# The Effects of Historic Land-use Activities on the Streams and Aquatic Resources of the North Fork of the Eel River

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**Introduction**

The use of fish as a food resource by the aboriginal people inhabiting the North Fork of the Eel River basin (located in southwestern Trinity and northern Mendocino Counties) is a difficult subject to document and evaluate when formulating a regional subsistence model. The principal reason these resources are so difficult to evaluate is the lack of both historical and biological data concerning the North Fork fishery and ethnographic data on the utilization of fishery resources in the region. That these resources provided a significant food supply to the local aboriginal inhabitants is certain. However, the question remains-where did the procurement of aquatic resources fit into the overall pattern of subsistence activities pursued by the aboriginal people who inhabited the North Fork basin?

Although early twentieth century ethnographers spent a great deal of time discussing the procurement activities related to the anadromous fishery of the Klamath River groups (Yurok, Karuk, Hupa), there is virtually no ethnographic data on fishing for the Wailaki and related inland Southern Athabascan groups. Essene (1942) failed to ask his Wailaki informants any detailed questions related to the fishery in his Cultural Element Lists and Goddard and Merriam, the other principal ethnographers who worked in the region, were primarily concerned with recording linguistic and geographical data (Keter and Heffner-McClellan 1991: 3-5). In addition, there is no biological data relevant to the historical fishery of the North Fork.

For the reasons outlined above, more recent biological data, and interviews with fisheries biologists and long-time residents of the area were utilized to formulate generalizations related to aquatic resources concerning relative abundance, timing of seasonal runs of the anadromous fishery, the species of fish present historically in the river system, and the length of time each year these resources were potentially available for procurement. In addition, it is important to note that the North Fork of the Eel River system, including its tributaries, like the terrestrial ecosystem of the region, has been greatly affected by the land-use activities which have taken place during the historic period. It is necessary, therefore, to document these historic activities and evaluate their impacts to the aquatic environment in order to establish a better understanding of the river system and of the resources it provided to region's aboriginal inhabitants.

The North Fork of the Eel River is considered a major stream course with many small to moderate size tributaries (see Map 1 and Appendix IV). The river is approximately forty miles in length to the head of the West Fork near Hetttenshaw Valley. The North Fork drains an area of approximately 240 square miles.  Hulls Creek, the major tributary of the North Fork, is approximately 17.7 miles in length. Its headwaters are at 5,100' in the Castle Peak area. Hulls Creek drains an area of about 78.5 miles and comprises about thirty percent of the North Fork drainage. Riparian vegetation found along the North Fork and its tributaries includes big leaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and willow (*Salix*). Other tree species including white oak, black oak, live oak, and Douglas-fir growing along the river in some locations also help to provide stream cover. Grass and forb species growing within the riparian zone are an important habitat for insects that are a major food resource for fish.

## The Biology of Anadromous and Resident Fish of the North Fork Eel River Basin

Both anadromous and resident fish species are found in the North Fork Eel River system. Anadromous fish spend at least part of their life in the Pacific. Refer to Appendix IV for data on the streams of the basin and the amount of potential habitat for both resident and anadromous species of fish. A description of each of the major fish species is presented below, including a brief overview of those portions of their life cycle relevant to this study.

### Anadromous species

<u>Coho (Silver Salmon)</u> (*Oncorhynchus kisutch*)

Coho or silver salmon range from about five to twelve pounds at maturity. It is not unusual, however, for some of the larger fish to weigh up to fifteen pounds or more. There are two types of Coho salmon: short-run Coho, which move up the smaller coastal streams, and long-run Coho, which migrate, considerable distances. Coho salmon prefer cold streams with deep summer pools and plenty of cover for immature fish (Moyle and Morford 1991: 9).

Salmon and steelhead trout have a number of common requirements and shared characteristics. These include a habitat of cool or cold water and the need to spawn in freshwater. The spawning habits of the Coho salmon and Chinook salmon are similar, although Coho prefer somewhat smaller streams; their young also seem to prefer the smaller tributaries. Coho salmon enter most of the streams along the north coast in the fall and winter shortly before spawning. Migration depends on when the fall rains begin and the water level of the streams begins to rise. Spawning occurs when the fish reaches its native stream. Spawning must take place in cold clear streams with a gravel bottom. Fish prefer spawning in the lower end of a pool where water begins to pick up speed, or other similar locations with moving water. The female digs a nest and creates a pit into which she deposits some eggs. The male immediately fertilizes the eggs and the nest is then covered by the female. This process is repeated several times until all the eggs are laid. Both fish then die within a short period of time after spawning, although some may survive as long as a week or two.

Eggs hatch in about two months and over the next few weeks, the young wriggle through the gravel to the stream. They remain in the general vicinity of their birth until they are ready to travel to the sea. Juvenile Coho are voracious feeders and a major portion of their diet consists of aquatic insect larvae, terrestrial insects, and small fish when they are available (Moyle 1976:118).

Coho salmon usually migrate to the ocean when they are about five to six inches long and just over one year old. Thus, they spend at least one summer in the river system (rarely some individuals spend two summers) before heading to sea. Salmon can only summer in waters that stay below seventy degrees or they are unable to survive. They normally remain at sea two-to-three years before migrating upstream to their place of birth to spawn. On the main Eel, the run of Coho salmon takes place in January and early February (Steiner n.d.:10). Although no evidence indicating the presence of Coho salmon in the North Fork River system could be documented for this study, their presence prior to the historic period cannot be ruled out at this time.

<u>Chinook (King Salmon)</u> *Oncorhynchus tshawytscha*

Chinook salmon are larger than the Coho, averaging about twenty pounds with some exceeding fifty pounds. The record for California is eighty-five pounds. Before 1963, the salmon catch in California was over ninety percent Chinook (Fry 1978: 78). The life cycle of the Chinook salmon is similar to that of the Coho salmon. The principal difference is that Chinook usually prefer the larger creeks and rivers. Juveniles migrate to the sea at about four months when they are about four inches long. They remain at sea about three years before migrating upstream to their place of birth.

Fry (1973:78) notes that in most stream systems of the North Coast Ranges, Chinook salmon begin their migration runs in the fall with the exact time varying from river to river. For this study, it is important to note that some races of Chinook do enter some river systems (historically this included the Eel) in the spring. Spring (sometimes called summer salmon) Chinook were at one time the most abundant salmon in California. Prior to the historic era as many as 500,000 to 600,000 fish may have spawned each year in the Sacramento/San Joaquin River system alone. Today, there are small runs of less than 1,000 fish in the Klamath (spawning takes place in the Salmon River drainage) and Sacramento (spawning takes place on Mill and Deer Creeks) drainages.

Some Chinook salmon that run in the spring are also produced by hatcheries on the Trinity and Sacramento Rivers. These fish have been hybridized with fall run salmon which are, genetically, unsuitable as replacements for the true native spring run of salmon (Moyle and Morford (1991: 8).

<u>Steelhead Rainbow Trout</u> (*Oncorhynchus mykiss*)

Compared to the salmon, the steelhead is relatively long lived. Individuals may live to be six or seven years old and some females may spawn more than one time returning each year to the ocean. Most mature steelhead weigh less than ten pounds but some may weigh more than twenty pounds.

The life cycle of the steelhead is similar to that of the salmon. They prefer cold, fast moving streams. They usually spawn, depending on the stream system, from February to May. Like salmon, steelhead have well-developed homing abilities and usually spawn in the same stream where they were born. This often leads to local races of steelhead adapted to the local conditions of a particular stream (Moyle 1971:13). Spawning is similar to that described for the salmon and the urge to migrate to the ocean seems to be related to size. They usually travel to sea after spending about two years in the vicinity of their birth and usually spend two to three years at sea before returning to spawn the first time.

Although steelhead are predominately anadromous, they do not depend on spending part of their existence in the ocean and some individuals (a very small part of the population) mature without ever migrating to the sea. There are no sub-species, but they are classified as summer-run, fall-run, winter-run, or spring-run steelhead depending on the time of year when they enter a stream on their spawning run. Runs, which begin in the fall or winter, are likely to last until March or April. Smaller fish, called "half-pounders", usually weighing one-half to one and one-half pounds are also known to return to their native streams after less than one year at sea.

Spring run (or summer) steelhead enter the rivers in about March or April. Fry (1973: 60) notes their presence in the Eel River system. These fish migrate upstream towards the headwaters of the larger and cooler streams and spend the summer in large deep holes in the river and suitable tributaries. They do not spawn until the next spring.

Today, a small population of spring run steelhead (also referred to locally as summer steelhead) remains on the Middle Fork of the Eel River. Some of these fish have been seen in the summertime in deep pools in Balm of Gilead Creek, a tributary of the Middle Eel (personal observation). These fish are nearly extinct in the Eel River system due to degradation of habitat and poaching. As Moyle and Morford (1991:11) note:

> The fact the fish are confined today to the most inaccessible canyons is presumably an artifact of poaching. Even in these areas, human activities may be gradually eliminating one of the most spectacular sights in California--a deep, clear pool in a sun baked canyon, full of immense fish cruising slowly back and forth, waiting patiently for the fall.

Pacific Lamprey (*Entosphenus tridentatus*)

Lampreys are not true fishes, but rather, a primitive class of fish-like creatures called cyclostomes. Although they are eel-like in shape, and are referred to as eels in the North Coast region, they are not related to eels which are true fishes. Lampreys are anadromous. The young are blind, have no teeth, and no sucking disk. They live in streams feeding on vegetable matter living what can be best termed a worm-like existence. After several years, they metamorphose into the adult form. At this time they travel to the sea where they feed on a variety of fish.

At sexual maturity they return to fresh water, however, they apparently do not always return to the same stream. They are adept at surmounting natural (or man-made) barriers in streams. One interviewee (Interview #445) has witnessed this phenomenon. Using their sucking disk to hold on to a rock, they contract their bodies, then quickly snap forward releasing their hold, then reattaching themselves to another rock. By doing this repeatedly, they are able to climb rather formidable barriers.

Like salmon, lampreys spawn when the water is flowing over a gravel bottom and prime habitat can be considered the similar for both species. A shallow depression is formed and the female extrudes her eggs. A waiting male then fertilizes them. After spawning the adults die.

Lampreys (which in this study are sometimes referred to by their common North Coast name of eels) can reach a length of thirty inches and weigh about one to two pounds at maturity. They are considered an excellent food source when taken at or near the river mouths, but deteriorate rapidly as spawning time approaches. It appears that the historic eel run took place on the North Fork in the late spring (about May). One interviewee (Interview #445) noted that he was told that Indians in this area did eat eels caught in the North Fork. He also noted that the eels seemed to know when the last heavy rainfall of the season was over and that was when their run would begin. This timing was critical to insure that the river would not rise and wipe out the beds after the eels had laid their eggs.

**Resident Fish Species**

Rainbow Trout (Oncorhynchus Mykiss)

Resident trout are the same species as steelhead. They do not, however, have the anadromous gene. Steelhead spawn about two-to-three months earlier than the resident trout and, therefore, have some advantage in out competing them. For this reason, if there is a healthy steelhead population, there is usually a correspondingly smaller resident trout population.

Resident trout usually occupy smaller streams, including the upper reaches above the natural barriers, which halt migration of anadromous fish. Ideal habitat, like that of steelhead, is cold, swift, and well oxygenated water with rocky riffles (Moyle 1976:35).

Today, adults average about six inches in size. Interestingly, one interviewee (Interview 445) remembers catching trout on the North Fork about twelve-to-thirteen inches in length with an average of six-to-ten inches. He said that the best time to catch trout was the summer time.

Sucker (*Catostomus humboldtianus*)

The Eel and Mad Rivers contain a sub-species of sucker related to those found in the central valley. It is believed that they entered the north coast drainages through the capture of a headwater stream that originally flowed into the Sacramento River (Moyle: 1976: 17).

This fish is found in the North Fork drainage and may reach a length of two feet and a weight of four-to-five pounds. They do not conflict seriously with other species of fish, although they have been known to compete for food with trout. They are used as a food source by predator fish and act as scavengers. Given the fact that a healthy population of resident and anadromous fish inhabited the North Fork, it is likely this fish which feeds on the bottom, was not a significant food resource; although some were undoubtedly taken in the summer when stream flow rates are low.

Western Roach (*Hesperoleucus symmetricus*)

Although today roach may play a part in the ecology of the stream environments, it appears that they may not be native to the area (Moyle 1976: 76). Due to their small size (2"-3"), even if they were present in the stream system prior to the historic period, they would not have been a significant food resource.

## Historic Land-use Activities and their Effects on the Aquatic Environment

Land-use practices during the historic period have not only affected the terrestrial environment of the North Fork basin, but they have also greatly affected the river and creeks comprising the aquatic environment as well. For that reason, today, the North Fork of the Eel River and its tributaries are very different streams than those upon which the aboriginal peoples depended for a large portion of their subsistence resources.

Ranching Period 1865-1904

There were large numbers of sheep and cattle grazing on rangelands within the North Fork basin during this era (Keter 1989, Burcham 1981). Livestock populations during this period were much higher than those of today (for example, at one time Fenton's Ranch on the lower part of the North Fork had 30,000 sheep). The grazing (and in most cases overgrazing) of the rangelands resulted in a number of adverse impacts to the basin's aquatic resources and watercourses. In addition to the effects from livestock, a large feral pig population became established in the region during the 1860s. These animals caused additional negative impacts to the aquatic environment.

Negative effects to the stream systems of the basin by feral pigs and livestock included:

* Disturbance of the riparian vegetation along stream courses

* Increased soil erosion from hoofed animals trailing and otherwise disturbing the highly erodible Franciscan Formation soils on steep mountainous slopes

* Collapse of overhanging banks and other stream course disturbance due to trampling

* Increased pollution from animal waste

* Increased erosion from damage to plant cover by overgrazing

* Rooting and other soil disturbance (by feral pigs)

* Increased peak runoff which changes stream morphology

Another factor which needs to be considered in documenting the anadromous fishery of the North Fork during this era is related to the commercial fishing taking place at this time on the lower Eel River. This activity began in 1851 and canned and salted salmon from this region was considered some of the best tasting salmon in the world. It was shipped to markets as far away as New York and Australia (Lufkin 1991: 8-9, Wainwright 1965: 8).

Interestingly, it appears that the major portion of activity related to commercial fishing took place during the fall runs and the activity usually ceased by about late November as seasonal water flows became substantial. It is possible that, despite commercial fishing greatly reducing the fall runs on the Eel River (refer to Wainwright 1965 who presents a compendium of articles on this subject for the years 1854 to 1892 from the *Humboldt Times* newspaper the major county newspaper of that period), the effects to the winter and spring runs of salmon may not have been significant on the North Fork. A caveat must, however, be placed on this supposition due to the lack of biological data since a fall run of salmon at the mouth of the Eel could be a winter run of fish in the North Fork. For example, on the Trinity River, salmon enter the river system in August, but spawn in the upper river two to three months later in October and November. It is possible; therefore, that salmon may have entered the lower Eel River several months prior to their appearance in the North Fork River system.

## Homesteading Period 1905-1945

Subsequent to the establishment of the Trinity Reserve (now the Six Rivers National Forest) in 1905 and the passage of the National Forest Homestead Act and the Indian Allotment Act, there was an influx of homesteaders into southern Trinity County including the North Fork basin (Keter 2017). Homesteads usually consisted of a 160 acre tract of land with some limited improvements; including a house (or more often a primitive cabin), barn, fencing and some domestic livestock (which also grazed on adjacent National Forest lands). Homesteaders, by law, were prohibited from claiming areas of the National Forest with commercial stands of timber. The preferred locations for settlement were the oak woodlands and savannas adjacent to small springs on the more open southern slopes.

One interviewee (Interview #444) spent time fishing along the North Fork during the summertime in the late 1930s. He remembers seeing remains of posts and chicken wire which had been strung across the river as a weir in order to catch salmon. He also indicated that it was not uncommon to see the remains of salmon carcasses along the river banks. One long-time resident of the North Fork region (Miller Papers) wrote that during the early 1900s: "Indians dammed the North Fork of the Eel River and caught salmon by night-flares from the river bank. There were no game laws at that time." One interviewee (Interview #445) noted that, like the Indians, homesteaders also caught fish at night using flares and that it seemed the runs were better at that time.

The influx of settlers and the associated land-use activities, including the tilling of the soil and the concentration of livestock along the river, creeks, and springs, all contributed cumulatively to negatively affecting riparian zone principally through affecting the hydrologic cycle of the basin.

The Modern Era

After World War II, limited logging and related ground disturbing activities, including road building, began to take place on private lands within the basin (for example on the Travis Ranch and some former homesteads owned at that time by the Twin Harbors Lumber Company). Most of the land with harvestable timber within the basin is, however, on national forest lands where timber harvesting did not occur to any significant degree until the early 1970s when intensive logging and associated road building began to take (this is not the case for other portions of the Eel River basin to the west).

Interview data (Interviews #445) indicates that, despite the impacts from historic land-use practices, the fishery of the North Fork was still relatively productive until the 1964 flood. An earlier flood in 1955, although considered a significant event, did not appear to affect the fishery to any great extent according to interview data.

In 1964, a catastrophic event, the "Christmas Week Flood" occurred resulting in severe damage to the North Fork of the Eel River and its tributaries. Heavy snows followed by warm and heavy rainfall caused flooding throughout the North Coast Ranges. In the North Fork region, the flooding severely impacted the stream channels of the basin. The damage to fish habitat was severe and resulted in almost destroying anadromous fish populations. A study for the California Department of Water Resources (Brown and Ritter 1971:25) noted that erosion from the storm: "was most severe in the eastern section of the Eel River basin where the North and Middle Forks of the Eel River were fed by runoff from the steep westward facing slopes."

While earlier impacts to the stream system from land-use practices most likely contributed to the severity of flooding, it should be noted, that one consultant interviewed by a fisheries biologist (Steiner n.d.:14) indicated that, while logging may have contributed to the flooding in 1955 and 1964, he also saw areas untouched by logging come down in those years. This appears to be the case for the North Fork basin where only limited logging had taken place up until this time (Interview #445).

After the flood, silt and sedimentation totally filled the stream channel. One consultant (Interview #448) indicated that the channel was so heavily filled with soil and debris that the river bed was level and vehicles could drive for miles up the river bed. Major water holes in the channel (there was a large deep hole on the North Fork near the mouth of Soldier Creek for example) were filled in, and thick sediment covered the gravels on the river bottom. Data indicate that the 1964 flood event deposited one-seventh of the total sediments deposited over the last 1,500 years as measured in the estuarine deposits of the Eel River (Steiner n.d.: 1). The flood also washed out or buried riparian vegetation and washed out gravels or buried them with sand and silt (Steiner n.d.: 8).

The result of this destructive flood was the near total decimation of the already declining fishery in one catastrophic event. One consultant noted that: "1963 was the last good year [for fish] and streams were closed in 1965-66. This made no difference in the fisheries, or rather, the fisheries continued to decline" (Steiner n.d.: 9). Other factors possibly affecting the salmon population during recent times must be mentioned. First, the increased mechanization of the ocean going fishing fleet after World War II. Another factor was sport fishing. Until the early 1950s, there were numerous resorts on the lower Eel River where tourists would stay during fishing season. It is likely that since the 1964 flood, sport and especially commercial ocean fishing, if not contributing significantly to a reduction in the salmon population, may have made their recovery more difficult.

The adverse and cumulative impacts outlined in this section, have resulted in significant reductions for both anadromous and resident fish populations through:

* Loss of habitat for reproduction
* Reduction of the terrestrial food supply affecting the aquatic food chain
* Reduction of aquatic resources (insects) low on the food chain
* Loss of summer habitat due to increased water temperature and decreased flow rates
* Loss of summer habitat by aggradation of deep holes
* Loss of water quality
* Nutrient rich runoff (animal waste) causing oxygen depletion in slow moving water and encouraging algae growth
* Sport and commercial ocean fishing reducing the breeding population

When the cumulative effects from historic land-use practices are combined with the flood event and modern land-use practices (principally grazing and logging), it is clear that the aquatic habitat of the North Fork and its tributaries have been altered dramatically over the last 120 years. Today, the stream system contains very few anadromous fish. It seems likely that, with the recent increase in logging and road building on private and public lands within the basin, stream degradation will continue, or at the very least, modern land-use activities will hinder the recovery of stream channels and improvement of fish habitat which are needed if anadromous fish are to again inhabit the North Fork of the Eel in any great numbers.

## The Hydrologic Cycle

Historic land-use practices have also had an influence on fish habitat by affecting the hydrologic cycle of the basin. Long-time residents of the area interviewed for this study agreed that the streams within the basin used to run at higher water levels in the summer forty-to-sixty years ago than they do today. They also noted that many of the springs in the region have dried up or have greatly reduced flows during the summer dry season (even allowing for the current drought). Numerous homesteads have been recorded within the basin, and many do not have evidence of an active perennial spring or other water source on or adjacent to the claim (see, for example, CA-TRI-1202/H, CA-TRI-991/H, and F.S. # 05-10-54-266). Long-time residents indicate all of the homesteads in this area had at least a small spring. As one consultant (Interview #448) noted, "a homestead had to have a spring on it or you couldn't live there."

Historic land-use activities related to ranching and homesteading probably produced some minor changes in ground water flow to springs and to summer flow rates in the streams of the basin. These impacts to the hydrologic cycle included, increased runoff due to soil compaction and loss of ground cover, and reduction of riparian vegetation.

The most significant factor affecting the hydrologic cycle and ground water within the basin, however, was the change in the distribution of vegetation associations documented earlier in this study (Keter 1986, 1987, 1988, 1995). The increase in the extent of Douglas-fir forests, the corresponding loss of the oak-woodland vegetation type, and the increase in brush and understory species throughout much of the region has resulted in an increased loss of ground water through interception and evapotranspiration (for a discussion of this subject see Lull 1964:6.17-6.23).

Lull (1964:6.17) noted that,

> ...The vigorous absorption of soil moisture by roots, together with losses due to interception [the reduction of precipitation reaching the ground due to leaf canopy], usually more than offset the effects of vegetation in retarding evaporation from the soil. Thus the soil in forest openings tends to have more moisture than soil beneath trees.

Studies on the effects of forests on stream flow volume indicate that, in areas where forests were harvested, the more intensive the cut, the greater the increase in water flow, and the less evapotranspiration (Lull 1964: 6.24-6.25, Troendle 1989: 108). In one study conducted by the Forest Service on a small watershed in western North Carolina, thirty-three acres were cut and during the following year seasonal stream flows increased by sixty percent (Lull 1964: 6.24).

It should also be noted that, while no definitive research has been conducted on hardwood forests, it appears the general consensus at this time is that hardwoods use less water than conifers (based largely on significant differences in interception and, in the case of the North Fork, most likely the relative size of the trees and density of stands). In some areas, this factor alone can result in a difference in the reduction of ground water by fifteen-to-twenty percent (Troendle 1989: 114).

Today, summer velocity of the North Fork is slow to non-existent (in the winter occasionally there are substantial flows). USFS Fisheries biologists (Reneau and Barnes 1982: River Survey Files) who surveyed the North Fork of the Eel River in 1982 concluded that:

> ...summer and fall are very inhospitable to those fish which did not move downstream as the late spring flows diminished. Because of the low flows and intermittent nature of the North Fork of the Eel River during summer and fall, along with very high [water] temperatures only those salmonoids holding in deep pools have a chance for survival.

Although the hydrologic cycle is a complex subject with many variables, including the ability of some soils to hold moisture better than others and composition of the underlying geology, it is clear that a significant increase in the extent of the Douglas-fir forest has been a major factor in the reduction of summer flow rates in streams and springs. This reduction in flow rates during the historic period has significant implications for interpretation of the prehistoric record. Predictive models related to site location and models based on the procurement and distribution of potential subsistence resources, as well as site function, must take into account the recent changes to the hydrological cycle of the basin.

## An Historic Model of Anadromous Fish Runs in the North Fork of the Eel River System

The timing of seasonal runs and the availability of salmon and steelhead for procurement as a food resource is critical to any regional prehistoric subsistence model. There is a lack of biological, historical, and ethnographic data on the subject of anadromous fish within the North Fork of the Eel River system. There was also disagreement among the fisheries biologists interviewed for this study over such basic data as the timing of the seasonal runs. Some of the biologists interviewed even questioned the likelihood of salmon ever inhabiting the upper portions of the North Fork drainage.

For the reasons outlined above, the anadromous fishery of the North Fork basin has proved to be the most problematic resource to evaluate in formulating a prehistoric subsistence model. The following discussion synthesizes interviews with both fisheries biologists who have worked in this region of the North Coast Ranges (see the References Cited section), and long-time local residents of the North Fork region, to produce a historic model of the anadromous fishery of the North Fork River basin.

Because of the lack of definitive biological data, a model of the anadromous fishery was developed based on integrating the most reliable and consistent data from the regional ethnographic record with information provided by interviews with long-time residents of the North Fork basin who have direct knowledge of the timing of runs and the species of fish in the river system (at least as far back as the mid-1930s). The biological characteristics of the various species and races of fish which today inhabit the Eel River were then correlated with the interview data to formulate an historic model of the anadromous fishery of the North Fork.

Today, there is a barrier of slide debris and a large rock (called Split Rock by the locals) about five miles above the mouth of the North Fork between Asbil Creek and Wilson Creek. This large rock barrier appears to have been caused by the 1964 flood (this slide area may have been active historically presenting some kind of a barrier prior to 1964). This is a significant barrier and has contributed to the lack of anadromous fish in the upper portions of the North Fork since 1964. Below this point some distance there is a series of small waterfalls five to seven feet high (Interview #446). These falls would have been at the least a seasonal barrier to fish prior to the historic period. It is significant to note that one interviewee (Interview #445) indicated that, when he was a young man living on the North Fork in this area, the runs of salmon and steelhead coincided with periods of precipitation. During rain storms and shortly thereafter when the waters were high, there would be runs of fish. Between these events very few fish would be coming up the river and homesteaders would not even bother to fish in the winter except when the waters were high. It is possible that the higher waters would have somewhat mitigated the waterfalls as natural barriers to upstream migration of anadromous fish. This would be especially true for Chinook that are not as aggressive or agile in surmounting barriers as steelhead.

It appears that one of the reasons fish run late on the Eel River system (and especially the North Fork) is due to the erratic nature of fall rains and the number of roughs on the river which are barriers at low water flows. For this reason, over time the genetic variation, which differs slightly from stream to stream, may have favored those fish which migrated during periods when these barriers did not prove to be substantial impediments to migration. Also, given the propensity of anadromous fish species to inherit, genetically, traits related to seasonal migration, it appears reasonable to conclude that the timing of anadromous fish runs on the North Fork during the historic period is analogous to that of the prehistoric period.

**Historic Salmon runs in the North Fork**

Ethnographic data on the subject of salmon in the North Fork is non-existent. Foster (1944:163) notes that on the Middle Fork of the Eel River: "Black salmon in the fall were followed by winter and spring salmon in those seasons." Essene (1942:84) notes that: "Late February or March marks the beginning of the silverside salmon run." Essene does not make clear if the run he refers to was on the Middle Fork or the North Fork. Several of his informants had lived in the North Fork drainage but were living in Round Valley when they were interviewed. The black salmon referred to by Foster are a race of fall or winter run Chinook (Interview #446). The silverside salmon referred to by Essene are spring Chinook.

One interviewee (Interview #445) remembers homesteaders in the 1940s netting salmon on the North Fork. He indicated that steelhead were usually taken with a hook and line. The North Fork had no fall run of salmon but there was a small run in January and another in about late March or early April, with both runs lasting about two-to-three weeks (Interviews #445, #448). Another interviewee (Interview #446), noted that he had observed spring run of Chinook salmon in the North Fork prior to the 1964 flood.

It is possible that salmon runs on the North Fork may have been limited by the natural barriers noted earlier. Not all of the biologists interviewed were in agreement on the presence of Chinook above Split Rock prior to the 1964 flood. Some biologists indicated that Chinook salmon may not have been able to surmount the natural barriers along the lower portions of the river since they are not as aggressive or acrobatic as the steelhead in breaching natural barriers. All did agree, however, that the North Fork contained suitable salmon habitat.

No evidence was found documenting the presence of Coho salmon in the North Fork. It is possible, however, that at one time Coho did inhabit the river system. They have a greater need than Chinook salmon for cool water (spending one summer in the stream before migrating to the ocean) and are usually found in habitats with a canopy of riparian vegetation and undercut banks. Heavy grazing and the destruction of riparian vegetation and the trampling of streamside banks during the late 1800s may have resulted in destruction of habitat and extinction of this species within the North Fork basin prior to the twentieth century. A run of Coho salmon still occurs on the South Fork of the Eel. This population is estimated to be fewer than 1,000. It is estimated that, at one time, the South Fork carried 40,000 Coho (Moyle and Morford 1991:9).

Given the data presented above, it is hypothesized that historically there were two seasonal runs of Chinook salmon on the North Fork. The first was a winter run (it might even be classified as a late-fall run) which took place in about mid-January to early February and lasted for about for about three weeks. Biological data confirms the fact that a late winter run of salmon could have occurred on the North Fork. Chinook have a wide range of migration patterns and a winter run could occur as late as February. These fish would be dark in color and probably the "black salmon" referred to by Essene.

The second run of salmon on the North Fork took place about late March or early April and would be considered biologically, a spring run of fish. These fish (the "silversides" described in the ethnographic literature) are a separate race of Chinook that are fat and silvery during their run. They spend the summer in the deep holes before spawning the next fall.

Formulation for an estimate of the salmon population for the winter and spring runs on the North Fork simply cannot be made on a basis of local biological or historical data. One study (Humboldt County Department of Natural Resources and Public Work 1977) uses a generalized model formulated to estimate anadromous fish populations based on available habitat. This study estimates that one mile of suitable habitat on the Middle Fork of the Eel River (above Dos Rios) will support about 200 Chinook (and 150 steelhead). These estimates are made on current habitat which, as noted earlier in this study, has been greatly reduced by historic land-use activities and changes to the hydrologic cycle.

It appears that prior to the historic era, there was at least 46.2 miles of anadromous fish habitat within the North Fork basin. This figure is based on estimates from fish habitat survey data on the North Fork River system presented in Appendix IV. By using this estimate for potential habitat cited above (although the North Fork is smaller this fact is compensated for by the more productive habitat existing during the prehistoric era), it is projected that the total number of salmon entering the North Fork on a yearly basis to have been at least 9,240 fish. These fish would be available as a procurement resource in the form of spawning runs periodically depending on stream conditions from about mid-January until Mid-April. Some spring salmon (and land-locked winter salmon) would also be available through the summer and into the early fall until the rainy season.

While this population estimate is a large number of fish, it is dwarfed by the numbers of fish caught in the Eel River during the 1800s. For example, an article in the *Humboldt Times* (December 19, 1857) noted that, from October 18th until November 5th, 1857, 16,000 salmon filling 800 barrels at 200 pounds each were caught on the lower Eel River (Wainwright 1965:6).

### Historic Steelhead Runs in the North Fork

It is hypothesized, based on the interview and biological data, that there were two separate runs of steelhead on the North Fork. A winter run (or late fall run) taking place in about mid-to-late January with the heaviest part of the run lasting about two-to-three weeks. Winter run fish continued sporadically for several more weeks beyond this time. These fish would spawn in late May and early June. According to biologists, this would make the North Fork of the Eel River the location of the latest spawning activities by steelhead in California and possibly the North American Continent. Some of these winter run fish become trapped in the deep pools by low water flows and would have spent the summer in the river before migrating to the sea.

The second run was a spring run taking place in about mid-March and lasted for three-to-four weeks (or possibly somewhat longer). This was probably the dominant run of steelhead in the North Fork. This conclusion is based on data supplied by discussions with the interviewees who indicated that the January run was smaller and that the main run took place in the early spring. Interviewees indicated that the spring run was very good and lasted about four weeks. One interviewee (Interview #445) indicated that local lore says: "the spring run ends when the bur clover blooms."

Spring run steelhead are a separate race and spend the summer in deep pools and spawn the next fall or winter before returning to the ocean. There are also spring runs of steelhead on the Middle Fork of the Eel and Mad River where fish spent the summer in deep holes on the upper portions of these stream systems. This fact is mentioned as it has implications for the ethnographic groups of the region who were linked by cultural and kinship ties to these areas (Keter and Heffner-McClellan 1991).

As with salmon, it is difficult to estimate the number of fish in each run during the historic era. One interviewee noted that it is possible that a large run could be in excess of 10,000 fish. Given the habitat potential for steelhead (Appendix IV) and applying the formula referred to in estimating salmon populations (that is 150 steelhead per habitat mile), the population of steelhead in the North Fork drainage prior to 1860 would have been approximately 6,930 fish.

This figure does not include potential habitat above the falls on Hulls Creek located below Hulls Valley (Interview #445). This is a significant barrier (the estimate is at least ten feet). As noted earlier, steelhead are better able to surmount natural barriers than Chinook. For this reason, an additional fifteen miles of habitat on Hulls Creek and its tributaries (this is a conservative estimate) would have produced an additional 2,250 fish (Interviewee #445 confirms the presence of steelhead in Hulls Valley before the 1964 flood). Combining this figure with the total for the rest of the stream system presented above would produce a steelhead population for the North Fork basin of approximately 9,180 fish. These fish would have been available for procurement in significant numbers from mid-January to as late as early June. In addition, like spring salmon, a significant number of steelhead would have been available in deep pools as a potential summer procurement resource.

The population estimates presented for both salmon and steelhead should be viewed as the potential number of fish in an average year. The total number of fish potentially available for procurement would have varied, perhaps significantly, from year to year depending on stream conditions.

It should be emphasized that the population estimates for both salmon and steelhead were developed principally to be a point of departure for discussions related to formulation of a prehistoric subsistence model.

**Conclusions**

Based on the data presented in this study, it can be concluded that anadromous fish populations in the North Fork of the Eel River system have declined to the point of near extinction since the beginning of the historic period, with the greatest decline since 1964. The principal reason for this precipitous decline is reduction of habitat resulting from the negative effects to the basin due to the cumulative impacts resulting from historic land-use practices and the catastrophic flood event of 1964. As Moyle and Morford (1991: 7) note: "[Fish} are the most important components of the ecosystems that support them and their decline reflects the deterioration of the ecosystems."

Further evidence in support of the hypothesis that the decline of fish populations is due to destruction of habitat is found in the corresponding reduction in the eel population during this same period. Eels have not been considered a desirable food resource during the historic era yet their numbers have still declined. Because their spawning habitat is the same as that of salmon and steelhead, it is likely that loss of critical spawning habitat and the warm summer water temperatures and low flows is a major contributing factor in the general decline of the anadromous fishery of the North Fork.

Today, some steelhead (which are more adapt at surmounting barriers than Chinook salmon) are still occasionally found in the North Fork above Split Rock (some are still taken on the lower portion of the river). It appears that Coho salmon are extinct or possibly may never have entered the North Fork River system. In 1986 during an archaeological survey along the North Fork in the spring, a salmon mandible (most likely Chinook) was identified by the author in the vicinity of the North Fork and Rock Creek. It seems possible, therefore, that occasionally Chinook may travel up the North Fork to spawn. This is, however, an uncommon event and, for all practical purposes, it is likely that Chinook salmon are extinct on the North Fork above Split Rock. Until this barrier is removed (California Fish and Game has tried to remove this barrier by blasting) and natural or human assisted restoration of spawning habitat takes place, runs of salmon and steelhead on the North Fork will be a thing of the past.

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Miller Papers
n.d. Collection of Letters from long-time residents of Southern Trinity County from the early 1900's. [See Keter 2017: Appendix 5]

Interviews with Fisheries Biologists [See Keter 2017: Appendix 9]

I#442 Eric Gerstung

I#443 Mike Morford

I#445 Floyd Barney

I#446 Weldon Jones

I#448 Lee and Irene Stapp

I#TSK Orvel Ballantyne (in author's possession)

Interviews are on file Heritage Resources Department, Six River National Forest, Eureka.

Fisheries Biologists contacted for this study

Jerry Barnes, USFS Eureka
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Eric Gerstung, California Fish and Game, Sacramento
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Weldon Jones, California Fish and Game, Ukiah
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Don LaFaunce, California Fish and Game, retired, Eureka
Park Steiner, Steiner Environmental Consulting, Potter Valley

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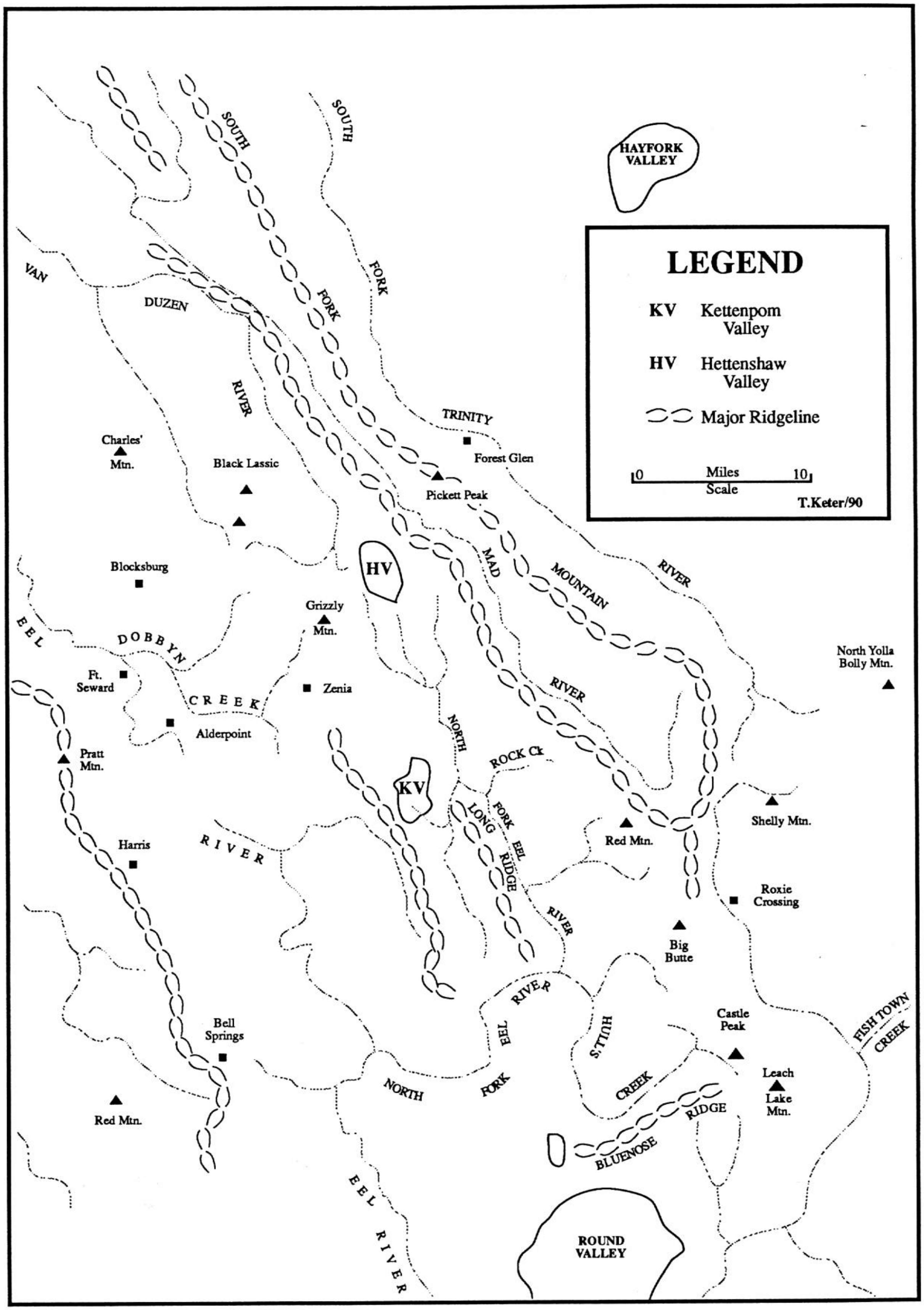
LEGEND
KV Kettenpom Valley
HV Hettenshaw Valley
Major Ridgeline
0 Miles 10
Scale
T.Keter/90
HAYFORK VALLEY
SOUTH
SOUTH
FORK
FORK
VAN
DUZEN
RIVER
TRINITY
Forest Glen
Charles' Mtn.
Black Lassic
Pickett Peak
HV
Blocksburg
MAD
MOUNTAIN
RIVER
Grizzly Mtn.
EEL
DOBBYN
CREEK
Ft. Seward
Zenia
Alderpoint
RIVER
North Yolla Bolly Mtn.
NORTH
Pratt Mtn.
ROCK Ck
KV
LONG RIDGE
FORK EEL
Red Mtn.
Shelly Mtn.
Harris
RIVER
RIVER
Roxie Crossing
Big Butte
RIVER
EEL
HULLS
Castle Peak
FISH TOWN CREEK
Bell Springs
NORTH
FORK
CREEK
Leach Lake Mtn.
Red Mtn.
RIDGE
BLUENOSE
EEL
RIVER
ROUND VALLEY

# Appendix IV

## Potential Fish Habitat
## North Fork of the Eel River System

(Six Rivers National Forest Stream Inventory Files)

| Major Course | Tributary | Length | Fish Habitat Resident | Anad. |
|---|---|---|---|---|
| North Fork | | 35.8 | 35.8 | 35.8 |
| | East Fork | 3.5 | 2.2 | .7 |
| | West Fork | 4.2 | 2.5* | 1.0* |
| | Bar | 2.5 | .8 | .2* |
| | Bluff | 4.5 | 4.3 | .2 |
| | Bradburn | 3.4 | 2.4 | .2 |
| | Cottonwood | 1.5 | 1.5 | 0 |
| | Dutchman | 3.0 | 0 | 0 |
| | Gypsy | 1.1 | .3 | 0 |
| | Hoaglin | 1.5 | 0 | 0 |
| | Kettenpom | 4.3 | 1.7 | .2 |
| | Lightfoot | 4.4 | 3.7 | .2 |
| | Little Red Mt. | 2.6 | 2.4 | 0 |
| | Panther | 2.2 | 1.0 | 0 |
| | Raglan Gulch | 2.2 | 0 | 0 |
| | Red Mountain | 4.3 | 3.9 | 1.5 |
| | Rock | 4.1 | 1.2 | .2* |
| | Salt (North) | 2.9 | 0 | 0 |
| | Salt (South) | 10.0 | 8.0 | .8 |
| | Soldier | 3.8 | .9 | .2* |
| | Tub | 4.1 | 0 | 0 |
| | Willow | 3.4 | 1.8 | .5 |
| | Yellowjacket | 2.0 | 0 | 0 |
| Hull's Creek+ (1) | | 17.7 | 16.0 | 4.0 |
| | Casoose | 4.5 | 3.0 | .2 |
| | Hull's Valley | 2.0 | 0 | 0 |
| | Horse/Brin | 7.5 | 4.0 | 0 |
| | Pepperwood | 2.0 | 1.0 | 0 |
| Below Hull's Creek+ | | | | |
| | Asbill W. Fork | 2.5 | 1.0 | .2 |
| | E. Fork | 1.8 | .5 | .0 |
| | Lousy | 1.5 | .0 | .0 |
| | Wilson | 4.3 | 2.0 | .5 |
| | Bear | 2.5 | .0 | .0 |
| | Totals | 159.0 | 101.9 | 46.2 |

* Estimate: No Fish survey estimates for streams in these drainages available (these are conservative estimates).

(1) Interview data note the presence of steelhead above the falls on Hull's Creek. Conservative estimate of habitat above the falls includes Hull's and Casoose Creeks is 8 miles.

\+ Estimate no actual mileage available