AN ABSTRACT OF THE THESIS OF

Robin S. Petersen for the degree of Master of Arts in Applied Anthropology presented on August 21, 2006.

Title: The Role of Traditional Ecological Knowledge in Understanding a Species and River System at Risk: Pacific Lamprey in the Lower Klamath Basin

Abstract approved:

Deanna M. Kingston

Pacific lamprey (*Lampetra tridentata)* have historically been considered by the Western scientific community as a "trash" fish and generally overlooked in West Coast fisheries management. Recent population declines in Pacific Northwest streams have triggered new research to understand the life history and ecological significance of this species. These new studies are significant, yet incomplete as they lack the historical context in which to place the data.

The Yurok and Karuk Tribes along the Klamath River in Northern California have long had a relationship with Pacific lamprey, utilizing it for both its subsistence and cultural value. Native knowledge of this species is integrated in a complex understanding of natural systems. However, only in the last few decades have the natural resource management skills of indigenous people been recognized by the dominant culture. Hundreds of years of suppression and exploitation limited the abilities of tribes to utilize their traditional management practices.

During 2004 and 2005, I lived in the local communities of the Yurok and Karuk tribes while working with their tribal fisheries programs. Utilizing

ethnographic methods of participant observation, focus groups, informal interviews, and semi-directed interviews, I gathered traditional ecological knowledge (TEK) of Pacific lamprey from more than 80 Yurok and Karuk tribal community members in the Lower Klamath River Basin.

While I discourage single species approaches to resource management, in my research I utilized this method to explore and learn from the holistic foundation of Karuk and Yurok TEK. Pacific lamprey became the lens through which I could view and understand lamprey more completely, as well as the ecological and cultural interconnections of the Klamath River system as a whole.

In this thesis, I have included much of the TEK shared with me by local eelers and tribal community members about the life history, biology, and ecological significance of Pacific lamprey. I also summarize some of the key points made by participants regarding the cultural significance of Pacific lamprey, including the social, spiritual, and health implications of a declining lamprey population. Additionally, I include knowledge shared with me regarding traditional fisheries management and the role of ceremonies in resource management.

Historically, millions of lamprey were seen throughout the Lower Klamath River Basin. Harvests began in late November at the mouth of the river and continued into August as the fish made their way up into the Scott Valley. Tribal community members emphasized the significant role lamprey have in the balance and health of the Klamath River system, both as prey and essential contributors of marine-derived nutrients. According to Karuk and Yurok tribal eelers, lamprey populations began declining in the Klamath River Basin more than forty years ago.

It was not uncommon for the eelers of the village to harvest over 1000 lamprey at a time, enough to take care of the entire community. Today, they are lucky to harvest 15 lamprey. Population decline factors have been attributed to the combined influences of logging practices, wetland delineation, Iron Gate Dam, fire suppression, contamination, and predation.

I utilize the main TEK contributions from this research to discuss aligning TEK and Western scientific knowledge. I also include recommendations for both Karuk and Yurok tribal fisheries programs and Western fisheries managers in the Klamath Basin on working with TEK and supporting local tribal fisheries management.

The Role of Traditional Ecological Knowledge in Understanding a Species and River System at Risk: Pacific Lamprey in the Lower Klamath Basin

by
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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Robin S. Petersen, Author

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The Role of Traditional Ecological Knowledge in Understanding a Species and River System at Risk: Pacific Lamprey in the Lower Klamath Basin

Eeling

A willow pole long and straight
Barbless hooks peeled and shaped.

A warm breeze says the time is right
Uncle and I will eel tonight.

The sun is setting, night draws near
The time for eeling is almost here.

I hear the river far below
The trail is long, steep, and slow.

A small fire glows to cook our catch
The first eel caught is always best.

Two for me and two for him
The rest go to Elder men.

Johnny W. Erickson, age 14
Yurok

(From "Night is Gone, Day is Still Coming" Ochoa et al. 2003: 112)

Introduction

My interest in the human side of natural resources was developed and nurtured while living and working among indigenous cultures of Kenya, British Columbia, and Zimbabwe. In addressing human conflicts over natural resource use, ownership, and cultural value, I gained a greater understanding of the often-disregarded human component of resource management. My decision to return to school for a graduate degree was influenced by my perspective that culture and local knowledge are both key components missing when addressing current environmental issues. Through my background in wildlife research, I had participated in species-specific management, experiencing both the value and shortfalls of this approach. One essential shortfall is the lack of local community participation and it was in this area that I decided to direct my research.

This project is a collaborative effort between myself and the Yurok and Karuk tribal fisheries programs in Northern California. I chose to research Pacific lamprey (*Lampetra tridentata*) because while they are native to the West coast, historically, the non-native world has regarded lamprey as a trash fish and they have not been a priority in fisheries management. However, lamprey have been an important cultural resource for many native people along the Pacific coast for thousands of years. In researching groups to work with for this project, I was referred to the Yurok and Karuk tribes along the Klamath River in Northern California. The tribes that live in the Lower Klamath Basin are some of the few who were not removed completely from their ancestral territories during the reservation era. While the Yurok were re-located onto the nearby Hoopa Indian Reservation and

the Karuk were forced to escape to the surrounding mountains, the environment they knew and understood remained essentially the same. Even through the devastating impacts of forced removal to boarding school, the middle and lower Klamath River tribes were able to retain much of their culture, including knowledge of Pacific lamprey. Both the Yurok and Karuk tribes historically and currently participate in harvesting this species.

During 2004 and 2005, I lived in the Northern California communities of Klamath and Orleans while working with the Yurok and Karuk tribal fisheries programs to gather traditional ecological knowledge (TEK) of Pacific lamprey in the Lower Klamath Basin. I utilized ethnographic methods to explore and learn from the holistic foundation of Karuk and Yurok TEK, which contributed to a more comprehensive understanding of Pacific lamprey, as well as the ecological and cultural interconnections of the entire river system. In the process of working with TEK, I also gained greater perspectives on aligning TEK with Western scientific knowledge and the importance of local resource management.

Chapter 1
Background

The Klamath River watershed encompasses 10.5 million acres including two states, seven national forests, two main mountain provinces, two national parks, and nine wilderness areas. The river flows over 260 miles from its source in south-central Oregon, journeying through four major dams and the Klamath Mountains, to its mouth at the Pacific Ocean (See Appendix A.1 for a map of the Klamath River Basin.). The Klamath River has been the third-largest producer of salmon on the West coast. The flora and fauna reach back farther into the past than any place west of the Mississippi River. Klamath rocks predate the last glacial age and are older than both the Coast and Cascade mountain ranges, with no peaks over 10,000 feet (Wallace 1983). Within this meandering world, lives an ancient, eel-like species called Pacific lamprey and communities of people that were born out of these very rocks[1] and the river that runs through them. A river that means life for both lamprey and the Klamath River Indians.

1.1 Pacific Lamprey

Pacific lamprey (*Lampetra tridentata*) are a boneless, primitive fish species native to the Pacific coast. They are anadromous to most streams feeding into the ocean, from the Aleutian Islands southward to Baja California, Mexico. Pacific

[1] The native people of the Klamath River have a complex belief system: some believe that the center of their world is Katamin, a small mountain right on the Klamath River, and that they were "born" out of that rock; some believe that their life as Karuk or Yurok people did not begin until they arrived on the Klamath River and were taught the proper way to live by the spirit people; other people believe that their ancestors migrated down into the area from another part of the world.

lamprey are one of at least six lamprey species, as well as two sub-species, that reside in the Klamath River Basin (Moyle and Davis 2000). They spend most of their lives in larval form, called ammocoetes, filter-feeding in the sand or fine silt of freshwater streams from four to seven years (Kan 1975, Pletcher 1963, Hammond 1979, Beamish and Northcote 1989). They play a very important role in processing nutrients that are stored as biomass or processed into particulate matter utilized by insects (Kan 1975, Moore and Mallatt 1980, Merritt et al. 1984). When they begin migration, the larvae undergo an extensive metamorphosis in which they become parasitic and physiologically adapted to salt water (Youson 1980, Potter 1980, Beamish 1980, Kan 1975). Adult lamprey are valued as a slow-moving, nutritious food source (Close et al. 1995), with a caloric value of 5.92-6.34 kcal/gm wet weight (Whyte et al. 1993), almost three to five times higher than that of salmon at 1.26-2.87 kcal/gm wet weight (Stewart et al. 1983). Lamprey have been found to make up a large percentage of the diet for pinnipeds, such as seals and sea lions, as well as other fish-eating predators (Williamson and Hillemeier 2001, Roffe and Mate 1984, Merrell 1959). Adult lamprey return after two to four years to freshwater streams to build nests in the gravel, spawn, and eventually perish to be recycled back into the system as scavenged food or decomposed matter (Kostow 2002). As a native fish species that has evolved for millions of years with the Klamath River system and as an important predator, prey, and nutrient source for this system, a decline in lamprey populations may have a serious ecological impact.

The Western world has long regarded native lamprey as a pest species or "trash" fish and essentially ignored them in fisheries management. Studies

conducted on lamprey focused mainly on the eradication of invasive sea lamprey in the Great Lakes. In the early 1990s, indigenous groups in the Pacific Northwest began to express their concern over a sharp decline in Pacific lamprey populations (Close et al. 1995). New research by agencies, tribes, and other groups emerged to determine the cause of this decline and to understand the ecological impacts. Initial studies point to several human impacts, including dam passage, land-use practices, insufficient spawning and rearing habitat, water quality, rotenone treatments, and food web shifts in the ocean (Potter et al. 1986, Close et al. 1995, Kostow 2002). These new studies are significant in jumpstarting our understanding of the intricacies of Pacific lamprey. Consequently, though, in utilizing a small number of controllable parameters in their research, they may miss the interconnections and complexities of the natural system as a whole (Grenier 1998).

1.2 Yurok and Karuk Tribes

The Klamath River is the major means of transportation and the geographical and spiritual reference point of Yurok and Karuk life (Huntsinger et al. 1994; King 2004). The river serves as the basis for their spatial orientation, using words such as *yurok*, which means downriver in Karuk, or *won*, which means uphill or away from the river in Yurok, to indicate direction (Bell 1991; Hotelling 1978; Kroeber 1925). Hundreds of Karuk and Yurok villages were spread along the Klamath River, at the mouths of streams, and up into some of the tributaries (Salter 2003). Yurok ancestral territory includes a narrow strip of land that extends along the coastline from six miles north of the Klamath River south to Trinidad, then up along the Klamath River to just above its confluence with the Trinity River (Huntsinger et al 1994; Curtis

1924). Karuk ancestral territory begins at Bluff Creek extending upstream along the Klamath River to just below the Seiad Valley and including the Salmon River halfway up to the Forks of Salmon (Bell 1991; Curtis 1924). Appendix A.2 includes maps of Yurok and Karuk ancestral territories. "For these tribes, the Klamath River was a highway connecting them as a cultural unit" (Salter 2003: 5). The Yurok and Karuk, as well as the neighboring Hupa[2] on the Trinity River, have their own unique languages, but share a similar culture. They have always inter-married, traded, and attended one another's ceremonies (Beckman 1998; Huntsinger et al. 1994; Thompson 1916; Bell 1991).

While Europeans began exploring areas just south of Yurok territory during the late 1500s, the Spanish did not claim the area around Trinidad Bay until 1775. Additionally, it was not until the expedition of Jedediah Smith in 1828 that the inland villages of the Yurok first encountered Europeans (Huntsinger 1994). The discovery of gold brought an influx of miners and settlers, which had devastating impacts on Yurok populations through disease and warfare. Alternately, until the highway to Karuk territory was paved in the 1960s, their land was relatively inaccessible to outside groups unfamiliar with traversing the rugged mountainous landscape. In fact, it was not until 1851 that the Karuk encountered their first group of non-native people (Salter 2003). The Karuk had their share of violence and disease because of these encounters, but the impacts were buffered by their remoteness.

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[2] While the Hupa are associated with the Klamath River Basin and have an intertwined history with the Yurok and Karuk, I only focused on those tribes that are historically based on the middle and lower mainstem of the river.

The middle and lower Klamath tribes value Pacific lamprey, *key'ween* in Yurok and *akraah* in Karuk, as an important ecologically and culturally significant species. Native people have harvested adult Pacific lamprey, fondly known as "eel", for thousands of years as an important subsistence fishery (Close et al. 1995, Pletcher 1963, Downey et al. 1993, Hammond 1979). "Just like everything in life that's sacred to us, they've been here as long as we can remember and I hope they're here long after we're gone" (Karuk eeler). Lamprey have an important place in the spiritual lives of people that live along the river.

> The eel has its place in our religion and in our survival. Not only do we have stories of them in our creation stories, but also physically, he allows us to survive. I really can't articulate further to say that there's really no separation between the Eel people and us because we go together. One without the other... Even myself, I'm an urban Indian...I miss having eel. So sometimes I come home and have an eel, I think, 'oh, the world is good'. It's just what we do. It's hard to articulate the separation because there really isn't any. They're a part of us, a part of our way of life, part of our identity. We're eel eaters, we're salmon eaters, we're deer eaters. It makes our culture who we are (Karuk tribal elder).

The harvesting of lamprey, known as eeling, is an important time for the communication of trans-generational knowledge from elders to the younger generations.

> It had a lot of social value. When you're sitting around that campfire down in there, you're hearing your elders tell you stories or tell you about the times when we were catching eels all night long for three straight days and nights. I mean just hearing the stories and just getting that feeling that you were moving into manhood. I think that was very key. I think right now that's what our children are missing. They're not having that experience to spend time with the elders, to be taught. Now they just go down to eel, without being taught the way it's supposed to be and the way it's been since the beginning of time (Karuk tribal community member).

Native knowledge of lamprey is integrated in a complex understanding of natural systems. Only in the last few decades have the natural resource management skills of indigenous cultures been recognized by the dominant culture. Hundreds of years of suppression and exploitation limited the abilities of tribes to practice their traditional management. Native knowledge of lamprey is sacred and passed on from generation to generation. Its wisdom lies in this sacredness and the thousands of years of close observation of these complex systems (Pierotti and Wildcat 2000). Indigenous knowledge utilized in traditional fisheries management is purposeful management that recognizes long-term consequences.

1.3 Traditional Management

Historically, neither the Karuk nor the Yurok had a formal system of political organization. A system of shared values regulated community life and village leaders were usually those who had prestige through the accumulation of wealth (Clarke Memorial Museum 1985). The resources of the Klamath ecosystem were plentiful, allowing for the development of rich expressions of culture and strategies of land management that supported the relative abundance of these resources. These developments promoted a well-developed sense of status and wealth. For the middle and lower Klamath tribes, wealth determines the value of a person's life, but is conceived as something beyond money. Wealth is not "possessed"; rather it represents the accumulation of a community of entities that acknowledge a person's spiritual power (Beckman 1998). That spiritual power and luck develops by an individual's deliberate practice and through rituals like the world renewal

ceremonies during which the world is put back into balance. Both the Karuk and the Yurok have a strong belief in an ancient spirit people that established the world and taught humans the proper way to live, how to hunt, fish, and gather, and how to perform the ceremonies that ensure the continuation of the world (Clarke Memorial Museum 1985; Salter 2003). The stability of the world, the success of food acquisition, and the acknowledgement of one's power and influence in the community depend upon one's ability to understand and control spiritual powers. Animals and plants are all animated spiritual beings. The maintenance of a good relationship with these beings is required for the continuation of their plentiful staple food (Beckman 1998).

Due to the dependence on fish as a major resource, harvests were moderated "by a rather elaborate system of rights assuming the force of law" (Kroeber and Barrett 1960: 3). Each village site had established family fishing holes. The ownership of these sites could be acquired by heredity, as a gift, or as payment. Other individuals could also rent them out in exchange for a share of the catch (Kroeber 1925; Kroeber and Barrett 1960). Everything native people needed for subsistence or for their secular and religious lives was found within their ancestral lands or traded for with neighboring communities.

In the past, management did not happen in the river, it happened out of the river. "Most Native Americans saw themselves as enmeshed in a web of interdependent and mutually complementary life" (Grinde and Johansen 1995: 36). The ceremonies handed down by the Creator at the beginning of time dictated the management of all of their resources. "It's about culture and the way we believe, we

have a right to go fish...we were directed from creation to take care of the fish" (Karuk eeler). The Creator gave them the formula for survival and that formula still exists (Chamber 2001). The use of low intensity fires as a management tool "existed within a rich and elaborate ceremonial expression of respect and responsibility to the natural environment and its spiritual expressions" (Salter 2003: 6). Native knowledge of the environment is derived from the close observation of and intimate involvement in the processes of nature.

> Native people were very observant and they had to know things very intimately to be able to survive. Through thousands of years of observing or being given special knowledge from the spirit people, they gained that information and they had a knowledge of this area (Karuk tribal elder).

These observations applied to the intentional and purposeful management of the land, and were fine-tuned to include additional factors such as seasonal changes and other natural characteristics (Salter 2003).

> The old people, surveying a landscape, had such a familiarity with the world that they could immediately see what was not in its place. If they discerned anything that seemed to be out of its natural order—a nocturnal animal in the daytime, unusual clouds or weather conditions, or a change of the plants—they went to work immediately to discover what this change meant (Deloria and Wildcat 2001: 63).

When they saw an imbalance, it was their responsibility to initiate ceremonies that would help bring about balance once again. They were well aware that when a certain sequence of things began, certain other elements or events would also occur. People had a sense of being personally involved in the functioning of the natural world (Deloria and Wildcat 2001). Management was adaptive and co-evolutionary.

Western views of the world place humans in control of, but without a sense of community with, the rest of the natural world. The price is that absolute values have to be maintained and space, time, and matter become absolute concepts (Deloria and Wildcat 2001). From an indigenous perspective, the elders were given specific instructions regarding plants, animals, birds, reptiles, and stones, as well as the technology for living in community with them; these came in dreams, visions, unusual incidents, and interspecies communications. Humans were given the ability to do many things, but not to have specific knowledge about the world. Their job is to learn from the other, older beings and pattern themselves after their behavior, to gather knowledge not dispense it. Through precise observation and through ceremonies, they can connect with the lives and minds of the other entities of creation (Deloria and Wildcat 2001).

> In one aspect, the ceremonies, as with other aspects of traditional perspective are reenactments of acts of the Ixkareya or immortal ones. In another sense these ceremonies go beyond symbolic reenactments and are themselves metaphors for close and careful husbanding of resources, of hard work, of making your own luck in the tradition of Karuk individualism, and of the seasonal lack of resources available to the people, even with the most careful of ritual observations (Salter 2003: 23).

It was understood that cycles may be larger than one lifetime; this information would be passed down from generation to generation and they would know how things worked, even if they did not live long enough to see the end. Meanings associated with a place or experience were subject to "suspended judgment". Answers were only a temporary statement subject to rejection or reformulation at any time (Deloria and Wildcat 2001: 6). "Traditionally, one waited

until knowledge was given...Oral societies are structured so that old people have high status as the custodians of knowledge, which they restrict and distribute at their discretion" (Smith et al. 2000: 15). Anomalies were tucked away in memory with the realization that the relationship of these things with their existing knowledge may become known at a later time (Deloria and Wildcat 2001).

Yurok and Karuk traditional management is based on long-term observations and interactions with the local Klamath River system that incorporates spiritual and cultural elements. This approach works both spatially and temporally with the natural processes and variability of the local environment.

1.4 Theoretical Framework

History provides the context in which to understand the dominant paradigm of Western science and the slow acceptance of indigenous knowledge. It reveals both where things are today and how they have come to be that way (Boas 1920). This history begins with centuries of European domination and exploitation that oppressed indigenous sacred practices and cultures. Beliefs in European superiority failed to recognize the sophisticated natural resource management practices that shaped what the first settlers labeled as "wilderness" (Hillman and Salter 1997). Nineteenth century evolutionary thought justified the oppression of native cultures by white Americans. Despite the fact that Darwin destroyed the basis for old racist views, he provided a new rationale within which almost all of the old ideas about racial superiority and inferiority could find a place (Gossett 1963).

While anthropologists like Lewis Henry Morgan and Franz Boas attempted to change the public image of the American Indian, the public and media made native

people into museum pieces to be studied. The idea of them as "living fossils" only reiterated the perception that they were lower forms on the evolutionary scale. Vine Deloria, Jr. writes, "If tribal peoples represented an earlier stage of human evolution, everything they said, believed, or practiced must necessarily reflect a stage of superstition from which Europeans had emerged. Therefore, their traditions were simply fairy tales made deliberately to explain a cosmos which they feared" (1995: 64). Only in recent years, have some non-native people understood and recognized the validity of traditional management practices and their application in current resource management issues.

1.4.1 Traditional Ecological Knowledge

Personal insights into a species life history are often disregarded as merely anecdotal. However, while they may not be understood in the context of Western scientific knowledge of lamprey, the connection of that observation to the larger picture may not have been revealed yet. As the fishers of a tribal community, eelers are on the river for most of their life; they know the place of things and recognize where they should be during a certain time of year or time of day. While these fishers may seem to be combining aspects that should not or could not be together, traditional ecological knowledge (TEK) may reveal relationships that the non-native thinker may not initially see (Deloria and Wildcat 2001).

TEK is the knowledge of a particular geographical location that involves politics and ethics and is reflexive, accumulated through empirical observation, and passed down trans-generationally and within group membership of the community. It centers on "natural places and connection to the natural world, which is capable of

generating a conservation ethic on the part of those who follow its principles" (Pierotti and Wildcat 2000: 1335). F. Berkes defines TEK as

> A cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with the environment...is both cumulative and dynamic, building on experience and adapting to changes (1999: 8).

TEK is an important component of how a group can co-evolve with the surrounding environment. Social, spiritual, and physiological adaptations emerge as a group changes in response to the dynamic environment and accumulates knowledge of this environment over long periods of time. People learn from their experiences, encode this knowledge, and pass it on to the next generation. Culture-based behavior adapts quickly as conditions and opportunities change (Redman 1999). The larger ethics of connection and relation also emerge based on ancestral ties, ecological community-focused theories of nature, and the causal relationships of all biological organisms.

TEK is often times compared to the ideologies of ecology; however, it is important to understand a key distinction. According to Berkes et al. (1998), while both focus on a holistic, long-term understanding of nature, ecology is still based on human dominion over nature, which differs from native beliefs that humans are a part of nature. Additionally, "indigenous, contextuali[z]ed ways of knowing contrast with the linear, compartmentali[z]ed ways of thinking that are integral to societies with written traditions" (Smith et al 2000: 22). This is an important distinction to consider when looking to "align" the two sets of knowledge.

Most TEK literature uses the words "bridge" or "integrate" to refer to working with both TEK and Western scientific knowledge. Sometimes a word is just a word; other times, a word can influence "the way that people can act upon and think about TEK and its relation to science" (Nadasdy 2003: 120). A "bridge" can often times be a one-way road, disregarding the reciprocity that needs to be in place for us to move beyond the political undercurrent that has directed history and allowed the dominant culture to "call the shots". The term "integrate" assumes that TEK and Western scientific knowledge are two comparable and compatible knowledge sets. However, TEK is often "encoded both in distinctive paradigms and into everyday practice, and these may get stripped away in translation because they do not travel easily across cultural boundaries" (Cruikshank 1998: 52). The tendency is "to shatter the holism of local knowledge by simply eliminating the parts that do not . . . migrate easily" (Cruikshank 1998: 62). While every word that comes from a Western language will have its shortfall when working with TEK, I have borrowed the term "align" from Rachel Novak (2002), whom I believe has found the most fitting word so far to describe how we can work with TEK and Western scientific knowledge together. An alignment of TEK and Western scientific knowledge means that the two knowledge sets are working side-by-side, equal and parallel, allowing for differences and similarities while not forcing one to fit into the other.

Some scientists emphasize how the holistic approach of TEK complements the limits of science to respond to emergent properties of complex systems. They find it counterproductive not to use a diverse array of approaches during a time of

emerging novel problems (Ford 2000). There have been a growth of community-based resource management projects since the 1980s that are utilizing ethnographic methods of participant observation, semi-directed interviews, and focus groups to document TEK and "integrate" it with Western science (Johnson 1992, Huntington 2000). While these researchers apply the information they acquire to current scientific studies, these projects are rarely included in the larger body of Western scientific literature, and many scientists have differing opinions on its validity and utility (Bielawski 1996). Additionally, TEK continues to be categorized into parts for use by science "rather than a system of knowledge that could inform science" (Cruikshank 1998: 50).

I only know of three studies that have utilized TEK in researching Pacific lamprey in the Pacific Northwest. All were short-term studies, but each emphasized the applied aspect of the valuable information acquired. Researchers for the Confederated Tribes of the Siletz Indians describe the importance of utilizing TEK in their lamprey research projects,

> The interviews with the Elders gave us insights to aquatic habitat parameters, local lamprey ecology and the population decline as it relates specifically to the Pacific lamprey in Rock and Little Rock Creeks. Additionally, the interviews substantiated the local concern about the Pacific lamprey and served as a guide for further research (Chapin et al. 1998: 1).

Research was also conducted for the Confederated Tribes of the Umatilla Indian Reservation to gather TEK of Pacific lamprey from tribal members "to gain additional natural history insights and baseline life history information for a poorly understood species" (Close et al. 2004: 141). These studies are important stepping-

stones to more in-depth studies that continue to refute historical biases and demonstrate the importance of this parallel system of knowledge. However, even these studies demonstrate the pressure that tribes feel to fit their traditional knowledge into Western scientific management terms and systems.

> The imperative of incorporating TEK into the state management system has caused researchers to focus on extracting from communities only that kind of information that can be expressed in a few very specific ways. . .forms that can be utilized within the institutional framework of scientific resource management. . .and then to interpret that information in a manner consistent with the assumptions of scientific wildlife management (Nadasdy 2003: 129).

While working with TEK, it is important to keep in mind the social, historical, and political conditions that have allowed one culture to analyze, translate, and redefine another culture's system of knowledge into their own categories of understanding.

1.4.2 Political Ecology

People are constantly adapting to both the physical and political environments around them in their everyday lives. The cultural core is that which is most immediately connected to those physical and political worlds. In today's human societies, this core includes complexities and uncertainty that stem from the involvement of players from multiple worldviews who provide both internal and external inputs into that culture. "In aboriginal peoples' 'holistic' view, biophysical components can be separated neither from each other nor from the human components—the social, cultural, spiritual, and economic aspects of the environment" (Sallenave 1994: 17).

A person's "environment" includes not only physical ecosystems but also regulating sets of institutions that range from the individual and community levels to the national and global levels.

> Cultural ecologists have long insisted on the role of culture in human adaptation and the consequent need to enlarge the unit of analysis to embrace entire culture areas. The logical outcome of this has been incorporation of the broader political and economic systems proposed in the field of political economy (Greenberg and Park 1994: 5).

The resultant political ecology "expands ecological concepts to respond to this inclusion of cultural and political activity within an analysis of ecosystems that are significantly but not always entirely socially constructed" (Greenberg and Park 1994: 1). At a local level, this means that cultures are adapting to both a cultural ecology that includes the physical landscape and a political economy that includes state and federal government policy.

Exploring the political ecology of the Klamath River system provides an opportunity for us to understand both the history and the future of fisheries resource management in the Basin. According to Smith et al (2000: 21), "...an ancestral past might be seen to hold up the immediate past, which in turn imbues the present...there can be no closure of the past. The view that the past imbues the present is common among Indigenous peoples from rural, urban, and remote locations in various parts of the world".

"Power" has played a key role in shaping the political, cultural, and natural environments of the Klamath River Basin. Tribal groups across the country are increasingly asserting their rights as sovereign nations. Sovereignty is an inherent

right as a consequence of their historical status as independent nations. It is the legal distinction between Indian tribes and other cultural groups in America and is the basis for their relationship with the federal government (Wilkins 2002). However, it does not guarantee self-determination or the opportunity for tribes, like the Yurok or Karuk, to support and regulate their people or resources as an independent nation. While the trust relationship established between tribes and the federal government protects tribal sovereignty, Congress still has the plenary power to terminate that trust relationship at any time. Tribal powers are inherent but may be limited by the United States expressly or through implication. In reviewing the historical development of Indian federal policy and tribal sovereignty, it becomes apparent that tribes are truly only "quasi-sovereign" or "semi-independent". They are "conquered" nations under the control of the federal government (Pevar 2002). This plenary authority is based on the dominant military power of the federal government to limit the activities of tribes and to abolish their governments at any time. These "nexes of complex processes" (Buckley 2002: 189) within the Klamath River Basin are illustrated in Appendix B, as well as the text that follows.

The Yurok were in contact with non-native people early on, while the Karuk remained relatively isolated from white contact until the discovery of gold and the arrival of miners, packers, and traders in 1850. As with many indigenous groups, the implications of this contact (e.g., disease, warfare, malnutrition, and poverty) had a devastating impact on population numbers. According to the Four Directions Institute (2004), Native American Historical Database calculations estimate Yurok and Karuk pre-contact populations at 2500 and 2700 people, respectively. By 1900,

these numbers had dropped to around 700 Yurok and 1000 Karuk (Four Directions Institute 2004). In 1999, according to the 2000 U.S. Census, the Yurok tribe had a population of 4029 people, while the Karuk had a population of 2702 people.

In 1851, the Yurok, Karuk, and Hupa signed a "Treaty of Peace and Friendship" with US representatives (Yurok Tribe 2002). Fishing rights were reserved with the signing of treaties, however treaties in California were never ratified so fishing rights are still unclear. Today, the federal government ties those rights with a land base. The Klamath River Reservation was established in 1855, but the Homestead Act brought settlers from across the United States with the promise of fertile land and plenty of water for farming. Soon much of the Klamath River Reservation was opened up to non-Indian settlement (Huntsinger et al. 1994). The Hoopa Valley Indian Reservation was established in 1876 with the expectation that the Yurok, Hupa, and Karuk would live there. Military efforts were used to force the Karuk onto the Hoopa reservation, however the attempts were eventually abandoned, and after their sacred villages were burned in the early years of the gold rush, many either escaped to the mountains or returned to their former communities (Salter 2003). Today, the Karuk have a land base, but it is not formally designated as a reservation.

Federal tribal trust responsibilities to the Klamath Tribe in the Upper Basin and the Yurok and Karuk Tribes downstream were often ignored. The Dawes Act of 1887 gave virtually unlimited power for the Bureau of Indian Affairs (BIA) to sell, lease, or administer lands and natural resources of tribal communities (Cornell 1988; Wilkins 2002; O'Brien 1985). Over 50,000 acres were removed from native

ownership, while timber companies heavily logged areas along the Lower Klamath River during this time period (Leshy 1993).

The Reclamation Act of 1902 and the formation of the Bureau of Reclamation pushed forward additional plans for irrigating the Basin (Marbut 2002). The Klamath valley in the Upper Basin was once covered in vast wetlands, which were soon drained and utilized for their nutrient rich soils. By 1905, the Klamath Project was developed as a federal reclamation project and thereby bound in contract the federal government and the Project irrigators. That contract, and with it the promise of water, remained strong, even as the US passed further legislation protecting waterfowl and creating wildlife refuges in the Basin.

The federal government has conflicting approaches when dealing with water issues. The Klamath Project contract between the US government and the irrigators who farmed within the Project states that the US will provide water for irrigation; however, the U.S. has the affirmative duty to protect tribal water rights, to assure adequate supplies of water to Indian reservations, and to manage tribal water in the best interests of the tribe (Wilkins 2002). The federal government also has an obligation to protect other federal water interests. Many times these interests do not coincide with tribal interests and the federal government has a history of dealing with other interests first (Wilkins 2002). In 1917, the Copco Dam was built and others soon followed, blocking fish passage along the Klamath River. The fish were and are valuable food and cultural resources for the Lower Basin tribes; however, priorities remained with energy production and the development of irrigation

systems. Iron Gate Dam was built in 1962, effectively blocking 350 miles of historic spawning habitat for anadromous fish species.

The first half of the 20th century saw a continued decline in water quality in the Basin. Tribes continued to see a loss of their resources and in a final blow, during the 1950s, the tribes of the Klamath Basin were terminated. While the trust responsibility of the federal government remained to protect aboriginal hunting and fishing rights and the resources that sustain them, the U.S. government focused on the forced assimilation of Native Americans. Young tribal members were shipped off to boarding school and many tribes fell into economic distress (Wilkins 2002). Many of the world renewal ceremonies of the mid and lower Klamath River tribes dropped off during the 1950s when people moved away to find work. Even at the turn of the century, the ceremonies were impacted by the assimilation practices of the dominant culture.

From the 1930s to 1970s, the state of California exerted its power over the Lower Klamath tribes, chasing them on the river even though they had a right to fish. The "fish wars" of the 1970s finally culminated in the 1973 federal court decision that states have no jurisdiction over "Indian Country" (Leshy 1993). The self-determination era empowered tribes to revitalize traditional ceremonies and organize themselves to have more weight in fisheries management decisions. The Karuk Tribe became incorporated in 1964 to preserve their traditional knowledge; they received federal recognition in 1994. After the Hoopa-Yurok Settlement Act of 1988 and the establishment of the Yurok Indian Reservation, the Yurok Tribe was

formally organized in 1993 and took over harvest monitoring from the state (Yurok Tribe 2002; Huntsinger et al. 1994).

Today, both Yurok and Karuk tribes have growing fisheries departments that struggle to establish themselves as purveyors of solid "scientific" data, while also empowering tribal members, reestablishing and protecting resource management rights, and revitalizing and supporting the transmission of traditional knowledge and management practices. Sadly, even as resource managers and agencies shift to incorporate TEK and local communities into their management decisions and policies, the expectation remains that this knowledge and participation will come in a comparable form to what they already know. Its value lies in its use as "data" and as a supplementary body of information, rather than as a way of life that may not fit in with Western culturally derived standards of relevance (Nadasdy 2003). Even among talk of co-management and local community participation, an undercurrent of Western forced assimilation still remains. Additionally, there is little protection of non-material knowledge once that knowledge is shared beyond the context of the community (Pinel and Evans 1994, Berkes 1999). Intellectual property rights cover material objects, but do not address tribal needs to protect cultural and spiritual knowledge. Outsiders often use this knowledge in exploitative and inappropriate manners (Pinel and Evans 1994). Historically, much of this knowledge has been taken away without reciprocity to a tribe and without respecting or understanding the importance of context and spiritual implications. The backlash has often been that more rights are taken away.

1.5 Research Project

Current trends of Klamath River Pacific lamprey populations may have detrimental impacts both culturally and ecologically. According to Karuk and Yurok tribal fishers, the lamprey fishery has experienced a dramatic decline in the past decade. In a preliminary study conducted by the Yurok Tribe, local eelers described harvests of 1500 lamprey in one day during historical runs. During this 1998 study, lamprey catch per unit effort (CPUE) was reported as ranging from zero to 100, with 20 lamprey found to be extremely good (Larson and Belchik 1998). However, much of the literature regarding lamprey is focused on populations in Oregon and British Columbia. "The limited information that exists concerning...Pacific lamprey populations in the Klamath and other nearby drainages reflects the gap in our knowledge of these species' population trends and man-caused factors which may affect them" (Larson and Belchik 1998: 10).

Western science and TEK are each limited in their abilities to alone interpret the complexities of today's natural systems. Human impacts on the environment and poor management decisions of the past have created natural systems that require a more holistic approach to resource issues. Western science is able to explore and research controlled parameters of natural systems in its understanding of Pacific lamprey. In resource management, however, there is a lack of ecological baseline data and an adequate framework to link ecological and social components of the environment. To mitigate these issues, it is important to include TEK in the process formally (Sallenave 1994). TEK can provide an alternative perspective to the standard scientific approach, providing avenues for further research and

collaboration. While it is ethnocentric to assume, or insist, that all TEK can be or should be translated into Western concepts, the alignment of these knowledge sets is an important step to developing comprehensive, system-based fisheries management.

As many sources indicate, the successful incorporation of local knowledge into resource management is still relatively rare (Berkes 1993; Deloria and Wildcat 2001; Grenier 1998). Possible reasons for this difficulty have been directed at the fishery managers for their inability or unwillingness to accept local knowledge (Ward and Weeks 1994; Jentoft and Mikalsen 1994; Pinkerton 1994). Additionally, the alignment of two knowledge sets that have different approaches to obtaining knowledge can be difficult in practice.

> Information in Indigenous systems of knowledge is rarely definitive. Instead, this knowledge, grounded in oral traditions, is multivalent, ambiguous and open to alternative renditions according to the context of interpretation. In contrast, the search by non-Indigenous peoples for absolute forms of representation is steeped in the essentialism of written traditions. In an interconnected world one issue that arises is how to transmit the fluidity of Indigenous understandings to a public whose education is grounded in written traditions (Smith et al. 2000: 11).

Even with these barriers, the potential for applying TEK to management is substantial; especially if we change our perspective and look at it as utilizing Western science within the context of traditional resource management.

> In celebrating the holistic analysis of linked ecosystems and institutions, we are not turning our back on science to celebrate the noble savage—rather, we are acknowledging the existence of a "people's science" as an antidote to excessively centralized and bureaucratized resource management science (Berkes and Folke 2002: 121).

The scope of most of today's environmental assessment and monitoring approaches is limited to the biophysical components and excludes the socio-cultural ones.

> ...all relationships, in human society as well as in the natural ecology, are subject to the same processes of nurturement or destruction as are ecological systems; understanding and harmony with these enduring principles exist at levels which include the conscious and verbal as well as the unconscious and non-verbal. Human life and society are affirmed as aspects of a more inclusive system of natural processes by these conceptions of the forest and of the place of the community in relation to the forest (Salter 2003: 9).

The everyday experiences of the local fisher and their knowledge of natural history can provide important information for managers (Stoffle et al. 1994). In traditional management systems, the core is derived "from the observations and experiences of generations of fishermen and fisherwomen working in environments with which they are intimately familiar" (Ruddle 1994: 175). Additionally, traditional ecological knowledge can be viewed "as a mechanism to implement co-management and self-government, and as a mechanism to integrate local values into decision making..." (Berkes and Henley 1997: 31). Again, the cautionary words from Nadasdy (2003) on the political dimensions and power plays of TEK are worth keeping at the forefront of our minds as we take strides towards co-management and locally directed approaches to resource decision making.

While I am critical of species-specific approaches to resource management, in this project I utilized this approach as a process to explore and learn from the holistic foundation of Karuk and Yurok TEK. I focused on Pacific lamprey as a lens through which to view and understand the Klamath River Basin environment as a whole. I have asked two main questions in this research: how does Karuk and Yurok TEK

contribute to a more comprehensive understanding of Pacific lamprey populations in the Lower Klamath Basin? Additionally, how does it provide us with a greater perspective of the interconnected ecological and cultural characteristics of the Klamath River system as a whole? In the following chapter, I share my approach for working with the Yurok and Karuk tribes and tribal community members to develop a relationship of trust and reciprocity. In the results chapters, I have included much of the knowledge shared with me by local eelers and tribal community members addressing the above questions and the inseparable connection of Pacific lamprey, the Klamath River system, and Karuk and Yurok cultures. Finally, I utilize the main TEK contributions from this research to continue the discussion of aligning TEK and Western scientific knowledge. I also include recommendations for both Karuk and Yurok tribal fisheries programs and Western fisheries managers in the Klamath Basin on working with TEK and supporting local tribal fisheries management.

Chapter 2
Methods

2.1 Approach

This research project provided the opportunity to work with the Yurok and Karuk tribal communities, two groups with similar natural and cultural environments but distinct political structures and histories. I utilized methods that were constructed in a flexible framework that allowed me to maintain cultural sensitivity, as well as address each tribe's distinct needs and desires for the direction of this research.

I came into this project with concerns about my position as both an outsider and as a woman. While women are key participants in the processing of lamprey, it is taboo for them to harvest lamprey. However, my presence was not seen as inappropriate because many women go down where the men are eeling to watch and help with picking up the lamprey that have been captured. Well aware of my role as an outsider, I took every step I could within the time constraints I was working to develop a relationship of trust and reciprocity with each of the fisheries programs and the participants. It has always been my goal to include both tribes in every step of the project, from the development stage to data collection to analysis to the final write-up. While this process has meant that data collection and analysis took many months longer than I originally intended, the very journey of the process made it well worth it. In an interesting twist, I found myself learning in a manner not unlike the process of traditional knowledge. "Understanding is a grasping of what things mean and knowing how to interpret them and how to respond in the course of events, and

is not about giving a definitive representation of them as an independent reality" (Merlan 1997 quoted in Smith et al. 2000: 11).

I mentioned earlier developing a relationship of trust and reciprocity with each of the participants and the fisheries programs. Smith et al. (2000: 19) writes that, "it is in the hands of the researchers themselves to adjust their methods so that the communities they work with do benefit. This adjustment is likely to entail engagement in the Indigenous struggle to gain control over their past, present, and future." My project idea evolved out of numerous discussions with both native and non-native people, as well as meetings with the Yurok and Karuk tribal fisheries programs. Not unexpectantly, in my presentation to the Yurok culture committee, I was met with reservation and concern over allowing an outsider to come in and share in their traditional knowledge, as past encounters had brought either consequences or nothing in return. While during that moment I knew that I would not be able to appease their concerns, I hoped my actions would reflect on me as not being "just another anthropologist" coming in to take their knowledge and leave with it, while not giving anything back in return. The committee may have been disinclined to approve the project, but they gave their okay because the fisheries program was supportive and I would be working with them directly.

When I approached the Karuk tribal natural resources department with my research proposal, I was surprised to find that they had fewer concerns than the Yurok. While I could speculate on numerous reasons for this difference in reception, I believe Salter has hit upon the source, "...the same remoteness that left the Karuk relatively less impacted by the invasion of Europeans than their downriver neighbors

the Hupa and Yurok, left them relatively unstudied by the ethnographers of the late nineteenth and early twentieth centuries" (2003: 7). For generations, the Yurok have been subject to the inquires of intellectual curiosity from numerous outside groups, not to mention years of social and cultural genocide. While Karuk first encounters with Europeans also developed into violence and forced relocation, their relatively inaccessible location has meant that only in recent years have research groups expressed greater interest in working with and learning more about the Karuk. In many publications, the Karuk are often grouped in with detailed descriptions of Yurok and Hupa culture.

The protection of intellectual property rights is an important issue when working with any indigenous group. Outsiders often use aspects of a culture that center on religious and spiritual knowledge in exploitative and inappropriate manners. Technically, tribes can use their inherent right of sovereignty to assert their own values and to control access to and the use of cultural knowledge. Sovereignty is limited, however, by the plenary power of the federal government. While it "guarantees" that laws can be passed that protect non-material resources within a reservation, there is little protection beyond the context of the community (Pinel and Evans 1994). Many tribes recognize the role of anthropologists and other outsiders in helping to protect native cultural knowledge. Although it becomes a two-edge sword when information must be shared in order to protect knowledge that they want to keep secret because it is sacred and has specific rules for the process and use of its transmission. The very act of disclosure destroys the sacredness that gives the meaning in the first place (Pinel and Evans 1994).

In each tribal fisheries program, a tribal member who worked in the program became one of my key informants. A key informant is a person in the position to know the culture and community as a whole, especially the particular area of interest, while also willing to "walk you through their culture and show you the ropes" (Bernard 2002: 187). These two men were fundamental in contacting and connecting me with my participants, whom they chose based on their own understanding of who was the most capable, as well as willing, to share with me their knowledge of lamprey and the Klamath River system. The key informants also provided valuable personal insight into their world as eelers and members of their native community, as well as the greater Klamath River ecological community.

I triangulated my data collection using participant observation, informal interviews, semi-directed interviews, focus groups, and archival and historical research. This approach allowed me to ensure the reliability and validity of my data by obtaining "comparable, confirmatory data from multiple sources at different points in time, and through the use of multiple methods" (Bernard 1998: 719). According to the 2000 U.S. Census, the Yurok and Karuk tribes currently have populations around 4029 and 2702 people, respectively. During this study, a total of 83 Yurok and Karuk tribal and community members participated through informal interviews, focus groups, and semi-directed interviews.

2.2 Participant Observation

Participant observation included observing the activities involved in the process of eeling. Both men and women participate at different times in this cyclical process, which includes more than just the act of harvesting the lamprey. The

process of eeling includes understanding the right way and time to gather materials for making the tools for harvest (hooks, gaffs, baskets, and nets) and acting in the proper way while making these tools. It also means being respectful of fellow eelers, the ocean and river that is providing this food source, and the lamprey that are giving themselves to the eelers. The process of eeling includes the cleaning and processing of the harvested lamprey. Additionally, following the proper way of living ensures that the waters are prepared so that the lamprey return again and again.

Observing the process of eeling was an important step in developing rapport with local eelers and learning more about the cultural and social importance of eeling and lamprey (Bernard 1998; Ervin 2000). Often times, informal interviews and discussion came out of these experiences. It was an ideal time to discuss and see harvest methods first-hand, as well as to place into context the changes in the river and landscape that had been described to me during interviews. While a person was in the act of eeling, making an eel basket, or cleaning a lamprey, it often triggered thoughts and ideas about the species and the river system that they may not have thought of during a more formalized interview (Ervin 2000).

Participant observation also introduced me to other eelers and tribal members, outside of my key informants' contacts, with whom I was able to set up semi-directed interviews or invite to participate in the eeler focus group. Table 1 below includes each of the eeling activities I observed and the number of participants involved in each activity. I counted a participant only once for a specific activity even if they were involved in more than one observation session. I did count a participant for each activity in which they were involved. Because there is overlap in

the number of participants, I did not include a cell with total participants for all activities in the table below.

Table 1 Participant observation activities by number of sessions and number of participants per activity

Activity	Number of Observation Sessions	Participants			Total Participants
		Elder Eelers	Eelers	Non-Eelers	
Eeling at the Mouth	**4**	6	6	1	**13**
Setting Basket Traps	**2**	3	2		**5**
Taking Out Eel Baskets	**2**	3			**3**
Processing Eel	**1**	2			**2**
Weaving Eel Baskets	**3**		3		**3**
Eel Fishing Holes	**2**	1			**1**

2.3 Informal Interviews

Many informal interviews came out of participant observation experiences. Additionally, some participants preferred to have an informal conversation with me to a more structured interview. Not including conversations that occurred during observation sessions, I spoke with 14 participants informally. Often times, both informal and semi-directed interviews occurred in unusual locations or unexpectantly. Conversations often arose in the car or on the trail while I was traveling with one of my key informants. Frequently, we would be on our way somewhere else and a quick detour would find us at someone's home or down by the

river to look for people fishing or eeling. It was not unusual to be eating lunch at the local restaurant and end up talking with someone while my sandwich sat half eaten. I found that my informal interviews with the eelers or other local people often filled in the missing pieces of my data. In talking with them about other subjects, I had the opportunity to learn indirectly about their views and knowledge on lamprey (Bernard 2002). Even though my other interviews were only semi-directed, the makeup of these informal discussions allowed us to move beyond the given topic and, in essence, they became the connectors that helped to make the picture more complete.

2.4 Semi-directed Interviews

From November to December of 2004, I lived in Klamath, California in a small RV trailer I borrowed from the Yurok Watershed Department. Based on my initial experiences, I was expecting to be met with reservation by the community. I came into the project planning to work with the fisheries program on projects that would keep me in contact with local fishers and help to develop a trust relationship. After a month or so, I would meet with the eelers to discuss the project, answer questions, and set up interviews with interested participants. However, both that plan and my expectations changed once I arrived in Klamath. With my key informant's assistance, I was conducting two to four interviews a day from the start. The people I talked with were receptive to the research and many were eager to speak with someone who was interested in lamprey and what they had to say about them. I have my doubts that I would have been received as warmly had my research been about salmon, basket weaving, or any subject that has been intensely researched in the past. I had a similar experience in the spring of 2005 when I lived in Orleans

for two months to work with the Karuk. Again, with my key informant's valuable assistance, I talked with at least one to three people a day.

I chose to focus my interviews on the men who harvest lamprey because they are the ones who are on the water and seeing the fish while they are moving through the river system. I also interviewed women because they are also a part of the process of eeling and have an equally important role in taking the lamprey once it has been harvested. Surprisingly, two of the eelers I interviewed were women who had been eeling their entire lives.[3] Additionally, I interviewed both men and women who do not or have not regularly participated in lamprey harvest. These participants provided insight into knowledge and experience that is gained through living a life that revolves around the river. It was also revealing to talk with those who eeled when they were younger and lived on the river, then moved away, and have since returned. They were valuable avenues to recognize changes that occurred on the river over time and to differentiate what is general knowledge and what is learned from spending a lifetime on the river.

Interviews included both elders[4] and non-elders, as it was important for me to explore the transmission of trans-generational knowledge. Elders provided knowledge that they were taught from their elders, as well as their experiences. Many of them have experienced significant changes even within their own lifetimes.

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[3] Women harvesting lamprey is generally seen as taboo. While these two women provided their own personal experiences as women eelers, I was not made privy to the cultural mechanisms that allowed them to eel throughout their lives.

[4] Status as an elder is not easily defined since it is not based primarily on age. Respect seems to be the more important element in determining who is considered an elder in the community.

Non-elders also shared knowledge that they have been taught from their elders, many of whom have already passed on. They also offered new perspectives that intertwined Western scientific knowledge with traditional knowledge.

Initially, I planned to conduct semi-directed interviews with 10-20 eelers and 5-10 non-eelers from each tribal community. I ended up conducting 59 interviews with 66 participants. Ages ranged from 24 to 90 years old. While many participants were Yurok and Karuk tribal members, others had Yurok and Karuk ancestry but were members of another tribe. I did not allow the complexities of multiple ancestries to be a limiting factor. Many people felt a connection, whether by ancestry, friends, or upbringing to both tribal communities and not necessarily based on their member status. Therefore, I included a participant in the tribal community to which they expressed a connection or in which they resided; I reference that tribal community when I quote a participant. Table 2 breaks down the participants by tribal community, gender, and eeler status.

Table 2 Semi-directed interview participants by tribal community

Tribal Community	**Participants**				**Total**
	Gender	**Elder Eelers**	**Eelers**	**Non-Eelers**	
Yurok	Male	15	12	3	30
	Female	1	1	7	9
					39
Karuk	Male	10	11	1	22
	Female	--	--	5	5
					27
Total Participants		26	24	16	**66**

Semi-directed interviews ranged from 25 minutes to 2 ½ hours, with the average length an hour; the total number of interview hours equated to more than 60. Participants were offered the option to have a tribal member conduct the interview; however, no one took this option. I explained the purpose of the interview, how the knowledge would be used, and if they had any questions. When I began my interviews with the Karuk, I also presented each participant with a one-page summary of the research goals and objectives (see Appendix C.1). Additionally, I gave both Yurok and Karuk participants a handout I developed called the "Biologist's Perspective on Pacific Lamprey" (see Chapter 2.10 and Appendix C.2), based on the most current research available on Pacific lamprey from the perspective of Western science. The handout was an important component of developing reciprocity with participants. Many people had asked me what science knew about lamprey, so I decided to make this information available for them. Those participants who I interviewed before I finished the handout were sent one in the mail. Each participant was explained their rights and given the opportunity to read and sign the Oregon State University Institutional Review Board consent form.

Participants were interviewed individually or, per situation, in groups and asked questions to start a discussion. As the conversation evolved, more questions were asked that pertained to the new topics and direction that had developed. This type of questioning allowed the information to come directly from the participants (Huntington 2000). While I understood and believe that it is impossible to completely eliminate my own biases in my research, by allowing participants to "define the content of the discussion" (Bernard 2002: 209), I hoped to limit my own

"culturally derived standards of relevance" (Nadasdy 2003: 121). In talking with the fisheries departments and informally with eelers on my first visits, I was able to develop an initial interview guide, which I followed informally during my first few interviews. As it became clearer what was most important to participants and to make sure that specific topics were covered in each interview, I developed a more detailed interview guide from which I could obtain reliable, comparable data (Nadasdy 2003).

By the end of my interviews with Yurok community members and through on-going analysis, my research themes began to emerge. By the time I began interviews with the Karuk, I had categorized the interview guide by general themes that were the basis of my research. These themes allowed me to maintain focus within the interviews while still allowing participants to direct their own answers and for me to ask additional questions based on these new insights. In this manner, new information arose that was very important in answering the research questions, but would not have been revealed if only the questions on the interview guide had been asked. I also individualized the interview guide for each participant type (elder, eeler, non-eeler, woman), while still maintaining the base questions. Appendix C.3 includes a sample version of the interview guide.

2.5 Focus Groups

I conducted two focus groups with Yurok and Karuk tribal community members for a total of four hours. The intent of the focus groups was to initiate conversation in a group setting that might be difficult to discuss on an individual level. The thoughts and ideas that came from one person sparked additional

comments from another and uncovered cultural norms and underlying ideologies (Bernard 1998; Morgan 1997).

The first focus group was conducted at the Yurok tribal office in Klamath and included nine Yurok eelers and two youth who listened in, but chose not to participate in the discussions. Eight men and one woman participated, with ages ranging from 24 to 78 years old. The focus group idea was first proposed to and accepted by some of the eelers with whom I had interviewed and shared in eeling experiences previously. Participants were recruited by myself and other eelers. I asked one of the younger eelers to facilitate the meeting to provide him with an opportunity to step up and take a lead in addressing the concerns of his fellow and elder eelers. I had also chosen someone who I felt was capable of guiding the other participants through the questions and referee time limits. He was provided with the focus group guidelines and questions prior to the meeting (See Appendix C.4). The questions were utilized to initiate conversation and to keep the group focused. The open-ended quality of this approach allowed the content to come from the group.

The second focus group took place on the Quartz Valley Indian Reservation along the Scott River. Thirteen families and original allottees were moved to this area during the violence along the middle Klamath. The reservation is now home to Karuk, Shasta, and Klamath Indians. The four people who participated in the focus group are closely related to Karuk people living along the mainstem Klamath River. Due to the nature of the focus group, the structure was much different from the first group. Two men and two women participated, two of whom had eeled when they were younger and two who had never eeled. The two elders who participated had

lived on the Scott River for most of their lives. I personally facilitated this meeting discussion around a map of the Scott River Valley, utilizing questions initially from the focus group guide and then from the conversations that arose from those first answers (See Appendix C.4).

2.6 Transcription of Audio-Recordings

Analog tapes were utilized for the first set of interviews and later copied as digital recordings onto the computer. A digital recorder was used for the second set of interviews. Each audio recording was transcribed using a transcription machine and software. Due to the number and length of interviews, audio recordings were transcribed for written content only, thus omitting "um", "er", "you know", etc., while maintaining the context and meaning of the interviews. Transcriptions of the interviews and focus groups totaled more than 400 pages. Quotes were transcribed verbatim and edited only for readability when included in the final thesis write-up.

2.7 Follow-up Interviews/Summaries

Originally I planned on following up with semi-directed interview participants through a second interview process in which they would be provided the opportunity in person to review and verify field notes and transcriptions from the audio-recordings, plus provide additional comments. Due to time constraints, I was only able to follow-up with three or four people. While the opportunity to meet a second time with people proved helpful in situations where the original interview had been limited in time or the person did not have the opportunity to say everything they wanted to in the first interview, it did not provide additional insight. If time

were not an issue, a second or follow-up interview would help develop greater rapport and trust with participants. Follow-up interviews are essential in situations where long term participation is possible and, in fact, would lead to greater insights over time. I sensed a deeper trust and was provided additional insight and knowledge from those eelers whom I had spent more time with through interviews, participant observation, and focus groups. If I had stayed many months or years longer, I may have been made privy to much more.

As an alternative to in-person follow-up interviews, I developed summaries of the interview transcripts for each person. These summaries were framed under the main themes that had emerged from the interviews. I sent each person a summary of their interview to provide them with the opportunity to review, edit, and comment on this first level of analysis. It was important to me to provide participants with the opportunity to remain actively involved in all steps of the project, including the analysis. Summaries were sent with a letter of explanation, contact information, and a self-addressed stamped envelope for ease of return. Overall, 21% of participants responded to the follow-up summaries. Comments included correcting errors in spelling and place names, as well as elaborating on previous responses to questions.

2.8 Archival and Historical Research

I was given access to the Yurok tribal archives to watch and take notes from videotaped fisheries interviews from the early 1990s. I also conducted research into Karuk and Yurok cultural, social, and political history in the Humboldt Room at Humboldt State Library and the California Indian Library Collections at Humboldt

County Library. Additionally, I met with state and federal agencies to research local fisheries management policy, research, and history.

2.9 Analysis

Data analysis was an ongoing process throughout my fieldwork. I maintained field jottings, field notes, a field journal, and a personal journal (Bernard 1998). These tools allowed me to process the information I gathered while I conducted the research (Bernard 2002). I developed a coded system based on the themes and sub-themes that emerged throughout the data collection and transcription process. The six main themes that emerged include eeling experiences, eel biology, population decline, ecological significance, cultural significance, and political ecology. Each main theme included eight to eleven sub-themes. These themes and sub-themes were given codes based on words that came from the theme subject and developed naturally from the study (Miles and Huberman 1994). I then went through the summaries of each interview and coded them. I developed a spreadsheet detailing the themes and sub-themes that were evident in each informal and semi-directed interview. Due to the immense amount of data collected, not all themes were included in this thesis. I chose to highlight the data that was most relevant for use by the Yurok and Karuk tribes in addressing current lamprey and resource management issues in the Klamath Basin. However, the coded data and theme spreadsheets will be available for future publications and for use by the tribes. I have included an abbreviated version of one of my theme spreadsheets as an example in Appendix C. 5.

I was able to follow up my analysis by talking directly with the tribal community member that provided the knowledge originally or by checking it with other community members to verify the accuracy of my analysis. I worked closely with the tribal fisheries programs to analyze the knowledge gathered and determine its immediate application to current and future lamprey research projects, as well as to current human land- and water-use issues. Two copies of my thesis draft were sent to each of the Yurok and Karuk fisheries programs for review and verification. I did not receive comments back from either group.

2.10 "Biologists' Perspective on Pacific Lamprey" Handout

In response to questions from participants regarding what fisheries biologists knew about lamprey, I designed a handout that I gave to eelers during semi-directed interviews and focus group meetings. I drew upon the most current research available on the biology and natural history of Pacific lamprey from the perspective of Western science (cs., e.g., Kan 1975, Pletcher 1963, Beamish 1980, Kostow 2002). The purpose of the handout was both to share this information and as an act of reciprocity for the time and knowledge that participants were sharing with me. It also provided a means to initiate conversation. Most participants were interested in the handout and found that it answered some of their own questions or validated their own perspectives about certain aspects regarding Pacific lamprey. I have included a copy of the handout in Appendix C.2.

2.11 Confidentiality

Research results have been written in a way that will not identify individual participants. It has always been my intention with this thesis to protect the knowledge and information that they chose to share with me. This confidentiality agreement allowed participants to feel more open to talk with me, knowing that others would not know what they said unless, at a later date, they chose to give their permission to share it. More than one participant expressed their appreciation for this confidentiality, that some of what they had to say they viewed as controversial and did not want to stir up trouble by having it associated with them. These community members may not have participated in the interviews or may have participated to a lesser extent without the confidentiality agreement. Other participants seemed indifferent and would quickly say that they did not mind if other people knew what they had shared with me. At the end of the project, all participants were given the option to receive a copy of the audio recording of their interview, to have a copy sent to the tribe, and/or to have it remain secure and anonymous.

Chapter 3
Biological and Ecological TEK

In chapters 3 and 4, data is based solely on the knowledge and opinions shared with me during my discussions and interviews with Yurok and Karuk eelers and other tribal community members. While many participants may use Western biological terminology and concepts because they are interested in and informed about aspects of Western scientific knowledge, they are still speaking from a traditional perspective.

I recognize that I was not able to move beyond the trap of "categorizing" TEK. However, my intent with this project was to conduct research that would be of use to the Yurok and Karuk tribes. At this time, they are continuing to fight a power struggle with state and federal agencies to be able to manage their own local resources in a way they deem most appropriate and which would potentially include both traditional and Western scientific approaches. The issues they are facing, dam re-licensing, harvesting rights, upslope management (i.e. traditional burns), are immediate concerns that require immediate action. While in an ideal world, TEK would be presented in its more holistic and comprehensive form, the time has yet to come when this presentation will result in the necessary actions that are immediately required to protect the Karuk and Yurok way of life. Additionally, I am the first to recognize that as a person who grew up with a Western worldview, I am not the most appropriate person to present a more accurate portrayal of traditional knowledge. As an advocate, I may assist in being a "translator" between different worldviews, but ideally, it would be a Yurok or Karuk person who has been brought up traditionally

and who is also well versed in Western science. This person would be able to recognize how Western science can be of use to the tribal communities, and to help to balance out this dichotomy of trying to maintain a way of life in a world dominated by an alternate worldview.

The results chapters include knowledge about the life history of Pacific lamprey; lamprey harvest experiences looking at lamprey presence, distribution, and relative abundance; population decline factors; ecological significance; and cultural significance. None of these "areas" are cut and dry, and were never meant to be. The cultural significance cannot be separated out from the ecological significance or harvest or population decline factors or any aspect; Pacific lamprey and the Yurok and Karuk people are the living, breathing entity that is the Klamath River.

3.1 Life History

I have outlined below the key observations made by participants regarding the life history of Pacific lamprey. These observations substantiate recent scientific studies, while also bringing new insight into lamprey behavior.

3.1.1 Ammocoetes

Participants found ammocoetes buried in the sand and fine gravel along the sides of the Klamath River and its tributaries. Most of these larvae are found in groups that increase in size as the substrate size decreases, so that more are found in sand and less are found as the gravel size increases. Ammocoetes come out at night to avoid predators. Participants who fish at night recall seeing the larvae making tracks on the shore, crawling along the shallows when the tide went out.

Ammocoetes filter feed in the silt and when all of the nutrients are gone, they get up and move to another spot. They have been observed feeding on the decomposing adult lamprey.

Ammocoetes were observed to be from one to six inches long. Those that were found to be six inches long were most likely macrothalmia, or juvenile lamprey, as they were described as being a pinkish color with eyes. Tribal community members with children remarked on how the number of young lamprey they see when they go swimming now versus when they were children has declined dramatically. Thirty years ago, they could easily pull up 100s of different size ammocoetes from the sand with their hands. As they disturbed the sand while walking in the water, people also remember watching the larvae pop up, swim around, and bury themselves back into the substrate.

Participants noted that during other times of the year 100s of ammocoetes were found underneath their boats or under the inner tubes for their net anchors. The last time participants saw these larvae ranged from "last spring" to 15 years ago, with most people speculating that it had been 5-6 years ago. One person remarked that he still sees spurts of young lamprey towards the end of September. Most of the participants who had seen ammocoetes or juveniles recently work in some capacity for the fisheries programs where they catch them in screw traps. The ones they find are of different age classes but are within three to four years of one another. Not many participants recall seeing juvenile Pacific lamprey migrating out to the ocean. A number of reasons were speculated, including that most people are not on the river if the juveniles are outmigrating during the late fall into winter when the waters are

higher. They are also less likely to be seen if they travel down the middle of the river since they are not fighting the current as they go back out.

3.1.2 Adults

Tribal eelers use harvesting methods for Pacific lamprey that capitalize on adult behavior and their own understanding of the complex interactions between this behavior and changes in the river system. Lamprey are well known as resilient, strong survivors. "Well, jeez, you can't hardly kill a damn eel. You take them out of the shittin' water and throw them in your damn kitchen sink and hell, they'll be alive the next day down crawling underneath your bed" (Karuk eeler). Many people recall seeing lamprey crawl straight up over dams, as long as there is plenty of water coming over. One participant described how they wiggle their tail to go up an inch or two, then suck back on, then go up some more, sometimes falling back off to start all over again. They are also known to make a suctioning or "popping" sound as they latch onto the rocks. In describing the large numbers of lamprey that used to move through the Klamath River system, one elder remarked, "You would be surprised how many damn eels run when they're running. There's no way of keeping track of them. You go along at Ishipishi Falls, these falls up here, you can hear them. Little suction cups on the bottom of the river."

Lamprey tend to be drawn to the path of least resistance, so eel baskets are placed to create eddies and changes in water current that can be felt downstream. "Eel follow the wake of the basket from downriver because it's easier swimming and they figure there's a resting place above where the water makes a whirlpool" (Karuk

eeler). The lamprey follow this slowing of the water current and swim up into the traps where they cannot escape.

> Eel always go upriver; the board at the upper end of a basket makes a wake so that the water goes around it and comes back together at the front end of the trap where the funnel starts. The wake will go way down river and the eel can feel it and follow it because they don't swim very good and it's easier swimming. The eel follow the wake figuring there's a resting place above where the water makes a whirlpool and that's where they'll rest. They funnel right in up against the backboard and then they're trapped in there (Karuk eeler).

When the water is moving fast, Pacific lamprey come in close to the shore and eelers will use dip nets to harvest them. They are seen moving along the top of the water when it is muddy to use their "breather hole" at the top of their body. Participants also find that lamprey "cruise the top" of the water when there is a lot of sand in the water because the sand clogs their gills. When there is a lot of gravel in the water, the lamprey will go to the bottom and hang onto a rock. Eelers utilize the knowledge of these behaviors to choose the most appropriate harvest method. "Eel is not a good swimmer in fresh water, which is why he sucks up the rocks in a swift area, whereas a fish will jump up the stream" (Karuk eeler). When an eeler is not able to see into the water because it is too muddy or when the lamprey are along the sides of the river, they use a dip net to capture them.

> When it gets muddy in the high water with all of the debris going down through the center of the river, the fish and the eels go down along the edges of the banks where the brush knocks all of the debris away coming down through the stream. There are these pockets in the high water when it's all muddy where you can dip into where the fish are swimming up stream. You can catch all different types of trout, eels, steelhead, sometimes salmon (Karuk tribal community member).

The tides also influence where lamprey are swimming in the river. Eelers at the mouth go out two to three hours before the low tide and eel during the "slack tide". They catch more during the outgoing tide when the water is swift because the lamprey come in closer to shore.

Lamprey use one another to climb over rock faces and dams. Eelers can use their hands or an eel hook to harvest at these locations, but they must first understand important aspects of the behavior of the lamprey to be successful at capturing all of the fish in this "wedge of eels".

> The head eel he goes as far up and another eel'll come along and he'll hold the head back like that and he'll catch a hold and he'll keep on doing that until he catches up with this top guy and he'll jump up there. And then he'll get a hold and the next eel comes up over the top of him and he'll come up and grab a hold. And they just keep on going 'til they get to the top of that rock and then they just start going like this...they throw their head...they throw themselves up like that and then they'll just kind of give a flip and they'll flip their head up and catch hold (Yurok eeler).

When an eeler starts to pull off a lamprey from this wedge, he must start at the bottom or they will all drop off. Any kind of scent or blood in the water will also cause them to drop back into the water. Lamprey have a strong sense of smell so eelers at the falls take thirty minute to an hour breaks between harvesting sessions to allow the next group of lamprey to come up. Otherwise, that first group will go deeper or move away from where they can be harvested.

Lamprey are harvested during the day and night at the mouth of the Klamath River and only at night upstream. Some participants feel that lamprey become more sensitive to light as they move upstream, while others see it as a predator evasion strategy. One of the more interesting observations made by eelers was that

any change in electromagnetic activity brings lamprey out of the water onto the rocks. During 1997, an eeler caught 200 to 300 lamprey in ten minutes during a solar burst. That same year, another eeler went out the night after a lunar eclipse and caught over 300 lamprey. Lightening storms and other phenomenon also seem to bring them out of the water.

> ...when I came back, you could see the northern lights because it sent a bunch of negative ions towards the earth and it made to where you could see the northern lights all the way down here and so I ran down to the eeling hole and there was, oh, there was eels everywhere. They were out on dry rock and we just caught a whole bunch of them real quick and left...They were like two and four feet up on dry rocks. That's the first time I've ever seen that (Karuk eeler).

More than one participant remarked that temperature and light are involved in the running of lamprey. They start moving up the river a few hours after it gets dark. Even at night, they move away from the moonlight, so eelers find out where and when the shadow of the moon is going to fall before they go out eeling. When it is cold, they do not move and ball up at the bottom of the river. Warmth can make lamprey very lively. Eelers that run eel baskets mentioned that when it is warm in the air and water, the lamprey move wildly around inside or come shooting out when they open up the basket. For those using other harvesting methods, it has to warm up before the lamprey surface enough to catch them.

At Ishipishi and Ikes Falls, they shine a light out onto the rocks to see the flash of the lamprey's belly and then reach out in the dark with their hook to grab it. At Coon Creek Falls, because the lamprey are able to stay on rocks under the water, they use a different method of hooking called "scraping the rocks". This method

allows an eeler to hook without seeing the lamprey first. Some eelers have switched over to using this method and combined it with the "hook what you see" methods at the Falls to capture lamprey during colder temperatures and other conditions that force them deeper into the water or into the willows.

Lamprey are also sensitive to water conditions upstream. Eelers at the mouth mentioned seeing lamprey ganged up, waiting for the right current before they begin moving up into the river. Lamprey at the mouth are seen swimming together in groups and running in pairs of three or four. Upstream they have found that these lamprey groups run a specific route or slot like an ant trail, leaving some kind of scent for the others to follow. The next group finds a different route as the water level changes.

> Eels follow certain paths and stay in those paths unless the water drops. It all depends on the water level. It seems that when the water is real low, the eels go right up the middle and don't have to struggle so hard. When it's higher or when the water is cold and the sides are a little warmer, then the eel stay to the sides more. When it's too cold they ball up and wait at the bottom of a hole (Karuk eeler).

Some people upriver make a morphological distinction between two runs of lamprey that come through the system, one bluer and one darker. Others mentioned only seeing one type of lamprey. One explanation given to me for this discrepancy was that people in the tributaries or at the mouths of the tributaries would only be seeing the lamprey that have been there for a year and are on their way to spring spawn. Those who have seen two different looking lamprey found that the blue eel come in later during June when the other darker lamprey are dying, but that they have the same teeth structure. One eeler noticed that a final run comes in during

April and spawns in the estuary. Another eeler mentioned that he always goes down to the mouth to eel on his birthday in the middle of April and catches over 100 lamprey on the same day every year; the whole week is good.

Differences between those lamprey caught at the mouth and those harvested upstream are apparent in both meat quality and relative size. Lamprey harvested upstream have a lower fat quantity and are found to take on the taste of the river. Interestingly though, while lamprey downstream by the mouth take on worms during the warmer months, those upstream are not found to have any worms. Many people make mention of "a yard of eels" or "out there chasing the 'yards'", referring to the length of a lamprey which is about three feet long. "Everybody said they could eat a couple yards of eels" (Yurok eeler). Upstream participants noticed that lamprey become half the size that they were at the mouth once they reach the falls, then half the size again when they reach the Scott Valley. Most people recognize that lamprey throughout the Klamath River Basin are not as big as they used to be.

3.2 Lamprey Harvest

Eeling is a flow-dependent fishery. The harvest methods utilized by eelers are determined by the morphology, flow, and substrate of the stream, as well as the behavior and relative abundance of the lamprey. Conversely, the chosen methods for a reach of stream are indicators of that stream's morphological characteristics and the lamprey relative abundance for that area.

3.2.1 Presence and Distribution

Eelers utilize their understanding of the landscape to identify where fish will be and how they should be harvested.

> Human beings can be as bad as the otters. They want the most amount of fish, the easiest fishing spot, and the quickest way they can get the most fish as possible which is generally at the mouth of streams, where the creeks are coming into the river and bringing cooler water and more oxygen and fish are naturally moving toward those places. In low water years you can see the fish holding up in the streams, trying to figure out how to solve the primal drive to get where they are supposed to get, spawn, and lay their eggs (Karuk tribal community member).

Historically, families had fishing holes up and down the river and up into the tributaries. These fishing holes were utilized for many of the fish species that come through the system, depending on the season and the water conditions. Spring freshets that came through each year cleansed the system, removing built-up sediments, debris, and contaminants, while keeping the morphology relatively the same. Fishing holes remained unchanged for generations, allowing the knowledge of these fisheries to remain intact. Land management practices and policy within the Klamath Basin impacted both these fisheries and the associated family fishing holes. These practices include commercial logging, dams, irrigation, water diversion, mining, herbicide use, and fire suppression. The most devastating impact on these fisheries and family fishing holes has been the loss of a natural flow regime, which has reduced the water flows and water quality necessary for productive spawning and rearing habitat. More frequent large-scale flooding has also had a dramatic impact on fishing holes and fish habitat by altering stream structure and dynamics significantly.

More detailed accounts of the cumulative impacts of resource management practices will be discussed in section 3.3 Population Decline Factors.

Some lamprey harvest practices have continued, while others are not viable means for harvest due to the low numbers of lamprey coming through the system or due to changes in stream structure.

> Even though they are from the same tribe, everyone has different eeling spots. There aren't very many fishermen anymore so the competition for the fishing hole isn't like it used to be. There used to be family rights by clans. The head of clans went first, prestige, wealth, elders, lots of different factors. You don't see that anymore, there aren't enough fish to let that happen (Karuk eeler).

All participants remarked on changes they had seen in lamprey population numbers and runs. Historically, the lamprey run always started at the same time every year. Now with fewer lamprey moving through the system, it is especially difficult for tribal community members to know if and when the fish have started running. When the water is colder at the beginning of the season, lamprey move deeper in the water; if the water is slow, they move out to the middle of the river where it is difficult to see them or fish for them. Only when conditions force the lamprey into narrow channels are people able to see them come through during the beginning of their run. One of the eelers recalled an experience eeling during 2002, a low water year, when the stream had narrowed so much he was able to see 100s and 100s of lamprey moving through the same area of stream at the same time.

Table 3 below summarizes the methods eelers use to harvest lamprey as determined by specific stream system structures and flows, as well as lamprey behavior and relative abundance. Many of these methods require strong flows of

water. Those methods that utilized platform fisheries are no longer in use today as a result of the decline in subsistence fisheries populations in the Klamath Basin. Historically, many of the family fishing holes had platform fisheries, where fishers utilized trigger nets and dip nets for both salmon and lamprey. As an eeler explained,

> If you're getting everything off of your platform then you're good. All of these traditional platform fisheries, trigger net, dip net, the lamprey fishery was right off of that same platform in the same area so you didn't have to move it...there are probably different reasons why they don't fish there now, but a lot of it is because there's no fish (Karuk eeler).

A trigger net, or A-frame, has a deep pocket with a string tied to the end of the net. Your finger holds the string so when the fish hits the net, you feel the trigger and pull up the net quickly to close the pocket with the fish inside. Both trigger net and dip net fisheries from platforms require the fish to be coming up through the system in large groups so that they move through the entire channel of the stream.

With fewer lamprey coming through the system, eeling now happens in the rapids where the flow is hard and the lamprey have to use the rocks along the margins. "If you have less flow, the eels have it easier and can slide on through and not be caught because they're in the middle of the river where you can't fish for them. You need the flow to force the eels to the side" (Karuk eeler). In the past, some families constructed ledges for the lamprey to crawl up so they could catch them. As one Karuk eeler pointed out, "If they relied on the eel for subsistence, life or death, they'd be down there building those runways for them." They would throw rocks down to make the lamprey expose themselves when they swam up,

filling in the crevices to almost create a staircase for them. One of the families that lives along a tributary of the Klamath used to fill in one of the riffles to create one channel so the lamprey would come in to where they could get to them; otherwise, they never saw them. "It's very important to realize that this is a flow-dependent fishery…low flow means less opportunity, more flow means more opportunity…fish are going to take the easiest migration route up the river and with less flow they can go up the middle of the river" (Karuk eeler).

Table 3 Eeling harvest technology corresponding to stream morphology and Pacific lamprey behavior
Data summarized from the observations and knowledge of participants

Technology	Morphology	Hydrology	Methods	Lamprey Behavior	Abundance
Eel Basket	Riffles; Eddies	Swift	Force of the water hits the basket to create an eddy on downstream side	Take the path of least resistance; look for resting places	Variable
	Estuary	Outgoing tide; Swift	Wade out during the high tide when the water is slower	Use the margins for protection during fast water to avoid predation and to look for slower moving water	Variable
Dip Net	Banks; Eddies	Muddy	Use when the water is muddy	Moving near the top of the water to breathe; cannot see the eeler	Variable
		High water; swift	"High water dipping"	Use the margins for protection during fast water to avoid predation and to look for slower moving water	Many
Platform Fishery	Eddies	High water; Swift	Use a trigger, A-frame, or dip net	Take the path of least resistance; look for resting places	Many at once
	Wide channels	Varies	Go out over the main channel of the stream where the fish are moving through the system	Moving through the slower water	Many at once
Eel Hook	Mouth--ocean side	Waves	Eel on an outgoing tide and the start of the incoming	Surf the waves into the river	Variable
	Mouth--river side	Swift	Stand along the edge to hook them during the low tide	Move along the shoreline during swifter water	Variable
	Banks	Varies	Scratch them out of the water	Large biomass so moving throughout the stream	Many
	Falls; narrow channels	Swift	Hook what can be seen out on the rocks	Moving up the rocks out of the water or at the surface	Variable
		Slow	Scrape off from under the rocks by feeling for them	Moving up the rocks under the water	Variable
Hand	Falls; Riffles	Swift	Use a glove or sock to grab them off the rocks; originally used a fern	Form a wedge as they make their way up a surface	Variable
	Narrow channel	Varies	Create a channel if not naturally there	Forced to move in close together	Variable

Figure 1 below illustrates the sites of different harvest technologies utilized in the past along the middle and lower Klamath River and tributaries. The use of a specific harvest method in a given location can be an indicator of the historical stream morphology, as well as the presence of lamprey in those streams.

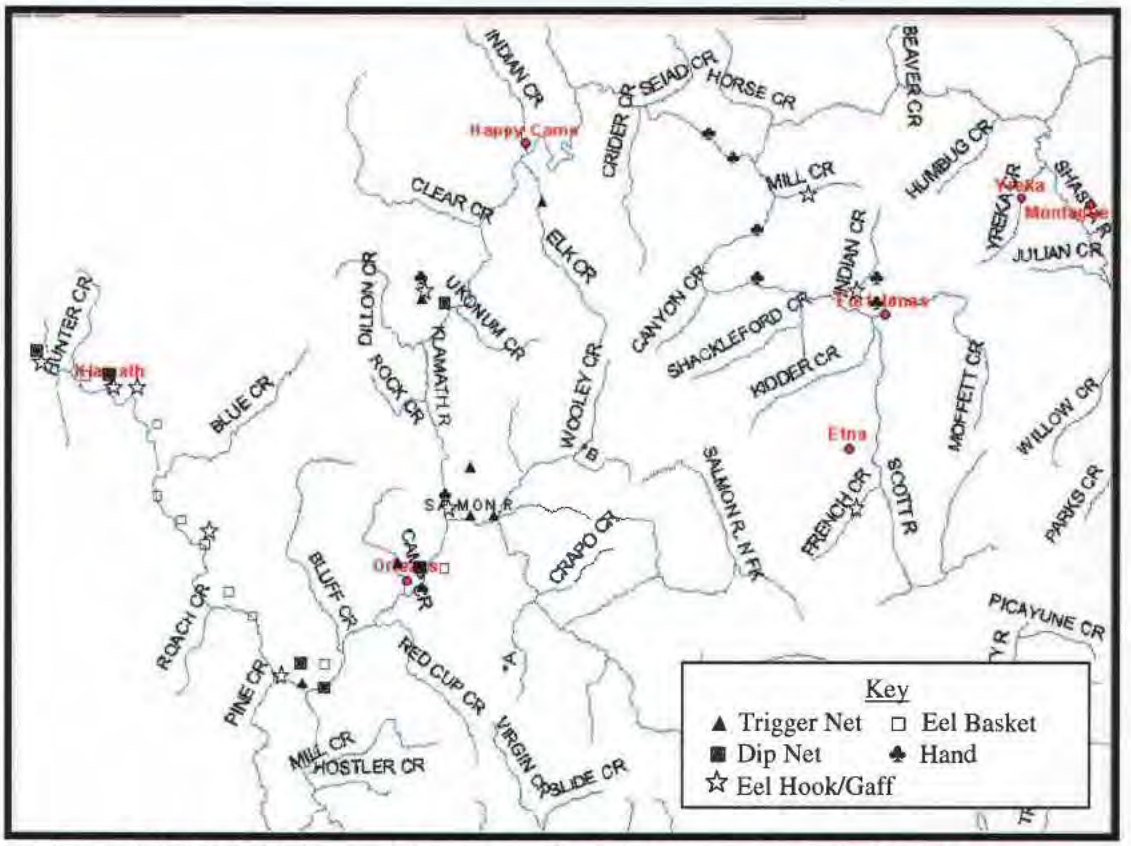

Figure 1 Historical lamprey harvest methods by stream reach in the Lower Klamath Basin (Data gathered from participant interviews)

During the interviews and focus groups, participants recalled where they had seen ammocoetes, macrothalmia, and live and dead adult lamprey within the middle and lower Klamath River system. The general presence and distribution have been illustrated on Figures 2 and 3 below:

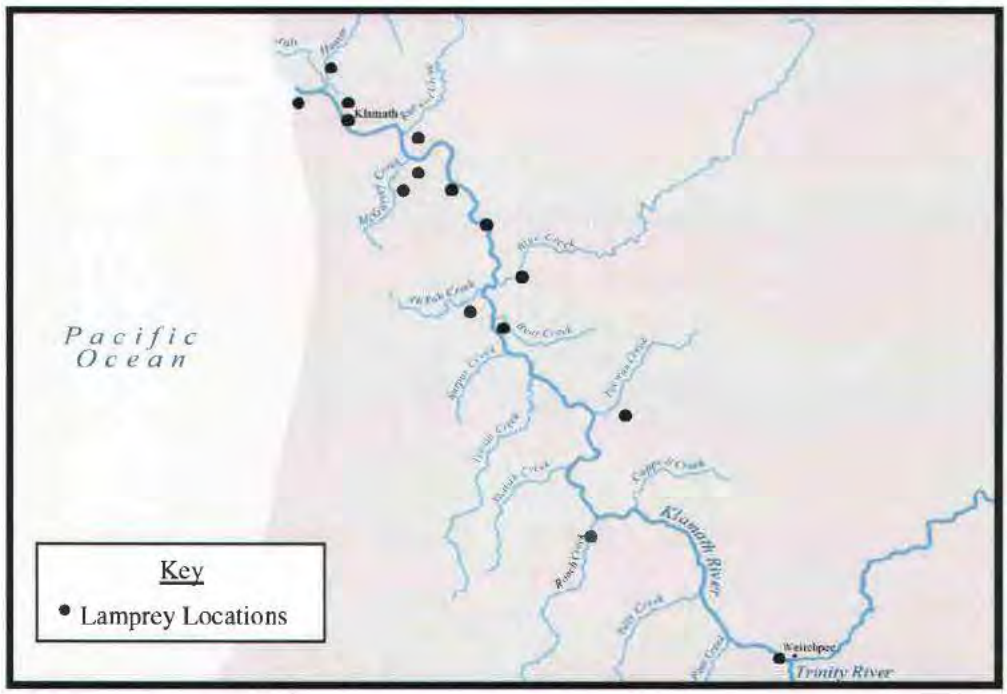

Figure 2 Pacific lamprey presence and distribution along the lower Klamath River (Data gathered from participant interviews)

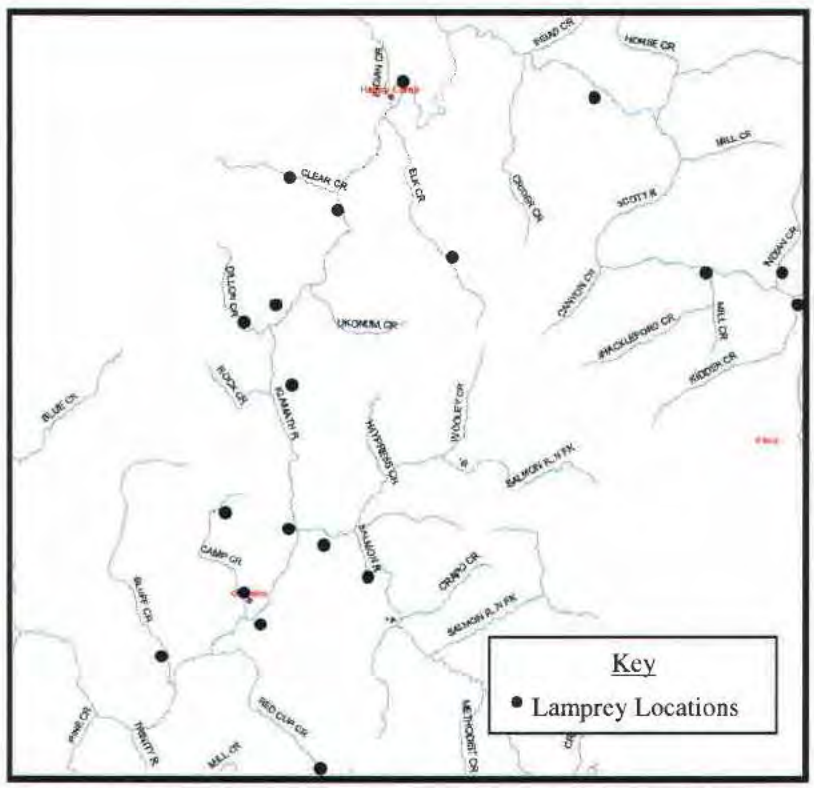

Figure 3 Pacific lamprey presence and distribution along the middle Klamath River (Data gathered from participant interviews)

3.2.2 Relative Abundance

The elders tell stories of how the lamprey used to be so thick, you could hear them. When eelers went out to harvest them at the mouth, at the falls, or up in the tributaries, they could easily pull out one lamprey after another because there were so many; anyone could harvest as much as they needed. "I remember seeing the rocks where we got the eels were just a solid mass, hundreds and hundreds" (Karuk tribal community member). Just over forty years ago, the lamprey were still so thick that crews were sent in to unclog the creeks because they had no flows. Up and down the river are rumors of the biomass being so great that the lamprey were poisoned in those creeks and at the dams where they were caught up in the turbines.

For those who were the fishers of their village, eeling "was no mystery back then". The elders have no recollection of ever going eeling and not catching lamprey. They saw millions moving up the river; enough that you could drop a basket in the water and within an hour or two, it was full. The baskets were so heavy with lamprey that they had to position the boat and pull the basket up at an angle. A Yurok eeler recalled that before the floods of '55 and '64, they could set three baskets and pull in 1500 lamprey at a time, enough that they had to tie a chain to the baskets to pull them up with a truck.

Those who process lamprey recall as children helping their mother or grandmother flatten 1500 lamprey at a time. Smokehouses held 1000 lamprey and were always packed solid. "Most eels I've ever caught, [he] and I got 600 in one tide...I had a thousand eels in that tide, in that smokehouse...it was two tides" (Yurok elder eeler). In the past, the Yurok never went eeling at night at the mouth

because there were enough lamprey to harvest during the day. Eeling at night is an very dangerous activity both at the mouth and upstream. Almost every year someone is washed out into the river or ocean. The most important lessons taught to all young or new eelers are "never turn your back on the ocean" and "always know where you are in relation to the river". The lamprey were so plentiful in the past that someone could go down anytime when they were running and see them, there were always plenty.

Thirty years ago, everyone came home with 200 to 300 lamprey, or a couple of gunny sacks, after a night of eeling. "In one tide, you fish the outgoing tides, sometimes you'd grab a hundred by the time you got down to the bottom" (Yurok elder eeler). One participant mentioned that his grandmother spoke of "picking out the better ones". They never had shortages or bad years for eeling. Even 50 years ago, participants have memories of catching 3000 to 5000 lamprey in one night during a peak run.

It was a lot of hard work carrying the sacks of lamprey off the beach or back up from the falls, so even though they could have caught more, most people stopped after they reached the number they needed. Forty lamprey equals about 80 pounds and is a good load up one of those hills. As the fishers in their village, it was important for the eelers to give away most of their harvest to other community members, especially elders. With a catch of 3000 during one night, an eeler would only come home with 100-150 lamprey because they had given the rest away. Even out in the Scott Valley, stories of catching 500 lamprey up in some of the tributaries are common. Just as it was told of the salmon, the elders recall the lamprey as

another fish that you could almost "walk across the backs of them" as they were coming through the Klamath River system by the millions. One Karuk eeler's uncle told him about his own grandfather being down at Ike's Falls one night watching them take out 4000 lamprey. The same eeler mentioned that with a couple hundred people living in that vicinity during those days, that would amount to around two lamprey per person, which would be gone in a couple of days.

Pacific lamprey populations began to decline rapidly in the 1960s. One participant recalled that the last time he had seen a full smokehouse was over forty years ago. Nowadays most smokehouses are smaller and hold only 100 lamprey, but even that size is difficult to fill in a whole season. While eeling was "no mystery" in the past, these days an eeler has to go down every day during the run to catch a lot of lamprey. "Now knowing where and when is not enough, you have to be there to get eel" (Yurok eeler). Those eelers that harvest 100 happened to hit a good run and are the only ones down there.

Participants felt that in the 1980s an eeler was lucky to catch 50 to 100 lamprey, which was considered a lot. By the 1990s, they were lucky to harvest any. Some years are good, while other years there are hardly any lamprey. Now anywhere from enough to eat to 30 lamprey is considered a good catch and it can take all day or night. An eeler has to work at it and spend a couple of nights to harvest 100. "When I was a kid, there was just thousands and thousands of eels. By the time you'd go down to check your basket, you could catch 300 in one basket. Nowadays you're lucky to catch, on a good night, maybe 10 or 15" (Yurok eeler).

Anything in a basket these days is considered successful. A good night is if you even catch a lamprey; for many, it is not worth it anymore to spend the night. Eeling has become a form of recreation rather than a means of subsistence.

The older people say that they hardly receive lamprey anymore because no one has any to bring them. One elder only received six lamprey last year, while another had not had any in the last 10 years. "I haven't had any since God knows when" (Karuk elder). Providing for your elders is a demonstration of respect and a primary responsibility for a Yurok or Karuk person.

One of the Karuk eelers recalled lamprey populations overlapping into one another so there was always a constant run. "...now you just have remnant populations and so when one population goes through, then it's over, and the next one comes up a couple weeks later. There's no continuous flow like there used to be and the peak season is a lot shorter." Another eeler has found that the peak season is not even there anymore. The lamprey are also not in all of the tributaries like they used to be, even up in the Salmon River. "It's not like the eel are going someplace else, they're just not there."

I have outlined in Figure 4 below the changes eelers have noted regarding the number of lamprey harvested over time using different gathering methods. Harvest sessions for eel baskets are based on three baskets overnight; all other methods are based on three to four hour sessions.

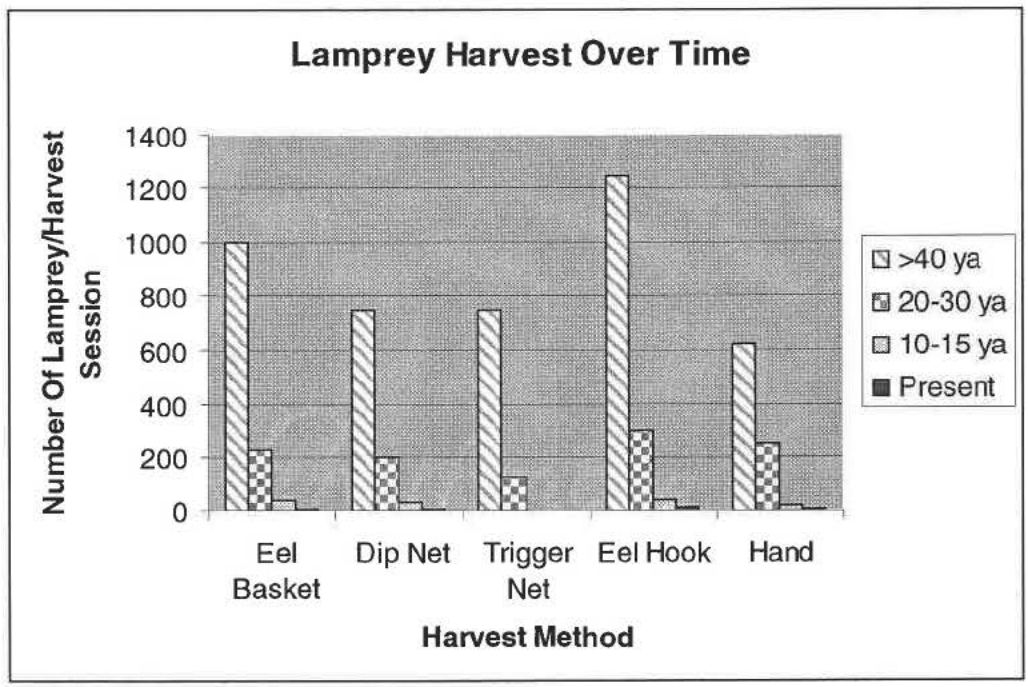

Figure 4 Changes in Pacific lamprey harvest over time (ya = years ago) (Data summarized from participant interviews)

Once in awhile, multiple factors come together to create a year where harvest numbers are higher than normal. During the 1996-97 lamprey season, four eelers at the mouth were able to pick up a sack of lamprey each after four to five hours. That same year upstream, as mentioned earlier, another eeler went out the night after a lunar eclipse and caught over 300 eels. He harvested over 1600 eel that year in three weeks. It was a high water year, borderline flooding, the mouth had blown open and the lamprey were able to avoid predators and move upstream quickly. They came through by the millions and the old timers talked of how they used to run that way during normal years.

3.3 Population Decline Factors

Tribal community members remarked on a number of key limiting factors that have influenced the decline of Pacific lamprey populations in the Klamath Basin, as well as other species that are dependent on river resources. These factors can be grouped into prevailing resource management approaches that include upslope management, natural flow regimes, contamination, and predation. According to participants, each of these management approaches do not stand alone, rather it has been through their continued combined influence that lamprey populations have not been able to recover. They say that because lamprey are a flow-dependent species, the loss of water quantity is the main limiting factor for both their decline and their recovery.

3.3.1 Upslope Management

Many participants commented on changes in upslope management[5] that developed after European presence, including changes in the fire regime, draining of wetlands, and intensive logging practices. Fire suppression leads to increased brush and an environment of dry fuel that contributes to large, hot fires, which eventually destroy large tracts of forest. Traditional fire management practices that were in place before European contact contributed to the health of a forest by increasing plant diversity and limiting the impacts of large, devastating fires.

> Fire was controlled because there wasn't as much brush and it was done every year so you don't have as much duff and insects that affect the acorns. There are great big huge acorn trees where there hasn't been a burn and out of 20 acorns only 3 will be good.

[5] Upslope management is the management of ecosystems that are upslope from aquatic ecosystems.

> Where there has been a burn, a majority of the 20 acorns will be good (Karuk eeler).

According to participants, today's upslope management practices allow the undergrowth to grow into the canopy, thereby blocking sunlight so that plants, like huckleberry, relied on by both humans and animals, cannot ripen their berries. Basketry materials need to be young and pliable, but without fire, they become infected by insects and disease and break easily.

Changes in the fire regime not only affect the plants native people rely on for food and basketry materials, it also impacts both the surface and subsurface hydrograph[6]. When you suppress fire, whether set through lightening or controlled burns, it leads to an increase in forest density and higher rates of evapo-transpiration, which uses up the water that goes into the streams, thus changing the hydrograph and the stream flow. When understory burns were set by local people, they happened during the right time of year to contribute to the moisture content for plants and the fish by adding more water into the streams. Increased amounts of brush draw up the water so that it is no longer available to go into the tributaries and the river. One participant remarked that the springs he used to know as a child are no longer there.

> It'll change with every little fluctuation in the water. It used to be a lot easier because the water was always in the same place every season and then lately it's been way lower, I don't understand it. I used to go down there all of the eeling season and then fish right off of these certain, you know, there'd be three or four levels. The water would be to where I knew where they were at that level and now it's like you stand down by the river and you're looking four or five feet up the bank at where you're used to being that time of year, you know, it's that much lower (Karuk community member).

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[6] A hydrograph is a representation of how a watershed responds to rainfall; it is a record through time of flow in a stream and/or of water level in an aquifer.

Fire suppression has made a direct impact on lamprey populations: "Ammocoetes that are in the fine mouth of these tributaries aren't getting the kind of hydrograph with the quantity and quality of water that they had historically." As another participant pointed out,

> So, if we don't burn, that affects our eels. I know it sounds weird, but it does. Because what happens is that now that we have all this new growth, they all have root structures. And what do roots like more than anything? Water. So, a lot of our water that is meant for our river is being sucked up by all this new growth (Karuk tribal community member).

Additionally, there used to be functioning wetlands that would soak up the water like a sponge and then release it into the river over time. "When you get rid of all those sponges alongside the river all the way up into the Upper Basin, and there were huge amounts of wetlands that got disrupted, then when you have a winter event now, instead of it all soaking up into that sponge, it runs down into the river" (Karuk eeler). Tribal community members have found that with the loss of wetlands, hundred year flood events are becoming more common and are occurring at a greater magnitude.

Participants believe that logging practices in the past also affected the streams through the loss of gravel bars, increased silt and sedimentation, and the build-up of debris and gravel filling in the creeks. The Klamath Basin has a long history of logging and sediment build-up. Management practices historically did not have all of the stringent laws they have today. It was not uncommon for the streams to be used as roads and to transport logs. As one participant put it, "the laws were made after the damage was already done." Small creeks that used to have salmon and

lamprey fisheries in them are almost dry now, either filled in with sediment or they no longer have the contributing flows from the surrounding upslope environment.

Large redwoods used to grow up to the stream's edge, shading and cooling the river. One participant said that his uncle described it as a cave of trees hanging over as he made his way up the river. Another participant remarked that as the water quantity decreases, the water temperature increases. They continued by saying that since Iron Gate Dam is an earthen dam, the water heats up as it comes out over the top. They believe that less water also results in more fish bodies moving around in the same space, heating up the water and creating an environment susceptible to greater disease transfer and higher mortality. One of the Karuk eelers remarked that the water temperature needs to be a certain way because the Maker made everything in balance. People think they can regulate this way or that way, but it is not the way it was designed to work. As many people I talked with attested to, the lamprey is a hardy species, a primitive creature that has evolved in response to many environmental changes throughout time. The decline of one of the most resilient species is an indicator that the system as a whole is in decline. As a Yurok tribal fisher surmised, "If we're losing him and he's the toughest along with the sturgeon, holy mackerel, no wonder we're losing our salmon because of the temperature, the water, and all that."

3.3.2 Natural Flow Regimes

The disruption of natural flow regimes through the building of dams, logging, mining, and changing weather patterns has contributed to a number of detrimental changes in stream morphology. Historically, streams were flushed out every year,

cleaning out the sand and the gravel and taking out the willows along the sides of the banks. Almost every tribal community member interviewed remarked on the loss of spring freshets and its impact on the health of the river system, including the loss of fish populations. Impacts from management practices are magnified without annual high waters to flush and cleanse the system, contributing to higher rates of sedimentation and woody debris contribution, the loss of spawning and rearing habitat, decreased water quality, and the intensification of flood events.

The clean sand areas along the river where the ammocoetes live were washed and cleaned when the river was high. Now when people dig into the sand bars, they run into layers of old leaves. Hydromining took all of the soils from the hills and put them into the streams, affecting the spawning grounds. Pesticides and other pollutants stay in the system longer because they are not flushed through by spring freshets.

The floods of 1955 and 1964 had extensive impacts on the Klamath Basin. Participants told me that, in the past, every year the rains and the snows would come and the river would rise in the springtime. Soon, the river was back to where it was the year before, nothing changed. They had the same fishing holes and the same swimming holes. Now where they used to go, the water is all flat or not there at all. Family fishing holes that had been with them for generations have changed dramatically or no longer exist. One Karuk tribal community member remarked that the river and creeks are not as big as when she was younger. The pools were so enormous, up to 30 feet deep, that they refused to swim in them because they could not see the bottom. Another person recalled going up the creeks when he was

younger to areas where there was a lot of sand and small holes behind logs where they would catch trout. Now he can go up a mile and not catch anything because the holes are filled in with rock from the 1964 flood.

Floods are not an unusual occurrence on the Klamath River, but the effects from the 1964 flood, especially, were exacerbated by changes in land topography due to management practices within the Basin.

> Now these hundred year events have been hastened to where now you have every ten years a hundred year event and I can look up to this upslope and say that's the reason why, logging, things like that, to where now instead of functioning wetlands which actually soak up the water like a sponge and as it gets in here and the water goes down, then that water releases into the river. When you get rid of those sponges all alongside the river all the way up to the Upper Basin, where there are huge amounts of wetlands that got disrupted, so now you have a winter event, instead of it all soaking up into that sponge, now it runs down into the river and now they're having these catastrophic events happening quicker, but they're having more magnitude; then you have the sediment and everything else behind that (Karuk elder eeler).

One participant remarked that prior to the floods he remembers seeing black clouds of lamprey coming through the system, something he never saw again afterward. The floods affected the spawning grounds of many fish species, including lamprey. In the 1960s, there was a timber harvest boom, with more roads being built throughout the Lower Basin. When the 1964 flood occurred, logging roads washed out into landslides and clear cuts contributed massive amounts of sedimentation into the tributaries. Big rocks piled up at the tributary mouths and when the large amounts of woody debris came down the streams, they dammed up until enough force blew open the mouths. The tributaries were changed dramatically; holes were filled in with sediment and sandbars were washed out or dirtied up with mud and

leaves. One avid tribal fisher remarked, "The leaves stop the water and all the fine silt settles there." He now finds that when he goes fishing he has to wade out to about thigh deep to get past the leaves and the mud that will sometimes be a foot deep.

Many tribal community members contribute the decline of lamprey populations to factors affecting the larval stage.

> One of the main reasons that the eels are being killed off is that there is no sand for them to incubate in. The kids used to find eels in a big pool at the sandbars below Clear Creek. The sand was fairly clean and they'd find a lot of eels in there, now it's all mud and clay. The sand needs to be open enough that the water can slowly flow through it and bring oxygen to the eels. When the sandbars are all mud, it suffocates them (Karuk tribal community member).

Many participants noticed a decline in water quality soon after Iron Gate Dam was built. The Klamath is one of the few rivers that becomes cleaner as it moves downstream, due to all of the tributaries contributing fresh water into the system. Many people who left the area for a period, upon returning, recalled noticing a dramatic change in the river, noting stagnant, slower flows, strong odors, dirtier water, more moss and algae, and higher temperatures. Those who used to swim in the mainstem river refuse to now because of the decline in water quality.

> There were always a few eddies where the water tended to slow down and the mud would grow up, but now there's algae and moss all along the river and you can see the line of leaves up along the river. The mud stays mixed in with the sand (Karuk tribal community member).

The disruption of a natural flow regime has created what one participant called, "a perpetual state of drought". He remarked that lamprey are a hardy animal,

but there is something in the system to which they have been unable to adapt, especially regarding water quality in their juvenile stage. The lack of spring flows and the fluctuation of flows, in general, are conditions related to the dams. Especially during the summer or early fall, a lot of ammocoetes are found stranded when there are drastic increases and then decreases in water released from the dams, which dry up the sandbars and take away the edge habitat; some people refer to them as "invisible fish kills". Many participants recalled stories of finding 100s, even 1000s, of stranded ammocoetes left in little side pools where the water had become hot or dried up. A tribal eeler who works for one of the fisheries programs remarked,

> And also, they got a long life span. They got to be in the river for so many years. Well, all these generations are in there through all these years and when they put that Iron Gate in there it...when irrigation time came around, boom, first thing they did they'd be pumping out maybe twenty, twenty-two cfs up, down. Overnight they'd shut it down to a thousand. And it'd leave all these, where their beds are, where they spawn, leave them high and dry. And then they couldn't get back to the river fast enough before they died. And then the eight year cycles, it takes a long time before it can rebuild. And you get all them spawning beds dead. I think that has a lot to do with it (Karuk eeler).

During natural flows, the water would go up and then decline gradually so the fish would be out of those high water areas once the water was down and they would have minimal stranding.

The diversion of water from the Klamath Basin for agriculture in the Upper Basin, the Shasta and Scott River Valleys, and the San Joaquin Valley impacts water flows for the Lower Klamath. Tribal community members told me that each species of fish spawns at certain elevations and topography, so if the water drops too much,

then the larval and juvenile stages do not have a chance for survival. The water has not been high enough in the tributaries to achieve spawning habitat for lamprey or other fisheries. Participants remember that when the creeks were big, the fish did most of their spawning up there, where there was not as much of a chance of being wiped out when the water did come up. Lamprey are not going into the tributaries as much now because the river is so low. According to one participant's grandmother, the fish never spawned in the river, they all went up into the creeks. The river did not have the sediment loads that it has now, which come down Ishipishi Falls, settle into, and fill up the deep fishing holes. The fish have no holding room like they used to or the hole might be out in the middle of the stream, so fishers have to build platforms to get out there. In the past, the fish were closer to the sides, so they only fished in the backwaters. Eelers now risk their lives building bridges or platforms to get out to where the fish are moving.

As children swimming in the Klamath River in the summer, community members remember trying to swim straight across the river and ending up a third of a mile downstream. Their elders would often warn them about the river. Nowadays, most people find it easy to swim straight across. All of the margin habitat for lamprey is drying up, which is mainly impacting the larval stage and has the greatest impact on the depletion of lamprey runs. Lamprey that go up into the Scott River will spawn in the irrigation ditches, which are later dewatered so that the ammocoetes become stranded and die.

> The decline has to do with when they are filtering in the silt. We've found strandings of 100s and 100s of eels, all dried up in the sand. The ammocoetes like the silt and sand, so you find them

> along the margins of the rivers. When they ramp the water down 200 cfs overnight, they don't really come out and wiggle across the land to get back in the water, they pretty much dry up where they are. We're monitoring a few spots where it happens regularly, but I'm sure it happens all up and down the river (Karuk eeler).

3.3.3 Contamination

Non-point sources of contamination in the Klamath watershed are attributed to agriculture, road runoff, and spraying. A common comment during interviews was that lamprey populations began their major decline during the 1960s when the timber companies began spraying up and down both sides of the river with chemicals like 2,4-D[7]. Spraying was heaviest during the 1980s when many plant, animal, and insect populations were affected. Community members mentioned not seeing any more bees, birds, squirrels, chipmunks, or porcupines. Stories were common about deer with tumors, deteriorating skin, or blindness, also birds with large and mutated eggs. "Wherever they sprayed, there was no life" (Yurok elder). Human impacts ranged from birth defects to high rates of rare cancers. Millions of candlefish used to come into the estuary to spawn during the same time as lamprey migrating into the river. One participant remarked that in 1963-64 it seemed like the river was poisoned and the candlefish tried to find another habitat. Many Yurok community members remember fishing for candlefish and catching truckfuls in an hour or two. By 1975-76, the candlefish were gone; now, once in awhile, someone will see a few in the

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[7] 2,4-D is a white crystalline irritant compound $C_8H_6Cl_2O_3$ used especially as a weed killer. 2,4-D is a phenoxy herbicide introduced in 1945 for use by the Allies in World War II to destroy enemy crops and was later used by the US Army during the Vietnam War as a component of Agent Orange. "Between World War II and the Vietnam War, civilian use of 2,4-D for weed control grew considerably. 2,4-D accounted for half of US herbicide production in 1960" (Doherty 2002).

river. As one participant observed about lamprey, "Plus, they got all of the spraying up there in these mountains that comes down and kills those in our estuaries. And I don't think they can live through that."

Participants have found that pesticides, fertilizers, and other agricultural runoff to the river create an imbalance in chemical and nutrient loads in the system. Toxins grow together as they move down the river and with a decrease in water quantity in the system, are not diluted as quickly. One of the frequent observations made by tribal community members is seeing an increase in large amounts of white foam in the river. Even as late as 1987, it was not uncommon to see boraide drops into the river after a forest fire had been put out. Only in the last five years, have agencies been required to keep records of these drops.

Participants told stories of vast numbers of lamprey that once came through the Klamath River system and clogged dam turbines and irrigation diversions. Tribal community members spoke of eradication programs carried out by California Fish and Game in the 1970s to poison lamprey that were seen as a nuisance to dam operators and farmers. While records of these programs on the Klamath are not readily available and were not mandatory at the time, participants claim that dam operators on the Columbia River are open about their own eradication programs during the same period of time. By analogy, similar Klamath programs may have been in operation at the same time. Tribal fishers recall catching 100s of poisoned lamprey in their nets in the early 70s.

One elder eeler summed up the multitude of contamination factors that have contributed to the decline of lamprey populations in the Klamath Basin,

> Well, I think they should be looking into why they're allowing all that poison to be put on the earth and they could care less for the animals, birds, or whatever, Indians and their eels or fish, salmon to live. And the fact that there is poison being put all in our Klamath River Basin from...all the way up there and the farmers are putting something on the earth to make their potatoes bigger and better. And then there's Simpson Timber Company and other companies, logging companies are allowed to spray. CalTrans is putting a lot of bad things on their roads and highways and byways. They're not concerned, all they're concerned about is progress and, if anybody's objecting to that then they probably would be considered a terrorist (Yurok elder eeler).

3.3.4 Predation

Historically, Native people of the Klamath River took seals and sea lions for their teeth, hides, oils, and meat to use for ceremonial and subsistence purposes. The inception of the Marine Mammal Protection Act (MMPA) of 1972 prohibited the taking of marine mammals in any U.S. waters.[8] Many fishers speculate that sea lions and seals are getting more abundant because they are so protected. "Yeah, you know, that's one of our big problems down there, too many seals and sea lions down there." A friend of one of the participants told him a story of cutting open a dead sea lion and watching the lamprey roll out "like candy". Another Yurok elder eeler told me, "I really feel terrible because we can't do anything about them anymore and you have to stand there and watch them eat the eels and you don't have any in your sack."

3.4 Ecological Significance

Many of the people that I talked to recognize the significant role Pacific lamprey have in the health and balance of the Klamath River system. For most, the

[8] The MMPA exempts Alaskan natives who reside on the coast of the North Pacific Ocean or Artic Ocean if the take is for subsistence purposes or for creating authentic native artifacts.

loss of the lamprey is another symptom of what is going on with the river. Others see its recovery as key to the survival of the river. As a tribal community member explained,

> When the eels don't come, it affects everything. If people aren't eating them, then they may have to harvest more salmon than they'd like to. The eels are here for a reason and are not here to be desecrated or made extinct by man. They're supposed to be here to help feed the animals. Everything will suffer when they're gone (Karuk tribal community member).

3.4.1 Seasons

The people who live along the Klamath River use environmental cues to determine when it is time to go eeling. "The old timers long time ago, boy, they seen that swallow, they knew those eels were on their way" (Karuk tribal community member). Especially upriver from the mouth, these indicators from nature told people what time it was when they did not have clocks or calendars. Nature moved the seasons along and every year it was the same. "...that's when we're inclined to say the temperature and parameters are right to where we should go fishing right now" (Karuk elder eeler). Depending on where they live on the river system, each family has their own indicators that tell them when the lamprey are running. One person would tell me that when the dogwoods are blooming and the crickets are singing, then the lamprey are at Ikes. Another would say that when the big creek fern blooms, the lamprey are in the water. "They call it the eel cleaning fern because they use it to hold onto the eel when they clean it. It still happens now, when the fern blooms, the Great Spirit is telling them that it's the cycle of the eel" (Karuk elder). Other indicators include moths flying around, buzzards and osprey returning,

hummingbirds, crickets singing, and seals and sea lions feeding. Some people went more by weather conditions, "Water is warm and it rains, it's good eeling" (Yurok elder).

> The eels like to run when it's warm. It's gotta be up to about around mid-50s, 60s, between 50 and 60 degrees and the frogs really start hollerin' and the moths start flying around. Can really tell that's the time that they love to run. Catch 'em in your basket and you pull your basket in and they're just floppin' all over the place 'cause they're runnin' so hard, you know, in the morning. They really get lively because of the warmth (Yurok eeler).

In general, though, most people I talked with agree that the calendar is off these days or needs to be recalibrated. The tree are blooming when it is still winter and the fish are coming in later. Migration timings may be obscured by the bell-shaped distribution of the lamprey run. Historically, the runs were so large that everyone knew when they started coming up into the system. These days, the numbers are low enough that the few that are coming up will be moving up through the middle of the river where they are not noticed until the run reaches its peak. In general, however, tribal members are noticing that the return of neo-tropical birds and the flowering of the plants are occurring one or two weeks earlier than in the past. As some fishers noted, sometimes the lamprey just do not come at all. "You see the dogwoods bloom, the buzzards are here, and the swallows are flying around, but no eels" (Karuk eeler). If you get disconnected with one species, then it disconnects you from season to season.

Lamprey has its place to feed the people and to be a part of the cycle, like salmon, deer meat, and berries. "That was the importance of eels, eating eels that time of year because different times of year we'd be eating those trout, but then at

that time of year that was not only a trigger for the fish but it was also a trigger to say quit fishing for those other species that are spawning" (Karuk eeler). A Yurok elder told me that the Creator made the lamprey and gave the Indian people the river; the river brings up different kinds of fish each season. Historically there were no dead spots in between runs of lamprey; the runs of different species would overlap. Another Yurok eeler said that when the other fish come in, you are supposed to harvest the next fish and leave the brood stock.

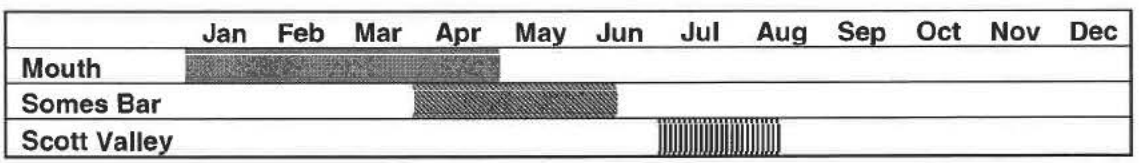
Lamprey filled a niche in the subsistence world. For the downstream people, lamprey arrive before the spring salmon, so when they have a hard winter lamprey play a significant role in feeding people as the first fresh meat source. "In the life cycle, they were meant to be here as a food source because during the time when the eels come in there aren't really fresh salmon or anything, so I thought they were in there for the time for us to eat" (Yurok tribal community member).

Once they begin moving upstream, lamprey are still valued as a food source because they arrive before the first salmon ceremony and no one is allowed to eat spring salmon yet. During the first salmon ceremony, the medicine man caught the first salmon, then everyone down below could start fishing, but people above that point could not fish until the ceremony above them was complete. Additionally, winter steelhead are in the water but are inaccessible because they swim where the water is very treacherous, while lamprey are accessible along the banks and in the eddies. It is also taboo to eat any fish when it is just about to spawn (e.g., when it is in the process of creating its redds). During that time of year, "the only thing they really have access to is terrestrial wildlife and the eel and that was the important part.

They didn't necessarily use eel for subsistence over the winter; they used them to get them through right now" (Karuk elder eeler). The lamprey was important because it filled that niche in a subsistence world.

Even in the recent past, lamprey were harvested at the mouth near the end of November in time for Thanksgiving. Now a few may come through during that time period, but most eeling begins in January and through April when eelers turn to other fishing or the lamprey begin to get wormy (see Table 4 below). The year I was living down at the mouth, the lamprey had not yet arrived when I left Klamath in late December. When I returned to Klamath for a long weekend visit in March, the run had just started a few weeks earlier in late February.

Table 4 Lamprey main harvest seasons within the Lower Klamath River Basin



The lamprey run lags from a couple weeks to a month from their arrival at the mouth to when they reach the Orleans and Somes Bar area. Table 4 above illustrates the main harvest periods for lamprey presently within the Lower Klamath Basin, including the Scott River Valley.

3.4.2 Interspecies Dependency

An understanding of the inter-dependency of all species in the Klamath River system goes back through the stories. The story of the Eel and Sucker gambling game illustrates this deeper knowledge. Sturgeon was drumming for Eel during the betting and Bullhead was drumming for Sucker. Eel and Sturgeon lost everything

they had, so in the last game they put up their bones and lost. This is why Sucker and Bullhead have so many bones and Eel and Sturgeon have none. Sturgeon is still going up and down sucking on the bottom looking for enough gold to buy back his bones (Yurok elder eeler).

The people who live along the Klamath River and those who harvest lamprey recognize the important connection the populations have with the health and preservation of other species in the system. "As a fisherman, you just know that they're connected, you know you've got to have one for the other. And if you lose one, you're going to lose the next one" (Yurok tribal community member). Lamprey are here for a reason and affect even those things that do not feed on them. They are an integral part of the ecosystem. As a Karuk tribal community member remarked,

> There's a reason the eels evolve, a reason they came into the Klamath River, and there's a reason they need to always be there. We may not know what those reasons are, but because we don't know what those reasons are, it's even more important to protect them (Karuk tribal community member).

Lamprey are water quality indicators. If the river is not healthy, then the lamprey and other resources cannot be healthy.

> It's all connected...there's nothing you're going to do, you're not going to just save the salmon, you're not going to do it. If you're going to save the salmon, you're going to have to save all of them because you're going to have to fix the system. I think the more species you look at, the further ahead that you are in the game and fixing the entire system. Because you're just looking at it from one species, what that one species needs and you're going to come up short (Karuk eeler).

At one time, lamprey probably had the largest biomass of any living species in the river. The mass of lamprey moving through the system helped to feed the

predators and acted as a decoy for the salmon coming through during the same time of year. Once lamprey spawn, they die and are recycled back into the system. They become "food for other fish or help prepare the waters" (Yurok eeler). All participants remarked on the significant difference they had noticed in the number of dead lamprey moving through the system in the last decade. When they were children, they remember seeing many dead ones settling in the swimming holes in the creeks and rivers in the summer. One participant recalled thinking when he was younger that the leaves in the water were "eel beds". There were so many that it was difficult to swim without stepping on or seeing them float by in the water.

Fishers would have to pick the dead lamprey out of their nets at the beginning of steelhead and spring salmon seasons around July. Most people recall noticing a decline in the "floaters" in the 1970s and early 80s. Before they started to decline, you could not drive up and down the river without smelling the rotting lamprey. Thousands of dead lamprey used to float down in the late spring or summer. "Old float back eel" or *per-ner-keesh*, in Yurok, was a derogatory name you call someone. One participant told me how his grandmother and her father would walk along and collect the dead lamprey that used to be all over the beach. They would boil them down and use the grease to saturate their dugout to keep it soft so it would not chip when it hit a rock. It took a lot of lamprey to obtain the thick amounts of oil they used for one dugout. These days, there is no odor around the river and except for those who work with the fisheries programs, most people have not seen a dead lamprey in years.

In the past, the holes would be so loaded with dead lamprey that people said they would only drink out of the side streams; the dead lamprey turn into a white "juice-like powder". Karuk tribal members recall seeing them up in the creeks from the end of July to early August at the bottom of the ponds and on the shores. The dead lamprey fertilized the river and replenished the riparian zone. They were also an important food source for salmon fry and other predators. "Well, they aren't only important to the people, they're important to our river. The river needs all the nutrients. The dead eel that goes up to spawn and it dies and it floats back. The buzzard eats it. Everything eats off it when they come back" (Yurok elder eeler). In the past, the carcasses would deposit at the bottom of the deeper holes where the sturgeon came in to spawn, which would then eat the dead lamprey before making their way back to the ocean. "Eel fed a lot of fish, he did after it died, that's why there were so many of them. That's why there was an abundance, that's why the Great Spirit had them in the river as an abundant food" (Karuk elder). Participants recalled seeing a variety of animals feeding on them, including gulls, eagles, ravens, crows, bears, and buzzards.

> The dead eels, when they came back down the river, my god, buzzards and ospreys and all of those birds had ample food to feed their young and they were in abundance around here. But now it's a thrill just to see any bird, let alone know they're around all the time. You know it's affected their food chain, as well (Karuk eeler).

The dead lamprey would fall apart and wash close to the shores, feeding all of the young fish and decomposing into nutrients that the ammocoetes then filtered through the system.

> I think the eel was one of the most valuable assets to all the fish in the river because I think he created all the food for them. Because the salmon in there, there wasn't enough dead salmon to do it, but there were so many dead eels that they all washed up along the shores, all your creeks, and the main river here thick, real thick and heavy and then they would just turn into that milk and foam that would float down the edge of the shore and the bank that the little bitty fish live on. Without the eel, we ain't got that (Karuk elder eeler).

> The eel has it's place, you know, they go up, they feed our people. And when they'd go up there and they died, they floated back. And after, there's a cycle thing, you know. They come up and they feed our people, they go up and spawn, and when they died they floated back and they'd land on the beaches. And about that time, the buzzards would come back, they'd come back down South and they'd go along and clean the beaches. Things fell pretty bad there for awhile; they'd clean them up real quick. That's the buzzard meal when they first came back in the spring. Come along and clean the beaches up. Plus it fertilizes our rivers and all, because the river it will die if it ain't, if nothing is coming up in it, no life, because all the vegetation along the rivers, all the nutrients will wash out after awhile because there ain't no dead matter" (Yurok eeler).

Both the live adults and the ammocoetes are an important food source for other species. Adults are fed on by osprey, eagles, hawks, river otters, fishers, mink, martin, blue heron, and bear, anything that is fish eating and can get a hold of them. Many participants downriver remarked on not seeing any of the old gray-haired whiskered otters anymore that rely on lamprey in the winter. Everything begins to decline when there is not any food in the river system. Ammocoetes serve as food for cutthroat, rainbow trout, mergansers, kingfishers, gulls, terns, and many other species. Some fishers mentioned using ammocoetes as trout fishing bait by straining them out of the sand.

3.4.3 Other Species

Participants mentioned many other species that have been impacted by changes in the water flows and water quality of the Klamath River system. "It's not only our eel and our salmon, which are so important to us, I think that there are a lot of those little, like the crawdad and stuff like that " (Karuk tribal community member). Many of the people who live downriver mentioned the correlation between the decline of lamprey and the decline of eulachon. Eulachon are so rich that they were used whole for candles, which is how they received their common name of candlefish. Their major population decline began in the 1960s when the timber companies began spraying. One participant recalled that in 1963-64 it seemed like the river was poisoned and the candlefish tried to find another habitat. The last time most people saw them come into the system was in the 70s and early 80s. Candlefish used to come in by the millions. One fisher remembered picking up 75 pounds of fish in one dip. Candlefish come into the estuary to spawn at the same time as Pacific lamprey, so many eelers would dip for candlefish at the same time. Another participant mentioned filling up a pick-up truck in one hour. "In '66, I bought a brand new pickup...I backed it down to the river in the Glen and in half an hour I had the pickup full of candlefish. The river was just swarmed with candlefish. Now there's no candlefish. Something had to kill them off" (Yurok elder eeler). In addition to the timber spraying, participants also mentioned siltation, changes in the river system, and offshore trawlers as possible reasons for their decline. Most point to the fact that candlefish are so greasy that their bodies easily absorbed all of the contaminants in the system.

Up and down the river, other changes in species populations were mentioned. Some remarked that there have not been as many sturgeon, steelhead, shad, suckers, or spring salmon since the early 1980s. "It isn't only the fish and the eel; it's all the rest of these animals, the duck, the geese. When there's no water, the animal is either going to move where there is water or it will die" (Karuk tribal community member). Other non-fish species include mudhens, monarchs, amphibians, deer, birds, frogs, raccoons, porcupines, crawfish, and other wildlife. "There were times that you'd go down to the river and watch the coons, sitting alongside the riverbanks, reach in, get a mussel, and sit there and eat it. We used to sit for hours watching them do that. Now you don't see anything like that happening anymore" (Karuk tribal community member). Some of the participants also mentioned the decline of mussels.

> I think a lot has to do, and I'm biased in this opinion, is the dams. The dams created a lot of changes that weren't noticed initially. There were subtle changes that occurred over a period of time. One of them, I believe was the freshwater mussels. Once they became, let's say, extinct on the Klamath River due to water quality, I think the lamprey were destined to follow suit. I think there's a correlation between the freshwater mussel and the lamprey" (Karuk fisher).

One fisher recalled stories by his elders that mentioned eating freshwater mussels; personally, he had a hard time remembering ever eating them.

3.5 Summary of Major TEK Contributions

The following are a summary of the major contributions of Karuk and Yurok TEK to our understanding of Pacific lamprey populations in the Klamath Basin, as well as the ecological and cultural characteristics of the Klamath River system.

1. Two morphologically distinct Pacific lamprey were observed along the mainstem Klamath River. One run was blue and larger, while the other was darker and smaller. Participants who eel primarily at the mouth only mentioned seeing the larger blue lamprey. Eelers who live and eel up in the tributaries only saw the smaller dark lamprey. Additionally, one Yurok eeler recalled seeing a run of lamprey come into the Klamath River estuary every April; another participant mentioned his abnormally large harvests when he goes eeling at the mouth on his birthday in April. Community members throughout the river system recall seeing much smaller lamprey feeding on salmon that were around twelve inches long and which they believed were not Pacific lamprey.
2. Adult lamprey have been observed to display specific behaviors in response to changing water conditions, such as temperature, water flows, and particulates in the water. Lamprey were seen to utilize a "breather hole" at the top of their body during muddy conditions. They also utilize one another to move over barriers, creating a wedge of lamprey that leapfrog their way over rocks and dams.
3. Participants observed groups of lamprey moving together through the system and following a specific "trail" through the water. That trail altered when the next group came through and responded to changes in water conditions. Participants also mentioned that they harvest more male lamprey first, then males and females, then mostly female lamprey.

4. Pacific lamprey were observed to be sensitive to electromagnetic activity, such as lightening and solar flares, during which times they either moved deeper into the water or came out of the water onto the rocks in abundance.
5. During normal years, the harvest of Pacific lamprey in the Klamath River Basin begins at the mouth in late November and in the Scott River Valley by late July.
6. In the past, Pacific lamprey were found in all of the tributaries, moving up higher in the system to spawn than steelhead populations. While eelers and other fishers typically do not see lamprey spawning, they have witnessed the dead lamprey floating down from above where they fish for steelhead.
7. Eeling is a flow-dependent fishery. Eelers have developed over thousands of years the most appropriate technology to harvest lamprey based on their knowledge of the morphology, flow, and substrate of the stream, as well as the behavior of lamprey in response to specific conditions.
8. Tribal community members noticed a correlation between the extirpation of eulachon populations, another high fat species, from the river system during the same time period that lamprey populations began to decline. Participants expressed concern over the persistence of toxins in lamprey and in the river system both as a limiting factor for populations, as well as a potentially serious threat to the humans who consume them.
9. Tribal community members noted predation from seals and sea lions as one of the major limiting factors for Pacific lamprey populations.

10. Participants noted that the number of ammocoetes, adults, and dead lamprey observed in the system has declined dramatically in the last 40 years. They correlate these changes with intensified upslope management practices (i.e., logging, herbicide spraying, dams, fire suppression, wetland delineation) and changes in the natural flow regimes, which have affected spawning and rearing habitats. Tribal community members believe that rapid increases and decreases in water released from Iron Gate Dam, especially during the summer and early fall, create invisible fish kills because the larvae are left stranded in the upper substrate.
11. The combination of intensive logging practices, hydraulic mining, wetland delineation, water diversions, loss of spring freshets, and road building have created a system prone to the magnified effects of natural episodic floods. These flood events have depleted lamprey spawning and rearing habitat, as well as generated a scarce primary food base and limited opportunities for population regeneration.
12. Fire suppression has led to an increase in forest density and higher rates of evapo-transpiration, so water is used up that would otherwise be available in controlled or cultural burn areas to contribute to the hydrograph and increased stream flows.
13. Tribal community members recalled a considerable biomass of Pacific lamprey moving through the Klamath River system in the past, serving a significant role in the ecological integrity of the ecosystem. They believe lamprey help prepare the waters in their own way of being a part of the circle

of life. Whether as prey for fish-eating species or scavenging matter for salmon fry and sturgeon, the lamprey are a primary food source. Pacific lamprey are also essential contributors of marine-derived nutrients and organic matter.

14. Tribal fishers place a high value on environmental indicators to know when lamprey are running in the system. These indicators may include dogwoods blooming, crickets singing, or frogs croaking. This "calendar" is a management strategy for knowing when to harvest a species and when to leave a species alone.

3.6 Conclusion

The vast amounts of knowledge shared with me regarding Pacific lamprey and the Lower Klamath Basin was immense. Chapter 3 only touched on some of the main topics that came out of my discussions and experiences with Karuk and Yurok eelers and tribal community members. The depth and expanse of this knowledge is a reflection of the diversity and breadth of the Yurok and Karuk cultures.

Chapter 4
Cultural Significance

As demonstrated in previous chapters, the cultural significance of Pacific lamprey cannot be separated from any of the aspects already mentioned in this thesis. While I gathered a large amount of data regarding the cultural importance of lamprey to the Yurok and Karuk, it is too much for me to go into greater detail within the context of this thesis. As I will mention further in the recommendations section, a future publication that is able to elaborate on the current and potential cultural impacts due to a decline in lamprey populations would be an important endeavor. In the following subchapters, I touch on some of the key points made by participants regarding the social, spiritual, and health importance of Pacific lamprey. I also include knowledge about traditional fisheries management and the role of ceremonies in resource management.

4.1 Spiritual, Social, and Health Implications

Tribal community members spoke of how the dominant culture has had a negative influence on the ability of indigenous people to pass on their knowledge to the younger generations. "When traditional paths were a lot closer and a lot better, these things were passed down and people knew what was going on with the interconnected cycles of multiple species" (Yurok tribal community member). Participants have found that cultural genocide, economic instability, and the decline of resources have all played their part in creating a disconnect in the transmission of trans-generational knowledge. For many of the older people, the river is a way of life. They have stories and each story has a teaching tool or lesson in it. When

people moved away or worked in the mills, they quit telling the stories. Those that were sent to government school were punished for "speaking Indian" and they left it all behind. Many elders do not hand down traditional knowledge as they used to and the younger people in the middle now have a tendency to be that teacher for the next generation. The impact can be both social and cultural,

> When you're not down there eeling, you don't learn about tides, you don't learn about river morphology, you don't learn about the other birds and other species that are out there at the same time. So, you lose a whole awareness of your environment and the seasonality and the timing and differences of stuff. You don't learn about what goes into it, like the quality of the yew wood or the other branches that are made to make the hooks or the gaffs. Understanding the eddies on how to use a dip net, so you lose a whole part of knowledge about the technology that goes into making the implements and how to effectively use different implements for different parts. River flows, eddy conditions, outgoing and ingoing tides. Your awareness of the environment isn't there for one. Plus, you don't learn how to make the implements or how to use them effectively. So, then there's the part of the manufacturing that goes along with it. Then you lose the part of it about preparing them or even how to slice the eels and how to cut their tails, how to flatten them out and then put them on. So, you're not even then learning how get smokehouse wood because you don't have any eels to smoke. You might use the same rotten alder or something for sturgeon or for salmon or deer or elk meat later on, but you still, that's another part of it that you're not then doing. You're not having to go out and collect smokehouse wood so you're not out looking along the creeks for rotten alders or down along the driftwood getting rotten alder. It's another thing that you're not out in the environment, so you're inside playing your game boy or watching videos or you're going to town hanging out at the mall (Karuk eeler).

For many it has become personal; it is about honoring the knowledge that the people who came before them had, including their lifestyle and how "they were able to live and survive and prosper in this land where the miners came in and nearly starved to death" (Karuk tribal community member).

Several of the elders I spoke with believe that the decline of the resources is pulling people away from their culture. The younger generation does not know or respect the traditions and they are not as interested in the older ways anymore. For many people, it is not worth their time to go eeling these days, especially if they work or live far from the fishing holes.

> You've got to be dedicated to walk down Ishipishi Falls and eel at night. When you keep going down there and coming back with nothing, with nothing, with nothing, with nothing, it gets disheartening. You kind of wonder, are there any out there? What's going on there? The lamprey is a species that they can't put a price on, they can't charge a fishing fee for, so I think it definitely goes under the radar. And it's getting to the point where they almost have to become extinct before we want to do anything about it (Karuk tribal fisher).

In the past, the elders were the first to receive fish or lamprey. For many of today's elders, it has been several years since anyone had brought them even one lamprey.

> We deliver fish to these types of people and in return we get a story or we get cookies or whatever. But, we're making these people, their last days on earth happy. And that's what we do. And last year, with 90 fish or little under a hundred fish at the falls, we were unable to do that. And I think lamprey is right falling in that same suit (Karuk tribal community member).

When an elder does receive a traditional food, whether a lamprey, a fish, or acorn bread, it brings them back to the old days.

Participants also mentioned the social value lamprey had to the community. In the past, a village would have an eel roast after the first lamprey arrived, bringing the community together in celebration. Now there are not enough lamprey to have an eel roast. Eeling also has an important social and spiritual component for many of the individuals with whom I spoke.

> There was Indian laws that were based on the gathering of food. And them laws applied to everyday life, being respectful, asking and stuff like that. So when you lose the one thing that them laws were most applied well then you lose the lessons of, you know, life (Yurok elder).

Lamprey are part of the cycle of gathering different things during different times of the year to provide for their families to keep them going and healthy. "Being an Indian you live on fish, you live on eel, you live on the river and the ocean" (Yurok elder). I was told that before the 1920s lamprey were a critical part of everyone's diet. Lamprey that showed up before they could harvest the spring salmon played a significant role in feeding their people. Today, diets are being altered because Karuk and Yurok people are not able to eat the same subsistence resources that were available in the past.

> Lot of people eat food from the stores, but there's no food like the food they used to eat, food that their people have grown up on through generation upon generation and depended upon as a food source. It's very healthy for your mind and body (Karuk elder).

Tribal community members are noticing the dramatic impacts of this change in diet, including high rates of heart disease, obesity, diabetes, and other health complications. Additionally, the average lifespan has dropped dramatically. One participant noted that his grandparents' generation lived into their hundreds, his parents' generation into their seventies, and now his own generation is passing away in their fifties.

4.2 Traditional Fisheries Management

Yurok and Karuk people had to be very observant and to know things very intimately to be able to survive. Through thousands of years of observing or being

given special knowledge from the spirit people, they gained knowledge of the Klamath River system. Participants told me that specific management strategies applied to tribal fisheries. "Our culture is designed around these different cycles of fish; our culture is like our management. It signifies different times of the year, instead of going by calendars and stuff; we can follow the moon cycles and the fish run cycles" (Karuk eeler). Fish runs were intentionally left alone to reach their spawning grounds. The first salmon ceremony was the conscious practice of letting the salmon move up through the system first before they could start fishing. In the past, from mid November to mid December, it was taboo to go fishing for any species. Some people speculate that this belief was substantiated by the idea of letting the first runs of lamprey migrate up as high as they could before they started to harvest them. It is also an issue of safety for eelers because the water and weather conditions are the most dangerous during that time of year. Once a community had the lamprey they needed to support their families, then eeling ceased and the eelers moved on to the next fishery.

The Yurok and Karuk believe that a fish will return only if it is harvested and not wasted. In the past, if a resource was wasted, consequences could be as extreme as excommunication from the community. "We also believe if we quit fishing for these eels and quit eating them, then maybe they won't come back anymore. There's a real strong belief that we have to utilize our resources, they're there for a reason" (Karuk eeler). Several eelers told me that the Creator made the eel and gave the Indian people the river, which brings up different kinds of fish each season. If you share your food, do things for other people, and pray about it and thank the Creator,

then the fish will come back to you. Another participant mentioned that if people are not able to utilize the resources that their ancestors always used, then they are not doing something they are supposed to be doing and the cycles are not happening as they should. The "fish are part of our way of life, our culture, the harmony, the cycle. The cycle has been broken, the balance has been upset for the fish and it's affecting the lamprey" (Karuk eeler).

Participants expressed the need for a radical change in current fisheries management, including restoring the fire regimes and that connection between fire, the forest, and the water. In the past, the use of low intensity fires as a management tool was both complex and multi-faceted.

> The way the world used to be, the way the creator had it was that the forest wasn't all wooded up, all thick, it was all open and it burned all the time so there was no two foot duff layers here and there where the water doesn't seep into the ground and get down into the caverns and stay cool and then come out into the river eventually; there are so many fir trees now, that it's sucking up all that water and everything has to suffer (Karuk tribal community member).

Cultural, or traditional, management cleared out the riparian and the understory along the riparian so there were more flows going into the tributaries.

4.3 Ceremonies

Several tribal community members spoke of the importance of ceremonies in their traditional management. In the past, ceremonies were used to dictate resource management and to put the world back into balance. Some participants believe it the responsibility of humans to honor the lamprey in their prayers and songs so they come back. The idea of reciprocity is important, "we take care of them, they take

care of us" (Yurok eeler). Many participants believe that the decline of lamprey populations is an indicator that they are losing their world, as well as the larger world around them.

> I think what's important. . .is that they're just indicators of how our world is. Until we take care of our world, until we start taking care of the ozone layer, until we start taking care of our pollution, we're going to go away. The earth is going to wallow us up and say, 'Time to clean. Time to wash my face.' And so the eels are just an indicator of that we're not doing something right. When we do things right, things happen in a good way and so we, meaning us humans, we're doing something wrong. We're either poisoning them, maybe the water's too warm. Do you know what I mean, we're doing something wrong with the earth and the eels are an indicator that something is wrong. We as humans, not just Indians, all of us, need to look at that and act accordingly (Karuk eeler).

A few participants mentioned hearing about a first eel ceremony performed by the neighboring Hupa that was similar to the first salmon ceremony, after which the people were free to catch and eat lamprey as desired. The first eel ceremony made medicine for the lamprey so they would be healthy and abundant to feed the people and have more seasons to come. Most people believe that it is highly likely that the Karuk and Yurok shared in similar ceremonies in the past. One eeler recalled his grandmother mentioning that they used to have a first eel ceremony.

The difficulty now with traditional management is that the ceremonies are so disrupted that they are not able to do them as a culture. "It's more of a gallant or a social thing rather than the basics of life" (Karuk tribal community member). Several tribal community members mentioned that the ceremonies are starting to become more intact, as more people are becoming involved in the praying and the dances. "Eels were here from the beginning of time as food for human beings and the rest of

the animals. It is our responsibility as humans to step up through dances and prayers..." Those tribal members who are true believers in the ceremonies feel that they will be enough to bring back the fisheries. Others want to incorporate management to bring their species back, but believe that their ceremonies are the basis for the return of these species. Most agree that the management of the river and the culture are one and the same. "It's the way it is, it's the way of the world, that's why we have to all pray together, dance together, make it right" (Karuk eeler).

4.4 Conclusion

The cultural significance of Pacific lamprey to the Yurok and Karuk people is important to understand on many levels, from the individual to the tribe to ecological and political communities. From the perspective of local tribal community members, tribes should have the central role in management, primarily because of their personal and cultural stake in it.

> What happens to Fish and Wildlife Service biologist at the end of the year, he goes home or, hell, at the end of the week, usually Thursday, he goes home. And he goes home and he goes to Safeway and buys himself a steak. I'm not saying that those guys and some of them don't have a passion for their work because most of them do, a lot of them do. It's not to say that they don't do some good work. They don't have the stake in it. Their way of life, their culture, their religion, everything that makes them who they are is not at stake each and every day in the work that they do. And that's not the way that it should be (Karuk eeler).

For the Yurok and Karuk, the loss of Pacific lamprey populations in the Klamath River system has multiple implications, from the loss of an importance subsistence food source to significant social, spiritual, and health consequences.

Chapter 5
Discussion

5.1 Pacific Lamprey TEK

One of the main questions I asked in this research was how Karuk and Yurok TEK contributes to a more comprehensive understanding of Pacific lamprey populations in the Lower Klamath Basin. I also posed the question of how this TEK provides us with a greater perspective of the interconnected ecological and cultural characteristics of the Klamath River system as a whole. As evident by the immense amount of knowledge shared with me during the process of this study, participants were able to provide a wide range of information about both lamprey and the Klamath River system, including knowledge that is currently lacking in Western science. Additionally, participants were able to share a local perspective and understanding that has been developed and fine-tuned over thousands of years about the specific ecology of the Lower Klamath Basin.

5.2 Aligning TEK and Western Scientific Knowledge

While there are Western biologists that have fought to give greater awareness to non-game species, until recently, attention has mainly focused on game species because the majority of funding generated for fish and wildlife agencies has been through license fees. Lamprey were historically viewed as parasites and non-game species, so there is little data on them. "Who else better has that data now than the traditional fishermen? They can tell you the upper distribution, the timing, and the relative abundance of eels or the fact that when there were solar flares going on the eels were more abundant up on the rocks" (Karuk tribal community member). As

this same participant went on to explain, science can help with things like genetic diversity or understanding the differences between the two runs of fish; things where traditional knowledge may not have as much detail or the knowledge has been lost. The two knowledge sets are mutually supportive, but Western science can come across as if they are the only source of information or understanding. Indigenous groups often see the value of science, but science often does not see the value of traditional knowledge.

As the federal government continues to pass legislation requiring state and federal agencies to work closely with local tribal communities in resource management issues, creating opportunities for aligning TEK and Western scientific knowledge becomes more imperative. Many agencies are finding this assignment overwhelming or unnecessary, so often times the extent to which tribes and local communities are involved in resource management decisions is minimal.

> Science-based management, however, appears to offer managers a way of restricting the uncertainty inherent in natural-resource management; it is, after all, 'scientific', thus promising a degree of rationality and precision that non-scientific approaches are believed to lack. It is therefore to be expected that decision-makers, grounded in the belief that science offers a powerful means of exerting 'control', and largely ignorant of alternative non-western cultural traditions, will necessarily remain partial to the advice originating from science-based state-management institutions (Freeman 1989: 106).

From the Western perspective, the idea of incorporating local knowledge into management decisions, let alone supporting local resource management initiatives, may seem daunting at the very least.

I have included in the sub-chapters that follow the main TEK contributions as outlined in subchapter 3.5. Where it was applicable, I attempted to align TEK with Western scientific knowledge of Pacific lamprey. My research focuses on the TEK of Pacific lamprey, so this is not an exhaustive collection of the Western scientific data available. I am also not an expert on the biology of lamprey, but found it interesting to note the research I was able to uncover that seemed to correspond to the TEK.

One of the main lessons I learned in this attempt to align TEK with Western scientific knowledge is the issue of translation. When a tribal community member utilizes a word to describe a behavior or physical characteristic, that same word may have a very different meaning to someone coming from a Western perspective. Additionally, some TEK may not have a counterpart in Western science, but are insights into a more comprehensive understanding of Pacific lamprey and the river system. Participants are products of their history; so many times, they utilized both Western scientific knowledge and TEK to develop their own understanding of Pacific lamprey and the Klamath River system. They may use Western concepts because they have a Western science background; however, these same words are incorporated into and understood from both a Western and traditional worldview.

5.3 Comprehensive Understanding of Pacific Lamprey

The following is a summary of the TEK contribution to understanding Pacific lamprey in the Lower Klamath Basin:

- ❖ Two morphologically distinct Pacific lamprey were observed along the mainstem Klamath River. One run was larger and blue, while the other was smaller and darker. Participants who eel primarily at the mouth only saw the larger blue lamprey. Eelers up in the tributaries observed only smaller dark lamprey. Additionally, one eeler recalled seeing a run of lamprey come into the Klamath River estuary every April; another participant mentioned his unusually large harvests of lamprey when he goes eeling at the mouth on his birthday in April.
    - Tagged lamprey in the John Day River have been observed by fisheries biologists to hide under boulders when they arrived in August and remain there until the following March during which time they moved to their spawning grounds (Bayer et al. 2000). If Pacific lamprey do over-winter before they spawn, it is speculated that participants are describing those lamprey that have just come into the river system (the larger, bluer) and those that have wintered over and are ready to spawn (darker, smaller). Alternatively, they may be describing two different runs of lamprey or two different life histories.
- ❖ Adult Pacific lamprey have been observed to display specific behaviors in response to changing water conditions, such as temperature, water flows, and particulates in the water. Lamprey were seen to utilize a "breather hole" at the top of their body during muddy conditions. They also utilize one another to move over barriers, creating a wedge of lamprey that leapfrog their way over rocks and dams.

- Many participants attributed lamprey behavior, such as moving along the sides of streams or utilizing eddies, as predator evasion strategies and taking the path of least resistance because they are "lazy swimmers".
- According to D. Markle of Oregon State University (personal communication, August 2006), lamprey fisheries biologists have found that lamprey breathe in and out of gill pores when they are attached to rocks and other fish. The "breather hole" observed by participants is called a "nostril" by biologists. This nostril connects to the esophagus, which is separate from the respiratory tube. Muddy conditions may make the nostril movements more obvious.
- A "breather hole" may have a different meaning for the participants who mentioned it. While they may believe that lamprey literally respirate out of it, it could be that they used a Western term to describe something that has a meaning outside of Western understanding or available terminology.

❖ Participants observed groups of lamprey moving together through the system and following a specific "trail" through the water. That trail altered when the next group came through and responded to changes in water conditions. Participants also mentioned that they harvest more male lamprey first, then males and females, then mostly female lamprey.

- These observations indicate that adult lamprey may release a chemical for both males and females to follow.

- Fisheries biologists find that male lamprey arriving first is a common strategy for males to maximize their chances and females to make sure they have a choice of all available males.
- According to D. Markle of Oregon State University (personal communication, August 2006), biologists have found no known examples of territory or trail "marking" in fish.
- Recent biological studies on sea lamprey are addressing sex pheromone communication. They have demonstrated that sexually mature sea lamprey release sex pheromones that attract the conspecific individuals of the opposite sex (Li et al. 2003).
- Other biological studies are looking at larval pheromones. Fisheries biologists are addressing questions of whether lamprey exhibit homing behavior, like salmon, or respond to bile-acid based pheromones released by larvae (Stone et al. 2002). Preliminary results are indicating that larval and adult bile acids may be pheromone cues for Pacific lamprey. The bile acid, petromyzonal sulfate, is found to be a migratory pheromone for sea lamprey (Yun et al. 2003).

❖ Pacific lamprey were observed to be sensitive to electromagnetic activity, such as lightening and solar flares, during which times they either moved deeper into the water or came out of the water onto the rocks in abundance.

- Biological studies have found that lamprey have an electrosensory system that is as sensitive as those of other electroreceptive fish

(Bodznick and Northcutt 1981). They also possess electroreceptors on their head and trunk regions that may be useful in finding prey (Bodznick and Preston 1983).

- Scientists speculate that lightening may be a source of "noise" that interferes with the detection of significant electrosignals or limits the resolution. It has been shown to cause millisecond pulses in natural water bodies, up to hundreds of miles in distance (Hopkins, 1973 cited in Bullock 2005); these pulses overlap in duration and form the same electric organ discharge (EOD) pulses of many species of weakly electric fish (Bullock 2005). Weak EOD may have many practical uses that are not fully understood or proven yet. These may include disorienting and confusing potential predators; determining location (electrolocation and electroorientation) by interaction with the earth's magnetic or electric field; social communication (including reproductive behavior); or sensing of weather, time of day, earthquakes, and distant lightning (Bullock 2005).
- During electromagnetic activity, it is speculated that lamprey may not be able to utilize their electrosensory system to avoid predators, so they move out of the water as an evasion strategy or the EOD pulses formed by lightening or other sources may overwhelm their sensory system causing them to try to "escape".

- ❖ During normal years, the harvest of Pacific lamprey in the Klamath River Basin begins at the mouth in late November and in the Scott River Valley by late July.
- ❖ Historically, Pacific lamprey were found in all of the middle and lower Klamath River tributaries and moved up higher in the system to spawn than steelhead populations. While eelers and other fishers typically do not see lamprey spawning, they have witnessed the dead lamprey floating down from above where they fish for steelhead.

5.4 Ecological and Cultural Characteristics of the Klamath River System

The following is a summary of the TEK that provides a greater perspective of the interconnected ecological and cultural characteristics of the Klamath River system as a whole.

- ❖ Eeling is a flow-dependent fishery. Eelers have developed over thousands of years the most appropriate technology to harvest lamprey based on their knowledge of the morphology, flow, and substrate of the stream, as well as the behavior of lamprey in response to specific conditions.
    - Thus, different environmental conditions ruled the life cycles of these species, controlled the methods by which each might be taken, and gave rise to the different devices: weirs, nets, traps, spears, harpoons, gaffs, and other inventions of the primitive fishermen (Kroeber and Barrett 1960: 8).
    - One of the eelers I interviewed with a Western scientific background explained this behavior using the optimal foraging theory. Eelers use

the most appropriate method that allows them to harvest the most fish in the least amount of time using the least amount of energy.

- ❖ Tribal community members noticed a correlation between the extirpation of eulachon populations, another high fat species, from the river system during the same time period that lamprey populations began to decline. Participants expressed concern over the persistence of toxins in lamprey and in the river system both as a limiting factor for populations, as well as a potentially serious threat to the humans who consume them.
    - The oil rich properties of lamprey may contribute to the bioaccumulation and biomagnification of contaminants being brought into the river system. Lamprey pick up toxins as they filter feed in the backwater areas of freshwater environments and when they feed on fish and whales as adults and juveniles in the ocean. When they return to spawn, they are most likely bioaccumulating some type of toxin in their bodies.
    - The Superfund Health Investigation and Education program of the Oregon Department of Human Services recently investigated the risks of ingesting lamprey for the Confederated Tribes of the Siletz Indians. Several contaminants were detected in the tissues of Pacific lamprey, especially fat-soluble compounds known to accumulate in the food chain. While dieldrin, PCBs, and arsenic exceeded their comparison values for carcinogenic endpoints, none of these chemicals were above levels considered significant for a cancer risk-based public

health hazard. However, the childhood exposure scenario did approach its minimum risk level for non-carcinogenic effects associated with PCBs (Oregon Department of Human Services 2005).

- ❖ Tribal community members noted predation from seals and sea lions as one of the major limiting factors for Pacific lamprey populations.
  - In 1981, C. Bowlby found that sea lions primarily came to the Klamath River between March and June to feed upon Pacific lamprey migrating upriver.
  - Twenty years later, during an assessment of pinniped predation, the Yurok fisheries program observed sea lions feeding in the Klamath River estuary throughout the year. During these same studies, they analyzed the scat of Pacific harbor seal and California sea lions to deduce the frequency of occurrence for prey species. Lamprey species made up a large portion of consumed prey, especially during sample periods April to July and September to November[9] (Williamson and Hillemeier 2001).
- ❖ Tribal community members are in the position to observe important changes in population dynamics within the Basin. The number of ammocoetes, adults, and dead lamprey observed in the system has declined dramatically in the last 40 years. They correlate these changes with intensified upslope

[9] Data was summarized by sample period so lamprey may not have been found in pinniped diets equally throughout each sample period. Additionally, seals and sea lions may not have been feeding on lamprey primarily in the river system during the entire sample period; they could have also been feeding on lamprey out in the ocean before entering the estuary.

management practices and changes in the natural flow regimes, which have affected spawning and rearing habitats.

- Participants observed that lamprey are most affected during their life stage as ammocoetes, which fisheries biologists have found they are in for up to seven years. Tribal community members believe that rapid increases and decreases in water releases from Iron Gate Dam, especially during the summer and early fall, create invisible fish kills because the larvae are left stranded in the upper substrate.
- The people that I interviewed believe that the combination of intensive logging practices, hydraulic mining, wetland delineation, water diversions, loss of spring freshets, and road building have created a system prone to the magnified effects of natural episodic floods. They told me that, historically, seasonal spring freshets were on a smaller scale and cleaned out the river system by washing out sediments and taking out the willows along the banks. Current flood events deplete lamprey spawning and rearing habitat, as well as generate a scarce primary food base and limited opportunities for population regeneration. Participants believe that contributing factors to the magnification of these flood events include the loss of wetlands in the Upper Basin, which naturally held large amounts of water in the system to release slowly over time. Additionally, logging roads and clear cuts contribute massive amounts of sediment that fill in the deep holes of the stream. Large rocks pile up at tributary mouths, catching

large woody debris and creating a dam that eventually blows out the mouth of that stream.

- Participants emphasized the impact of fire suppression because it has led to an increase in forest density and higher rates of evapo-transpiration. Water is used up that would otherwise be available in controlled or cultural burn areas to contribute to the hydrograph and increase stream flows.

❖ Tribal community members recalled a considerable biomass of Pacific lamprey moving through the Klamath River system in the past, serving a significant role in the ecological integrity of the ecosystem. They believe lamprey help prepare the waters in their own way of being a part of the circle of life. Whether as prey for fish-eating species or scavenging matter for salmon fry and sturgeon, lamprey are a primary food source.

- Biological studies emphasize the importance of anadromous species as a significant link between aquatic and terrestrial ecosystems (Willson and Halupka 1995).
- The function of dead lamprey in the system has been de-emphasized in current scientific literature. Along with salmonids species, Pacific lamprey are essential contributors of marine-derived nutrients and organic matter (Beamish 1980). Especially within the nutrient-limited systems of the Pacific Northwest, biologists have found that even small nutrient pulses are found to increase benthic macroinvertebrate

abundance and elevate freshwater productivity (Wipfli et al. 1998; Wipfli et al. 1999; Naiman et al. 2002).

- Tribal eelers place a high value on environmental indicators to know when lamprey are running in the system. These indicators may include dogwoods blooming, crickets singing, or frogs croaking. If these indicators are affected by changes in the environment, then indigenous people will be the first to observe that change. As one eeler remarked, if upslope management practices include the cutting down of all the dogwoods then eelers will no longer be able to look on a hillside and be reminded, "dogwood flowering and that cricket's singing, we have a responsibility to go down there and fish the falls" (Karuk eeler). This "calendar" is a management strategy for knowing when to harvest a species and when to leave a species alone.
- An eeling story that was mentioned earlier demonstrates how seemingly unconnected variables may tie in together to create an unexplainable event or experience. The last large flood event was in 1997, during which there was also a lunar eclipse. One eeler told a story of going down with his family during the lunar eclipse to catch the first lamprey of the season. They only caught a few, but he returned the following night alone and after putting his hook in the water, he never stopped throwing lamprey for four hours. The bank behind him was crawling with them. That season he caught over 1600 lamprey in about three weeks. The mouth of the river blew out that year and fish were able to move into the river untouched by the seals and sea lions that would normally hunt for them at the narrow opening into the estuary. The

combination of high water, a decrease in predation, and high electromagnetic energy may have influenced the ability or motivation of that lamprey run to move rapidly up into the system in large numbers. Just three or four eelers took 5000 to 6000 lamprey out of Ikes Falls and they "never even dented it".

Chapter 6
Recommendations

6.1 Recommendations for Tribal Fisheries Programs

The incorporation of TEK and traditional fisheries management practices are fundamental in rebuilding both Pacific lamprey populations and the health of the Klamath River system. Traditional fisheries management includes the local human element that is often missing in contemporary resource management, by taking into consideration local perspectives and empowering the local community in decision-making.

6.1.1 Incorporation of TEK into Current and Future Fisheries Projects

Karuk and Yurok tribal fisheries programs are currently working on tribal harvest and out-migrant fish trapping monitoring projects, as well as a mainstem larval lamprey study. Observational data is also available from other studies and monitoring projects. Future studies include assessing lamprey distribution and biology in the Lower Klamath Basin. Tribal fisheries programs are able to combine traditional practices with the projects they are already working on. For instance, when they dip at the falls or at the mouth, they are able to capture live fish. They can also do the same by catching them in eel baskets. The lamprey are healthy and available for harvest, monitoring, or other studies.

These days, lamprey are difficult to monitor because they come up in short spurts, unlike the continuous runs of the past. The Karuk are developing a program using baskets to know when the lamprey start coming up through the system, to notice any trends, and to persuade more eelers to participate in this process. By

using this approach to management, they are also able to jumpstart their traditional fisheries, which may mean choosing not to fish for lamprey. The important point is that control is handed over to the tribes to make these decisions. Some people would like to see eeling limited to those who use traditional methods, which would relegate it mostly to the native community.

Currently, basic information about lamprey in the Klamath is limited, such as presence, distribution, and life history characteristics. As this study demonstrates, much of this knowledge is available and alive in the indigenous people who live along the river. It is recommended that further studies be conducted that focus on lamprey distribution in the tributaries of the Klamath, including the Scott and Salmon Rivers. Additionally, gathering information about the technology utilized in specific stream reaches may provide insight into present and historical stream characteristics, as well as lamprey life history and behavior.

> When you depend upon a resource and it's very place-based, there's fine attention to detail. Whether the water flow was this much on this rock at that point because that's where we set up our scaffold or the water isn't high enough to submerge this rock where we usually hook off of because it's still high and dry. All of those micro site conditions are filtered in because, as the optimal foraging theory says, it feeds in to how successful you'll be (Karuk tribal community member).

TEK is able to tie the physical to the biological to the cultural. With enough quality traditional knowledge, you can reconstruct certain flow regimes.

> "The health and the condition of the river is something that, even in this year, you don't have to be a biologist or a professional land use manager armed with studies and technical data and information to see...we all keep track of high water marks and certain places in the river that reach, that are flood stage for lower down and what are signs when the river is not doing as well. If the river is not

> doing as well, then all the other resources can't do as well" (Karuk tribal community member).

Science can learn from people's understanding of the fisheries. "They can say that eel used to be able to spawn in this certain area because they were up there in June picking maidenhair fern for basketry and they remember seeing spawned out eels below the creek" (Karuk tribal community member).

6.1.2 Eeler Participation

It is highly recommended that eelers and elders be included in tribal fisheries program activities, both on an individual and a group level. The more that local people are included in management processes, the more likely they will be involved in other aspects of tribal issues. As one participant commented,

> The people who do understand them, who do depend on them, they'll telling us we're the ones that have to change it and nobody's going to damn hand it to us, nobody's going to change it for us. We have to change it. And not that's going to happen overnight either. It's a long, slow arduous process and who knows if it's even possible. But if it is possible then it going to have to come from within, not from without. Nobody is going to come in and impose the solution as a fix on us. It's not going to happen that way. It has to come from here. It has to come from the people. That's just what I think about it (Karuk elder).

The elders know how the fisheries and the river system were before and they know the ceremonial aspects of management. If children see their parents and grandparents working together on these programs, then they will be more likely to step up and take on these responsibilities when they are older. The fisheries biologists need to be in touch with the people who harvest lamprey because they are the ones that are on the river and know what is going on with these species. On a group level, gatherings of local fishers seasonally based on a specific fishery would

provide opportunities for transmitting information, answering and asking questions, and open discussions.

6.1.3 Additional Recommendations

It is highly recommended that a publication be pursued that focuses on the cultural significance of Pacific lamprey to the Yurok and Karuk people as an issue of environmental justice. As the following dialogue taken from the Yurok focus group affirms, the loss of lamprey populations in the Klamath Basin would have social, cultural, and spiritual implications:

> Yeah, I think it's important too because it brings generations together, like father, son, grandson, you know. I learned from a lot of people here, you know. I never even knew how to eel or anything. My best friend and his dad, they'd take me down there. We'd go down there everyday, and it was just something we looked to. I'd be at school, just waiting for the weekend to happen so we go eeling. Middle of the night, all night. I see kids and their dads go down there, cousins, it just brings a lot of people together, and it's like an outing. It's great, it's a great sport. It's kinda like a competition, and you have fun with it. You know that even if you don't catch anything you have a good time down there just 'cause it's in one of the best places in the world.
>
> Yeah, I can agree with what he's saying because part of [his] young life down there, he's learned how to sing Indian songs down there, you sing many of them down there. I know that.
>
> Yeah, when you sing and stuff, it's the best background. You got the ocean and...
>
> Seagulls...
>
> ...and the river and everything's just...
>
> The sea lions barking...
>
> ...yeah, everything's just this big orchestra down there. And, you don't have to worry about anybody hearing you. You know that it's just you and the world. It's great to go eeling and I'm glad to

> be a part of, I'm a lucky person to be down there to eel every day. I feel that everyone feels that too.
>
> Yeah, that's one thing I like about it. You feel free down there.

Another recommendation for the tribal fisheries programs is the development of a fish distribution program for elders. "This lamprey project we have going on . . . we were able to go give elders lamprey for the first, some of them received lamprey for the first time in five years. We're talking about medicine people" (Karuk tribal fisher). Some tribal members have already been pursuing this type of project on an informal level. A more formalized program could also involve the younger generations, who would participate in harvesting the lamprey or salmon. Active fishers could teach the young boys the techniques and lessons involved in the process of harvesting. Together the young boys and their mentors would take the fish they caught to share with elders in exchange for a story or time spent talking and learning from the elder. Girls could also participate by learning the cleaning and processing techniques from other women, as well as taking the prepared fish to share with their elders. The younger generations would learn the laws and about having respect in the same way previous generations were taught, while also participating in the restoration of their culture.

Finally, as mentioned throughout this thesis, it is highly recommended that both tribes encourage their youth to learn about Western scientific knowledge, as well as their own traditional knowledge. The tribal members that are proficient in both knowledge systems will be more adept at communicating with non-tribal

resource managers and taking the lead on utilizing traditional management approaches to local resource management.

6.2 Recommendations for Western Fisheries Managers

Since the historical perspective of lamprey as a trash fish created an environment in which they were essentially ignored in Western fisheries management, there is little data available about their populations in the Klamath Basin. Yurok and Karuk people have been harvesting lamprey for thousands of years and have valuable knowledge that can inform fisheries biologists about the specific biology of and ecological role played by Pacific lamprey in the Lower Klamath Basin. Additionally, they are able to make connections between lamprey and other aspects of the Klamath River system that is yet to be understood by Western science.

6.2.1 Working with Traditional Ecological Knowledge

The complexity of TEK means that as outsiders we are not merely looking for common ground or data to support our own hypothesis. The tendency "is to find where the tangent points exist with Western science and to proclaim, quite rightly, that Indians arrived at the same conclusions using a much different epistemology or metaphysics" (Deloria and Wildcat 2001: 5). This approach provides the opportunity for communication, but it is not the whole goal, nor is it always culturally appropriate.

Additionally, we must be cautious in assuming that what is true for one indigenous group is true for all indigenous groups. As we recognize the diversity

among tribes, we need to go beyond superficial appearances and understand that most cultural differences arise from divergent ideas about nature and human connections with nature. As "experts" from the dominant worldview, it is easy to fall into the trap of ignoring these differences by analyzing and redefining TEK into our own categories of understanding.

Rather than try to work with TEK on their own, Western fisheries managers should find it more important to include the people who have the traditional knowledge into each step of the management process and to develop local management strategies that place decision-making in the hands of those who know and understand the systems that are being managed. "The consultative integration of local folk knowledge in management decisions can increase the legitimacy of those decisions" (Jentoft and Mikalsen 1994: 313). One participant who works in a Western scientific field, explained to me that,

> Managers need to start listening to Indian people and those scientists that think they can't learn anything from the indigenous population. It is very interesting to read what the Indian people said to Kroeber in 1880 or so about how it should be managed and what's wrong. And it's true, those things that they told him are true, those cause and effects, they happened. The Indian people were very observant and they had to know things very intimately to be able to survive. And for thousands of years of observing or given special knowledge from the spirit people, they gained that information and they had a knowledge of this area. A lot of times Western science wants to have these control plots and measurements and if doesn't happen five times in a row, then it's not legitimate. Most of what I have seen is that the Indian people know when things are going wrong (Karuk tribal community member).

The acceptance of traditional ecological knowledge does not mean we are utilizing a knowledge base that is centered on historical conditions. Nor does the utilization of Western scientific knowledge in traditional management mean that we are losing aspects of the traditional. "'Modern' influences do not necessarily make contemporary local knowledge less 'traditional,' as they are incorporated into a framework of existing knowledge" (Ruddle 1994: 175). A society's TEK is

> ...an encyclopedic and complex organized body of information that has evolved through generations and is still evolving. A local knowledge system is "traditional" by virtue of its long and deep roots and its origin in a specific culture and a local ecological system, but it is not static (Ruddle 1994: 174).

In utilizing aspects of each knowledge base to inform one another, we can develop a more comprehensive understanding of a species within the context of and relationship to its local ecological and socio-cultural system.

6.2.2 Local Tribal Management

Issues of "power" have played a key role in shaping the political, cultural, and natural environments of the Klamath Basin. The federal government's recognition of tribal rights to self-determination has vacillated over the past 150 years between acknowledging the principle and attempting to eradicate tribal existence (O'Brien 1985). These discrepancies have greatly influenced the power and manner in which tribes are able to manage their own natural resources. Treaties guarantee specific rights like fishing on traditional grounds that the tribe did not cede to the federal government when they sold or exchanged a majority of their lands (Wilkins 2002). While the Yurok and the Karuk signed a treaty with an Indian agent

representing the federal government, the treaty was never ratified. The Yurok currently occupy reservation lands they received in 1988, however the Karuk were never provided a reservation. Both are on land bases that are a small percentage of their original ancestral territories. The combination of these factors creates many difficulties when the tribes are advocating for self-determination and the right to manage their aboriginal lands and resources as sovereign nations.

The implementation of traditional fisheries management is as much an issue of local community resource management as it is of self-determination. As history reveals, external regulations can create problems when they replace a system already in place (Kottak 1999). The modern intervention philosophy seeks to impose global ecological moralities without paying attention to cultural variation and autonomy. Outsiders often expect local people to give up their customary economic and cultural activities without clear alternatives (Kottak 1999).

Even well meaning conservation efforts can be as insensitive as development when they do not involve local people in the planning and carrying out of policies that affect them. People often resist projects that interfere with their daily lives, especially subsistence (Kottak 1999). Indigenous people have managed subsistence economies for thousands of years; these economies are dependent on a reliable source of natural resources (BOR 2003). As a Karuk tribal member acknowledged, those people who live in the poorest areas, monetarily, are the ones who are affected the most. So having the ability to gather food resources and to live off the land is important to them.

Federal government agencies tend to manage in similar ways for everyone in the country; however, the Klamath Basin is its own niche. "You can't manage generically for every person in the United States because you're being biased and excluding local, special populations that have special needs, wants, and desires from the forest that are totally separate from what somebody in the city wants" (Karuk tribal community member).

> It's a cultural landscape. Everything in it is related. And that's the way the tribal people have always looked at it. And finally, some biologists, in certain circles, are beginning to use the words, 'ecosystem management', which means everything has to work together. The only thing with ecosystem management is they're still, mostly, leaving the people and their hearts and their feeling and their culture out of it, which is also a part of it. It's a whole (R. Pierce quoted in a documentary by Chamber 2001).

The native people who live along the Klamath River are asking for acknowledgement of their fisheries for the purpose of management and a voice in the larger management system. Western fisheries managers can assist the Karuk and Yurok in protecting their aboriginal rights by making the Lower Klamath Basin an adaptive management model and transferring authority to tribal management and those that depend on the resources. The Yurok and Karuk tribes would take on a central role in defining management goals and policies for the Lower Klamath Basin, while local, state, and federal agencies would function as support systems for the implementation of these policies and research projects. Management plans would incorporate a cultural focus, as well as traditional systems of management. Both tribal and outside groups would maintain a reciprocal relationship with one another

through continued communication and tribal representation on all levels of resource management decision-making that affects the Klamath Basin.

6.3 Future Studies

Many aspects of TEK provide avenues for further study utilizing the strengths of Western scientific study. "Based on the best available traditional knowledge at this time, this is how we understand it; perhaps this then provides a venue for scientific research to then pursue looking into investigating that further" (Karuk tribal community member). The following are some of the general subjects that I recommend for future scientific and traditional knowledge studies:

1. Lamprey reactions to electromagnetic and light changes in the environment, such as lightening storms, solar bursts, eclipses.
2. More extensive historical distribution study of Pacific lamprey within the Lower Klamath Basin, including each of the main tributaries, through more targeted interviews with elders.
3. Marine-derived nutrient contributions of dead lamprey.
4. Ammocoetes habitat preference and distribution.
5. More extensive interviews to identify dead lamprey and ammocoetes distribution in the river system as an indicator of historical and current adult spawning activity.
6. Determine if the two different lamprey observed in the system are distinct runs or if one has wintered over.

These studies can build on the information that has been collected during this research, as well as expand on those areas that I was not able to pursue and that need additional exploration and follow-up.

Chapter 7
Conclusion

The results that came out of this research project with the Yurok and Karuk Tribes surprised me on many levels. First, I was overwhelmed and amazed by the response from community members that were interested in and willing to be involved in the research. I recognized immediately that this response had nothing to do with me; rather it was the urgency of the subject that I hoped to address. People had something to say and they wanted to make sure someone heard it. Perhaps they recognized something personal in lamprey and its historic role as the species always misunderstood and disregarded by the dominant culture. On the other hand, perhaps they just realized that now was the time to have a voice in change and in trying to save their way of life.

I was also surprised by the immense amount of knowledge that people shared with me and am grateful for their trust in me. What an amazing opportunity to step outside of what I have always known as "truth" and to learn about an area of the world and a species unlike any I have ever known. Throughout this research, I have found myself participating in both a personal and larger process of understanding how we can work with TEK to empower indigenous groups while working within and without the dominant culture. With participants' permission, the knowledge gathered will be passed onto the tribes to come to their own conclusions and to use for their own ends. For more than a hundred years, the dominant culture has used its power to influence the resource management decisions throughout every region of the country. I believe it is time to pass the torch on and advocate for culturally

appropriate management strategies that are locally initiated and locally based. Again, I want to emphasize the importance of empowering Karuk and Yurok tribal community members to step up and be the ones that work with TEK and learn about Western scientific knowledge so they can best decide how to align the two knowledge systems.

My limited experience with TEK has demonstrated to me that there is so much that we do not know or understand and may never understand. When a species that has been around for millions of years is showing signs of weakness, then something dramatic needs to happen for the whole system.

> There's a reason the eels evolve, a reason they came into the Klamath River, and there's a reason they need to always be there. We may not know what those reasons are, but because we don't know what those reasons are, it's even more important to protect them (Karuk tribal community member).

Fish represent a major food resource, the focal point of ceremonies, and more recently, an issue of cultural sovereignty and survival for the tribes along the Klamath River. Today both the Yurok and the Karuk are facing the challenge of self-determination with a land and resource base that has been greatly reduced or altered. As species and cultures are driven to the edge of extinction, we must also examine the relationship between cultural and biological diversity. The decline of Pacific lamprey populations in the Klamath Basin is more than a symptom of what is going on with the river; it marks the decimation of an entire way of life.

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Appendices

Appendix A
Maps

A.1 Klamath River Basin

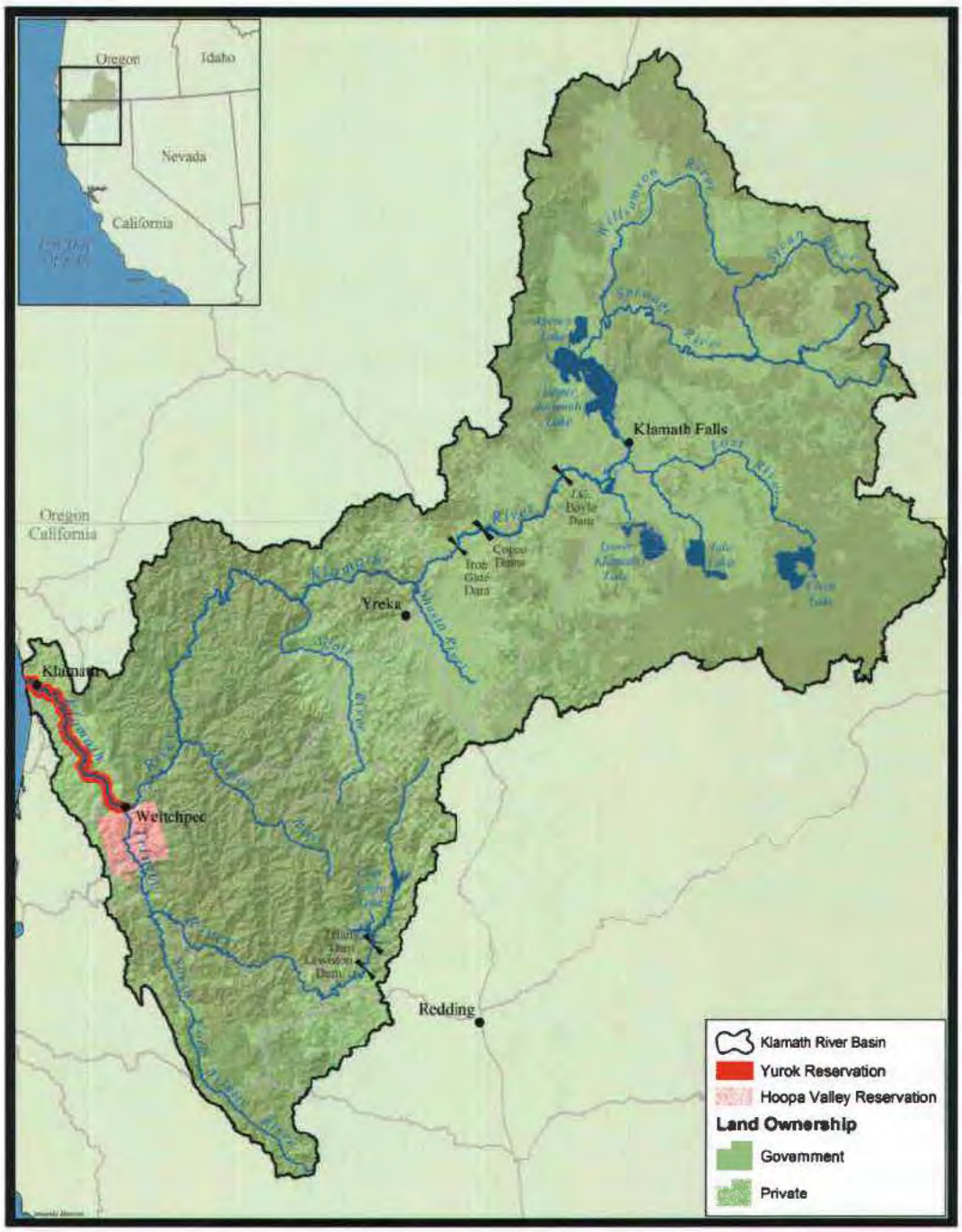


Figure 1 Klamath River Basin with land ownership
Courtesy of the Karuk Tribe Fisheries Program, 2005

A.2 Yurok and Karuk Ancestral Territories

Figure 2 Yurok ancestral territory and reservation boundaries
Courtesy of the Yurok Tribe Fisheries Program, 2004

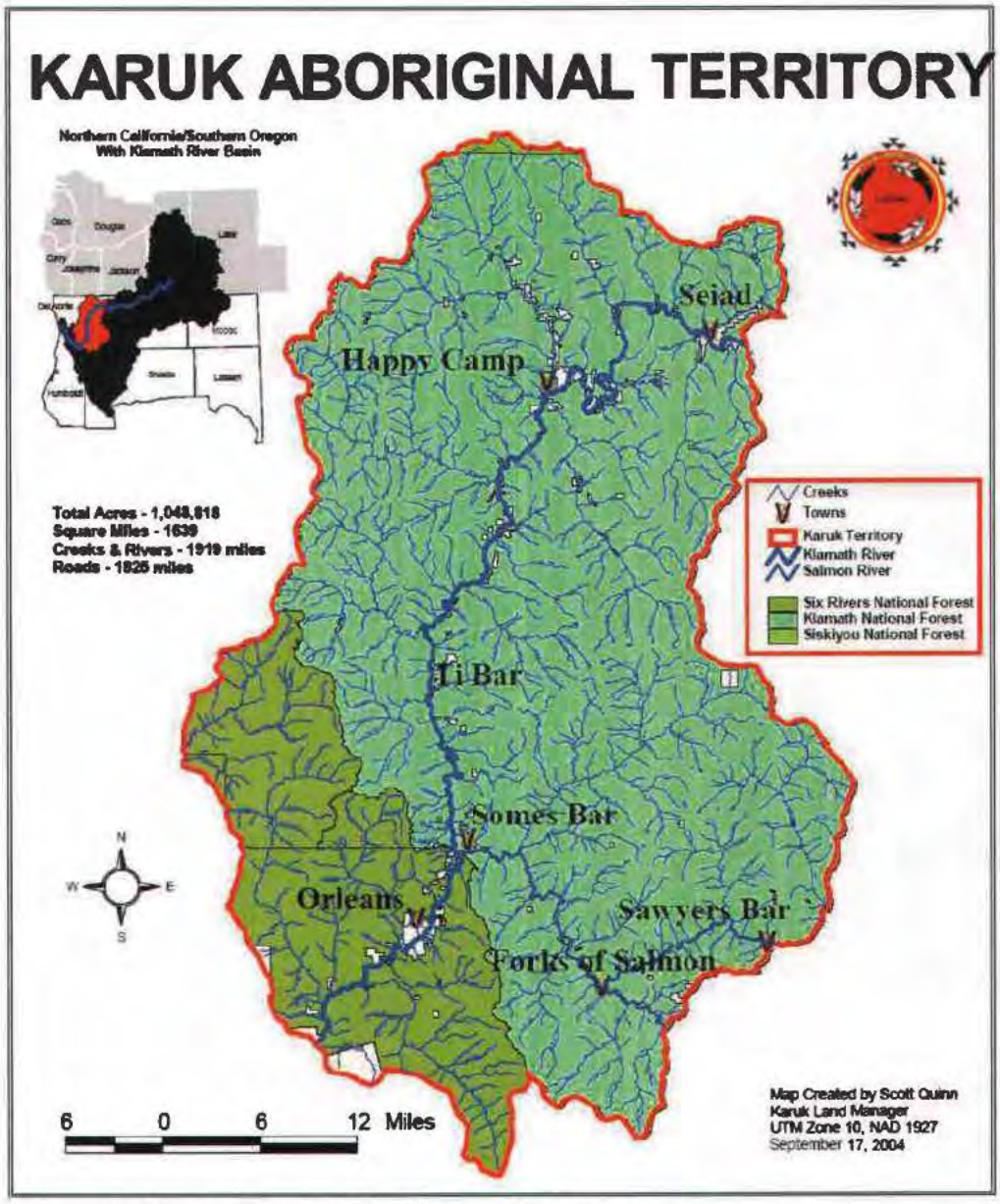


Figure 3 Karuk aboriginal territory and land ownership
Courtesy of the Karuk Tribe Fisheries Program, 2005

A.3 Pacific Lamprey Distribution

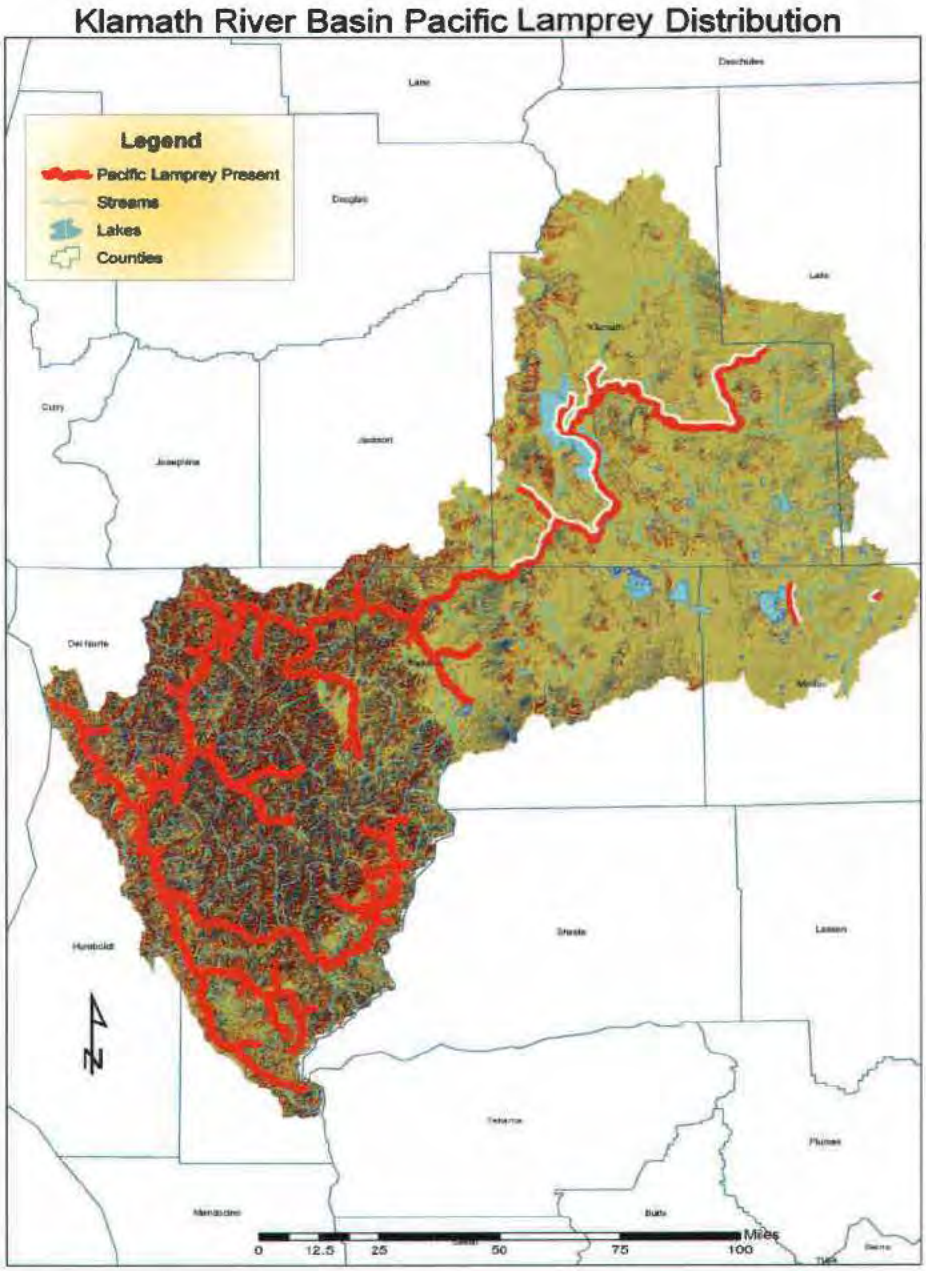
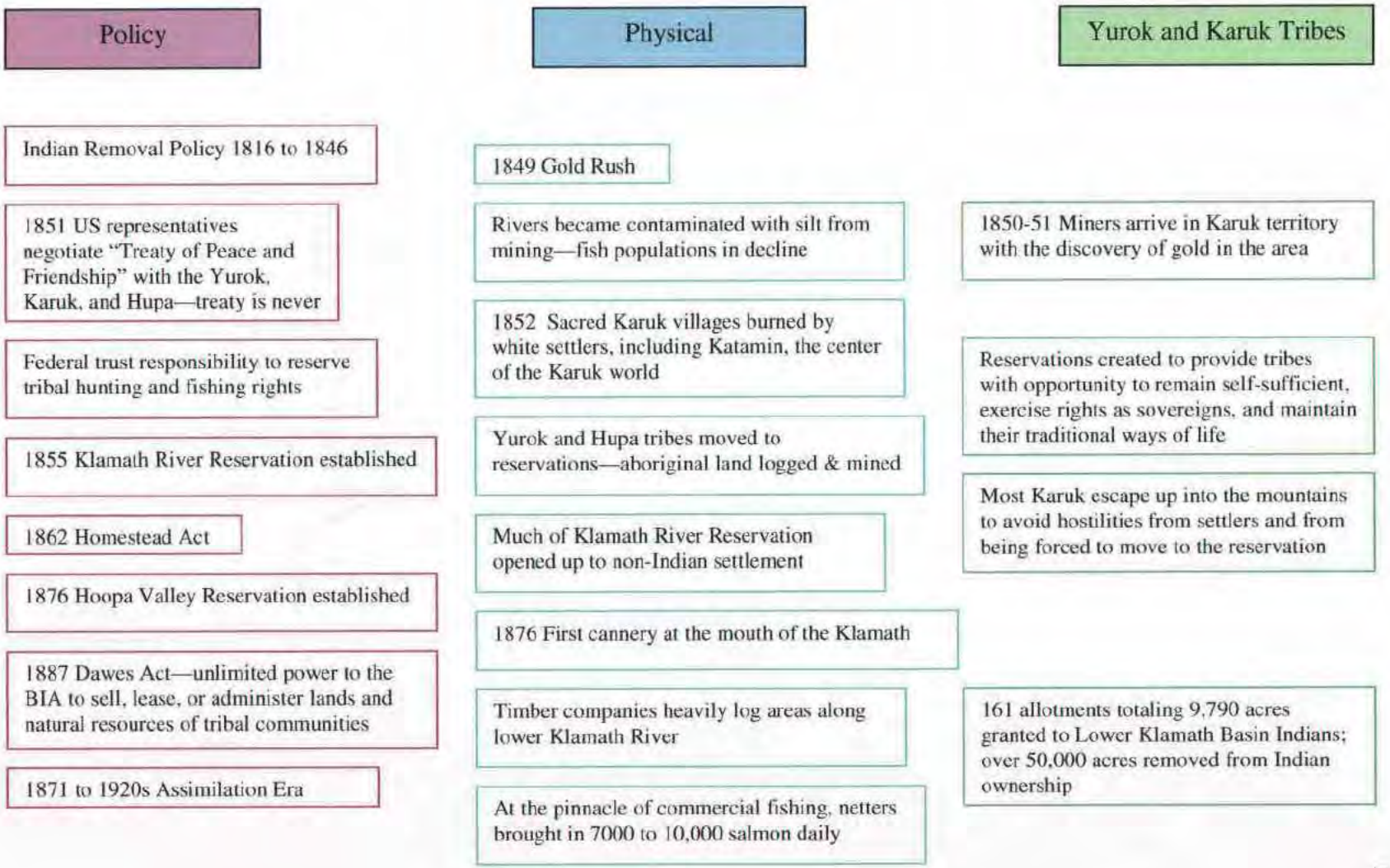


Figure 4 Klamath River Basin Pacific lamprey present distribution Courtesy of the Karuk Tribe Fisheries Program, 2005

Appendix B
Political Ecology of Fisheries Management Influencing the Lower Klamath River Basin



Political Ecology of Fisheries Management Influencing the Lower Klamath River Basin
(continued)

Policy	Physical	Yurok and Karuk Tribes
1902 Reclamation Act		Late 1800s to 1950s Yurok and Karuk children taken from their families to attend boarding school
1905 Klamath Project developed as federal reclamation project	Klamath Basin wetlands drained to construct irrigation projects—Basin will eventually lose 80% of its original wetlands	
1908 Winters Doctrine—established rights to water by Indian tribes to fulfill the purposes of the reservation		
1917 Copco I Dam built	Fish passage blocked to Upper Klamath Basin	
1925 Copco II Dam built	Large flood before WWII wiped out fishing areas up and down the river	All the young men left the river to fight in WWII; fisheries never rebuilt
1934 Commercial fishing prohibited until mid 1970s		Fishing with nets prohibited, including dip nets and trigger nets
	1955 Severe flood in the Lower Basin	Town of Klamath and bridge destroyed
1944 to 1958 Termination Period—forced assimilation		Economic development on reservations halted and people encouraged to seek a life off the reservation
1960 Trinity River Dam built		

Political Ecology of Fisheries Management Influencing the Lower Klamath River Basin
(continued)

Policy	Physical	Yurok and Karuk Tribes
1961 to present Self Determination Era—Indian nations are domestically dependent nations subject to the superior sovereignty of the federal government		1950s-1970s traditional ceremonies revitalized
1962 Iron Gate Dam built	Over 350 miles of historic spawning habitat for anadromous fish species blocked	
1964 Trinity River Dam built	1964 Severe flood in the Lower Basin—fish populations noticeable decline	Klamath townsite and bridge wiped out—many people leave town
Gill netting prohibited	1960s Lamprey eradication program	
1967 Endangered Species Act	1970s Klamath Project grown to over 200,000 irrigated acres	1965 Karuk Tribe incorporated to preserve traditional knowledge
1972 Marine Mammal Protection Act		1970s Fish Wars
1973 Federal court declares state has no jurisdiction over "Indian Country"		1983 Quartz Valley Indian Community receives federal recognized

Political Ecology of Fisheries Management Influencing the Lower Klamath River Basin
(continued)

Policy	Physical	Yurok and Karuk Tribes
		1988 Hoopa-Yurok Settlement Act—separation of Hoopa Valley Reservation and Yurok Reservation
	1992-96 Drought years	
USFWS and NMFS develop BiOps raising minimum lake elevation and increasing stream flow	For the first time in 80 years, irrigators do not receive their full supply of water	1993 tribal allocation of 50% harvestable surplus
		1993 Yurok Tribe formally organized—primary objective is fisheries management
Bureau of Reclamation provides full irrigation deliveries to the Klamath Project during a drought year	2002 Fish Kill	1994 Karuk Tribe receives federal recognition
Magnuson-Stevens Act—fishery management plans must take into account socioeconomic impacts on fishing communities		

(Bell 1991; Beckman 1998; Huntsinger et al. 1994; Leshy 1993; Yurok Tribe 2002)

Appendix C
Interview Materials

C.1 Research Summary

Pacific Lamprey Research Project
Robin Petersen
Oregon State University

Research Questions

1. What factors have influenced the decline of Pacific lamprey populations within the Mid and Lower Klamath River Basin?

2. What are the current and potential cultural and ecological impacts as a result of this decline?

Objectives

1. To learn about Pacific lamprey from the perspective of local eelers.
    a. Cultural significance
    b. Population changes
    c. Biology and behavior
    d. Connections to the water, the land, and other living things

2. To develop a more comprehensive understanding of lamprey by aligning local indigenous knowledge with Western scientific knowledge.

Benefits for the Yurok and Karuk Tribes

1. Document knowledge
    a. Direct future lamprey research
    b. Open up funding opportunities
    c. All information collected will be returned to the Karuk and Yurok tribes.
2. Empower the Yurok and Karuk tribes
    a. Current land and water use issues
    b. Tribal fisheries management
    c. Protection of harvesting rights

Methods and Analysis

In order to obtain knowledge of lamprey from the perspective of local eelers, ethnographic methods will be utilized, including semi-directed interviews, focus groups, and participant observation. Interviews and focus groups will be conducted by myself or by a tribal member, as deemed most appropriate. Notes will be handwritten and/or tape recorded, depending on the preference and comfort of the interviewee.

Data analysis will be an on-going process. Each participant will have the opportunity to review and verify summaries developed from the notes and audio-recordings of their individual interview and add in additional comments or information if desired. I will be able to verify my analysis by talking directly with the tribal member that provided the knowledge originally or by checking it with other tribal members to validate the accuracy of my analysis. I will also be working closely with the tribal fisheries departments to analyze the knowledge gathered and to determine its immediate application to their current and future lamprey research projects. A draft of the final analysis for my thesis will also be sent to the tribe for review and verification.

C.2 Informational Handout

The Biologists' Perspective on Pacific Lamprey (Eel)

What are lamprey (eels)?

Pacific lamprey (*Lampetra tridentata)* are jawless, boneless ancient fish. Their scientific name, *tridentata,* means "three teeth".

They are found from Baja California (Mexico) north to the Aleutian Islands (Alaska) and Hokkaido Island, Japan. It is thought that historically they were found wherever there were salmon.

The following includes data collected from studies throughout the range of lamprey and may vary by individual population and location:

What is their life cycle?

Ammocoetes (Larvae)/ Macrothalmia (Juveniles)

- Eggs hatch 2-3 weeks after fertilization.
- Appear 2-3 weeks after hatching and are 10 mm (0.4 in) long.
- Move downstream at night to areas of fine silt and slow water.
- Remain in burrows for 2-7 years, continuing to move downstream in response to low or high water conditions.
- Feed by filtering their food:
  - Digest 30-40% of the food they filter.
  - The rest of the food gets passed through and is utilized by insects.
- Before they migrate to the ocean, young lamprey undergo metamorphosis (change) to become parasitic (attach and feed on other animals) and adapted to saltwater.
  - May occur from July to October during which they do not feed.
  - Out-migration to the ocean is between late fall and early spring.

Adults

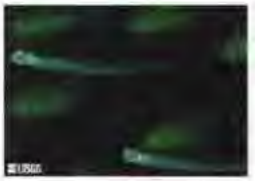
Currently, it is difficult to study adult lamprey while they are in the ocean. In the Northwest, they have been found to live in saltwater from 20-40 months. Lamprey have been located 10-100 km (6-63 mi) off the coast and 100-800m (333-2667 ft) deep.

Researchers have found it to be easier to study adult lamprey while they are in a river system.

- Stop feeding when they reach freshwater and migrate in schools into the rivers between October and June.
- It is not known whether lamprey return to spawn in the same streams in which they hatch.
- Some spawn immediately, while others over-winter before spawning.
- Spawn upstream of riffles where pools and riffles meet:
  - Typically in water 1.5-3 ft deep.
  - Occurs April to July in 10-15°C (50-59°F) water temperatures.
- Spawn around the same time as winter steelhead (on the Oregon coast).

- Males and females construct redds (nests) in the gravel by removing stones with their mouths or tails.
- Nests are typically 20 cm (8 in) across and 50 cm (20 in) deep.
- Lay from 100 to 500 eggs covered beneath sand and gravel during each spawning "bout".
- Thought to die 3-36 days after spawning.
- Eggs hatch in ~19 days at 15°C (59°F).

How are lamprey connected with other living things?



Lamprey feed on a variety of fish

- Including five types of salmon, nine other fish species, and four whale species.

Lamprey are prey for marine and land mammals, birds, insects, and other fish.

- Found in sea lions to be a substantial part of their diet (Klamath & Rogue Rivers).
- Dead lamprey are scavenged by sturgeon (Columbia & Fraser Rivers), great blue heron, mink, and other animals.
- Salmon fry eat the eggs and the emerging larvae.
- Lamprey are a nutritious food source:
  - Number of calories for every gram of wet weight:
    Lamprey=5.92-6.34
    Salmon=1.26-2.87

Dead lamprey are recycled back into the natural system as nutrients for plants and food for other animals.

Migrating juvenile and adult lamprey may provide a buffer for migrating juvenile and adult salmon and steelhead by protecting them from predators.

- Found in northern pike minnow and channel catfish (Snake River).
- Make up a large part of the diet for gulls and terns below the McNary Dam (Columbia River) during the juvenile lamprey migration in May.

Why are lamprey populations declining?

Human impacts include:

- Dam passage
- Insufficient spawning and rearing habitat
- Water quality
  - Larvae are found to be more susceptible to toxins due to their stationary life in silt and sand areas.
- Chemical treatments
- Food web shifts in the ocean
- Water flow
- Channelization of streams
- Invasive fish species

Lamprey declines are found to be related to declines in salmon populations and habitat changes (Oregon coast and Columbia River).

Where are people studying Pacific lamprey?

Oregon, Washington, and California coastal streams; Klamath River Basin; Columbia River Basin; Willamette River Basin; British Columbia; and throughout the world.

Sources Available Upon Request

C.3 Sample Interview Guide

Elder Eeler Interview

Background

- What year and where were you born? Where did you grow up? Where is your family from?

Eeling Experiences

- How old were you when you first started eeling? Did someone teach you to eel?
- How do most young eelers learn how to eel? What knowledge are they taught about eel?
- Have you taught anyone to eel? When?
- When was the last time you went eeling? What time of day do you go?
- What indicators do you look for and listen for to know when it is time to go eeling?
- Can you describe a typical day of eeling?
- What is your favorite way to eat/prepare eel?

Eel Behavior

- When do you see eel moving up the river? Stop moving? Spawning? Moving downriver?
  - What are eel doing when you see them? During the day? At night?
  - Weather, temperature, water conditions
  - Have you seen dead eel? Where?
- Has anything unusual ever happened related to eel or while you were eeling?

Map Reference

- Where do you find adult eel? Young ones? Where do you see eel creating their redds?
- Are there different kinds of eel? Where and what time of year do you find these different ones?
- Where did you find eel in the past? How far up the creeks did they travel?
- Where do you usually go eeling and how often?
- What techniques do you use in these places? Has that changed from when you were younger?

Ecological Significance

- How are eel important to other living things around them?
  - What do eel feed on? Where? What feeds on them?
- What changes have you noticed about the number of eel you catch?
  - When did you first notice this change?
  - What is considered a good catch now compared to what was a good catch in the past?
    - How long does it take you to catch that many eel?
  - Why do you think this change happened?
  - Have these changes happened before in the past?
- How/why have the water and the land changed over the years?
- What do you think needs to happen to bring back the eel?

Cultural Significance

- Why/how are eel important to the Karuk people?
  - What stories are there about eel? Are there important Karuk ceremonies related to eel?
  - Do/did eel have other important uses besides being a food source?
  - Why is eeling considered a men-only activity?
- Why/how are eel important to you?
  - What do you feel is your relationship with eel?
  - What is your responsibility to eel and other living things?
  - What do you do with the eel that you catch?
- How is eeling different now than when your grandfather was a young man eeling?
  - Do your children and/or grandchildren eel?
- What changes have you noticed about the eelers? Number? Age?
- What changes have you noticed in Karuk culture?
  - When did you first notice these changes?
  - What do these changes mean for the Karuk culture?
- If the eel go away, how will this impact the Karuk?
  - How will it impact the waters, the land, and other animals around here?

Fisheries management

- How would you describe traditional fisheries management practices?
- How has the traditional approach to tribal fisheries management changed?
- How do you see science and local knowledge working together to develop a better understanding of lamprey and other fisheries?
- What should be the role of local non-tribal agencies in the management of local fisheries?

C.4 Focus Group Materials

Focus Group Procedure:

1. Explain the purpose of the focus group:
   - To learn more about eels and their relationship to the people and land around here from the perspective of local eelers.
   - To provide an open discussion among eelers to talk about the eel population decline and management issues.

2. Go through the procedure:
   a. Each person will take a turn being the first person to answer a question.
   b. That person is given **two** uninterrupted minutes to answer the question.
   c. After those two minutes, the discussion will be opened up to all participants. Responses should be kept to less than **two** minutes.
   d. There will be a short break after question #3.
   e. After all of the questions have been answered, time will be provided for anyone to bring up any additional topics that they think should be addressed.

3. Before beginning with the first question, have everyone introduce themselves, including when and where they were born, where they grew up, and who are their parents/family.

Guidelines for the Focus Group:

- If a person seems to be going off on a tangent, wait it out to see if it relates to the original question or provides further insight.
  - If it seems off topic, ask the person how it relates to the original question and if it doesn't, ask them to come back to the original topic.

- Do not feel the need to fill in long pauses or silences. Some people need that time to process before answering.

- Allow each person their full **two** minutes to process and respond.
  - If they seem to be done, ask them if they have anything else to add before moving on.

- After the first person responds, it is okay to allow the group to bounce around on who is speaking, but make sure that someone who is interrupted eventually has the opportunity to complete their thoughts.
  - When the talk slows down, go back to those people.

- Allow a few moments for silence when the talking has stopped for processing and additional responses. Ask if anyone has anything else to add. If not, then move on to the next question.

- Be respectful, but do not be afraid to gently interrupt someone if it is time to move on.

Focus Group Questions:

1. How are the eel and eeling important to the people who live along the Klamath River?
2. What are the major reasons for the decline of eel populations?
3. What can we do to help bring the eel back?
4. What should be the role of the state and federal government in managing the eel?
5. Is it more important to manage each species individually or to manage everything together? Why?
6. How can science and local knowledge work together?
7. What are the positives and negatives of listing the eel as an endangered species?

Focus Group Questions:

1. How are the eel and eeling important to the people who live along the Scott River?
2. What changes have you noticed about the number of eel that you see?
   - *(Looking at the Map)* Where did people go eeling in the past? How far up the creeks did the eel travel? Where do you see them now?
3. What are the major reasons for the decline of eel populations?
4. How has the river and land changed over the years?
5. What needs to happen to help bring the eel back?
6. What should be the role of the state and federal government in managing the eel?

C.5 Coded Theme Spreadsheet Example

Eeling Experiences (EE)

Interview #	Name	Age Started Eeling (EEAS)	Teacher (EET)	Methods Used (EEM)	Eeling Locations (EEL)	Year Stopped Eeling (EEYS)	Number of Eel (EEN)		Processing (EEP)		
							Past (EENp)	Present (EENpr)	Cleaning (EEPcl)	Preparing (EEPp)	Cooking (EEPc)
1, 14, FG		7-8 yrs old2	X X2	X	X X2		X X2	X X2	X2	X	X X2
2		7-8 yrs old	X	X	X		X			X	X
4		As long as can remember	X	X	X	X	X	X		X	X
6		X	X	X	X		X	X	X		X
7, FG		7 years	X	X	X		X	X	X	X	
10		8 yrs old	X	X	X		X	X		X	X
11, FG		little bitty guy		X	X		X	X		X	
16		6-7 yrs old	X	X	X	X	X		X	X	X
17		late 20s		X	X	X		X		X	
21, INF-FC		5 yrs old	X	X			X	X			X
22		6-7 yrs old; 12-13 yrs old	X	X	X		X	X		X	X
23, FG		since he was walking	X	X			X	X			X
23		4 yrs old	X	X	X						
24		very young		X		X	X	X	X	X	
25		teens	X	X	X	X	X			X	X
26		7-8 yrs old	X	X	X	X		X		X	X
27		15-16 yrs old	X	X	X		X	X		X	X
33		on and off		X	X	X	X	X			
34		in diapers; 14-15 years old	X	X	X		X	X	X	X	X
35		9 yrs old	X	X			X	X			
40		4-5 yrs old	X	X	X		X	X			
41		5-6 yrs old	X	X	X		X	X	X	X	X
42		9 yrs old	X	X	X		X	X			
INF, 55		big enough to walk		X	X			X	X		X

Appendix D
Photographs*

D.1 Eeling

Photo 1 Eeling on the coast with an eel hook
Photo courtesy of the Yurok Tribe Natural Resource Department; Date unknown

Photo 2 Group of eelers at the mouth of the Klamath River
Photo courtesy of the Yurok Tribe Natural Resources Department; Date unknown

Photo 3 Eelers at the mouth of the Klamath River, 2005

Photo 4 Eeling at the mouth of the Klamath River, 2005

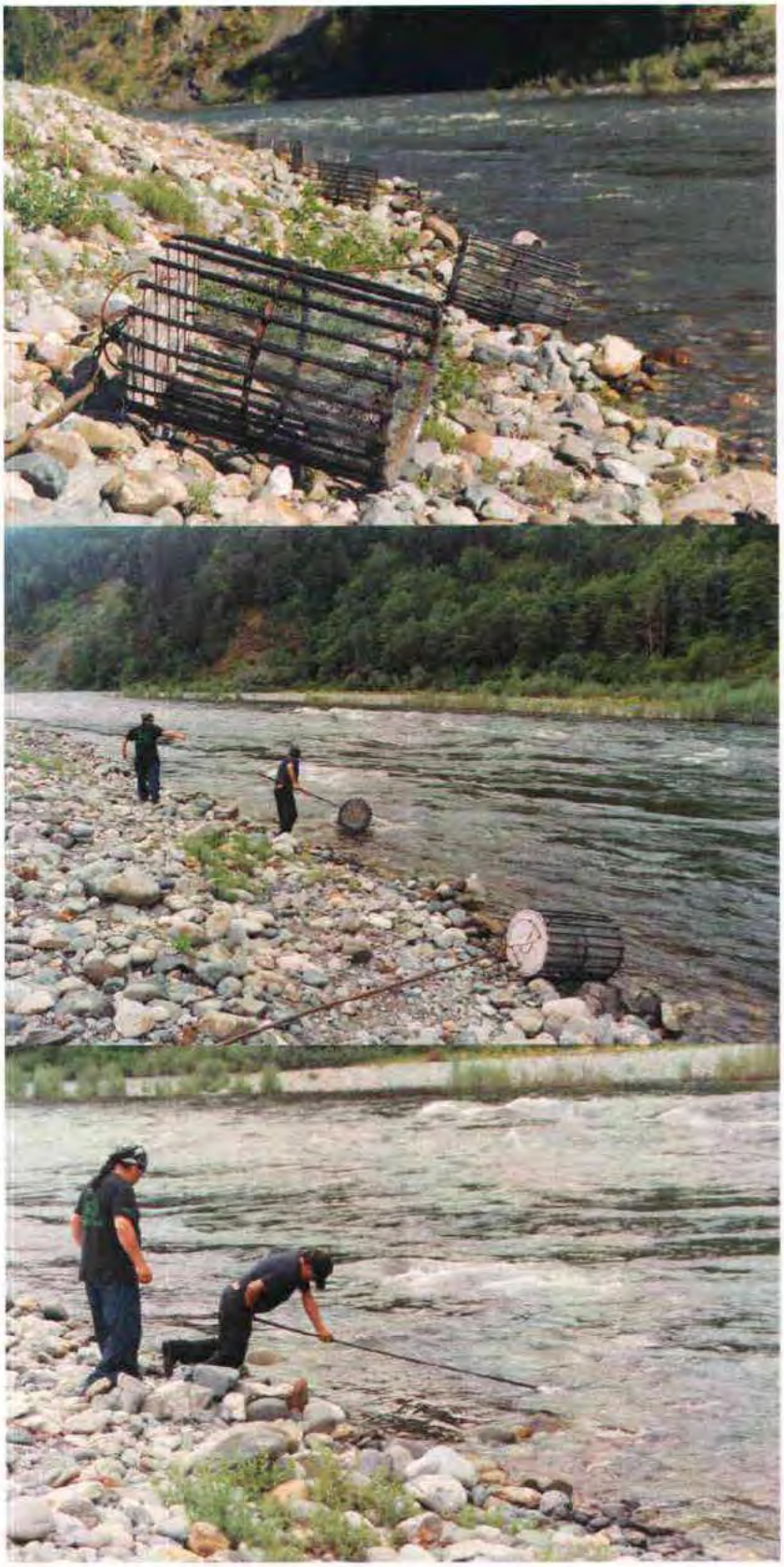


Photo 5 Setting eel baskets along the middle Klamath River, 2005

D.2 Eeling Technology

Photo 6 Dip netting at the falls with a full-size dip net
Photo courtesy of the Yurok Tribe Natural Resources Department, Date unknown

Photo 7 Half-size dip net, 2005

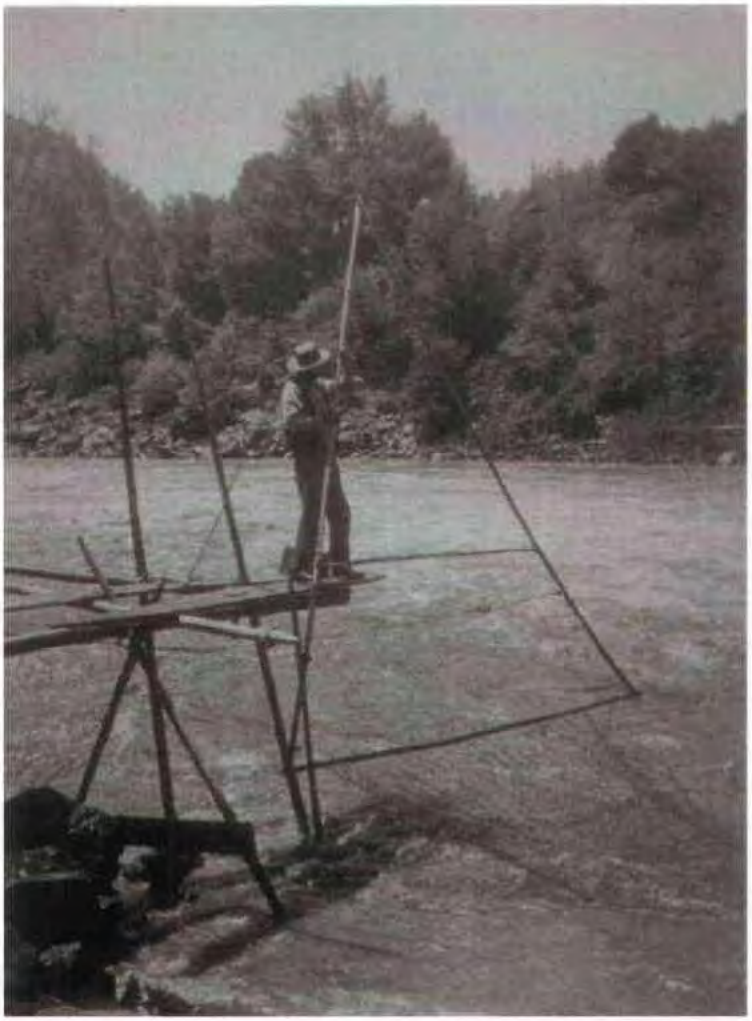


Photo 8 A-frame or trigger net off of platform fishery
Photo courtesy of the Yurok Tribe Natural Resources Department,
Date unknown

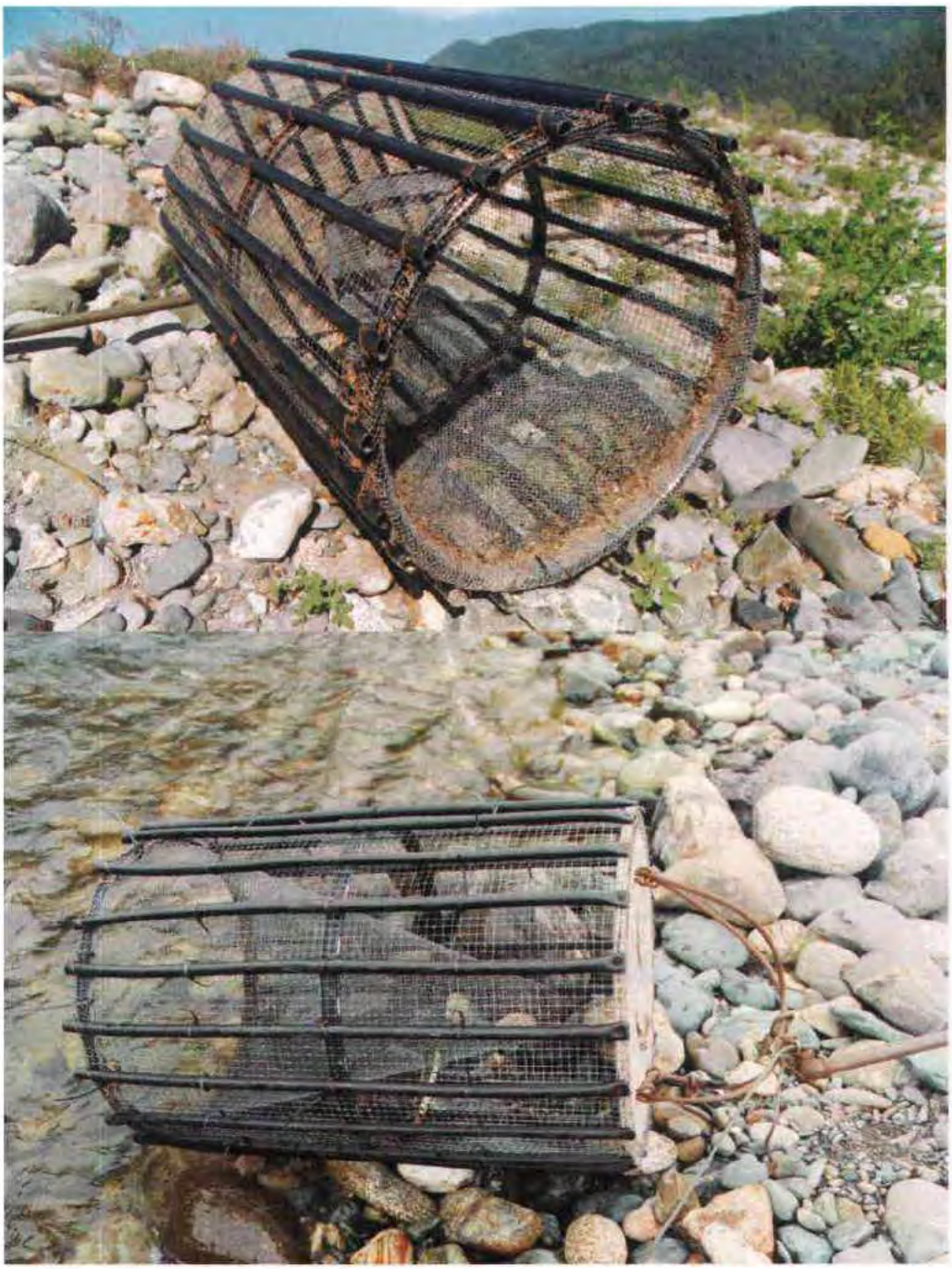


Photo 9 Bicycle rim eel baskets, 2005

Photo 10 Traditional hazel stick eel basket, 2005

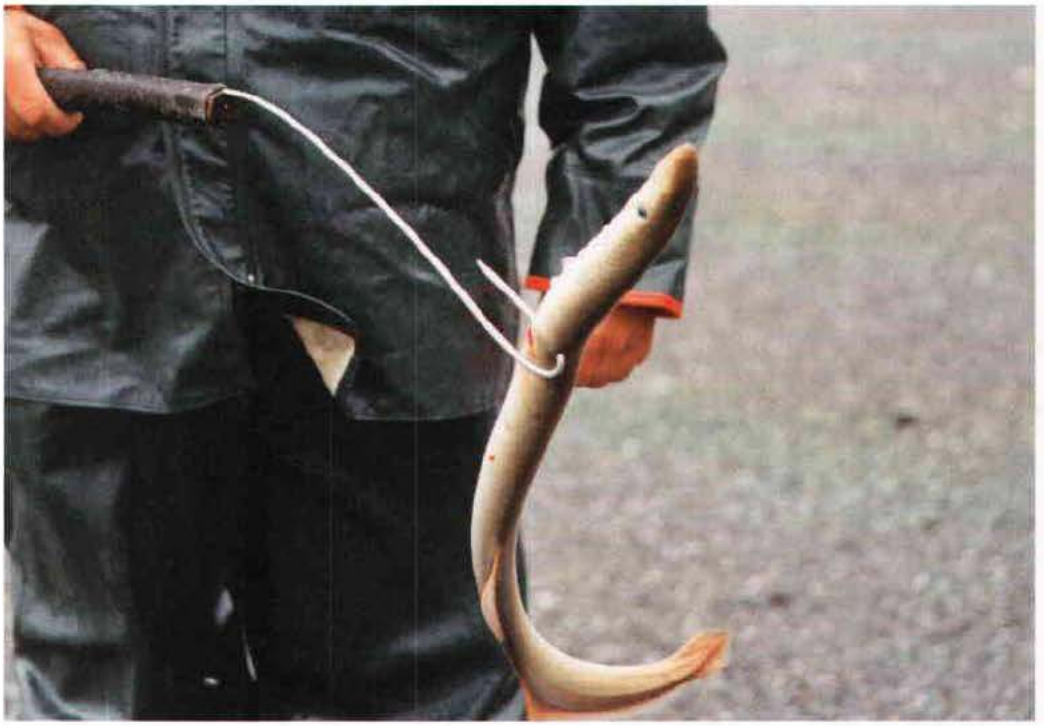


Photo 11 Short eel hook used at the mouth, 2005

Photo 12 Six to 12-foot long treble hook used at riffles and falls, 2005

Photo 13 Flattening out the lamprey, 2005

D.3 Pacific lamprey (*Lampetra tridentata*)

Photo 14 Pacific lamprey up-close with eel hook wound, 2005

Photo 15 Pacific lamprey moving across the wet sand, 2005

Photo 16 Pacific lamprey suctioned to a rock, 2005

*All photographs were taken by the author unless otherwise indicated.