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The Coastal Route: The Role of the Pacific Northwest Coastline in Facilitating Human Travel into the Americas

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Abstract: How Homo sapiens first entered North America has historically been attributed to a crossing of Beringia and a subsequent movement south through an ice-free corridor in Canada. Biological and physical research on the history of the region suggests an ice free corridor could not have existed in the same time frame as the first human travelers. Ecologically, the ice free corridor would not have been functional early enough to facilitate initial human travel. These biological constraints would not have been present along the northwest coast of the continent. Physical constraints in the ice free corridor would also have prevented travel at the time of the earliest southward migration, while at the same time the geography of the coastline would have become easier to traverse. Archaeological discoveries show early human settlement along the northwest coast, and archaeological discoveries at inland sites show human occupation much earlier than the ice free corridor. Used together, this evidence supports a coastal human migration instead of an inland route into North America.

Introduction: *Homo sapiens* first appeared in eastern Africa almost 250,000 years ago and by 15,000 years ago, humans had reached the tip of South America, effectively extending their range to include the entire globe. Such large scale migration is almost unprecedented in history, making travel and movement in human prehistory a fascinating story. Because of this, prehistoric human migration has become the subject of much research, however there are still many gaps of knowledge in this field of study. How humans first entered North America is one such gap. This initial migration to the Americas has become a point of contention in recent years amongst the scientific community. Historically, it has been accepted that *Homo sapiens* traveled across Beringia, a land bridge formed between Russia and Alaska as sea levels dropped, during the last glacial maximum following the game animals they relied on for hunting. After crossing into

Alaska an ice free corridor between the Laurentide Ice Sheet and the Cordilleran Ice Sheet, located in the interior of modern Canada, would have facilitated human migration further south.

Coming to a conclusion on the migration route of humans into North America is important for understanding our history and our story. Determining the route taken can give an insight to the lives of early human settlers, as well as perhaps their motivations for migration. We can also learn much about the conditions prehistoric humans were able to adapt to, giving us an idea of their creativity and intelligence. Three major theories currently dominate the scientific understanding of how humans reached North America. The first involves an ice free corridor in between the two large ice sheets that covered Canada in the late Pleistocene. The second involves human migration along the Pacific Northwest coastline. The third involves human migration from Europe over ice sheets that covered the Atlantic, known as the Solutrean hypothesis (Westley 2008). The idea of the ice free corridor and inland route has dominated thinking for a long time and now that there is a mounting amount of evidence to challenge it, it is important to determine which of the three theories are more viable to further scientific understanding and end this long running debate. Evidence now supports that humans first entered North America along the northwest coastline.

With the evolution of new dating methods as well as new findings of human settlement in the Americas, the theory of an interior route has become less viable. Evidence now supports that humans were established in the Americas before the ice free corridor would have become a viable migration route. Biological evidence, including faunal remains, phylogeography, and pollen stratigraphy show a viable range of dates where the ice free corridor would have been habitable (Heintzman et al. 2016; Federovich 1970; White et al 2017). Determining when native North American fauna, and fauna native to Eurasia first occupied the area has also proved useful

in providing a time frame for the existence of an ice free corridor (Pedersen et al. 2016; Heaton and Grady 2003; Al-Suwadi et al. 2006; Erlandson et al. 2007). What is consistently found is that the habitable date range of the corridor occurs later than the oldest human settlement sites in the Americas (Pedersen et al. 2016). Paleogeographic reconstructions of the area show physical barriers to the ice free corridor as well that would prevent inland human migration at the earliest settlement dates (Clark et al. 1993; Dixon 2015; Pedersen et al. 2016; White 2017; Heintzman et al. 2016). These reconstructions offer a better idea of what the geography of inland Canada and North America would have looked like during the last glacial maximum. Also, these reconstructions show lower sea levels along the northwest coast, providing more habitable land for human migration (USGS; NPS; Dixon 2015; Carrara et al. 2003; Lesnek et al. 2018; Blaise et al. 2017; Bobrowsky et al. 1990).

Archaeological remains have been found along the northwest coast, and although they are limited in number, they do show human occupation (Erlandson et al. 2011; Josenhans et al. 1997). These remains however, are not old enough to show migration before the ice free corridor. Most of the archaeological evidence that suggests earlier human migration comes from more inland sites south of the glaciers (Goebel 2008; Adovasio et al. 2017; Goodyear 2005; Dillehay et al. 2017). However, because these sites are dated to be older than the viable ice free corridor, they still support the idea of a different migration route. Genetic evidence also shows southward human travel before the ice free corridor and can also determine the origin of the Native American population, an important aspect in concluding whether the Solutrean hypothesis is viable or not. Dating when Native Americans became genetically distinct from their ancestors provides a timeline for when southward travel began (Skoglund et al. 2015; Potter et al. 2018).

All of this evidence from a variety of disciplines shows the coastal migration route as the most likely for initial human migration.

Biological Constraints: For the ice free corridor to exist as a migration route during certain times, it must be biologically active and habitable. *Homo sapiens* would not have the ability to travel an inland route unless it had the resources necessary for life. Because of this, providing a date range for when the ice free corridor could have been biologically active has become a focal point for research looking to determine human migration routes. The biological activity of the area can be and has been determined using a variety of methods. One such method comes from a 2016 study examining bison phylogeography. Phylogeography looks at the genetic diversity of species in relation to their geographic dispersal. Using current as well as fossilized bison genetic information to determine the effects of the last glacial maximum on separating bison population, bison north of the ice sheets were genetically different from bison south of the ice sheets (Heintzman et al. 2016). More specifically, mitochondrial DNA could separate bison into two distinct clades. If the northern clade was found in the southern population it would show migration south while if the southern clade was found in the northern population, it would show migration north. These migrations would only be possible with the existence of an ice free corridor during the last glacial maximum or after the retreat of the glaciers.

A total of 78 North American bison fossils were dated using radiocarbon dating, 49 of which were found near the proposed ice free corridor region. These fossils were also genetically identified and categorized into mitochondrial haplotypes. This information identified when an ice free corridor capable of supporting large scale faunal dispersal was available. The radiocarbon dates of fossils that belonged to haplotypes historically separated by the glacial ice sheets showed a mixing in the ice free corridor region around 13,000 years ago (Heintzman et al. 2016).

This date is important in that it provides evidence that a viable ice free corridor only existed after human arrival into the Americas, as dating of human settlements shows migration potentially started 15,000 years ago.

Other research has examined the timeline of other faunal habitation of the ice free corridor to determine a time frame for its existence. The appearance of many fauna has been dated to later than the first human appearance (Pedersen et al. 2016). The Peace River drainage basin is the remnant of Lake Peace, which was one of the last major lakes to geographically cut off the ice free corridor for travel. Its location in this bottleneck region of the corridor makes it ideal for sampling as almost every species must have crossed through it during their migration. By collecting lake sediment cores from Charlie Lake and Spring Lake in the Peace River drainage basin they were able to identify a timeframe for faunal habitation. Dating environmental DNA found in the sediment cores showed mammoth presence by 12,600 years ago, elk and moose by 12,400 years ago as well as smaller mammals such as jackrabbit and vole around the same time. Dates of faunal habitation are consistently later than that of the earliest human sites in the Americas (Pedersen et al. 2016). Most animals discovered in the eDNA from the sediment samples showed an almost 2000 year gap between human presence and their own. The implications of these findings support the coastal migration route. If faunal presence in the ice free corridor was limited until 2000 years after the first human settlement in North America, it indicates that the ice free corridor was not available for travel during the initial human migration. Without ecological ability to support other fauna, there would likely be no resources to support human travel.

Besides faunal remains and genetic evidence, researchers have also looked at flora and pollen deposits in the ice free corridor area. Dated cores from the Peace River drainage showed

that prior to 12,600 years ago pollen levels were low indicating sparse vegetation presence in the region (Pedersen et al. 2016). Later than 12,600 years ago, grasses and sedges began colonization in the area. This vegetative growth would continue and ultimately support faunal travel between the ice sheets. Stratigraphy of a dated sediment sample from Lofty Lake, located in the ice free corridor area, showed the earliest organic layer to be around 11,400 years ago (Federovich 1970). Two lake sediment cores from the ice free corridor area dated the arrival of vegetation to around 12,000 years ago (White et al. 2017). These findings all provide evidence that the ice free corridor did not support vegetation before the first humans reached North America, removing the ice free corridor as a viable route for initial human travel.

Biologic evidence has not only been used to determine the habitability of the ice free corridor, it has also been used to determine the habitability of the northwest coastline of North America. If humans did take a coastal route instead of a route inland, the coastline must have been biologically active. On the Alexander Archipelago, an area of the northwest coastline of Canada, vertebrae fossils that dated between 44,500 and 35,400 years ago were found. Species such as the brown bear, marmot, red and arctic fox, caribou, and ringed seal all were extant in the area through the last glacial maximum, coinciding with the earliest dates of human migration (Heaton and Grady 2003). Stellar Sea Lion in southeast Alaska was dated to the last glacial maximum, as well as the same species further south near Vancouver Island at 14,570 years ago (Heaton and Grady 2003). The presence of sea lions and seals also indirectly indicates the presence of their prey. These animals feed on a variety of marine life including many types of fish, octopus, shrimp, and crab. Black and brown bear presence on the island also indicates a variety of food resources on land. Both bear's diets include berries, fungi, plants, and roots as well as animals such as fish, insects, and other mammals. West of Vancouver Island, at Port

Eliza Cave, radiocarbon dating has indicated the presence of vole, mountain goat, marmot, numerous fish species, mollusks, and birds at around 20,000-18,000 years ago (Al-Suwaidi et al. 2006). There is a pause in the record from 18,000 to 14,500 years ago indicating the area may have been glaciated. However this still leaves a biologically active area for human travel before 18,000 years ago and after 14,500 years ago, both still earlier than a biologically active ice free corridor. Archaeological and marine ecology data indicate that the kelp forest ecosystem that spreads from Japan along the coast to Baja California could have served as a refuge for much marine life during the last glacial maximum, providing resources for early human travel by 16,000 years ago (Erlandson et al. 2007).

The evidence presented clearly supports the idea of human migration along the northwest coastline instead of an interior route. Fossilized biological data consistently shows that the interior route of an ice free corridor would not have been ecologically sustainable until after the first humans entered the Americas. Most fauna appeared in the inland region almost 2000 years after the oldest human dated sites (Pedersen et al. 2016). Because evidence indicates the timeline of an ecologically stable inland route to be after initial human travel it almost eliminates it as the first used travel route. In contrast to this, data show that during the last glacial maximum the northwest coastline of North America in places seemed to actually be ice free, and acted as a refuge for biota. Also the kelp forest ecosystem provided shelter for marine life which could provide the necessary resources for human life (Erlandson et al. 2007). Because of these factors, it appears that the coastline would have been ecologically active during the time of initial human migration. This strengthens the idea that instead of an inland route, *Homo sapiens* initially traveled along the coast during their first voyages into the Americas, because the route they followed would have needed to be ecologically active.

Geographic Constraints: Another major factor influencing human migration into North America is the geography of the potential routes taken. *Homo sapiens* entered the new world at the end of the Pleistocene era, after the last glacial maximum as the glaciers began to retreat. The ice-free corridor is proposed to have existed between two large ice sheets, the Laurentide and the Cordilleran. The Laurentide ice sheet was one of the largest in the world during the last glacial maximum, extending through most of eastern Canada and parts of the northern United States. The Cordilleran ice sheet was the smaller of the two, but covered most of northwest Canada and stretched about as far south as the Laurentide sheet. Combined, these two sheets covered nearly all of Canada during the last glacial maximum and the periods directly after it. In order for any inland travel to have occurred, a separation in these sheets must have been available for human use at the same time as initial human migration.

Current evidence on the expanse of the Cordilleran ice sheet indicates that the sheet reached its full extent around 15,000 years ago, around the same time as the earliest human remains in North America (Clark et al. 1993). Despite this, evidence does suggest that a narrow area of deglaciated land did exist between the two ice sheets by 14,000 years ago (Dixon 2015). Dixon writes that this deglaciated corridor was different than other deglaciated areas as it was extremely narrow and between two large ice sheets. Because of this, the corridor only had two narrow openings to large ecosystems on each side, geographically limiting any form of species colonization. Other consequences to the terrain of the corridor were present because of its situation between two ice sheets. Glacial run-off leading to shifting rivers and large lakes would have proved difficult to cross. Also dangerous would have been the katabatic winds, strong winds that would have flowed downward from the top of the glacier into the deglaciated area. Melt-filled lakes seemed to provide many bottleneck areas for travel in the corridor. Areas of the

Peace River drainage basin would have proved difficult to cross, as the lakes contained there acted as a bottleneck in the region (Pedersen et al. 2016). Data even suggest that the Peace River drainage basin could have possibly been occluded by the two ice sheets for a longer period of time due to how narrow it was (White 2017). Evidence suggests that along with these physical constraints, dispersal in the ice free corridor actually favored south to north expansion rather than north to south. Studies of bison remains show that bison belonging to a distinct genetic group found south of the ice sheets, predominates the remains found in the corridor (Heintzman et al. 2016). The reason for this preference came from the ecology on either side of the corridor. The conditions in the south allowed for greater access to the ice free corridor. This shows that southward travel through the ice free corridor would be even harder for humans.

If the ice free corridor provided physical and geographic barriers to travel then a separate route must have existed without these constraints for humans to proceed further south. The coastal route became viable during the last glacial maximum due to sea level changes. Around 21,000 years ago sea levels dropped 410 feet from present levels (USGS). One of the most important aspects of this change was the opening of Beringia as a traversable land mass. Beringia connects modern day Alaska with northwestern Russia and when sea levels fell it was used by humans and other mammals as a migration route. Unlike most of the majority of arctic lands at the time Beringia remained ice free allowing for ecological activity and travel (NPS). Along with emergence of a land bridge in Beringia, the coastline of the northwestern North American continent also expanded. It has historically been thought that the coastline was glaciated by the Cordilleran ice sheet, however new research suggests the coastal route appears to have been deglaciated for most of the last glacial maximum (Dixon 2015).

This correlates with the earliest arrival of humans into North America. The probable expanse of the Cordilleran ice sheet left areas of deglaciated land in the Alexander Archipelago of northwest Canada. Parts of the inner continental shelf, exposed due to rising sea level, were probably deglaciated as well (Carrara et al. 2003). The deglaciation of the pacific coast during the last glacial maximum has been examined heavily. The extent of the Cordilleran ice sheet in southeastern Alaska was studied, as the area served as a bottleneck for human travel along the coast. Using radiocarbon data of biologic remains and Be^10 data to date the emergence of continental crust, a viable ice free route along the coastline was dated to 17,000 years ago, correlating with the oldest known human arrival (Lesnek et al. 2018). Deep sea cores taken from the eastern North Pacific contained stratigraphic evidence that indicated ice sheet retreat and deglaciation along the coast by 15,600 years ago in Queen Charlotte Sound, Hecate Strait, and Dixon Entrance, areas along northwest Canada (Blaise et al. 2017). Using carbon 14 dating, many areas of western and northwestern Canada were found to have remained unglaciated throughout the last glacial maximum. Areas of southwestern Alberta would have remained ice free serving as a refuge for biota and providing a route for human travel (Bobrowsky et al. 1990). In addition to remaining deglaciated, the Pacific Northwest went through three warming periods of around five degrees Celsius between 18,500 to 15,000 years ago, each lasting 500 to 1,500 years (Sarnthein et al. 2006). These warming periods could have helped facilitate human travel, and the time frame does line up with the earliest known human migrations.

Because the ice free corridor region presents physical barriers to travel at the time of the earliest human migrants, it is unlikely it was used. This does not prove that the coastline was used however. Humans initially traveled from Beringia to the rest of North America following some path. Since the coastline does not present the same barriers as the ice free corridor and in

fact may even have become more facilitative to travel, it seems more likely to be the chosen travel route. If only two real paths were available to the first human migrants, the less constrictive of the two, and the one that actually was physically passable, would be the initial travel route.

Archaeological Evidence: Archeological evidence of human occupation of Beringia is at least 28,000 years old (Goebel 2008).With the subsequent warming and deglaciation of some areas, humans then began to travel southward. The exact timing of the migration can be inferred from examining the oldest human sites in the Americas. It has historically been thought that humans did not reach the Americas until 13,500 years ago, however discoveries of sites that are dated older have started to become more common (Goebel 2008). The Topper site in South Carolina can be dated to around 15,000 years ago (Goebel 2008). Using new dating technologies in the form of accelerator mass spectroscopy, rock shelter remains in Meadowcroft, Pennsylvania were dated to between 14,000 and 14,500 years ago, indicating human presence in Pennsylvania by that time (Adovasio et al. 2017). At Saltville, near the Appalachian mountains of southwest Virginia, dating of soil horizons show the earliest human occupation to be around 14,510 years ago (Goodyear 2005). The oldest horizon at this site actually contains human remains which date to this time frame. At Cactus Hill, a sand dune overlooking the Nottoway River in Virginia, charcoal remains can date to earlier than 15,000 years ago (Goodyear 2005). There is difficulty in determining if the charcoal is from human burning or from forest fires, though some of the excavated material does appear to be from hearths. Older sites have also been found in South America. At Monte Verde in modern Chile, stone artifacts, burned areas, and faunal remains can be dated around 14,500 years ago (Dillehay et al. 2017). Some artifacts may date to 18,500 years

ago, yet it is far from conclusive. Either way this data shows human presence in South America before a viable ice free corridor could have existed.

Homo sapiens entered the Americas much earlier than previously thought. All of the sites listed above date to before a viable ice free corridor could have existed to facilitate travel. This supports the arguments made in the biological and physical/geographical sections that humans must have initially migrated to the Americas using a different route. However these sites do not prove that humans used a coastal route. While it can be inferred based on the availability of viable pathways at the time, archaeological evidence of human presence along the northwest coastline is necessary to support that the coastal route was used initially. This has presented a challenge, as the coastline is by nature very unpredictable and chaotic, easily washing away any human presence. Also as mentioned previously, sea levels during the time of human migration would have been 410 feet lower than today, meaning many potentially archeological sites would now be under water. Despite this, some findings have been made of human coastal occupation.

The Paleo-Indian inhabitants of the Channel Islands, off the coast of California have been extensively studied. The Channel Islands during the last glacial maximum would have been connected into one large island, and would have been along the coastal path of migratory humans. Human remains from the Santa Rosa Island have been dated to around 13,000 years ago (Erlandson et al. 2011). Artifacts found in a shell midden on San Miguel Island dates to 11,500 years ago (Erlandson et al. 2011). Perhaps one of the most intriguing findings was that some of the tools found on the Channel Islands came from a Californian volcano field 300 km away. Dating these artifacts indicates that by 12,000 years ago, the Channel Islands community was involved in some form of long distance training (Erlandson et al. 2011). For the inhabitants to have such a trade network means they must have been established on the island even earlier than

12,000 years ago. Human artifacts found in British Columbia were dated to around 10,200 years ago, and dated human remains found in a cave on Prince Whales Island, in Northern Canada were dated to around 10,000 years ago (Josenhans et al. 1997). However, the findings suggest the area to have been habitable by 13,000 years ago (Josenhans et al. 1997). Many coastlines available to human travel are now drowned due to the rise in sea level from the last glacial maximum.

While these findings and others like them are not as old as the earliest human findings they clearly show human occupation of the northwest coastline even as far south as the Channel Islands. With human occupation of the Americas dating to as old as 15,000 years ago, and the ice free corridor not being a reliable means of travel at that time, it is clear humans must have used another route. So the evidence of human occupation of the coastline, even if it does not date as late is still valuable in showing that humans used that route at some point.

Genetic Evidence: Along with archeological evidence, genetics can be used to give an accurate timeline of human dispersal into the Americas. Genetics can also be used to refute the Solutrean hypothesis. The Solutrean hypothesis believes that the first Americans did not cross Beringia or come from Asia; it hypothesizes that humans initially came to the Americas along a biologically active corridor in the ice along the northern Atlantic (Westley 2008). This would make the Native American peoples descendant from Europeans which can be tested using genetics. What geneticists consistently find is that Native Americans are most genetically similar to eastern Asians. All Native Americans have a common ancestor from a population that migrated from northeast Asia across Beringia around 15,000 years ago (Skoglund et al. 2015). Potter et al. (2018) Native Americans separated genetically from East Asians around 23,000 years ago as

they took up residence in Beringia (Potter et al. 2018). Genetic evidence has all but proven an East Asian origin for Native Americans, making the Solutrean hypothesis extraordinarily weak.

Genetic evidence can also show when Native Americans separated from the population in Beringia and became distinct genetically, as they moved southward. Mitochondrial DNA can place this separation at around 14,500 years ago (Skoglund et al. 2015). Other evidence suggests a more complex and even earlier divide, identifying two groups that separated from the population in Beringia, a northern and a southern branch, that split around 17,500 to 14,600 years ago (Potter 2018). The reason for this split is due to the genetic isolation that came with expansion into North America. As humans traveled further south, they became separated from the inhabitants in the north, eventually leading them to be genetically distinct. So, based upon the timeline of when Native Americans split, we can say when they started to travel southward. Similar to the archaeological evidence it appears the humans traveled south into North America around 15,000 years ago. This date would preclude the ice free corridor as a travel route, as it would not have been ecological viable or physically passable at this time.

While the genetic component is smaller than the others, it is still helpful when providing evidence for the coastal route theory. Determining when the human populations from East Asia split to become genetically distinct in Native Americans helps researchers determine when the two populations became separate due to distance. In many ways this is more helpful than even archaeological data as it can potentially pinpoint the exact time humans began their southward expansion, while archaeological data can only say when humans already occupied an area. The genetic evidence of North American populations found thus far clearly indicates that humans began southward travel before the ice free corridor was a viable route.

Discussion: All of the evidence presented thus far provides a strong argument for human travel following a coastal route instead of an inland route. Biological evidence shows that the ice free corridor was not ecologically sustainable at the same time of the earliest human travelers. It could not support enough vegetation or faunal occupation, leaving it virtually resource less for humans (Heintzman et al. 2016; Federovich 1970; White et al 2017). Without sustained ecological activity humans would have not been able to survive. In contrast to this, the northwest coastline seems to have served as refuge for fauna during the last glacial maximum (Pedersen et al. 2016; Heaton and Grady 2003; Al-Suwadi et al. 2006). Also the kelp forest ecosystem along the coast would have sustained a sizable marine population (Erlandson et al. 2007). So the northwest coastline did have the potential for sustaining human travel. Physically, the ice free corridor would have been very narrow, unpredictable, and rather chaotic. Being situated between two glaciers, it would have been subjected to changing rivers and lakes made of melt water, as well as strong katabolic winds coming off of the tops of the glaciers(Clark et al. 1993; Dixon 2015; White 2017; Heintzman et al. 2016). Some lakes, such as Peace Lake, could have been so large and situated in a bottleneck area that they could have prevented travel all together (Pedersen et al. 2016).

The northwest coastline would have expanded during the last glacial maximum. Due to falling sea levels more coastal land would have been available for travel. Research has consistently shown that part, if not all, of the northwest coastline was deglaciated at several points during the last glacial maximum (USGS; NPS; Dixon 2015; Carrara et al. 2003; Lesnek et al. 2018; Blaise et al. 2017; Bobrowsky et al. 1990). The timeline for these ice free periods coincides with the earliest evidence of humans in the Americas. Along with this, periods of warmth seem to have stuck the coastline during this time, further facilitating human travel

(Sarnthein et al. 2006). Archaeological findings show that humans were present in the Americas by 15,000 years ago, with findings this old even in South America (Goebel 2008; Adovasio et al. 2017; Goodyear 2005; Dillehay et al. 2017). This shows that human presence may have been even earlier. These early dates do not line up with a viable inland ice free corridor, but they do line up with a viable coastal route. Archaeological evidence of human occupation of the coastline earlier than 13,000 years ago has not been found, but evidence has been found of human occupation of the coastline, showing that it was used as a travel route at some point (Erlandson et al. 2011; Josenhans et al. 1997). Genetic evidence has been able to determine when Native American populations became genetically distinct from their East Asian ancestors and has also been used to disprove the Solutrean hypothesis. This time frame contributes to dating when humans initially began to travel southward, as the two populations became genetically distinct due to distance. Genetic evidence has consistently shown that Native Americans split from the Beringia population before the ice free corridor would have been viable for travel (Skoglund et al. 2015; Potter et al. 2018). When combined, this evidence supports the coastal migration route as the initial route of human travel into North America.

There are some counter arguments to the coastal route that need to be addressed. Firstly, and probably the biggest problem with the theory, is that sites along the pacific coast are not as old as the first humans living in the interior. If humans initially traveled along the coast to get to the Americas, it is logical to assume the oldest sites would be located along the coast, not inland like they are. Many critics of the coastal route will point to this as evidence that humans used a different route. A common defense is that the coastline was much bigger during the last glacial maximum and human travel. Sea level was lowered by around 410 feet at the time humans would have initially traveled along the coast. As sea levels rose, many artifacts that would prove

earlier human presence would have been washed away. There are flaws in this thinking. A meta-analysis concluded that more than half of the Northwest Pacific coastline retained its' shoreline after the glacial retreat. The meta-analysis examined sediment cores and used radiocarbon dating to find out how long they have been above sea level. It was found that in many key coastal route sites, sea levels have been relatively stable for the past 15,000 years (McLaren et al. 2014). This does pose a problem for the coastal route theory, as it removes sea level rise as a player in removing artifacts that would prove early human occupation.

The coastline itself, even if sea level is stable, is still a constantly changing, somewhat volatile landscape. Human artifacts could easily be washed away due of the unpredictable nature of the ocean. Along with instability the salt and wind common to coastlines creates an environment more prone to artifact degradation. Humans also may have not stayed in one place very long during their initial migration, removing any hope of finding permanent structure. Based on the archaeological record that is available, it is obvious humans expanded southward rapidly, as they reached South America less than 1000 years after they first entered North America. Another explanation for the lack of artifacts could be that they were made of biodegradable materials such as bone, and that the popular Clovis technology did not start until after humans had spread into North America. Evidence for this can be found at the Manis Mastodon site in Washington State. Researchers discovered a projectile point made of Mastodon bone lodged in the remains of another mastodon. Recent dating methods have dated it to around 13,800 years ago (Waters et al. 2011). This bone projectile is similar to the ones used in Beringia, and indicates hunting of large fauna before the Clovis industry of stone tools. Because this technology is so similar, it can be assumed that it was brought from Beringia.

This sheds new light on the possibility that the reason for the lack of earlier findings along the coast is that humans were still using readily degradable materials during their initial migration. While humans along the coast did not hunt Mastodon, the tools they did use could have likely been bone or other degradable material, making recovery of the artifacts nearly impossible as they would have disappeared. Another counter to the argument of older sites not being found along the coast is that older sites have also not been found in the ice free corridor region. Charlie Lake Cave and Vermillion Lake contain some of the oldest artifacts and they only date to around 10,500 years ago (Fladmark 1996) and 10,770 years ago (Fedje et al. 1996) respectively. This gives more evidence to the idea that the earliest humans to travel south into North America used biodegradable tools such as the bone projectile tips found at the Manus site. This would explain why the earliest finds of humans in North America are all south of the extent of the glaciers during the last glacial maximum. The technology to use stone points may have only become popular and widespread once humans were settled in North America

Another claim against the coastal route theory is that there were too many physical/geographic barriers along the coastline for facilitative travel. Sea ice and recurrent volcanism could have made travel along the coast too challenging for humans (Potter et al. 2018). However, when looking at the physical barriers to travel present in the ice free corridor, these do not seem as dangerous. The ice free corridor was often impassable due to melt water lakes and while sea ice could have affected human travel, it would be hard to prevent it entirely. There is also the evidence that most of the Pacific Northwest Coast was unglaciated at some point, as well as evidence for severely warming periods during the timeline of human migration. Both of these pieces of evidence would have made sea ice much less of a threat. Also evidence against these harsh physical conditions comes from the discovery of biotic refugee along the

coast during the last glacial maximum. Areas such as the Alexander Archipelago have been shown in this paper to have harbored a variety of biota, which would have been impossible if the physical barriers were too extreme. Finally human presence in central North America before the ice free corridor was viable shows that the geographic constraints of the coast must not have been so harsh as to prevent travel.

This is the main point of the coastal route argument that is so hard to refute. Evidence from a variety of disciplines shows that the ice free corridor was not ecologically viable or physically viable at the time of the earliest known humans in North America. A different route must have been taken. There may be problems with the coastal route, however with the knowledge that it was physically passable and that there was refuge for biota along it, it makes it the most viable options for human travelers. Humans traveled southward to expand across the Americas, and the coastal route seems to be the only real option for initial travel once the ice free corridor is really examined. Proving that the ice free corridor was impassable at the time of the first human migrants does not entirely prove that humans used the coastal route, however when the coastal route is examined it becomes clear that it facilitated travel instead of impeding it. It becomes the likely travel route as without the ice free corridor it was the only one available at the time.

Finally, an important thing to remember about the argument this paper is presenting is that it is arguing only for the initial migration path. Potter et al (2018), while offering evidence against the coastal migration route, concluded that both it and the inland route remained viable and that they did not have to remain mutually exclusive. That does not directly contradict the argument of this paper. The ice free corridor was eventually ecologically viable and physically passable, and it is likely that humans did travel along it at some point. However for around 1000

years of initial travel, the only viable option available to humans was the coastal route. This paper is not arguing that the ice free corridor never existed, it is arguing that it existed after humans had already spread into the Americas.

Conclusion: *Homo sapiens* first traveled to the Americas following a coastal route along the Pacific Northwest coastline. A combination of archaeological evidence, biological evidence, physical reconstructions, and genetics all support this claim. This changes the common narrative that humans traveled inland traveling through an ice free corridor, following the fauna they relied on for hunting. This new route has some implications that indicate further study. Firstly if humans did not travel to following the game they were hunting, what inspired them to travel southward? Perhaps the coastline was more inviting than the cold of Beringia, or maybe they were forced to leave the area. There are many possibilities and investigating them or even just adding speculative thoughts can contribute to the story of humanity.

Another question that could be investigated is since humans traveled along the coast, were they capable of sea travel? There are theories that humans traveled across the pacific by boat, though genetic evidence shows that Native Americans originated in Beringia. However, travelling along the coast, while physically possible and easier than traveling the ice free corridor, could have been made even easier if humans used boats. A sea faring population would change the narrative of how advanced the first humans in North America were. It would also show just how creative and adaptable humans are. There are many questions like these that could be further investigated, which is what makes the research presented here so valuable. While the coastal route versus the inland route or Solutrean hypothesis may not be the biggest or most significant part of our story it is still valuable in our understanding. The scientific debate about the origins of aboriginal Americans has been going on for a long time, and this paper hopes to

put some of this argument to rest. This paper concludes that the initial human migration into the Americas followed a coastal route, and while further research is necessary to undoubtedly prove this, this paper will still help in ending the debate over which route the initial migrants took.

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