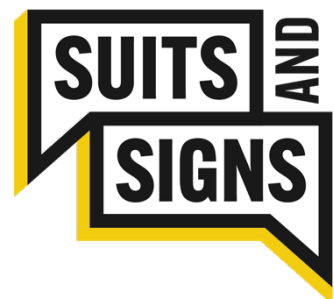


Karuk Traditional Ecological Knowledge and the Management of Spring Chinook Salmon

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Executive Summary

Chinook salmon populations throughout the Pacific Rim are generally distinguished as two seasonal runs, spring and fall, based on what time of the year they enter freshwater to spawn. Aside from run timing, spring Chinook can be differentiated from fall Chinook by body fat content at their entry into fresh water, their ability to reach high-elevation spawning habitats unavailable to later migrating fall Chinook, and taste. More recently, genetic research determined that spring Chinook and fall Chinook can be differentiated by small differences in the DNA sequence at a specific genetic locus.

Despite the phenotypic and genetic differences between seasonal runs of Chinook, state and federal agencies generally manage the two as a single population. By contrast, the Karuk traditionally managed spring and fall Chinook differently, and each run plays a unique role in Tribal cultural and subsistence practices. While we focus on Karuk-specific management practices as they pertain to seasonal runs of Chinook, other Tribes in the region likely employed their own traditional management strategies.

Spring Chinook returns to the Klamath river basin have steeply declined for decades. The Karuk Tribe and the Salmon River Restoration Council have been conducting fish counts in the last remaining stronghold, the Salmon River, since 1990. The counts have yielded their lowest aggregate cumulative numbers in the past five years since the program's inception. What was once the most robust and bountiful run of Chinook in the Klamath basin—a staple to the tribal people, culture, and economy—is nearly extinct in the wild.

This paper will describe the distinction between spring and fall Chinook through the lens of Karuk traditional ecological knowledge and practice. It is divided into three sections.

Section I dives into Karuk tradition, law, and fishery management practices to highlight the distinction and importance of the spring Chinook run in Karuk Culture. It also emphasizes how these traditional practices serve, at least to some degree, to provide Salmon River spring Chinook with reproductive isolation. To make this case, we have conducted and incorporated various ethnographic interviews of cultural practitioners while simultaneously dissecting the region's early anthropological records. This section demonstrates traditional precedence and practice and emphasizes spring Chinook's importance in tribal culture.

Section II offers background on the existential threat to the continued existence of the spring Chinook. This section includes a discussion of the distinct population genome, loss of habitat quality, loss of habitat exclusivity, anthropogenic changes to natural habitat, and the resulting dilution of genetically distinct runs in the Salmon River. Contrasting this approach with the practices emphasized in Section I is useful because it demonstrates the complementary interlinkage between traditional and western science models.

Section III acknowledges and dissects the religious, cultural, health-related, and economic impact of the fish's demise on the Karuk people. This section also offers policy recommendations.

The analysis reaches two main conclusions. **First**, the Karuk have long understood the distinction between spring Chinook and fall Chinook based on language, customs, and ceremonial practices. **Second**, the protection of spring Chinook is vital to the continuation of Karuk religious practices, customs, traditions, and laws. The lack of spring Chinook poses systematic cultural, communal, health-related, and socio-economic burdens to the Karuk way of life. **Third**, a potential short-term remedy for sustaining the unique genetic material that underlies the early run timing of spring Chinook in the Klamath Basin may include re-establishing selective fish passage barriers that allow spring Chinook to access spawning habitat that fall Chinook cannot reach. These barriers have natural and aboriginal precedencies in the area and may be the most crucial action necessary for sustaining spring Chinook populations in the short term.

Section I: Spring Chinook in Karuk Tradition, Religion, and Science

While the genetic division between spring and fall Chinook has only recently surfaced in western science, Karuk people have long distinguished between the two species. This detailed understanding of the differences between various salmonid species is part of a greater refined knowledge of the reciprocal relationship between the environment and the people.¹ Some of the differences noted in Chinook runs: spring Chinook taste different, they have a higher fat content, they enter fresh water at different times of the year, they behave in an unalike manner by lingering in cold-water pools for months before spawning, and they even look comparatively different.² Before the construction of dams on the Klamath River, spring Chinook may have been the largest salmon run on the river.³ It was an essential staple to the traditional diet and physical well-being of Karuk people. This section focuses on how these differences were incorporated into the Karuk language, ceremony, and management efforts.

1. Linguistics, the Spring Salmon Ceremony, and Traditional Law

The genetic separation of Chinook is documented through formal differences in language. While Salmon are now commonly referred to as *áama*, there are numerous terms to describe different fish and their respective life cycles.⁴ For example, *afúuxich* describes the fingerling, or small fish going out to sea, while *achvuun* is designated as the distinctly shaped Coho salmon. Most notable for the differentiation of the Chinook runs was the term *ishyâat*, a stand-alone description that translates to ‘spring salmon.’ This term is coined from a linguistic grouping of both *ishyaav* which roughly translates to wintertime, and *âat*, which is another description for King Salmon.⁵ In contrast, summer and fall Chinook were described simply as *áama* or *pimnanih’áama*, which translates directly to ‘summer salmon,’ or *pishyavpish’áama* for ‘fall Salmon.’⁶

The Spring Salmon Ceremony at Ameekyáaraam marks the temporal differentiation between the usage of *ishyâat* and *áama*. The Spring Salmon Ceremony is a stand-alone first rites ceremony that historically served as the official beginning of the salmon fishing season throughout the basin.⁷ Tribal law dictated that no salmon were to be eaten along the river until the ceremony was completed. Traditionally, this law was binding not just in Karuk territory but

¹ John F. Salter, “White Paper on Behalf of the Karuk Tribe of California”, written under contract with PacifiCorp in connection with Federal Energy Regulatory Commission proceedings concerning the relicensing of Iron Gate Dam, 2003.

² An ethnographic interview of Earl Aubrey conducted by John Salter noted the distinction in flavor: “The spring salmon was the best eating, the best flavor of the fish we caught. It’s so beautiful. That’s when you eat a salmon [spring salmon].” Salter, “White Paper on Behalf of the Karuk Tribe of California”.

³ William Bright and Susan Gehr, *Karuk Dictionary*. LBD PUBLISHERS, 2005.

⁴ Julian Lang (Cultural Practitioner and Master Karuk Language Speaker), interviewed by Luis Neuner, October 18, 2022. In a conversation with Julian Lang, he expressed the various shifts the Karuk language experienced following colonial contact. With the influence and forced adoption of English language, many terms became more generic in use, such as “*aama*”. Nevertheless, Karuk remains a language that originally refrained from these generic terms.

⁵ William Bright et al. *Karuk Dictionary*.

⁶ Ibid.

⁷ John P. Harrington. "Tobacco among the Karuk Indians of California." BUREAU OF AMERICAN ETHNOLOGY BULLETIN, 1932.

was also adhered to by other tribes up and down the river.⁸ This cooperative restraint across territorial lines established fishing procedures that were vital to the sustainability and survival of spring Chinook. An ethnographic interview conducted on October 12, 2022, with Leaf Hillman, a ceremonial leader and cultural practitioner, revealed the following:

Our Spring Salmon Ceremony at Ameekyáaraam was recognized by the Yuroks as to when they could start fishing. The completion of our Spring Salmon Ceremony up here was the signal for them that they could start fishing. The purpose of that was to allow the first, the head of the run, to travel upstream unmolested, with no fishing pressure on them. To allow that first pulse of fish to go to the spawning grounds unmolested by anyone or any tribe was how that was timed.

The timing of the Spring Salmon Ceremony therefore aligned with the beginning of the first run of spring Chinook. Cultural practitioners and anthropologists both noted that the ceremony usually took place during the first moon of April, which roughly coincides with data indicating spring Chinook entering the Klamath river basin as early as March.^{9,10} During the ceremony, the medicine man assistant fished for the first salmon (presumably at Yu'tim'ín, a fishery located adjacent to Ameekyáaraam). Following the success of a first catch, “the priest and his assistant would build this altar...and finally, the assistant would eat as much [of the spring fish] as he could until he threw it all up.”¹¹ The vomiting ritual was partially induced by the pronounced fattiness and richness of the spring Chinook, which grew foreign to the stomach during the harsh winter months. This ritual would mark the entry of the medicine man into the sweathouse for ten days. In the sweathouse, the medicine man would conduct prayers referencing first the return of ishyâat, followed by other runs of salmonids and species.¹²

Alfred Kroeber noted—though not to the full extent—the robust understanding of salmonid species amongst the Karuk in his records: “Every night men join him in the sweathouse to sing songs about various “salmon”—dog salmon, steelhead, Chinook.”¹³ Most importantly, during these ten days, fishing remained taboo throughout most of the Klamath basin.¹⁴ Following the ceremony's completion, the terminology used for fish, changed from ishyâat to àama or the respective seasonal name during which the fish were in the river.

The differentiation of the spring Chinook was so pronounced in Karuk Culture that even various traditional stories incorporated and were explicitly dedicated to ishyâat. These educationally grounded folktales/ myths had the purpose of teaching young children and people about cultural values. While the stories primarily follow the antagonist Pihnêefich, or Coyote, as

⁸ According to the interview conducted with Leaf Hillman, both Yurok and Shasta tribes historically adhered to Karuk's Spring Salmon ceremony as the law of the land. Leaf Hillman (Karuk Tribal Cultural Practitioner and Ceremonial Leader), interviewed by author, Orleans CA, October 10, 2022.

⁹ Ibid. See also, John P. Harrington, 1932. "Tobacco among the Karuk Indians of California."

¹⁰ Peter B Boyle, Rob Lusardi, and Patrick Samuel, “SOS II: Fish in Hot Water ,” CALIFORNIA TROUT, accessed November 6, 2022.

¹¹ Leaf Hillman, Interview, October 10, 2022.

¹² Ibid.

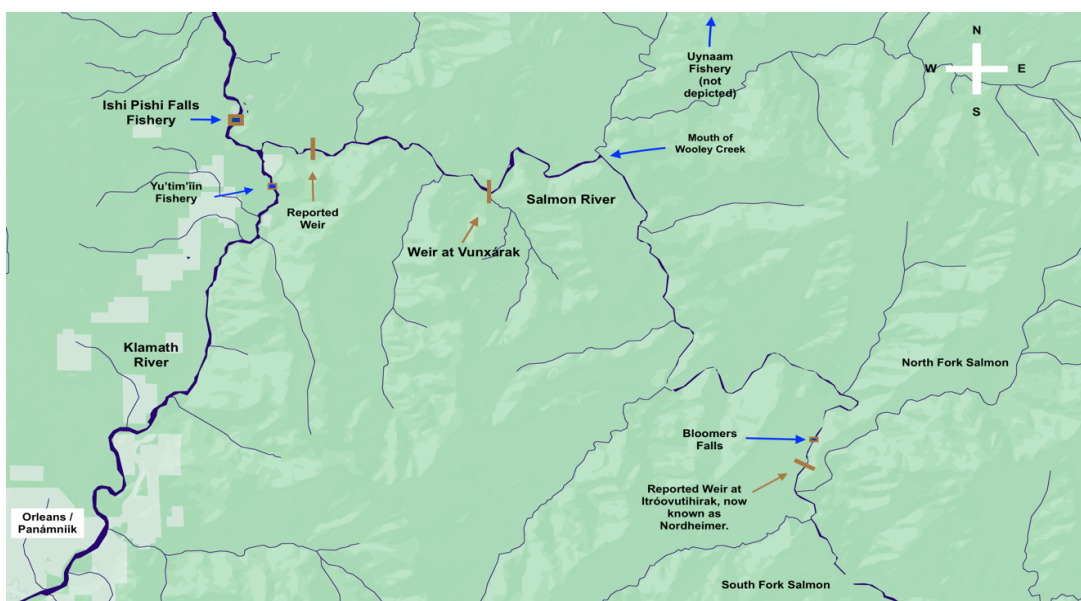
¹³ A. L. Kroeber and E.W. Gifford, *Anthropological Records*, UNIVERSITY OF CALIFORNIA PRESS BERKELEY AND LOS ANGELES, 1949.

¹⁴ In his interview, Bill Tripp notes that the one exception to this rule was the fishery at Úynaam, a fisheries located on Wooley Creek. See, e.g., Bill Tripp (Director of Department of Natural Resources), interview by author, Orleans CA, October 11, 2022.

he navigates the spirit world (the world which the Karuk believe to be the world that preceded the common day) while engaging in misfortune, his interactions with spring Chinook regularly play a role in teaching lessons about life, humility, willingness to share, and the importance of prudence in harvesting and managing ecosystems.¹⁵

2. Weirs on the Klamath River

While no accounts stated that weirs were built for the sole purpose of distinguishing and separating runs from one another, they undoubtedly played a significant role in creating some form of seasonal migration barrier for fish. The completion of the Spring Salmon Ceremony marked the beginning of the fishing season up and down the river, as families and localities would begin the formal process of assembling weirs.¹⁶ The weir built at Kepel in Yurok territory represents the most detailed account in the anthropological records.¹⁷ Weirs, however, also played a role in managing fisheries in Karuk territory on both the Klamath and the Salmon Rivers. Interviewees listed weir sites at various sites, such as a quarter mile upriver from the confluence of the Salmon into the Klamath, *Vunxarak* (now known as Oak Bottom), and even *Itróovutihirak* (Nordheimer flat).¹⁸ *Itróovutihirak* is also recognized by many to be the historic territorial boundary separating Karuk from the Shasta Band of Konomihu.



¹⁵ William Bright, *The Karok Language*. (University of California Publications in Linguistics, 1957.)

¹⁶ Leaf Hillman, Interview, October 10, 2022.

¹⁷ Analyzing early anthropological records on this subject (and other culturally relevant subjects) is often tricky, given the lack of accuracy reflected throughout reports. Often, researchers had little overall understanding of tribal affairs and spent little time and effort making note of them. Hillman noted in his interview this weakness when considering accounts of weir-building by anthropologist: “While a number of them did record the presence of large fishing weirs, they rarely recorded things such as timing, ownership, operations. On the other hand, based on Tribal oral history accounts, we know that the construction of these weirs was carefully timed, calibrated by location, to target specific runs of salmon while observing community taboos related to harvest.” For contrast, See e.g., T. T. Waterman and A. L. Kroeber, *The Kepel Fish Dam*, California Indian Library Collections Project Distributor, 1989.

¹⁸ Julian Lang, Interview, October 18, 2022.

*Figure 1: Locational Reference of reported weirs and fisheries on Salmon and Klamath.*¹⁹

The exact material used varied and depended heavily on location as weirs were predominantly constructed out of locally available materials.²⁰ The construction of weirs was a difficult and time-consuming task that could take weeks, if not months, to complete. It also depended heavily on river flows. If flows were strong, which generally was the case in April, given the vigor of spring freshets, construction was inhibited until water levels were considered manageable.²¹ Flows typically fell to appropriate levels to allow for weir construction on the Salmon River in mid to late July or August. It is important to note that this timing also roughly coincides with the end of the spring Chinook migration, as determined by genotypic analysis.²²

Fishing rights on weirs generally derived from a person or a family helping and aiding in its assembly.²³ Following the weir's construction at Kepel, families in Yurok country would come together to dance.

According to Leaf Hillman:

The purpose of that dance was not only to celebrate the opening of the weir and the opening of fishing season, but was actually used to physically plant that dam in place. The Klamath River is a big river and a strong river, and when you install that weir, they would dance actually on the weir, to embed it in the river, to get a lot of weight on it, and to dig it down.

It is unclear how this form of pile-driving took place on the Salmon River. However, it is clear that construction required large numbers of people and a nuanced understanding of local river conditions, flows, building materials, etc. In essence, these weirs provided a means of social gathering that collectivized practice and robust intergenerational scientific and structural expertise. An excellent example of the interplay between weirs and communal gatherings is the village of Vunxarak, which also doubled as a central hub of traditional learning and training for young women from villages throughout Karuk ancestral lands.

Bill Tripp on the importance of Vunxarak:

*The nature of that village [Vunxarak] itself was a place where a lot of different families came together, and it was also a teaching spot for young women. So, from what I understand, there were many houses there...when the young girls were in their preadolescent stages of life, that's where they went, and that's where they were taught different languages, that's where they were taught how to manage fire, how to manage and put together and do all the things they do in preparation for their flower dance.*²⁴

¹⁹ Map courtesy of authors.

²⁰ Bill Tripp, Interview, October 11, 2022.

²¹ Julian Lang, Interview, October 18, 2022.

²² Boyle et. al. "SOS II: Fish in Hot Water".

²³ Leaf Hillman, Interview, October 10, 2022.

²⁴ A flower dance is the coming-of-age ceremony conducted when a young girl begins the transition out of childhood preadolescences.

Additionally, the weirs' non-lethal method of catching fish was advantageous for one main reason. Fish would swim up to the barrier and either be funneled through a smaller opening, above which the fishermen stood, or enter a separate compartment. No harm was done if the fishermen chose to release the fish or allow safe passage upstream. This resulted in the ability to selectively harvest certain fish while sparing others, not unlike the other methods of traditional Karuk fishing, which included dip-netting and fish trapping.²⁵ While weir usage declined following contact, given the widespread persecution of Native people and genocidal practices, non-lethal harvest management tools still play an essential role in Karuk culture. Dip-netting continues to thrive at Ishi-Pishi Falls and is considered one of the last remaining traditional fisheries in Karuk territory. Recently, the ability to selectively harvest fish while sparing others has been fundamental because it has enabled fishermen to distinguish endangered runs such as spring Chinook or Coho and offer them passage without inflicting injury.²⁶

These customary laws, practices, and ceremonies significantly impacted the fishery and environment. Most importantly, allowing the head of the migration to pass before establishing a robust fishery enabled early-run fish to press forward into the upper basin with little resistance.²⁷ Families and villages across territorial lines respected these intertribal regulations to ensure that spring Chinook continued to reach the upper river basin and reproduce. Management efforts utilized these comprehensive tools that, despite not being fully understood by western observers following contact, were designed to accommodate and protect different runs, or as western science may put it, protect phenotypic variability.

Leaf Hillman on the sophisticated and capable technology used by tribal people:

Anthropologists wrongly assumed...that Indians never had these problems that we do today, with the extinction of species and the like, because Indians had a low population and weren't capable of having a very large impact on species, which is a totally false narrative that is based on total fantasy. The fact of the matter is that tribes had well-developed technology to exploit each of these runs of fish that come into the Klamath and all the tributaries and it was well within their grasp to overharvest these species and actually cause their extinction.

Thus, while Karuk and neighboring tribes had the technological capacity to harvest spring Chinook to the point of extinction, their management strategies and cultural values prevented such an outcome. When colonizers reached the basin, reports suggested spring Chinook as the single greatest run on the Klamath River. Some estimates indicated yearly runs in the hundreds of thousands of adult fish. The numbers were so large that R.D. Hume wrote in his journal: "In 1850 in this river [Klamath] during the running season, salmon were so plentiful, according to the reports of the early settlers, that in fording the stream it was with difficulty that they could

²⁵ Bill Tripp, Interview, October 11, 2022.

²⁶ Leaf Hillman, Interview, October 10, 2022.

²⁷ Ibid.

induce their horses to make the attempt, on account of the river being alive with the finny tribe.”²⁸

3. Summer Flows and Natural Fish Passage Barriers

The seasonal fluctuation of flows not only informed when to erect fishing platforms and weirs but also played a crucial role in the fish passage itself. The spring freshet flows that flooded the Klamath and Salmon Rivers allowed spring Chinook to navigate rapids and waterfalls that became impassible to fall Chinook under low flow conditions. The most significant natural barrier on the lower Salmon River was recorded at Bloomer’s falls.²⁹ With its narrow and steep drop, the rapid could only be traversed by salmon during high flows, which were often only available in the winter and spring. In the summer, when flows dwindled, Bloomers Falls became impassable for fish until the wet season returned in October or early November.³⁰

This naturally occurring phenomenon was also recorded at Wooley Creek, a major tributary to the Salmon River and one of spring Chinook’s last remaining cold water spawning grounds.³¹ Several miles upstream from the mouth lies the tributary of Deadhorse Creek, where there was a similar seasonal fish passage barrier. Water would stream over a sheet of bedrock, dropping into the creek, resulting in an unnavigable wall for fish in the low flow season. Reports suggest that this steep bedrock was also a primary fishing ground for the Karuk, commonly known as *Úynaam*, because the rapid required fish to jump out of the water physically to get upstream.³²

According to Bill Tripp:

There was a rule, that it [Úynaam] was a spear fishery, so you would stand there on that sheet, as the fish went up. You couldn’t spear them when they went up—that was against traditional law. You could only spear the fish that didn’t make it and were coming back down. And so, you look at that and the perspective of how that would over thousands of years work to modify genetic stocks. Only the strongest ones are making it up there. And the ones that aren’t able to do it in the first shot, are going to have a higher likelihood to get caught.

Thus, before colonization, spring Chinook would travel largely unaffected by human interference, until after completion of the Spring Salmon Ceremony, to their respective spawning grounds while taking advantage of higher spring flows to navigate seasonal fish passage barriers. From then on, spring Chinook remained relatively secluded and protected as flows began to dwindle, and summer and fall runs were cut off—at least to some degree—by natural obstacles, the installment of weirs during low flow season, and other forms of fisheries. Once fishing

²⁸ This quote was used in: Sean L. Swezey and Robert F. Heizer. "Ritual management of salmonid fish resources in California." *The Journal of California Anthropology* 4, no. 1 (1977)

²⁹ Bloomers Falls is about one mile west of what is considered the outer Karuk territorial boundary. Julian Lang, Interview, October 18, 2022.

³⁰ Leaf Hillman, Interview, October 10, 2022.

³¹ Bill Tripp, Interview, October 11, 2022.

³² Harold Tripp (Karuk Tribal Cultural Practitioner, Elder, and descendant of Fishery owner at Úynaam), interviewed over phone by author, October 25, 2022.

began, Karuk fishing strategies therefore likely contributed to the natural selection of a genetically distinct run of spring Chinook as weaker fish, unable to navigate past barriers, were selectively harvested. While stronger fish were left to reproduce, the earliest migrating individuals were left unmolested to reach spawning grounds. All these factors ensured a relatively low level of hybridization between spring and fall Chinook. In Wooley Creek, the distinction between the fish was so substantial that two ethnographic reports even noted that, to the trained eye, Wooley Creek springers were visually distinguishable from others.^{33,34}

Section II: Existential Threat to the spring Chinook

From a biological perspective, maintaining phenotypic variability (i.e., the timing of spring Chinook vs. fall Chinook) in the Klamath River Basin is crucial not just for tribal and cultural well-being, but for the overall preservation and protection of the ecosystem, given the various environmental challenges the region faces. The McKinney Fire Fish Kill of 2022 demonstrated that factors such as increasing wildfire risks, a warming climate, and forest mismanagement directly affect salmonid populations. The slurry of mud and ash resulting from this high-intensity wildfire, followed by flash flooding on the Klamath and Salmon Rivers, suffocated tens of thousands of fish, including juvenile spring Chinook and endangered Coho.³⁵ Luckily, this event occurred after migration of adult spring Chinook and before that of fall Chinook. Nevertheless, the 2022 McKinney Fire fish kill demonstrates that maintaining two distinct seasonal run phenotypes provides a fail-safe for the survival of Chinook salmon in the Klamath River Basin on a geologic time scale, as climate change driven events and anthropogenic hazards can easily eradicate entire sub-populations in any given year.

To maintain this distinction in runs, the importance of spring Chinook reaching spawning grounds that exclude fall Chinook cannot be understated. Thompson *et al.* highlight that variability in DNA sequence at a single genetic locus drives this variability in timing (between spring-run and fall-run Chinook).³⁶ This genotypic variation may be responsible for maintaining and building the fat storage necessary for the extended period the fish remains on the river and in cold holding pools before spawning. Unfortunately, the spring-run variant of this allele can also be rapidly lost through inter-breeding. In other words, the spring-run allele is rapidly lost when spring Chinook interbreed with fall Chinook as these heterozygous individuals attempt to return in the summer when main-stem river conditions are unsuitable for adult salmon.³⁷ The study examined former spring-run strongholds in the Klamath Basin, such as the Shasta and Scott rivers, that have suffered anthropogenic changes to flow and habitat that led to the loss of spring

³³ Harold Tripp, Interview, October 25, 2022.

³⁴ Bill Tripp, Interview, October 11, 2022.

³⁵ “Klamath River Fish Kill Caused by Storm and Wildfire Activity, Says Forest Service,” LOST COAST OUTPOST (September 20, 2022), <https://lostcoastoutpost.com/2022/sep/20/klamath-river-fish-kill-caused-storm-and-wildfire/>. See also, Karuk Tribe, (August 5, 2022). Fires Lead to Klamath Fish Kill [Press release]. Retrieved from, <https://www.karuk.us/images/fISHKILL8.5.pdf>.

³⁶ Tasha Q. Thompson et al., “Anthropogenic Habitat Alteration Leads to Rapid Loss of Adaptive Variation and Restoration Potential in Wild Salmon Populations,” PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES, 116, no. 1 (April 2018): pp. 177-186, <https://doi.org/10.1073/pnas.1811559115>.

³⁷ Ibid.

Chinook. They found that current anadromous populations do not harbor the spring-run.^{38, 39} On the Shasta, out of the 427 samples examined, only two fish contained a heterozygous phenotype, while the rest was “homozygous for the fall-run [phenotypic] allele.” Similarly, the Scott River exhibited only two heterozygous phenotypes out of 425 specimens.⁴⁰

Unfortunately, state and federal agencies rarely incorporate these small but significant genetic differences in management efforts. A 2017 study conducted by Miller *et al.* made note of the failure of this process:

Although current ESUs [evolutionary significant units] and DPSs [distinct population segments] certainly protect adaptive differences between distant populations, adaptations within highly connected populations [such as the spring and fall Chinook] are not necessarily protected (10, 34). However, the evolutionary significance of these adaptations and the potential long-term consequences of not independently protecting them are poorly understood.⁴¹

Thompson *et al.* also note that the Salmon River remains one of the last strongholds of the spring Chinook in the Klamath Basin. Unfortunately, however, numbers continue to decline even on the Salmon River. A count conducted by the Karuk Tribe and Salmon River Restoration Council tallied only 290 spring Chinook in 2022. This continues an overall declining trend for this last remnant of the Klamath Basin’s once prolific spring Chinook population.

³⁸ Ibid.

³⁹ According to Thompson, the Shasta experienced its last recorded Spring-run in the 1930s, while the Scott saw it its last in the 1970s.

⁴⁰ Notably, the spring-run allele frequency is 0.002 for both Shasta and Scott rivers respectively. *See e.g.,* Thompson *et al.*, “Anthropogenic Habitat Alteration Leads to Rapid Loss of Adaptive Variation and Restoration Potential in Wild Salmon Populations.”

⁴¹ Daniel J. Prince *et al.* “The Evolutionary Basis of Premature Migration in Pacific Salmon Highlights the Utility of Genomics for Informing Conservation.” *SCIENCE ADVANCES* 3, no. 8 (08, 2017). <https://doi.org/10.1126/sciadv.1603198>.

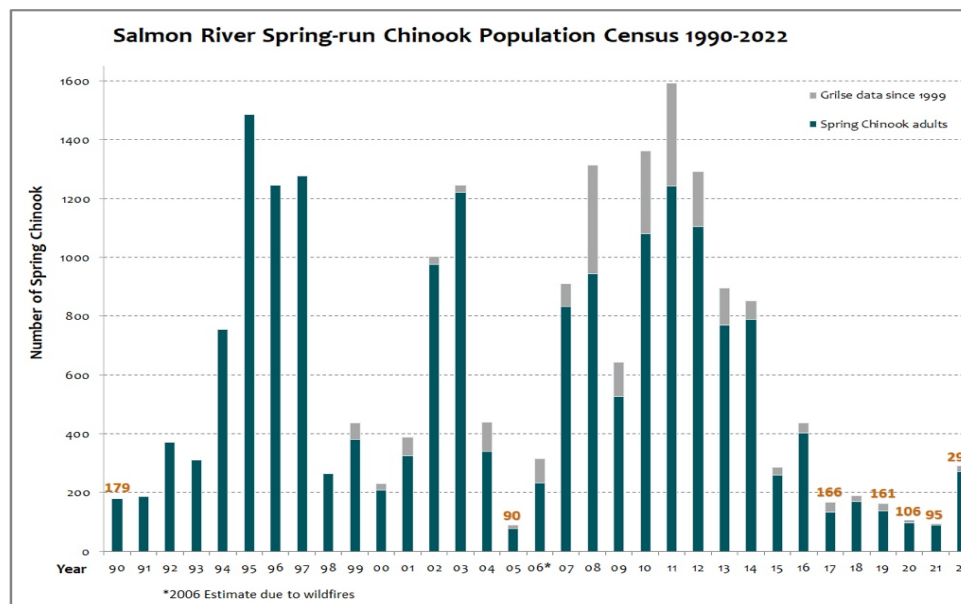


Figure 2. spring Chinook counts conducted on the Salmon River. Graph courtesy of the Karuk Tribe.

The recovery of Salmon River spring Chinook requires two critical ingredients. The first ingredient is habitat quality. Adult-holding, spawning, and juvenile-rearing habitats must be of sufficient quality to sustain the spring Chinook population. These habitats are the focus of crucial ongoing watershed restoration work conducted by local tribes and NGOs such as the Salmon River Restoration Council. But the benefits of habitat restoration are often only realized after years to decades of action. Consequently, while watershed restoration is fundamentally important, it cannot provide the immediate benefits to UKT spring Chinook that are urgently needed now.

The second ingredient is habitat exclusivity. Spring Chinook require near-exclusive access to productive habitats that fall Chinook cannot reach. This habitat exclusivity is necessary to offset the many disadvantages of spring Chinook’s early river entry, which include giving up growth opportunities at sea, fasting several months before spawning, and an extended stay in fresh water, exposing individuals to extremes of flow, temperature, disease, and predation. Interbreeding with fall Chinook can rapidly swamp the unique genetic composition of spring Chinook, especially given the already depleted nature of spring Chinook populations. Consequently, a high rate of hybridization with fall Chinook represents an existential threat to the persistence of the spring Chinook phenotype. In short, without habitat exclusivity, spring Chinook is unlikely to persist in the face of competition and genetic introgression with fall Chinook.⁴²

The loss of habitat exclusivity is driven primarily by recent anthropogenic factors that have altered these selective fish passage barriers or made them inaccessible by constructing

⁴² Thompson et al., “Anthropogenic Habitat Alteration Leads to Rapid Loss of Adaptive Variation and Restoration Potential in Wild Salmon Populations.”

dams, impassible culverts, and other structures. In the Salmon River, we find that spring Chinook habitat exclusivity was lost through modifying these naturally occurring selective fish passage barriers and disrupting indigenous communities' traditional fish management activities. Several historical obstacles, including the formerly mentioned Bloomer Falls and the *Uynaam* fishery, were modified by dynamite in the early 1980s to allow fall Chinook passage during low flows.⁴³ While the intention behind this action was to enable upstream access and increase the overall salmon population, Chinook salmon carcass genotyping reveals that these actions have allowed fall Chinook to interbreed with spring Chinook resulting in the loss of the spring Chinook allele.⁴⁴ In essence, the destruction of these natural barriers has enabled Summer and fall Chinook to reach the spawning pools of spring Chinook that, under pre-modification conditions, were exclusively reserved for spring Chinook. This loss of reproductive isolation is a critical factor in spring Chinook declines as spring/fall Chinook hybrids do not survive well in the Klamath system, leading to a loss of the spring allele.

Section III: Impact and Recommendations

The dwindling numbers of spring Chinook in the Klamath basin has had devastating impacts on the Karuk people in three primary ways: First, the near loss of a species that plays a central tenant in traditional culture has imposed a massive stressor on the Karuk way of life. While systemic racism and forced assimilation facilitated the suppression of ceremonies and other traditional activities historically, cultural revitalization has been inhibited by the lack of fish in general and spring Chinook in particular.⁴⁵ This is because tribal members cannot properly conduct ceremonies, such as the Spring Salmon Ceremony when there are no spring Chinook in the river to catch. The importance of the fish is so pronounced that Tribal Elder and cultural practitioner Harold Tripp even stated: “Everywhere where we had ceremonies, it was because of fish. That’s the main reason we had them.” To this day, the Spring Salmon Ceremony at *Ameekyáaraam* has yet to be revitalized for this very reason. While it is difficult to analyze and quantify the overall impact of a potential spring Chinook extinction, given the magnitude of its interconnectedness, it is clear that any trickle-down effects would be devastating for Karuk culture and communities.⁴⁶

Secondly, the lack of access to spring Chinook as the primary nutrition and vital component of the traditional diet has correlated with an overall decline in health and well-being amongst Karuk people. A study by Dr. Kari Norgaard emphasized the association between the Fall of fishery in the 1970s and 80s and the increasing rate of diet-related illnesses in Karuk

⁴³ A.D. Olson, O.J. Dix, “Lower Salmon River Sub-Basin Fish Habitat Condition and Utilization Assessment 1990/1991.” USDA FOREST SERVICE, 1-40 (1993). *See also*, Salmon River Restoration Council (SRRC), “Salmon River Flows, Weather, & Wildfire Information,” Salmon River Flows, Weather, & Wildfire Information from SRRC, <https://srcc.org/news-info/index.php>. *See also*, Harold Tripp, Interview, October 25, 2022.

⁴⁴ Thompson et al., “Anthropogenic Habitat Alteration Leads to Rapid Loss of Adaptive Variation and Restoration Potential in Wild Salmon Populations.”

⁴⁵ Kari M. Norgaard, “The Effects of Altered Diet on the Health of the Karuk People.” (2004).

⁴⁶ Here one might note that these ceremonies, for Karuk people, are not just a way to uphold their inherent duties to their surroundings, but they also provide and maintain vital communal inter-civic engagement. People get together to “make medicine” but also build bonds and relationships with their fellow tribal people. The importance of this, along with so many other factors, are impossible to quantify.

communities.⁴⁷ While the study did not draw a causal relationship between the two, given the difficulty of accounting for other related variables, previous empirical research has directly linked the proportionally high diet-related illnesses amongst Native Americans to the loss of access to traditional foods.⁴⁸ Karuk territory is at the forefront of these diet related-illnesses, with diabetes and heart rates at roughly 2-3 times the national average.⁴⁹ Norgaard found that lack of access to Spring Salmon (and other traditional foods) likely was the cause.⁵⁰

Finally, the decline of fish also eradicated the fishery-based economy, which, before contact, helped make Karuk and other area tribes some of the richest communities in the region.⁵¹ The abundance of spring Chinook was a central tenant in the local economy, enabling transactional trading with neighboring tribes. Most notably, our ethnographic reports revealed that the Shasta and Shasta Band of Konomihu Tribes engaged in the active trade for fish in exchange for essential goods such as obsidian.⁵² All in all, this abundance of spring Chinook contributed to the overall high wealth held by the Karuk people pre-contact. Shortly after contact, the economic importance of the spring Chinook remained strong. Many tribal members, who had experienced the direct consequences of state-sponsored genocide, colonization, and forced assimilation, were still actively utilizing spring Chinook fisheries to make ends meet. Harold Tripp on the microeconomy of the Wooley Creek fishery at *Úynaam* shortly after contact:

My grandfather had that fishery...made a living right there on that fishery. People brought stuff from out the valley and everywhere and traded for fish. It was a good fishery until the forest service blew it out.

Today, Karuk territory is considered one of the poorest parts of the country. Recent data reports analyzing tribal populations on Karuk trust land in 2019 show a poverty rate of 42.7% and a median per capita income of around \$14,553 per year.⁵³ While this number slightly increases when looking at localities off trust land, Karuk's ancestral territory remains one of the most poverty-stricken areas in California and the US.⁵⁴ The lack of spring Chinook has likely contributed to this poverty in various ways, including lack of income related to the Spring Salmon fishery and higher medical bills resulting from disproportionate dietary-related illnesses.

It is essential, however, to only consider this summary a partial analysis. A more thorough impact analysis would need to include direct and indirect factors, ranging from issues

⁴⁷ Norgaard, "The Effects of Altered Diet on the Health of the Karuk People."

⁴⁸ H.V. Kuhnlein, et al. "Arctic indigenous peoples experience the nutrition transition with changing dietary patterns and obesity." JOURNAL OF NUTRITION, (2004).

⁴⁹Jennifer Sowerwine et al., *Food Security Assessment of Native American Communities in the Klamath Basin with the Karuk Tribe, Klamath Tribes, Yurok Tribe, and Hoopa Tribe*. KARUK-UC BERKELEY COLLABORATIVE, Berkeley, CA: University of California at Berkeley, (2019).

⁵⁰ Salmon offer various nutritional benefits that not only help prevent diabetes, but also can be considered the "best treatments for such conditions. Norgaard, "The Effects of Altered Diet on the Health of the Karuk People."

⁵¹ Norgaard, "The Effects of Altered Diet on the Health of the Karuk People."

⁵² Bill Tripp, Interview, October 11, 2022.

⁵³ "Comprehensive Economic Development Strategy 2021-2026", KARUK TRIBE, (2021), https://www.karuk.us/images/Karuk_Tribe_CEDS_-_Public_Review_Draft_9_14_21.pdf.

⁵⁴ Changes in income vary across the region. In Happy Camp, for example, average per capita income was tallied at \$22,279. See e.g., "Comprehensive Economic Development Strategy 2021-2026", Karuk Tribe.

such as food deserts to high suicide rates and increased crime rates in the region, as all these factors are likely to bear some relationship with the demise of the spring Chinook.⁵⁵

Recommendation: To mitigate dwindling runs and maintain unique spring Chinook genetic material, a weir could be constructed and operated based on a discharge threshold to mimic natural/historical conditions and restore the primary advantage of spring Chinook run-timing. For example, the weir could be installed for the season as the Salmon River drops below 300 CFS, typically around August 1. If precipitation events causing Salmon River discharge to exceed 300 CFS occur while the weir is in place, the weir could be opened temporarily to mimic natural passage conditions. Once continuous precipitation is forecasted, and discharge exceeds 300 CFS for an extended period, the weir could be removed for the season. This typically occurs around October 15, near the end of the spring Chinook spawning season.

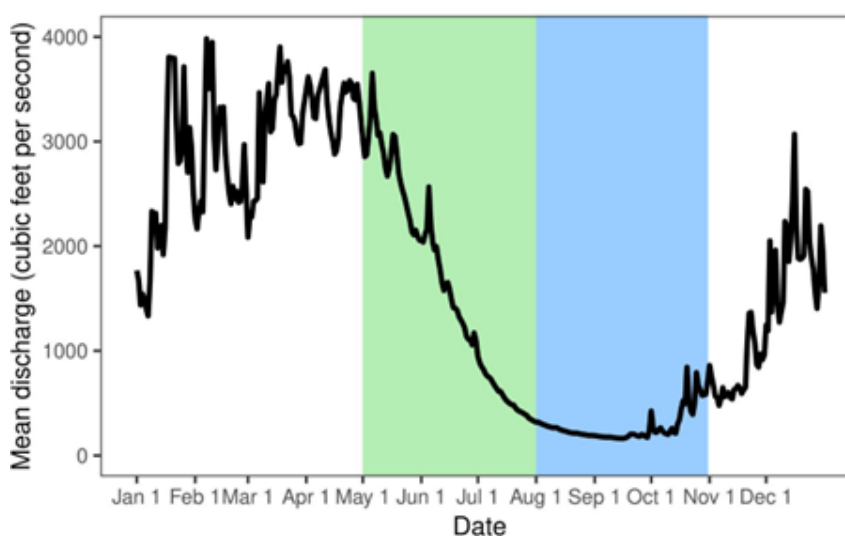


Figure 3: Salmon River Discharge Reference.

Finding the proper location for such a weir requires merging traditional ecological knowledge and law, observations in western science, and local input. Any weir must be placed carefully— not too high or too low on the river— to achieve the project’s objectives. The weir would therefore need to be placed strategically near historic selective barriers, such as Bloomer Falls, to allow the passage of springers while not blocking off summer and fall Chinook from attaining viable breeding grounds.

⁵⁵ For a more in-depth discussion of the impacts of declining traditional foods and the demise of Spring Chinook, See e.g., Norgaard, “The Effects of Altered Diet on the Health of the Karuk People.”

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