AN ABSTRACT OF THE THESIS OF

Gail J. Woodside for the degree of Honors Baccalaureate of Science in Natural Resources: Aridland Ecology presented on May 28, 2008. Title: Comparing Native Oral History and Scientific Research to Produce Historical Evidence of native Occupation During and After the Missoula Floods.

Abstract Approved: _____

Douglas Edward Johnson

Abstract Body

The Missoula Floods occurred approximately fifteen thousand to thirteen thousand years ago during the last ice age. The floods occurred when waters held back by a finger of the Purcell Ice Lobe gave way allowing water which covered present day Missoula, Montana to inundate areas of Idaho, Washington, and Oregon. The flooding moved mass amounts of silt and aggregates on its way to the sea. The flooding also carved out and deepened the Columbia Gorge and caused slack water areas or temporary lakes to form when narrow channels backed up the flooding currents.

Native American oral history tells about the flooding and the deep formation of the Columbia River, though some scientists feel that human occupation of the areas ravaged by the floods had not taken place. Native historians hold information regarding Tribal occupation of the areas flooded as well as information regarding survivability by noting techniques of survival and as well as significant peaks used as resting places until flood water subsided. Anthropological dating of the ancient Native people does point to human occupation of these lands with findings of human feces in caves found in Oregon dating approximately fifteen thousand years ago, although occupation by current tribes may not have occurred until later.

An equation created out of the histories of Native people from the affected regions gives validity to survival by proving tensile rope strength on cedar ropes used as well as drag force on canoes under force by the moving water. The equation was populated by actual canoe dimensions from similarly made modern canoes. The strength of the ropes, drag force on the canoes, and comparison of the histories in regard to peaks and places for survivorship fit together in a time frame best described in geologic time for the people who emerged in the regions affected by the cataclysmic floods.

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Comparing Native Oral History and Scientific Research to Produce Historical Evidence

Of Native Occupation During and After the Missoula Floods

by

Gail J. Woodside

A PROJECT

submitted to

Oregon State University

University Honors College

in partial fulfillment of
the requirements for the
degree of

Honors Baccalaureate of Science in Natural Resources: Aridland Ecology
(Honors Scholar)

Presented May 28, 2008
Commencement June 2008

Honors Baccalaureate of Science in Natural Resources: Aridland Ecology project of Gail J. Woodside presented on May 28, 2008.

APPROVED:

Mentor, representing Natural Resources

Committee Member, representing Ethnic Studies

Chair, Department of Rangeland Resources

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I understand that my project will become part of the permanent collection of Oregon State University, University Honors College. My signature below authorizes release of my project to any reader upon request.

Gail J. Woodside, Author

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Dedication

I would like to dedicate this thesis first and foremost to my parents, John T. and Bonneva A. Woodside; who without their love and support throughout my life I would not be able to enjoy the richness and beauty I constantly have surrounding me. Thanks Mom and Dad for allowing me to wear turquoise moccasins with the beads on the toes. I would like to thank Dr. Douglas E. Johnson; my mentor for this project for his patience and support encouraging me to write from an indigenous view. Holy Cow a breath of fresh air! I would like to thank Dr. Kurt Peters and Dr. Mitch Wilkinson and their unabated understanding of indigenous views and the courage to address subject matter normally not accepted in the scientific world. I would also like to remind Dr. Peters there is one pink bead in 880,000, and Mitch that's another story for another day. I also wish to thank Dr. Derron Rafiq Coles, for his expertise and patience in guiding me through two terms of math and calculus, and inventing spreadsheets I could understand in regard to velocity, Drag Coefficients, and the Reynolds Number. Truly Dr. Coles has more patience than a Saint. To Dr. John C. Buckhouse for his many years of advice and instruction in aridland hydraulics and upland watershed knowledge, and for not knowing you do not smoke peyote. I wish to thank my sister Clarissa Bertha, confidant, support mechanism, flautist extraordinaire whose beauty of soul is breathtaking. Along with Clarissa, appreciation and heartfelt admiration goes to Allison Davis-White Eyes, an amazing person who deserves respect and accolades, if only people saw her moving and shaking for the betterment of the world. Thank you Connie Davis, DREAM Girl for all of your help. Thank you to my brother who I know would be interested in the 400,000 seeds within the cones of a Western Red Cedar. I want to embrace and thank my empowered, intelligent, amazing daughters Lynn, Gennifer, Serene and Alyssa, who are the lights of my life who help keep me balanced and youthful. Shii jei yishdlo ayoonishnii.

~

Thank you Honors College for this amazing opportunity.

~

Last I want to show appreciation to the Crew from Olympic College

~

Dr. Susan Digby, Geographer; Care Giver of My Spirit
Steve Macias, Geologist; Cinder Angel
Ted Baldwin, Chemist; Keeper of the Molecule of the Week
And lastly
Dr. Don Seavy, Marine Biologist
You gave me the strength to become a scientist and explore a universe
I had never intended.
You empowered me and believed in me, encouraged me, and understood me,
You didn't bat an eye when exploring indigenous scientific knowledge.
You prayed for me and I am truly grateful for the lifting up your care has always
contributed to my wellbeing.

Thesis Statement

Oral history of native people compared to the geomorphic events surrounding the Missoula Floods will present a better understanding of native sustainability and livelihood within the regions of Washington and Oregon affected by the release of water from Lake Missoula.

Methodology

The methods used for this research came from existing written forms of information located electronically on the internet, or in journals, newspapers, books and research papers from other authors. There is some information from personal experience and from public forum including classroom studies, and field trips while in a course of study.

For future work on this project (post doc) contact will be made to the designated Tribal Governments and representatives regarding oral history (in the unwritten sense.) While collecting oral histories use of cameras, recordings, or written notes by the investigators may be used. At the time of future investigation on this thesis, an Institutional Review Board will be obtained by the investigator from Oregon State University.

For the purposes of this Honors College Thesis interviews or gathering of information from Tribal Entities through interview did not occur.

Printed oral history and written oral history located electronically was gathered and compared to the events surrounding the Missoula Floods. These excerpts in some cases were paired with the time frames and geologic flood events which may have

occurred at the time of the Missoula Flood episodes. Some other flood research was also studied and discarded due to the historical emphasis which may have angled the flooding at an event slightly or distinctly different from the Missoula Flood episodes. Research was completed to ascertain if any other large scale flooding had occurred in the last 15,000 years to ensure data collected didn't match criteria from other recorded mass flooding episodes separate from the Missoula Floods.

These historical remembrances were then compared to location of modern tribes whose history has survived colonization and the locations and name places noted during the retelling of history through oral traditions. The name places or tribal locations are evident that another flood episode (tsunami) of dynamic proportions was not confused with the cataclysmic floods.

Some excerpts are parts of remembrances or stories which are in public viewing form and within publications which are found electronically or in print. These publications offered information which was used to compare with information accessed on the internet.

Data used in regard to comparisons of geologic, anthropologic and indigenous time frames was supplied by books and data collected in research in the form of abstracts, thesis, electronic and printed form.

Mathematical data collected was supplied by studies from other geologists who have included equations for velocity and other information in regard to water movement and aggregate or erratic sedimentation on sites within the flood regions of Washington, Oregon, Idaho and Montana. Other scientific data was obtained from classroom attendance, and classroom field research. All other mathematical data and advice was

specified by a civil engineer, with a focus on hydraulics at Oregon State University utilizing a M.S. Excel Spreadsheet format for Pounds Force and Total Drag Coefficient calculating a Reynolds Number format.

Knowledge of cedar work and use comes from personal knowledge from working with cordage and natural plant materials for the last forty years. Other personal knowledge in regard to materials comes in the form of personal knowledge from my cultural background not only within the native community but within the military community in which I was raised. Other data used on cordage and its tensile strength comes from documents supplied from printed or electronic material used by rope companies, indigenous paddling societies, and boat makers, and the knowledge shared by my father while growing up in the United States Coast Guard and the United States Navy.

Chapter One

The Missoula Floods:

Topography, Frequency, Geologic Time, Velocity, Depth, and Erratic Deposits

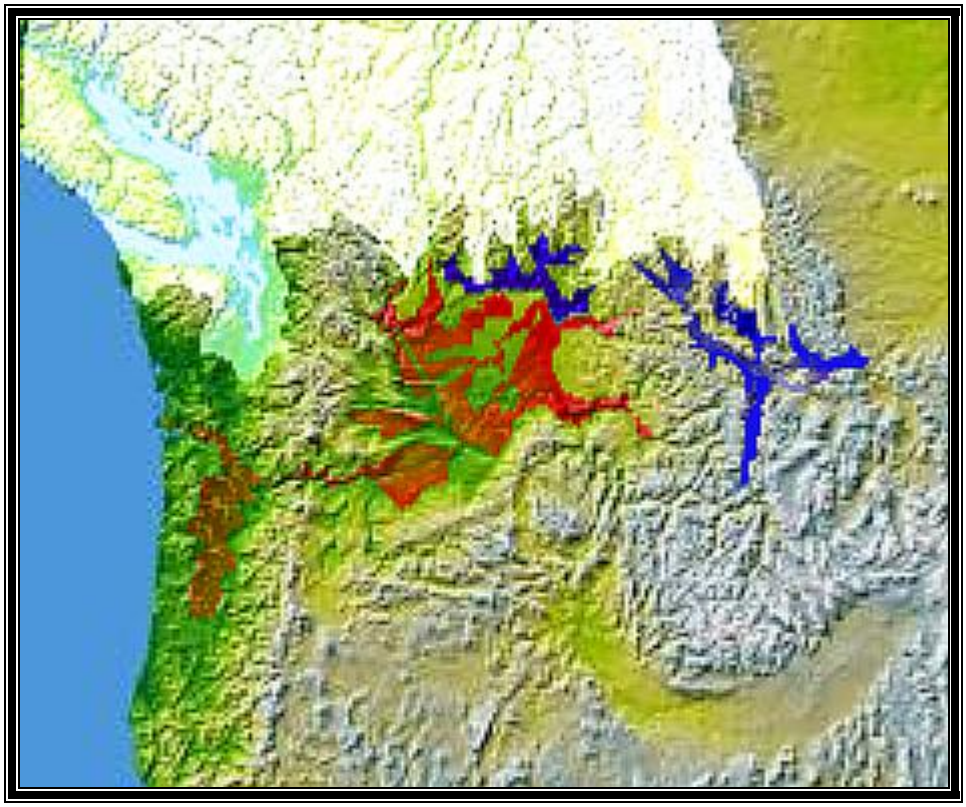

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Figure 1.1
Location of Lakes in blue, areas affected by flooding in Red

Tracing the Path of the Missoula Floods

The Missoula Floods occurred approximately fifteen thousand to thirteen thousand years ago spanning a period of two thousand years. During the last ice age, the Purcell Lobe of the Cordilleran Ice Sheet blocked today's Clark Fork River where present

day Missoula, Montana is now located. The ice sheet was approximately four thousand feet thick (Waitt and Thorson 1983) and held water back from the river that formed Lake Missoula. Lake Missoula held about 600 cubic miles of water or 2,027,520,000 acre feet. The water depth was approximately 762 meters (2,500 feet) at the dam site, and covered approximately 7,800 square kilometers (Lindsay and Tolan 1999) or 3,100 square miles of surface area. Today by Mount Jumbo outside of Missoula, Montana you can see striations etched into the landscape which represent the ancient shorelines. At this time, Mount Jumbo would be an island surrounded by water (Montana Natural History 2002) and the City of Missoula would be sitting on the valley floor under approximately 900 feet of water.

Eventually water was able to enter small cracks in the ice dam at its base, and weakened it allowing water to breach the dam and flow out. These flood waters moved past the present day area of the Clark Fork River Valley. (Montana Natural History 2002) Flood waters moved at approximately 65 miles per hour and emptied glacial Lake Missoula within approximately 48 hours of the lake water breeching the dam, (Waitt and Thorson 1983) this resulted in movement of soil, aggregates, ice and boulders. Within the Clark Fork River Valley, a silt bar was left behind by the episodes of raging waters approximately 700 feet above the current river location.

As flood waters moved toward the Pacific Ocean, they rippled across a location in Montana known as Camas Prairie. This is one of the locations where Bretz, a geologist who first brought his hypothesis to the scientific community, realized the strange rolling hills in the area appeared to be ripples from a gigantic flood. (Montana Natural History

2002) These giant ripple marks measure between 13 and 30 feet and were formed at speeds of approximately 50 mph.

Figure 1.2
NPS Photo
1: Glacial Lake Missoula, 2: Clark Fork River Valley, 3: Camas Prairie, 4: Channeled Scablands, 5: Dry Falls, 6: Flood Debris, 7: Erratics, 8: Temporary Lakes, 9: Columbia River Gorge, 10: On to the Pacific.

The Channeled Scablands were then formed as severe flooding engulfed the eastern and central regions of Washington State, and parts of the Columbia River Gorge. The swift moving currents swept away soil and exposed standing basalt columns that had been sculpted by lava flows millions of years earlier. Water then moved through Dry Falls which is measurable to approximately five times the width of Niagara Falls. The amounts of water that passed through this area scoured out pre-existing river valleys (Lindsey and Tolan 1999) of the Columbia, Palouse and Snake River systems. Some geologists estimate episodes of flooding resulted between 1 to 40 separate events (Waitt and Thorson 1983) during the 2,000 year time period. The scouring or cutting of the

Columbia Gorge give evidence that the cutting did not occur naturally, in other words by normal or natural movement of the river in its usual course. Instead the deep channels and chasms the river now flows through are in-fact a direct result of the cataclysmic flooding caused by the breeching of the ice dams, this is not true of most rivers.

The water moved from the Columbia River Gorge and began to wash back into the valleys near Kalama, Washington and the Willamette Valley of Oregon, partly caused by a narrowing near Wallula Gap, Washington. This backwash affect caused small lakes to form and spread, some as deep at 400 feet. (Waitt and Thorson 1983) The flooding also ripped up huge boulders called erratics and moved them downstream toward the Pacific Ocean and the Willamette Valley where some are evident today.

Figure 1.3
Erratics moved by floodwaters outside Hanford Reach
Photo by Gail J. Woodside

Figure 1.4
Erratic outside of Sheridan, Oregon in the Willamette Valley
Photo by Gail J. Woodside

Scientific testing of erratic rocks found in the Willamette Valley and outlaying areas of Oregon, as well as some parts of the scablands of Central Washington, contain argillite, a sedimentary rock which is also known as “Black Slate.” (Government of British Columbia 1995) These rocks can be traced back to the Purcell Anticlinorium (Thompson 1998) and were moved downward into the areas of the Kootenai Ranges by the Purcell Ice lobe. They were then rafted along with large pieces of ice and carried by the flood waters where they were deposited on hillslopes and left on valley floors by receding waters. Erratics were also found in clumps and scattered patterns in the slackwater areas of Rattlesnake Mountain in the Hanford Reach area near Richland,

Washington. These erratics were found up to 1200 feet elevation (Bjornstad 2003) on the slightly sloping hillsides of the mountain as well. Rattlesnake Mountain was one of the peaks that was left above flood waters during the flooding events. Erratics located in this region also have similar geologic makeup of other erratics located in Oregon.

As the flood waters slowed and traced their way to the Pacific Ocean near Astoria, Oregon, the area now known as the Willamette Valley began to fill with water. An inland lake was formed and covered parts of Salem, Corvallis, and ended in the foothills of Eugene.

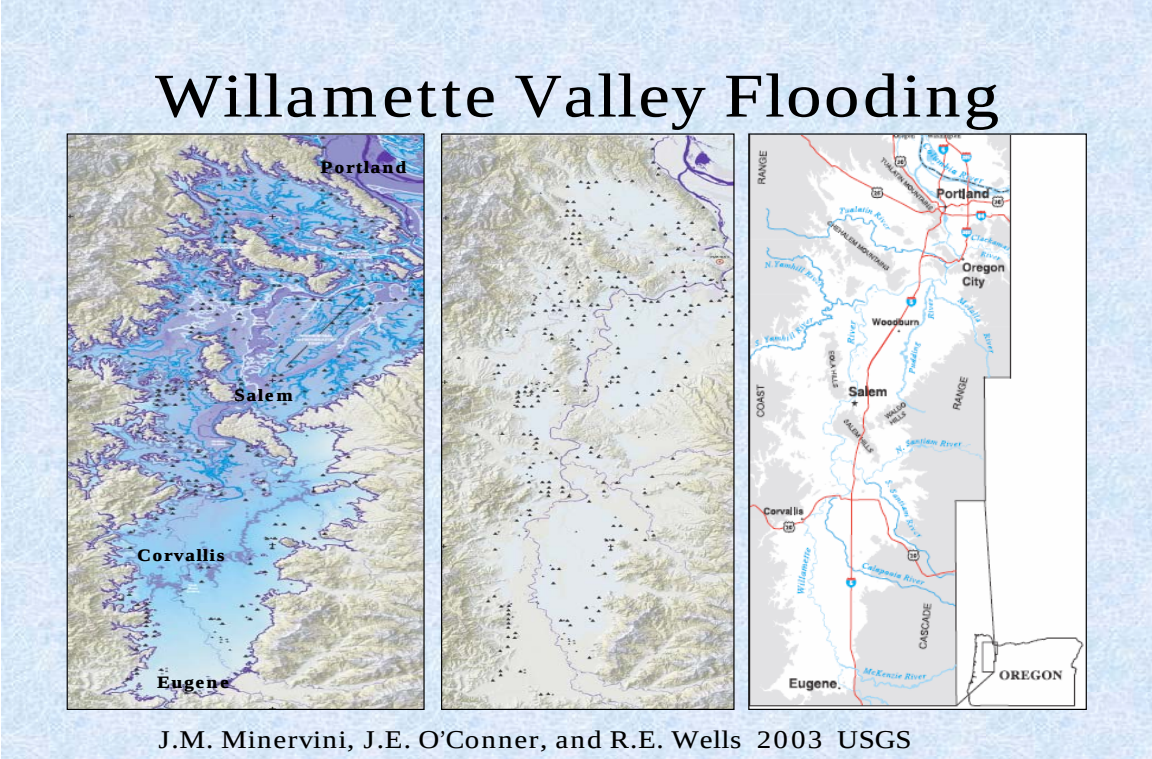

Figure 1.5

The silts and aggregate debris which was deposited in this part of the valley is what has contributed to the rich fertile soils along the Willamette River basin.

In a study of water elevation associated with the Missoula Flood episodes by Allen and Burns, (1986) estimated water measurements were derived for the following table:

Missoula Floods		
Location	**Water Levels**	**Land Elevation**
Pasco, Washington	1250’	383’
Wallula Gap	1250’	1000’
Umatilla, Oregon	1210’	5000’
Rattlesnake Mountain	1200’	3500’
Arlington, Oregon	1180’	285’
John Day River, Oregon	1140’	263.3’
John Day Dam Gap, Oregon	1130’	269’
Deschutes River, Oregon	1070’	4739’
Ortley Gap, (Columbia Hills)	1000’	1000’
The Dalles, Oregon	1000’	246’
Bingen Gap	950’	7071’
Hood River, Oregon	925’	400’
Dog Mountain Gap	875’	2860’
Bonneville Dam	830’	80’
Crown Point Gap	700’	1200’
Troutdale, Oregon	540’	36’
Portland, Oregon	400’	20’
Kalama, Washington	400’	855’
St. Helens, Oregon	400’	73’
Woodland, Washington	400’	25’
Longview/Kelso, Washington	375’	20’
Clatskanie, Oregon	275’	59’
Astoria, Oregon	0	240’

Figure1.6
Table of water levels by Burns and Allen
Table of elevations by Gail J. Woodside, with addition of Rattlesnake Mountain

The Burns and Allen water levels were enhanced by the author adding elevations to the sites they described, clarifying perspective of water depths against geologic formation and location along the river and throughout the pathway of the flood zone.

As you can see by the table, Umatilla, the Deschutes River, Bingen Gap, Crown Point Gap, Kalama, Rattlesnake Mountain, and Astoria are all above flood stage.

In conclusion the Missoula Flood episodes were cataclysmic and it would be unlikely that anyone could have survived the flooding of some of the regions surrounding the path of the flood waters. However in backwash or slackwater areas where water formed large temporary lakes due to restricted flow could have allowed for Native populations to survive.

Some western scientists and anthropologists believe that indigenous people did not occupy the steppe regions of Central and Eastern Washington, Central Oregon and the states western valleys as well as the coastal regions during this time period. However, some believe the floods were contemporaneous with Native people. Tribal oral history may link to geomorphic events surrounding the Missoula floods and could be an indicator that Native people did occupy and survive the flooding as recorded by Tribal oral history.

A few scientists today are looking closer at indigenous populations and posing the question about pre-flood settlement in regions that became inundated by the floods. Comparisons of oral history to actual geomorphic developments will present a time line of tribal influence and sustainability within the Missoula Flood regions before and after the flooding episodes occurred. By comparing oral history to actual geomorphic information surrounding the Missoula Floods, tribes will be able to re-write history to demonstrate origination in usual and accustomed sustainable areas, and to begin a new dialogue within the western realm of scientific communities. I hypothesize that the technology that Tribal people used for sustainability and survivability during these events

is measurable. Some of this technology is still used today by Tribal artisans and elders and is being passed forward to future generations.

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Chapter Two
Oral History and Time Scale

Since the arrival of Christopher Columbus indigenous people of the New World have lost their voice and place in historical believability.

> *"One of the supposed characteristics of primitive peoples was that we could not use our minds or intellects. We could not invent things, we could not create institutions or history, we could not imagine, we could not produce anything of value, we did not know how to use land and other resources from the natural world, we did not practice the 'arts' of civilization…we disqualified ourselves, not just from civilization but from humanity itself (Smith 2006)."*

This quote from Smith reflects the hopelessness many Native people feel when approached by scientific methodology and research. Native people since colonization have suffered realizations of dismissal from scholars and historians when attempting to discuss believable and useful data through oral traditions.

Chronological taxa for Native people have been devised by archaeologists and anthropologists without the benefit of considering the information oral traditions offer. This has caused the archeological modeling of historical fact (Echo Hawk 2000) which often obscures, rather than clarifies a sense of connectedness within the chronology. The taxonomic systems try to make sense of the past, but instead discourage an acceptance of oral documentation as historical fact.

Another problem Tribes face is that historians and scientists seem to dismiss oral traditions unless scientifically substantiated facts accompany them and give a burden of proof or realism to what is being conveyed. Often Native people struggle with the suggested thoughts that if the subjects have a written language, then their intelligence and history can be accepted and proven as true intellect. However if the subjects lack a

written form of intelligence, then they appear less than human and any documentation which may exist is null and void in academic and intellectual circles. A written language is more readily accepted by scholars and historians of the modern world, therefore making their historical reference more believable and more honest.

In a book written by Linda Smith called "Decolonizing Methodologies, Research and Indigenous Peoples," Smith states that native people are now branching out to validate history by first making claim or reclaiming. This includes re-establishing legitimacy to existence and historical knowledge. She also states that testimonials and oral histories become an integral part of research when paired with other stories or other fact makes a complete historical notation of existence. This also gives validation to the knowledge being presented, the sharing and rewriting of the history and the connecting of that history with geologic events and time lines, therefore disqualifying some western thought on the historical fact of the nations it represents.

The Bering Straight Theory; originally conceptualized by Spanish Priests; (Ehecatl 2002) became for Native Americans a great burden which broadcast many obstacles to survivability and in most cases has worked against traditional teachings of oral history and belief as presented by indigenous groups. This theory's corroboration is readily accepted by archaeologists in the Americas and beyond because it gives validation to manifest destiny. In light of contradicting evidence, archaeology continues to rely upon the Bering Straight Theory and has developed a scenario for the entirety of Native American history based upon this false doctrine. (Ehecatl 2008) The formerly accepted date of entry into the New World therefore is based upon the time period of the end of the last ice age which falls sometime between 12,000 and 13,000 years ago. Most

Native Oral Traditions do not allude to the Bering Straight Theory, nor is it accepted or believed as the precipice in which Native people arrived in their traditional homelands. Yet in western scientific research today this theory is still used as the precursor to arrival for many native nations as the actual way of determining native existence.

The dating and time specifications for all native nations set at 13,000 years by western historians and scientists brings burdens to the validity of oral traditions and historical belief. There is an awakening however, where some anthropologists and archaeologists are recognizing some oral traditions.

Scientists who believe that Native Oral Traditions do actually tell a story that is significant are starting to increase in number. One such person is Ruth Ludwin, (Chautauqua Field Center 2007) a seismologist at University of Washington who stated:

> *"Native American oral traditions are sophisticated and evocative mnemonic keys that categorize, compress, and communicate information about catastrophic geologic events through deep time…traditional stories from indigenous cultures with profound geography provoke cross-discipline-thinking about cognition, science, art, culture, history, pre-history, past and future events. These messages have endured through centuries and through extreme cultural disruption by using powerful and informative imagery."*

Darby Stapp, a Cultural Resource Management Archaeologist with the United States Department of Energy stated in a recent article (Stapp 2004) that:

> *"The idea of archaeologists using oral histories as evidence about the past is slowly gaining acceptance…it is intriguing that Native Americans were talking about a great flood in the Columbia Basin even before the geologists started talking about it."*

Utilizing geologic time frames to compare Native oral histories makes a lot of sense. Being able to compare actual events with oral histories gives the time frame a

better understanding and linkage due to the connections between oral history and large events such as earthquakes, floods and volcanic eruptions. The linking of geologic events to give Native perspective of origination also makes sense due to Native sense of space and relation to the earth.

Bruce Bjornstad, a geologist working at the Pacific Northwest Laboratory in Richland, Washington has recently stated in a letter (Bjornstad letter 2008) that he strongly believes that evidence for Native Americans will eventually be uncovered in sediments laid down during the floods. He is currently working with Darby Stapp in regard to future scientific investigations surrounding this event.

Recent Findings

Dr. Tim Dillehay from the University of Kentucky found after carbon testing wooden tools and charcoal that the inhabitants of Monte Verde, Chile had lived in the area approximately 12,500 years ago. (Hecht 1997) Dr. Dillehay tested his findings placing people in the Americas more than 1000 years before commonly thought by archeologists and anthropologists. He stated that it has taken him twenty years to convince colleagues that his conclusions were accurate. If the Clovis people were the first immigrants dated at about 11,200 years in North America, then this settlement should have been more recent dating approximately 10,000 years ago. (Hecht 1997) The findings regarding Monte Verde have caused modern scientists to rethink the Bering Straight Theory of migration, which would have originally taken migrants 1000 years to move south to Chile.

Earlier this year the oldest evidence found yet of human occupation in North America was found near Paisley Caves, Oregon. The fossilized human feces were carbon dated at 14,300 years, with DNA analysis linking them to Native Americans. The DNA analysis held genetic markers called A2 and B2 (Hecht 2008) which is found in Native Americans and not in people of European descent.

Dennis Jenkins a University of Oregon archeologist along with students offer first hard evidence that Native Americans were here longer than thought. The Monte Verde sight now re-dated from earlier reports when findings were brought forward show carbon dating approximations at 14,500 (Bolt 2008) and 14,600 years. (Hecht 2008) This recent re-dating of the Monte Verde site compared with the Paisley Caves site gives evidence of overlapping points of origination within the Americas.

With the above findings mentioned, the acceptance of Native American occupation dating before the Bering Straight Theory of emergence brings the thought of survivability of the Missoula Flood episodes more into perspective. The Native oral histories shared with us document that there was survivorship and witness to the great cataclysmic episodes which occurred 15,000 years ago. In the next section I will introduce oral histories which after careful inspection reflect that survivability did occur and traditional scientific knowledge was used to accomplish the task of survivability.

The Oral Histories

Ktunaxa Account

Our first oral history is based on the shape of a land form and comes from the area known to the Salish, Kalispel, Blackfeet, and Ktunaxa people. Today these people

currently reside in Montana and British Columbia. The passage given is from a translation of the Ktunaxa people, in regard to the "Old People" who gave location specific explanations (National Park Service 2007) of how land forms were made.

In the Ktunaxa story called "The Origin of Flathead River," a great beaver creates Flathead Lake by damming up the south end of the lake near what is present day Polson. (*Polson, Montana is a city located on the present day Flathead Indian Reservation at the entrance to Flathead Lake. This city is located North West of Missoula, Montana*.) The great beaver allows the water to overrun into the Camas Prairie (*Figure 2*) slightly above present day Elmo and Big Arm. (*Elmo and Big Arm have glacial moraines or sediments which look similar to a beaver dam.*) The story follows that after some extremely hard winters and a warming period (*which may be linked to another oral tradition about blue jay bringing the Chinook wind*) the mountain runoff (National Park Service 2007) overcomes the dam and breaks free, (*present day Kerr Dam is located near Polson, MT*.) and the great beaver gets tired and gives up.

The history that is preserved by the Ktunaxa people brings to light the situation as remembered and brought forward to the people generation after generation. The actual translation is not available but in comparison with my own language and other native languages many words do not translate into definable English. The possibility that the history was altered to reflect descriptives as presented may be due to changes in description to get the point across to the translator. Regardless, the history as presented does infact give validity to the Ktunaxa people and other people living nearby with similar history that this occurrence was witnessed in real time.

Nez Perce Account

In an abstract written by Shane Smith a student at Washington State University, in Pullman, Washington, it is stated that to present a geomorphology interpretive program he first had to look at the oral histories of the Nez Perce people which included the formation of the Columbia River, the Bridge of the Gods, and Hell's Canyon of the Snake River. (Smith 2005) The oral histories were then compared to the modern geomorphic hypotheses explaining the carving away of the Columbia and Snake Rivers, the incisions by flooding from the Missoula Flood episodes, the Lake Bonneville Flood, and the formation and collapse of the Bridge of the Gods.

The Nez Perce refer to the entity of Coyote who is involved in many of the oral histories described in the abstract. Coyote (Woodside 2008) is akin to a teacher, creator, or trickster depending on your belief systems. Smith states that using the connotation of Coyote is similar to a Christian using the reference of God being the one who caused formation and certain things to occur.

Unfortunately this account of the oral history is only a summary of the story, instead of a synopsis of the story itself:

Long ago there was a lake located in northeastern Washington and Coyote dug a river from the lake to the ocean so the salmon could migrate (Smith 2005) up the river to feed the people. While digging (*out*) the river Coyote dug a tunnel through the Cascade Range creating a bridge over the river known as Bridge of the Gods. The lake drained down the river, after it was dug. Years later an earthquake collapsed the Bridge of the Gods into the river.

This brief summary of the oral history of the Nez Perce describe the draining of the glacial lake (probably Lake Columbia) which formed near glacial Lake Missoula and spilled its contents concurrently. The earthquake which caused the Bridge of the Gods to tumble into the Columbia River is recorded in geologic time and created a subsequent landslide near present day Bonneville (*Bonneville Dam.*) The quake also helped shape the Cascades (a water formation) on the Columbia River. The incident of the tumbling of Bridge of the Gods is a more recent memory dated somewhere around 900 years ago. The summary of the oral tradition does give specific information regarding the emptying of glacial lake flooding through the Columbia River Gorge, and as stated describes the earthquake which occurred years later.

Cheyenne

The Cheyenne relate to an excerpt of a historical importance which pertains to the separation of the Northern and Southern Cheyenne by great flooding episodes. The Cheyenne are located today in present day Montana.

They talk about how they went south and after they acquired culture were able to go north again. The Cheyenne were told there would be a great flood in the south of them so they went north, after this flood subsided, they went south again and were again hit by a great flood which scattered them, and they never came together again. The history again explains how they tried to go north again but it was now barren, so they (Isaak 2002) returned south and lived the best they could. There is also reference to one hard winter with an earthquake, volcanic eruption, and another flood which destroyed all

of the trees forced the people to live in caves for an undetermined amount of time. Eventually the Great Medicine felt pity on them and no more floods came.

This story has a lot of information in regard to the splitting of the Northern and Southern Cheyenne, as well as four counted episodes of the flooding in historical remembrance. The Cheyenne accounts are one of the few accounts which talk about surviving several episodes of flooding. The Cheyenne people would have been living on the southern edge of the flooding, but if they went southwest into present day Idaho could have been caught in some of the flooding episodes, which would also explain why when returning everything was barren.

Shoshone Bannock

A Shoshone Bannock elder named Ed Edmo participated in a conference (OSU 1999) in 1999 called "Sacred Landscapes: Native American Perspectives on the Pacific Northwest." During this conference Ed Edmo presented an oral history about the Columbia River and reference to the Missoula Floods.

Ed talked about how the Columbia River is called Chihuana and that it is like a lullaby, and that Chihuana is like his mother. He said:

> *"A long time ago, there was no Chihuana where the Cascade Mountains are. There was a great big lake behind the mountains. Even the scientists prove that there was a lake behind there. They found inland sea fossils up at what they call South Dakota…The Colville People said, a long time ago, Coyote decided to make a river. He went to the Cascade Mountains, got a great big stick and used his power and dug on the top of the mountains. Water broke through – you know, water is powerful – we know by the floods. It broke through the Cascade Mountains, formed Chihuana. Oh Coyote was proud of himself: he made Chihuana…We have been there for 15,000 to 20,000 …for a long time on the Chihuana."*

Reading the story of Chihuana as related by Ed Edmo reinforces the idea that the Shoshone Bannock have been in existence since the formation of the river. The relation of Coyote as a creator also surfaces similarly to the accounts of the Nez Perce. The history Ed presented also related to Coyote ushering the salmon up the river so the people would always have nourishment.

Rafting Stories

A Series of Similar Stories Which Talk About Survival on a Canoe or Raft

The following excerpts are all related flood stories where people were rafted in canoes or raft type vessels trying to survive the flooding. All excerpts illustrate several different Nations who relate to the flooding in different ways. It is interesting to see some Christian influence in the histories as time has evolved during the telling of oral traditions. Descriptions of cedar ropes and types of vessels change from Nation to Nation, but similarities in description connect traditional scientific technological advances in thinking through remedies for survivability. One description of the vessel implies that a sail is being employed to help send the boat along. All excerpts are from a source by Mark Isaac's collected stories last updated in 2002.

Cascade Mountains

(Unknown Modern Tribal name)

"A flood overflowed the land, an old man and his family in a boat or raft was blown by the wind to a certain mountain. He stayed there and sent a crow to search for

land, but it returned without finding any. Later, it brought back a leaf from a certain grove, and the old man knew the water was abating."

Spokane, Nez Perce, and Cayuse

These tribes also have traditions of a flood in which one man and his wife survived on a raft; however each different Nation speaks of a different mountain where they may have landed. Other than this information there is nothing printed which can be added.

Yakima

The history states that one of the good men heard from the "*Land Above*" that big water was coming. The man told the other people who were considered good. This connotation might reflect there must have been some controversy in those days. The man and the other people decided to make a dugout canoe out of the largest cedar they could find. (Isaak 2002) "Soon after the canoe was finished, the flood came, filling the valleys and covering the mountains…we do not know how long the flood stayed. The canoe came down on the east side of Toppenish Ridge." The people say the outline of the canoe can still be seen today.

Warm Springs

"*Twice a great flood came. Afraid another might come, the people made a giant canoe from a big cedar. When they saw a third flood coming, they put the bravest young men and…young women in the canoe, with plenty of food. Then the flood, bigger and deeper than the earlier ones, swallowed the land…the people saw land (Mount Jefferson)*

and paddled to it. When the water receded, they made their home at the base of the mountain. The canoe was turned to stone and can be seen on Mount Jefferson today."

The different oral histories specify mountains, many which have been identified and some which have not. It is interesting in some of the stories how reference is made to the canoe being visible today on one side of the mountain or another. An additional observation about the combined rafting histories is that the areas where people have survived are in slackwater areas where the flood water backed up due to narrowing of the route to the sea.

One of the mountains not mentioned in the stories related here but known as a refuge point for survivors of the flooding is Rattlesnake Mountain and is located outside of Richland, Washington. Rattlesnake Mountain (Bjornstad 2008) is known as Laliik, which means "*Stands Above the Water*." Laliik is located nearby Toppenish Ridge which is mentioned earlier in the history of the Yakima Nation. Toppenish Ridge and Laliik are both high enough to rise above the slackwater during the inundation of flooding from Glacial Lake Missoula. Both mountains have been mentioned in different accounts as refuge to flood victims in those days.

In conclusion, oral histories shared by Native people located in the area of the flood regions when compared with actual geologic information give evidence of occupation and survivability of Native populations in flood regions. The technology of oiled ropes and canoe construction as known today is similar to ancestral construction, and give measurable interest to structural survivability of the vessels and ropes used in ancient times. The cataclysmic flooding which occurred during this time caused mass casualty of many people who were within the floodways of the racing water. Some who survived may have been separated by water movement because of the removal of mass

amounts of soil and landscape and survival was bleak. These survivors used caves as refuge until the flooded areas were able to be traveled once again, but found when returning home a barren landscape which kept them separated from loved ones. Those who were able to escape in vessels struggled as well and survivorship limited but not completely lost because of knowledge acquired by scientific research in rope, vessel, and sail construction.

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Chapter Three

Rope and Vessel Construction
Mathematical Assumptions

Thinking about traditional knowledge, thoughts reflect on the craftsmanship and technology of the ancient implements used to survive the flooding events. The ancestors of the Native people who lived in ancient times remain in their emergence places upon the earth. Traditional technology coupled with traditional knowledge has not changed much as the years have advanced even though much has been lost during colonization. Because of the carrying forward of ancestral remembrance the knowing handed down within indigenous communities allow scientific and artistic skills to be retained. There are many definitions of this type of knowledge because it encompasses many realms of thought and experience. Grasping even one element or fraction of this knowledge is a great undertaking (McGregor 2004) and requires many skills of listening, observing, organizing, implementing, and utilizing the knowledge in not only the seen but within the

unseen world as well.

When reflecting on the oral traditions in regard to rafting and use of ropes aiding survivability, as an artisan and holding life remembrance of my father's service in the Navy and the United States Coast Guard, I can think of how the ropes made of cedar were strong and did employ useful security to vessels and their cargo if but for a short time under a current moving at approximately 65 mile per hour.

Many times in my lifetime, my father talked about the hemp ropes they used during WWII and the tensile strength of the ropes natural fibers. As a native artisan learning years ago how to work with cedar from my distant cousins of the Pacific Northwest, and working with fibers within my own culture as well, I am able to understand the strength natural fibers contain and the ability to stretch and retract under pressure. When reflecting on the histories of survivability in the slackwater areas of the flooded regions caused by glacial Lake Missoula, I can picture the craftsmanship which was placed into the development of ropes and how they may have been tested for resistance to breakage by their makers.

The ropes are made of fiber prepared from the aromatic Western Red Cedar (Thuja plicata) located in the Pacific Northwest which is a type of arborvitae. Western Red Cedar is found from the Alaskan panhandle through British Columbia, western Washington, and western Oregon. It grows in elevations from sea level up to 4500 feet. It also occupies the wettest parts of the Rocky Mountain regions which includes southeastern British Columbia, northeastern Washington, Idaho, and northwestern Montana.(Arno and Hammerly 1977) These trees are usually found in moist climates with approximately thirty inches of precipitation per year. In higher elevations they tend

to prosper in valleys, wet bottomlands, and ravines. The trees are conical in shape and have massive root systems, when reaching maturity they can have large spreading canopies and drooping branches. The bark of the Western Red Cedar is loose and fibrous and between May and late June, bark can be gathered in long continuous strips. These strips are used for clothing, cordage, basketry, and as medicinals. The leaves of these trees are embrocated (they fold over themselves) and appear lacy and are aromatic. Seeds are compartmentalized in small brownish cones that are usually not disturbed by rodents because of their size and can yield approximately 4000,000 per pound. Seeds rain down on the earth at about a few million per acre.

The cedar is considered the "Tree of Life," and was used for everything from clothing, medicinals, housing planks, water vessels, and fibers for weaving and rope making. In early colonization of the west, roof shakes were made of cedar because they could last up to 100 years or more on a roof top. The Nez Perce introduced Lewis and Clark to the Western Red Cedar while they traveled through the Clearwater River area in Idaho, (Arno and Hammerly 1977) where they found the value of boat making from these trees, due to their natural abatement to rotting. Many times sections of living trees were removed for use by native gatherers without harming it and ceremony is always preformed before taking.

Cedar ropes are developed by gathering many limbs, removing the leaves and soaking them in water. The branches are then worked to pliability, where the fibers of the branches will break down. They are then twisted into rope, holding their shape, which is very strong, and will stretch under tension without breaking similarly to the tensile strength of a hemp rope used in the military. Rope makers also used the rope products to

tie cross pieces into canoes and tie the corners of planks in housing or for the corners of bentwood boxes. I can understand using oils to make the already rot resistant fibers more buoyant and resilient under pressure. Applying oil also allows the fibers to be more flexible as well. I have assisted in making the ropes, and marveled at the maker for his expertise in merging or grafting fibers for lengthening. These hand made cedar ropes which are used for whaling or vessels can hold a circumference of any size, the last one I saw was at approximately 7 to 9 inches.

I have also had the honor of being near the making of canoes from single cedar logs and have seen how they are constructed. While living near my distant relations in Washington State for many years we were immersed in our relations culture. We were honored with the ability to observe carvers create a new canoe many times. Some of the cedar logs used for canoe making had to be floated across the sound from Canada and most came from a village near Victoria, British Columbia. The trees at maturity and girth large enough for a canoe are usually aged at approximately 600 years or more. These canoes can take from months to years to carve, encompassing twelve to sixteen hours a day into the work. Much care is given to the tree emerging into a vessel and is usually not left alone at night, or is held in the canopy of a carving shed for safety. Carvers sometimes sleep inside the hull absorbing the spirit and giving spirit into the vessel. Finished canoes will be tested by floating them to check for correct ballast and balance in the water, allowing carvers to make adjustments.

After adjustments are made on the canoe, (Helin 1995) the steaming process begins and rocks are heated in fire pits then placed into the water filled canoe. This process allows the carvers to fit the sides of the canoe into shape, widening the sides

sometimes by about ten inches or so. The final stages are honing the bow and stern, placing seats, painting and paddle making. When these stages have finally been completed the canoe can be ceremonially blessed and given prayers for many safe journeys.

I thought about a mathematical equation that could be formulated to test this strength in modern times with a recombination of traditional knowledge and westernized scientific thought. I visited with Dr. Derron Rafiq Coles, a Civil Engineer at Oregon State University whose focus during study was based on hydraulics. I posed the question to him about the histories and how we could create an equation to test this hypothesis. I gave Dr. Coles some dimensions surrounding a canoe within the Pacific Northwest societies which I had seen carved.

Canoe Dimensions:	
LOA (Length Overall)	32'
LWL (Length Water Line)	29'
Beam	4.16’
Hull Depth	2’
Weight	261 lbs

Figure 3.1

Doctor Coles and I talked about the coefficient of drag which surrounds the various two dimensional bodies in a stream of water, which can be calculated if the total drag is measured. The hull shape of the canoe can be compared to a Reynolds number which then gives a measurement that can be used to compute total drag on an object.

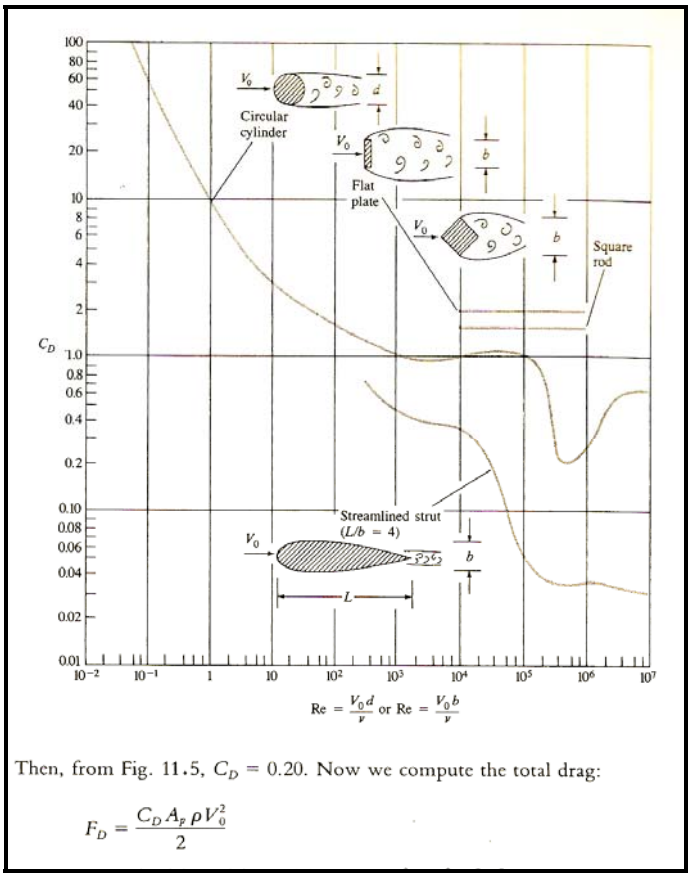

Figure 3.2
Source Klingeman
Coefficient of drag versus Reynolds number for two dimensional bodies

$$F_D = C_D A_p \rho \frac{V_o^{\,2}}{2}$$

Dr. Coles stated that many fluid dynamics, hydraulic engineering, and sediment transport texts have outlined theory and research on the topic of dynamic fluid flow. A brief summary of this topic found in such texts and instruction where (Henderson 1966, Roberson and Crowe 1990, Yang 1996, Coles 2008) a canoe floating in a river has buoyant and weight forces acting along its hull. The weight is due to the mass of the canoe, while the buoyant force is due to the volume of water displaced by the presence of the canoe in the water. These forces are important to consider for purposes of

determining if the canoe will remain afloat; however, the impact of flowing water creates additional forces that determine the probability of movement of the canoe down river. The dynamic action of the water causes pressure and viscous stresses that manifest through so-called lift and drag forces. The drag forces acting on a submerged body due to the flow of water can be calculated using the drag force equation (*Equation 1*)

$$F_D = C_D A_p \rho \frac{V_o^{\,2}}{2}$$

Equation 1

Dr. Coles then stated where F_D is the drag force, A_p is the projected area of the canoe perpendicular to the flow of water, ρ is the density of water, and V_o is the velocity of the flow. The drag coefficient, C_D, reflects the pressure distribution along the submerged body and can be calculated if the pressure and shear stress distributions are known. The drag coefficient can also be calculated if the total drag is known. Experiments in wind tunnels have resulted in data that allows one to determine the drag coefficient as a function of Reynolds number. He said the Reynolds number (*Equation 2*) is the ratio of inertial (motion) forces to viscosity (resistance to flow),

$$R_e = \frac{\text{inertial forces}}{\text{Viscous forces}} = \frac{V_o d}{\nu}$$

Equation 2

where R_e is Reynolds number, d is the width used to calculate A_p, and ν is the kinematic viscosity of water. Once the Reynolds number and drag coefficient are known, the drag force due to the impact of flowing water on the canoe can be determined.

Key of Terms for Drag Coefficient Equation		
FD		Drag Force
CD		Drag Coefficient
A		Area
ρ		Density of Water
VO²		Average Velocity

Figure 3.3

The equation was figured by setting approximate numbers:

Description of parameter	symbol	value
Kinematic viscosity of water at 20°C	ν	0.000010906
Density of water at 20°C	ρ	1.936
Velocity of the flow of water	V	95.3
Width of cross-sectional area	d	4.16
Cross-sectional area of the portion of the canoe that is perpendicular to the flow	A	6.16

Drag Force = 6351366.2

Drag Coefficient = 0.043542408
Drag Force = 2358.06

Figure 3.4

In our example using the dimensions of a canoe carved in recent times, the cross-sectional area of the portion of the canoe perpendicular to the flow of the water approximates at 6.16. This figure is approximated by calculating the area of the hull width and depth.

The maximum tensile strength on the cedar rope has to be higher than the total Drag Force of the water or the rope will fail. Tensile strength is the average strength of new rope placed under tension in laboratory conditions until it breaks. Working load for new rope is approximately 15% or 25% of the tensile strength. A knot placed somewhere in the rope would bring the working load closer to 50% of the (Rope Inc. 2008) tensile strength. The factor used to figure tensile strength on a rope is the percentage of actual working load the rope will provide. An equation to figure the ropes actual work load is computed by multiplying the circumference by itself, and the approximate strength of a new rope made of natural fibers is approximately 8000 times its square of its diameter in inches. As a result after multiplying the perimeter by itself, then divide by 50 due to loss of initial strength caused by a knot, so theoretically the rope equation will appear similar to this equation:

$$7 * 7 * 8000 / 50 = \text{approximately } 7840 \text{ pounds force.}$$

If the Total Drag Coefficient is 2358.06 in pounds force, the number of approximated tensile rope strength is higher than that of the total Drag Coefficient which means the ropes would have held against a current moving at a velocity of 95.3 feet per second squared.

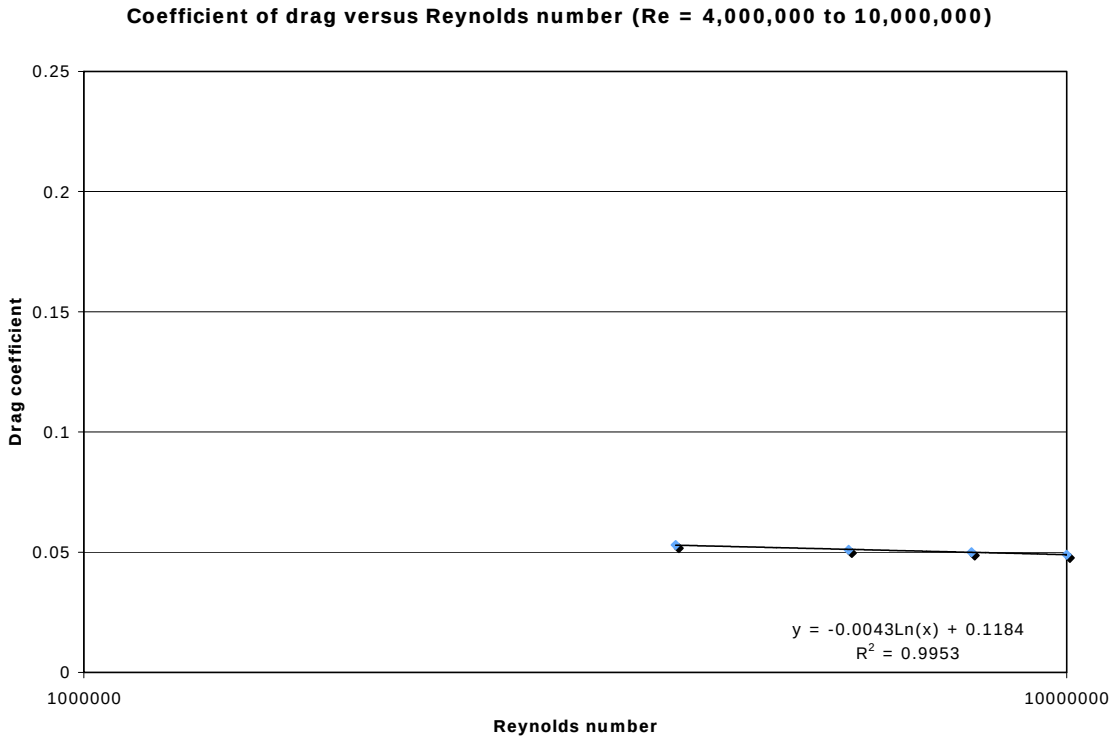

Figure 3.5

The Reynolds Number used for Figure 3.5 is figured at 10,000,000; this indicates that when the total force was in excess of the Reynolds Number figures, the drag leveled off even more than shown.

The figure and data above give credibility to the actual strength of ropes made in conjunction with modern tensile strength data for natural fiber rope. Similar ropes made of cedar were used for whaling and hauling the bulk of a whale against sea currents to land. The slack water areas flooded by glacial Lake Missoula were figured at the full channel figures for the flood water velocity at 65 miles per hour or 95.3 feet per second. Slackwater areas while filling with water would measure remarkably slower than 65 miles per hour. The figures conclude that the rope tensile strength against a total drag coefficient would withstand these currents.

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Results

The calculations performed in Chapter Three point to the fact that survivability was possible for the ancient peoples who were affected by the cataclysmic flooding of Glacial Lake Missoula. The oral histories tell the story of survivability while using canoes and oiled ropes. The slack water areas or backwash areas formed by the narrowing of the waters passage filled basins and valleys creating temporary lakes where survivor's boarded canoes held by cedar ropes and paddled toward higher peaks for survival until the water subsided. The velocity of the mainstream of water from Glacial Lake Missoula when released is approximated at 65 miles per hour by other scientists. The equations

show that the rope tensile strength in pound force along with total drag force for the canoes is greater than the total drag force of the moving water. This illustrates that the ropes would have held even under the maximum velocity in main stream. One can argue that the velocity of the water while filling the slack water areas was much reduced, therefore allowing less pound force on the cedar ropes and less drag on the canoes.

Through examining these equations with the great possibility that the canoes and ropes held reveals the survivability of the people during this time. The oral histories also contribute to the validity of survivability carrying forward their history making comparisons with geologic time of events more realistic in dating the existence of Native people's emergence into these regions.

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