Ancient Human DNA Research in North America and Abroad: Challenges and Opportunities

by

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B.A., Simon Fraser University, 2013

Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of
Master of Arts

in the
Department of Archaeology
Faculty of Environment

SIMON FRASER UNIVERSITY

Summer 2015

Approval

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Abstract

The field of ancient DNA has revolutionized the way in which archaeologists and anthropologists investigate the lives of ancient people. However, there is a growing awareness that genetic research has important and diverse implications for people living today. These considerations are of particular importance for Indigenous peoples for whom genetic pronouncements about identity and ancestry may have important social, cultural, and political consequences. This thesis addresses these complex issues through three sources of information: literature on genetic research involving modern populations and how this translates to the context of ancient DNA; a review of case studies involving the genetic analysis of eight archaeological individuals found in British Columbia; and a survey completed by 47 ancient DNA researchers working around the world. The results of this tripartite study suggest that researchers working in this field face an array of social, ethical, and political challenges that differ significantly depending on the geographic location of their study. The unique needs, interests, and values of descendant communities situated around the world with whom the survey respondents interact, and in many cases work with, are important factors to consider when interpreting this difference. Three recommendations are provided along with relevant resources to assist researchers in navigating the challenges associated with ancient DNA studies and to create opportunities for a more equitable and collaborative investigation of the human past.

Keywords: Ancient DNA; genetics; bioarchaeology; ethics; survey; British Columbia; North America

What is past is prologue.

-William Shakespeare

Acknowledgements

I am very grateful for the help and support of my senior supervisor, Dr. George Nicholas. Your encouragement, patience, humour, and surprise deliveries of chocolate kept me going. I also thank Dr. Dongya Yang for his continued support throughout this project and Dr. Roger Chennells for his thoughtful questions and constructive feedback. I am grateful for the financial support I have received from the Intellectual Property Issues in Cultural Heritage (IPinCH) Project, Simon Fraser University, and the Social Sciences and Humanities Research Council (SSHRC).

I am thankful to all participants of this project who so generously shared their knowledge and perspectives with me. In particular, I acknowledge Dr. Ripan S. Malhi for the valuable constructive feedback he provided in the early stages of this project.

Additionally, I thank Brian Egan and Kristen Dobbin, as well as other members of the IPinCH team at SFU and elsewhere around the world. It has been an absolute privilege to work with you. I am grateful to the Archaeology Graduate Program staff, as well as my fellow Archaeology grad students. I'd especially like to thank: Mariane Gaudreau for many entertaining and informative discussions at coffee shops around the city, Joe Hepburn for his willingness to assist with various aspects of this project, and Alyssa Jordan for our much needed Skype debriefs

Finally, a special word of thanks goes to my parents, Leslie and Gord, and to my brother, Caden, for their continuous support and encouragement throughout this process.

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Chapter 1.

Ancient Human DNA Research in Archaeology

Unprecedented insight into the lives of ancient people may be gained through the analysis of DNA preserved in bone, tissue, and other biological materials. Molecular methods have been used to investigate questions of great archaeological significance including the study of human evolution and the interaction between *Homo sapiens* and other early hominins as they dispersed across the world (e.g., Green et al. 2010; Krause et al. 2010; Reich et al. 2010; Vernot and Akey 2014), and efforts to learn more about the first inhabitants of the Americas and their genetic link to people living today (e.g., Chatters et al. 2014; Cui et al. 2013; Eshleman et al. 2004; Kemp et al. 2007; Malhi et al. 2001, 2002, 2007; Rasmussen et al. 2014). Ancient DNA analysis has also been used to identify historically significant figures including King Richard III (Bucklet et al. 2013) and Russia's Imperial Romanov family (Gill et al. 1994), to study ancient human pathogens (Harbeck et al. 2013; Müller et al. 2014; Swanston et al. 2011), to investigate ancient plant and animal remains found at archaeological sites (Cannon and Yang 2006; Jaenicke-Despres et al. 2003; Speller 2005; Speller et al. 2013), to determine potential kinship relations between archaeological individuals (Baca et al. 2012; Bouwman et al. 2008), and, finally, to provide additional osteobiographic detail on ancient human remains, such as sex identification (Mays and Faerman 2001; Skoglund et al. 2013). The field of ancient DNA has seen tremendous advances in the past several decades and promises exciting opportunities for future research (Sarkissian et al. 2014).

While ancient DNA research may focus primarily on the analysis of genetic material preserved in the remains ancient people, there is an increasing awareness that such studies can have important and diverse implications for present-day descendant communities and other stakeholders (Adcock et al. 2001; Callaway 2014; Cilli et al. 2011; Lewis et al. 2007). This is especially true for genetic research involving Indigenous

peoples[1], for whom biogenetic pronouncements about their history and present-day identity may have very tangible impacts related to obtaining federal recognition, ongoing and future land claims, and the repatriation of human remains (e.g., Bardill n.d.; Past Horizons 2013; Raff et al. 2010; Taylor 2011). As a result, ancient DNA researchers may encounter a wide variety of complex and highly nuanced challenges that are linked to the implications—both perceived and actual—of ancient DNA research for people living today.

To date, investigations into the potential social, ethical, and political implications of ancient DNA research and the related challenges faced by individuals involved in this field, remains a critical but underdeveloped area of study. This thesis serves as a first step towards filling this knowledge gap while also serving as a resource for ancient DNA researchers grappling with these issues in their own studies taking place around the world. Through three different lines of investigation I provide insight into the on-the-ground experiences of ancient DNA researchers as they navigate unchartered ethical terrain. The first component of this study is a literature-based review of current discussions regarding the implications of modern genetic research[2] and how this translates to the context of ancient DNA research. The second is an examination of completed ancient DNA case studies on archaeological human remains found in the province of British Columbia, Canada. This provides practical examples of the ways in which ancient DNA research is being carried out, often through collaborative partnerships between researchers and descendant communities. The third component is an analysis of a survey distributed to an international sample of ancient DNA

[1] For the purposes of this thesis, I employ the term “indigenous peoples” to refer to “those who are marginal or dominated by the states that claim jurisdiction over them” (Maybury-Lewis 2002:7, as cited in Nicholas 2008:1661). Additional detail is offered by Jose R. Martinez Cobo (2010) who states that “Indigenous communities, peoples and nations are those which, having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing on those territories, or parts of them. They form at present non-dominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal system.”

[2] In the United States the study of the ethical, legal and social implications of genetic research is known as ELSI, and in Canada GE3LS (Genomics and its Ethical, Environmental, Economic, Legal, and Social Aspects. See Henderson et al. (2012); Kaye et al. (2012); Oliver and McGuire (2011) for a review of ELSI and GE^{3}LS.

researchers. The survey data provide insight into some of the common challenges faced by ancient DNA researchers and the practical ways in which these issues are being addressed or mitigated. Together, these three elements provide a foundation of practical knowledge, examples, and resources to assist those working in the field of ancient DNA.

1.1. **A Shift in Orientation**

The orientation of this thesis is itself an expression of the challenges associated with conducting ancient DNA research with descendant communities. Originally, my Master's thesis research was to focus on ancient DNA analysis of the remains of a 700-year-old woman, to be conducted in collaboration with the British Columbia First Nations band[3] upon whose land she was found. Following the excavation in 2006, the community had expressed interest in using ancient DNA to learn more about the woman and potential genetic affiliations with present-day populations (Copp 2006). Prior to her reburial, which took place shortly after the excavation, permission was given by the-then Chief and several Elders for samples to be sent to Simon Fraser University for genetic analysis.

In 2013, the earlier proposed ancient DNA project was re-introduced to the Chief, Band Council, and Elders by myself, joined by the archaeologist and the community member who had initially been involved in the excavation. In October of 2014, I traveled to the community to give a presentation (open to the public) with the goal of reviving the project. Following this meeting, interest in the study appeared to be high, and I subsequently began to work with Chief and Band Council to procure their final approval. Unfortunately, progress slowed in late 2014 and it became apparent that even if approval was granted, it would be too difficult to complete the ancient DNA project within the desired time frame for a Master's degree[4]. As a result, I re-focused my attention on understanding the various challenges that I, along with other ancient DNA researchers,

[3] In order to respect the privacy of the community, I refrain from naming the community or any individuals involved.

[4] Despite the change of course, I remain in contact with the archaeologist and community member who have been vocal advocates for the project since 2006, and hope to resume the original project in the future.

experience in the course of working with descendant communities and other stakeholders.

1.2. Research Objectives

Ancient DNA analysis offers unparalleled insight into the lives of ancient people. However, researchers involved in this field of study face new and complex challenges related to the actual and perceived social, ethical, and political implications of the genetic analysis of ancient human remains. This study thus has three broad research objectives:

1. To identify emerging challenges related to the actual and perceived social, ethical, and political implications of ancient DNA studies, as identified by those working in the field of ancient DNA research;
2. To investigate whether the challenges experienced by survey participants working in North America differ from those situated elsewhere in the world; and
3. To provide recommendations and associated resources for effectively addressing or mitigating the issues, as identified by survey participants.

These research objectives were achieved through a tripartite approach utilizing three complementary methods of data collection: background research; case study analysis; and a survey. First, I conducted extensive research on the social, ethical, political, and legal dimensions of genetic research as it is predominantly being discussed in relation to studies involving modern populations. I then examined all ancient human DNA case studies that have been completed in British Columbia, Canada, to provide examples of the different ways in which ancient DNA research is being carried out within the province. Finally, I created and distributed a survey to an international sample of researchers actively involved in the field of ancient human DNA studies to identify common challenges experienced by respondents, as well as how the issues identified by participants differed according to whether their research took place in North America, or elsewhere around the world.

Through these three approaches, this thesis offers specific information on ancient DNA research in British Columbia, and more broadly, the varying perspectives and approaches to the genetic analysis of ancient individuals adopted by researchers

working around the world. In addition, I offer recommendations, resources, and other examples to assist researchers and communities who are currently navigating the complex ethical terrain of ancient DNA studies.

1.2.1. Thesis Organization

This thesis is organized into six chapters. In the first chapter, I have presented my broad research goals and objectives, along with a brief description of my own personal experience working with a band in British Columbia on a proposed ancient DNA project.

In Chapter 2, I present an overview of the background research undertaken. I begin with a brief overview of past genetic studies involving Indigenous peoples. I then investigate the emerging social, ethical, and political considerations in genetic research, and how these apply to the context of ancient DNA studies. This background research also informed the development of my survey questions.

A review and discussion of completed ancient DNA projects in British Columbia are the focus of Chapter 3. A total of eight archaeological individuals have been studied using ancient DNA analysis within the province. This comparative review was designed to identify commonalities and differences between these studies, and subsequently demonstrated the notable degree of collaboration between researchers and descendant communities occurring in British Columbia.

I introduce and discuss the survey I distributed to ancient DNA researchers working around the world in Chapter 4. This includes an explanation of the survey questions, descriptions of how the survey was deployed, the manner in which the data were analyzed, and also the potential limitations of using a web-based survey for this study.

In Chapter 5, I provide the quantitative results of the survey, coupled with text responses provided by participants, to highlight the complex and nuanced issues that can arise in ancient DNA studies. The results provide insight into the most common challenges encountered by the survey participants and also indicate that respondents'

experiences differ according to whether the research was conducted in North America or elsewhere in the world.

My final chapter is centered on a discussion of the components of this thesis and the unique information provided by the three areas of investigation. Here I reflect upon my research objectives and provide recommendations for addressing and mitigating emerging social, ethical, and political challenges in ancient DNA research, based on the responses provided by survey participants. Finally, I consider the significance of this thesis as a first step towards more fully understanding the implications of ancient DNA studies and the various ways in which these challenges are being addressed by researchers working around the world.

Chapter 2.

Understanding the Social, Ethical, Legal, and Political Dimensions of Ancient DNA Research

What can we learn from studying the DNA of ancient people? Biomolecular analyses can reveal fascinating details about culturally significant figures, such as King Richard III's blonde hair and blue eyes (King et al. 2014), or Ötzi the Iceman's lactose intolerance (Keller et al. 2012). Questions of great archaeological value may also be explored through ancient DNA analysis, from tracing the evolution of *Homo sapiens* and other hominins (e.g., Fu et al. 2013; Krause et al. 2010; Meyer et al. 2012, 2014; Reich et al. 2010) to learning more about the earliest inhabitants of the Americas (Chatters et al. 2014; Gilbert et al. 2008; Kemp et al. 2007; Raghavan et al. 2014; Rasmussen et al. 2014). According to Sarkissian et al. (2014), further prospective research directions in genomics include studies of the origins and evolution of human pathogens, and the process of gene selection produced through animal and plant domestication, as well as opportunities for insights into how past climatic changes affected different species.

While ancient DNA may provide unparalleled understanding of the past, it is critical to consider the direct and tangible implications this knowledge may have for people living today. This is particularly true for Indigenous peoples for whom pronouncements about identity, ancestry, and early population movements —stemming from ancient or modern genetic analyses—may have important social, cultural, and political consequences (Adcock et al. 2001; Cilli et al. 2011; Kent 2013; Lewis et al. 2007; Pullman and Nicholas 2011; TallBear 2013). Moreover, the bleak history of genetic research involving Indigenous peoples, specifically the controversy surrounding the Human Genome Diversity Project (HGDP) and the profoundly negative experiences of the Nuu-Chah-Nulth and Havasupai peoples, has left a legacy that many researchers seeking to work with Indigenous communities are still struggling to overcome. Thus, in

consideration of the historical context and informed by an awareness of the potential implications of ancient DNA research for diverse stakeholders, this is a topic warranting some urgency.

In this chapter I identify and explore the real and perceived social, ethical, legal, and political implications of ancient DNA research from the perspective of diverse stakeholders.[5] I contextualize this by briefly considering how the HGDP and the experiences of the Havasupai in Arizona and Nuu-Chah-Nulth people in British Columbia continue to impact genetic researchers seeking to work with Indigenous peoples. In considering the potential implications of genetic research, particular attention is paid to the perspectives of Indigenous peoples for whom the prospect of DNA analysis may evoke unique concerns (Dodson 2000; Dodson and Williamson 1999; Gillett and McKergow 2007; Schroeder et al. 2006; TallBear 2013). Although views held by Native Americans towards genetic research were previously explored in a survey conducted by Kari Schroeder, Ripan Malhi, and David Glenn Smith (2006), their survey did not focus specifically on ancient DNA work in an archaeological context. I do so here by here by examining the social, ethical, and political dimensions of research pertaining to five broad topics:

1. Debates over ownership and intellectual property rights arising from ancient DNA research (Elliott 2009);
2. Challenges surrounding the consent and consultation processes when descendant communities are not easily identifiable, or if multiple groups claim descent from an ancient individual or population (O'Rourke et al. 2005);
3. Ensuring that ancient DNA research is compatible with the unique cultural values of the involved communities (see Beattie et al. [2000]; Cybulski et al. [2007]; and Worl [2014] for examples);
4. Issues arising when genetic analysis is perceived to challenge long-held understandings of identity and ancestral affiliations (Bolnick et al. 2007; Gaieski et al. 2011; Kent 2013); and
5. Interpreting the results of ancient DNA research through a political lens for a variety of purposes, including the repatriation of human remains, as additional support for land claims, or in relation to tribal enrollment (Bardill n.d.; Taylor 2011; Past Horizons 2013).

[5] This discussion is informed by the broader discussion related to the ELSI and GE^{3}LS literature but otherwise it is beyond the scope of this thesis to delve into this large area of research

This chapter begins with an overview of the controversies surrounding the Human Genome Diversity Project, and the studies involving the Havasupai and Nuu-Chah-Nulth peoples. I then discuss the potential implications of genetic research related to the five topics identified above. Ultimately, this chapter is intended to serve as a solid foundation for understanding current and future ethical developments in the field of ancient human DNA research.

2.1. Considering the Historical Context of Ancient DNA Research

The history of genetic research—and, more broadly, bioarchaeological investigations of human skeletal remains—involving Indigenous peoples in North America and elsewhere around the world is one of friction and disconnect. This largely stems from the fact that in the past, anthropological research was predominantly conducted *on* but not *with* Indigenous peoples. Three case studies are particularly demonstrative of the colonialist and exploitative nature of past genetic research. These are the controversy-ridden Human Genome Diversity Project (HGDP) in the 1990s, along with the profoundly negative experiences of the Nuu-Chah-Nulth in the early 1980s, and Havasupai in the 1990s in which biological samples were used in ways that both communities had no knowledge of and had not consented to.

In this section I consider these examples of problematic research projects that involved the genetic analysis of DNA samples provided by Indigenous peoples. While these case studies are not specific to the analysis of ancient human DNA, they do provide a glimpse into the unequal power dynamics that have characterized past genetic research with Indigenous peoples, and help to reveal the legacy that researchers today must strive to overcome.

2.1.1. The Human Genome Diversity Project

In the mid-1990s, the Human Genome Diversity Project was launched with the mission of collecting DNA samples from Indigenous groups around the world in order to explore human genetic diversity (Dodson and Williamson 1999). The project proposed

“collecting blood, hair, or human tissue samples from ‘isolated human populations’ of ‘special interest’ around the globe” (Reardon 2001: 360). Moreover, according to Luca Cavalli-Sforza, a leader of the HGDP, there was an urgent need to collect DNA from these isolated indigenous populations “before they merged with their neighbors… destroying irrevocably the information needed to reconstruct our evolutionary history” (as cited in Reardon 2001:357). The specific targeting of Indigenous peoples for DNA collection, as well as the apparent urgency with which to gather these samples before they “mixed with other populations, and evidence of population origins became forever lost in a murky soup of admixed DNA” (TallBear 2007:412) led to critiques centered upon the exploitative nature of the project and concern regarding a new era of “biocolonialism” (Indigenous Peoples Council on Biocolonialism 2000).

Beginning in 1993, the HGDP faced an onslaught of criticism and controversy, largely led by the Rural Advancement Foundation International (RAFI), an Indigenous advocacy group based in Canada. While the researchers involved in the HGDP acknowledged that the populations they were seeking to collect DNA from were “historically vulnerable to exploitation by outsiders” and that there were “ethical, legal, and human-rights issues connected with the project,” this admission was insufficient for RAFI and other critics of the project (Reardon 2001:368).

Opposition to the HGDP reached a fever pitch in 1995 when RAFI discovered that a patent had been filed by the U.S. government on a cell line from the DNA of a 20-year-old Hagahai man from Papua New Guinea (Cunningham 1998). The sample was initially collected by medical anthropologist Carol Jenkins, who was now listed as an “inventor” on the patent. Not only did this raise “concerns about the humanitarian objectives of the Hagahai project” but also provoked “serious queries about the discipline of anthropology itself and the connection of biological anthropologists to the commercialization of indigenous DNA” (Cunningham 1998:212). RAFI interpreted the Papua New Guinea patent as conclusive proof that the HGDP represented the beginning of an era of biocolonialism, and that the human genome was the newest territory upon which “a continuation of the oppressive power relations that have historically informed the interactions of western and Indigenous cultures” was being played out (Whitt 2009:1). Despite a purported financial benefit-sharing arrangement between the United

States' National Institute of Health and the Hagahai in which the tribe would receive "50 percent in the royalties of any breakthrough in Leukemia research resulting from their genetic sample" the patent was revoked in the face of ongoing controversy (Chennells 2014:23).

Ultimately, the failure of the Human Genome Diversity Project cannot solely be attributed to methodological challenges, but as Jenny Reardon (2001:357) argues, the organizers of the Diversity Project had failed to "coproduce" a social and ethical framework in which their project could operate. Today, many of the concerns that were first highlighted by the HGDP remain unresolved and pose a challenge for genetic researchers working with Indigenous peoples, including the Human Genographic Project launched in 2005[6]. As described on the official website, the project has "used advanced DNA analysis and worked with Indigenous communities to help answer fundamental questions about where humans originated from and how we came to populate the Earth."

While the Human Genographic Project has gone to great lengths to distance itself from its predecessor, the HGDP, Kimberly TallBear argues that the two projects ultimately share the same goal: "to greatly increase the size of the existing [genetic] data base in order to produce a more detailed story about human migratory history and the deep historical genetic relationships between different peoples of the world" (TallBear 2007:413). Large-scale genetic research initiatives present complex ethical challenges

[6] First launched in 2005, the National Geographic's Genographic Project (HGP) has sampled DNA from over 700,000 individuals around the world (many of whom submitted their own DNA samples through a DNA test kit for purchase on the HGP's website for $199. As identified on the HGP's website, the project has three goals: 1) "To gather and analyze research data in collaboration with indigenous and traditional peoples around the world"; 2) "To invite the general public to join this real-time scientific project and to learn about their own deep ancestry by purchasing a Genographic Project Participation and DNA Ancestry Kit, Geno 2.0"; and 3) "To use a portion of the proceeds from Geno 2.0 kit sales to further research and the Genographic Legacy Fund, which in turn supports community-led indigenous conservation and revitalization projects." While the HGP has made efforts to distance itself from the earlier Human Genome Diversity Project, concerns remain about the potential for exploitation (Hollowell and Nicholas 2009; Reardon 2009; TallBear 2007) and the effect the HGP may have for molecular anthropologists who seek to build long-term collaborative relationships with indigenous communities (Malhi 2009).

that defy simple solutions, as demonstrated by the controversy that plagued the HGDP and that continue to confront genetic researchers working with Indigenous people.

2.1.2. The Havasupai

In the 1990s, members of the Havasupai tribe in Arizona participated in a genetic study focused on the high-rates of diabetes within the community (Marks 2010:4). Diabetes is a pressing health concern for the Havasupai and many other Native American communities; as a result, members of the Havasupai tribe participated in the study with the belief that the diabetes-related research would be of direct benefit to them (Garrison 2013). In 1993, the researcher who collected the blood samples, Therese Markow (Markow and Martin 1993), published a paper related to genetic markers of diabetes among the Havasupai. However, she and other researchers continued to use DNA samples for additional studies "on schizophrenia, ethnic migration, and population inbreeding, all of which are highly charged topics that are taboo in the Havasupai culture" (Garrison 2013:202).

In response to the misuse of their biological samples, the Havasupai tribe filed a lawsuit against the Arizona Board of Regents and Arizona State University in 2004 (Garrison 2013). A settlement was reached in 2010, with $700,000 paid to the Havasupai and the return of the tribe's biological samples (Harmon 2010). In addition, Arizona State University agreed to partner with the Havasupai to assist them with securing funding for a new health clinic and high school (Marks 2010:4). This case highlights the challenges surrounding informed consent and the harm that may be experienced when biological samples are used for additional research of which the donor is unaware. As explained by Carletta Tilousi, a member of the Havasupai Tribal Council, "I'm not against scientific research…I just want it to be done right. They used our blood for all these studies, people got degrees and grants, and they never asked our permission" (Harmon 2010).

2.1.3. The Nuu-Chah-Nulth

Similar to the case of the Havasupai, the Nuu-Chah-Nulth people of northwestern British Columbia participated in genetic research that they believed would result in health benefits for their community. From 1983 to 1985 blood samples were collected by Dr. Ryk Ward, University of British Columbia, for a study funded by Health Canada on the high rate of rheumatoid arthritis among the Nuu-Chah-Nulth people (Arbour and Cook 2006). In a letter to the Ahoursaht Chief and Council, Ward emphasized the potential benefits of the study to the participating communities: "We feel that if a proper study is carried out it will identify all people who have a problem with their joints and physiotherapy treatment can be started as a way of helping them. In order to carry out the study, I would like to survey every person in Ahousaht so that we can be sure exactly who has a problem with rheumatic disease and who needs help" (Wiwchar 2000).

At the time of the study, rheumatoid arthritis was a pressing health concern, with the disease prevalence estimated to be as high as 66% among the Nuu-Chah-Nulth people (Wiwchar 2000). Gertrude Frank, a participant in the study, explained that she "was interested [in the study] because my mother has arthritis, I have arthritis really bad, and some of my children have it, including my oldest daughter who has it really bad now" (Wiwchar 2005). With entire families debilitated by the disease, the Nuu-Chah-Nulth saw Ward's study as being of immense potential benefit to the community.

However, by 1988, almost four years after Ward had collected the samples from the Nuu-Chah-Nulth, the communities were informed that he was unable to determine the genetic roots of arthritis and had since left the University of British Columbia for the University of Utah. Continuing his research using the biological samples provided by the community, Ward published a paper in 1991 on the results of his study of the genetic ancestry and population history of the Nuu-Chah-Nulth people (Wiwchar 2005). This research occurred without participants' knowledge or consent, and directly contradicted Nuu-Chah-Nulth oral histories, which state that they have been on the West Coast since time immemorial (Wiwchar 2005).

When the community became aware of this, a tribal research ethics committee was formed and began proceedings to have the blood samples returned to the

community following the sudden death of Ward in 2003 (Wiwchar 2004). The University of Oxford, where Ward served as a professor at the time of his death, returned the blood to the University of British Columbia where it will be housed until the Nuu-Chah-Nulth Research Ethics Committee reaches a decision as to how to proceed. Despite the harm caused by Ward's research, community members claim that they are not opposed in principle to genetic research in the future, as long as researchers follow "follow our [Nuu-Chah-Nulth] protocols and rules" as set out by the ethics committee (Wiwchar 2004:4).

2.1.4. Learning from the Past

These three cases — the Human Genome Diversity Project, Markow's Havasuapai study, and Ward's Nuu-Chah-Nulth study—have had a significant (and continuing) impact on genetic research conducted today with Indigenous peoples around the world. In particular, these three examples highlight several problems:

1. The persistence of a colonialist perspective in which it is the "right" of geneticists to collect and study the genetic material of Indigenous peoples in order to improve our "shared" understanding of human evolution and migration (Reardon and TallBear 2012:5239);
2. The potential for large-scale research projects that investigate the genetic "differences" between individuals, including the HGDP and others, to reintroduce antiquated notions of biological race (Koenig et al. 2008; Reardon 2005; TallBear 2003); and
3. The challenges inherent within individual informed consent when (a) populations are the unit of study, as with the HGDP (Greely 2001; Reardon 2001), and (b) the limited protections available with regards to the potential future uses of genetic data, as demonstrated by the experiences of the Havasupai and Nuu-Chah-Nulth.

While these case studies are not specific to the realm of ancient DNA research, they provide useful lessons regarding the social, ethical, legal, and political dimensions of genetic research for Indigenous peoples. Moreover, the issues present within these examples, such as the limitations of individual consent in genetic research, continue to pose problems for genetic researchers decades later. A consideration of the historical context, which informs the environment in which ancient DNA researchers operate, is necessary to understand emerging challenges in relation to ancient DNA analysis.

2.2. Intellectual Property, Ownership, and Ancient DNA

Determining ownership over and access to genetic resources is becoming an increasingly important and contentious area of discussion. The rapid expansion and development of the biotechnology industry, projected to reach $453.3 billion US dollars in 2016 (MarketLine 2012), have fuelled proprietary interest in the human body and it's components, with a particular emphasis on the human genome. Given the immense economic value rooted in the tangible and intangible products of human genetic research, it is of the utmost importance to develop clear proprietary guidelines as well as policies on fair and equitable use of genetic resources and knowledge. Despite this, human DNA continues to exist within a legal and ethical grey area. For example, from 1992 – 1995 under the Convention of Biological Diversity (CBD), human DNA was conceptualized as property subject to the sovereignty of states. However, by 1995, human DNA was excluded from the CBD and repositioned as "the common heritage of humanity" (Chennells 2014:43-49).

While it is apparent that proprietary and intellectual property issues play a prominent role in the realm of modern human genomic research, how do these challenges translate to the field of ancient DNA? In the following section I first consider the problematic nature of determining ownership over the human body, in both ancient and modern contexts, and then discuss the utility of the "DNA on Loan" model for determining proprietary rights over ancient and modern genetic information.

2.2.1. Property Rights and the Human Body

Historically, property rights lay in the physical entity of the human body, rather than the intangible information that may be derived from studies of the human body and its various cells, tissues, and organs. Beginning in the 17th century, the "no-property rule" maintained that the living could hold no ownership rights over a human corpse (Sperling 2008). Despite the no-property rule and the unwillingness of the legal system to recognize proprietary rights in the bodies of the deceased from the 17th – 19th century, one could still secure a "comfortable living" as a body-snatcher selling corpses to medical institutions in 18th – century England (Richardson 2000:57).

However, with scientific advances in the 21st– century came a shift towards finding value not within the physical confines of the human body but in the information that may be derived from its study. The ensuing shift in legal perspectives with regards to ownership over the human body and its various components is exemplified by the infamous case of John Moore who sued his doctor for the use of his DNA to create a highly profitable cell-line, without his knowledge or consent (Dickenson 2004). The court ruled that the cell-line belonged to the doctor, not Moore, as it represented the doctor's investment of work and skill (Pálsson and Rabinow 2001). Another example that demonstrates the shift towards claiming ownership and intellectual property rights over knowledge and products originating from the human body include the billion-dollar industry of the HeLa cell line, originally derived from cancer cells sampled from a woman named Henrietta Lacks in 1951 (Skloot 2010)

Of particular importance to the field of archaeology and ancient DNA is another exception to the no-property rule: the "long-dead exception" present in British and American law. This exception maintains that less recent human remains, particularly ancient or archaeological remains, may be considered as property (Elliott 2009; Sperling 2008). The long-dead exception is rationalized by Philippe Ducor who theorizes that it is easier to accept property rights over an anonymous individual or a person from a "dissimilar and remote society than from one's own community" (as cited in Sperling 2008:110). In an archaeological context, there are numerous instances where property rights have been claimed in the bodies of the long-deceased. For example, the discovery of the mummified remains of Ötzi in 1991 sparked a fierce debate between Austria and Italy over who owned the 5,300-year-old remains (Fowler 2001). Ultimately, ownership was determined based on the geographic location of the remains: Ötzi had been found 92.56 metres on the Italian side of the border and thus belonged to Italy[7]. Now on public display in the South Tyrol Museum of Archaeology, it is estimated that Ötzi brings in about $3.2 million (US) each year in admission fees (Walker 2013).

A similar situation recently unfolded regarding the remains of King Richard III. Discovered beneath a car park by archaeologists working for the University of Leicester

[7] http://www.iceman.it/en/node/241

in 2013, the final resting place of King Richard III was a point of contention between the University of Leicester and York, England (Walker 2013). An additional dimension to consider in both cases of King Richard III and Ötzi is the economic privilege associated with access to and control over the remains of a historically significant individual (Walker 2013). The so-called "Richard III effect" has contributed an estimated £45 million pounds to the Leicester economy (BBC News 2014; Walker 2013).

These two cases also demonstrate another potential exception to the no-property rule: ownership rights may be created in "culturally relevant bodies" (Elliott 2009:108), such as King Richard III, Ötzi, and others. In practice, legislation such as the Native American Graves and Repatriation Act (NAGPRA) encouraged the creation of property rights in the remains of the deceased by describing ancestral remains as "cultural objects" to be owned and controlled by their descendants (p.108). Thus, the practice of claiming ownership rights over the physical remains of individuals with cultural significance, including figures of historical importance or deceased ancestors, is already being practiced in archaeology.

2.2.2. Claiming Ownership over Ancient Genetic Information

It is apparent that "long-dead" bodies of cultural value can be subject to claims of ownership, but what ownership rights can be exercised over the information arising from the genetic analysis of ancient human remains? Two contrasting strategies have been proposed in order to provide some guidance on the issue of DNA ownership: 1) to view the human genome as the common heritage of all humanity, or 2) to apply the concept of property rights to the human genome[8]. The common heritage approach maintains that DNA does not belong to anyone but is the shared heritage of all humanity (Elliott 2009:114). However, the political and legal tools by which to implement this approach are lacking and the potential for genetic information to be used in ways other than what was initially intended remains a concern (e.g., the misuse of the samples provided by the Havasupai and Nuu-Chah-Nulth). Others argue that human DNA should be subject to

[8] See Rogen Chennells (2014) for a detailed discussion of the changing legal status of human DNA.

ownership and viewed as the property of the individual (Elliott 2009:118). Those who advocate for this approach insist that individuals must have control over their DNA and genetic information in order to prevent exploitation, as experienced by John Moore following the commercialization of a cell line derived from his spleen.

However, viewing DNA—whether from ancient or modern sources—as property has caused unease for many people. This is particularly true of research conducted with Indigenous people for whom a sense of stewardship and collective responsibility to care for resources for present and future generations is of greater relevance than individual property rights (Gillett and McKergow 2007:2098; Tsosie 2007:398). In indigenous societies, *community* rather than *individual* ownership generally governs the sharing of cultural property, ranging from sacred sites to oral histories to human DNA (Dodsen and Williamson 1999). An additional drawback to viewing DNA as the "property" of a particular Indigenous group is to risk perpetuating the belief that "cultural identity can be established from a particular subset of genetic markers" (Pullman and Nicholas 2011:152) and that "culture" can be reduced to a molecular origin. Thus, it is apparent that neither the common heritage model nor the cultural property model adequately addresses the complex issues surrounding ownership over human DNA.

Complex issues related to ownership and intellectual property demand innovative agreements between institutions, researchers, and communities. One strategy for addressing these challenges is to view DNA as being "on loan" by the individual or community to the researcher. As proposed by Laura Arbour and Doris Cook (2006), the "DNA on Loan" approach reorients the power balance so that researchers become the stewards of the biological samples while ownership rights remains with the participant or community. The stewardship of the DNA by the researcher may span several decades, but the agreement that the sample is on loan will continue indefinitely. The practical implications of this arrangement are powerful as the researcher must continue to seek consent from the community if the nature or scope of the research changes. By viewing researchers as the stewards and not the owners of DNA, the authority over their DNA remains with individuals and communities. Additional support for the DNA on Loan approach can be found within the Canadian Institute of Health Research (CIHR)'s guidelines for research involving Aboriginal communities, which states that "biological

samples should be considered "on loan" to the researcher unless otherwise specified in the research agreement" (CIHR 2010).

2.3. Considering the Limitations of Individual Consent in Genetic Research

There are few explicit policies and protocols in place related to the process of consent and consultation that are specifically designed to suit the unique context of ancient DNA analysis on human remains. The limitations of individual consent in genetic research have long been recognized due to the potential for an individual's decision to participate in genetic studies to impact family and community members (Annas 1993; Greely 2001). To prevent exploitative or potentially harmful genetic research, as was experienced by the Havasupai and Nuu-chah-nulth (discussed above), informed consent[9] is now required practice in all research involving humans. However, the act of requiring consent does not in and of itself eliminate the problematic power imbalances that plagued genetic research in the 20th century (Dickenson 2004). This section examines the limitations of individual consent in genetic research and considers the various approaches that are adopted in the unique context of ancient DNA studies.

While individual informed consent is an essential component of all research studies involving humans, it may be insufficient to adequately address the potential risks of participating in a genetic research project. One commonly acknowledged limitation of individual consent in relation to genetic research is that DNA analysis reveals information "not only about the subject, but also her group, family, and community" (Chennells 2014:171). The need to consider the broader community that may be affected by genetic research is echoed by Sharp and Foster (2002:145) who state that "regulatory standards focused on the protection of individual research subjects may be insufficient" when conducting genetic research in a community context. Additionally, McGregor (2007:362) offers an alternative conceptualization of the ethical considerations in genetic research

[9] As set out by the Canadian Tri-Council Policy Statement (TCPS2 2014) on Ethical Conduct for Research Involving Humans, "consent" must be "free, informed and ongoing" (Chapter 3, introduction).

as internal versus external risk. External risks may be comprised of discrimination or stigmatization (2007*:* 362). Alternatively, internal risks may include a loss of dignity, "privacy and psychological issues experienced within the group" (p.362).

In response to the limitations posed by individual consent, group consent or community approval has been proposed as an alternative consent model in genetic research (Greely 2001). However, while group consent or approval may address some of the limitations of individual consent, it is certainly not a straight-forward process and introduces new challenges for researchers. One such challenge is determining exactly *which* communities, governing bodies, or other organizations should be to approached for gaining consent for a research project. The issues inherent within group consent are demonstrated in a study by Schuster et al. (2010) in which the complete genomes of Khoisan and Banta peoples from southern Africa were published. The article was met with much opposition by the San who allege that consent had been sought not from community leaders but from "the deliberate selection of illiterate aged participants" (Chennells 2014:189). Moreover, there was an apparent failure on the part of the researchers to engage with the broader San community "in order to ascertain its inputs or concerns" (Chennells 2014:189). This case study highlights the fact that individual or group consent, in and of itself, does not result in ethical genetic research and that researchers have a responsibility to identify the culturally appropriate persons or group to approach for consultation and consent.

2.3.1. Considering Consent and Consultation in the Context of Ancient DNA Research

In addition to the complexities posed by the very nature of genetic research, the unique context of ancient DNA analysis adds novel ethical challenges in relation to obtaining consent from appropriate communities or other stakeholders. Simply put, individual consent is not an option when seeking to analyze the genetic material of a long-deceased person. Thus, a series of questions are introduced: in place of the deceased, who should be approached for consultation and is it possible for a descendant to give proxy consent? Additionally, O'Rourke et al. (2005:231) note three other consent-related challenges faced by ancient DNA researchers: 1) access to

research samples; 2) the consent process that resulted in access to the samples; 3) and "a realistic assessment of what risks and/or benefits might obtain, and to whom, if molecular analyses are conducted on prehistoric materials." Moreover, consent and consultation procedures may also be directed or stipulated by legislation, such as the Native Graves Protection and Repatriation Act (NAPGRA) in the United States (O'Rourke et al. 2005: 231).

The inability of the subject of study in ancient DNA research to provide consent has evoked philosophical and ethical theorizing. Soren Holm (2001) argues that a key way to navigate this ethical quandary, using the Egyptian Pharaoh Tutankhamun as an example, is to seek proxy consent from descendants. However, this introduces the subsequent difficulty of defining and identifying subsequent descendants, whether based on biological or cultural affiliation. Also focusing on the ethics of studying mummified remains, Kaufmann and Rühli (2010:609) consider the arguments for and against allowing ancient DNA research. They identify four categories of pro and con arguments for ancient DNA analysis of mummies: 1) factors related to religion and culture; 2) law and guidelines; 3) information and progress of knowledge; and 4) individualism and the right of integrity[10]. Both of these articles demonstrate the diversity of perspectives that exist towards the destructive analysis of ancient human remains.

Obtaining proxy-consent from descendant communities is the primary means by which ancient DNA researchers address the ethical impasse inherent within the scientific study of ancient human remains. From a practical perspective, it is important to determine *who* is an appropriate proxy-decision maker, which can be a considerably challenge. Unlike with genetic research involving living people where appropriate decision-making bodies are relatively easy to identify, ancient DNA researchers must grapple with the complexities introduced by the extensive temporal span of their study:

[10] As noted by Kaufmann and Rühli (2010:609), individualism "defines human beings as an end in themselves, and not just as a means to broader social ends" while the right to integrity is the "right of each human being to be protected from any kind of harm." They contend that destructive biological tests, including ancient DNA analysis, may be perceived by some to infringe upon the ethics of individualism and the deceased's right to integrity, or, alternatively, such analyses may support the principle of individualism "when research results put aside false accusations (e.g., speculations about cause of death or disease)" (2010:609).

an ancient individual may have many thousands of genetic descendants, the vast majority of whom may be unaware of any biological affinity. Moreover, the continual movement and melding of populations—past and present—adds a further layer of complexity when attempting to link ancient and modern populations.

While numerous individuals and communities may experience perceived or actual implications resulting from DNA analysis of ancient human remains, there are practical limitations to the number of individuals or groups that can be consulted for a research study. The challenges and limitations of widespread consultation are demonstrated by Rasmussen et al.'s (2014:225) study of the remains of the Anzick child in Montana, which suggest that the child (dated to approximately 12,000 years ago) "belonged to a population directly ancestral to many contemporary Native Americans." Recognizing the potential implications of this study for present-day Native American groups, attempts were made by the research team to engage with tribes in the state of Montana. Evolutionary biologist and lead author in the study Eske Willerslev explained that he "didn't want a situation where the first time they [Native Americans] heard about the study was when it's published" (Callaway 2014). This example demonstrates the strategy adopted by one recent ancient DNA study to attempt widespread consultation with local tribes, and the ensuing complexities with regards to *who* should have been consulted and/or provided consent for the analysis and *when*.

2.4. Ancient DNA, Ancestry, and Identity

Recently, there has been discussion over how genetics and ancient DNA is being used to define—or redefine—concepts of identity and understandings of ancestral affiliations. An increasingly common source of information for understanding personal identity (in spite of their scientific limitations) are DNA kits available for purchase online that purport to reveal one's ancestral affiliations (Bolnick et al. 2007; TallBear 2013). The trend towards a reduction of identity and ancestry to a molecular basis is of particular concern for Indigenous peoples, for whom genetic pronouncements regarding identity may have profound social, political, and economic implications (TallBear 2013). For example, in the United States the Cherokee Nation, the Picayune Rancheria of the Chukchansi Indians, and several other tribes have each introduced genetic criteria to

inform tribal enrolment decisions (Bardill 2014; Taylor 2011). In other cases, ancient DNA analysis may have implications for ongoing or future land claims (Cui et al. 2013), or may take on significance for the repatriation of human remains, as demonstrated by the recent developments in the genetic analysis of Kennewick Man (Rasmussen et al. 2015). Ultimately, ancient DNA analysis and other forms of genetic research may provide additional support for traditional understandings of the past, or the results may be unexpected and provide new insight into the complex relationship between ancient peoples and those living today.

Using genetic methods to investigate the past may yield unexpected results that challenge long-held understandings of identity and ancestry. Gaieski et al. (2011) conducted a genetic study with community members of St. David's Island in Bermuda with the goal of piecing together the complex colonial history of the island. Contrary to historical documents and the community's own oral histories of their descent from enslaved Native Americans, Gaieski et al. (2011) found a relatively low percentage of Native American mitochondrial and Y-chromosome lineages in the present-day inhabitants of St. David's Island. Biogenetic histories may thus differ vastly from other forms of understanding identity and ancestry, as suggested by this example.

Alternatively, DNA analysis may confirm traditional understandings of identity and ancestry, which may have important cultural, legal, and political significance. For example, the Uros of Peru saw DNA analysis as a potential means by which to solidify their long-contested claims of descent from the ancient Uros, the first indigenous peoples to have inhabited the Andes (Kent 2013). In an attempt to establish their identity as the "real Uros" (Kent 2013: 548), members of the community provided DNA samples to the Human Genographic Project[11]. Genetic analysis supported the Uros' long-standing claims of descent from the ancient population and was lauded by the community as an important victory with political significance in relation to ongoing territorial conflicts with the government of Peru (Kent 2013).

Finally, genetic analysis may provide an understanding of an individual's biogenetic origin and ancestry when other historical sources of information have been lost. For example, genetic testing of individuals buried in the African Burial Ground in New York City indicated maternal descent from living populations in Benin, Nigeria, Senegal, and Niger (Mack and Blakey 2004). Most recently, Schroeder et al. (2015) conducted genome-wide analysis on the remains of three enslaved Africans buried on the Caribbean island of Saint Martin. One individual's DNA indicated descent from Bantu-speaking groups living in northern Cameroon while the other two individuals showed close genetic affinity to non-Bantu speaking peoples living in present-day Nigeria and Ghana (p. 3). Thus, while it is important to understand the limitations of genetic analysis in relation to understanding identity and ancestry, DNA is a powerful tool by which the histories of marginalized peoples may be reclaimed.

2.5. Integrating Cultural Values into Ancient DNA Research

The scientific study of human remains is a topic that provokes vastly differing responses from Indigenous individuals and communities. For some Indigenous peoples, any form of scientific study including ancient or modern DNA research, is an impermissible violation of cultural appropriateness (Harry and Dukepoo 1998). However, many Indigenous peoples support ancient DNA research and have participated in studies that have been positive and productive for both the communities and researchers involved (e.g., Beattie et al. 2000; Cui et al. 2013; Cybulski et al. 2007; Nicholas et al. 2008). Researchers wishing to conduct ancient DNA research must be aware of the unique cultural values possessed by the individuals and community with whom they are working.

Not all ancient DNA studies will directly involve descendant groups, but for those that do, genetic research may conflict with cultural values. The Western practice of extricating and commodifying aspects of the human body has led to a widening of "the gap between scientific and other perspectives" (Gillett and McKergow 2007:2094). For many Indigenous peoples, *all* parts of the body including, hair and blood, are considered interconnected and sacred elements, and that the collection of biological samples from human remains represents "a serious violation of the sanctity of our deceased

ancestors" (Harry and Dukepoo 1998:8). As explained by Native American geneticist, Frank Dukepoo, "to us, any part of ourselves is sacred. Scientists say it's just DNA. For an Indian, it's not just DNA, it's part of a person, it is sacred, with deep religious significance. It is part of the essence of a person" (as cited in Arbour and Cook 2006:155). The view that the body represents a sacred whole is in stark contrast to the current practices regarding the repatriation of human remains at the British Museum, under which hair and nails are generally excluded from the repatriation policy (Callaway 2011).

However, many Indigenous peoples view the opportunities presented by ancient DNA analysis as outweighing concerns regarding its destructive nature. For many, ancient DNA analysis is viewed as an opportunity to learn about ancient peoples in a way that is culturally respectful, and may serve as a way to perpetuate traditional values and knowledge (Worl 2014). An example of the compatibility between ancient DNA research, oral histories, and traditional knowledge can be found in the collaborative analysis of the frozen remains of Kwäday Dän Ts'ìnchi or "Long Ago Person Found," which were recovered on a glacier in far northern British Columbia in 1999. Oral histories from local First Nations communities suggested that the ancient person was Kaakaldeini, an ancient hunter who urged his hunting party to leave him behind on a glacier after he was injured (Worl 2014). Ancient DNA analysis was conducted on the remains in close collaboration with the Champagne and Aishihik First Nations and compared to DNA samples provided by 250 participants, of which nine individuals from Alaska and eight from Canada were found to be close genetic descendants of Long Ago Person Found (Worl 2014).

The example of Kwäday Dän Ts'ìnchi demonstrates the potential for genetic analysis to co-exist with traditional values and knowledge. When explaining why the Southeast Alaskan Tlingit, Haida, and Tsimshian peoples decided to participate in the ancient DNA study, Rosita Worl, President of the Sealaska Heritage Institute, pointed to the traditional values of *Haa Shágoon* (Tlingit), *Ítl' Kuníisii* (Haida), and *Hlaagigyadm* (Tsimshian), which refer to the unity between Native peoples and their ancestors, as well as future generations (Worl 2014).

Additional examples of ancient DNA research done in collaboration with Indigenous communities along the Northwest Coast include: genetic research with the Aleut communities involving ancient and modern individuals (Rubicz et al. 2003), and DNA analysis of a 10,300-year old individual from On Your Knees Cave, Alaska (Kemp et al. 2007). Moreover, community involvement in ancient DNA is not restricted to the study of humans. Ancient DNA analysis has been proposed by the Kamloops band in British Columbia to learn about the extinct Shuswap Hunting Dog (Nicholas et al. 2008:238) and was used by Kasia Zimmerman (2014) to study the archaeological remains of dogs kept by the Tla'amin people in British Columbia.

A recent study that involved the genomic analysis of a 12,000-year-old boy from the Clovis culture (Rasmussen et al. 2014) also demonstrates the potential for DNA analysis to operate within the boundaries set by cultural values. Dr. Shane Doyle, a member of the Crow Tribe, played a key role in the study by serving as a liaison between researchers and Native American communities in Montana with whom consultation was undertaken. Doyle explains that he saw his role in the project as ensuring that the scared circle—which had been disturbed by the removal of the young boy from his grave—was repaired. Doyle also spoke about the shared goal of learning about the ancient boy, but ultimately, to ensure that he was reburied where his loved ones had laid him to rest:

> We can come to terms with each other [Native Americans and genetic researchers] and we can learn and we can be respectful and we can put these people back where they need to be, which is back in the earth [sic]. That doesn't mean that we can't learn from them. It doesn't mean that sacred wheel, or that sacred circle that was disturbed, that we can't repair it, that we can't heal it, and that we can't actually make it stronger and better and bigger (Doyle 2014).

While this study has not been exempt from criticism surrounding its consultation process, it does demonstrate the potential for scientists, archaeologists, and Indigenous peoples to work together towards a common goal of learning from an ancestor in a respectful way.

An additional avenue of inquiry that may prove valuable for establishing "a middle ground between American Indian systems of belief and scientific methods" is to use

dental calculus as a source for DNA analysis (Black et al. 2011: 1). Jill Black, a member of the Confederated Tribes of the Colville Reservation, and her co-authors were able to extract mitochondrial DNA from five calculus samples originating from individuals up to 1,000 years old. As they describe (p.3), the benefits of this approach are three-fold: 1) it is a less destructive approach than that traditionally employed in aDNA analysis; 2) a smaller quantity than what is usually required for analysis is permissible; and 3) while a variety of indirect methods of aDNA analysis are used in order to minimize damage to skeletal remains (e.g., analysis of hair or coprolites), dental calculus is unique as it is an indirect method in which the biological material can be confidently linked to a specific individual. Research such as this will undoubtedly prove valuable for its potential to reconcile differing views on what is—and is not—a respectful way to study human skeletal remains.

2.6. The Politicization of Ancient DNA Research

The results of ancient DNA research may hold political significance for individuals, communities, and other stakeholders. The potential implications of ancient DNA research are of particular importance for descendant Indigenous communities for whom the use of genetic analysis for political purposes represents a double-edged sword: ancient DNA analysis may provide additional support for claims, or, in other cases, the results of a genetic study may not reflect or support a group's traditional history or understanding. As with all research involving human participants, obtaining truly *informed* consent as to the potential risks and benefits of the study is critical, but it is of exceptional importance when the results of ancient DNA analysis take on political significance and could potentially have long-term consequences for participants. In this final section I consider the potential political implications of ancient DNA research, with a particular focus on land claims and the repatriation of human remains.

For Indigenous groups that are in the position of having to "prove" their long-term occupation of their territory to the government and others for the purposes of land claims or other identity based rights, the potential for ancient DNA analysis to show genetic continuity between past and present populations is an enticing option (Kaestle and Horsburgh 2002). The significance of identifying an ancestor-descendant relationship

was explained by Barbara Petzelt, an author in the Cui et al. (2013) study which established direct genetic descent between three individuals spanning over 5,000 years on the Northwest Coast, as being “huge as far as helping the Metlakatla prove that this territory was theirs over the millennia” (Past Horizons 2013). Genetic evidence was also employed by the present-day Uros of Peru to demonstrate their descent from the ancient Uros, the first people to inhabit the Andes. Proving descent from the ancient Uros became a powerful political tool for the Uros who were engaged in territorial conflicts with the state of Peru (Kent 2013). While this study did not involve the sampling of ancient human remains, it demonstrates how a genetic link between past and present peoples may be used to support land claims.

Alternatively, DNA analysis may negate such claims by providing contradictory or unexpected results. For example, after comparing the DNA of ancient human remains and present-day people living in the Aleutian Islands, Smith et al. (2009) found evidence of genetic discontinuity between the ancient and modern populations inhabiting the island. Archaeological evidence from the island indicated a possible population replacement event occurring at AD 1000. Ancient DNA analysis corroborated the population replacement hypothesis by revealing a difference in haplogroup frequencies between Paleo-Aleuts (pre-dating AD 1000) and the Neo-Aleuts (post-dating AD 1000) (Smith et al. 2009). Finding evidence of a genetic discontinuity between ancient and modern populations therefore has the potential to “upset land claims or otherwise cause social or economic harm” (Pullman and Nicholas 2011:145). However, it is also important to recognize that a variety of events, including population bottlenecks and migrations, may result in different genotypic frequencies between ancient and modern populations (Malhi et al. 2007).

The utility of ancient DNA analysis for the purpose of repatriating archaeological human remains to genetically affiliated bands or tribes remains to be seen. In the United States, repatriation is governed by the Native American Graves Protection Act (NAGPRA), which provides guidelines for the repatriation of cultural items, including human remains, to culturally affiliated descendants and federally recognized tribes. As explained by Edgar et al. (2007) NAGPRA’s definition of Native American as “of, or relating to, a tribe, people, or culture that is Indigenous to the United States” leaves

significant room for interpretation in terms of which ancient individuals meet NAGPRA's definition of Native American[12]. It is possible that as awareness grows of the potential for ancient DNA studies to identify genetic affiliation (to varying degrees of specificity) between ancient and modern populations, that DNA analysis may come to play an important role in future repatriation cases.

The discovery of Kennewick Man and the ensuing controversy over his biological affiliation with present-day Native American tribes demonstrates the intense political significance that biological analysis, including DNA testing, may take on. The over 9,000-year-old remains of Kennewick Man, referred to as "The Ancient One" by the local Umatilla tribe, were found washing out of a riverbed in Kennewick, Washington in 1996 (Burke and Smith 2008:21). The remains of the Ancient One came to represent the battleground upon which the strength of NAGPRA was tested and "contemporary identity politics" played out, as five Native American tribes fought for repatriation while eight scientists struggled to gain access to and control over the remains (Burke and Smith 2008:22).

In 2002, the court concluded that the Ancient One's remains "were not subject to NAGPRA's provisions because they could not be determined to be Native American" working under the definition that Native American means "of or relating to, a tribe, people, or culture that is *presently-existing* in the United States" (Burke and Smith 2008:22). Initial efforts at extracting DNA from the Ancient One failed, but due to advancements in ancient DNA technology, a team of experts working in Denmark have been successful in their efforts to sequence the Ancient One's DNA. As expected by many, the genetic analysis revealed that "Kennewick Man is closer to modern Native Americans than to any other population worldwide" (Rasmussen et al. 2015:455). Moreover, the authors state that of the genomic data available from Native American groups, "several seem to be descended from a population closely related to that of Kennewick Man, including the Confederated Tribes of the Colville Reservation (Colville), one of the five tribes claiming Kennewick Man" (p. 455). Given the additional genetic

[12] See the discussion of Spirit Cave Man (Edgar et al. 2007:113-114) and Kennewick Man (Burke et al. 2008).

evidence that has come to light, it appears likely that the case to repatriate Kennewick Man will be reopened (Callaway 2015). Going forward, this case will undoubtedly serve as an important precedent regarding the potential for ancient DNA analysis to inform repatriation efforts.

Thus, ancient DNA analysis appears to have positively contributed to the efforts to final resolve the ongoing controversy surrounding the Ancient One and his relationship to present-day Native Americans. While some scientists fought hard for the opportunity to study the remains of the Ancient One, Heather Burke and Claire Smith (2008:20) question the price at which this privilege came: "have the scientific benefits to study any archaeological discovery outweighed the damage done to relationships between Native Americans and archaeologists?" On a more general level, genetic testing can offer biological evidence when attempting to repatriate human remains whose cultural or ethnic affiliation is unknown. However, there is the risk of privileging biological evidence over other forms of understanding cultural affiliations and connections. As explained by Pullman and Nicholas (2011:153), reducing the complexities of culture to a biological origin—whether for the repatriation of human remains or for other purposes—risks making "all of the other beliefs, practices, and traditions that together inform a rich notion of cultural identity, contingent on a somewhat arbitrarily defined list of genetic markers."

2.7. Chapter Summary

The analysis of ancient human remains using genetic techniques continues to be a rapidly developing area of study. However, there are associated social, ethical, political, legal, and even practical implications that researchers must overcome in order to practice more collaborative and mutually beneficial ancient DNA research. While there has been too little attention directed specifically towards the implications of ancient DNA analysis, this chapter highlighted five issues that are relevant: 1) determining ownership and intellectual property rights over ancient DNA; 2) the inherent limitations of informed consent and challenges associated with consultation when there are multiple and diverse stakeholders; 3) how the results of ancient DNA may impact long-held understandings of identity or ancestry; 4) the varying ways in which cultural values may

clash with or be complemented by ancient DNA analysis; 5) and the potential for ancient DNA analysis to take on political significance, particularly in relation to tribal enrollment, land claims, and the repatriation of human remains. As ancient DNA technology continues to develop and provide ever greater insight into the past, it is increasingly important to understand the potential implications of this knowledge for people living today, as demonstrated in the examples provided.

Chapter 3.

Assessing the State of Ancient DNA Research in British Columbia

Ancient DNA research in British Columbia is situated within the broader practice of archaeology, which has undergone "significant, albeit often gradual, changes in the process of doing archaeology and, in recent years, to the development of new protocols and collaborations" in response to "issues of First Nations rights and the ways government and industry have chosen to address them" (Nicholas 2006:355). The development of collaborative research frameworks is especially important for archaeologists seeking to study the biological remains of ancient peoples, including through ancient DNA analysis, due to the highly sensitive nature of the topic. To date, ancient DNA analysis has been completed on a total of eight individuals found in British Columbia: four from the Lucy and Dodge Islands along the Northwest Coast, one from the far north in Tatshenshini-Alsek Park close to the Yukon border, and the remaining three individuals from the Thompson-Nicola region in the interior. While relatively small, this sample nonetheless provides important on-the-ground examples of the way in which ancient DNA research is being carried out in British Columbia in recent years.

In this chapter I review the nature and results of the ancient DNA projects completed in the province. In order to contextualize this review, I begin by discussing the intersection between archaeology and the current sociopolitical context in British Columbia and how this guides the study of human remains by archaeologists and ancient DNA researchers. Next, I describe the circumstances surrounding genetic analysis of each of the ancient individuals. These cases were selected because they represent the extent of published ancient human DNA studies from British Columbia. Although there are several additional ancient DNA studies that are underway or proposed, they are not included here for lack of information.

This review was intended to compare and contrast different characteristics of each study to elucidate potential research trends. Based on the studies that have been completed and upon the information available to me, all demonstrated a notable degree of collaboration with local First Nations communities. In comparison to these studies, other examples (described below) demonstrate the problems that can arise when there is a lack of dialogue and collaboration between stakeholders, including descendant communities, researchers, the general public, and the provincial government, with regards to the appropriate treatment of archaeological and heritage sites. It is important to note that this review is based upon a review of a relatively small number of ancient DNA case studies. Thus, direct relationships cannot be established, but it appears that a high degree of collaboration between researchers and First Nations groups has played a key role in ancient DNA projects completed in the province.

3.1. Current Tensions Regarding Archaeological Human Remains in British Columbia

Recently, issues related to the treatment of First Nations burial grounds and ancestral remains in British Columbia have been forced once again into the spotlight. In 2012, land clearing for the construction of a residential home began on Grace Islet, B.C., a small (less than a hectare in size) island long recognized as an important First Nations burial site containing at least 16 burial cairns (Hunter 2015). Protests led by local First Nations groups resulted in the eventual abandonment of the building project and a tentative deal was reached early in 2015 between the landowner and the province to purchase Grace Islet for $5.45 million (Harowitz 2015).

The Grace Islet debacle demonstrates the flaws within the Heritage Conservation Act (1979, revised 1996), the primary piece of legislation governing the protection of heritage sites in British Columbia. According to the Heritage Conservation Act, all sites pre-dating 1846—a date that Canadian courts recognize as signifying the establishment of British sovereignty in British Columbia—are automatically protected as sites of historic value. However, this means that Aboriginal burial sites pre-dating 1846 are not recognized and protected as cemeteries, but as heritage sites, and thus treated differently.

The situation at Grace Islet is not the first example of a high-profile stand-off between First Nations, landowners, and the B.C. Government with regards to the protection of First Nations burial sites. In 2013, the Musqueam First Nation purchased land in Vancouver's Marpole area in order to protect an ancestral village and burial site believed to be 3,000 years old from development (CBC News 2013). More recently, the City of Abbotsford put a halt to a $40 million industrial and residential development after learning from the Sumas First Nation and archaeologists that the site contained 40 burial mounds, believed to date back to a smallpox epidemic in the 18th century (McCue 2014).

The discord surrounding the protection of Grace Islet and other First Nations burial sites demonstrates the unequal protections afforded to Indigenous burial grounds under the Heritage Conservation Act. In an open letter regarding Grace Islet (Sept. 2, 2014), members of the Intellectual Property Issues in Cultural Heritage (IPinCH) Project, an international organization comprised of archaeologists, lawyers, ethicists, and others, identified the overarching problem as:

> …inequities in identifying, evaluating, and protecting significant heritage sites. In Canada, Aboriginal peoples' burial sites are largely treated as archaeological sites and not afforded the same respect or protection as Euro-Canadian cemeteries. This is a significant point of inequity, as it implies culture- and race-based distinctions between Aboriginal and non-Aboriginal Canadians. Shouldn't all Canadians be able to expect that the burial grounds of their ancestors and loved ones remain protected, and that they have a say in any decisions made about their protection?[13]

The IPinCH Project subsequently released a declaration in which they call upon:

> The Federal and Provincial governments of Canada, local governments, local authorities, First Nations leaders, public and private sector stakeholders and civil society to: act immediately in protecting First Nation ancestral burial grounds in British Columbia from destruction, damage,

[13] As defined on its website (www.sfu.ca/ipinch) the Intellectual Property Issues in Cultural Heritage (IPinCH) Project is a seven-year international research project based at Simon Fraser University which seeks to explore "the rights, values, and responsibilities of material culture, cultural knowledge, and the practice of heritage research." The IPinCH Declaration on Grace Islet is available online: http://www.sfu.ca/ipinch/resources/declarations/ancestral-burial-grounds

> and alteration; develop effective mechanisms that go beyond consultation and directly involve First Nations in British Columbia in the stewardship of their ancestral burial grounds and heritage sites; and uphold the requirement for free, prior and informed consent of First Nations communities in approving any project that has a potential to impact their cultural heritage rights and responsibilities.

Despite the challenges presented by Grace Islet and other cases, in many ways the realm of heritage and archaeology in British Columbia is representative of a growing movement within the discipline towards a more collaborative and inclusive approach to investigating heritage (Hogg 2014). This collaborative approach has also been successfully integrated into the bioarchaeological study of human remains (e.g., Beattie et al. 2000; Cybulski et al. 2004, 2007; Hebda et al. 2012; Williamson and Pfeiffer 2003). These projects are representative of a growing emphasis on collaboration and partnership between academic institutions, researchers, and First Nations communities occurring within archaeological projects in the province.

3.2. Ancient DNA Case Studies in British Columbia

For the remainder of this chapter, I focus on the case studies involving ancient DNA analysis on eight archaeological individuals. The studies are distributed across the province: two individuals from China Lake (Malhi et al. 2007), one individual from Big Bar Lake (Cybulski et al. 2007); four individuals from the Dodge and Lucy Islands (Cui et al. 2013); and the individual known as Kwäday Dän Ts'ìnchi whose frozen remains were recovered from Tatshenshini-Alsek Park (Hebda et al. 2012; Monsalve et al. 2002) (Figure 3-1).

It is important to note that the individuals included in this review represent only a fraction of the total number of skeletal remains that have been excavated or otherwise recovered in the province (Cybulski et al. 2007: 62-63), and that ancient DNA analysis has been used, thus far, to study a very small minority of ancient individuals. I begin this section with a brief description of each case study, which is followed by a discussion of what these projects have in common.

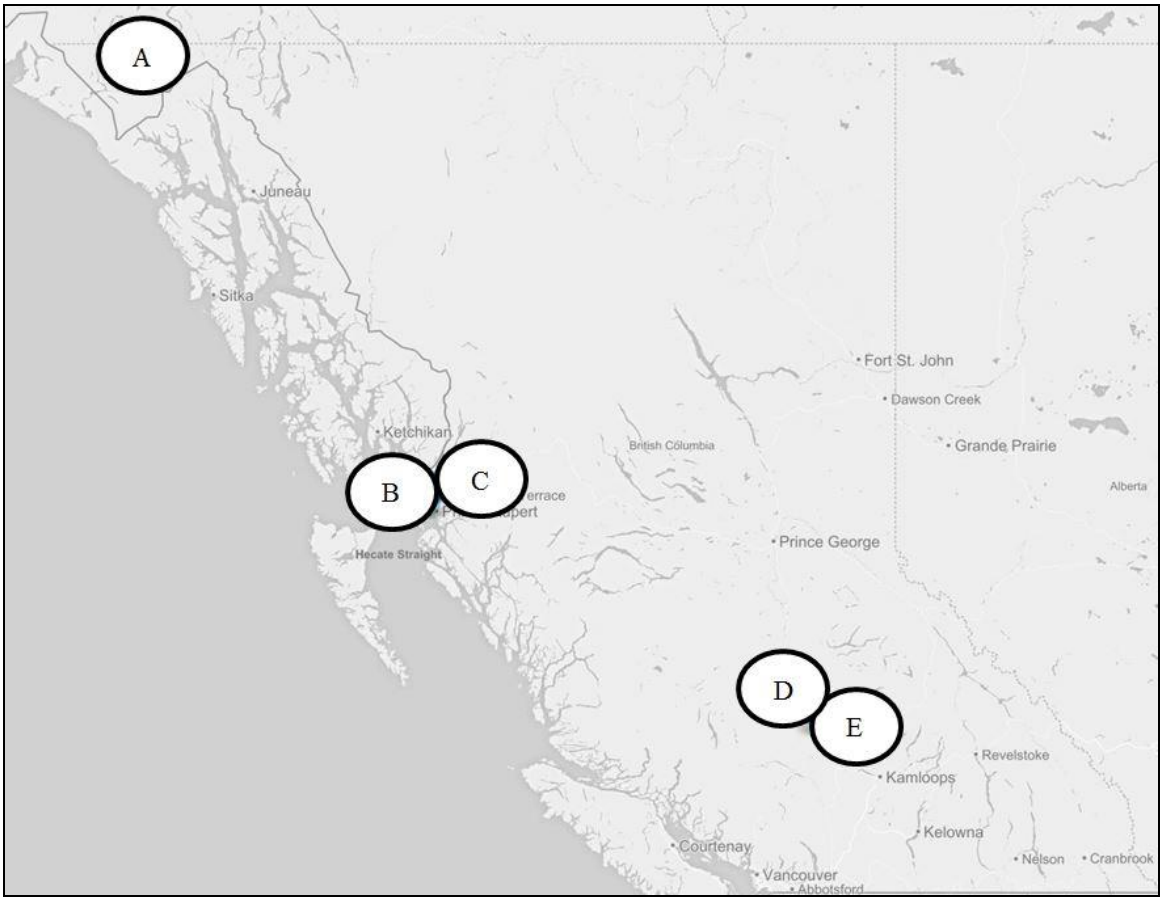

Figure 3-1. Map of completed ancient DNA case studies in British Columbia: A) Tatshenshini-Alsek Park; B) Dodge Island; C) Lucy Islands; D) China Lake; and E) Big Bar Lake

3.2.1. Kwäday Dän Ts'ìnchi or "Long Ago Person Found," Tatshenshini-Alsek Park

The frozen remains of the individual known as Kwäday Dän Ts'ìnchi (or "Long Ago Person Found") were discovered in 1999 in Tatshenshini-Alsek Park, located in far northern British Columbia (Figure 3-1: A) within the traditional territory of the Champagne and Aishihik First Nations (CAFN). A recovery team consisting of experts in archaeology, physical anthropology, glaciology, and representatives from CAFN, the Yukon Heritage Branch, BC Parks, and the BC Archaeology Branch visited the discovery site the following week (Beattie et al. 2000). Samples were extracted from items found in association with the individual and have provided an age of approximately 500 years old (Hebda et al. 2012:18). Osteological analysis suggests a young male 18–20 years old,

with no visible signs of pathology or trauma (Beattie et al. 2000*:* 141-142). Numerous artifacts were recovered with the body, including a hand tool, a woven hat, several garments made of hide and fur, and a small pouch believed to be a medicine bag (Beattie et al. 2000:137; Hebda et al. 2012:33-46).

Ideas were solicited by CAFN for "individual and collaborative research related to the human remains" and permission was given by the community to proceed with genetic analysis (Beattie et al. 2000:140; CAFN 2009; Monsalve et al. 2002). The ancient DNA results demonstrate that on a general population level, Kwäday Dän Ts'ìnchi belongs to haplogroup A and was found to have close genetic affinity to the Canadian Inuit and Chukchi people from Northeast Asia, as well as the Athapaskans and Tlingit [14] (Monsalve et al. 2002; Hebda et al. 2012: 52–53). However, as Hebda et al. (2012: 52) explain, it was important to the Champagne and Aishihik First Nations and other communities "to connect him [Kwäday Dän Ts'ìnchi] on a person-to-person basis because of cultural obligations" to ensure that he received proper burial rites. As a result, First Nations peoples from northwestern British Columbia and southeastern Alaska were invited to participate in a "community DNA study" to identify the potential clan affiliations of Kwäday Dän Ts'ìnchi, an invaluable piece of information due to the "important obligations and protocols rooted in knowing the clan to which an individual belongs" (Hebda et al. 2012: 53). Ultimately, 17 individuals living in were identified as "living relatives" and their own clan affiliations suggest that the Long Ago Person found was likely of the Wolf or Eagle clan (p. 53).

The analysis of Long Ago Person Found was built upon a foundation of collaboration between diverse stakeholders, including the Champagne and Aishihik First Nations, the BC Archaeology Branch, the Yukon Heritage Branch, and many other stakeholders. As the cultural stewards of the ancient person, the Champagne and Aishihik were required to "develop ways to make decisions, while acknowledging and respecting the interests of other neighbouring First Nations and Tribes" (Hebda et al.

[14] Haplogroup A is commonly understood to be one of the founding mitochondrial lineages in the Americas (Eshleman et al. 2003; O'Rourke and Raff 2010); however, recent studies (Cui et al. 2013; Kemp et al. 2007; Malhi et al. 2007) indicate a more complex picture than initially represented by the five major haplogroups A, B,C, D, and X.

2012:23). Through formal and informal meetings, as well as other outreach initiatives, such as newsletters, important decisions were reached regarding the study and eventual disposition of Kwäday Dän Ts'ìnchi in a culturally appropriate manner (pp. 22-23). Learning about Long Ago Person Found has inspired other community-based projects, including the revitalization of traditional art forms such as sewing gopher skin garments and spruce weaving (Hebda et al. 2012: 54; also see Frankenstein 2014[15]). In sharp contrast to the controversy surrounding the scientific analysis of Kennewick Man, the recovery and study of Kwäday Dän Ts'ìnchi demonstrates the immense potential for researchers and communities to work together in a collaborative and respectful manner with a shared goal of learning more about the life and death of an ancestor.

3.2.2. Dodge and Lucy Islands

In 2013, the results of an ancient DNA study conducted by Cui et al. (2013) in partnership the Lax Kw'alaams, Metlakatla, and Laxgalts'ap First Nations were announced. The study received significant attention in the popular media because of its discovery of a genetic link between two ancient individuals, one from the Lucy Islands and the other from Dodge Island (Figure 3-1: B and C), and a living First Nations individual. The results were welcomed by local First Nations groups who saw the research findings as confirming their oral histories and demonstrating their long-term occupation of the land (Boswell 2013). The study involved genetic analysis of four ancient and three living Tsimshian, Nisga'a, and Haida individuals, as described below.

Ancient 938 and Ancient 939[16] were recovered from a shell midden during the 1984–1985 excavation season on the largest island of the Lucy Islands. The remains of Ancient 938 included fragments of a skull, jaw, and associated tibia. Osteological analysis indicated that the individual was a young adult female, with evidence for cribra orbitalia and abnormally thick bones in the cranial vault (Cui et al. 2013:3). The remains of Ancient 939 included an incomplete mandible, which gave indications of belonging to

[15] The documentary film *Tracing Roots* (Frankenstein 2014) follows Delores Churchill, a master weaver, Haida culture bearer, and Elder, as she embarks on a journey to understand and replicate the spruce root hat found with Kwäday Dän Ts'ìnchi.

[16] I use Cui et al.'s (2013) nomenclature.

a middle-aged or older male (p. 3). The male individual had heavily worn teeth, a build-up of calculus, and several other dental pathologies (p. 3). Radiocarbon dating was conducted on Ancient 938 and Ancient 939, providing dates of 5870-5480 cal BP (Early period) and 6260-5890 cal BP (Early period) (Ames 1996:526-527; Cui et al. 2013: 4). Ancient 160a and Ancient 152 were excavated in 1967 from Dodge Island as part of the North Coast Prehistory Project[17]. Neither sex nor age was discernable for Ancient 160a (Cui et al. 2013:4). Ancient 152 was identified as a young woman, who was likely buried in a partially flexed position (p. 4). Radiocarbon dates for Ancient 160a were estimated at 5130–4580 BP and for Ancient 152 at 2770–2300 BP placing the individuals within the Late period (Ames 1996:526-527).

Unlike the other studies conducted in British Columbia, full mitogenomic analysis was performed on the four ancient individuals, which permitted a much more detailed understanding of potential ancestry relations. The analysis of the seven mitogenomes from ancient and modern individuals living in the area provided critical insights into the population changes—and apparent continuity—amongst people living on the Northwest Coast over the last five millennia. The authors were able to identify a genetic relationship spanning over 5,000 years between Ancient 938 and Ancient 152 and a living Tsimshian individual (Cui et al. 2013). The importance of demonstrating direct genetic continuity from the mid-Holocene to present-day inhabitants of the area was described by one of the authors as being extremely helpful in demonstrating the long-term occupation of the territory by the Metlakatla First Nations (Past Horizons 2013).

In addition, the study provided support for divergent “evolutionary paths” among mitogenomes in North America. Ancient 939 displayed genetic markers characteristic of sub-haplogroup D4h3a. Sub-haplogroup D4h3a was also identified in an individual from On Your Knees Cave, Alaska dated to 10,300 BP (Kemp et al. 2007). However, as stated in Cui et al. (2013:5), “sub-haplogroup D4h3a is not identified in any ancient or living individuals on the Northwest Coast after approximately 6000 years BP.” A similar

[17] The North Coast Prehistory Project started in 1966 and was led by George F. MacDonald. The project has resulted in the extensive excavation of archaeological sites located in the Prince Rupert area, Haida Gwaii, and along the upper Skeena River (MacDonald and Inglis 1980-81:41)

conclusion regarding the apparent divergence between ancient and present-day people living in the same approximate geographic location was reached in the analysis of the two individuals from China Lake (as discussed above) belonging to haplogroup M (Malhi et al. 2007).

Evidence of collaboration and long-term partnership between members of the research team and local First Nations communities can be found in the Cui et al. (2013) study. As with the Big Bar and China Lake study, individuals from the partnering First Nations communities are listed as authors. For the Cui et al. (2013:7) study, two individuals from the Metlakatla Treaty Office, one an archaeologist and the other a staff member, were involved in the conception and design of the experiment. As described in the article, collaborative DNA studies were first initiated by several of the authors in 2007 with the Laxgalts'ap and in 2008 with the Lax Kw'alaams and Metlakatla communities (p. 3). Good working relations with all communities have been maintained through annual visits by Ripan Malhi and Jerome Cybulski "to provide the latest updates on the research study and answer any questions the participants may have" (p. 6). The apparent commitment between members of the researcher team and the community to create a successful and long-term partnership is demonstrated in various ways throughout this article.

3.2.3. China Lake

Ancient DNA analysis was conducted on the remains of two individuals recovered from the same burial near China Lake (Figure 3-1: D) in 1982 (Cybulski et al. 2007; Malhi et al. 2006). One individual was excavated *in situ* by archaeologists while the other had been accidentally removed by a backhoe during road construction (Cybulski et al. 2007: 71). According to Cybulski et al. (2004), the similarity of morphological characteristics between the two individuals indicates a close familial relationship. The age and sex of the individuals or evidence of any pathology is not discussed in their report.

Radiocarbon dating and isotopic analysis were conducted on both individuals. Radiocarbon dating provided an age of 4950 ± 170 BP. As explained by Cybulski et al.

(2007), this places the two individuals in the transitional period between the Lehman Phase and the Lochnore Phase. The Lehman Phase (6000–4500 BP) is characterized by the hunting of large terrestrial ungulates, while the Lochnore Phase (5000–3500 BP) represents a shift towards a dependence on marine resources, specifically salmon (Cybulski et al. 2007:72; Rousseau 2004). I note this here because the results of the isotopic analysis for the China Lake individuals indicate a marine-based protein intake of 37 ± 10% and 38 ±10% of the total dietary protein.

Mitochondrial DNA analysis of the two China Lake individuals yielded unexpected results. Separated by only 25 kilometres, the individual at Big Bar Lake belonged to haplogroup A, while both China Lake individuals were found to belong to haplogroup M. The authors explain the significance of this result as owing to the fact that haplogroup M has "never before been reported in ancient or living indigenous populations in the Americas," but is common in East Asia (Malhi et al. 2007:642). Moreover, the discovery of haplogroup M in North America has major implications for the five-founder model, which posits that only five founding lineages were involved in the colonization of the Americas: A, B, C, D, and X (Eshleman et al. 2003; O'Rourke and Raff 2010). Malhi et al. (2007:647) highlight the need for additional ancient DNA analysis of archaeological individuals rather than a reliance on genetic information from modern Indigenous populations, as modern genetic profiles have been shaped by various evolutionary processes and population bottlenecks. Thus, the genetic diversity that exists in modern Indigenous populations may not be directly representative of the genetic diversity of prehistoric populations (Cui et al. 2013:1-2; Malhi et al. 2007: 646).

Limited information is available on the degree of community involvement in the China Lake case study. Malhi et al.'s study (2007) does list two members from the Canoe Creek band as authors. Moreover, the acknowledgements section reads: "we are indebted to the members of the Canoe Creek, Soda Creek, and Dog Creek Bands who allowed the DNA testing of their ancestors" but their specific role in the study is unclear. In a presentation given by Cybulski et al. (2004), they describe the China Lake project, as well as the analysis conducted on the two individuals from Big Bar Lake, as "examples of mortuary and osteological research in community settings, involving community members in their design, implementation, and ongoing management." Based

on these indications, it appears that community members played a significant role in this project.

3.2.4. Big Bar Lake

In 2002, the remains of a 5,000-year-old woman were excavated from the archaeological site EhRk-4 at Big Bar Lake (Figure 3-1: E), located near the town of Clinton (Cybulski et al. 2007). Notably, this burial site and others in the area were identified first by local First Nations community members, who then took lead investigator Jerome Cybuski to the site to confirm that archaeological human burials were present. The subsequent decision to "remove the burial using archaeological and physical anthropological techniques" was made by "elders, councillors, spiritual leaders, and community members" (p. 56).

A detailed osteological analysis of the individual revealed the ancient person's age, sex, and general health—a female, likely over the age of 60 (Cybulski 2007:61). A comparative assessment of the limb measurements of the Big Bar individual to other archaeological individuals from the interior plateau supported the identification of the individual as female (2007:61). This conclusion was then confirmed through ancient DNA analysis. While no evidence was found for disease-related pathology, "degenerative changes were indicated and likely associated with the advanced age of the woman" (p. 65). Additional notable features were the robusticity of the humerus, the woman's relatively short stature, and the lack of arthritic change to the woman's joints (pp. 65–66).

With permission of the Canoe Creek and High Bar Indian Bands, samples were sent for radiocarbon dating, isotopic analysis, and mitochondrial DNA analysis. Radiocarbon dating using fragments from three ribs and a small sample from the left fibula provided a calibrated age range of 5740–5600 BP, placing the individual between the Lehman Phase and the Lochnore Phase. (Cybulski et al. 2007: 68; Rousseau 2004:3). Isotopic analysis revealed a marine protein intake of 24–36% and terrestrial protein range from 64–76% (Cybulski et al. 2007:68). The lower right third molar of the ancient individual was submitted for mitochondrial DNA analysis. Genetic analysis identified the individual as belonging to haplogroup A, which is recognized as a common

haplogroup present today among Indigenous peoples in North America (p. 69*)*. The study also identified an identical genetic match to one living Nuu-Chah-Nulth individual, and a near match to a second (p. 70).

The high degree of collaboration that occurred between researchers and members of the Canoe Creek and High Bar First Nations is apparent throughout the article. The excavation of the ancient individual from Big Bar Lake is a clear example of a community-based archaeology project with community members revealing the location of the burial to Cybulski, and their continued involvement "at every stage of this project, including the location, excavation, and analysis of remains" (p. 56). The cultural and spiritual values of the community guided the excavation process, with each day of excavation beginning with a smudging ritual and concluding with a burnt-food offering to the dead (p. 56). Canoe Creek spiritual advisors were present to bless the ancient individual after she was removed from her burial and being prepared for transport to the Canadian Museum of Civilization for additional osteological analysis.

3.3. Discussion

Having described the eight case studies that have been conducted to date in British Columbia, I now consider commonalities shared by the projects. Originally, I was interested in examining variables such as the geographic distribution of the studies throughout the province, the length of time required for completion of the ancient DNA studies, and whether additional destructive biological tests had been conducted on the ancient individuals included in this review. However, too few ancient DNA projects have been completed in British Columbia to serve as a sample upon which to base these analysis. Thus, I focused upon identifying general trends apparent within the identified case studies. Through this review an overarching theme emerged: based on the published literature, the ancient DNA case studies appear to share a high degree of collaboration between the researchers and local First Nations communities.

3.3.1. Degree of Collaboration with Communities

In North America, collaboration with communities and the general public is playing an increasingly important role in archaeology. From public archaeology to community-based participatory research projects, the voices of descendant communities and other stakeholders are playing a greater role in archaeological projects around the world. In North America, community-based participatory research and other forms of community engagement in archaeology serve to rectify the power imbalances that have characterized historic research relationships in the field of archaeology and elsewhere (Atalay 2012; Colwell-Chanthaphonh and Ferguson 2008; Lyons 2013). As discussed in Chapter 2 in relation to the Havasupai, Nuu-Chah-Nulth and the controversy surrounding the Human Genome Diversity Project, genetic research—whether in ancient or modern populations—may have important and long-lasting consequences for both individuals and communities. Thus, it is of great importance that genetic research is sensitive to, or even guided by, the unique cultural values and the sociopolitical context of the individuals and communities with whom researchers seek to work with.

The case studies included in this review share what appears to be a high degree of collaboration between the researchers, community members, and other stakeholders. Assessing the degree of community collaboration and engagement within a specific archaeological project is a challenging endeavour (see Hogg 2014). For the purposes of this review, “collaboration” was identified in a number of general ways. From assisting with the excavation of the human remains, to ensuring that the scientific analysis is conducted in a culturally respectful manner, to demonstrating the potential for ancient DNA research to complement traditional values and oral histories, collaboration with communities was apparent in the studies considered.

In the studies discussed, the close involvement of community members facilitated and guided the scientific analysis of the ancient individuals in a culturally appropriate manner. This is particularly apparent in the publications describing the genetic analyses of the ancient individual from Big Bar Lake and Kwäday Dän Ts'ìnchi. Both Cybulski et al. (2007) and Hebda et al. (2012) make specific references as to how the cultural values of the participating communities guided the scientific research process. For example, Cybulski et al. (2007:60) describe how “a smudging ritual preceded the work each day

and a closing ceremony, which included a burnt-food offering to the dead, took place at its conclusion" during the excavation of the individual from Big Bar Lake. Upon the complete removal of the individual from their burial, the "assemblage was then blessed by Canoe Creek spiritual advisors and shipped to the Canadian Museum of Civilization, where the bones were analyzed on authority from the Canoe Creek and High Bar First Nations." Similarly, special care was taken to ensure that the remains of Kwäday Dän Ts'ìnchi were stored in a respectful and culturally appropriate environment. At the direction of community leaders, an artifact believed to be the young man's medicine pouch was "cremated with him because it was too private to be studied or retained" (Hebda et al. 2012:24).

Moreover, the case studies demonstrate the potential for ancient DNA research to perpetuate and enhance traditional cultural values. Rosita Worl, President of the Sealaska Heritage Institute, has played a key role in several ancient DNA projects conducted with southeastern Alaska's Tsimshian, Haida, and Tlingit groups, including genetic comparisons between community members and Kwäday Dän Ts'ìnchi and another project involving an ancient individual from On Your Knees Cave, Alaska (Kemp et al. 2007). Worl explained that her motivation for participating in ancient DNA studies stems from a desire to perpetuate unity between Native people and their ancestors, as well as with future generations (Worl 2014). Traditional values, including the desire to perpetuate unity between generations, play an important role in guiding the involvement of Indigenous peoples in ancient DNA research, as demonstrated by this example.

Moreover, ancient DNA analysis may serve as an important tool by which to fulfill important cultural and spiritual obligations to the deceased. As explained by former Chief Diane Strand of the Champagne and Aishihik First Nations, determining Kwäday Dän Ts'ìnchi's clan affiliation was critical for his proper burial, because:

> Traditionally, when a member of one clan dies, another clan takes care of the rites… the majority of people who have worked on this project were Crow people and I truly believe things happened in the way they were meant to happen. Spiritually he was a wolf person and the people who looked after him came from the proper clan (Lavoie 2008).

The results of ancient DNA analysis were thus of great significance to the participating communities as it informed the burial process for their ancestor.

Examples of collaborative and culturally appropriate modes of disseminating the results of ancient DNA research are evident in all of the case studies I reviewed. Each resulted in academic outputs, including journal articles and books, with the inclusion of community members as authors (e.g., Cui et al. 2013; Cybulski et al. 2004, 2007; Malhi et al. 2007). However, the Champagne and Aishihik First Nations' approach to sharing the results of the scientific study of Kwäday Dän Ts'ìnchi deserves particular attention. The *Kwäday Dän Ts'ìnchi Newsletter*[18] produced by the Champagne and Aishihik First Nations to share the results of the research with members of CAFN but also with neighboring communities in northwestern British Columbia and Alaska (CAFN 2009; Hebda et al. 2012: 22). The findings were presented in a simple and engaging manner, with a clear emphasis on making the research relevant and accessible to multiple audiences. The newsletter presented the scientific tests as a means by which to "learn about the life and times of an ancestor." Specific questions including "where did he come from?," "where was he heading to?," and what was "his last meal" are addressed in the newsletter. Thus, in the case of Kwäday Dän Ts'ìnchi, the dissemination of information was unique as it was interpreted *by* and *for* community members.

3.3.2. Chapter Summary

Ancient DNA research in British Columbia is located within a complex sociopolitical landscape in which archaeology and the study of human remains can take on political significance. Most recently, this was demonstrated by the controversy surrounding Grace Islet and the lack of legal protections afforded to Aboriginal burial grounds under the Heritage Conservation Act. This chapter reviewed the ancient DNA studies that have thus far been completed on eight individuals found in British Columbia. These individuals were recovered throughout the province, from the far north in Tatshenshini-Alsek Park, to the interior locations of Big Bar Lake and China Lake, to the

[18] Available online: http://cafn.ca/wp-content/uploads/2015/04/Kwaday_Dan_Tsinchi_Newsletter_March_2009.pdf

Dodge and Lucy Islands on the central coast. The ancient DNA case studies completed in British Columbia to date share one important characteristic: a notable degree of collaboration with local First Nations communities. This review provides practical examples of how such research can be carried out in a collaborative manner with First Nations communities.

In this chapter, I have suggested that the ancient human DNA case studies in British Columbia are notable for the high degree of collaboration with First Nations communities; however, the limitations inherent within this assertion must be considered. This review was conducted using only information available within the published literature, and as a result, I was not able to include ongoing projects that may or may not share this characteristic. I also do not have a way to include projects that are not yet at the publication stage, or were never completed for a variety of potential reasons. Furthermore, there may be examples where researchers sought to engage in collaborative ancient DNA work, but were unable to identify a community with whom to form a partnership. Thus, while I would suggest that the studies included in this review are notable for their collaborative nature, this does not necessarily mean that an ancient DNA project *must* be collaborative in order for it to be successfully completed. As noted by Chip Colwell Chanthaphonh and TJ Ferguson (2008:1), the process of collaboration can involve a spectrum of strategies that share the goal of linking "the archaeological enterprise with different publics by working together." To this end, the appropriate degree or type of collaboration will be unique to the specific context as well as the individuals and groups involved. These factors and others are important pieces to consider, but were not available for consideration in this review.

Chapter 4.

Using a Web Survey to Identify Emerging Challenges in Ancient DNA Research

This chapter describes the survey I designed to investigate emerging challenges in the field of ancient DNA studies in North America and elsewhere around the world. The survey was employed to gather information in order to meet my three research objectives, specifically: 1) to identify emerging challenges in ancient DNA research in the realm of the social, ethical, and political; 2) to investigate the different challenges encountered in ancient DNA studies as reported by an international sample of survey respondents; and 3) to provide recommendations and associated resources for effectively addressing or mitigating the issues, as identified by survey participants, in ancient human DNA research. I begin with a description of the methods and resources utilized to create and deploy the web-based survey, as well as my rationale for selecting this method of data collection. Next, I discuss the quantitative tests used to analyze the survey data collected. I conclude by considering the limitations of my methods. The results of the survey are presented and discussed in Chapter 5.

4.1. Designing the Survey

Overall, a web-based survey was considered an appropriate method of data collection for this study. Given that the population of interest is primarily composed of researchers working in academic institutions, the flexibility of a web-based survey that can be readily accessed on any electronic device and filled out and submitted at their convenience fit the specific characteristics of this population. Moreover, web surveys offer many benefits to the researcher or survey administrator. For example, they provide an almost immediate method of delivering surveys to participants, and rapid reception of

responses upon survey completion. Additionally, web surveys reduce data entry time as compared to both mail and in-person surveys.

4.1.1. Developing the Survey Questions

My survey was designed to elicit responses to carefully crafted questions related to the process of conducting ancient DNA research on archaeological human remains, which in some cases involved present-day descendant communities. The development of the questions was informed by two major sources of information: 1) the knowledge and experiences I have gained by working in the field of bioarchaeology and ancient DNA; and 2) background research conducted on the social, ethical, political, and legal implications of ancient DNA studies and genetic research more broadly. Since 2012, I have also been actively involved in related academic studies (Walker 2014) through my work as a Research Assistant for the Bioarchaeology, Genetics and Intellectual Property Working Group for the Intellectual Property Issues in Cultural Heritage (IPinCH) project. Moreover, my experience working with a First Nations band in British Columbia to lay the foundation for an ancient DNA study provided me with invaluable first-hand knowledge of the practical challenges facing ancient DNA researchers. This experience informed not only the objectives of this thesis, but also guided the thematic investigation of the survey questions.

Through these educational experiences, I identified eight specific thematic issues or challenges in ancient DNA research that would provide valuable information for addressing my research objectives. These are: 1) ownership and intellectual property rights over the ancient genetic data; 2) the future use of genetic data arising from ancient DNA studies; 3) genetic privacy in the context of ancient DNA research; 4) cultural values and their role in ancient DNA research; 5) consent and consultation in relation to ancient DNA studies; 6) ancient DNA analyses and understandings of identity and ancestry; 7) the potential political implications of the results arising from ancient DNA research; and 8) communicating the findings of ancient DNA research to multiple and diverse audiences. The individual questions used to explore these themes can be found in Table 4-1 and a copy of the survey is located in Appendix A. Since all themes might not be relevant to all survey participants, or encompass all issues they have

encountered, a text-box was provided for participants upon completion of the survey to note any additional challenges they experienced in the course of ancient DNA research. Additionally, multiple choice questions were presented in a randomized order for each participant.

Table 4-1. Research themes and associated survey questions.

Theme	Survey Question
Ownership and Intellectual Property	Have you experienced challenges in terms of determining who owns or controls the ancient genetic data?
Future Use of Genetic Data	Have stakeholders expressed concern about controlling the type of research that the ancient genetic data may be used for in the future?
Genetic Privacy	Have stakeholders expressed concerns about any indirect implications the ancient DNA study may have for their own genetic privacy?
Cultural Values	Have stakeholders expressed concerns about whether conducting ancient DNA analysis on human remains is culturally appropriate?
Appropriate processes of consultation and consent	Has it been a challenge to identify the appropriate modern populations to consult with and/or gain consent from for the analysis of ancient human remains?
Identity and Ancestry	Have you experienced difficulties when the results of ancient DNA analysis are seen to challenge stakeholders' long-held understandings of identity and ancestry?
Politics	Have you experienced challenges when the potential results of an ancient DNA study are seen to carry political significance?
Communication	Has it been a challenge to ensure that the results of ancient DNA analysis are communicated to stakeholders and the general public in an accurate manner?

Prior to being asked specific questions on the eight themes, participants were asked to provide more general information in the following four questions:

1) In which country has the majority of your ancient DNA research taken place?
2) Based on your experience, how long on average does it take to complete an ancient DNA project, from project conception to the publication of the final results?
3) What is the general level of collaboration with descendant community in ancient DNA projects that you have been involved with?

4) For individuals and communities who permit ancient DNA analysis on human remains, what do you see as the main motivating factors for allowing genetic analysis?

Additionally, participants were asked to provide details regarding how they addressed or mitigated the specific issue (if encountered) in a text-box accompanying each multiple choice question (see Appendix A for copy of the survey). The responses provided in the text-box comprise the qualitative data gathered by this survey

4.1.2. Considering the Survey Themes

The themes investigated in the survey were identified through my own work in the fields of genetics and bioarchaeology during which time I have had the opportunity to discuss these issues with other researchers. The rationale for and brief description of each is as follows:

1. *Ownership and Intellectual Property (IP):* This survey question was included to explore *if* and to what degree questions have arisen about who owns and controls the genetic data derived from an ancient DNA study. Ownership may be defined in different ways, from accruing the economic benefits of research to rights over the intellectual property produced through research. As defined by the World Intellectual Property Organization on their website[19], intellectual property refers to "creations of the mind, such as inventions; literary and artistic works; designs; and symbols, names and images used in commerce."

   Researchers are generally required by university Ethics Review Boards to provide provisions regarding intellectual property as well as control over and access to research data. However, as research moves towards more collaborative venture with communities, there is a need for this changing relationship to be reflected in the ownership and IP arrangements. It is the

[19] http://www.wipo.int/about-ip/en/

intention of this survey to investigate how these terms are being negotiated in the field of ancient DNA.

2. *Future Use of Ancient DNA Information:* This question was included to determine whether survey participants have encountered concerns from descendant communities and other stakeholders about the future use of genetic information arising from an ancient DNA study. The importance of this issue is demonstrated by the experiences of the Havasupai and Nuu-Chah-Nulth (see Chapter 2) and the harm they experienced when their biological samples were used for additional research that they were unaware of.

   Additionally, this question was intended to identify the practical ways in which ancient DNA researchers are defining and limiting the future use of genetic data in a way that is acceptable to all parties. For example, prior to developing this survey, I was informed by one ancient DNA researcher working in Canada that he has developed a system of strict access agreements with terms and conditions set by himself in consultation with the community he is working with. Through this survey, I sought to learn if similar strategies were also being put into practice by other ancient DNA researchers working with descendant communities.

3. *Genetic Privacy:* This question was included to consider whether ancient DNA researchers face unique challenges related to protecting the genetic privacy of the individuals and communities with whom they work, and how these concerns are addressed. While university ethics review boards have strict guidelines for protecting the privacy of all participants, including anonymizing or de-identifying research data, I was interested to learn if ancient DNA researchers took additional practical steps due to the often sensitive nature of the research.

   For example, Foster et al. (1998:696) note that while it may be “standard practice to name ethnically, geographically, and linguistically identifiable population in public databases and scientific publications,” this may have

risks or other implications related to a perceived infringement of privacy for “all members of those populations, not just those who choose to participate in research studies.” With this survey question I sought to understand the practical ways in which ancient DNA researchers are protecting the privacy of participating individuals and communities.

4. *Cultural Values:* Through this question I explored the ways in which traditional values influence and/or guide the ancient DNA research process. For example, as explained by Frank Dukepoo and Debra Harry (1998:8), the genetic analysis of ancient human remains represents “a serious violation of the sanctity of our deceased ancestors” for some Indigenous peoples. Alternatively, others view ancient DNA analysis as a means by which to learn more about the life of the ancient person and their connection to people living today, as demonstrated by the genetic analysis of Kwäday Dän Ts'ìnchi.

5. *Consent and Consultation*: This question provided insight into the consent and consultation processes involved in ancient DNA research and the subsequent challenges. This topic is particularly difficult to address given that the link between the past and the present is dynamic, not static, and at times, convoluted. As a result, descendants may be unaware of, seemingly apathetic towards, or firmly against further investigation into their connections to an ancestral group. In other cases, there are multiple groups that may identify themselves as descendant communities; alternatively, the most-likely descendant group might simply be unknown. The topic of group consent is also important in ancient DNA research (Greely 2001), as genetic studies may have implications that extend beyond the immediate participants to their larger community and social group. The responses to this question provide insight into the varying ways that these practical and ethical dilemmas are being negotiated by survey respondents.

6. *Identity and Ancestry*: This question was included to assess *if* and *how* ancient DNA research is conforming to—or contributing to the re-construction of—long-held understandings of identity and ancestry. This is a particularly important issue for Indigenous peoples for whom the reduction of identity and ancestry to a molecular origin may have important political and legal implications. For example, the controversial adoption of genetic criteria (see Chapter 2) as an additional method of evaluating applicants' tribal enrollment claims (Bardill 2014; Taylor 2011) demonstrates the tangible impacts of genetics on tribal belonging.

7. *The Politics of Ancient DNA Research*: This question provided insight into the ways in which the results of ancient DNA research can take on political significance. This issue is of particular importance for Indigenous communities around the world for whom the results of ancient DNA research may hold implications in relation to federal recognition, land claims, and the repatriation of human remains. For example, the recent study conducted by Cui et al. (2013) was interpreted by many as providing support for future land claims because it demonstrated the long-term inhabitation of the land by a genetically similar group of people. Similarly, the Urus of Peru found the results of genetic analysis to be useful in a series of ongoing political conflicts with the state of Peru (Kent 2013). Through this question I explored the various ways in which ancient DNA research may take on political meaning—intentionally or unintentionally—for descendant communities and other stakeholders.

8. *Communication*: This question facilitated the exploration of the difficulties associated with communicating the results of ancient DNA research to multiple audiences, including descendant communities, other stakeholders, and the general public. Subsequently, there are numerous opportunities for miscommunication, which may have unintentional social and ethical consequences. This is demonstrated by the infamous case of the MAO-A gene, also dubbed the "warrior gene," found among New Zealand's Maori population due to its purported association with

aggressive and risk-taking behaviours (Wensley and King 2008). In addition to the social and ethical implications that may result from miscommunication of genetic and ancient DNA research, there are practical challenges associated with the dissemination of ancient DNA research results in a manner this is relevant, accessible, and understandable to all. The responses to this question should help to identify the points at which miscommunication can occur and what strategies are being implemented to address these issues.

4.2. Identifying a Survey Sample

This study required selecting a sample of researchers with the necessary knowledge and experiences to be able to identify and describe the challenges they had encountered while conducting ancient human DNA projects. As a result, participants were identified primarily through two means: 1) purposive sampling; which was then supplemented through 2) convenience sampling to increase the sample size and diversity. *Purposive sampling* aims to include individuals who are seen to "typify a circumstance or hold a characteristic that is expected or known to have salience to the subject matter under study" (Ritchie et al. 2014: 116). As the target population for this survey was very specific (i.e., researchers involved in ancient DNA studies), purposive sampling was identified as an appropriate method by which to identify a sample of individuals to include in this survey. In order to increase the sample size produced through the purposive identification of potential participants, convenience sampling in the form of a targeted email invitation to participate in the survey was also used. *Convenience sampling* is another form of non-random sampling, which refers to a sample comprised of easily accessible individuals, or the self-selection of individuals to participate in the survey (Ritchie et al. 2014). Both strategies are described in detail below.

An alternative strategy, *randomized sampling*, is often not a practical choice for web surveys in general—and this study in particular—for three reasons. First, the traditional methods used to collect a random sample of participants, such as Random Digit Dialing, don't yet exist for web surveys as there is currently no national database of

e-mail addresses, as there are for phone numbers. Second, there was no pre-existing list of researchers working in the field of ancient DNA from which I could randomly select a sample. As a result, I was required to generate a sampling frame for this specific study. I made the decision not to conduct random sampling from within the identified target population, as I wanted to invite as many individuals as possible to participate in the survey. Finally, the low response rate gleaned by web surveys necessitated an approach that would result in as large a sample as possible, rather than a smaller sample identified through random sampling. Thus, all individuals who were identified as having the desired knowledge and experiences were invited to participate in the survey.

4.2.1. Purposive Sampling

Purposive sampling is defined by Ritchie et al. (2014:113) as the selection of sample units based on "particular features or characteristics which will enable detailed exploration and understanding of the central themes and questions which the researcher wishes to study." The target population for my study consisted entirely of individuals who I determined to have been involved in the research or decision-making process regarding the genetic analysis of archaeological human remains. I identified four potential sub-groups within this population: 1) archaeologists, anthropologists, and other heritage professionals; 2) geneticists, genetic anthropologist, and biomolecular archaeologists; 3) members of descendant communities, if known; and 4) other stakeholders, including museum curators or landowners upon whose property the remains were found.

For this project, I included only the first two groups in my sampling frame. I did not include group 3 (descendent communities) and group 4 (other stakeholders) for three practical reasons. First, it would be difficult to identify which community members or other stakeholders were involved in the research as this may not be recorded in a way that is accessible to an outside researcher. Second, accessing the contact information of community members to invite them to participate in the survey would be a major challenge. Finally, a web survey might be an inappropriate method for understanding the perspectives of community members and other stakeholders, as compared to mail-out surveys, or organized interviews and focus groups. While there is a clear need to survey

descendant communities and other stakeholders on their perspectives towards ancient DNA research, this was beyond the scope of this thesis

Designing a Purposive Sample

As described by Michael Ornstein (2013:85), three principles must be considered when designing and identifying a purposive sample. I describe each of these below, briefly noting how they were incorporated into the design of this survey:

1. *A purposive sample must resemble the population of interest:* The population of interest for this survey is ancient DNA researchers. In order to meet this criterion, my survey participants were selected from a comprehensive list of authors listed on ancient DNA studies (additional details below);
2. *Increasing diversity within a purposive sample:* I attempted to identify a geographically diverse group of participants, as well as a sample comprised of emerging and established scholars; and
3. *If possible, to obtain measures that allow for comparisons between a purposive sample and the general population:* To my knowledge, a survey conducted by Kari Schroeder et al. (2006) which investigated the perspectives of 83 Native American participants towards genetic research represents the closest comparative study to the survey conducted in this thesis. However, there are important differences specifically that Schroeder et al. (2006) focus on genetic research in a broad sense, and not ancient DNA specifically. Thus, some similar issues were investigated (e.g., genetics and understandings of identity and ancestry) but additional topics that are of indirect relevance to ancient DNA studies (e.g., the potential medical benefits of participating in genetic research) were also discussed.

Once I had selected the study population (individuals involved in the technical and/or decision making process involved with ancient DNA research) I had to further specify the sampling frame in order to identify and recruit researchers with the desired knowledge and experience. This was achieved in two steps. I began by compiling a list of studies focused on the analysis of archaeological human remains through ancient DNA analysis. Next, I selected a purposive sample of authors associated with these publications in either a technical laboratory-based capacity and/or for their activities outside of the lab working with descendant communities and other stakeholders during the ancient DNA research process.

As there is no pre-existing list of ancient DNA researchers, the sampling frame needed to be generated specifically for this study. Three criteria were developed whereby the authors of an ancient DNA study were included within the sampling frame as potential participants:

1. *The study they were involved in must employ ancient DNA analysis to study human remains*: While genetic analysis of ancient plants and animals represents an exciting field of research, it was not considered for this study, which focuses only on human remains;
2. *The human remains must be from an archaeological context:* While both forensic and archaeological human remains require specialized methods to analyze degraded DNA, forensic human remains present unique ethical and legal considerations.
3. *The study must have been published within the last five years*: the field of ancient DNA is rapidly changing in terms of both technology and ethical practice. Thus, the five-year limit served as a method of sampling relatively recent ancient DNA studies that are reflective both of the contemporaneous political trends and of current practices in the discipline of archaeology and biomolecular anthropology. This time frame may have imposed some minor limitations on the scope of this study, but its use is justifiable for two reasons: 1) it served the function of ensuring that researchers who are *currently active* in ancient DNA projects were included in the survey sample; and 2) the goal of this thesis is to understand issues and challenges facing ancient DNA research as they are unfolding *now*. Therefore, while this thesis is informed by several ancient DNA case studies that occurred more than five years ago, the goal of the survey is to provide insight into the challenges researchers are experiencing today.

In order to generate a comprehensive list of studies and authors, a keyword search was conducted within the Web of Science. The Web of Science database proved to be an invaluable tool as ancient DNA studies are published in topically diverse journals (i.e., not just in “archaeology” journals); conducting an individual search of topic-specific journals would also have been highly inefficient. The keywords “ancient DNA” and “human” were kept deliberately broad so as to generate a greater number of results. Additional search parameters limited the results to studies published within the last five years, for reasons described above. Initial keyword searches returned over 700 citations, many of which did not meet the three criteria described above. Ultimately, 132 ancient DNA studies and their associated authors were included in the sampling frame. The studies located were diverse in geographic focus and represent an interdisciplinary

sample of research projects ranging from molecular paleopathology to studies of genetic diversity and structure.

A second step was required to identify a purposive sample of authors with particular expertise in ancient DNA research from all authors listed in the 132 studies. This step was necessary because not all of the authors in the identified studies were specifically involved with the ancient DNA analysis, but may have contributed other expertise. For example, an archaeologist who has worked with descendant communities throughout the ancient DNA research process was included in the sample, while a co-author whose research expertise was in statistics and computer modelling was not.

Several sources of information were used to determine whether an individual met the criteria for inclusion and had knowledge of and experiences in the areas of interest. If available, the “author contributions” statement provided a general understanding of the division of research expertise within the study. If such attribution information was not included in the article, or was insufficiently detailed, then a comprehensive examination of each individual’s research history was conducted. This included a search of the individual’s publications and their online research profile (if available). If the individual was a young scholar with limited publications, they were still included in the sample to increase diversity. All information used to compile this sample was publicly available online.

Based on purposive sampling, a sample of 125 individuals was subsequently identified. It became apparent in the sampling process that many authors were involved with multiple studies. Thus, there was a degree of redundancy or repetition, which indicated that the sampling strategy was successful in identifying appropriate ancient DNA researchers for inclusion in the survey.

4.2.2. Convenience Sampling

To ensure adequate sample size, *convenience sampling* was also employed to supplement the individuals identified through purposive sampling. Moreover, it served as a back-up mechanism in case the purposive sampling technique had failed to identify an individual with relevant knowledge and expertise. A call for participants was sent out

through the list server for the World Archaeological Congress (WAC) and the mailing list for the International Symposium of Biomolecular Archaeology (ISBA). This type of sampling required a degree of self-selection as each participant had to contact the author in order to receive an individualized access code to the survey.

The call for participants was distributed to an unknown number of individuals through the WAC list servers. Subsequently, two individuals from the WAC list server responded and were sent an e-mail invitation to complete the survey. The 160 individuals included on the ISBA mail list were sent an invitation to participate in the survey [20] (any individuals identified during the previous round of purposive sampling were removed). A total of 11 individuals responded, agreeing to participate in the survey (of which five individuals completed the survey). Thus, the total sample size achieved through purposive and convenience sampling was 138 individuals.

4.3. Launching the Survey

Once the sample of potential participants had been identified, their e-mail addresses (all publically available online) were stored in FluidSurveys, the web survey software used to create and administer this survey. While there are other options for researchers using web surveys, I selected FluidSurveys as it met the requirement set by Simon Fraser University's Office of Research Ethics that all data collected in the web survey be stored on Canadian servers.

A total of 138 e-mail invitations to participate in the survey were sent out in early March 2015,[21] with the deadline to complete the survey set for March 18th. Seven e-mail

[20] Not all 160 researchers listed on the ISBA mail list are specifically involved in ancient human DNA research, but may instead be involved with other forms of biological analysis.

[21] E-mail invitations were distributed on Thursday, March 4th to the 124 individuals identified through purposive sampling. Additional organization and permissions were required prior to sending out the call for participants through the WAC and ISBA mailing lists, from which 13 individuals expressed interest in participating in the survey. All email invitations were distributed by March 10 with the deadline for completing the survey set for March 18. Participants were provided with a short response window; however, Lemon (2007) notes that *if* participants are planning on completing the survey, they will generally do it within 36 hours of receiving the survey and/or an email reminder.

addresses bounced; I was able to locate updated e-mail addresses for four of the participants, but was forced to remove three individuals for whom up-to-date contact information could not be located. “Away” messages were received for two participants who were then removed from the sample (as they would not return until after the response period had ended). One individual had retired and replied that he felt that the field of ancient DNA had changed significantly during his time away so was removed from the sample. Additionally, four individuals were removed from the survey after indicating that ancient DNA analysis was a tangential research interest and felt that there may be others better situated to respond to the survey. Lastly, four individuals unsubscribed from the survey. With these adjustments, my *total survey sample* was comprised of 124 individuals.

To ensure that I received an adequate response rate from my sample of 124 individuals, I employed two strategies: e-mail reminders and the personalization of all email correspondence. A series of two e-mail reminders were sent to participants who had either not opened the survey, or those who had only partially completed it. Such reminders are recognized as an essential tactic to boost response rates to surveys (Sue and Ritter 2012). Reminder e-mails were sent to participants on Tuesday, March 10th (for participants from the WAC and ISBA mailing lists reminders were sent on March 12th) and Monday, March 16th, 2015. A significant spike in survey completion was experienced immediately following the distribution of the reminders. This is consistent with the expectation that participants will generally respond to a survey invitation or reminder e-mail within 36 hours, or not at all (Lemon 2007).

4.4. Analysis of Quantitative Survey Data

Of the remaining 124 individuals, 47 completed surveys were received—resulting in a completion rate of 38%. The survey data were downloaded from FluidSurveys into an Excel spreadsheet and then uploaded to SPSS and coded for categorical analysis. Quantitative analysis performed in SPSS provided answers for the first two research objectives of the survey: 1) to examine the common challenges related to the social, ethical, and political implications of ancient DNA research, as identified by participants; and 2) to explore how these challenges differed according to the reported geographic

focus of respondents' ancient DNA work. I first consider the methods used to analyse the multiple choice questions (quantitative data), and then turn to the text responses provided by respondents (qualitative data).

4.4.1. Statistical Analysis

Almost immediately upon beginning the quantitative analysis, it became apparent that participants' responses differed notably between those who work in North America and those working in other countries, the majority of whom are from Western Europe. Initially, respondents were asked to identify the specific country in which the majority of their ancient DNA research had taken place (Part 1: Question 1) as I had originally planned to compare the responses of participants from Canada and the United States. However, only two participants identified Canada as the geographic location of the majority of their research, compared to 15 from the United States. The disproportionate representation hindered any useful comparisons between the responses of participants from Canada and the United States.

In order to increase the statistical power of the survey, geographical regions were first condensed into continents (e.g., North America, South America, Europe, Asia, Australia). Ultimately, geographic location was further condensed into two major groups, "North America" and "Other Continents" to better elucidate patterns in the data. Additionally, while it is common practice in academia to include responses such as "uncertain" or "not applicable" to close-ended questions, these responses functioned as confounding variables that impeded analysis; they were removed from the analysis and only "yes" or "no" responses were considered.

To address my first objective—to identify common challenges arising in ancient DNA research—a contingency table was created for each of the eight challenges comparing participants' responses to whether they had encountered a specific challenge ("yes"/"no") versus the geographic location of research (condensed to "participants working in North America" versus "participants working in Other Continents"). Using this table, it was possible to identify the most common challenges as identified by respondents working in North America as opposed to Other Continents.

My second objective—to explore whether the challenges experienced by individual survey respondents differed according to the geographic focus of their research—was met through the use of a Fisher's exact test to determine if an association exists between the variables of interest: geographic location ("North America" vs "Other Continents") and each of the eight identified challenges. The data were analyzed using this method as they did not meet the Chi-square requirement that each cell contain an expected count of 5 or higher (Drennan 2009:192; McHugh 2013:144). The Fisher's exact test of independence is generally recommended for small sample sizes, since it does not have sample size restrictions (Drennan 2009:192; Moore 2010). As with the Chi-square statistics, a Fisher's exact test will indicate whether there is an association between two variables, but it will provide an exact rather than approximate p-value (Drennan 2009; Moore 2010). In small samples, the difference between an approximate and exact p-value can have important implications for interpretation. Finally, in order to evaluate the strength of the association, Cramer's V was calculated (Drennan 2009:199)

4.5. Analysis of Qualitative Survey Data

In addition to quantitative data, the survey also collected qualitative information in the form of open-ended text responses. Participants were presented with a series of multiple choice questions asking if they had encountered each of the identified challenges during the course of their research. If the participant indicated "yes" to a particular challenge, they were asked to provide additional detail in the form of an open-ended text response box. Such responses comprised the qualitative data collected during this study. Initially, the data were to be analyzed using Nvivo. However, after conducting test queries in Nvivo, I decided that its functionality was limited due to the relatively short and concise nature of the responses. However, I did employ Nvivo as a tool with which to organize participants' responses according to survey question rather than as a tool for analysis. The quality and number of text responses provided for each question differed widely. As a result, when possible I endeavored to include all responses to demonstrate the breadth of perspectives provided by survey respondents.

However, in the case that comments were very extremely short and/or fragmentary, I chose to include a more fully developed quote of a similar nature or theme.

Protecting Participants' Privacy

Upon beginning the survey, participants were asked to indicate whether they would prefer to have their names withheld, or gave consent for their names to be used in the thesis. A total of 18 individuals gave permission for their names to be attached to their comments provided in the survey. For those who indicated their preference not to be named, they are identified in the following manner: as either *NA* (North America) or *Intl* (international/other continents), indicating the geographic focus of their research, followed by a unique numerical code. For example, a survey participant from North America may be identified *NA-4,* and another respondent working in the United Kingdom as *Intl-7.* This method protects the privacy of participants while still providing useful context for their comments.

4.6. Potential Limitations

Although my methods and data were carefully selected to gain insight into the challenges facing ancient DNA researchers, they did have limitations. All surveys—but web surveys in particular—are subject to limitations. Four potentially limiting factors that warrant examination are: 1) coverage error; 2) sampling error; 3) non-response error; and 4) sample size. I address each of these below.

Coverage refers to "the proportion of the target population that can actually be selected and surveyed" (Ornstein 2013:61). For web surveys, a common source of coverage error occurs when individuals within the target population do not have access to (or know how to use) the internet. Fortunately, for the target population in this survey (researchers involved in the analysis of ancient human DNA) this was not considered a major concern as many respondents already had a large online presence meaning that their contact information was readily available. Moreover, due to the nature of their jobs as professors and international researchers, a familiarity with web-based modes of information delivery was expected. Additionally, as the sampling frame was constructed

based on individuals listed as authors on recent ancient DNA studies, it is possible that error in the form of “under coverage” occurred, meaning that I may have omitted individuals who do have the desired knowledge and experience, but are *not* listed as authors on academic publications.

Potential *sampling error* within this survey is also important to consider. Sampling error, defined as “the expected difference between the sample-based estimate and the population value” (Ornstein 2013:61), is inevitably present in all surveys. For this survey, the primary concern related to sampling error is the small sample size, which will inevitably restrict the degree to which this survey can be generalized to the general population. However, diversity within the sample, especially in relation to the geographic location of researchers, helps to mitigate this concern to some degree.

Non-response error refers to “the differences between the respondents to the survey and the larger pool of volunteers from which the respondents were drawn,” and is a “challenge for all surveys” (Tourangeau et al. 2013: 36-40). The response rate for my survey was 38%, based on the calculation (completed surveys/number of cases successfully contacted and deemed to be eligible +non-contacts) proposed by Raymond Kent (2001:57). While a higher response rate would be advantageous, this is within the expected response rates for web survey, which have an estimated response rate 11% below what can be expected from a paper-based mail survey (Fan and Yan 2010:132). In a comparison of eight different web surveys, Duncan Nulty (2008:302) estimates an average response rate of 33%. A literature review of web survey response rates conducted by Schonlau et al. (2002) identified response rates for professional web surveys ranging from 8% to 62%, with an average rate of 35%. Therefore, while I would have preferred a higher response rate to reduce non-response error, my response rate is consistent with that expected for web surveys.

Sample size is an important consideration in all surveys, but it is rarely easy to determine how large of a sample size is adequate for qualitative research. I received a total of 47 completed responses, a relatively small sample of the actual number of individuals working in the field of ancient DNA worldwide. According to Neuman

(2000:217), there are three factors to consider when determining an appropriate sample size for qualitative research:

1. *The degree of accuracy required from the survey results*: This survey functions as a first step towards gaining a more in-depth understanding of the challenges related to the social, ethical, and political implications of ancient DNA research. Thus, it is exploratory in nature and not intended to provide absolute quantitative results;
2. *The degree of diversity within the sampled population*: While this study seeks to gain insight into the perspectives and experiences of a sample of researchers involved in ancient human DNA analysis, there is a great deal of variability within this population. Sources of diversity include the different locations around the world in which a participant is involved in an ancient DNA study and the degree of collaboration (if any) that occurs between the participant and other stakeholders; and
3. *The number of variables that are analyzed in the survey data*: A modest number of variables were analyzed in this survey. I focused primarily on investigating the potential association between the geographic focus of participants' research and the whether they had encountered eight identified social, ethical, or political challenges in their research. I also considered variables including the estimated time frame required for ancient DNA studies and the degree of collaboration with descendant communities and other stakeholders, as defined and reported by survey participants.

An additional aspect of sample size to consider in this survey is the comparative number of participants working in North America as compared to those situated elsewhere in the world. A total of 17 participants reported that the majority of their research took place in Canada or the United States, and were thus included in the geographic category of "North America." A further 29 participants were included in the "Other Continents" category (excluding the one individual who did not report the geographic focus of their work). While it would be desirable to have an equal number of participants for both categories, steps were taken to reduce the potential impact this may have on the statistical analysis. Specifically, all percentages presented in Chapter 5 are based on the responses of individuals *within* each geographic category, rather than an overall percentage of the total number of participants.

4.6.1. Chapter Summary

In order to meet my research objective of identifying emerging challenges facing ancient DNA researchers and to explore how the experiences of individual survey respondents varied according to the geographic location of research, I designed and distributed a web survey. E-mail invitations to participate in the survey were sent to a sample of 124 ancient DNA researchers, identified through purposive and convenience sampling. A total of 47 completed responses were received resulting in a completion rate of 38%. The data were analyzed in SPSS and Fisher's exact test was used to examine possible associations between each of the eight identified challenges and the geographic location of the research. The limitations of this study are shared by web surveys in general and relate specifically to coverage error, sampling error, and nonresponse error, and the relatively small sample size. This may restrict the generalizability of the research results, but nevertheless serves as an important exploratory study to gain insight into the implications of ancient DNA research, as identified by the survey respondents.

Chapter 5.

Survey Results

The focus of the survey described in the previous chapter was to provide insight into the various challenges experienced by survey participants as they negotiate the potential social, ethical, and political implications of ancient DNA research. Each of the multiple-choice questions (quantitative data) in the survey had an associated text response box in which the participant could provide additional thoughts, comments, and when possible, ways in which they have addressed the specific challenge in their own work (qualitative data). Thus, a more nuanced understanding of challenges in ancient DNA research was permitted through the integration of quantitative and qualitative data gathered in the survey data.

In this chapter, I present the results of the web survey. I begin by discussing background information regarding the research conducted by participants, specifically: 1) the countries reported by respondents as the geographic focus of the majority of their ancient DNA work; 2) the estimated average length of time required to complete an ancient DNA project, from project conception to the publication of the final results; and 3) the general level of collaboration with descendant communities in the projects that the survey respondents have been involved with. Next, I present the survey results in the order of the most to least commonly experienced challenges in ancient DNA research, as identified by survey respondents working in North America. The order is as follows:

1. Potential future uses of genetic information arising from an ancient DNA study;
2. Ancient DNA and understandings of identity and ancestry;
3. Compatibility between ancient DNA and cultural values;
4. Consent and consultation processes with descendant communities and other stakeholders in ancient DNA studies;
5. Politicization of ancient DNA research and results;

6. Difficulties related to the communication of results from ancient DNA studies;
7. Determining ownership and intellectual property rights over ancient genetic information; and
8. Concerns related to genetic privacy.

5.1. Reported Location of Survey Respondents' Ancient DNA Research

The survey asked participants to identify in which country the majority of their ancient DNA research has taken place. The respondents identified a total of 19 different countries in which they are involved in ancient DNA studies (Figure 5-1). The final sample of participants is geographically diverse: Argentina (n=1), Australia (n=1), Canada (n=2), China (n=1), Colombia (n=1), Denmark (n=2), France (n=1), Germany (n=2), Hungary (n=1), Italy (n=3), Mexico (n=1), New Zealand (n=1), Poland (n=1), Russia (n=1), Spain (n=2), Sweden (n=2), Ukraine (n=1), United Kingdom (n=7), the United States (n=15), and unknown[22] (n=1). Proportionally, the greatest geographical representation came from the United States followed by the United Kingdom.

As discussed in Chapter 4, to increase the statistical power of the survey, the survey data were condensed into responses provided by participants working in North America versus elsewhere in the world. This approach served to highlight broad geographical differences but may obscure other trends in the responses of researchers in other countries who also work with descendant communities in countries with colonial pasts, such as Australia and New Zealand.

[22] This participant did not provide a response to this question and was thus excluded from subsequent analyses.

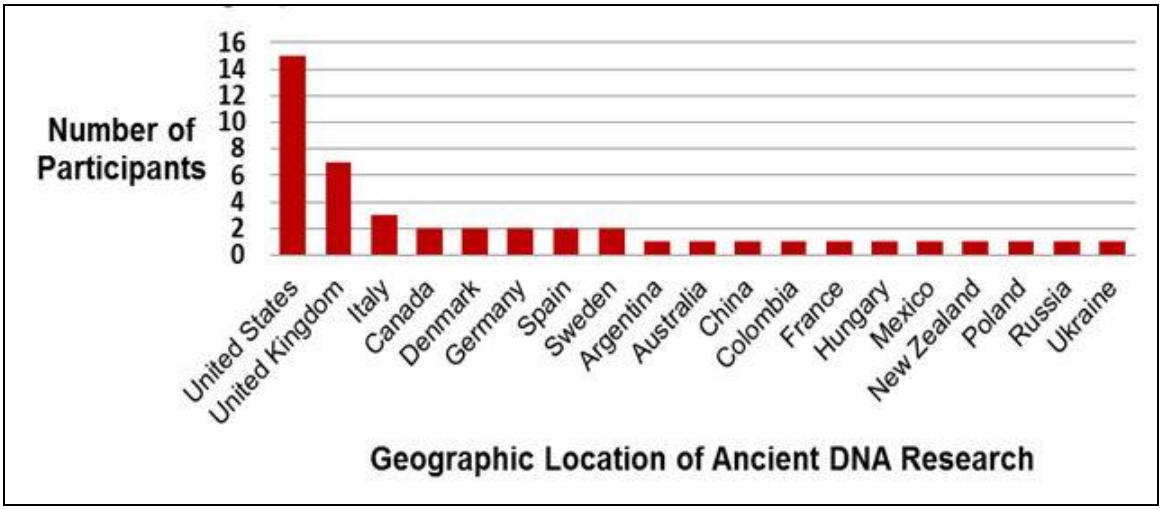

Figure 5-1. Survey participants and the reported geographic focus of their ancient DNA research.

5.2. Degree of Collaboration in Ancient DNA Research

Survey participants were asked to indicate the general level of collaboration with descendant communities in the ancient DNA projects they are currently involved with. Participants could select one of five responses: very high, high, neutral, low, and very low. To increase the statistical power of the survey, these response options were subsequently condensed into three categories: high, neutral, and low. Overall, the survey results indicate that there is a fairly even split between levels of high, neutral, and low collaboration with descendant communities, as demonstrated in Figure 5-2. Ultimately, a greater percentage of *all* participants (35.9%) working around the world reported collaboration with descendant communities as high, as compared to those who reported neutral (30.77%) or low (33.33%) levels of collaboration.

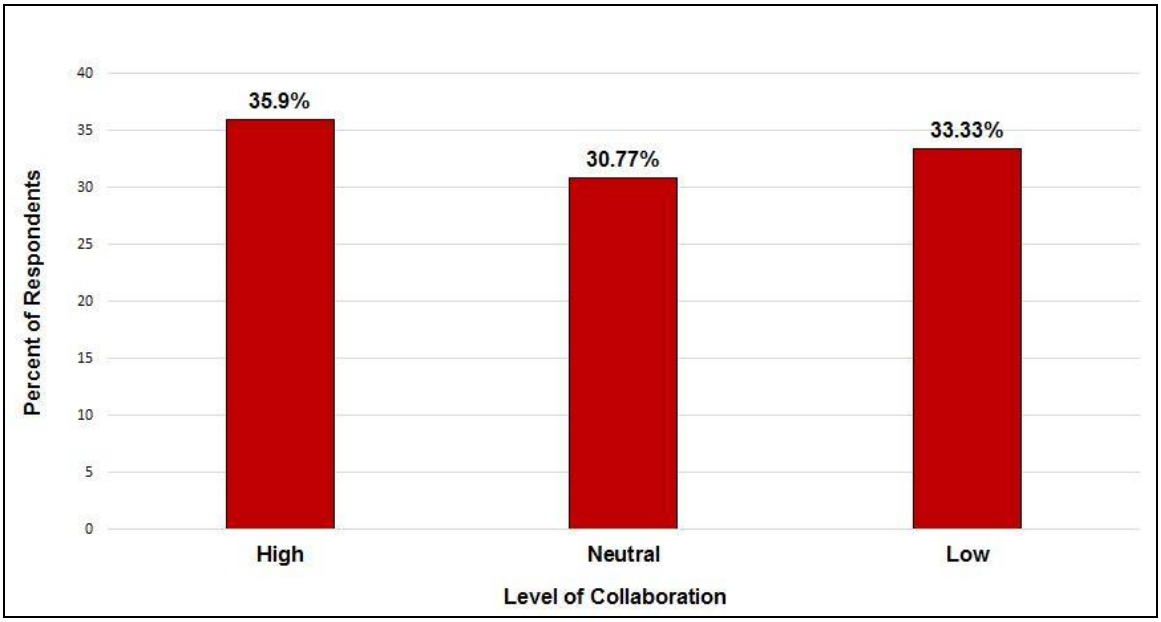

Figure 5-2. Differing levels of collaboration in ancient DNA research according to all survey participants.

I then considered collaboration in relation to the geographic location of the research. As demonstrated in Figure 5-3, a greater percentage of international survey participants reported levels of high and neutral collaboration than did survey participants from North America. A total of 15.79% of participants from both geographic groups indicated that collaboration with descendant communities was generally low in the projects they have been involved with.

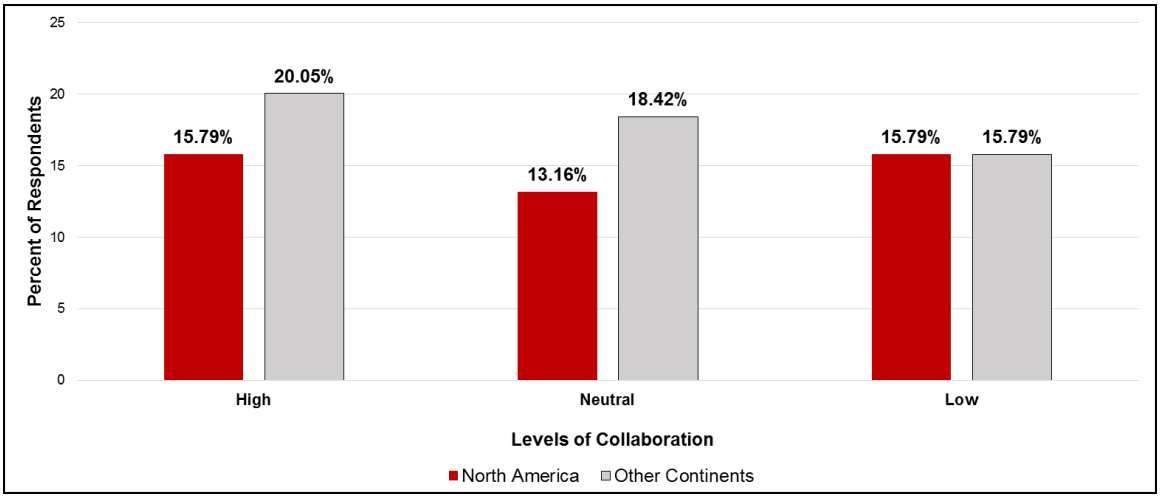

Figure 5-3. Levels of collaboration in ancient DNA studies in "North America" and "Other Continents."

When considering North America specifically, there is an even split between survey participants who reported high levels (15.79%) and low levels (15.79%) of community collaboration with neutral levels falling in the middle (13.16%), as illustrated in Figure 5-4. Based on the pattern of high community collaboration apparent in the ancient DNA case studies in British Columbia (Chapter 3), I had expected a similar level of collaboration with descendant communities across North America. The difference may lie in differing understandings of what "collaboration" involves, as well as distinguishing between collaboration and consultation. For example, two researchers who participated in the survey were involved in the recent DNA analysis (Rasmussen et al. 2014) of a 12,000-year old child (Anzick-1). Following genetic analysis of Anzick-1, several members of the research team met with nine different Native American tribes located in the area where the remains were found. The tribes made their wishes clear for the boy to be reburied, and earlier this year, a reburial ceremony was held. Both survey participants involved in the Anzick study responded that collaboration with descendant communities was "low." This example highlights the different ways in which collaboration may be understood by multiple parties and how "consultation" differs from "collaboration."

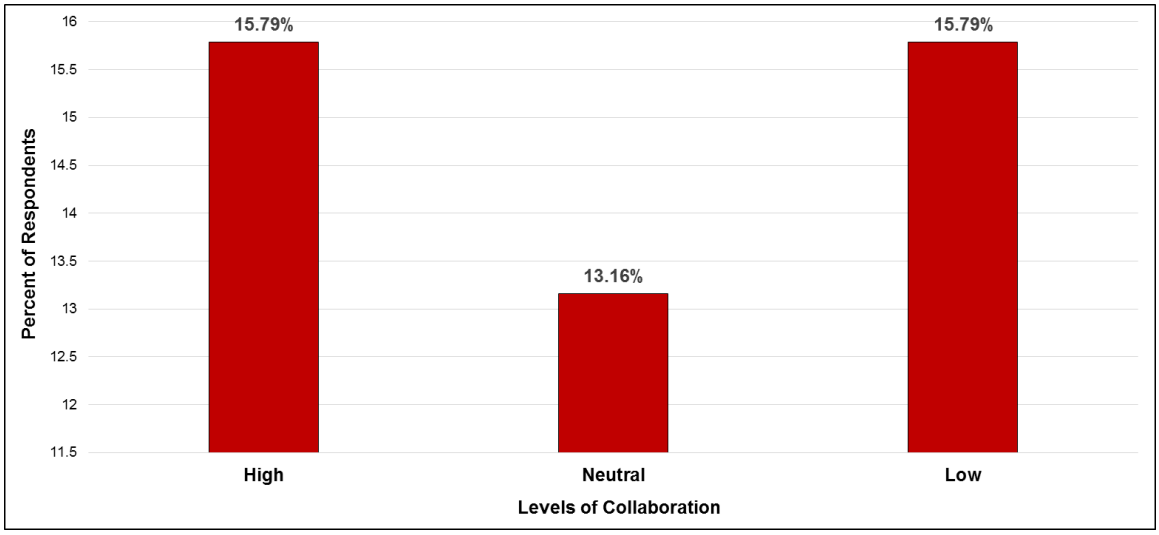

Figure 5-4. Levels of collaboration in ancient DNA research according to participants working in North America.

Overall, the survey data do suggest that some ancient DNA researchers are engaged in collaborative projects with descendant communities around the world (35.9%), which is encouraging. However, a majority of respondents (64.1%) characterize their involvement with communities as neutral or low. This suggests that the high level of collaboration between researchers and First Nations communities in British Columbia represents the exception rather than the rule. This supposition is supported by the fact the two survey participants who work in Canada each described their collaboration levels with descendant communities as “high.”

5.3. Estimating the Time Required for an Ancient DNA Study

Survey participants were asked to estimate the average length of time required to complete an ancient DNA study, from project conception to final reporting of the results. As indicated in Figure 5-5, 40% of all survey participants (20% in North America, 20% in Other Continents) reported that the projects they have been involved with took *more than 3 years* to complete. The results also indicate that for survey participants working in North America, fewer than 4.44% of the ancient DNA projects they have been involved in were completed in less than two years. Overall, the survey data support the

interpretation that ancient DNA projects are multi-year endeavours, with many extending beyond three years. It is important to note that this timeframe is not unusual for archaeological work, especially when a collaborative approach is adopted.

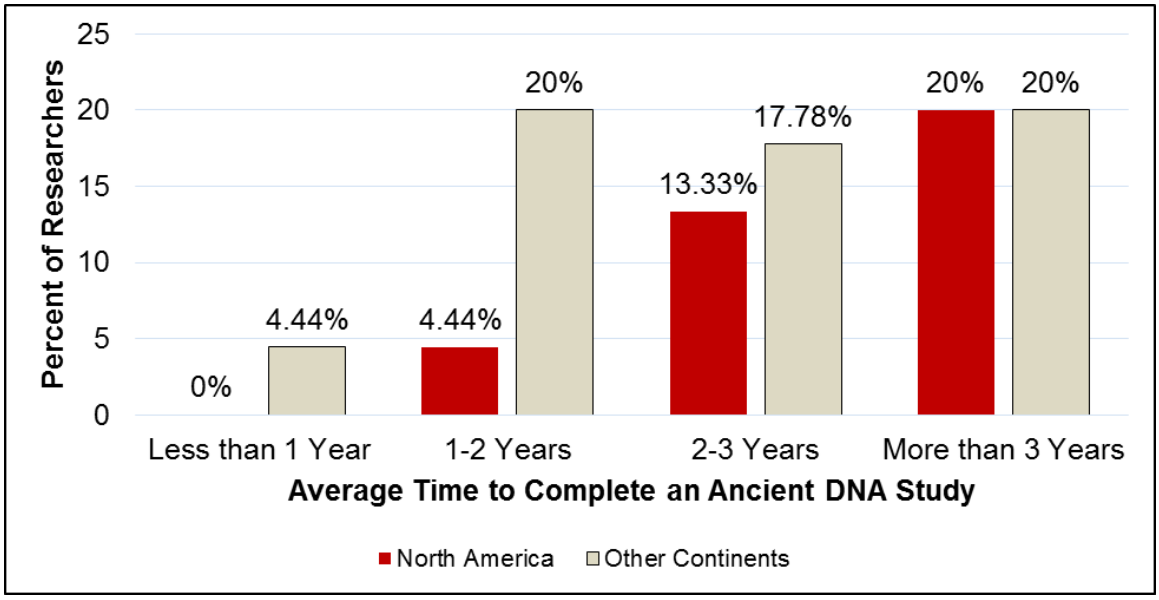

Figure 5-5. Estimated average time to complete an ancient DNA study in "North America" versus "Other Continents."

5.4. Identifying Challenges in Ancient DNA Research through the Survey Results

Analysis of the survey data allowed me to meet the first two research objectives set out in this thesis. The first was to identify common challenges experienced by individuals working in the field of ancient human DNA research. The responses received indicated that all eight identified challenges were experienced by survey respondents, but to vastly differing degrees (Figure 5-6). The most common challenges identified by a majority of participants working in North America include:

1. The future use of data arising from ancient DNA studies (75%);
2. Issues related to ancient DNA studies and understandings of identity and ancestry (60%);

3. Uncertainty with regards to developing processes of consent and consultation with appropriate descendant communities and other stakeholders (56.3%); and
4. Concerns related to the compatibility of ancient DNA with cultural values (56.3%).

In comparison, participants involved in ancient DNA studies taking place outside of North America identified the politicization of ancient DNA studies (52.6%) and communication related difficulties (41%) as the most common challenges they encountered in their ancient DNA projects (Figure 5-6).

The second research objective was to explore how the various challenges experienced by researchers differed according to the geographic focus of their work. The results indicate that a greater percentage of researchers working in North America have encountered seven of the eight challenges, with a statistically significant association found between participants working in North America and specific issues related to the potential future uses of genetic data and cultural values of descendant communities and other stakeholders.

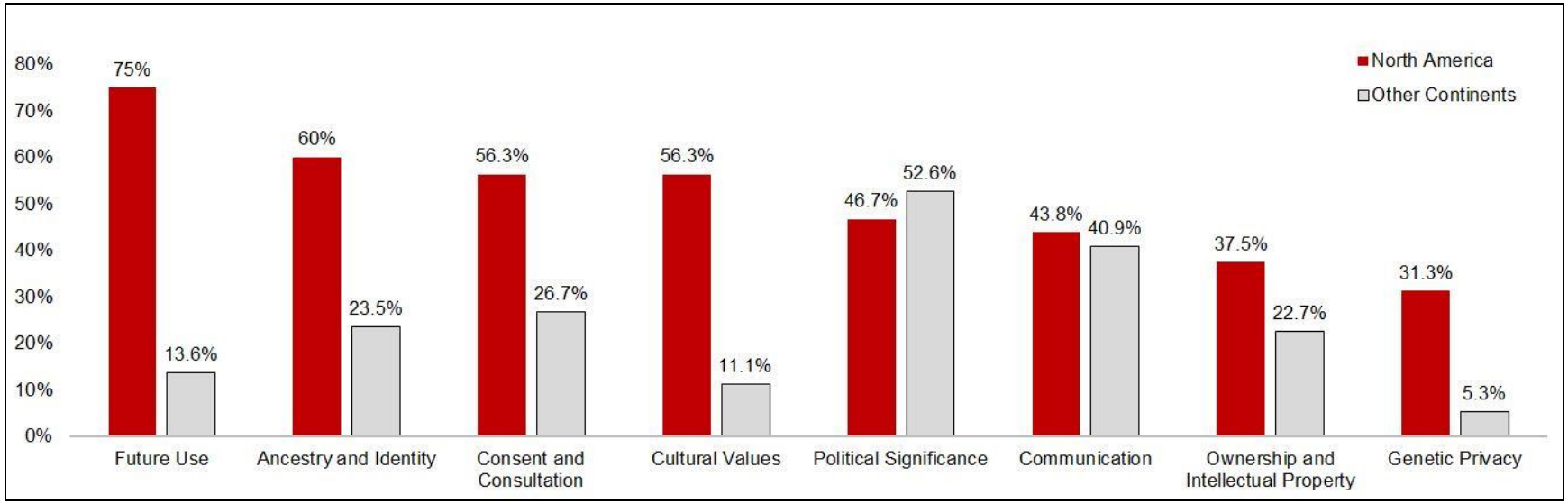

Figure 5-6. Comparison of the degrees to which survey participants in "North America" and "Other Continents" experienced each of the identified challenges.

5.5. Regulating Future Research Involving Genetic Data

Survey participants were asked “have concerns been expressed about the types of research that the ancient genetic data may be used for in the future?” In response, 75% of researchers working in North America indicated that this was a challenge they had encountered, while only 13.6% of those working outside of North America encountered this difficulty (Figure 5-7). Overall, determining the future use of data was the most common challenge experienced by researchers working in North America.

A Fisher’s exact test was conducted to examine the association between difficulties experienced by participants with regards to the future use of genetic data and the geographic focus of respondents’ research. The results of the analysis indicate that there is a statistically significant association between these two variables ($\chi^2(1) = 14.599$, $p < 0.001$). In order to determine the effect size of this association, a subsequent Cramer’s V was also conducted. The results suggest that there is a very strong effect size for this association (Cramer’s V = 0.62, $p< 0.001$). Therefore, a significant association was found between the geographic location of the research and whether it was a challenge to address the concerns of stakeholders regarding the future use of genetic data arising from ancient DNA studies.

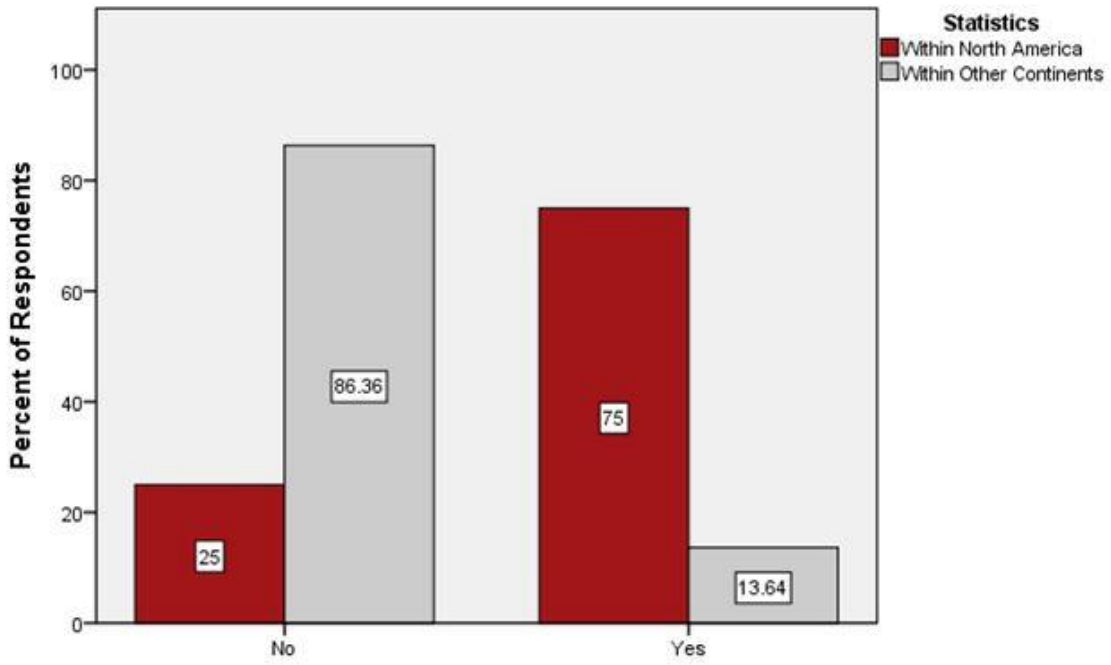

Figure 5-7. Responses of survey participants (No/Yes) on the future use of genetic data.

5.5.1. Participants' Reflections (on Future Use)

The qualitative data gathered by the survey suggest that regulating the future use of genetic data arising from an ancient DNA study is an important challenge that many survey respondents have been confronted with. The text responses indicate that concerns regarding the future use of genetic data are greater when present-day community members also provide DNA samples to be compared against the ancient samples. Moreover, there appears to be a greater willingness on the part of participating individuals and communities to allow for the future investigation of certain research topics and not others. Additionally, the survey responses indicate a struggle among ancient DNA researchers to balance their responsibility to regulate the use of genetic data without the consequence of stifling future studies that may be of interest and benefit to the community.

Based on the responses of survey participants, certain research topics were more likely to be considered as "acceptable" future areas of study than others. *NA-11*

described a research agreement that was developed in which there were terms "explicitly limiting the research that could be done with them" and that "no medical research was allowed, but ancestry-related questions were permitted." Similarly, in the experience of participant *NA-11*, descendant communities are generally more willing to list demographic and ancestry-related topics as acceptable future uses of the genetic data. A general hesitation towards the use of DNA samples for future research into health "or disease traits" was echoed by several others who identified these topics as "off-limits" (*NA-14*).

Concerns surrounding potential areas of future research appear to increase when modern populations provide biological samples for comparison with the ancient genetic data. As explained by *NA-8,* additional research questions that can be explored through ancient genetic data are relatively limited and that "we can't really do a lot …in in regards to medical inferences." Instead, *NA-8* suggests that the concerns and subsequent challenges arise when "modern data sets are used to place the ancient samples within present-day context." In her own experience, modern data sets:

> can only be used for demographic analyses, and even then the (modern) samples should be anonymized and most often only released under access agreement. Approval from the local ethics committee for the type of research being conducted, and signed informed consent forms which clearly outline the aims of the research.

Echoing the comments of *NA-8*, numerous survey participants highlighted the importance of developing access agreements and research agreements in which both parties devise acceptable terms and conditions for the sharing of genetic data. However, the responses provided by some participants indicate that it is a challenge to balance the concerns of communities with regards to the future uses of ancient genetic data while not eliminating the possibility of all future research. As one participant, Lisa Matisoo-Smith, Professor of Biological Anthropology at the University of Otago in New Zealand, explained, "there have been requests as to the possibility of controlling the data—we explain about the need to make genetic data public in databases and once we explain what people can and cannot do with this data, generally concerns are reduced." Likewise, participant *NA-3* noted the conflict that may be experienced within and between Indigenous groups as "some tribes understand the value to people of the

future, others don't want to find out something that might challenge or conflict with certain aspects of their current knowledge."

Thus, the survey responses indicate that there is a clear need to restrict the future use of data to projects that are acceptable to all stakeholders involved. Based on the responses provided by participants, setting out the terms of access within a more encompassing research agreement is an effective way to ensure that information is shared responsibly and in a manner that is acceptable to all parties involved.

5.6. Ancient DNA, Identity, and Ancestry

Survey participants were asked "have you experienced difficulties when the results of ancient DNA analysis are seen to challenge stakeholders' long-held understandings of identity and ancestry?" In response, 60% of researchers working in North America indicated that they had encountered challenges compared to 23.5% of those working outside of North America (Figure 5-8). Overall, challenges related to negotiating the sometimes tenuous relationship between identity and ancestry with regards to ancient DNA was identified as the second most common difficulty facing researchers working in North America.

A Fisher's Exact test was conducted in order to determine if the location of research produced a statistically significant difference in participants' responses. The results of the analysis indicate that there is not a statistically significant association between these two variables.

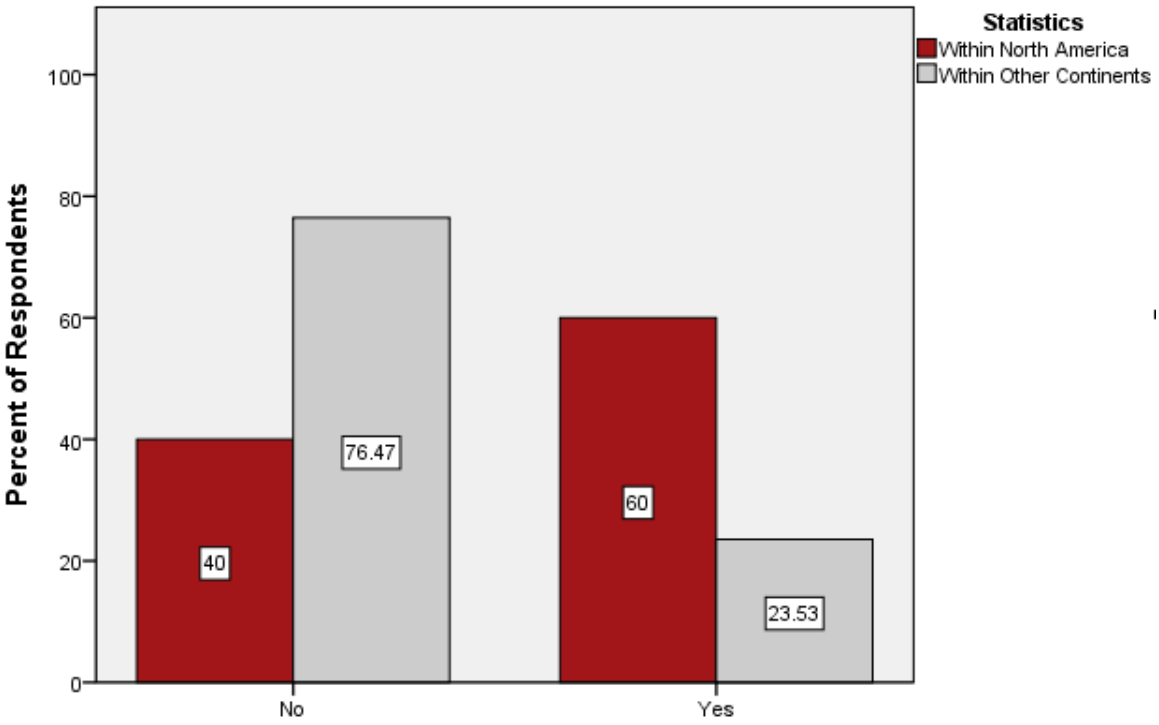

Figure 5-8. Responses of survey participants (No/Yes) on challenges associated with identity and ancestry.

5.6.1. Participants' Reflections (on Identity and Ancestry)

Negotiating different or multiple understandings of identity and ancestry between communities was a noted difficulty, especially when biogenetic information was seen to challenge traditional understandings. In the experience of participant *NA-13* working in the United States, balancing genetic narratives of the past with other forms of understanding was made more difficult when "oral histories say something else" regarding population migration events. Participant *NA-10* spoke to the value of engaging in "a discussion of the different ways of knowing about the past, the possibility of a

coexistence of different understandings of the past, and a discussion regarding biological vs. cultural perceptions of identity and ancestry[23]."

However, this does not mean that all interpretations of ancestral relations should be accepted without question. Participant *NA-11* pointed to the "popular appeal" of alternative theories such as the "lost Moundbuilders"[24] and how this theory regarding the "ancestry of North American populations not only doesn't fit with the ancient DNA results, but also undermines Indigenous sovereignty by attempting to insert Europeans into their own history. These ideas often have popular appeal…and are given more attention than the data warrant." Space must therefore be created for multiple understandings of the past, especially in relation to identity and ancestry, but not at the risk of perpetuating harmful colonialist narratives of the past.

The responses of survey participants noted the risk for the results of genetic analysis to differ from long-held understandings of identity and ancestry, or understandings of the past more generally. Lisa Matisoo Smith addresses this issue by always offering "to present multiple viewpoints in publications." To date she has yet to encounter a situation where the results of genetic analysis "conflict with traditional views." Another respondent, Jelmer W. Eerkens, Professor of Anthropology at University of California-Davis, described the desire of some tribes he has met with to have "veto power" over the research results if "they don't fit their current understanding" and to "not have the data published." In his response, Eerkens stated that "ethically, as a scientist, I could not do this" and so the study was never conducted. This demonstrates the ethical challenges facing ancient DNA researchers as they seek to respect the needs and

[23] The potential to move beyond "agreeing to disagree" is being explored in archaeology, particularly in relation to oral histories. In her work on reconciling the disparate narratives provided by archaeologists and the oral traditions of the Huron-Wendat in the St. Laurence Valley, Quebec, Mariane Gaudreau (2015) argues for investigating the underlying reasons for the discrepancies rather than simply agreeing to disagree. This perspective may prove to be of use for future genetic studies related to identity and ancestry.

[24] This refers to the myth created by American colonialists in the late 18th and early 19th centuries that a lost race of people built large earthen burial mounds, temple mounds, and other enclosures (Echo-Hawk and Zimmerman 2006). The "Moundbuilders" were described as an "advanced race" that were "more sophisticated technologically and morally superior" to the "bloodthirsty race of Indians" who were blamed for killing off the Moundbuilders (Echo-Hawk and Zimmerman 2006: 474-475). This myth has since been rejected by archaeologists, dismissed as pseudoscience fuelled by racist and colonialist motives.

desires of the communities they work with, but also, to eventually share the results of the study with the broader academic community and general public.

Standard privacy protection measures were identified by participants as ways in which to address concerns, especially when living people provide DNA samples to be compared to the ancient individual (e.g., Chatters et al. 2014; Cui et al. 2013; Kemp et al. 2007; Monsalve et al. 2002; Rasmussen et al. 2014). This may include making arrangements to protect the collective identity of the present-day participants, if stipulated by the community. The strategy adopted by participant *NA-8* working with First Nations groups in Canada is that, if requested, "community/tribal identities can be omitted from the study altogether (when using modern samples as reference in aDNA studies)" and that all results were communicated "to the involved communities prior to publication" regardless of "whether the results are controversial or not." In this case, open communication throughout the research process was considered essential in mitigating potentially difficult concerns related to preserving and protecting multifaceted understandings of identity and ancestry.

5.7. Ancient DNA Studies and Cultural Values

Survey respondents were asked whether "stakeholders have expressed concerns to them about whether conducting ancient DNA analysis on human remains is culturally appropriate?" Overall, 56.3% of researchers working in North America indicated that the sensitive negotiation of the cultural values of the descendant communities presented a challenge, while only 11.1% of international respondents identified this as a difficulty (Figure 5-9). Overall, cultural values was tied with consent and consultation as being the third most common challenge identified by survey participants researchers working in North America, but one of the least common challenges experienced by those working elsewhere.

A Fisher's exact test was conducted to examine the association between challenges related to the compatibility of cultural values with ancient DNA studies and the location of the researchers. The results of the analysis indicate that there is a statistically significant association between these two variables ($\chi^2 = 7.886$ $p = 0.009$.) In

order to determine the effect size of this association, a subsequent Cramer's V was also conducted which found a very strong effect size for this association (Cramer's V = 0.482, p = 0.009).

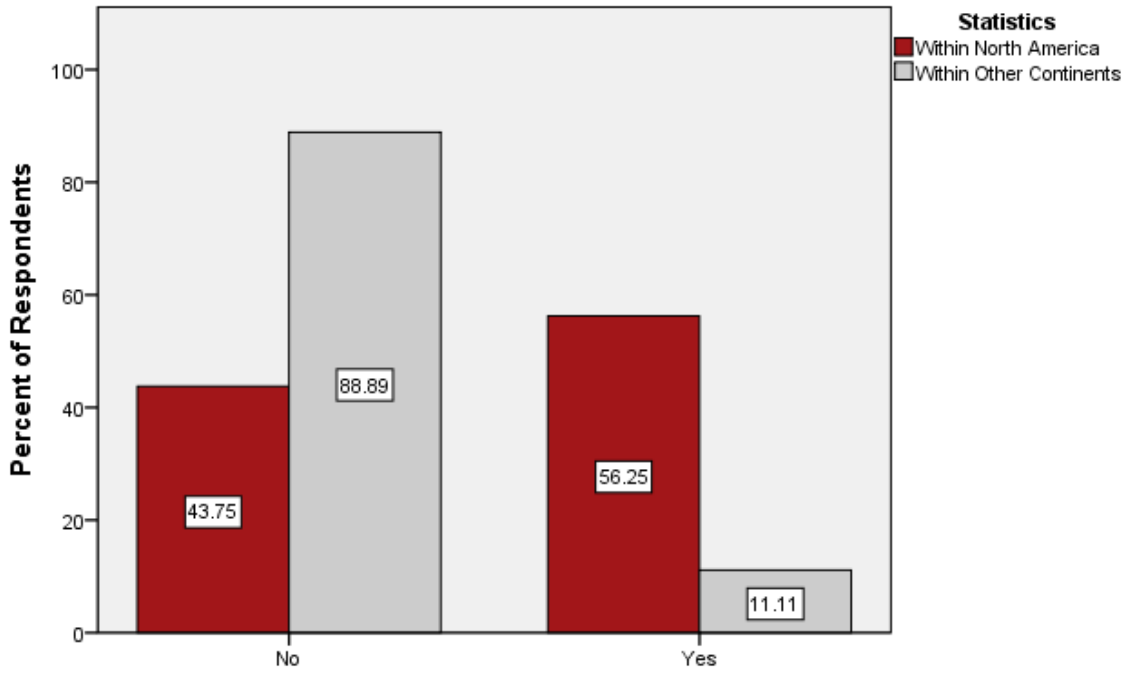

Figure 5-9. Responses of survey participants (No/ Yes) on ancient DNA and cultural values.

5.7.1. Participants' Reflections (on Cultural Values)

Ancient DNA research is a polarizing issue for many Indigenous peoples, with some groups outright banning all forms of genetic research (Schmidt 2001), while others choose to engage in genetic studies to help answer questions of interest to the community (see Chapter 3). This reflects a key challenge identified by survey participants: the wide variety of cultural views towards ancient DNA studies that can be found *within* and *between* communities. Participant *NA-13* described her efforts to assess the cultural values and feelings of different tribal members within a single group only to find that perspectives between individuals were extremely diverse. Similarly, Jelmer Eerkens stated that "some tribes do not allow non-Indians to handle or analyze remains," while other groups "allow handling but are not supportive of conducting destructive analyses for fear of offending spirits of the deceased." Eerkens also notes

that some tribes “worry about how they will appear in the eyes of other tribes, if they allow such analyses,” suggesting that pressures or concerns regarding ancient DNA studies may come from external sources, as well as originating internally within the community.

The importance of discussing the unique cultural values of communities and other research partners early on in the research process was repeatedly identified by survey participants. One prominent ancient DNA researcher (*NA-19*) who has worked extensively with tribes throughout the United States explained his own approach:

> In my research this question [of cultural values] is usually raised by me during early discussions with communities and cultural leaders. If the research is generally considered inappropriate, the project does not proceed. If there are questions, they are addressed directly in both individual and community level meetings and discussions. Subsequent to the meetings, it is determined whether the analyses are considered appropriate or not.

The survey responses also demonstrate the variety of practices that have been adopted by the respondents to ensure that ancient DNA research is conducted in a culturally respectful way, as directed by the specific communities they are working with. In her work in New Zealand, Lisa Matisoo-Smith ensures that “the *iwi* (tribal group) are always consulted—they bring the samples to the lab, they blessed the lab, they discuss all results and interpretations.” This was echoed by researcher *NA-10* working in the United States who discussed the need to “respect groups' wishes as to how the remains are stored and treated, as well as treatment of the lab” pointing to the specific example of smudging for purification.

Cultural values may also provide guidance on the appropriate manner in which to treat the remains of ancient individuals once research has been completed. Dr. Shane Doyle, who played a key role in facilitating communication between the genetic researchers studying the genome of the 12,000-year-old Anzick child and Native American communities in Montana, described how “tribal representatives requested that the boy be reburied, with no more testing done, and no samples remaining above ground.” In the survey, Doyle reflected on his initially conflicted perspective towards

ancient DNA analysis and how he was eventually able to reconcile this with his own cultural beliefs:

> The biggest challenge I faced was dealing with my own perceptions and perspectives on studying ancient people. I had to re-examine my beliefs and values as a contemporary tribal person. I decided that I would rather support the study and figure out how to conduct future studies in the most respectful and sensible way possible. I also came to the conclusion that the knowledge is mostly good and important and in the long run it will be good for us as tribes and for the world in general to learn as much as we can about ourselves. Turning away from important knowledge has never been a traditional value in tribal culture. But seeking knowledge just for the sake of knowledge has not been a traditional value either. So there needs to be a balance there, and Indian people need to contribute to that understanding and lead the way for wayward researchers who have lost their logistical compass.

The integration of the unique cultural values of descendant communities and other stakeholders into the ancient DNA research process is a challenge experienced by over half of the survey participants working in North America. As suggested by the survey responses, it can be difficult to negotiate the diversity of perspectives held by descendant communities towards ancient DNA analysis. The responses also indicate that if concerns exist with regards to the cultural appropriateness of ancient DNA analysis, and there is opportunity for discussion with descendant communities, then they will be voiced early on in the project. Therefore, it appears that proactive and ongoing consultation and dialogue between researchers, community liaisons, and community members are considered critical to ensuring that the samples from ancient individuals are treated in an appropriate and respectful way throughout the ancient DNA project.

5.8. Consent and Consultation in Ancient DNA Research

Survey participants were asked if it has been a "challenge to identify the appropriate modern populations to consult with and/or gain consent from for the analysis of ancient human remains?" The responses indicate that 56.3% of participants working in North America have experienced this challenge, compared to 26.7% of respondents working elsewhere in the world (Figure 5-10). Overall, challenges related to identifying appropriate communities and stakeholders with whom to consult are tied with ancient

DNA and cultural values as the third most common challenge identified by participants working in North America.

A Fisher's Exact test was conducted in order to determine if the location of research produced a statistically significant difference in participants' responses. The results of the analysis indicate that there is not a statistically significant association between these two variables.

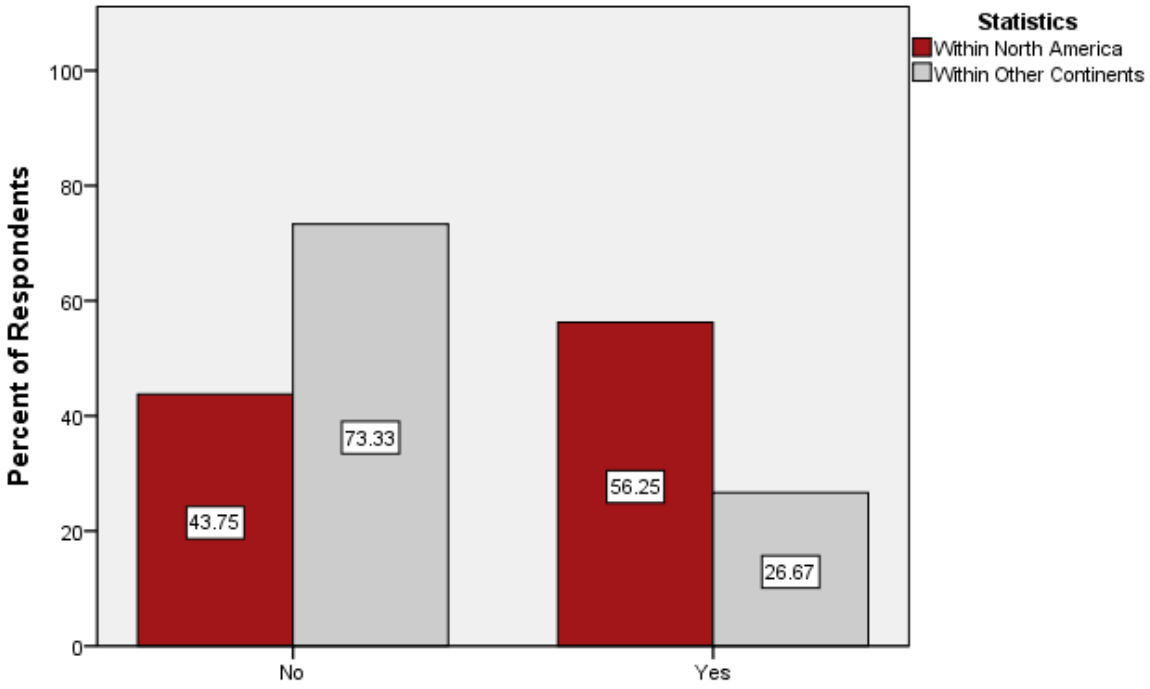

Figure 5-10. Responses of survey participants (No/Yes) on challenges related to consent and consultation.

5.8.1. Participants' Reflections (on Consent and Consultation)

Given the discussion regarding group consent in genetic research (see Greely 2001), I had expected this to be a major point of discussion for survey participants; instead, the text responses suggest that it is the process of identifying and *consulting* with potential descendant communities and other stakeholders, rather than obtaining consent, that poses significant challenges for respondents. The survey responses highlight several key challenges in the consultation process, primarily related to

appropriate methods for ethically carrying out DNA analysis on culturally unidentifiable human remains, or when more than one potential descendant community is identified.

In the United States, the Native American Graves Protection and Repatriation Act (NAGPRA) provides strict requirements for consultation with tribes regarding the repatriation of human remains and funerary objects. However, it is estimated that the remains of 120,000 individuals are still culturally unidentified, which "represents 70 percent of all inventoried human remains held by federally funded institutions" (Kretzler 2015:21). Section 10.11 of NAGPRA regarding the Disposition of Culturally Unidentifiable Human Remains requires that when a request is received, consultation must be undertaken with all tribes "whose tribal lands, at the time of the removal, the human remains and associated funeral objects were removed." Thus, by following the guidelines set by NAGPRA, the location of the burial and whether it is on the lands of a federally recognized tribe is a natural starting point for identifying the appropriate descendant communities and other stakeholders with whom to consult for an ancient DNA study[25].

While NAGPRA sets out clear rules for working with Native American groups, participant *NA-10*—who has worked extensively with Native American tribes—notes that these requirements "don't necessarily align with concerns regarding other stakeholders not recognized in NAGPRA," including tribes not federally recognized. The situation is further complicated when there is more than one potential descendant population associated with the location of the remains, or otherwise culturally affiliated with the ancient individual. This is a relatively common situation in ancient DNA research as an ancient person may have many thousands of genetic descendants, some of whom are aware of the connection while others are not. This is a challenge participant *NA-11* is currently facing in her work:

[25] However, this does not take into account population migration events, including forced relocations (e.g., The United States' Indian Removal Act (1830) which resulted in the forced migration of members of the Choctaws, Creek, Chickasaws, Seminoles, and Cherokee nations (Davis 2008) and the disconnect this can create between the historic and current occupants of a geographical area.

> We have three potential descendent populations, although none have proactively come forward to claim affiliation over the remains. We are likely going to consult with all three populations to see if they have any research questions they would like us to include in our project, although we won't expressly ask permission from them to conduct the research (as it is unclear who is entitled to give permission).

The experience recounted by this individual provokes difficult questions about which communities or individuals are able to "give permission" for an ancient DNA study. Another individual (NA-13) working in North America spoke to the difficulties inherent within the ancient DNA consultation process:

> There appears to be no general consensus for ancient DNA studies. While some tribal members are supportive, others are not. It is challenging but in some cases, it's not getting "consent" but rather informing and communicating about the work. If the lineal descendants are unknown, it is difficult to determine the best group in which to engage in a conversation and involve.

The importance of developing trusted research networks with Indigenous communities was emphasized by *NA-8* who recalled that consulting with Indigenous communities in North America had been a challenge previously, but was:

> not as much anymore. Primarily because we've built up a good rapport and a trustworthy relationship with the communities over time, both directly and also via collaborators who provide us with samples. Still, several communities remain opposed to genetic testing (even if only for demography) and… large parts of the U.S.A. remain under-sampled.

The survey responses demonstrate the importance of creating and expanding trusted research networks, which can be invaluable in terms of negotiating difficult issues related to consultation and consent.

Overall, identifying descendant communities and developing a process for consultation is a common challenge encountered by 60% of participants working in North America. Numerous individuals provided personal accounts of such difficulties, but few offered strategies that had been used to successfully navigate this potentially complex issue. As set out in NAGPRA, consulting with the tribes upon whose land the

ancient person was found is a good place to start, but may be inadequate given the unique nature of DNA as shared biological heritage. Thus it appears that developing guidelines or strategies related to consultation in ancient DNA research is necessary to aid future ancient DNA research.

5.9. The Politics of Ancient DNA Research

Participants were asked whether they had “experienced challenges when the potential results of an ancient DNA study are seen to carry political significance?” Notably, the political nature of ancient DNA research was identified as a challenge by a greater percentage (53.3%) of survey participants working internationally, than those working within North America (46.7%) (Figure 5-11). Overall, the potential political significance of ancient DNA research was identified as the most common challenge encountered by participants working internationally, and the fifth most commonly identified by participants working within North America.

A Fisher’s Exact test was conducted in order to determine if the location of research produced a statistically significant difference in participants' responses. The results of the analysis indicate that there is not a statistically significant association between these two variables.

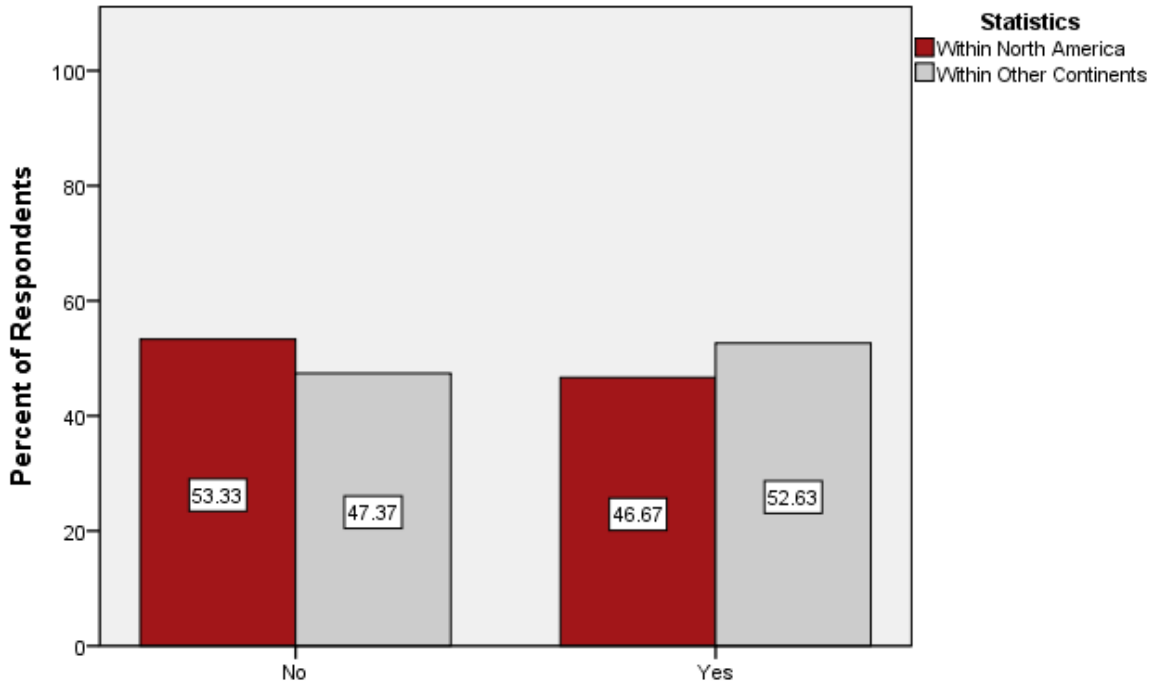

Figure 5-11. Responses of survey participants (No/Yes) on the political significance of ancient DNA research.

5.9.1. Participants' Reflections (on the Politics of Ancient DNA Research)

As expected, the responses from participants working with bands and tribes in North America strongly suggest that political motives related to federal recognition, land claims, and the repatriation of human remains play a role in the decision of Indigenous communities to participate in ancient DNA research. Somewhat unexpectedly, however, the political nature of ancient DNA research was ranked by researchers working *outside* North America as *the most* common challenge they encountered in their research (52.6%), while fewer (46.7%) of participants from North America indicated that it was a difficulty. I first discuss examples provided by survey participants in which ancient DNA projects have taken on political significance; next, I consider the interconnected nature of communities' motivations for participating in ancient DNA research and the potential political benefits, as perceived by the survey respondents.

The text responses provide insight into potential reasons for the high percentage of respondents working outside of North America who experienced challenges related to

the political nature of ancient DNA research. Four different cases were provided by participants working outside of North America as examples of how the results of ancient DNA research can take on political significance:

1. The discovery of the remains of King Richard III, the subsequent confirmation of his identify through mitochondrial DNA analysis, and the ensuing disagreements over his final resting place (*Intl-5)*;
2. The genetic analysis of the Royal Egyptian mummies, and noted "concerns by the Egyptian authorities that the data could probably be used for political reasons" (Albert Zink, Scientific Director of the Institute for Mummies and the Iceman in Bolzano, Italy);
3. DNA analysis of Vaimaca Péru, chief of the Charrúa of Uruguay. Archaeologically, little is known about the early Indigenous inhabitants of Uruguay, and as a result, the remains of Vaimaca Péru became embroiled in the country's national identity politics (Kent and Santos 2014; Verdesio 2008:1122-1124) (Monica Sans, Director of the Biological Anthropology Department at Universidad de la República, Uruguay); and
4. The DNA analysis of ancient (Hervella et al. 2012) and modern (Behar et al. 2012) individuals living in the Basque region of Spain to investigate "the putative genetic continuity between present-day Basques and Paleolithic Europeans" (Behar et al. 2012: 488).

Thus, the survey results suggest that the potential political significance of ancient DNA research is a challenge for participants working around the world.

Political motivations were perceived by North American survey participants as playing a significant role in a community's decision to partake in ancient DNA research. When asked to speculate as to the primary motivating factors for a community's decision to allow and/or participate in an ancient DNA study, many pointed to a genuine interest in the past, but that this was often accompanied by a hope that the results may prove to be politically useful, specifically in relation to federal recognition, land claims, and the repatriation of ancestral remains. The interconnected nature of a group's curiosity about their past with potential political benefits is described by survey respondent Jelmer Eerkens who identified four key motivating factors for participating in ancient DNA research that he has heard from descendant communities:

> 1. For federally unrecognized tribes in the United States, they see aDNA [ancient DNA] as a way to potentially help their goal to obtain

> federal recognition, vis-à-vis genetic relations between people today and people of the past;
>
> 2. For some individuals, from both federally recognized and unrecognized tribes, they would like to determine how they, personally, are related to people from the past, giving them a connection to the archaeological record. In this case, it's more about curiosity;
>
> 3. Some tribes I have worked with see aDNA as a potential way to exclude some individuals, factions/families within tribes, or other tribes altogether, from making claims on collections, and/or from working as MLDs [Most Likely Descendant] in particular areas;
>
> 4. For some tribes collectively…they see aDNA as a way to learn about their ancestral roots and history (this is probably the least common of the four).

As described by Eerkens, the politics of ancient DNA research may occur on a macro-level (e.g., attaining federal recognition from the government) but that the political dynamics occurring on a micro-level *within* a community can also pose a major challenge for researchers. This difficulty was noted by Konstantina Drosou, a biomolecular archaeologist at the University of Manchester, who wrote that "it is not just the results that carry political significance" but that "to get a permit for valuable samples is a process that can take months, and in many cases it is a dead end because there are political challenges that have to be overcome." Similar difficulties were noted by participant *NA-9* who had new tribal leadership revoke permission "to do work the previous tribal government endorsed and participated in willingly." Thus, it is apparent from the survey responses that the entire ancient DNA research process, and not just the results, may take on political meaning.

Additionally, the use of ancient genetic information for the political purpose of repatriating human remains was identified by several survey participants. As explained by researcher *NA-19*, people are interested in "utilizing all possible avenues to learn about earlier populations and peoples in their region" whether "they are considered ancestors or not", and, when possible, to use this information "to assist in repatriation claims" (*NA-19).* Moreover, as noted by Shane Doyle, genetic analysis can provide "the legal authority that goes along with being officially identified as the next of kin to the ancient ancestors who are being studied" and that this "allows tribes to claim the

individuals and then rebury those ancient people." Therefore, the survey responses suggest that the authority or legitimacy provided by confirmation of a genetic link between ancient and modern populations may prove beneficial to Indigenous communities who are seeking the repatriation of ancestral remains.

Overall, the potential political benefits of ancient DNA research appear to be intimately connected to the decision to participate in an ancient DNA project. Participants in the survey also noted the potential for the research process—and not only the results—to take on political significance. In particular, the use of ancient DNA analysis to assist with the repatriation of human remains was discussed by several participants as a way in which ancient genetic information is being interpreted for a political purpose.

5.10. Communicating the Results of Ancient DNA Research

Participants were asked in the survey whether "it has been a challenge to ensure that the results of ancient DNA analysis are communicated to stakeholders and the general public in an accurate manner?" Based on the responses, 43.8% of researchers working in North America indicated that they had experienced communication-related challenges. Comparatively, 40.9% of researchers working in other continents identified this as a challenge they had experienced, while 59.1% had not (Figure 5-12). Overall, challenges related to communication were identified as the second most common difficulty for researchers working outside of North America.

A Fisher's Exact test was conducted in order to determine if the location of research produced a statistically significant difference in participants' responses towards this challenge. The results of the analysis indicate that there is not a statistically significant association between these two variables.

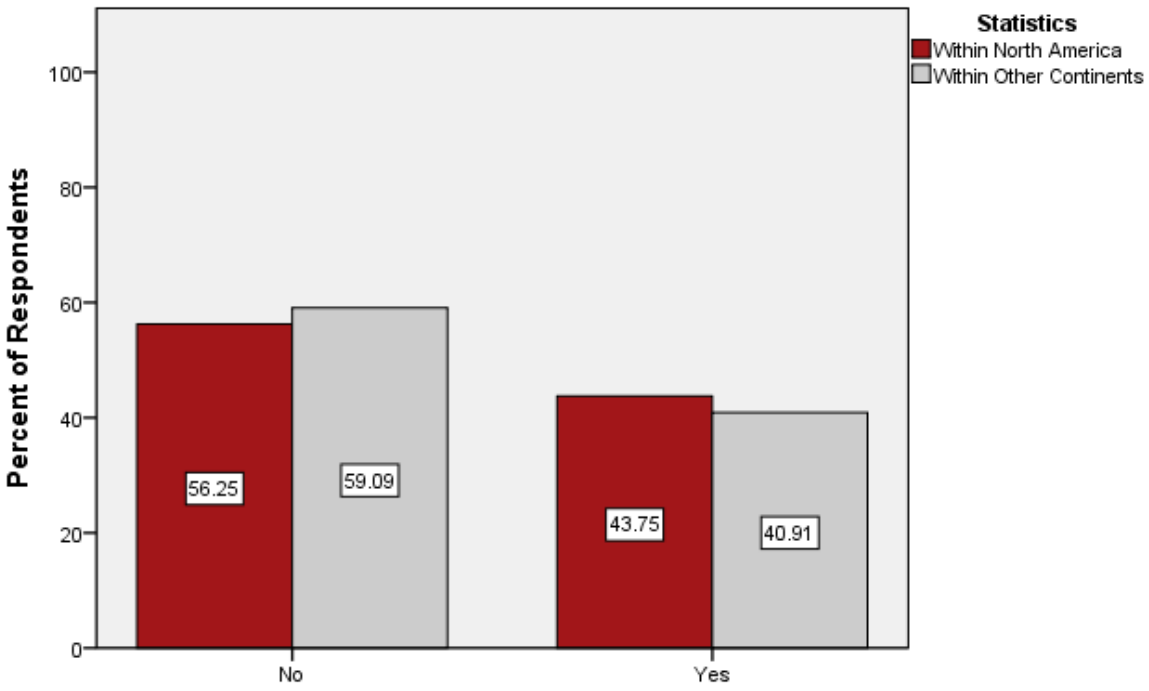

Figure 5-12. Responses of survey participants (No/Yes) on challenges related to the communication of ancient DNA research.

5.10.1. Participants' Reflections (on Communicating Research)

Ancient DNA research poses unique challenges for communicating the results of studies to diverse audiences around the world. The respondents identified both practical difficulties associated with sharing research findings, as well as the pervasiveness of misconceptions regarding ancient DNA analysis and genetics in general. Specifically, participants identified a lack of understanding of the information encoded with the genome and its interpretive limitations, as well as the misconception that genetic narratives offer a form of "truth" regarding the past that unattainable through other means of understanding or investigation.

Numerous participants emphasized the ongoing difficulties they face with regards to ensuring that accurate information regarding the results of an ancient DNA study are communicated to the public. The role of the media in perpetuating inaccuracies was repeatedly brought up, with participant *NA-13* noting that "in some cases, the media may omit important information or misinterpret the results." Participant *NA-17* stressed the

importance of getting reporters—as well as colleagues—to “use precise language and not exaggerate findings or implications.” The potential for the results of ancient DNA research to be “exaggerated” so as to gain media attention, or “to satisfy the descendant groups’ concerns” was noted by a researcher working in Sweden as a major difficulty (*Intl-19)*.

Participants also identified practical challenges associated with sharing research results with diverse stakeholders. As explained by respondent *NA-10,* who has experience working with tribes in the United States, “significant communication issues have come up, given that tribal leadership and tribal office staff sometimes have a high turn-over rate. This has negatively impacted plans to share results in some cases.” Difficulties associated with coordination amongst different stakeholders may be mitigated by working with a dedicated community collaborator. This approach was suggested by participant *NA-8,* working in Canada, who noted previous challenges related to communicating with her community collaborators, but that now “we work with collaborators who liaise with the communities and aid in the communication of the aims and results of the studies to the stakeholders.” As collaboration with descendant communities and other stakeholders becomes more common, researchers will need to develop strategies for effective and accurate dissemination of results.

In addition to practical communication issues, the survey provided insight into misconceptions surrounding ancient DNA research, of which two were identified and discussed by participants. The first is a general lack of understanding held by the public regarding the limitations of knowledge produced through ancient DNA analysis: what questions *can* and *cannot* be answered by studying the DNA of ancient—or modern—peoples? While it is possible that this lack of understanding is a product of the so-called “CSI effect” and other representations of genetics in the popular media, survey participants predominantly attributed it to a general lack of knowledge regarding genetics, especially in relation to establishing genetic relationships between ancient and modern populations. This perspective is expressed by Jelmer Eerkens who explained that:

> People often don't understand DNA. For example, some people think each tribe has a distinctive DNA signature, and that analyzing ancient

> remains will fingerprint what modern tribe they are associated with. Other tribes have unrealistic expectations about how ancient DNA will help solve medical problems they currently face (e.g., diabetes, alcohol abuse).

Therefore, clarifying the limits of the information that may be gleaned from ancient DNA studies—regarding ancient *and* modern peoples—is an important and necessary discussion for researchers to have with all stakeholders.

Misconceptions regarding the limitations of genetic data are particularly important with regards to conceptualizing and discussing different interpretations of identity and ancestry. One researcher identified the "assumption that identity is, at its core, genetic" rather than "a social construct" as a particularly problematic misconception (*NA-10)*. The problems associated with biogenetic reductionist approaches (which risk reintroducing antiquated notions of biogenetic race) are discussed in detail by Guido Barbujani, Professor of Genetics at Ferrara University in Italy:

> Racial paradigms are all but dead…recreational genetics companies contribute to spreading the idea that each of us has just one biological origin (or two, associated with mitochondrial DNA and Y-chromosome haplogroups), and that that origin can easily be mapped [*sic*]. I find it useful to remind people that each of us has 2 parents, 4 grandparents and, just 20 generations ago, 1 million ancestors (theoretical ancestors, in fact; this calculation does not take consanguineous marriage into account). Yet, we are speaking of many people, who could not possibly be living in the same place.

Explaining the limitations of genetics with regard to understanding identity and ancestry, which are complex and multifaceted concepts (Goodman 2007; Tallbear 2013), is necessary to dispel an increasingly common tendency to turn to our DNA for answers regarding sociocultural phenomena.

An additional point of tension that was apparent in the responses of participants is the belief that DNA analysis offers a form of "proof," "truth," or "legitimacy" that is not obtainable through other means of investigation. While on one hand, many respondents emphasized the need to discuss and present multiple ways of understanding the past, several indicated that ancient DNA analysis can provide a "true" account of claims related to heritage and ancestry. For example, one participant responded that:

> In many cases ancient DNA can be the only means to reveal information about our past that cannot be gleaned in any other way. Where conventional archaeology or anthropology stops, is where ancient DNA begins. Morphological examination and/or historic sources will only lead to assumptions, but with ancient DNA we can potentially reach the truth.

The use of words such as “truth” and “legitimacy” become relevant when they are employed to solidify, or in some cases, to undermine claims that can have political implications (e.g., regarding federal recognition of tribes, land claims, and the repatriation of ancient remains)

From a practical perspective it can be difficult to communicate within and between different stakeholder groups regarding ancient DNA research. When presenting the results of an ancient DNA study to the general public, participants spoke to the commonality of fellow researchers and the media presenting information in a way that is exaggerated or misleading and contributes to common misconceptions regarding genetics, and ancient DNA specifically.

5.11. Determining Ownership and Intellectual Property Rights

The survey asked participants whether they had “experienced challenges in terms of determining who owns or controls the ancient genetic data?” In response, only 37.5% of researchers working in North America indicated that this was a challenge they had encountered. Similarly, a minority (22.7%) of survey participants working in other continents have encountered this difficulty (Figure 5-13). Overall, determining ownership and intellectual property (IP) rights over ancient genetic data does not appear to be a common challenge for researchers working in North America or abroad. It is unclear whether this is because the surveyed participants are supportive of the intellectual property and ownership rights of participating individuals and communities, or, alternatively, because it is not perceived as a challenge because the participants support open access to the data. However, given the frequency with which respondents emphasized the importance of access agreements and other such memoranda of understanding, I surmise that it is likely the former explanation.

A Fisher's Exact test was conducted in order to determine if the location of research produced a statistically significant difference in participants' responses. The results of the analysis indicate that there is not a statistically significant association between these two variables.

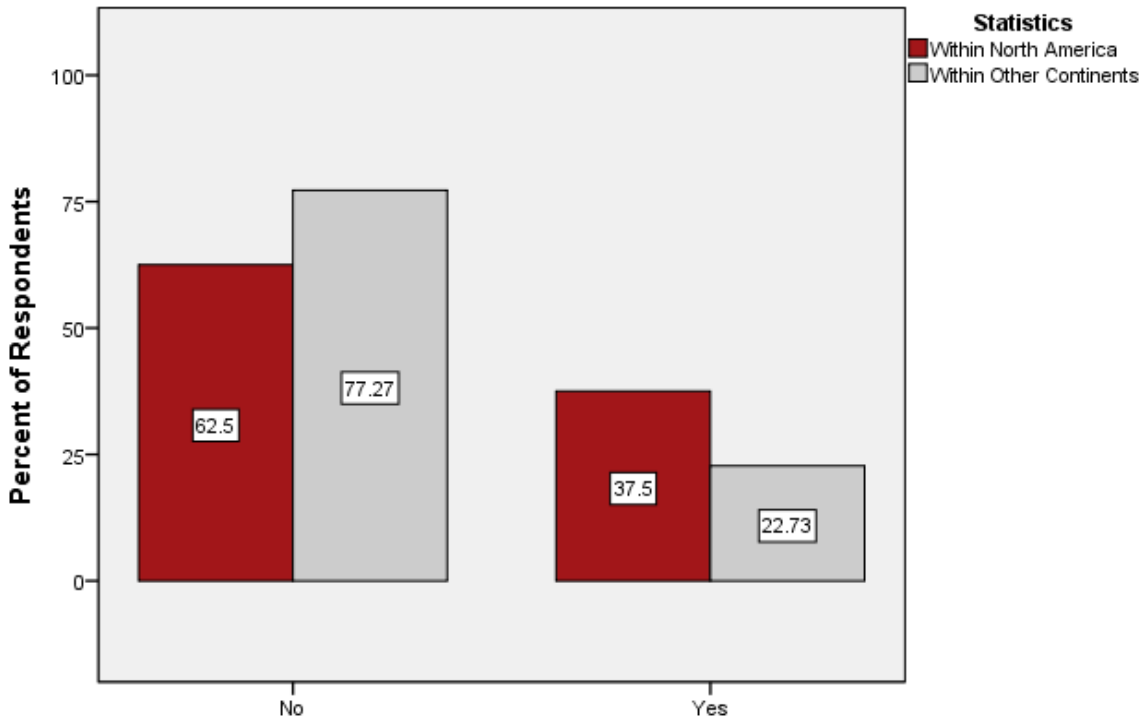

Figure 5-13. Responses of survey participants (No/ Yes) on challenges related to ownership and intellectual property in ancient DNA research.

5.11.1. Participants' Reflections (on IP and Ownership Rights)

The qualitative responses provided by participants were limited as relatively few participants identified intellectual property and ownership rights as difficulties they had encountered in their research. Several participants noted the lack of policies and protocols that exist around the world to govern ownership and intellectual property rights over ancient genetic information. While there has been a shift towards the view that the original donor retains ownership rights over all biological samples (see Arbour and Cook 2006 and guidelines from the Canadian Institute of Health Research 2010), this is not

uncontested. Participant *NA-20*, a leading expert in the field of ancient DNA who has worked extensively with First Nations and Native American groups, had his own university challenge the premise that research participants own their biological samples and any subsequent genetic data. Clearly, issues related to ownership and intellectual property over genetic and biological samples are complex issues that defy an easy and universal solution. Instead, the answer to resolving challenges related to intellectual property and ownership rights may not be in the application of universal rules and protocols, but rather through the discussions occurring between researchers and communities on an individual level.

Another North American participant (*NA-13)* questioned the premise of claiming "ownership" over any information regarding the past: what does it mean to "own" genetic information, whether from an ancient or modern source? What are the ensuing rights and responsibilities? For those working in the field of modern biotechnology, ownership rights in the forms of genetic patents can mean huge economic benefits. This type of economic "ownership" may be translated to some degree to the context of ancient DNA. For example, Michael Kent (2013:547) notes that the genetic link uncovered by the Genographic Project between the ancient Uros and their modern-day descendants plays a prominent role in tourism marketing. Similarly, significant economic benefits were experienced by the South Tyrol Museum in Italy following the arrival of Ötzi the Iceman, or the number of tourists projected to visit the tomb and newly constructed King Richard III Visitor's Centre (Walker 2013). Based on the survey data, however, ownership and intellectual property rights appear to play a rather minor role in ancient DNA studies.

5.12. Genetic Privacy and Ancient DNA

Survey participants were asked whether "stakeholders expressed concerns about any indirect implications the ancient DNA study may have for their own genetic privacy?" For those working in North America, 31.3% of participants indicated this was a challenge they had experienced, while only a minority of participants (16.7%) working elsewhere gave affirmative responses (Figure 5-14).

A Fisher's Exact test was conducted in order to determine if the location of research produced a statistically significant difference in participants' responses. The results of the analysis indicate that there is not a statistically significant association between these two variables.

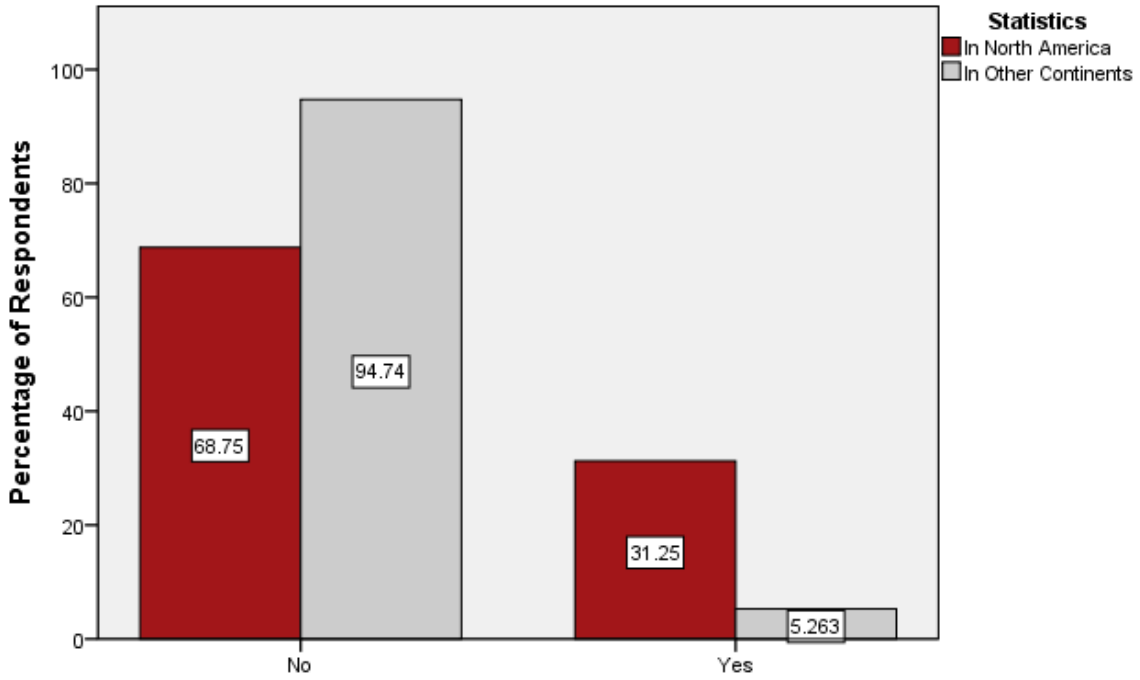

Figure 5-14. Responses of survey participants (No/Yes) on challenges related to genetic privacy.

5.12.1. Participants' Reflections (on Genetic Privacy)

The results indicate that the majority of participants have not encountered challenges related to the indirect implications of ancient DNA research for the genetic privacy of stakeholders. However, for participants who did provide additional comments in relation to protecting genetic privacy, standard privacy-protection procedures commonly employed in genetic research were suggested as ways to address any concerns.

Protecting individual privacy by removing potentially identifying information is already common practice in genetic research, but participant *NA-8* also noted the need in some cases to obscure "details that could connect the data directly to the individual and at times, the community." M. Thomas P. Gilbert, Professor in the Natural History Museum of Denmark at the University of Copenhagen, also spoke to "how the ancient data cannot be linked to living individuals accurately" and that this is important to explain to potential participants. The interconnected nature of genetic privacy with concerns related to the future use of genetic information is described by researcher *NA-19* who discusses how he addresses these questions in his research:

> Community meetings were held to address any and all questions regarding the research. Privacy and cultural heritage questions were addressed and discussed directly, and we made an effort to determine that all questions were answered effectively. We made sure participants understood who would have access to any results, who would not, and that no health related genetic results would be obtained. This was at the request of the community, and their request was honored. We also discussed the cultural risk of genetic reconstruction of population history, although this was not considered a concern by the communities involved.

It appears that concerns related to genetic privacy for descendant communities and other stakeholders are not common challenges in ancient DNA research. Standard privacy protection measures, including obscuring the identities of participating individuals and communities, can be an effective way of addressing privacy concerns.

5.13. Chapter Summary

Quantitative analysis of the survey was undertaken to (a) identify the most common challenges arising in ancient DNA research, as identified by the survey participants; and (b) investigate if these challenges differ according to the self-reported geographic focus of participants' research. Of the eight identified challenges, the surveyed participants working in North America were more likely than their colleagues working elsewhere to encounter or experience issues related to the following eight topics: the future use of ancient genetic data (75%); identity and ancestry (60%); cultural values (56.3%); consent and consultation with descendant communities and other

stakeholders (56.3%); the political nature of ancient DNA research (53.3%) the communication of research results (43.8%); ownership and intellectual property (37.5%); and genetic privacy (31.3%). The only challenge that was experienced by a greater percentage of survey participants working internationally was the potential for the results—and, in some cases, the entire research process—to take on political significance. Possible explanations for this result may be found in the responses of survey participants working internationally who point to several high-profile examples of politicized ancient DNA research.

The results suggest that the challenges encountered by ancient DNA researchers are closely linked to the perceived or actual social, ethical, and political implications the research may have for descendant communities and other stakeholders. Subsequently, a statistically significant association was found between the reported geographic focus of participants' ancient DNA studies and the specific challenges of cultural values and the potential future uses of genetic data. Overall, a greater percentage of survey respondents working in North America reported experiencing all challenges, save for difficulties resulting from the politicization of ancient DNA results.

Chapter 6.

Discussion, Recommendations, and Conclusions

There is a growing awareness of the potential social, ethical, and political implications of ancient DNA research for all people, indigenous and otherwise. Thus, a key challenge facing those working in the field of ancient human DNA research is to negotiate the complex and ever-changing challenges associated with the perceived and actual implications of ancient DNA research for descendant communities and other stakeholders. Through three complementary modes of investigation—background research on current issues in human genetics; a review of completed ancient DNA case studies in British Columbia; and an international survey of ancient DNA researchers' perspectives and experiences—I have investigated the different ways in which ancient DNA research is being carried out around the world, the challenges that arise, and the practical strategies that are being adopted to create a more equitable and inclusive field of research.

In this chapter, I return to my three research objectives, the significance of this study, and prospective areas for future research. For my first research objective, I reflect upon each of the eight challenges explored through the survey and the subsequent lessons learned. For my second research objective, I consider an important factor that may contribute to the differing experiences of survey respondents according to the geographic focus of their work: the unique needs, interests, and values of descendant communities situated around the world with whom the survey respondents interact, and in some cases, collaborate with. I then turn to my third research objective and provide three recommendations and relevant resources to assist researchers and communities involved in ancient DNA studies. Following this, I discuss directions for future research, including ways in which to expand the survey to include a greater number of participants, as well as including the perspectives of descendant communities who have previously

been involved in ancient DNA studies. Finally, I consider the significance of my thesis as a first step towards a more in-depth understanding of the social, ethical, and political implications of ancient DNA research and effective ways of mitigating and addressing any associated challenges.

6.1. Reflecting on Research Objectives

Ancient DNA studies promise unparalleled insights into the lives of ancient peoples. However, these opportunities are accompanied by complicated and nuanced issues for researchers ranging from questions over ownership and intellectual property rights, to the compatibility of ancient DNA analysis with traditional cultural values, to identifying the appropriate community with whom to engage in consultation regarding an ancient DNA project. Additionally, these challenges are experienced to vastly differing degrees by researchers working around the world. The survey results suggest that respondents whose work is focused in North America are frequently confronted with social and ethical issues, while those involved in studies outside of North America face more general issues in their work related to politics and communication. What follows is a discussion of each of my three research objectives, the degree to which they were met, and subsequent questions that arose during this study.

Objective 1: To identify emerging challenges related to the actual and perceived social, ethical, and political implications of ancient DNA research, as identified by survey respondents.

In order to obtain a fuller understanding of the challenges arising in ancient DNA research, I identified eight potential issues for further investigation in the survey. Here I discuss each of the challenges (presented from the most common to least common challenge):

1. *Future uses of genetic data arising from ancient DNA studies:* This was the most common challenge reported by 75% of North American survey participants. Respondents indicated that concerns regarding the future use of genetic data are greatest when using modern DNA samples to be compared against

archaeological samples. They also suggested that, generally, medical and disease-related research is more likely to be declared “off-limits” than studies that investigate ancestry and demography. The importance of drafting a research agreement in which the terms of access to the genetic data—from ancient samples, or those provided from present-day participants— are clearly laid out in a way that is satisfactory to all parties, is essential to proactively address potential issues in this area.

2. *Ancient DNA, identity, and ancestry:* The implications of ancient DNA research for long-held understandings of identity and ancestry was the second most common challenge experienced by 60% of survey respondents. Survey participants emphasized the need to appreciate the multifaceted and complex nature of identity and ancestry, whether on a group or individual level. Although no respondents reported experiencing a conflict between the results of ancient DNA analysis and traditional views, suggestions for navigating such a situation (should it arise) include presenting multiple perspectives in publications and offering to withhold the identity not only of individual participants, but also of the wider community.

3. *Ancient DNA and cultural values:* Respecting the unique traditional values of descendant communities involved in ancient DNA research was identified as a challenge by 56.3% of survey participants. Respondents spoke to the polarizing nature of ancient DNA research and the existence of many diverse perspectives towards the topic within and between communities. The responses also demonstrated the willingness of survey participants to find ways in which to complement or integrate traditional cultural values into the research process, from blessing the laboratory space to ensuring that the ancient individual is laid to rest in an appropriate manner.

4. *Identifying descendant communities for the purposes of consent and consultation:* Knowing which descendant groups and other stakeholders to approach for the purposes of consultation and/or from whom to obtain permission for an ancient DNA project was identified as a difficulty by 56.3% of participants.

In hindsight, the issues of consent and consultation should have been addressed in two separate questions. However, the accompanying qualitative data suggests that of the two issues, identifying groups for the purpose of consultation is the challenge more commonly experienced by respondents. While in some cases, consultation between researchers and communities is mandated by NAGPRA in the United States, this does not always recognize or include all stakeholders, such as federally unrecognized tribes. Moreover, uncertainty may arise when there is more than one likely descendant community, and thus, it is unclear who can actually provide permission for an ancient DNA project to move forward. This appears to be an ongoing difficulty that participants continue to grapple with in their own research.

5. *The politicization of ancient DNA results:* The politicization of ancient DNA results was identified as a challenge by 46.7% of researchers working within North America and 53.3% of participants working elsewhere around the world. Notably, this is the only challenge encountered by a greater percentage of participants working internationally, as compared to North America. Respondents also indicated that the *entire research process* and not just the results of the ancient DNA study may take on political significance depending on the dynamics within and between communities. Moreover, when asked to speculate as to the perceived motivations for communities to allow an ancient DNA study, many respondents pointed to the potential for the results to prove helpful politically in relation to federal recognition, land claims, and the repatriation of human remains.

6. *Communicating the results of an ancient DNA study:* Sharing the goals and results of an ancient DNA research project with multiple and diverse audiences was a challenge reported by 43.8% of participants working in North America and 40.9% working abroad. Some respondents noted difficulties communicating the results of their research through the media and fellow academics to the public in an accurate manner. Overall, survey respondents indicated that the public's knowledge of genetics is fairly limited, making it particularly important to dispel potentially harmful misconceptions surrounding human genetics. In particular,

there appear to be misunderstandings regarding the limitations of the information encoded within the genome, and that this information provides a "true" account of the human past.

7. *Ownership and intellectual property rights over ancient genetic data:* Issues arising from debates over ownership and intellectual property rights in the context of ancient DNA studies were noted by 37.5% of respondents situated in North America. The survey responses demonstrate an ongoing shift in research ethics towards the view that biological samples, and genetic information arising from subsequent analysis, belong to the original donor rather than the researcher. Moreover, the DNA on Loan approach (in which ownership rights remain indefinitely with the donor individual) is included in the Canadian Institute of Health Research Guidelines for Research Involving Aboriginal People (2010). However, this perspective is not widely known or universally accepted, as in the case described by one respondent who had his university challenge this arrangement.

8. *Genetic privacy and ancient DNA:* Perceived infringements on genetic privacy for individuals and communities as a result of ancient DNA research was only identified as a difficulty by a minority of respondents situated around the world. According to survey participants, standard privacy protection methods, including the de-identification of data to obscure individual and group identity, was an effective means by which to reduce any associated concerns.

Objective 2: To investigate whether the challenges experienced by survey participants whose research takes place in North America differs from those working elsewhere in the world.

As suggested by the survey results (Chapter 5), survey participants working in North America encounter the identified challenges in their work to a greater degree than their colleagues working elsewhere, save for those associated with the politicization of ancient DNA research and difficulties arising from the communication of research findings. A statistically significant association was found between the reported geographic focus of research and the specific challenges of cultural values and the

future use of genetic data. A potential explanation for the differences experienced by survey participants working in North America versus all other locations is that this is a reflection of the unique needs, concerns, interests, and sociopolitical circumstances of the descendant communities with whom the respondents interact, and in some cases, collaborate with. I begin this discussion by considering briefly the various ways in which "community" has been defined by both archaeologists and geneticists, and, how these ideas can be used to inform those seeking to engage with descendant communities in ancient DNA research.

Increasingly, communities are playing a key role in the archaeological process, from research design, to excavation, to interpretation. This has, in turn, led to questions surrounding how to identify and define "community" when it is generally recognized as a complex, multifaceted, and fluid entity (Chilton and Hart 2009; Colwell-Chanthaphonh and Ferguson 2008; Marshall 2002). This difficulty is summarized by Elizabeth Chilton and Siobhan Hart (2009:87) who state that "one of the greatest challenges facing archaeologists today is engaging the diverse individual and community stakeholders who make up pluralistic communities."

In an archaeological context, communities have been defined in multiple ways. Yvonne Marshall (2002:216) recognizes two types of communities in archaeology. The first includes "people who live locally, either on or close to a site" (p. 216) while the second type is comprised of "those who can or choose to trace descent from the people who once lived at or near the site" (p. 216). Building upon this, Erin Hogg (2014:3-4) identifies an additional three types of "community" in relation to archaeology sites:

1. *Local communities* are comprised of the individuals who live in close proximity to an archaeological site.
2. *Descendant communities* include the individuals who can trace "their perceived genealogy to the archaeological site" (Hogg 2014: 3). Moreover, Descendant communities are not homogenous or static; rather, they can have issues of "social, special, and temporal distance, such as community members living far apart, or having lost cultural ties to the site" (Hogg 2014: 3-4); and
3. *Stakeholder communities* are comprised of individuals who share a common interest with regards to the archaeological site.

A definition for the term “descendant community” is also offered by Chip Colwell-Chanthaphonh and T.J. Ferguson (2008:8) who note that recognition as a descendant community should not be based solely upon biological affinity, but should describe “all of the groups that link themselves intensely to archaeological heritages because of their cultural, social, and historical affinities.” Moreover, they state that “these communities do not necessarily have more *rights* (legal or otherwise) to the past revealed by archaeology, but often more complex and compelling *interests* than other communities, including the archaeological community itself.”

Identifying and defining community groups is also a challenge for those working in the field of human genetics. The sub-discipline of “community genetics” is defined by ten Kate et al. (2010: 19-22) as:

> the art and science of the responsible and realistic application of health and disease-related genetics and genomics knowledge and technologies in human populations and communities to the benefits of individuals therein. Community genetics is multi-, inter-, and transdisciplinary and aims to maximize benefits while minimizing the risk of harm, respecting the autonomy of individuals and ensuring equity.

Leo P. ten Kate et al. (2010:21) subsequently identify four types of communities commonly recognized within the field of genetics:

1. Communities defined by geography (e.g., those living in the same town).
2. Communities defined by origin (e.g., immigrants from Asia to Canada).
3. Communities defined by culture, religion, or shared socio-economic status (e.g., Roma, Irish travelers).
4. Communities who share a common health-related risk or problem (e.g., the disproportionate prevalence of diabetes in some First Nations communities in Canada).

In relation to population genetics, Eric Juengst (1998: 674) describes the conceptualization of human social groups (including communities) as “demes”, defined as “groups of individuals more genetically similar to each other than to any other individuals.” However, Juengst (p. 674) argues that such genetic groupings “would bear little resemblance to a map of the world’s self-identified autonomous human groups that

are empowered to speak on behalf of their members" as there is often more genetic diversity *within* than between human social communities. Moreover, it is the "socially constructed groupings" that "command our loyalties, by giving us our connections, origin stories, and identities," and not simply the categorization of individuals according to their genetic profile. It is apparent that any form of community, whether in an archaeological or genetic context, poses difficulties in terms of its definition and the subsequent identification of individuals belonging to said groupings.

As has been previously discussed, ancient DNA research may have important implications for Indigenous descendant communities. There are at least four points in which Indigenous descendant communities differ from non-Indigenous descendant communities that are relevant to this thesis and ancient DNA research in general:

1. There are lasting effects from a "brief and harsh history" characterized by the exploitation of Indigenous participants in genetic research (Chennells 2009:148);

2. Indigenous peoples are considered by some to be a vulnerable population, especially in relation to genetic research where much harm has already been experienced. In relation to medical research ethics, Schroeder and Gefenas (2009:117) define "vulnerability" as an individual or population facing "a significant probability of incurring an identifiable harm while substantially lacking ability and/or means to protect oneself" (as cited in Chennells 2009: 147);

3. Indigenous descendant communities may have vastly different world views that are in "jagged opposition" to those held by the Western communities and researchers (Little Bear 2000: 77). For example, some Indigenous peoples "regard their bodies, hair and blood as sacred elements, and consider scientific research on these materials as a violation of their cultural and ethical mandates" (Harry and Dukepoo 1998:8); and

4. The perceived harm arising from genetic research may be understood or experienced in vastly different ways for Indigenous and non-Indigenous

> descendant communities. For example, Indigenous communities can experience harms that have "legal implications for a tribe's standing and relationship to land, change perceptions of relationships to other groups, and affect collective notions of ancestry and identity in different ways" (Sharp and Foster 2002: 147, as cited in Chennells 2014:173). In contrast, it is unlikely that a Western descendant community will experience similar risks or harms from allowing an ancient DNA study.

These four points and others are important when considering the differences that exist between descendant communities situated around the world. As suggested by this discussion, a "descendant community" is identified and defined differently depending on the discipline (archaeology or genetics). Moreover, each descendant community will likely have a unique approach to and perspectives on the potential benefits and risks of participating in ancient DNA research. This is reflected by the different degrees to which the survey participants reported challenges related to the social, ethical, and political implications of their work.

An additional factor that may contribute to the differing experiences of respondents working in North America versus internationally is the *thematic focus* of the ancient DNA research being conducted. For example, do similar social, ethical, and political challenges arise in studies that investigate ancient pathogens when compared to those that examine ancient human migration and population history? Because survey participants were not asked to indicate their primary area of research interest, I was limited in my ability to investigate this question. However, to explore this on a general level, I reviewed the studies in which participants were involved and subsequently identified two broad thematic areas of investigation: 1) ancient DNA studies that explore genetic diversity (using ancient DNA, and, in some cases, modern DNA samples for comparative purposes); and 2) ancient DNA studies that investigate pathogens found in archaeological human remains and tissues.

For the 18 participants working in North America, 17 were involved in studies that focused on genetic diversity, while one individual's research was categorized as molecular paleopathology. For the participants working outside of North America, 17 of

28 individuals focused predominantly on patterns of genetic diversity, while the other 11 were categorized as molecular paleopathology. While it is difficult to demonstrate any clear association between the research topic and challenges encountered by survey respondents, it is intriguing to note that a majority of individuals working in North America are involved in research investigating genetic diversity in ancient—and often modern—populations, while just under half of international participants focus on the genetic analysis of *pathogens* rather than *people*. Further investigation into how the research topic (e.g., investigation into early population migration) may affect participants' willingness to participate in a genetic study is an interesting topic for future investigation.

Objective 3: To provide recommendations and associated resources to help researchers address potential or realized issues in ancient DNA research related to the perceived or realized social, ethical, and political implications of ancient DNA studies.

To address this final objective, I have developed three recommendations to assist ancient DNA researchers working in North America and abroad. These are: 1) to develop a comprehensive, representative, and streamlined process of consulting with multiple descendant communities; 2) to work collaboratively to create Research Agreements that will help to avoid any future issues that may arise; 3) to adopt an interdisciplinary approach that borrows from both archaeology and genetics to effectively communicate the results of ancient DNA research. These recommendations are deliberately broad in recognition of the fact that there is no "one size fits all approach" and that the best way forward will differ according to the unique context of each study.

Recommendation 1: Revising the Consultation Process for Ancient DNA Research

Identifying descendant communities and other stakeholders with whom to consult with over the course of an ancient DNA study was identified by 56.5% of participants working in North America as a challenge they have experienced. In order for the consultation processes to be thorough and representative, but also timely and efficient, I recommend that researchers work with existing community organizations (e.g., tribal review boards, heritage or archaeology committees) or, if these do not exist, to propose the formation of a committee or consortia of community representatives that is specific to

the ancient DNA project. Forming a consortium of community representatives will facilitate communication between the community and researchers, clarify the roles and responsibilities of individuals within the project, and allow for the inclusion of representatives from different families or communities who may approach the ancient DNA study with different cultural values and perspectives. Two examples demonstrate the utility of this approach: 1) the use of tribal consortiums in the repatriation of culturally unidentifiable human remains under NAGPRA in the United States; and 2) the formation of a committee of representatives comprised of First Nations, the provincial Archaeology Branch, and others to oversee the respectful study of Kwäday Dän Ts'ìnchi.

Different approaches to community consultation may be voluntarily undertaken by the researcher, or in some cases, be required by law. Unlike the United States, in which NAGPRA requires consultation with federally recognized tribes, "Canada does not have comprehensive federal legislation governing the excavation, research, or curation of indigenous archaeological human remains" (Cybulski and Katzenberg 2014:94). Conventionally in Canada—and as mandated by NAGPRA in the United States—the geographic provenience of the remains serves as a necessary starting point for consultation with the bands or tribes upon whose land the individual was found. However, as Ian Kretzler (2015: 21) points out, there are thousands of "culturally unidentifiable" skeletal remains housed in museums, universities, and elsewhere for which basic information about where and when they were recovered are lacking. Moreover, he notes that NAGPRA does not require consultation with non-federally recognized tribes, thus excluding potential descendant communities from providing their input (Kretzler 2015:21). Additional complications may arise when the traditional territory of an indigenous group is disputed, as in the case of the Fallon Paiute-Shoshone tribe of Nevada and their ongoing efforts to repatriate the remains of Spirit Cave Man (Edgar et al. 2007).

In some cases, the process of consultation can be informed and expanded by those already involved in the project. Returning to my original ancient DNA study, the community that I was working with—and upon whose traditional land the ancient individual was found—indicated that they would like to involve a neighboring tribe located in the United States in the consultation process, and potentially, to also provide

samples for comparison with the ancient person. Similarly, Rasmussen et al. (2014) sought to consult with a number of tribes living in the state of Montana about the results of their ancient DNA study. The approach described by the authors is as follows (2014: 228):

> Acknowledging the complex ethical and legal issues surrounding the research of Native American human remains in the United States, we have striven not only to comply with federal and state law but also to proactively consult with Native American tribes. The Anzick burial site was discovered on private land and the remains recovered have not been in control of a federally funded museum or federal agency, and thus the Native American Graves Protection and Repatriation Act (NAGPRA) does not apply… However, to ensure that Native American concerns were addressed, we have informed nine Native American groups with reservations in the surrounding area of the Anzick site about our work… We received no objections to our research from these groups; however, many of the tribal representatives requested reburial of the remains. The Anzick family is working towards reburial of the human remains from the site.

In this case, importantly, efforts were made to contact local tribes despite the fact that the burial was located on private land, and thus not subject to NAGPRA. Tribal representatives also emphasized the importance of reburying the individual, which was carried out in a traditional ceremony on June 28, 2014. While the wide-scale consultation that took place is an important step forward, it has not been without criticism: tribal representatives expressed that they wish consultation had occurred *prior* to the analysis being conducted, instead of retrospectively (Callaway 2014). Nevertheless, Rasmussen et al.'s (2014) study provides a practical example of the difficulties—but also benefits—of consulting with multiple tribes and potential descendant communities.

The results of my survey suggest that identifying the appropriate descendant communities and other stakeholders with whom to engage in consultation is a key challenge for ancient DNA researchers, particularly for those working in North America. One strategy to help address this is for researchers to suggest that an existing community organization (e.g., tribal ethics review board, heritage committee) take on a leadership and liaison role in the ancient DNA project. Alternatively, if no such organization exists, a specially formed committee or consortium could be formed to oversee the ancient DNA project and act as the intermediary link between researchers

and the broader community. Developing a new committee of community representatives or identifying existing organizations is helpful for two reasons: 1) consulting with individual community *representatives* rather than entire communities reduces logistical and scheduling hurdles; and 2) it clarifies the role of each individual within the project and what is required from each person in order to streamline the consultation process and move the project forward.

The formation of committees or consortia comprised of community representatives has already proven to be successful in archaeological research in certain situations. For example, with regards to the repatriation of culturally unidentifiable human remains in the United States, "the formation of tribal repatriation consortia representing federally recognized and non-federally recognized groups has proven particularly effective" (Kretzler 2015: 22). By bringing together individuals who share "responsibility towards Native American ancestors" it may be possible to avoid "critiques regarding whether individuals will be repatriated to the "correct" tribe" (Kretzler 2015:22). This approach was also successfully implemented in the case of Kwäday Dän Ts'ìnchi, in which a special committee was formed specifically to act as stewards for Long Ago Person Found and to oversee research (including DNA analysis) of his remains (Monsalve et al. 2002: 288, 291). Working with a specific committee or organization comprised of community representatives also reduces the logistical demands imposed by wide-ranging consultation practices and clarifies the role of individuals within the larger project.

Recommendation 2: Develop a Research Agreement for Ancient DNA Studies

Research agreements (also known as a *memorandum of understanding* or *memorandum of agreement*) are an essential tool to proactively address potential issues in archaeological and other research (McGill et al. 2015). Developing a research agreement for a heritage project will "promote exchanges that are fair, equitable, and culturally appropriate to all parties involved" and can play a key role in addressing questions regarding "who will be involved? What mutual benefits or potential harms are involved? How will heritage be defined? How will dispute resolution take place? What are the costs? Who owns products resulting from the partnership? When will the project

be completed?" (McGill et al. 2015:1). As described in Chapter 9 of the Canadian Tri-Council Policy Statement (TCPS 2 2014) titled *Research Involving the First Nations, Inuit and Métis Peoples of Canada,* research agreements function as the "primary means of clarifying and confirming mutual expectations, and where appropriate, commitments between researchers and communities." (TCPS 2, Chapter 9, Article 9.11). Moreover, the drafting of a research agreements necessitates the discussion of all potential "risks"—whether on a social, ethical, political, economic, or spiritual level—with participating individuals and communities so that truly informed consent is provided.

There are numerous resources available online to assist researchers and communities with the development of a research agreement (Table 6-1). While none of those offered here are specific to ancient DNA research, they may be modified to fit the specific context of the study. Additional guidance is offered in the Canadian Institute of Health Research's *Guidelines for Research Involving Aboriginal People* (2010: section 2.15), which states that a research agreement must cover the following topics:

> Issues of data ownership, use and interpretation/analysis, rights to intellectual property (if appropriate), and expectations regarding process, content and authorship of publications, with identified mechanisms for dealing with conflicting interpretations or inappropriate use of the data. There should be prior agreement on the respective roles of the parties, desired outcomes, measures of validity, control over the use of data, funding and the dissemination of research findings

Further detail on the development of a research proposal with an Indigenous community is provided in Sections 2 and 3 of the Canadian Institute of Health Research (CIHR 2010)'s guidelines for research involving First Nations people.

According to CIHR guidelines, research agreements should (at minimum) include the following sections: background information, the potential significance of the project for the participants, methods related to the approval of the study by participating communities and support from granting agencies, an explanation of the sampling strategy in terms of *who* will be sampled and *how* the samples will be collected, how participants will be recruited for the study, the process of data collection and analysis, the process of reporting and disseminating results, and potential next steps following the

conclusion of the research (CIHR 2010). Additional research agreements templates can be found online and are summarized in Table 6-1.

Table 6-1. Examples of research agreement templates for studies involving Indigenous peoples in genetics and other fields.

Organization	Web Link
Centre for Indigenous Peoples' Nutrition and Environment	https://www.mcgill.ca/cine/files/cine/partreresearch_english.pdf
Indigenous Peoples Council on Biocolonialism	http://www.ipcb.org/publications/policy/files/appndex1.html
American Indian and Alaska Native Genetics Resource Centre	http://genetics.ncai.org/files/Principles%20and%20Models%20for%20Data%20Sharing%20Agreements.pdf
Canadian Aboriginal AIDS Network	http://depts.washington.edu/ccph/pdf_files/Principles_of_Research_Collaboration_Template.doc.pdf
American Indian Law Centre, Inc.	http://www.nptao.arizona.edu/research/NPTAOResearchProtocolsWebPage/AILawCenterModelCode.pdf
Indigenous Wellness Research Institute	http://iwri.org/research-core/research-data-request-process/

Research agreements offer an invaluable opportunity to proactively address nearly all issues identified by survey participants. To consider the specific challenges of IP, ownership, and the future use of genetic data, the CIHR advocates for all biological samples to be considered as “on loan” by the individual donor to the researcher. The role of the researcher is thus to act as a steward for the biological samples and to continue to consult with the “owners” of the samples prior to any future research (Arbour and Cook 2006: 155-156). Viewing researchers as “stewards” also clarifies the obligations they have to the community in terms of regulating the future use of genetic data.

Ultimately, research agreements require that potential points of tension are discussed prior to research beginning and strategies for mitigating these challenges, should they arise, have already been negotiated. Thus, it is of benefit to both the researcher and community to work proactively to address any potential issues rather than retrospectively.

Recommendation 3: Strategies for the Effective Communication of Ancient DNA Research

All academics have a responsibility to communicate the results of their research to multiple audiences. For ancient DNA researchers, this task is sometimes difficult as it requires a synthesis of genetic analysis and archaeological practice. This challenge is reflected in the answers provided by the survey participants, many of whom pointed to a lack of understanding held by the general public regarding the limitations of genetic analysis, particularly in relation to identity and ancestry. In the following section I discuss this difficulty and then identify several relevant resources—including some developed with, for, and by Indigenous scholars and communities—that hat help to explain genetics and ancient DNA research in a clear and relevant manner.

In their book *The DNA Mystique: The Gene as a Cultural Icon,* Dorothy Nelkin and M. Susan Lindee (2004:2) argue that DNA has been transformed in a cultural icon that functions as both a "scientific concept and a social symbol" featured prominently in everything from magazines to film. The increasingly prominent role of genetics in popular media inspires the question: what message is being broadcast to the public about the potential, and, perhaps more importantly, the limitations of DNA testing? According to Ley at el. (2012:63), DNA testing on shows such as CSI, a popular forensic science TV show, promotes the message that DNA testing is "easy, quick, routine, and epistemologically strong" and has resulted in "unrealistic expectations regarding the promise of genetic research and technologies, uncritical support for such research and technologies, and genetic essentialism." In reality, the public's understanding and knowledge of genetics is rather limited, as suggested by a population study funded by the National Science Agency in the United States, in which only 45% of participants were able to correctly define "DNA" (Condit 2010:2).

A variety of resources are now available to assist researchers to communicate the often complex and nuanced nature of genetic research, in an ancient or modern context. This effort has been greatly assisted by the development resources by Indigenous organizations that aim to increase knowledge and dialogue about genetic research within communities. A particularly noteworthy example is the American Indian

and Alaska Native (AI/AN) Genetics Resource Centre. The website[26] provides a plethora of online resources from data access agreements, informed consent templates, to discussions on important topics such as genetic ancestry testing, benefit-sharing in genetic research, and how to navigate tensions between cultural values and DNA analysis.

In my own experience, so-called fact sheets are an especially useful resource for providing general information and knowledge about ancient DNA analysis, or to communicate the goals and objectives of a specific study. The IPinCH Project has created a fact sheet that provides an introduction to ancient DNA research and an overview of the potential social, ethical, legal, and political implications of such studies (see Appendix B; Walker et al. 2014). Fact sheets are also an effective method for the researcher to ensure that accurate information about a proposed ancient DNA study is being communicated amongst other research partners and collaborators. When working on my original ancient DNA project, I prepared a fact sheet to share at a community meeting that provided basic information on DNA, specifically mitochondrial DNA as that was the focus of the genetic analysis, the objectives and methods of the study, as well as standard ethical considerations, such as protecting participant privacy. Community members were invited to take the fact sheet home with them and to share with others who were unable to attend the meeting. Thus, the fact sheet proved useful by helping to ensuring that accurate information regarding the study could be easily disseminated within the community.

Additionally, the Summer Internship for Native Americans in Genomics (SING) is an important initiative that aims to increase opportunities for leadership in the field of genetics and ancient DNA for Native American people. As described on the SING website, the “lack of leadership also leaves few individuals who can explain the uses and limitations of scientific research to Native American communities that are considering participating in a scientific project. The SING workshop (whose advisory panel is comprised of experts including Ripan Malhi, Jessica Bardill, Deborah Bolnick, Brian

[26] http://genetics.ncai.org/

Kemp, and Kimberly TallBear), has three goals[27]: 1) to facilitate discussion on indigenous cultural values and whether scientific methods can be beneficially incorporated with these values; 2) to provide aware awareness of how genomics is currently used as a tool to assist in projects focused on natural resources, history, and health; and 3) to increase the number of Native Americans in science research, leadership, and teaching careers at all levels. This workshop represents an important opportunity to increase tools and knowledge for informed and dialogue within and between Native American communities and genetic researchers.

6.2. Significance

This thesis has provided an understanding of the challenges faced by ancient DNA researchers working around the world as they negotiate the emerging social, ethical, and political implications of ancient DNA research, as well as offering practical tools and resources to help researchers and communities proactively address these issues. To date, there is little published literature or resources available to assist researchers in navigating the unchartered ethical terrain arising from ancient DNA research. Therefore, this thesis is an essential step towards developing new and innovative ways in which to address or mitigate such challenges.

Additionally, this study has offered a glimpse into the ways in which the culture of ancient DNA research is changing with regards to the relationship between researchers and communities. This is most vividly demonstrated by a number of survey participants who unequivocally stated the need to respect the decision of communities when they say “no” to a proposed ancient DNA study. Lisa Matisoo-Smith explains that “the decision to proceed [with an ancient DNA project] is always with the indigenous group—and that "no" is a perfectly acceptable answer.” Likewise, participant *NA-14* stressed that “just because a population or sample is interesting to study, does not automatically mean you have the right to study it. We all need to learn that and respect the word "no." These perspectives demonstrate the internal shift that was taken place within the field of

[27] http://conferences.igb.illinois.edu/sing/home

ancient DNA research, and genetic research involving human participants more generally.

While there are many reasons that a community may be opposed to an ancient DNA study, there are also reasons why they may perceive it to be an exciting and positive opportunity. As noted by survey participant Cara Monroe, Research Associate and Manager of the Kemp Lab at the University of Washington, the decision to participate in or allow ancient DNA research is highly personal and that "most criticism comes from other non-ancestral groups, who assume, or cannot believe that any Native American not only want ancient DNA analysis done, but who also feel it is *empowering* to do so [emphasis added]." Ultimately, the views of survey respondents demonstrate the potential for an ancient DNA project to serve as an empowering opportunity for communities to engage in research on their own terms with the purpose of satisfying their unique needs and interests.

6.3. Directions for Future Research

Two potential directions for the expansion of this study include: 1) to increase the scope of the survey undertaken in this thesis to include a greater number of ancient DNA researchers; and 2) to more fully understand communities' perspectives towards ancient DNA research and what they perceive as the main challenges as well as future opportunities. Gaining insight into the perspectives of different communities towards ancient DNA research is beyond the scope of this thesis but is important for the future of the discipline, and thus warrants a brief mention here.

The responses provided by participants obviously represent only a sample of the substantial range of responses, experiences, and perspectives held by those working in the field of ancient DNA. It is true of all surveys that it is difficult to capture a representative sample and that this challenge may be further exacerbated by a small sample size. Expanding the sample size for the survey could be achieved in a number of ways, from distributing it through additional discipline specific list servers and mailing lists (in addition to the World Archaeological Congress and the International Symposium on Biomolecular Archaeology), or, potentially, through a form of network-sampling such

as respondent-driven sampling. Using respondent-driven sampling, the researchers' original contacts are asked to recruit additional participants from within their own social networks, who can then contact the researcher if they are interested in participating in the study (Bernard 2006:194). Ultimately, the results of the survey function as a foundation upon which to build a more comprehensive and expansive understanding of the emerging social, ethical, and political implications of ancient DNA research and how these issues manifest themselves within ancient DNA projects.

A study that assesses the perspectives of communities that have participated in ancient DNA analysis would be extremely helpful for researchers who seek to engage in collaborative and community-based genetic research. By bringing in the voices of community members who have been involved in ancient DNA studies, it may be possible to identify new ways of thinking about and potentially resolving common points of tension that arise in ancient DNA research. However, it is important to note that there is no "one size fits all" approach to conducting equitable, relevant, and mutually beneficial research. Instead, the project must reflect the unique interests, culture, and context of the researchers and communities involved in the study.

Another point to consider is that while this thesis utilized a web survey to investigate researchers' perceptions, other methods may prove more appropriate for reaching out to communities, such as interviews and focus groups. Moreover, due to the sensitive and often highly charged nature of discussions around DNA analysis, communities would likely have to be approached by a researcher with whom they already have an established and trusted relationship with. This represents a challenging but potentially very rewarding area of study that would supplement the perspectives offered by ancient DNA researchers in this thesis.

6.4. Summary and Conclusion

Ancient DNA research has the potential to revolutionize our understanding of the past and to provide a powerful point of connection between people living today and their long-ago ancestors. However, the knowledge arising from ancient DNA research may have diverse social, ethical, and political implications for people today that can result in

challenges for those working in the field of ancient DNA. This thesis helps to increase our understanding of this important but under investigated area of study by identifying common social, ethical, and political challenges that researchers working in the field of ancient DNA experience and the ways in which these issues are addressed or mitigated.

In order to gain insight into the challenges faced by ancient DNA researchers, I utilized three sources of information: literature on current issues in human genetics; a review of completed ancient DNA case studies on archaeological human remains found in British Columbia; and a web survey distributed to an international sample of ancient DNA researchers. The background research and British Columbia case studies provided a contextual foundation upon which to consider the results of the survey.

The survey responses indicate that individuals working in the field of ancient DNA research face numerous challenges related to actual or perceived social, ethical, and political implications of the study, but that the experience of individual respondents differed notably according to where in the world their research took place. The four main challenges identified by a majority of respondents working in North America were:

1. The potential future uses of genetic data arising from ancient DNA studies;
2. The possible impact of the ancient DNA results upon long-held understandings of identity and ancestry;
3. The co-existence of traditional cultural values with the genetic analysis of archaeological human remains; and
4. The complexities associated with identifying modern groups with whom to engage in consultation.

In contrast, for survey respondents involved in ancient DNA projects outside of North America, the potential for ancient DNA research to take on political significance was the only challenge experienced by a majority of participants. Furthermore, a statistically significant association was found between respondents working in North America and specific challenges related to the future use of genetic data, and compatibility with cultural values. Based on the results of the survey as well as through a consideration of the case study examples, I identified three recommendations and associated resources to help address or mitigate the identified issues.

Finally, the main contribution of this study is that it identifies some of the key social, ethical, and political implications of ancient DNA research for descendant communities and other stakeholders. Only through a more in-depth understanding of the differing experiences of ancient DNA researchers and the spectrum of approaches adopted to address these issues can opportunities emerge for a more equitable and collaborative investigation of the human past.

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Appendix A.

Survey Questions

This is the survey that was distributed to participants, along with the informed consent document.

Ancient DNA Research in North America and Abroad: Challenges and Opportunities

A Research Project by:

Alexa R. Walker, MA Candidate, Department of Archaeology, Simon Fraser University

Consent and Permissions

Simon Fraser University and Alexa Walker, the researcher conducting this research study, subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort and safety of participants. The chief concern of the Board is for the health, safety and psychological well-being of research participants.

TITLE: Ancient DNA Research in North America and Abroad: Challenges and Opportunities

Who is conducting this study?

This study is being conducted by Alexa Walker (PI), a Master's student at Simon Fraser University in the Department of Archaeology in Burnaby, British Columbia. If you choose to participate, the information that you share in this survey will be published in the PI's Master's thesis and potential future uses such as journal articles.

Who is funding this study?

This study is being funded by the Social Sciences and Humanities Research Council (SSHRC).

Why are we doing this study?

There are many challenges and obstacles to completing an ancient DNA study. This study seeks to identify key challenges and describe strategies that have been successfully employed used to mitigate these obstacles.

Why are you being invited to participate?

You are being invited to take part in this research study because of your knowledge of and involvement with one or more ancient DNA case studies in British Columbia and abroad.

Your participation is voluntary

Your participation in this research is entirely voluntary. You may choose not to complete the survey at any point without giving reasons and with no negative consequences.

How is the study done?

If you accept the invitation to participate in this study, you will be asked to complete a one-time web-survey. The survey has 14 questions and will take approximately 20 minutes to complete. The survey will ask you general questions about your involvement with ancient DNA research, to identify key challenges that arose in this research, and how these were challenges were addressed

What are the potential benefits of participating?

Your participation is invaluable in identifying key challenges in ancient DNA research and describing strategies used to resolve these issues. There may or may not be any direct benefits to you for participating in this study; however, this thesis may serve as a future resource for you and others working in the field of ancient DNA.

What are the potential risks of participating?
There are no foreseeable risks to you in participating in this study.
Will you be reimbursed for taking part in this study?
We will not pay you for the time you take to fill out this survey.
How will your privacy be maintained?
Your privacy will be respected. Information that discloses your identity will not be released without your consent, unless required by law. Please note, that confidentiality cannot be guaranteed because e-mail is not a completely secure means of communication. Additionally, the survey data will be collected and stored using FluidSurveys, whose servers are in the U.S. There may be differences in the limits of privacy and confidentiality between Canada and the US.
It is your decision whether you would like your identity to be withheld. If you consent to reveal your identity, this is how it may be used: ***[your name] describes the strategy he/she developed with his/her community partners to overcome challenge Y.*** Please note, even if your identity is withheld, the information you provide may be indirectly identifying due to the inclusion of participants working in a specific area of research. To further protect your privacy, only the PI will have access to the data. All electronic files will be password protected; any hard copies will be kept in a locked filing cabinet. Please indicate your preference below:

I consent to reveal my identity/ I do not consent to reveal my identity *(check box)*

Sharing the Results:
The results of this study will be reported in the PI's Master's thesis which will be publically available.
Future use of participant data:
Your personal information will not be shared now or in the future. The research data from the interviews may be published by Alexa Walker in future journal articles or books.
Who can you contact if you have any questions about the study?
If you have any questions or concerns about any aspect of the study, please contact Alexa Walker (PI) [redacted]
Who can you contact if you have complaints or concerns about the study?
If you have any concerns about your rights as a research participant and/or your experiences while participating in this study, you may contact Dr. Jeffrey Toward, Director, Office of Research Ethics[redacted]
ELECTRONIC CONSENT
Please select your choice below. You may print a copy of this consent form for your records. Clicking on the "Agree" button indicates that:

- You have read the above information
- You voluntarily agree to participate
- You are 19 years of age or older

[redacted]
I agree/ I do not agree

Part 1: Background

1. In which country has the majority of your ancient DNA research taken place? *(Drop-down menu)*
2. Based on your experience, how long on average does it take to complete an ancient DNA project, from project conception to the publication of the final results? *(Drop-down menu)*
3. What is the general level of collaboration with descendant community in ancient DNA projects that you have been involved with? *(Drop-down menu)*
4. For individuals and communities who permit ancient DNA analysis on human remains, what do you see as the main motivating factors for allowing genetic analysis? *(Text box)*

Part 2: Challenges

There are numerous challenges to conducting ancient DNA research projects. The following questions are designed to help me better understand the challenges faced by researchers carrying out this kind of work.

Please indicate *if* you have experienced any of the challenges identified below in the course of the your research, and, if you did, *how* the challenge was resolved or mitigated. For the purposes of this survey, "stakeholders" are defined as the individuals or communities involved in the ancient DNA analysis process, or those who were impacted by the results of the genetic analysis.

Have stakeholders expressed concerns about any indirect implications the ancient DNA study may have for their own genetic privacy? *(multiple choice)*

- If yes, please briefly describe how the concerns were addressed *(text box)*

Have concerns been expressed about the types of research that the ancient genetic data may be used for in the future? *(multiple choice)*

- If yes, please describe how the concerns were addressed *(textbox)*

Have you experienced challenges in terms of determining who owns or controls the ancient genetic data? *(multiple choice)*

- If yes, please briefly describe how this challenge was addressed *(text box)*

Have stakeholders expressed concerns about whether conducting ancient DNA analysis on human remains is culturally appropriate? (multiple choice)

- If yes, please describe how the cultural values of stakeholders guided or were integrated into the research *(text box)*

Has it been a challenge to identify the appropriate modern populations to consult with and/or gain consent from for the analysis of ancient human remains? *(multiple choice)*

- If yes, please describe how the challenge was addressed *(text box)*

Have you experienced difficulties when the results of ancient DNA analysis are seen to challenge stakeholders' long-held understandings of identity and ancestry? *(multiple choice)*

- If yes, please describe how the challenges were addressed *(text box)*

Have you experienced challenges when the potential results of an ancient DNA study are seen to carry political significance? *(multiple choice)*

- If yes, please describe *(text box)*

Has it been a challenge to ensure that the results of ancient DNA analysis are communicated to stakeholders and the general public in an accurate manner? *(multiple choice)*

- If yes, please explain *(text box)*

Have you experienced any other social, ethical, or practical challenges when conducting ancient DNA studies? *(multiple choice)*

- If yes, please describe the challenge and how it was addressed *(text box)*

Part 3: Working Together and Sharing Knowledge

There are few policies and protocols in place for ancient DNA research to help address the implications of such research. Alexa Walker (PI) is gathering resources (Research Agreements, Fact Sheets, Informed Consent templates, etc.) to create a practical "toolkit" of successful strategies and agreements developed collaboratively between researchers, communities, and other stakeholders to address the unique challenges of ancient DNA research. This toolkit will be available to all researchers working in the field of ancient DNA.

Please indicate (*check box: yes/no*) whether you would be willing to share resources that you have either developed or, resources from other sources that have been useful in your own work, to be included in the appendices of Alexa Walker's (PI) thesis. If you choose to share resources, please ensure that any information which may compromise the confidentiality of participants is not included. The authors of any resource materials will be consulted and fully credited. If you agree, Alexa Walker (PI) will follow-up with you via e-mail to arrange this.

Appendix B.

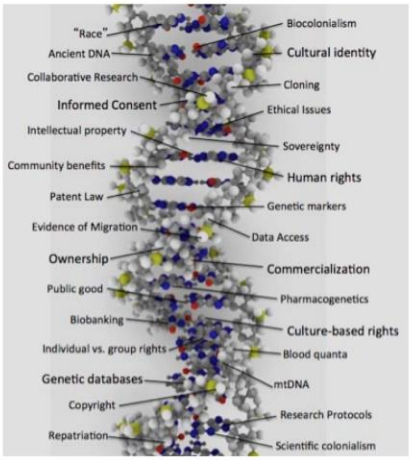
Ancient DNA Fact Sheet

This fact sheet produced by the Intellectual Property Issues in Cultural Heritage (IPinCH) project provides an introduction to the field of ancient DNA and a brief overview of the perceived and actual social, ethical, and political implications.

FACT SHEET

Presented by the Intellectual Property Issues in Cultural Heritage Project.

ANCIENT DNA (aDNA)
What is it? Why is it important?



INTRODUCTION

As genetic research is increasingly applied to new areas of study, including in archaeological and heritage contexts, a range of questions arise concerning the social, ethical, legal, and political implications of ancient DNA. This fact sheet explains the nature and challenges of aDNA research, and why information from it is important and relevant to people today.

WHAT IS ANCIENT DNA AND HOW DO WE DECODE IT?

DNA (deoxyribonucleic acid) is a sequence of some three billion nucleotides that encodes genetic information. DNA is found in all living things, and is sometimes preserved in ancient human, animal, or plant remains. Because nucleotide sequences vary among individuals, groups and species, DNA is useful in identification and showing genetic/evolutionary relationships. There are three types of DNA/aDNA:

- Nuclear DNA contains the most information about an individual, but often there isn't enough preserved in archaeological samples for study;
- Y-Chromosome is a type of nuclear DNA that is only present in males and used for tracing paternal ancestry;
- Mitochondrial DNA (mtDNA) is found in the mitochondria of cells and used to trace maternal ancestry as it is passed from a mother to her children. MtDNA is more likely to be preserved in ancient samples because there are many more copies per cell than nuclear DNA.

WHY ARE ARCHAEOLOGISTS INTERESTED IN STUDYING aDNA?

- Historical Mysteries: Archaeologists identified the skeleton of King Richard III of England (1483–1485) by matching his DNA to a known relative, a 17th-generation great nephew.
- Human Evolution: In 2010, the complete genome of a young Neanderthal woman from Croatia (>38,000 years old) was sequenced. Recent studies indicate modern humans inherited between 1–3% of their genomes from Neanderthals.
- Ancient Diseases: Pathogens may still be present in the bones and tissue of past peoples. aDNA has been used successfully to identify ancient cases of Tuberculosis and Bubonic Plague.
- Living Descendants: Using aDNA, a direct genetic link was established between a woman who died 5,500 years ago, another 2,500 years ago, and a living Tsimshian woman from the Metlakatla First Nation in British Columbia.
- Sex Identification: DNA analysis provides a very specific and simple method of distinguishing between males and females

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irrespective of the condition of skeletal remains or the age at death.
• Animal or Plant Identification: aDNA can be used to identify archaeological remains of animal and plant species to gain insight into prehistoric subsistence practices and the local economy.
• Migration Patterns: Comparing the DNA of ancestral remains found in one part of the world to that of people living there today can help to determine the migration patterns of human populations spreading out of Africa into Europe and Asia, and eventually to the Americas.

WHAT ARE SOME OF THE CHALLENGES OF CONDUCTING aDNA RESEARCH?

Researchers must consider the current social, political, cultural, and economic context of the community in which they work, and how research findings may be used now and in the future. Two areas that require particular care are:
• Informed Consent: Deciding who needs to provide informed consent for aDNA research is challenging. Since the deceased cannot provide consent, we must turn to their descendants. But how do we define and identify a "descendant"? Do all descendants—who may number in the thousands or millions—have an equal claim over the remains of their ancestor? What about the remains of now extinct peoples where no definitive cultural or genetic link to living descendants can be established?; and
• Intellectual Property: Who owns the information arising from aDNA research? Who controls how the information is shared now and in the future? Will the information be created and shared in a manner that is culturally appropriate according to the descendant communities?

HOW CAN aDNA RESEARCH IMPACT PEOPLE LIVING TODAY?

Although it is the DNA of ancient peoples being studied, the information obtained can impact the lives of living people. This is especially true for Indigenous peoples who are sometimes referred to as a "genetically vulnerable" population. Three realms where ancient DNA research has social, cultural, and political implications for people today are:

• Reducing identity to biology: A person's identity is comprised not only of biological and genetic connections, but also sociocultural and geographic factors, family histories and lived experiences. What problems arise when one's identity and ancestry is reduced to a molecular origin, such as when genetic markers are used for tribal enrollment?
• Repatriation: Genetic information can play a role in the repatriation of human remains by confirming (or in some cases failing to confirm) a direct genetic link between an ancient individual and living individuals or groups. In the case of Kwäday Dän Ts'ìnchi ("Long Ago Person Found"), DNA analysis confirmed a genetic connection to individuals living in Canada and Alaska. Yet, repatriation is based on establishing cultural affiliation, which can be informed by, but is not exclusive to, biological identity.
• Land Claims: aDNA analysis may be helpful if it shows that the ancient occupants of the land are genetically similar to modern occupants. However, DNA analysis may also reveal that modern populations are not direct genetic descendants of the ancient inhabitants.

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This Fact Sheet was developed by Alexa Walker, George Nicholas, Daryl Pullman, Alan Goodman and the Bioarchaeology and Genetics Working Group. Published in August 2014. Image courtesy of George Nicholas.

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Appendix C.

Memorandum of Agreement Fact Sheet

This fact sheet produced by the Intellectual Property Issues in Cultural Heritage (IPinCH) project, titled *Collaborative Projects and Memoranda of Agreement (MOA),* serves as a practical resource for researchers and communities who are interested in learning more about the basics of research agreements.

Collaborative Projects and Memoranda of Agreement (MOA)*

FACT SHEET

Presented by the Intellectual Property Issues in Cultural Heritage Project.

*This Fact Sheet describes MOAs governing collaborative research and community-based projects, and does not provide specific guidance for MOAs developed per the United States National Historic Preservation Act (1966) or other cultural resources laws.

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WHAT IS A MOA?

A Memorandum of Agreement (MOA), or Memorandum of Understanding (MOU), is a document that describes the terms of a cooperative agreement between two or more parties, as well as the goals of the cooperation. A MOA typically marks the beginning of a collaborative project, and is an opportunity for stakeholders to outline their visions, conduct debates, and resolve issues. A MOA is normally ***not*** considered to be a legal contract. The main difference is that a contract is an agreement where something of value is exchanged (for example goods or labor) – "John agrees to pay Jane $500 to create a website about his family's history." A MOA is an agreement for parties to work together to meet an objective, without necessarily exchanging anything – "John and Jane agree to work together on such and such terms in a collaborative project to document family histories."

WHY CRAFT A MOA FOR A CULTURAL HERITAGE PROJECT?

All cultural heritage projects, whether they are education, research, or community-based advocacy focused, include multiple stakeholders exchanging resources, such as time and knowledge. Crafting a MOA will promote exchanges that are fair, equitable, and culturally appropriate to all parties involved, and may help reveal potentially troublesome or contentious areas of the future project before it even begins. Developing a MOA also helps to define important terms of collaboration — ***Who*** will be involved? What mutual ***benefits*** or potential ***harms*** are involved? How will ***heritage*** be defined? How will ***dispute resolution*** take place? What are the ***costs***? Who ***owns*** products resulting from the partnership? When will the project be ***completed***?

WHERE TO BEGIN

The process of crafting, revising, and executing a MOA, rather than the signed document itself, leads to relationship-building and successful collaborations. Parties involved in a collaborative project should agree to meet, preferably face-to-face, to work together on an outline for the MOA. All parties should strive to maintain excellent communications throughout the process, and consult with others who have been through this process before. Once a community has created a Cultural Heritage MOA, it can be used as a template for future projects, customized as needed for each project or to address different concerns.

TYPICAL MOA OUTLINE

A MOA can include as many or few sections as necessary. Typically, a MOA includes tailored versions of the following components:

I. Detailed Background // A history of relationship between the parties, including past injustices and past successful collaborations.

II. Purpose // A description of why the MOA is being crafted, and what each of the parties hopes to gain.

III. Definition of Terms and Parties // The inclusion of a glossary and detailed list of stakeholders may help avoid confusion later in the project. Stakeholders relevant to collaborative cultural heritage projects could include: Indigenous individuals, Indigenous organizations, museum staff, archaeologists, anthropologists, historians, and government officials.

IV. Principles of Collaboration // What ethical, moral, religious and/or legal principles/protocols/codes will guide the spirit of collaboration outlined in the MOA? Examples include the World Archaeological

Congress Code of Ethics, Code of Ethics of the American Anthropological Associations, Indigenous protocols or codes for research on their lands/people, as well as overall principles of inclusiveness, generosity, respect, empowerment, gratitude, and transparency.

V. Statement of Mutual Benefit and Potential Harms // Many collaborative projects involve both benefits and potential harms to the parties involved. Crafting the MOA provides an opportunity to communicate honestly about these benefits and potential harms before commencement of the project. Mutual benefits might include the creation of a new communication network, the documentation of a resource (for example, cultural heritage sites), technical training, or even financial gain from tourism. Potential harms could include disruption of privacy, sharing of protected information, or personal injury if the responsibilities outlined in the MOA include physical tasks.

VI. Agreed Upon Actions and Responsibilities // Every MOA should include a detailed list of the actions each party will take during the collaborative project. For example, if consent of individual project participants or communities will be sought, who in the project will be responsible for obtaining and archiving evidence of consent? If research materials are created, who will keep the originals and how will authorship be decided?

VII. Modification and/or Termination of the MOA // What is the process by which the MOA can be altered or terminated? How will disputes about the MOA be resolved?

VII. Reporting // How, when and to whom reports will be submitted or presented.

IX. Timeline for Action and Future Meetings // The crafting of a MOA often marks the beginning of a collaborative project. It is important that the MOA include a timeline for when future actions or responsibilities should be met, including when the project is scheduled to end. MOAs should also be seen as living documents that need to be revised at appropriate times, as stakeholders, resources, or other terms of the agreement change.

X. Signatures // The MOA must be signed and dated to come into official effect. In some cases, it may be appropriate to include the signatures of all "signatory parties," who have listed responsibilities in the text of the MOA and are the people involved in amending or terminating the agreement, and "concurring parties," who are people consulted about the project but who do not have responsibilities or the authority to execute the MOA.

INTELLECTUAL PROPERTY CONCERNS

The terms of an MOA can help determine ownership or use of intellectual or intangible Indigenous property or heritage. For example, for a MOA that guides an Indigenous cultural heritage research project where participants will interview community members, parties involved may consider including a statement about publication or ownership of Indigenous intellectual or intangible property, such as: "Researchers may use information collected during this project for educational purposes, but researchers cannot claim copyright or any exclusive rights to the acknowledged Indigenous intellectual property of [XXX community] such as traditional teachings or songs. The community retains the right to review and edit all reports and publishable documents that result from the research prior to publishing." If products were generated as a result of the actions/projects within the MOA, the agreement may state where they will be housed and who will oversee this action.

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This Fact Sheet was developed by Dru McGill, Davina Two Bears, Julie Woods and the Research Ethics and IP Working Group, and published in January 2015 (photo: Hasmat Ali, 2013, pdpics.com).

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