical unit as a columns, and the harvest rates for each scenario as rows.

POW.harvest is range of values for harvest on Prince of Wales

Inbred.D is an offset for lambda caused by inbreeding

Years is the number of years

Pop.estimates are the max and min estimates for the maximum population size that can be sustained within an analytical unit

r is a distribution of the intrinsic rate of growth 200,000 draws

h is a distribution of the effect of h 200,000 draws

K.factor is the multiplier for the maximum population size (1.5) to account for expert opinion/knowledge that the wolf populations were potentially higher that estimates from the 2015 SSA

Freq is the frequency of disease events (0.1 would be a 0.1 chance of an event every year)

```
AAwolffuture.fn<-function(harvest, POW.harvest, Inbred.D,years, pop.estimates, r,h,
K.factor,freq){

  Nt<-array(0, c(length(r),5,ncol=30))

  r<-r

  h<-h

for(j in 1:5){

  K<-runif(length(MT.r),pop_estimates[j,3],pop_estimates[j,4])*K.factor   ###max population
size

  add.event<-(1-(rbinom(length(r),1,freq)*0.25)) ###add disease event?

  ID<-rep(ifelse(j%in%c(1,2,3),Inbred.D[j],1),length(r)) ###is there inbreeding applied to that
unit
```

```
  Nt[,j,1]<-0.9*K  ###starting population size
  #####For POW include poaching and a variable harvest rate
if(j==2){
    for(k in 2:years){
      harvest.rand<-runif(1, POW.harvest[1],POW.harvest[2])
      m<-as.numeric(harvest.rand)*(Nt[,j,k-1]+(r)*ID*Nt[,j,k-1]*(1-(Nt[,j,k-1]/K)))
      Nt[,j,k]<-(Nt[,j,k-1]+(r)*ID*Nt[,j,k-1]*(1-(Nt[,j,k-1]/K))-h*m)*add.event
      Nt[,j,k]<-ifelse(Nt[,j,k]<0,0,Nt[,j,k])
    }
  }else{
    for(k in 2:years){
      m<-as.numeric(harvest[j])*(Nt[,j,k-1]+(r)*ID*Nt[,j,k-1]*(1-(Nt[,j,k-1]/K)))
      Nt[,j,k]<-(Nt[,j,k-1]+(r)*ID*Nt[,j,k-1]*(1-(Nt[,j,k-1]/K))-h*m)*add.event
      Nt[,j,k]<-ifelse(Nt[,j,k]<0,0,Nt[,j,k])
    }
  }
}
  return(Nt)
}
```