

**CASCADIA EARTHQUAKE AND TSUNAMI EVENTS AS
REFLECTED IN ABORIGINAL ORAL TRADITION**

Presented to
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by

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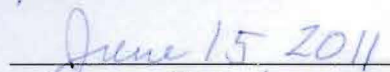
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For Harland Malyon who taught me about Classic Greece, mythology, and Washington State history. For Mike Allen who taught me about American and Pacific Northwest history, folklore, and rodeos. For Bob McCarl who taught me about folklore and tale types. For everyone who taught me about geology, earthquakes, volcanoes, and landslides, and for answering my many questions. For Brian Atwater, Curt Peterson, and Lee Walkling, a huge "thank you". For Martha Henderson who gave me a long leash. And for Marian Harlow and Hal Simonson, thank you for the encouragement - once upon a time. This project would not be without every one of you.



“The mythologies of Indian peoples of the Northwest Coast are the source of a lasting contribution to the imaginative life of all for whom its landscape and history come to have meaning.”
Dell Hymes, 1990



"Nor should we omit to mention the havoc committed on low coasts, during earthquakes, by waves of the sea which roll in upon the land, bearing everything before them, for many miles into the interior throwing down upon the surface great heaps of sand and rock, by which the remains of drowned animals may be overwhelmed."
Charles Lyell, 1832

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CHAPTER 1:

INTRODUCTION

The Northwest Coast of North America, also known as Cascadia, encompasses mainland British Columbia, Vancouver Island, Washington State, Oregon, and northern California. Cascadia is known for temperate rain forests, historic timber production, and both coastal mountains and Cascade volcanoes. Cascadia is also the location of the Cascadia Subduction Zone, a continental and oceanic plate boundary capable of great earthquake and tsunami (Figure 1).

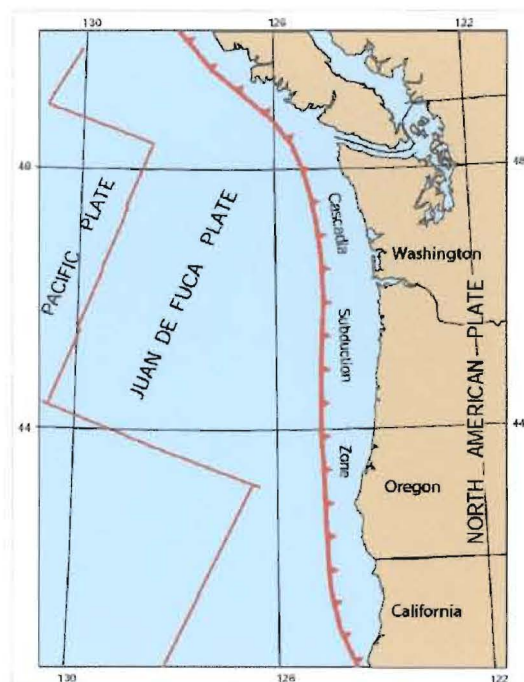


Figure 1: The Cascadia Subduction Zone along the northwest coast of North America (USGS).

Following the 1980 eruption one Cascade volcano, Mt. St. Helens, many academics and scientists began to consider potential linkages between historic eruption events, and local aboriginal cultural oral story motifs regarding Mt. St. Helens, and other adjacent Cascade

volcanic peaks. Traditional oral story motifs of Mt. Hood (Wyeast) and Mt. Adams (Phato) battling over Mt. St. Helens (Loowit) with Mt. Adams losing a portion of his head in the process, are common oral story motifs across the Pacific Northwest. Additional traditional oral story motifs reference Cascade volcanic peaks fuming with anger, burning with jealousy, or even ripping off portions of their own "heads" to hurl at an opponent. Traditional story motifs of these types appeared to mirror both the very public 1980 Mt. St. Helens eruption, and the subsequent geologic eruptive histories discovered at Mt. St. Helens and other Cascade volcanoes after 1980. Could these oral traditions reflect some eyewitness account(s) at the core regarding past eruptive events?

It appears that this is likely the case in many aboriginal oral story motifs from the Cascade Range when the eruption event histories are considered (Figure 2). Since the

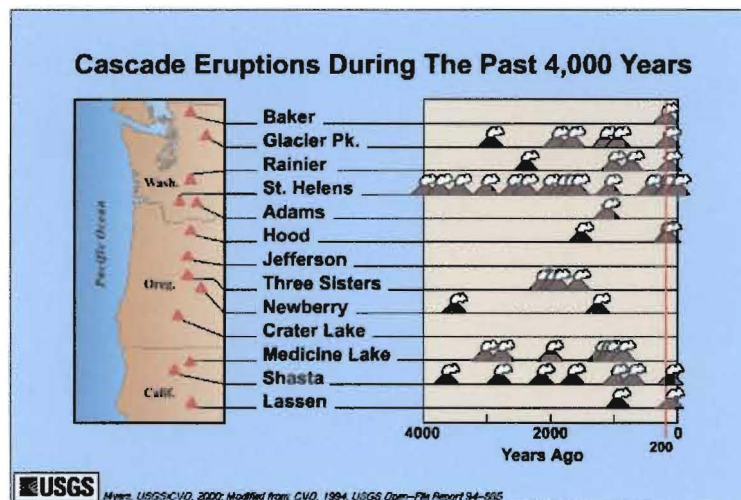


Figure 2: A graphic showing Cascade volcano eruptive histories for the last 4,000 years. Mt. St. Helens, shown as the most active, a likely source of the many oral story motifs among aboriginal groups from the Region (USGS, 2000).

1980's, scientific investigation has increased understanding of the geologic history of Cascadia, and more importantly, increased the understanding of geologic hazards of coastal zone. Considerable evidence of historic Megathrust (magnitude 9.0+) earthquakes

exist along the Pacific Coast in the form of 1) tsunami deposited sand layer(s) over forest soil(s), in coastal lake beds, and in coastal wetlands in numerous locations; 2) standing dead coastal old-growth forest remnants, known as "ghost forests"; 3) land form alteration in the form of landslides, co-seismic ground deformation and/or subsidence; and 4) a continuous geologic record of earthquake and related tsunami event(s) extending back some 7,000 to 10,000 years preserved in coastal marshes and sub-marine canyons in the near shore zone.

Found in select locations along the entire length of the Pacific Coast of Cascadia are cultural archaeological sites that are situated above and below numerous tsunami deposited sand layers. These select archaeological sites suggest an aboriginal habitation history for Cascadia in conjunction with tsunami event history. Traditional oral story motifs of ground movement, ocean wave event(s), and/or landslides are frequently combined with conflict motifs between mythical beings, human beings, or even as punishment to the wicked or immoral. In many cases, very similar story motifs of ground movement or tsunami events, combined frequently with physical land form creation or modification motifs, are found to exist from across Cascadia. A few similar oral traditional story motifs exist from distant ends of Cascadia that appear to mirror each other, suggesting a possible shared event or cultural memory. Some of these traditional oral story motifs even exist among aboriginal groups from east of the Cascade Mountains.

Folklorists are divided on the reliance of aboriginal oral motifs as a historical source for

understanding the past. Not all disciplinary experts agree on the usefulness of linking oral motifs to natural events. Some folklorists and academics see no connection between what they consider mythology of aboriginal groups and reality, or reliability, in and upon these "stories". Other folklorists and academics acknowledge the potential of these motifs as a source for understanding some past event or series of events, yet cannot overcome the lack of a tangible source, such as a book or tape recording of a personal interview from the past, having been hidden in some dusty archive. However, some academics detract from this view by stating "(o)ral traditions, however, cannot simply be read as historical records" (McMillan and Hutchinson 2002:44).

Other folklorists and academics are not so fast to dismiss aboriginal motifs as true folklore. Vansina attempts to make a distinction between "oral history" and "oral traditions" (Vansina 1985:8). Oral history, according to Vansina, is that immediate history, that memory collected from an event participant, bystander, or eyewitness. On the other hand, oral traditions are "passed from mouth to mouth, for a period beyond the lifetime of the informants" (Vansina 1985:12-13). Vansina sums it up by stating "(w)hen there is no writing or almost none, oral traditions must bear the brunt of historical reconstruction" (Vansina 1985:199). This "reconstruction" of history in aboriginal oral story motifs of potential earthquake and tsunami event(s) from Cascadia is aided by the supporting scientific literature identified in this project.

In summary, what true folklore is and is not, the words of folklorist Rodney Frey are relevant to this study as well,

“the authorship of oral literature and of oral history is often anonymous, seldom easily identifiable with a single person.....and imbedded within an oral literature are also the revered teachings and sacred truths of people....in contrast, oral history is, above all, history, linked in varying degrees to historical events, personalities, and geographic locations, and thus to idiosyncratic, unique events in time and space....it should be stressed that the term myth, as applied to Indian mythology, refers to that which is considered a ‘deeply true story’. Myth is not to be understood here as fable, fiction, or illusion.....tales are not, however, oral histories....like myths, tales are invariably linked with the surrounding landscape, referring to this river or that mountain valley. The land is richly endowed with mythic meanings and references. It is a landscape spiritually endowed”. (Frey 1995:10-14)

Northwest Coast aboriginal peoples, like the ancient Greeks, were polytheistic and used many different gods to explain natural events, natural features, and the power of the natural world. The role of mythology to the Greeks, as a focal point for an oral based religious tradition and as a cultural expression, is comparable to the myth traditions of the Pacific Northwest Coast. Like the Greek gods, the supernatural beings of aboriginal groups of the Northwest Coast of North America held human personality traits such as humor, anger, empathy, or love, yet they also held powers to rule over and change both the heavens and earth. The aboriginal oral traditions meet Frey's definition of true folklore as they have no common authorship, are purely oral in nature (at least until recorded by non-natives), reference specific geographic areas or locations, and have a foundation in some historical event or cultural memory.

This paper is an interdisciplinary investigation of theoretical linkages, if any, between aboriginal oral traditions and natural geologic events of Cascadia, with a combination of information sources from academic fields such as ethnography, cultural anthropology, archaeology, seismology, geology, dendrology, and history. Published historical

ethnographic and folklore based aboriginal oral interviews from the late nineteenth and early twentieth century's, are examined in conjunction for contemporary geologic based peer-reviewed field investigation reports from the late twentieth and early twenty-first century's. Chapter 2 discusses the theoretical context and methodology used in this investigation, as well as outline the history of non-aboriginal researchers that assisted in preservation of the oral story motifs utilized here in. Chapter 3 discusses previous geologic research of Cascadia, and comparisons between both different scientists and different locations along the coastal zone. Chapter 4 discusses historic aboriginal oral traditions from Cascadia and look for story motif comparisons between aboriginal groups. Chapter 5 discusses the known earthquake and tsunami history of Cascadia and contrast northern, central, and southern Cascadia earthquake and tsunami histories. Chapter 6 discusses linkages and analysis between aboriginal oral traditions identified in this project, and current scientific understand of both geologic events and coastal processes of Cascadia. Chapter 7 concludes and summarize the research topic and findings of this investigation.

CHAPTER 2:

THEORETICAL CONTEXT AND METHODOLOGY

Do aboriginal oral story motifs from the Pacific coast of Cascadia reflect actual earthquake and tsunami events? This is the core question of the research objective, to investigate linkages between aboriginal oral story motifs of the aboriginal groups of Cascadia (Figure 3) and geologic evidence from the coastline of Cascadia. Similar to other research investigations that compare eruptive histories of the Cascade volcanoes with connections to aboriginal oral story motifs that describe eruption events, the methodology for this project is to compare historic oral interview transcripts, conducted



Figure 3: Aboriginal groups of the northwest coast of North America shown by historic occupation zones prior to European contact. The Cascadia Subduction Zone covers roughly the southern half of this area and it is those aboriginal groups which are the focus for the oral story motifs utilized in this paper (Encyclopædia Britannica).

with aboriginal tribal group members, against current geologic understanding of Cascadia. This comparison will look for patterns, regional connection, and common story motifs in aboriginal oral tradition, and then make comparisons with known geologic event history from across Cascadia. This paper at the core is an investigation of the relationships between traditional cultural knowledge and western science.

To begin this research, a library investigation was conducted in the Pacific Northwest Room at the Tacoma Public Library, the Special Collections, Allen, Suzzallo, and Odegaard Libraries at the University of Washington, the Geology Library at the Washington Geologic Survey, in the Special Collections, Holland, and Terrell Libraries at Washington State University, and the publication archives of the United States Geologic Survey found at www.usgs.gov.

Literature identified in this project center in two distinct camps: 1) literature regarding aboriginal traditional oral motifs which date from the late nineteenth and early twentieth century, and 2) published peer-reviewed scientific literature, and state and Federal government scientific agency publications. It must be stated here as a qualifier that in European based folklore and literature, there exists an underlying tone or spirit of sarcasm and half-truths, or "tall tales" in the spirit of Paul Bunyan, that must be viewed as satire. By contrast, aboriginal cultural stories are believed to contain some grains of truth at the core of the story, and are therefore not automatically considered tall tales within the ethnographic field. (folklore vs. fakelore) This paper will query linkages between

historic Northwest Coast ethnographic accounts of possible natural catastrophic events, and best available geologic and archaeological peer-reviewed science.

The aboriginal cultural stories and traditions identified in this investigation have been almost exclusively preserved by non-native persons. Usually possessing some deep personal interest in aboriginal traditions of the Northwest Coast, this select group of academics, government employees, and educators were employed in some way as to be in contact with aboriginal groups. The most widely known was Dr. Ella Clark, English Department, Washington State University and author of several "Indian Legend" series books on Western North America. Clark began her "studies" during World War II while serving as a Fire Lookout with the U.S. Forest Service and was told many legends by "locals" (Washington State University Library). Franz Boas, is often called the Great White Father of American anthropology from Columbia University, and developed of the first Anthropology Doctorate curriculum in the United States (Columbia University Library). Rev. Myron Eells, founder of Whitman College and early missionary at Skokomish Indian Reservation, recorded many cultural traditions from the Twana, S'Klallam, and other aboriginal groups of Hood Canal and Puget Sound (www.historylink.org). These non-material aboriginal tales were considered "tangibles" or "collectables" among non-native Americans of the period and were collected along with other material items such as basketry, textiles, or other types of artifacts.

Other notable contributors to the cultural oral story motif preservation include Judge James Gilchrist Swan, Makah Tribe Indian Agent and Smithsonian correspondent

(www.historylink.org), and Katherine Berry Judson, History Department at the University of Washington in the early Twentieth Century (University of Washington Library). Additionally, Clarence Bagley, who was 17 years old when he arrived in Seattle in 1860, assisted in the building of the Territorial University, later renamed the University of Washington (www.historylink.org). Bagley was a noted lecturer in the early period of the University of Washington during the late nineteenth century and was the founder of the Washington State Historical Society (www.historylink.org). Another notable contributor was Albert B. Reagan, Hoh and Quileute Indian Agent in the early 1900's, later trained as a geologist, then went on to earn an ethnographic related PhD from Stanford (American Folklore Society).

Additional notable contributors to cultural oral story motif recording and/or preservation efforts include Erna Gunther, an anthropologist from the University of Washington and a former student of Franz Boas. (University of Washington Library) Wayne Suttles, another anthropologist from the University of Washington and a former student of Erna Gunther, herself a former University of Washington Anthropologist, and Columbia University Graduate who had been a student of Franz Boas. (University of Washington Library)

Dr. Dell Hymes, linguist, folklorist, and anthropologist was a classmate of Kenneth Burke. Hymes was a faculty member at Harvard, University of California, Berkley, and the University of Virginia. (University of Virginia Library) Dr. Stith Thompson, was a folklorist and Harvard graduate, later he became a faculty member at Indiana University.

(Indiana University Library) Thompson is widely credited for his Motif-Index of Folk-literature matrix, which is a valuable tool to break down abstract story motifs (tale types) into a comprehensible and useable format. Hymes and Thompson are considered the co-godfathers of American folklore studies by many academics, linguists, folklorists, and ethnographers. Ethnographic research is a qualitative research method for analyzing or describing a specific population group for common patterns of cultural beliefs, traditions, and speech, or for making comparisons or contrasts between population groups. Many of the researchers mentioned above used some style of ethnographic research methodology, combined with other disciplines in their various projects. Perception of the quasi-spiritual world, that world between reality and the spirit realm, is what the early ethnographers and other academics inadvertently recorded in the oral interviews conducted. Due to the fact that Cascadia extends to cover both the United States, with Native Americans, and Canada, with First Nations, the term "aboriginal" is thus used here instead to mean both groups. It is possible to use both Native American and First Nation traditional oral story motifs from the Northwest Coast of North America, as there is much cultural similarity of coastal aboriginal groups of this region.

In contrast, geologic research also has been conducted across Cascadia by academics and professional scientists employed by state and Federal government agencies. These persons, by the scope of their individual efforts and publications, have opened a window in time on the earthquake and tsunami history buried in the coastal areas of Cascadia. Some of these individuals from the have considered aboriginal oral traditions in their geologic theories, but they are the exception. The next chapter will provide a more

thorough discussion of the geologic research conducted along the Cascadia Subduction Zone margin.

CHAPTER 3:

PREVIOUS RESEARCH AND COMPARISONS

Similar to the small number of individuals who preserved the aboriginal oral traditions of Cascadia, an equally small number of individual academics and professional geologists have worked to solve the geologic puzzle of Cascadia as well. From these geologic investigations, new understanding of the geologic history of Cascadia has emerged, frequently through professional peer-reviewed science. Notable contributions have been made by individuals such as Atwater, USGS, Peterson, Portland State University, and organizations such as the Washington Department of Natural Resources - Geology Division (DNR-Geology), the Oregon Division of Geology and Mineral Industries (DOGAMI), and the United States Geological Survey (USGS).

A majority of the literature identified in this investigation has combined interdisciplinary geologic field investigation with possible oral natural event motifs. Much of the geologic and scientific literature identified in this project centered around the published works of a diverse group of professional scientists and academics from across Pacific Northwest, and Western Canada. Both Atwater and Ludwin have focused on story motifs from the Washington Coast and Vancouver Island regions. Peterson has focused on the Oregon Coast, Columbia River, and South Washington Coast Regions. McMillan and Hutchinson have focused on Vancouver Island, Coastal British Columbia, and the Olympic Peninsula of Washington State. Goldfinger, et al, have focused on Northern California and Southern Oregon. Ludwin has also focused on locating and interpreting cultural stories from the

Washington Coast and Puget Sound Basin, which have some connection to possible geologic event(s) in the Region. A host of other science and academic professionals were also identified that had utilized aboriginal oral traditions and natural events. This investigation, and subsequent peer reviewed publication process, has led to vast improvement in current geologic understanding of earthquake and tsunami events potential of Cascadia. This earthquake and tsunami history for Cascadia has been pieced together using physical evidence identified from field investigations of coastal estuary mud flats, marshes, and soils, as well as standing dead "ghost forests" (Figure 4) located across the coastal portions of the Cascadia.



Figure 4: Standing dead "Ghost Forest" trees at Copalis River, WA, died as a result of the 1700 Cascadia Megathrust earthquake when coseismic subsidence dropped the forest floor several meters and the trees were "drowned" by post earthquake tidal marsh conditions (Brian Atwater, USGS).

Additional advancements in underwater sonar and increased sea floor study and mapping efforts over the past three decades has shown a complex sea floor volcanic vent system, sea floor spreading and subduction regiment, turbiditie deposits showing shaking origin, and major sea floor fault extending 1,000 km south to north parallel along the Pacific coasts of northern California, Oregon, Washington, and Vancouver Island, with an

earthquake potential in excess of M 9.0. The work by Atwater and Yamaguchi on tree ring from "ghost forests" at both Willipa Bay and Copalis River, Washington shows

“widespread sudden subsidence at the Cascadia subduction zone shows that a single rupture, or a brief series of ruptures, extended along hundreds of kilometers of the Pacific coast about A.D. 1700. Such extensive rupture (earthquake) best explains the timing of tree death in forests killed by tidal submergence soon after sudden subsidence” (Atwater et al 1995:8).

A professional paper produced by the U.S. Geologic Survey on the Willipa Bay area lists “seven (earthquake) events” over “the past 3,500 years” (Atwater and Hemphill-Haley 1997:2). These seven earthquake events are very likely the source of oral traditions of ground movement and landslide motifs on the Northwest Pacific Coast. The word Hoquiam is said to mean “hungry woods”, named for the many dead trees in the area around Grays Harbor, Willipa Bay, and the Copalis and Columbia Rivers, Washington”



Figure 5: State Route (Highway) 109 @ Copalis River Bridge along the Washington coast showing massive damage from a tsunami event resulting from the 1964 Alaska Earthquake. Tsunami debris are lodged in and against the bridge footings from a 10-12 foot tsunami wave surge. (Tim Walsh, WA-DNR)

(Castile ed, 1985:281). The Copalis River Bridge was impacted and damaged by the 1964

Alaska earthquake tsunami event, showing the continual risk from geologic processes along the coastal margin of Cascadia (Figure 5). It is this Copalis River "ghost forest" location which yields tree ring evidence and C¹⁴ test results which point to the 1699/1700 growing season as the last "Megathrust" earthquake and associated tsunami event which impacted the Northwest Coast (Yamaguchi 1997:922). Trees that were alive in the fall of 1699, were shown to be dead by spring 1700 (Yamaguchi 1997:922). The Copalis River site has evidence of sudden land elevation changes, tsunami event(s) with sand layer deposit(s), and evidence of de-facto human impact from these events in the form of submergence of an aboriginal fishing camp (Figure 6).



Figure 6: Tsunami sand deposit (tan layer) located directly above aboriginal "shell midden" fire pit deposit (black layer) at a seasonal fishing camp site at Copalis River, WA showing potential direct impact to aboriginal groups from tsunami events. Repeated tsunami (and earthquake) events such as this over millennia are likely the source of many aboriginal oral story motifs from Cascadia (Brian Atwater, USGS).

Peterson has completed studies for the central portion of the Cascadia Subduction Zone, demonstrating earthquake, land deformation, and tsunami event evidence history for the Oregon and South Washington Coast. Peterson has also utilized ground penetrating radar

technology in his tsunami deposit field studies of Central Cascadia with good results. Specific sources were identified not only by subject and relevance, but also by publication date in an effort to identify current, best available science.

Losey (University of Alberta) has focused on earthquake and tsunami event impact(s) to aboriginal groups and environmental disturbances along the Oregon Coast. Losey has published two peer reviewed journal articles (2005 and 2008) that give specific treatment to earthquakes, tsunamis, and aboriginal peoples of the Oregon coast. Losey also co-authored a paper (2005) with Ludwin et al that examined the 1700 Cascadia Megathrust earthquake event in aboriginal oral tradition.

McMillan (Douglas College, British Columbia) and Hutchinson (Simon Fraser University) have focused on aboriginal groups and post-event village abandonment, with additional studies on aboriginal cultural memory of earthquake, tsunami, and landslide event(s). McMillan and Hutchinson published two papers (1997 and 2002) which addressed both village abandonment and earthquakes, and aboriginal traditions and earthquakes, from the northern portions of Cascadia. McMillan also co-authored the paper (2005) with Ludwin, Losey et al that examined the 1700 Cascadia Megathrust earthquake in aboriginal oral tradition.

Parke D. Snavely, Jr., United States Geologic Survey, was an early geology pioneer who published a 1985 paper covering tsunami event history and aboriginal traditions from the Oregon Coast. Snavely worked for the USGS for nearly 60 years! Snavely and co-author

Thomas Heaton published this paper, titled Possible Tsunami Along The Northwestern Coast of the United States Inferred From Indian Traditions, that relied largely upon the historic Native American legend publications (1857, 1868, and 1874) of James Swan. Snively showed early interdisciplinary thinking in his consideration of Cascadia aboriginal oral traditions in conjunction with geologic studies of the region. This information seems to have been considered and expanded upon by subsequent researchers following the geologic trail blazed by Snively. This trail of information contained in the aboriginal oral story motifs from Cascadia has led the academics and professional geologists to new territory in their consideration of earthquake and tsunami events history of the region.

CHAPTER 4:

CULTURAL ORAL TRADITIONS OF CASCADIA

From Northern California to Vancouver Island, the literature identified in this investigation contains numerous Native American cultural references or stories which appear to revolve around some type of geologic event(s), and/or mirrored stories between separate Native groups at either end of the region, or mix one or more motifs into one story or tradition. Other cultural story motifs found across the region also may reference historic earthquake and tsunami (and perhaps landslide) event(s), but are combined with morality, relationships, and conflict motifs and are somewhat more cryptic in their specific details, reference, or meaning. Many of these motifs also encompass Coastal, Strait of Juan de Fuca, Puget Sound, and Cascade Mountains or Peaks into oral story motifs which cover a greater geographic area, some with much landscape alteration.

Aboriginal oral story motifs appear to encompass three portions of event perception, what actually occurred, what is remembered in retelling, and what is handed down from word of mouth. Landform origin, geologic event, and landform disturbance or modification motifs identified during the literature review in this project center upon several forms, that include but are not limited to:

- conflict between husbands and wives
- conflict between lovers or love triangles
- conflict over a human object of desire
- natural geologic events and human beings

- metamorphosis of human beings into natural geologic features in the physical realm
- the role of a supreme transformer figure in human being to terra firma metamorphosis
- lesser other conflict and “trickster” motifs
- multiple motif variants within these above contexts

On the Northwest Coast, the most mighty of the mythic beings was the Thunder-bird, from which thunder was created by the flapping of its wings and lightning created from the gleam of its eye. Thunderbird was revered above all other creatures, mythical and real, by the aboriginal groups of the region. Whale, sometimes identified as "Killer"



Figure 7: Thunderbird and Whale, as depicted in this historic photograph on a traditional Northwest coast longhouse exterior (Asahel Curtis).

whale, with some versions containing multiple whales, was often the foe of the Thunderbird and the two entities often clashed violently (Figure 7). In yet other versions,

Thunderbird is the nemesis fighting an assortment of entities. One story states that Thunderbird fought two whales and....

"there was a great storm and hail and flashes of lightning in the darkened, blackened sky and a great and crashing thunder-noise everywhere.....there was also a great shaking, jumping up and trembling of the earth, and the rolling up of the great waters".
(Regan 1934:36-37)

Other stories from the Region along this same motif tell of "numerous sea monsters and mammals" stranded on dry land, or when the "prairie became ocean". (Krober 1976:460)

The Pacific Coast of Washington, the Olympic Mountains, and the greater Olympic Peninsula, are areas where the literature identified many motifs that may reference landform disturbance and/or geologic event(s). Part of this area is now contained in the coastal strip and interior portions of Olympic National Park. One such tradition identified in the literature, the creation of Lake Crescent in Olympic National Park, pertains to the wrath of the land against those who live upon it. Taken from Ella Clark's, Indian Legends of the Pacific Northwest, a Clallam myth tells of a two day battle at the foot of Mt. Storm King between warriors of the Clallam and Quillayute tribes.

"After watching the bloodshed for two long days, Mount Storm King became angry. On the third day he broke off a great piece of rock from his head and hurled it down into the valley. The rock was so huge that it killed all the men fighting in the valley below him, all the Klallam warriors and all the Quillayute.

Through the valley flowed a small river. The rock hurled by Mount Storm King dammed this stream, and soon at the foot of the mountain where the fighting had been the fiercest a peaceful little lake sparkled in the sunshine. For many generations no Indian ever went to the place where the warriors had been punished by death" (Clark 1953:66).

Lake Crescent does in fact owe its very existence to catastrophic geologic process. In the words of Babcock and Carson,

"(A) huge landslide...roared down Storm King Mountain in prehistoric time damming the drainage and creat(ed) Lake Crescent. Quite possibly the landslide was triggered by one of the magnitude 8+ earthquakes in Western Washington during the last few thousand years" (Babcock and Carson 2000:40).

A second myth from the Olympic Peninsula, pertaining to the Quinault River Valley on the western exposure of Olympic National Park, also follows the landform disturbance and/or geologic event(s) motif. Again taken from Clark, it is said that tribes came from all areas to meet each year in the meadows of the upper Quinault Valley, known as the "Valley of Peace" (Clark 1953:46).

"These friendly gatherings were held for many years in the Valley of Peace. But Seatco, chief of all the evil spirits....became angry, without reason, at all the nations that gathered in the Valley of Peace. One year when they were there for trading and for contests of peace, Seatco came among them. He caused a great trembling and rumbling of the mountains. Then he caused the earth and water to swallow the people.

Not many Indians escaped. A few rushed away in time to save themselves from the anger of Seatco. They returned to their villages to warn their people away from the valley. The Indians never went there again" (Clark 1953:46).

In addition to the Quinault tradition, the literature consulted also demonstrates a similar story motif regarding the Valley of Peace in Chehalis and Cowlitz cultures (Parratt 1984:43). This connection or mirroring of similar traditions from separate Native groups is a small clue to some possible greater regional event. This may add additional credence to the Mt. Storm King landslide and Lake Crescent motif, and may represent another earthquake event experienced by aboriginal groups.

A third myth of the earthquake and or landslide motif identified in the literature comes from the Makah, Chemakum, and Quillayute cultures and pertains to the area around Neah Bay and the behavior of the Pacific Ocean,

“A long time ago, but not at a very remote period, the waters of the Pacific flowed through what is now the swamp and prairie between Waatch village and Neah Bay, making an island of Cape Flattery. The water suddenly receded, leaving Neah Bay perfectly dry. It was four days reaching its lowest ebb, and then rose again without any waves or breakers till it had submerged the Cape, and in fact the whole country except the tops of the Mountains at Clayquot (on Vancouver Island). The water on its rise became very warm, and as it came up to the houses, those who had canoes put their effects in them, and floated off with the current, which set very strongly to the north. Some drifted one way, some another; and when the waters assumed their accustomed level, a portion of the tribe found themselves beyond Nootka, where their descendants now reside, and are known by the same name as the Makah in Classet, or Kwenaitchechat. Many canoes came down in the trees and were destroyed, and numerous lives were lost. The water was four days in gaining its accustomed level” (Castile, ed. 1985:266-267).

A similar story to the Neah Bay flood motif is also found in the Coos culture of the Central Oregon Coast. The Coos story almost mirrors the Neah Bay motif in several portions. The Coos motif discusses a "flood-tide" without and "ebb-tide". It continues along the same path by discussing people taking to "canoes" to escape the "flood", and the "canoes" become caught in "trees" and "that when evening came, the water ran out" leaving "people.....scattered" (Frachtenberg 1913:45). These traditional story motifs, if viewed at the foundation, may reference a ocean Tsunami event or series of events which impacted the greater Northwest Coast at some earlier time.

The Coos have a rather complex version of a similar bird-thunder (not thunder-bird) motif, minus the "whale" with some odd twists. Thinking that Crow talked too much, a man trades speech with Crow, receiving "Thunders language" at a time "when the river was full and there was no low tide". Crow tells the man to "speak with this language" which causes the ground to "almost shake". Crown tells the man that "whenever you get angry, you shall use this language". The man then says to Crow, "close your eyes.....the

water will run down (and) one-half of the ocean will become dry (and) to (Crows) surprise the river was almost dry.....All kinds of food (fishes) began to flop around...(Crow) saw different kinds of food lying along the beach" (Frachtenberg 1913:15-19).

Earthly beings are also sometimes responsible for earthquake events in some story motifs. A Kwakwaka'wakw (Kwakiutl) motif series from Vancouver Island pertains to the village dogs.

"This is not a myth for what I talk about is a tale, for my tale is seven generations old.....all the men had many dogs....the men always took their fire tongs and struck the dogs when they came into the house.....(t)he dogs were always hungry.....they were not fed by their owners and therefore were just emaciated....(t)he dogs were always sleeping outside....(in the) sun...snow or rain or wind.....all the many dogs went into the woods...(the dogs summon the dog "chief" to the dog council).....(one dog rises to speak) I am maltreated by our masters....another dog arose and he said the same as the first (dog).....another dog arose and he followed the words of those spoken first....(the last dog speaks) we will take revenge and we will all together kill our masters....(the "chief" dog replies) my only wish is that you should only not kill my master...(when) nearly midnight....there was a great earthquake and all the houses of the Kwakiutl collapsed....only the house of the master did not collapse...(they) were the only ones (left) alive...the Indians know that the dogs take care of the earthquakes.....therefore the Indians now treat their dogs well" (Boas 1969:122).

A second Kwakwaka'wakw (Kwakiutl) motif series from Vancouver Island has a few story lines regarding earthquakes and tsunamis. One story motif states,

"it was late at night when he was startled by a rumbling sound.....the floor of his house was shaking as in an earthquake....it did not last long before it became quiet.... he heard the rumbling sound; then the floor of his house shook again.....it was that way four times" (Boas 1969:28).

A third Kwakwaka'wakw (Kwakiutl) motif series states,

"I shall just be in my house underwater....(t)hen his house was underwater when his tribe was drifting about.....(they) drifted about....(others)

disappeared all around.... (the) tide went down...now the house site of his tribe did not feel so good. The ground was made bad" (Boas 1969:68).

Other evidence of earthquake and tsunami event(s) comes from a variety of other sources found in the literature reviewed for this project. The Heiltsuk tribal group from mainland British Columbia coast have a tradition that tells of "people return(ing) to their ruined village following a great flood" and finding "four little people dancing on the shore" (McMillan and Hutchinson 2002:47). The Nuxalk people of the northern mainland British Columbia coast had a tradition story that the world was "held in place with strong ropes held by a giant supernatural being..... earthquakes occur(ing) when the ropes slip from this beings grasp or when he moves his hand to get a better grip" (McMillan and Hutchinson 2002:47).

On the Pacific Coast of Vancouver Island, Nuu-chah-nulth motifs speak of "mountain dwarves" "afflicting" the unsuspecting with a fatal disease caused by accidentally kicking a sacred drum, known as "earthquake foot" (Figure 8), and the "ground shaking" when the ill individual tried to walk (McMillan and Hutchinson 2002:46-47). A Cowichian traditional story from Vancouver Island states "In the days before the white man there was a great earthquake. It began the middle of one night.....threw down.....houses and brought great masses of rock down from the mountains.....one village was completely buried beneath a landslide" (Hill-Tout 1978:157-158).

A Vancouver Island traditional story discusses Panchea Bay and states in part: "at nighttime the land shook....a big wave smashed into the beach.....the Panchea bay people were lost.....they who lived at Ma:Its'a:s, :House-Up- Against_Hill.....the wave did not

reach them because they were on high ground.....they came out alive. They did not drift out to sea with the others" (McMillan and Hutchinson 2002: 54). An earlier treatment of this subject by McMillan stated that following the Panchea Bay village loss, "(s)everal of

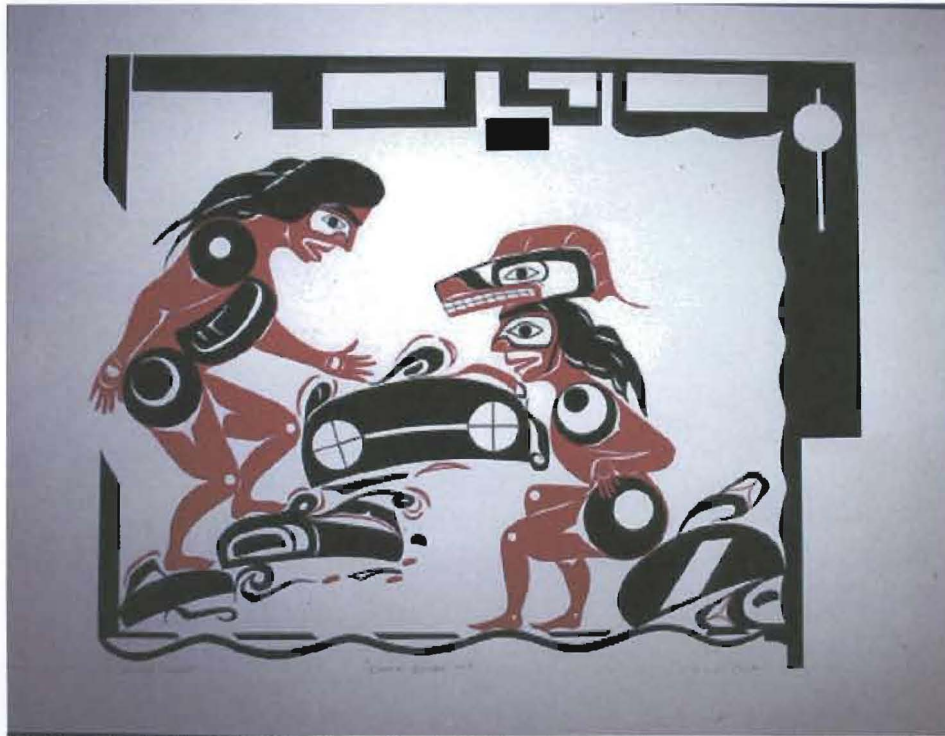


Figure 8: "Earthquake Foot" as depicted in traditional Northwest Coast aboriginal art. A unsuspecting individual is tricked by a mythic being into accidentally kicking a magic drum, thus causing earthquakes when the individual moves their feet (McMillan and Hutchinson, 2002, and artist Tim Paul).

the outer coastal local (aboriginal) groups disappeared as independent polities at that time, either due to losses in warfare or as a result of a natural catastrophe - an earthquake and tsunami that destroyed a village at Panchea Bay" (McMillan 1999:209).

A Clallam tradition also possibly refers to some earthquake and tsunami event when it is mentioned that "the rivers became salt" (Gunther 1925:119). This would be the case if a ocean tsunami entered or surged into a fresh water river system in the near shore area, and may represent another possible geologic event incorporated into cultural motif. A

second story motif from the Clallam group of the Strait of Juan de Fuca mentions a flood event that had occurred "not very long ago, perhaps not more than three or four generations" (Eells 1985:266).

From the northern Oregon coast, a Tillamook story motif references Thunderbird as capturing the "largest ones (whales)", returning to his "large cave" with the catch to feed, with the whales causing the "mountain" to "violently" shake in the process, and making it "impossible to stand" (Boas 1898:225). From the southern Oregon Coast, a series of oral motifs reflect earthquake and/or tsunami events. A Coos area oral story motif/second hand memory (circa 1940) references a Native man who remembered "that my grandmother told when years ago there was a big earthquake that caused cracks in the ground" (Minor and Nelson 2004:46). A second Coos oral story motif titled "when salmon did ill" references a tsunami event caused when adolescent boys "belittle food" by teasing a sleeping peer with a salmon and "lay(ing)" it next to him, stating "let that be his wife" (Jacobs 1934:52-53). A third Coos area oral story motif references the area around the current Oregon coastal community of Glasgow, and a tsunami event where this high ground area was used as a refuge and the area "never (getting) wet" and with "bear, deer, and all the Indians congregat(ing) there" for refuge (Minor and Nelson 2004:47). A fourth Coos oral story motif regarding an earthquake and tsunami event states in part, "(t)hey watched the heavy waves....(waves) continually went back and forth....the land was not solid....waves were rolling over....(b)each sand was on the land" (Phillips 2007:184).

From the Olympic Peninsula and Hood Canal areas oral tradition motifs are identified that encompass the creation of the mountains, near shore islands, and coastal rivers. Included in these myth types are three motifs; one involving conflict, usually conflict between husband and wife; the intervention of a Changer or higher power in this conflict; and the children of the conflicting husband and wife. This Changer figure was called "Do-ki-batl", or "Do-ki-batl", among the Twanas, "Do-kwi-batl" among the Skagit and Nisqually, and "Nu-ki-matl" among the Clallam (Castile 1985:362). The Makahs also had a Changer figure, but never spoke his name out loud (Castile 1985:362).

In Twana mythology, Dosewallips, the mountain, was once "a man" and neighboring "Mt. Solomon" "was his wife", and also human (Castile 1985:278). A small mountain in the Dosewallips Valley "was their child" (Castile 1985:278). Mt. Tacoma "was another wife of the same man" and "the two women quarreled so badly that after a time the big woman.....picked up a basketful of the heads, tails, and parts of fish and left to find a more peaceful home" (Castile 1985:278). As she went, she "dropp(ed)ing" salmon in the Skokomish River, but also "dropp(ed)ing" salmon in the Nisqually River as well (Castile 1985:278). The second wife settles near present day Mt. Rainier. The Changer, or "Do-ki-batl", passes and sees their quarreling and changes them all to mountains (Castile 1985:278).

In contrast, the husband and wife conflict motif, involving two wives, and a child(ren) motif is found in another Twana myth. However, the central Changer figure is omitted. The story tells of long ago, when the "mountains and stars and rocks were living beings",

a mountain above Hood Canal, named Dosewallips, "had two wives" who "were jealous of each other and quarreled often" (Clark 1953:29). Finally, one wife packed her baskets and left, "cross(ing) over the eastern shore of Puget Sound" or Whaluge (Clark 1953:29). As she passed over the Skokomish River, the wife "dropped" some silver and hump-backed salmon in the river, which explained their historic existence only in that river (Clark 1953:29). As she passed the prairies near Olympia, she "dropped some bulbs of blue camas", explaining their existence in that area (Clark 1953:29). The jealous wife finally settled east of Olympia, but continued to brood and "throw fire" at the other wife, "burn(ing) the trees off her head" (Clark 1953:29). The jealous wife is now Mt. Rainier and a large valley in the Olympic (mountain) interior marks her prior spot (Clark 1953:29). The other wife is now Mt. Constance, treeless on the summit due to the fire thrown on her head (Clark 1953:29). The children of Mts. Constance and Dosewallips are the surrounding peaks of the area (Clark 1953:29). The word Skokomish in Skokomish River is said to mean "fresh water people" (Parratt 1984:153).

In further contrast, a variation of this motif has husband and wife conflict, a Changer figure, and a child of the couple, but only involves one wife. This Clallam tale states that a mountain near Freshwater Bay, west of Port Angeles, "was once a woman" (Castile 1985:365). A large rock at the west end of the bay was "her daughter" and Mt. Baker was "her husband" (Castile 1985:365). The wife was a "bad" woman and "abused her husband shamefully", until after much torment "he filled his canoe and went across the Straits (of Juan de Fuca)" (Castile 1985:365). When Do-ki-batl came, "he changed them into what they are now" (Castile 1985:365). Both the Twana and Clallam tales have all

three motifs, the husband and wife conflict, the Changer, and child(ren) of the couple. Lastly, another Clallam story motif follows the husband and wife conflict motif, but omits the Changer or child(ren) motif. In this story, the husband intervenes in a wife to wife conflict, and with one wife, known as "Tokkobad", "scratch(ing) her husband's face" (Parratt 1984:38). These scratches are visible in rock cracking near Jackson's Cove along central Hood Canal (Parratt 1984:38).

The next motif, within two offshore island myths contains a central husband and wife conflict motif, but further varies with both a Changer figure in creation of a landmark, and no central Changer figure at all. A Makah myth states, once Destruction and Tatoosh Islands "lived together" as husband and wife near the mouth of the Hoh River (Clark 1953:120). Their "many children" being the spires and off shore sea stacks on the Olympic Coast (Clark 1953:120). The two fought often, and "Tatoosh decided to leave her husband", taking her children with her in a canoe (Clark 1953:120). As she paddled away to the north she thought and became more angry, saying to the children, "You will probably grow up to be just like your father!", then tossed her children into the sea (Clark 1953:120). When Tatoosh reached the area of Cape Flattery, she decided to stop and "make her new home there" (Clark 1953:120). Her children still to the south; now the Point of Arches (Clark 1953:120). The name "Tatoosh" is said to come from the Chinook Jargon, but is perhaps instead "tu-tutsh" from the Makah word for "Thunderbird" (Castile 1985:281).

The second story comes from Clallam mythology and pertains to Protection Island. Once,

the Olympic Peninsula and Protection Island were human, and being husband and wife, were connected together (Castile 1985:365). Becoming angry with his wife, the man “kicked her away” and the wife became separate from her husband (Castile 1985:365). Then Do-ki-batl came, and “he changed them both into land”, the wife now being Protection Island, separate from the mainland (Castile 1985:365). This may be but one example of this more cryptic reference to earthquake events in oral story motifs.

A Quillayute oral tradition involves Kwatee, and the creation of the coastal rivers. Kwatee was fleeing the wolf people after Kwatee had “killed” the Chief Wolf as punishment for his murdering many people (Clark 1953:121). “Kwatee had his comb” and when the wolf people reached for him, Kwatee “stuck his comb in the sand”, creating the hills and coastal rocks (Clark 1953:122). Kwatee then “ran down the coast”, dumping his “hair oil” on the beach, which created a great river (Clark 1953:122). Kwatee then used his comb to make more offshore rocks and the Quillayute, Hoh, Queets, Quinault, and all other coastal rivers and streams “from Neah Bay down to the Columbia” (Clark 1953:122). Hidden in this traditional story motif may be a cryptic reference to ground shaking and tsunami.

Earthquake related masks and dances were identified among the Chinook of northern Oregon, the Comox of eastern Vancouver Island, the Kwakwaka'wakw of northern Vancouver Island, and the Nuxalk of the mainland British Columbia Coast (McMillan and Hutchinson 2002:43). This interpretive style of dancing usually accompanied the oral version of the danced story line. For some cultural anthropologists, no aboriginal group in

North America surpassed the Northwest Coast groups in complexity of their art, religion, and cultural expression through this interpretive dance. The dancing of the costumed human dance participants also reflected the oral motif story lines which had natural and super natural beings as dance participants, a perceived explanation of earthquake caused ground movement. The Chinook story motif of a gathering of small birds (Stellar's Jay) who collectively state, "our legs are small but we (can) make the ground shake", which they proceed to in fact cause "the house...to shake" is but one example of earthquakes resulting from dancing (McMillan and Hutchinson 2002:52).

Each of these oral story motifs from across Cascadia appear to reflect, in some way, ground movement and/or tsunami events at the core of the story line. Before these can be considered further, the geologic history of the coastal margins of Cascadia must also be considered.

CHAPTER 5:

GEOLOGIC HISTORY OF CASCADIA

Geologic field studies of Cascadia have produced a series of earthquake and tsunami event timelines for the entire Pacific Coast of the region. Broken up into three parts, northern, central, and southern Cascadia, the individual researchers have produced a wealth of geologic history information.

A 2008 paper on the Ales Bay area in Oregon, site of tsunami deposited sand layers, opens a window on 2,000 years of geologic event history for southern Cascadia. Focusing on "paleogeodesy", this paper examined "peat-mud contacts", "peat-sand contacts", and "diatom and foraminifera assemblages" (Nelson 2008:749). Nelson concluded,

"four sand sheets of tsunami-deposited sand interrupt the upper 2m of tidal peat and mud beneath (salt) marshes fringing the eastern shore of Ales Bay. The sheets have characteristics typical of tsunami deposits and 14C ages that correlate with ages for evidence of regional subsidence and tsunamis during four of Cascadia's most recent plate-boundary earthquakes" (Nelson 2008:763).

These findings fit closely to the geologic event history of northern Cascadia as reported by the USGS (Atwater) along the Coplais River, Grays Harbor Bay, and Willipa Bay. These three areas likely "share a 3000-year history of repeated coseismic subsidence at irregular intervals" (USGS 2005:339). "To be considered evidence for co-seismic subsidence, the top of the buried soil must mark a change from a relatively high environment....to a relatively low one" (USGS 2005:339). Or in more simple terms, the subsided forest evidence must be covered by newer tidal flats. Many sites across

Cascadia in the coastal margins have strong evidence of repeated co-seismic subsidence from Megathrust earthquakes. Sand deposits identified across the Region in the co-seismic subsided areas also give strong evidence of related tsunami events with these earthquake events. A "Ghost Forest" at Neskowin Bay, Oregon, is evidence of coseismic subsidence with a former forest platform now located below sea level (Figure 9).



Figure 9: Ghost forest at Neskowin Bay, Oregon, evidence of a sudden, rapid subsidence of the forest floor several meters just like the Copalis River, WA site shown in Figure 4 (Brian Atwater).

Nelson et al reported that there was a threefold puzzle to the history of the Cascadia Subduction Zone. A "long rupture" or an entire 680 mile (1094 km) length Cascadia Subduction Zone earthquake event(s) had occurred 1350 ybp, 2500 ybp, 3400 ybp, 3800 ybp, 4400 ybp, and 4800 ybp (Nelson et al 2006:360-363). Two rupture events were limited to the northern portion of the Cascadia Subduction Zone "about 700-1100 cal yr B.P." and "about 2900 yr B.P." (Nelson et al 2006:360-363). The first event at 700-1000 yr B.P. is likely to have affected the central areas of the Cascadia Subduction Zone as well. The southern portion of the CSZ has an rupture event history about 1100 ybp, 1700 ybp, 3200 ybp, 4200 ybp, 4600 ybp, 4700 ybp (Nelson et al 2006:360-363). Nelson also points out that co-seismic subsidence may also be followed with compression uplift, which can make for some confusion in soils and mud site data interpretation. Nelson further points out that non-earthquake sub-marine landslides can also generate tsunamis, "and mapping along the continental slope shows topography characteristic of large

slides" (Nelson et al 2006:360). A professional paper produced by the USGS on the Willapa Bay area lists at least "seven (earthquake) events" over "the past 3,500 years" (Atwater and Hemphill-Haley 1997:2). The evidence demonstrates an incredibly violent and regular earthquake history across Cascadia.

Peterson published or co-authored several studies from Oregon and Washington. In a 2010 paper, published by Peterson et al the use of Ground Penetrating Radar shows evidence of seven tsunami "scarps" over the last 3,200 ypd in the Cannon Beach, Oregon area (Peterson 2010:on-line). This estimate is very similar to the seven earthquake and tsunami events over the last 3,500 years identified to the north by Atwater. The seventh event of Atwater's work represents the extra 300 years between the Atwater and Peterson studies.

A 1997 paper that tree ring data from standing dead "ghost forest" (Figure 8) trees collected at several locations along the southern Washington Coast show consistent death ages. "Six of the snags narrow the time of tree deaths to the months between the end of the 1699 growing season (August) and the start of the 1700 growing season (May)" (Yamaguchi et al 1997:922). A 2001 paper reports that in the coastal areas of the southern Washington Coast and Columbia River mouth areas states, "(s)ubsidence from the 1700 Cascadia earthquake probably produced the extreme scarcity of trees more than 300 years old in today's tidal forests of coastal Washington" (Benson et al 2001:145).

Further literature identified in this project comes from Goldfinger et al and focuses on

marine sediments or "turbidities" which show

"a ~10,000 year earthquake record....based on sediment cores collected along the continental margins.....New stratigraphic evidence from Cascadia demonstrates that 13 earthquakes ruptured the entire margin from Vancouver Island to at least the California border since the eruption of the Mazama ash 7700 years ago. The 13 events above this prominent stratigraphic marker have an average repeat time of 600 years, and the youngest event ~300 years ago coincides with the coastal record" (Goldfinger et al 2003:555).

This long (~10,000 year) history of numerous, somewhat regular interval earthquake event along the Cascadia Subduction Zone supports the findings of other studies of the region. The long earthquake event history brings to light the cultural oral traditions collected in the work by Ludwin. Connections between catastrophic earthquake and/or tsunami activity, and cultural accounts in Native American oral motifs, is not such a stretch of the imagination when these type of event(s) histories are proposed with peer review scientific literature identified in this project.

Additional support comes from a more recent work by Goldfinger et al, with a portion of the study focused on turbidites and "Cascadia Paleoseismicity" along the Northern portion of the Cascadia Subduction Zone. Goldfinger et al states,

"In the coastal paleoseismic record, the average recurrence time of great earthquakes along the northern Cascadia subduction zone for the past 3500 yr (526 yr) (Atwater and Hemphill-Haley, 1997) agrees quite closely with the offshore average of 470 yr for the same period (one offshore event was not reported at Willapa Bay) and the 524-yr average over the 10,000-yr turbidite paleoseismic record (revised slightly from Goldfinger et al 2003a). Along the southern margin, an 4,600-yr record with 14 disturbance events likely from Cascadia subduction earthquakes has been carefully documented in Bradley Lake, on the southern Oregon coast (Kelsey et al., 2005), along with a 5500-yr record (11 historic events) at the Sixes River (Kelsey et al., 2002). The Bradley lake record is the most complete land record on the southern margin and yields a shorter recurrence interval of 340 yr along that part of the southern margin" (Goldfinger et al 2008:866).

Atwater stated that "the earthquake history evidence on the Coast goes back probably about a 100,000 years or longer" and that "a Grays Harbor construction site for the Hood Canal Floating Bridge portions (relocated from Port Angeles due to a site there being discovered to be a Native American burial ground) yielded boring samples which showed a tsunami sand deposit (at 27 meters depth) about 30,000 years old" (Atwater personal communication, 03/2010).

The "evidence for the A.D. 1700 earthquake and tsunami occurs in several estuaries in southwestern Oregon including the Coquille River, the Sixes River, and Euchre Creek" (Witter et al 2003:1292). Witter et al also reported that for the Coquille River area on the southern Oregon coast has evidence of "twelve earthquakes in the last 6500-6790 yr B.P., recurring on average every 570-590 years" (Witter et al 2003:1304). Like other sites to the north, the Coquille River area also has evidence of co-seismic subsidence of marsh and forest soils. Witter also states that an "earthquake 760-1140 cal yr B.P. in southwestern Washington may have ruptured as far south as Coos Bay" stopping "before it reached the Coquille estuary" (Witter et al 2003:1289). Another partial rupture of the southern portion of the Cascadia Subduction Zone "1940-2130 cal yr B.P. probably did not rupture north of the Coquille estuary" (Witter et al 2003:1289). Some of these tsunami layers "are as much as 10 km up tributary valleys" (Witter et al 2003:1289). In the literature review process, it was discovered that there exists scientific and ethnographic literature from other cultures which may be connected to the Northwest Coast. In a USGS publication titled *The Orphan Tsunami of 1700*, discusses a January 1700 tsunami event along the west coast of Japan which caused some damage and deaths.

Throughout the written texts of government journals for that period from Japan, many mentions of "evening water", "waves high", and "unusual seas" are found (USGS 2005:68). The "Orphan" part in the Japanese texts for the 1700 Cascadia Subduction Zone originated Tsunami event comes from the astonishment of the local population that the tsunami wave train had arrived with no preceding earthquake (USGS 2005:78).

Both the scientific investigation field work in Cascadia and the archival work from Japan, the literature states that the 1700 "Orphan Tsunami" event most likely occurred on January 27, 1700 at about 9 o'clock pm Pacific Time (USGS 2005:74). This was calculated using the Japanese government documents for that day, as show above, and worked out backwards to the 9pm time. This time does somewhat match the cultural stories of the Northwest Coast, as they mention waves arriving "at nighttime (after) the land shook", or "there was a great earthquake. It began the middle of one night...." (McMillan and Hutchinson 2002: 54).

CHAPTER 6:

LINKAGES AND ANALYSIS

Geologic evidence along the coastal margins of the Cascadia Subduction Zone gives much evidence of a long, continuous, and somewhat semi-regular Megathrust earthquake event reoccurrence timetable. Using turbidite data, an early paper identified that "At least thirteen large earthquake events have affected the CSZ in the last 7000 years" (Adams 1990:573). This data was collected from the numerous submarine canyons that line the continental shelf edge along the Cascadia Subduction Zone.

In the coastal margins, this earthquake event reoccurrence history record is varied. For the northern portions of the Cascadia Subduction Zone, roughly six buried forest soils layers are identified at Willipa Bay and record a roughly 3000 year earthquake event record (Hutchinson and McMillan 1996:80). Just to the north of Willipa Bay, buried forest soil layers in the Grays Harbor area, show a similar earthquake event history as does the Willipa Bay area (Hutchinson and McMillan 1996:80). The Willipa Bay age ranges are recognized by the science community as representative of earthquake and/or tsunami events for the northern portion of the Cascadia Subduction Zone (Hutchinson and McMillan 1996:80). However, for some portions of the northern Cascadia Subduction Zone earthquake event history is less than 3000 years along the rocky, short beach, high bluff areas of the northern Washington Coast, and the coastal areas of Vancouver Island (Hutchinson and McMillan 1996:86).

For the central portion of the Cascadia Subduction Zone, the area of northern and central

Oregon has a similar earthquake and tsunami event history. In the vicinity of Cannon Beach, Oregon, tsunami deposited sand layers show roughly six tsunami events contained in local area soil profiles (Schlichting and Peterson 2008:577). However, one of these six tsunami layers identified dates to a period not recognized as being associated with a known Cascadia Megathrust earthquake event, and is thus considered a tsunami event of foreign origin or a tsunami from a distant portion of the Pacific Ocean (Schlichting and Peterson 2008:577).

For the southern portion of the Cascadia Subduction Zone, the area of southern Oregon and northern California also has a long record of earthquake and tsunami event history. Roughly twelve earthquake and tsunami events have occurred in the past 6600 years, as recorded in the coastal area soil profiles in the vicinity of the Coquille River, Oregon, area (Witter 1999:iv). However, the differences identified between the ages of the multiple tsunami deposits from this southern portion of the Cascadia Subduction Zone, when compared with the multiple tsunami deposits of Willapa Bay to the north, "suggest that segmented rupture of the CSZ occurs" (Witter 1999:iv) pointing to different event experiences among aboriginal groups .

The estimated tsunami wave height for a Cascadia Subduction Zone Megathrust earthquake event is between 23 and 30 feet above sea level, meaning wave energy spreading several kilometers inland along low-lying areas of the coastal zone (Losey 2008:2). This suggests an increased impact to aboriginal groups that occupied low estuary marsh areas away from the open coast. However, the varied bathymetry along the

entire near-shore area of the Cascadia Subduction Zone can affect tsunami wave energy and behavior. As demonstrated during the March 2011 Japan Megathrust tsunami event, locations along the Washington, Oregon, and California coasts received a variety of tsunami wave behaviors from these bathometric factors.

Aboriginal cultural oral story motifs from Cascadia identified for this paper are rich with both obvious and clandestine references to earthquake and/or tsunami events. From the southern to northern end of Cascadia, earthquake oral traditions are identified among the Yurok of northern California, the Tillamook and Chinook of the northern Oregon Coast, the Quileute of the northern Washington Coast, the Cowichan of eastern Vancouver Island, the Nuu-chah-nulth of western Vancouver Island, the Kwakwaka'wakw of northern Vancouver Island, and the Squamish of the southern mainland coast of British Columbia (McMillan and Hutchinson 2002:43).

Oral motifs from the Quinault group regarding the Valley of Peace landslide event(s) in a southern Olympic Peninsula interior coastal valley, with human deaths reported in the story line, is remarkable in similarity to another story motif from British Columbia coastal mountain area. From the Squamish group, a traditional oral story motif references a group being camped at "Rubble Creek" with an earthquake causing a rockslide and "many of the people were killed and buried" (McMillan and Hutchinson 2002:53). Earthquake induced landslide evidence has been identified in many areas of the Olympic Peninsula and interior Olympic Mountains, the mythical home of Thunderbird from aboriginal oral traditions.

On the northern end of Washington's Olympic Peninsula, a landslide complex at Lake Crescent, Olympic National Park, shows evidence of two historic landslide events, with one event damming the eastern outflow of Lake Crescent and creating neighboring Lake Sutherland, raising the Lake Crescent water level 80 feet, and changing the Lake Crescent outflow to the Lyre River drainage to the north (Logan et al 1998:61). C¹⁴ test results on submerged upright tree trunks in Lake Crescent returns two dates (280 ybp +/- 60 and 300 ybp +/- 60) consistent with the 1700 Cascadia Megathrust Earthquake time period, and one date (750 ybp +/- 50, corrected to an estimated 600 ybp due to sample tree ring erosion) (Logan et al 1998:61). These C¹⁴ results give some credence to the Mt. Storm King aboriginal motif identified by Ella Clark,

“After watching the bloodshed for two long days, Mount Storm King became angry. On the third day he broke off a great piece of rock from his head and hurled it down into the valley.....(t)hrough the valley flowed a small river. The rock hurled by Mount Storm King dammed this stream” (Clark 1953:66).

The southern Olympic Mountain area also shows much evidence of seismic generated landslide events. Landslide events assisted in creation of Lena Lake, Jefferson Lake, Pine Lake, Spider Lake, Upper Dry Bed Lake, and Lower Dry Bed Lake (Logan et al 1998:63-64). Submerged and partially (seasonably) submerged standing dead trees in these landslide created lakes were sampled and tested for C¹⁴, yielding dates ranging from 1010 ybp +/- 50 to 1160 ybp +/- 50. across eighteen samples (Logan et al 1998:60-61). This tight spacing of C¹⁴ age dates falls within the range for both a historic Seattle Fault and Cascadia Subduction zone earthquake event. The overall C¹⁴ date range of 300 ybp,

1100 ybp, and 2900 ybp (Hamma Hamma River landslide) (Logan et al 1998:60-62) is consistent with age ranges proposed by Nelson et al, with the 1100 ybp result possibly representing partial fault rupture for only the northern and central Cascadia Subduction Zone, and the 2900 ybp representing partial fault rupture for only the northern portion of the Cascadia Subduction (Nelson et al 2006:363). Given this landslide age range consistency, multiple landslide events identified in the southern Olympic Mountains, and landslide event history and geologic record around Lake Crescent, the Valley of Peace motif may further represent actual events incorporated into oral tradition. The fact that this story is mirrored among other aboriginal groups, such as the Cowlitz who occupied the southwest Washington interior, supports a regional earthquake event.

In some aboriginal groups, it was these super natural beings who had bestowed the power of ground shaking in dance upon human beings. The Nuu-chah-nulth story motif of "Earthquake Foot", where "mountain dwarves" afflict an individual with this "earthquake foot" condition, and "whenever he walked the earth trembled" is another example of bestowed dance upon human beings (McMillan and Hutchinson 2002:46-47). The Heiltsuk of the Mainland British Columbia coast have a dancing dwarves story motif (mentioned above), but they have no direct interaction with human beings and merely observed "dancing on the shore" following a "great flood" that "ruined (their) village" (McMillan and Hutchinson 2002:47).

Additionally, tsunami type oral traditions were identified among the Tolowa of the northern California Coast, the Coos of the southern Oregon Coast, the Quileute and

Makah of the northern Washington Coast, and the Nuu-chah-nulth of western Vancouver Island (McMillan and Hutchinson 2002:43). The March 2011 Japan earthquake gave an example of a tsunami of distant origin affecting the Pacific coast of Cascadia. According to one researcher, "The Pacific Ocean has seen roughly 1453 (as of 2001) tsunamigenic events for the period 47 BC to 2000 AD" (Guiaskov 2001:266). Tsunami type story motifs, though sometimes cryptic, also were identified in this thesis project. The Coos group of the southern Oregon Coast have a oral motif that speaks of "the ocean (going) far into the land" (McMillan and Hutchinson 2002:54). This is comparable to both the Makah oral motif of "the prairie (becoming) ocean" from the northern Washington coast, and is remarkably similar to the oral motif from the Yurok of the northern California coast that discusses "how the prairie became ocean" (McMillan and Hutchinson 2002: 54-55).

Tsunami type sea behavior of retreating seas and subsequent high wave surge return is identified among the Nuu-chah-nulth, Quileute, Makah, and Pentlatch (McMillan and Hutchinson 2002:43). The Quileute group were believed to have been spread out by a tsunami event, with a portion becoming the Chemakum and explaining the similar language type between the two separate groups (Curtis 1913:150). Swan first identified the Waatch Prairie area near Neah Bay as having tsunami generated sand layers in the soil profile, an early use of oral motifs and scientific field investigations (Swan 1868:57).

Additionally, a Yurok oral motif from northern California also incorporates water and prairie, with an earthquake and thunder theme:

"(he) shall tear up the earth.....if (he) see(s) the earth tilt, (he) can level it again.....he shook the ground. He tore it and broke it to pieces.....all the trees shook, some fell.....(he) will take care of these human beings.... (he) will make it level again...he shook the ground.....he shook it hard..... the earth (was) all torn...and the trees sunk into the ground.....they saw (a) great rock fall" (Kroeber 1976:176).

A similar version from the same Yurok Myths text states:

"(earthquake and thunder) then went north together and did the same: they kept sinking the ground. The earth would quake and quake again and quake again. And the water was flowing all over.....then they went south, where they had sunk the ground before. All (game) had gone.... all that had lived there, had lived on prairie where the ocean was now" (Kroeber 1976:464).

The contrasts between south and north Cascadia is that in the Yurok motif, earthquake and thunder are mythical beings, where as northern Cascadia aboriginal groups viewed earthquake and thunder, and to some extent lightning, as being caused by mythical beings, usually during some type of conflict. Five earthquake event layers for the last 1700 years are evidenced in the tidal estuaries of northern California, which supports the Yurok earthquake motif traditions (Clarke and Carver 1992:188).

Wave caused turmoil, human death, and destruction of village motifs following earthquake and tsunami events are also widespread across the Cascadia. These type of oral motifs are identified in the Makah, Coos, Quileute, Nuu-chah-nulth, and Tolowa groups (McMillan and Hutchinson 2002:59-61). Village sites were abandoned following earthquake or tsunami events on the British Columbia, Washington, and Oregon coasts as shown with current archaeological evidence (Ludwin 2005:143). McMillan stated that "(a) thick sand layer near the base of midden deposits at the Ittatsoo North site near Ucluelet (Vancouver Island) may be archaeological evidence of a tsunami which struck

the village about 2300 BP" (McMillan 1999:111). The Cowichan have an oral motif that speaks of an earthquake and landslide, resulting in the destruction of a village (McMillan and Hutchinson 2002:52).

Also identified in the coastal areas of Cascadia, from north to south, are select archaeological sites which are situated under tsunami deposited sand layers, or are partially submerged "wet" sites pointing to co-seismic subsidence, and suggesting direct impact to aboriginal groups from earthquake and tsunami events. Hutchinson and McMillan noted "that the modern Makah community of Neah Bay sits on deposits of an earlier village (45CA22)" and further stated "Wessen (1991) noted two closely spaced layers of sand in the stratigraphy of a test pit near the back of the site and speculated that these may be tsunami deposits" (Hutchinson and McMillan 1997:84). As discussed earlier, Neah Bay has aboriginal oral traditions associated with earthquakes and tsunami events, and that one motif discusses the "prairie became ocean". To the south, "(A) stratigraphic profile from the Quileute village of La Push (45CA23) shows two phases of occupation separated by a thick intervening sand layer (Duncan, 1981)" (Hutchinson and McMillan 1997:85). A 2002 paper noted that "(t)he Copalis River Site (45GH104) was exposed by erosion of Cedar Creek in a buried subsided peaty layer dated to the 1700 event" (Gilsen 2002:132). Gilsen also noted "(t)he Niawiakum site (45PC102) was in the uppermost of six buried peaty horizons exposed at extreme low tides" (Gilsen 2002:132). Hutchinson and McMillan utilized C¹⁴ dating and multiple field site studies on the northern portion of Cascadia and identified,

"The hypothesis that prehistoric great earthquakes at the Cascadia subduction zone affected native peoples is supported at many sites

by the presence of inferred tsunami deposits or other non-cultural layers in midden stratigraphy and by fluctuations in site activity levels based on the distribution of radiocarbon ages. Some sites (such as Yuqout) appear to have gone through a cycle of abandonment and reoccupation following each major earthquake. In other cases (such as Hesquiat Rockshelter DiSo9), the site was reoccupied after one great earthquake, but was permanently abandoned following a later event. Clusters of nearby sites showing sequential occupation (such as Lower Sand Point, Cedar Creek, Ozette, and White Rock on the outer Olympic Peninsula) may indicate village relocations following catastrophic events. The impact of individual events on site occupations may not have been uniform. Variability in site impact may reflect differences in the magnitude of events or the location of rupture areas" (Hutchinson and McMillan 1997:85).

Recurring experiences of earthquake and tsunami events for aboriginal groups reinforced cultural oral traditional motifs. In the sharing a common disaster survivor mentality, perhaps some earthquake and tsunami oral motifs were a type of post-event group therapy for event survivors. In essence, "(o)ral history may have provided critical direction to those facing these hazards, and accounts of positive outcomes may have provided some level of solace to the survivors" (Losey 2008:9). It is possible that the oral earthquake and tsunami motifs were a type of public education campaign to prepare the aboriginal population for disaster events, similar to contemporary public disaster preparedness education campaigns. A traditional story motif of tribal members acting to save possessions when a tsunami wave was observed in the Nehalem Bay area, and moving to higher ground to escape the wave event is eerily similar to contemporary Tsunami Warning Sirens and Tsunami Evacuation Route planning (Losey 2008:9). Across Cascadia, mythical beings blamed for earthquakes and tsunami events, or earthquake events resulting from moral misbehavior of human subjects, which result in wrath or punishment upon humanity for misdeeds, is but one oral cultural motif story

group. Mythical beings are the root cause of earthquake or tsunami activity in most aboriginal group oral motifs along the Cascadia Subduction Zone.

CHAPTER 7:

CONCLUSION

The long history of somewhat regularly spaced earthquake and tsunami events along the Cascadia Subduction Zone, identified in this project, is preserved in the coastal muds, buried forest soils, standing dead "ghost forests", and tsunami deposited sand layers along entire Northwest Coast of North America. Also along the coastal margin of the Cascadia Subduction Zone is archaeological evidence of village site abandonment, shell midden strata intra-layered with tsunami deposited sand layers, and co-seismic submerged archaeological sites. This archaeological evidence gives testimony that aboriginal groups occupied the coastal margin of the Cascadia Subduction Zone. Aboriginal oral traditions are clear indicators that coastal groups lived with earthquake, tsunami, landslide, and landform alteration events. Aboriginal groups understood the earthquake and tsunami event re-occurrence potential along the Cascadia Subduction Zone, even in an abstract way, still choosing to occupy the coastal margin areas. In essence, they assumed or accepted the risk - as do those who occupy the coastal margins of the British Columbia, Washington, Oregon, and the northern California coast today.

Aboriginal oral traditions from the Northwest Coast were an expression of their cultural religious beliefs and were (are) vastly important to group identity. These traditional cultural oral story motifs may provide the only record, if one chooses to accept them, of the human earthquake and tsunami event history prior to European exploration of the Northwest Coast. The 100,000 year earthquake and tsunami event re-occurrence history along the Northwest Coast is evidence that aboriginal groups experienced these events.

Some earthquake and tsunami event history contained in aboriginal cultural memory, and identified in this project, likely are a result of the January 1700 earthquake event - especially those story motifs that mention a night time event. However, older event motifs were identified, with dates varying by location on the Cascadia Subduction Zone of each aboriginal group.

Identified here in this paper are a strong history of both aboriginal oral traditions and geologic event evidence for the northern portions of Cascadia, as well as some traditional

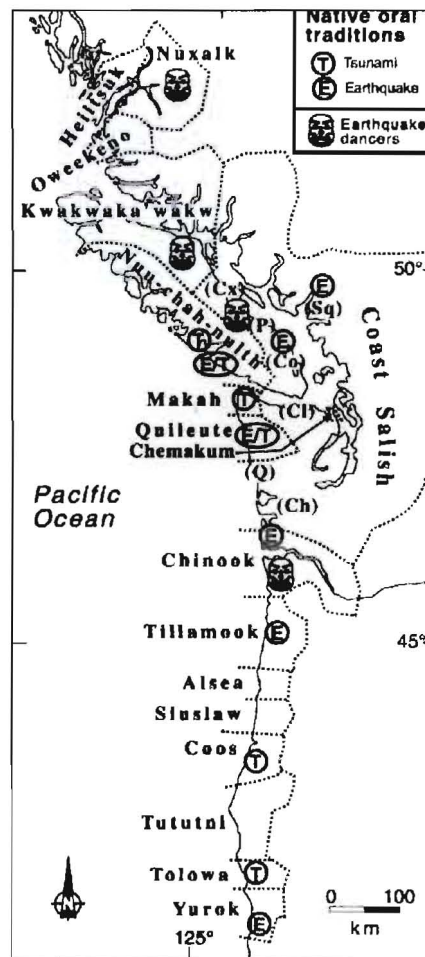


Figure 10: Taken from McMillan and Hutchinson (2002), this graphic shows some but not all of the earthquake and tsunami related aboriginal oral story motifs identified in this project, with additional aboriginal earthquake related dance motifs among select groups also shown. Several landslide related "L" symbols could also be added for the Olympic Peninsula of Washington State and Vancouver Island, as earthquake related landslide oral story motifs were also identified in this research from the two areas (McMillan and Hutchinson, 2002).

earthquake inspired dances among select groups (Figure 10). Also identified here in this paper are a strong history of both oral traditions and geologic event history for the southern portions of Cascadia. Further, identified here in this paper is a strong geologic event history for the central portion of Cascadia, however the oral tradition history is not as well established when compared to areas to the north or south. This may point to two ends of a spectrum, either the oral tradition was lost due to time and aboriginal group attrition (pandemic disease) along portions the Oregon Coast (Boyd 1999:24), or oral traditions reflecting past earthquake and tsunami events from the Oregon Coast requires further study.

Recent examples of earthquake and tsunami events Banda Ache 2004, Samoa 2009, Chile 2010, New Zealand 2011, and Japan 2011 provide examples of the power of tsunami waves and their impact on humans. Personal technology devices, on the spot Live news media broadcast, and the Internet now allow the world to see and replay earthquake and tsunami events. Public awareness and education of the earthquake and tsunami event possibility in the Pacific and Indian Ocean areas was driven home with the tsunami event of December 2004. The resulting death of ~230,000 persons from this Indian Ocean tsunami event was a chilling reminder of the geologic processes of this planet. The March 2011 Japan Megathrust earthquake (and smaller aftershocks that also generated tsunami) demonstrated that even the most at risk Nation, and also the Nation that is considered the most earthquake and tsunami prepared (and wired), can be devastated by a tsunami event.

The similarities to the coastal plains of northeastern Japan, with the inland surge of multiple tsunami waves, bears a strong topographic and population resemblance to many portions of the Washington, Oregon, and California coasts. The risks and potential destruction from a Cascadia Megathrust Earthquake event are demonstrated and reinforced by viewing the Japan tsunami video footage of March 11, 2011. Despite a large investment of government dollars and resources to build a tsunami warning system along populated portions of coastal Cascadia, combined with extensive evacuation planning and public education campaigns, an earthquake and tsunami event today would likely see similar effects as Japan.

As demonstrated in this research, traditional cultural knowledge can be used by western science as a portal for consideration and understanding of past geologic events. Though cryptic in nature, traditional oral story motifs can be used in opening a window to view a distant period of human understanding and perception - even if the window is somewhat cloudy.

Like Aesop's Fables, aboriginal cultural oral traditions were ethics or morality lessons at the core, sometimes cryptic and but often humorous. The spirit of the aboriginal oral traditional story motifs of Cascadia still exists across the Region, in the story of place, and in the story of how or why. Aboriginal cultural oral traditions should be considered verbal art: To speak and remember this precious form of true North American folklore is to bring the earth alive and retain this priceless tradition and spirit of Pacific Northwest

culture. The future of earthquake and tsunami events for Cascadia is preserved in both the historic aboriginal oral story motif and coastal geologic record of the region.

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