An Analysis of Coastal Marine Impacts Caused by Prehistoric and Historic Fishing Practices in Morro Bay, Ca

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Introduction

Recent commercial fishing, within the last 100 years, has had serious impacts on fisheries worldwide. This impact is far reaching, and even includes the relatively isolated port of Morro Bay in central California. After reaching record highs of roughly 15 million pounds per year in the late 1980's, Morro Bay's annual total catch has plummeted, with lows of around 1 million pounds by the early 2000's. As Robert Deacon points out, "with an overcapitalized fleet and declining fish stocks, Morro Bay's commercial fishing industry has suffered economically over the past two decades" (Deacon 2009). The once thriving fishery of Morro Bay has been decimated by decades of overfishing. But is this all due to the recent historic trends in commercial fishing? Recently, opponents to the theory that prehistoric peoples had severe impacts on coastal marine resources have posited new theories suggesting that prehistoric peoples did have severe and noticeable impacts. However, given the relative harmony that the prehistoric inhabitants of the Morro Bay region were able to sustain for thousands of years prior to the arrival of the Spanish, this new suggestion appears highly improbable. The Native Americans that utilized Morro Bay's rich natural resources prior to the arrival of Europeans were able to sustain populations for thousands of years; whereas, Europeans decimated this once pristine coastal environment and its resources in under 100 years. Understanding how the prehistoric inhabitants of Morro Bay were able to thrive for millennia will shed light on how they were able to have little to no severe, long-lasting negative impacts on their coastal resources.

Development of Morro Bay

Morro Bay is located at 35° 24' N, 120° 50' W, roughly halfway between San Diego and San Francisco on a relatively rugged stretch of coastline (Dubsky 1974). Today, Morro Bay is

one of few major ports located between Santa Barbara and Monterrey (Krieger 1998). Currently, Morro Bay is approximately 4.25 miles long and 1.75 miles wide with roughly 2000 surface acres of water at high tide, and about 1400 surface acres of water at low tide (Dubsky 1974). However, Morro Bay has not always appeared as it does today, and in fact was drastically different throughout prehistory. Studies have shown that during the late Pleistocene, estuaries and lagoons were almost nonexistent, and that estuaries were not formed until as late as 6,000-7,000 B.C along the California coast when sea-level rise inundated these river valleys, although there is some evidence for estuaries forming millennia earlier (Jones 1992).

Morro Bay and the surrounding areas were formed partly out of tectonic uplift, changes in sea level, and erosion over thousands of years. Up until around 15,000 B.C., at the time of the Wisconsin maximum, what today is known as Morro Bay was situated well away from the ocean as a small part of the Morro and Los Osos river valleys. However, environmental changes caused sea level to rise dramatically during the Flandrian transgression, leading to Morro Bay's present location. Morro Bay therefore, is situated on a deep, river channel that has been flooded within approximately the last 17,000 years (Jones et. al 1994).

Paleoenvironment

As with most aspects of the prehistory of the Morro Bay region, little effort has been put in to determining the paleoenvironment of Morro Bay. However, findings from previous archaeological work done at CA-SLO-165 and CA-SLO-877, as well as other sites in the area, provide some important clues into Morro Bay's prehistoric past. Radiocarbon dates from molluscan fauna at CA-SLO-165 indicates that Morro Bay was a lagoon/estuary from 3400 B.C. to A.D. 500, and this data is very similar to the formation of other lagoon/estuaries in the area.

This information suggests that the structure of Morro Bay has been very similar to its present form for the past 5,000 years; however, over the years the bay has been filling in because sediment accumulation from the Chorro and Los Osos creeks is outpacing the rate of sea level rise (Jones et al. 1994). Furthermore, evidence from CA-SLO-877 provides further insight into the paleoenvironment of Morro Bay. This evidence suggests that, prior to the stabilization of sea-level rise around the mid-Holocene, the shoreline of Morro Bay—and the larger Estero Bay—was an exposed rocky shelf. At around the time of sea-level stabilization, sediment filled Morro Bay faster than sea-level rise, and therefore beaches began to replace the aforementioned rocky coast (Jones et al. 1994).

Additionally, evidence from the Santa Barbara channel area just south of Morro Bay provides clues as to what the climate was like throughout prehistory. Evidence from radiolarian data as well as pollen cores from the Santa Barbara area suggest that the central coast region underwent a change from cool and wet conditions to warmer and drier conditions around 6,000 B.C. These conditions stayed this way for several thousand years until around 3,400 B.C. when, according to the radiolarian data, the conditions shifted back to a cooler and wetter climate. Around A.D. 500, this cool and wet climate shifted back towards one of higher temperatures and decreased rainfall, until around A.D. 1200, when conditions became very similar to the way they are today (Jones et al. 1994). This shifting of environments would have a dramatic impact on the marine flora and fauna of the entire region. Both marine and freshwater fish that had adapted to a certain environment around Morro Bay would suddenly be forced to adapt. The same is true of the Chumash that exploited these species, and this should be reflected in the archaeological record.

Modern Environment

Presently, Morro Bay is a smaller, sheltered bay situated within the larger Estero Bay that includes the cities of Los Osos, Morro Bay, and all the way up the coast to the town of Cayucos. Technically, Morro Bay is a lagoon within the larger bay of Estero Bay, but it remains open due to dredging by the Army Corp of Engineers (Gerdes 1974). Along with being a bay, lagoon, and being part of an ancient flooded river valley, the Morro Bay lagoon is formed by an estuary. The salt water of the ocean meets fresh water arriving from Chorro and Los Osos Creeks (Gerdes 1974). Morro Creek used to drain into Morro Bay until the development of the harbor area occurred. Because of this, today Morro Creek drains directly into Estero Bay, north of Morro Rock. The mixing of salt and fresh water that occurs here forms many unique features, including a delta and a salt marsh. The climate of Morro Bay, like much of California, is a Mediterranean climate with cool summers, mild winters, and moderate rainfall (Jones et al. 1994). Also, Morro Bay is located at the merging of cool northern waters and warm southern waters (Krieger 1988). The merging of many differing environments leads to a diverse array of both fresh water and salt water fish species that would have been exploited by the Chumash near Morro Bay prior to the Spanish arrival, as well as exploited by modern day fishing enterprises.

Morro Bay was a rather unimportant town in San Luis Obispo prior to World War II because the bay was always so silted up that it was inaccessible to most boats. The town of Morro Bay, originally called "El Morro" due to the shape of Morro Rock, was established in the 1860's, and by 1875 the population barely surpassed 100 individuals. A wharf and embarcadero were established in the 1870's which allowed small scale shipping of products to and from Morro Bay (Jones et al. 1994). However, there was no commercial fishing industry and only local recreational fishermen existed that sold their catch to the occasional transport ship that

passed through. Up until World War II, Morro Bay remained a small, unimportant town due mainly to the harsh sailing conditions that made it almost impossible to land at Morro Bay. By 1930, the population had only grown to around 800 inhabitants according to the census taken that year (Gerdes 1974). Because of Morro Bay's inaccessibility, the main port for San Luis Obispo County was located further south at Port San Luis near Avila. Due to this, Morro Bay didn't gain importance until after the dredging by the US military during World War II, which allowed for the creation of the harbor, and therefore made it much safer to land at Morro Bay. This dredging, which must be done every few years, allows for an entrance to the harbor of Morro Bay, which is located between the end of the long sand spit that juts out from the south, and Morro Rock to the north. Prior to the dredging, Morro Bay was rather inaccessible, and therefore was not a prominent port until after the war. It was the dredging that allowed for the small, rather economically unimportant town of Morro Bay, to become an important city within the county, especially for commercial fishing after World War II (Krieger 1988). After the creation of the harbor, the commercial fishing industry flourished.

History of Exploration

Although Morro Bay did not become a city until the late 1800's, westerners had explored the area for centuries. Possibly the first written record of Morro bay in western culture was in the diaries of Juan Rodriguez Cabrillo in 1542 (Krieger 1988). The Spanish explorer Cabrillo encountered the native Chumash here, and he recorded his observations in his diary while he was traveling north along the California coast in search of riches, as well as the fabled Northwest Passage. The fishing and maritime ability of the Chumash was already evident to Cabrillo by the time he reached Morro Bay. Further south, around Catalina Island, Cabrillo encountered the

Chumash, which is nearly 100 miles from their nearest population center. Upon first encountering Cabrillo, the Chumash offered to exchange sardines for glass beads that Cabrillo's entourage carried with them (Krieger 1988). Clearly fish was an important commodity to the Chumash at this point due to their willingness to trade fish for beads. After this encounter with the Chumash at Catalina Island, Cabrillo continued north on his mission to find riches and the Northwest Passage. In his search, Cabrillo sailed past Morro Bay, and unfortunately he never made contact with the Chumash of this area due to strong winds and rough seas. Cabrillo did note several villages in and around Estero Bay, but rugged coastline, lack of sheltered anchorages, and strong storms made it impossible for Cabrillo to take shelter here (Krieger 1988).

After Cabrillo, there were few attempts to make landfall in the Morro Bay area. The first European to make landfall in the Morro Bay area is argued to be Pedro de Unamuno, who in 1587 explored the central coast area briefly before being scared off by several encounters with the Chumash (Krieger 1988). However, many historians—even Henry Wagner who proposed this idea—are doubtful that Pedro de Unamuno really did come ashore in the Morro Bay area. It is possible, but the descriptions left by Pedro de Unamuno are open to interpretation (Jones et al. 1994). Others argue that Sebastian Rodriguez Cermeño was the first to land in the Morro Bay area based on his description of the Native Americans and their use of tule balsa boats, but the first confirmed mention of the Morro Bay area came from Sebastian Vizcaino during his 1602-1603 voyage (Jones et al. 1994).

It wasn't until centuries later, in 1769 when the Portola expedition passed through, that Morro Bay was further explored and documented by Europeans. Father Juan Crespi, the journalist of the expedition, noted upon seeing Morro Bay for the first time:

> *"Upon the south side, there reaches up into this hollow an inlet of enormous size, which we though must be a harbor; however, its mouth, which opens up southwestward, is covered by reefs that give rise to a raging surf. A short distance northward of the mouth . . . was seen an extremely large rock shaped like a round head [Morro Rock], which at high tide, becomes an island separated from the shore"* (Krieger 1988: 20).

Upon the Portola expedition's second voyage into the Morro Bay area, much like Cabrillo noted, the Chumash of the Morro Bay area had a dependence on the marine ecosystem. Father Juan Crespi, thanks to his keen observations and journal entries, noted this importance of marine resources, specifically fish, to the Chumash diet. While camping at Cambria for Christmas, Father Juan Crespi describes that the expedition was "close to a small village of Indian fisherman, from whom a great deal of fish was obtained, in exchange for beads" (Krieger 1988: 21). As Cabrillo noted, fish was an important and abundant commodity to the Native Americans of the central coast.

The Portola expedition and other prior expeditions of the area are the only observations of the Morro Bay area Chumash prior to the arrival of the Mission Era in California; however, they still provide some insight into the lifestyles of the Morro Bay inhabitants. These expeditions suggest that, at least at the time of the arrival of Western Europeans, fish was included as some part of the diet of the Morro Bay area Chumash. However, in most villages visited by the Portola Expedition, "gruel" and "mush" made of acorns and other seeds, was a staple food source: "They came over to visit us, offering us a sort of gruel made out of parched seeds which we all thought tasted well, with a flavor of almonds (Jones et al. 1994). Although

these Chumash lived along the coast, no fish was offered to the Portola expedition in the Morro Bay area which comes as a surprise because other tribes further south had offered fish to the explorers, but not the Chumash in the Morro Bay area. Several years later however, a description of the Chumash around Morro Bay by Pedro Fages indicates that both freshwater and marine species were important to the Chumash at this time:

> *"Among the sea fish there are many sea bream, crabs, whitefish, curbina [white seabass], sardines of three kinds, cochinillo [possibly croaker], and tunny; in the streams and rivers there are trout, spinebacks, machuros (an Indian name), and turtles. The fishing. . . The tridents they use are of bone; the barb is well shaped and well adapted to its use. The fishhooks are made of pieces of shell fashioned with great skill and art. For catching sardines, they use large baskets, into which they throw the bait which these fish like, which is the ground-up leaves of cactus, so that they come in great numbers; the Indians then make their cast and catch great numbers of sardines"* (Jones et al. 1994: 15).

Therefore, although the Portola expedition was not given any fish by the Morro Bay area Chumash, the account by Fages only a few years later clearly shows that fish was an important aspect of the diet, but to what extent is not known solely based on these expeditions.

With the arrival of the Mission Era in California, traditional ways of life for the native Chumash suffered tremendously. The Chumash village located at Morro Bay and referred to as *El Morro* by the Spanish ceases to exist after 1803, most likely due to conversion practices of the Spanish (Jones et al. 1994). The missions were set up in part to convert the native peoples of

California from godless heathens, to "God's own children" (Krieger 1988). As with many native populations all over the state of California, the Chumash welcomed the Spanish explorers with open arms, which lead to the eventual collapse of their ancestral ways of life. Because a primary focus of the missions was on converting the "heathen" Chumash, observations of their pre-contact, natural lifestyles did were few and far between at this time. The "massive recruitment for Mission San Luis Obispo from a small, scattered population, the high death rate, and over sixty years of contact with a dominating European culture made inevitable the disintegration of Obispeño village life and its wider social context" (Jones et al. 1994). Therefore, due to this annihilation by the Spanish, little is known—or even existed—of traditional Chumash subsistence strategies during the mission era.

Although much less studied than the Santa Barbara area Chumash, the Chumash of the Morro Bay area have a unique history. Prior to the arrival of the Spanish, The Chumash that lived in the Morro Bay area—called Obispeño after Mission San Luis Obispo—occupied a territory ranging from Nipomo in the south to San Carpoforo Creek in the north (Jones et al. 1994). The inland border of the Chumash is less well defined, but was somewhere in the area of the Santa Lucia and San Rafael mountain ranges. Therefore, the Obispeño Chumash were coastal peoples that utilized this varying terrestrial and marine environment.

Chumash Population

Observations by early Spanish explorers to the area, like Portola, describe the Morro Bay area as a sparsely populated region with no large villages as seen in the Santa Barbara area (Greenwood 1978). Although figures for the Obispeño Chumash alone are hard to come by, the population for the entire Chumash territory has been estimated to be around 15-20,000 at the

time of contact, with about 5-7,000 of those living on the coast. These figures are rough estimates based on total number of sites discovered and the estimated population of each site. One thing that is certain is that the population of the Obispeño Chumash was only a small fraction of the total Chumash population. Based on Mission records, after much decline, the population of the Obispeño Chumash is estimated to be between 10 and 20 percent of the total Chumash population. This would put the total population of the Obispeño Chumash, at the time of Spanish contact, at only a few thousand individuals (Campbell 1978). Population density estimates by the Spanish also confirm that the Obispeño Chumash were a sparsely populated group of people. The Spanish estimated the populations of the Obispeño Chumash to be around 25-45 individuals per 100 square kilometers. However, archaeological evidence shows that in the past, there was a large house located at Morro Bay, and a large village at Diablo Canyon which lacks historic materials. This evidence suggests that the Chumash were already in a state of decline prior to the arrival of the Spanish. Unfortunately, the Spanish hastened the decline of the Chumash, and by 1928 only 4 individuals were reported as being survivors from Mission San Luis Obispo (Greenwood 1978).

Explanatory Models of the Morro Bay Region

Although a regional model relating specifically to Morro Bay does not exist, extrapolations based on a few Morro Bay sites within the larger central coast area do exist. Based on findings from nearby sites, including CA-SLO-2, the inhabitants of the Morro Bay area supplemented their diet with shellfish and fish from Morro Bay throughout prehistory. According to Greenwood, fishing by hand and with traps had existed throughout the 9,000 years of occupation at Diablo Canyon, and only intensified later in prehistory with the introduction of

the shell fishhook. Furthermore, Greenwood's work suggests that marine resources were only a compliment to the more widely utilized terrestrial resources (Greenwood 1978).

Despite being about 70 km south on the central coast, regional models of prehistory of the Santa Barbara area indicate that marine resources had a greater importance to the Santa Barbara area Chumash, than they did to the Morro Bay area Chumash. Subsistence models for the Santa Barbara area show a trend of decreasing utilization of terrestrial resources, and an increasing sedentism and exploitation of marine resources. In the Santa Barbara area, initially shellfish and seeds are the main constituents of the diet, but due to sea-level rise and cooling ocean temperatures, the terrestrial environments are being inundated, while the marine resources begin flourishing at this time around 3,500-4,000 B.C. This change in sea temperature and rising sea-levels has been observed in the Morro Bay area as stated prior. Evidence from the Little Pico site in San Luis Obispo County also shows evidence of increased fish exploitation, with fish becoming the most significant faunal resource after about 3,500 B.C. However, while the Chumash of the Santa Barbara area began intensifying their fishing habits around this time, evidence suggests that the Obispeño Chumash did not intensify their fishing practices until the introduction of the shell fishhook to the area much later in prehistory. It is important to note hear that the open coast environments of Santa Barbara and Little Pico are very different from the protected lagoon of Morro Bay. Evidence from a site at Piedras Blancas in northern San Luis Obispo County also suggests that the marine exploitation strategy of the Obispeño Chumash remained relatively consistent throughout much of prehistory (Jones et al. 1994).

Fish Species of Morro Bay

Morro Bay contains a wide variety of fish species, each occupying a specific niche throughout the bay. There are many differing niches throughout Morro Bay, including the estuarine/lagoon region, open rocky coast, kelp beds, near-shore sand flats, and the unprotected open ocean. One of the most prominent and important to Morro Bay is the estuarine/lagoon habitat, and most fish occupy this area at some point throughout their lifetime. For example, English Sole tend to use the estuary as a nursery for their young, and then travel out onto the sandy near-shore areas for the remainder of their lives. Starry flounder, on the other hand, tend to occupy the estuarine region throughout their entire lives. Another important inhabitant of the bay is the perches. Perch are one of the most abundant fish in Morro Bay, and can be found all the habitats of Morro Bay, especially the estuary. In a 1973 survey of fish species in Morro Bay, Firestine et. al identified 66 different species, of which Shiner Perch and Black Perch totaled roughly 40% of the total population of the bay (Gerdes 1974). Species such as white croaker and various pricklebacks also inhabit the entirety of the bay.

Other more migratory species, like the Northern Anchovy and Pacific Herring, use the estuarine habitat as well. Northern Anchovy and Pacific Herring migrate along the coast and often occupy each habitat of Morro Bay, but especially the estuarine habitat to lay their eggs. These are extremely important species for any bay because they are a primary food source for many large predators, such as rockfish, halibut, flounders, lingcod, tuna, and others. The rockfish and lingcod can primarily be found in the rocky coastal areas and kelp forests around Morro Bay. The halibut, flounders, and sole all prefer to lie flat on the sandy near-shore waters inside the bay, as well as utilize the estuarine environment at various times of their lives, like most species of Morro Bay. Other important migratory species that appear at times in and

around Morro Bay are salmon and tuna. The salmon utilize the freshwater creeks and streams that deposit into Morro Bay to lay their eggs and eventually return to the ocean upon reaching adulthood. On the other hand, the tuna tend to stay out of the bay in much deeper waters (Love 1996).

Fishing Practices of the Obispeño Chumash

As Cermeño noted in his exploration of the central coast, at the time of early Spanish contact, the Obispeño Chumash were using tule balsa canoes rather than the sewn plank canoes of the Santa Barbara area Chumash (Salls 1988). Archaeological evidence suggests that the Chumash had been utilizing the marine resources of the area as far back as 7,000 B.C. Since the ocean is often violent outside the protection of Morro Bay, the Obispeño Chumash did not develop a deep water fin fishery according to work done by Roberta Greenwood on the central coast. Her work implies that the Obispeño Chumash harvested the tidal pools as well as the near shore area using traps, poles, nets, hook and line, and even their bare hands. The sturdier sewn plank canoes used by the Santa Barbara area Chumash, which were introduced later by the Spanish, would have been necessary to exploit the marine resources outside of Morro and Estero Bay. Furthermore, Greenwood's work at CA-SLO-2 and CA-SLO-51 indicate that single piece shell fishhooks made from abalone or mussel shell were introduced late in prehistory to the Obispeño Chumash, and were very simple in their design (Greenwood 1978). This indicates that prior to the introduction of shell fishhooks, fish were apparently easily caught using traditional methods of traps, nets, spears, gorges, and even by hand (Salls 1988).

Analysis of fish bone at CA-SLO-165, by Dr. Kenneth Gobalet, indicates that the Chumash utilized many differing environments to catch fish. Based on this work, the Obispeño

Chumash of the Morro Bay area exploited the open sandy beaches, the rocky coast, as well as the estuary and lagoon area of Morro Bay. The inhabitants of the open sandy beaches include species such as herrings, sardines, perch, croaker, and thornbacks. Along the rocky coast, the main species that were harvested by the Obispeño Chumash were rockfishes, lingcod, hake, prickelbacks, and perch. In the estuarine/lagoon setting, sculpin, perch, midshipman, smelts, and anchovies were all taken. Many of these species would inhabit different localities throughout their life cycles. For example, sharks, skates, and rays were important species for the Morro Bay residents, and could be taken in all three of these habitats (Salls 1988). Along with indicating where a specific species was taken, certain species indicate seasonality of catch. For example, the spring and summer months appear to be the most productive times of the season because that is when temporary, like Pacific barracuda, Pacific hake, northern anchovy, plainfin midshipman, smoothhound sharks appear. All of these fishes are present in the archaeological record at CA-SLO-165, with the majority of the seasonal occupants of Morro Bay arriving in the spring and most leaving by the fall (Jones et al. 1994).

The species taken by the inhabitants of Morro Bay not only indicate where or when they were caught, but also shed light on the technique used to catch them. For example, all the species identified at CA-SLO-165—except for the smallest like herrings, sardines, and anchovies—could be caught using either a fish hook or a bone gorge. The shell fishhook was not introduced to the Morro Bay area until late in prehistory around 200 B.C., while the bone gorge had been utilized in the area since roughly 7,000 B.C. (Jones et al. 1994). The bone gorge is described in the field notes of Kroeber: "it was of bone, about an inch and a half in length, pointed at either end; to the middle a 2-ft sinew leader was attached" (Salls 1988: 121). The

bone gorge was then covered with bait, and when the fish swallowed the gorge, it would become logged in the fish's throat.

One possible reason why the bone gorge was used so extensively throughout prehistory is that the bone gorge is much stronger than a shell fishhook. As noted by Salls, large, hard striking pelagic fish, like a tuna, would break shell fishhooks and therefore the bone gorge would be more efficient to make and utilize (Salls 1988). This, plus the fact that the Obispeño Chumash only had small, near shore, tule balsa canoes, explains the absence of large pelagic fish from the Morro Bay archaeological record (Jones et al. 1994). The necessary boats to reach these fish, and the necessary gear to acquire these strong pelagic fish did not appear until well into the 20th century. Once the technology was available, these offshore pelagic fish became an extremely important commodity in historic times (Fish and Game 1976, 2010; Robertson 2012). This is one of the most obvious differences between prehistoric Obispeño peoples and the large-scale commercial fisheries of historic times. The Obispeño peoples simply did not have the technology to harvest marine resources further than the near shore areas. Nevertheless, the single piece shell fishhook introduced after 200 B.C. to the Morro Bay inhabitants did have some benefits. One important benefit of the shell fishhook is that, "an incurved point tended to foul less on rocks, and tended to retain bait and fish more effectively" (Salls 1988: 126). The ease of catching fish within the sandy areas of the bay using nets and traps, and the ease of production and use of the bone gorge made the fishhook of little value to the Morro Bay residents until later in prehistory.

Other than the bone gorge and shell fishhook, the Obispeño Chumash that inhabited the Morro Bay area used a combination of nets, traps, and spears to acquire these fish. Large nets were used, possibly in conjunction with tule balsa canoes, in the near shore sandy area to catch a

variety of fish, including smaller fish like herring, sardines, and anchovies. Along with these nets, the Obispeño Chumash would utilize spears in the shallow areas of Morro Bay and the creeks that feed the bay to catch larger fish, especially sharks, skates, and rays which appear in the archaeological record of many sites around Morro Bay. A common technique utilized by the Chumash, as well as in other locations similar to Morro Bay like Newport Bay, was to use nets, traps, and weirs to trap a large, varied group of fish. The Chumash would then use dip nets and sometimes baskets to collect the smaller fish, and spears for the larger fish, usually sharks, skates, and rays (Jones et al. 1994). Evidence from CA-SLO-165 indicates that the Chumash were using this technique extensively. Of the 2155 elements identified during the Caltrans excavation at SLO-165, 23.2% were surfperches, 21.3% were silversides, 18.3% were herring and sardine, and another 15.3% were identified to be larger species such as bat rays, sharks, skates, and requiem sharks (Jones et al. 1994). This makes up 78.1% of the total identified species at SLO-165. These species would be acquired most efficiently using the aforementioned net and spear combination, rendering the bone gorge or shell fishhooks almost obsolete. The remaining 21.9% consists of dozens of different species, including pacific hake, rockfish, pricklebacks, sculpins, and many other species. While these species were clearly not targeted by the inhabitants of Morro Bay, they were a welcome bycatch. As noted by Jones et al., the findings from SLO-165 indicate:

> *"An exceptionally rich fishery, which reflects the presence of an estuary/lagoon adjacent to the site. Diachronic patterning shows some continuity through time as well as changes related to environmental shifts, technological innovation, population pressure, and varied mobility strategies"* (Jones et al. 1994: 129).

The work done at SLO-165 also conforms to the idea that fishing was of lesser importance earlier in prehistory for the Obispeño peoples, and that the technology was less sophisticated. During the Millingstone Period (6100-3500 B.C.) at Morro Bay, fishing intensity was low as indicated by a bone density of 340.6 elements per cubic meter, yet the species taken remains the roughly the same throughout time. Sharks, skates, and rays however were of less importance than the smaller fish that could be taken by nets, traps, or seine, indicating that using nets, traps, or seines was the preferred and most efficient technique. This could also have occurred due to the fact that the sea level was lower than today and therefore the habitat for these larger fish had not fully developed yet (Jones et al. 1994). With the arrival of the Early Period (3,500-1,000 B.C.), the Morro Bay fishery became more intensive as indicated by a bone density of 1,445 elements per cubic meter. Again, the reliance on small fish that could be taken near the shore with nets, traps, and seines, and a small reliance on larger, spearable fish remains the same. With the transition from the Early Period to the Middle period (1,000 B.C.-A.D. 1), the same pattern of targeting smaller fish remains the same; however, fishing intensity appears to have decreased slightly as evidenced by the bone density dropping to 1,221 elements per cubic meter. Some significant changes occur with regards to what smaller fish are taken. Sardines, herrings, and northern anchovy are almost twice as abundant in the Middle Period as they were in the Early Period, but the number of surfperches at SLO-165 decreases by almost 50% during this time (Jones et al. 1994).

Unusually, the transition between the Middle Period and the Late Period (A.D. 1-1500) was not nearly as pleasant as the prior transitions that had occurred at SLO-165. As opposed to the other periods of Morro Bay prehistory dating back thousands of years, there is almost no fish

to speak of during the Late Period at SLO-165. Only two elements were discovered that belong to a type of requiem shark. This comes as a great surprise because at other sites along the central coast, especially in the Santa Barbara region, fishing only continues to intensify during the Late Period. However, much like Greenwood discovered at CA-SLO-2, although a different environment, fishing became much less important during the Late Period, as native inhabitants shifted towards a focus on terrestrial fauna. At SLO-165, it appears that the reason for this drastic decline in fish elements can be attributed to natural events, rather than depletion caused by native inhabitants. According to archaeological and environmental data, the lagoon/estuary of Morro Bay had almost completely silted in by A.D. 1200 (Jones et al. 1994). There is evidence that other lagoon/estuaries began silting up, such as Batiquitos Lagoon, which began silting in around 1,500 B.C. and eventually was completely silted in around A.D. 1500 (Glassow 1992). The fact that this decrease in fishing intensity in Morro Bay is due most likely to environmental factors, rather than human induced factors, is important in determining which prehistoric marine effects were caused by humans, and which were bound to occur due to the unpredictability of nature.

State of Fishery Prior to Spanish Contact

The state of the coastal environment prior to Spanish contact has been hotly debated throughout California. Until recently, the prevailing theory regarding the coastal marine habitat utilized by Native Americans throughout California can be summed up perfectly by Salls in his 1988 dissertation on the Prehistoric Fisheries of the California Bight. Salls notes that, "before modern commercial fishing depleted the southern California fisheries, the waters of the Bight provided richness beyond modern conceptions" (Salls 1988: 203). This theory seems to make

the most sense given the data that exists regarding prehistoric peoples and the astonishing increases in fishing after World War II. By looking at the commercial catch data since the mid-1940's (see Table 1 and Figures 1a/b, 2 attached), the yearly catch for the port of Morro Bay shows an increasing trend until the last few decades when the fishery begins to decline (Fish and Game 1976, 2010; Robertson 2012).

During the beginning stages, the commercial fleet of Morro Bay made a living primarily by collecting abalone and catching tuna far offshore (Fish and Game 1976, 2010; Robertson 2012). During the 1950's the rockfish industry developed to become one of the main catches by commercial fishermen in Morro Bay, and has remained a staple of the industry ever since. The decline of the commercial abalone fishery during the late 1960's due to overfishing corresponds well with the increase in lingcod and various species of sole during the early 1970's to secure income that was lost with the destruction of the abalone industry. At this same point in time, beginning around 1970, the rockfish industry also begins to grow tremendously until its peak in the mid-1980's. The growth in rate of catch of these other species, mainly lingcod, sole, and rockfish, appear to correspond well with the destruction of the abalone fishery, as well as the unpredictability of the tuna fishery. From the beginning of recorded data in late 1940's to the eventual destruction of the tuna industry during the mid-1980's, the annual tuna catch varies tremendously from year to year. During peak years, the annual tuna catch for the port of Morro Bay approaches 4 million pounds, but between these peaks, the catch often falls below 1 million annual pounds (Fish and Game 1976, 2010; Robertson 2012).

The commercial tuna fishery at Morro Bay eventually collapses in the mid to late 1980's. Ironically, the collapse of the tuna industry leads to the most productive overall fishing era at Morro Bay. With the decimation of the commercial tuna industry, previously less desirable

species, such as sablefish, various kinds of sole, and thornyheads become the most sought after species, along with rockfish. However, during the 1980's, the rockfish industry already shows evidence of a drastic decline. At its peak, during the 1980's and into the early 90's, the Morro Bay commercial fishing industry alone was bringing in nearly 15 million pounds of fish every year. However, all good things must come to an end, and after the early 1990's, the entire commercial fishing industry of Morro Bay begins a drastic downturn. Rockfish, various sole, and thornyheads continue to be the most sought after fish, supplemented by other species such as sablefish, swordfish, and salmon. However, beginning in the year 2000, the species that used to be the most important, mainly rockfish, sole, and thornyheads, take a back seat to lower ranked species, such as sablefish, hagfish, and various crustaceans. Sablefish and hagfish become staples of the Morro Bay commercial fishing industry and a strategy of catching any species that can bring a profit begins to take over (Fish and Game 1976, 2010; Robertson 2012).

Given the extremely small population of the Obispeño peoples, the primitive fishing technologies, and the fact that fish was only a compliment to an extremely varied diet of both marine and terrestrial resources, it appears that the inhabitants of Morro Bay lived in somewhat of a state of harmony with the environment. If there was a depletion of marine resources, the peoples of Morro Bay would intensify their use of terrestrial resources, and vice versa. The Obispeño would utilize a wide array of both terrestrial and marine resources in their diet, and thus is highly unlikely that they would have a substantial impact on the coastal marine environment. As stated earlier, for the Morro Bay region, it is believed that intensive fishing is a more recent adaption by the Obispeño people that occurred from the Early to Middle Periods, and was used to compliment terrestrial food resources, yet was much less intensive than the sedentary fishing villages of the Santa Barbara region. The fact that the Santa Barbara area

Chumash were able to sustain large villages for generations, almost entirely on marine resources, gives insight to the extreme productivity of the coastal marine environment of the central coast (Salls 1988). It has been suggested that the reason these fisheries remained so productive over the span of 10,000 years is due to the extreme diversity of kelp forests that exist on the central coast. Rick et. al hypothesize that this diversity, as compared to the less-diverse kelp forests of the coast of Alaska, is what allowed the Chumash of the central coast to retain such a viable fishery (Rick et al 2008).

Overfishing and Resource Depletion

Recently however, some experts have argued that prehistoric peoples have had severe and noticeable impacts on coastal marine environments. A recent paper on the history of impacts of the central coast argues that:

> *"Archaeological data suggest that human seafaring and fishing originated much earlier than once thought. This deeper history implies that humans often had measurable impacts on coastal fisheries long before the modern era of industrialized and globalized fisheries"* (Erlandson 2011: 1).

This paper focuses on the Chumash of the Santa Barbara area, and posits—due to sea-level rise of roughly 120m in the last 20,000 years—that archaeologist only can see the "proverbial tip of the iceberg" of prehistoric sites (Erlandson 2011). While this is true, archaeological evidence from the Santa Barbara area points to increasing intensification of marine resources continuing to occur throughout the Holocene, with large sedentary

villages, whose main subsistence strategy is the procurement of marine resources, existing throughout much of late prehistory (Rick 2008). While fishing occurred much earlier along the central coast than most archaeologists and fish ecologists originally believed, extreme intensification of marine resources did not occur until much later in prehistory along the Santa Barbara channel with the introduction of more advanced technologies, like the shell fishhook. During the late Holocene, fish meat begins to make up over 70 percent of the diet of the Santa Barbara area Chumash. Therefore, strong intensification of fishing in the Santa Barbara area did appear until much later in the Holocene when "growing population densities, improvements in fishing technologies, and the greater biomass and availability of fishes than other marine resources" (Rick et al. 2008: 8) allowed it to be possible.

Furthermore, Rick et. al suggest that the reason that there is little evidence of severe impacts on coastal fisheries in North America is because exploitation of coastal marine resources had not yet peaked with the arrival of the Spanish. Across North America, there is evidence for a transition from terrestrial resources, to supratidal and intertidal zones, then to subtidal and near shore habitats, and eventually, most recently, exploitation of pelagic and deep water habitats (Rick et al. 2008). Rick et. al suggest that the arrival of the Spanish halted this trend, and that given more time, prehistoric peoples would have eventually decimated the coastal environments. Whether or not this is the case, we will never know. However, it is known that the technology available to the Obispeño—even that of the more technologically advanced Santa Barbara area Chumash—at the time of Spanish contact was nowhere near as sophisticated as that developed by westerners several centuries later. This highly sophisticated technology developed by westerners was capable of decimating the marine environment all over the world. While the

Obispeño Chumash were able to coexist with the marine environment for at least 8,000 years, historic fishing practices decimated these coastal fishes in just the past 100 years.

Much like during modern times, prehistoric peoples overexploited resources when they were abundant, and used more conservative subsistence strategies when such resources became depleted, and therefore were less economically viable. However, as noted in Human Impacts on Ancient Marine Ecosystems,

> *"Evidence for localized resource depression does not necessarily signal a complete lack of conservation practices or sustainable economics . . . shifting residence patterns can cause the serial depletion of marine resources within local foraging territories without a long-term alteration of the larger ecosystem . . . local resource depletion combined with patterns of "shifting sedentism' might be part of a sustainable settlement and economic strategy that could span hundreds or even thousands of years"* (Rick et al. 2008: 6-7).

Although localized marine resource depression or depletion most certainly occurred in prehistoric times, prehistoric peoples simply did not have the technological ability to cause widespread ecological destruction. As noted earlier, the population for the entire Chumash at the time of contact was roughly 20,000, with the Obispeño Chumash being only a small fraction of that. Given that there were no more than a few thousand individuals throughout the entire territory of the Obispeño, it seems impossible that these peoples could even come close to the 10 to 15 million pounds landed annual during the peak years of the commercial industry at Morro Bay during the 1980's. The commercial industry was able to support these tremendously high

catch rates for years before the eventual collapse of the entire industry in the early 90's. This was an extremely viable industry that lasted roughly 50 years until its' collapsed.

The fact that the commercial industry was able to increase its annual catch for 50 years after its beginning, does not suggest that there were any severe, long term impacts caused by the prehistoric peoples in the area. Despite pointing to isolated depression of a few marine resources throughout the Holocene, J. M. Erlandson states that:

> *"The prehistoric impacts of Native American peoples through the Holocene still pale in comparison to the rapid, pervasive, and devastating effects caused by the introduction of globalized and increasingly industrialized 'western' economies"* (Erlandson 2011: 5).

As stated earlier, the Obispeño of the Morro Bay area almost certainly caused localized depression of marine resources, but this localized depression does not even come close to that caused by the commercial fishing industry during the 20th century. One reason is that the Obispeño inhabitants of Morro Bay, prior to the arrival of the Spanish, simply did not have the means to cause anywhere near the severity of impacts that occurred after the commercial fishing industry began in Morro Bay in the 1940's. Archaeological evidence presented earlier shows that these marine environments were exceptionally productive, and that the Obispeño were able to exploit the bay for several thousand years until the lagoon silted in, due to environmental factors. One major reason for this is that prior to historic times there were always areas that humans were incapable of exploiting. For example, because the Obispeño Chumash only used tule balsa canoes that were used to fish within a few kilometers of the shore, there were always

refuges for these fish to avoid capture. With the substantially greater technology—especially in watercraft design—that appears during historic times, these safe niches once used by the fish as refuges, rapidly shriveled up and disappeared (Rick 2008).

Discussion

One reason suggested for the long-term sustainability of prehistoric fisheries is that prehistoric inhabitants of the central coast tended to practice a strategy of "fishing up the food web", as opposed to modern day practices of "fishing down the food web" (Pauly et al. 1997). In modern times, commercial fishermen tend to target higher trophic-level species—such as swordfish, tuna, and shark—due to their economic profitability. Evidence from the central coast suggests that the opposite strategy was used. Because these higher trophic-level species have much longer reproductive rates than species lower on the food chain—such as perch, herring, sardines, and anchovies—it is suggested that higher trophic-level fish were mostly avoided for this reason. "Fishing up the food web" by targeting lower trophic-level fish with faster reproductive rates is a much more sustainable strategy than the "fishing down the food web" strategy in use today by commercial fishermen. Whether or not prehistoric peoples were aware of this is not understood at this time. It could simply be that this strategy was used due to limitations in fishing technology, but either way, the fact that prehistoric peoples of the Santa Barbara channel were "fishing up the food web" for thousands of years at a relatively stable rate, implies that they did have some knowledge of sustainable fishing practices (Pauly et al 1997).

Over the past 10,000 years of human occupation of the Morro Bay region, the area has undergone drastic change. Initially, after arriving in Morro Bay, the Obispeño Chumash lived in harmony with the environment, with only slight variations in environment to deal with. Both

terrestrial and marine resources were abundant upon arrival, and stayed that way for millennia. It wasn't until the sediment deposition of Chorro and Los Osos Creeks outpaced sea-level rise during the mid-Holocene that the fishery of Morro Bay was impacted severely in any way. This sort of devastating impact to Morro Bay was not seen again until the mid-1940's when the U.S. Military dredged the bay. This dredging of the bay brought species back to the bay, but it also allowed for the most severe decimation of the natural resources of Morro Bay since the mid-Holocene sedimentation.

The key difference between these important events is the reason behind why they occurred. The catastrophe during the mid-Holocene was caused by natural factors; whereas, the more recent destruction of Morro Bay's resources has been human induced. While the Obispeño Chumash were able to sustain growing populations for millennia, Europeans needed only a few decades in Morro Bay to reduce the fish populations to all-time record lows. The practice of "fishing down the food web" in use by most modern commercial fishermen appears to be a significant factor. This, along with pure overfishing and pollution, has led to the state that the Morro Bay fishery is in today. The recent upswing in annual landing totals appears promising; however, upon further inspection, the upswing is caused by a shift to lower ranking species—primarily sablefish and hagfish—rather than a recovery of existing targeted species. This suggests that the recent growth is not a sign that Morro Bay is recovering, rather that the commercial fishing industry shifted its focus to less desirable species. In this case, Morro Bay is not recovering, and the coastal marine environment will continue to degrade rapidly.

Although some experts theorize that prehistoric peoples had severe and noticeable impacts on coastal resources, there just simply isn't any evidence in Morro Bay that this is true. Severe and noticeable impacts do not arrive until after Europeans arrive in the Morro Bay area.

Certainly, the Obispeño that inhabited the region throughout most of prehistory could not have come anywhere close to the 15 million pound per year average attained by Europeans during the 1980's. The small populations and relatively primitive technology utilized by the Obispeño, combined with their strategy of “fishing down the food web” allowed them to sustain populations for thousands of years and avoid causing severe negative impacts on the coastal marine resources.

Works Cited

Campbell, G. 1978. Chumash: introduction. *In* R. F. Heizer, editor. Handbook of North American Indians, volume 8: California. Smithsonian Institution, Washington, D.C.

Deacon, R. 2009. Morro Bay fishery charts bold course. PERC Reports, 27.2.

Dubsky, P. A. 1974. Movement patterns and activity levels of fishes in Morro Bay, California as determined by ultrasonic tagging. Senior project. California State Polytechnic University, San Luis Obispo.

Erlandson, J. M. 2011. Archaeology, sustainability, and fisheries: lessons from a deep history of human seafaring and marine fishing. Academica Sinica, Taipei.

Fish and Game. 1976. Fish bulletin's fish catch statistics: value of landings and shipments by port for the years 1947-1976. California Department of Fish and Game. Electronic version available from: http:// libraries.ucsd.edu/apps/ceo/fishbull/index.html. University of California, San Diego.

Fish and Game. 2010. California commercial landings for 2000-2010. California Department of Fish and Game. http://www.dfg.ca.gov/marine/fishing.asp#Commercial.

Gerdes, G. L., E. R. J. Primes, and B. M. Browning. 1974. Natural resources of Morro Bay: their status and future. Department of Fish and Game, California.

Glassow, M. A. 1992. The relative dietary importance of marine foods through time in western Santa Barbara County. *In* T. L. Jones, editor. Essays on the prehistory of maritime California. Center for Archaeological Research, Davis.

Greenwood, R. S. 1978. Obispeño and Purisimeño Chumash. *In* R. F. Heizer, editor. Handbook of North American Indians, volume 8: California. Smithsonian Institution, Washington, D.C.

Love, M. S. 1996. Probably more than you want to know about the fishes of the Pacific coast. Really Big Press, Santa Barbara.

Jones et al. 1994. Toward a prehistory of Morro Bay: phase II archaeological investigations for the highway 41 widening project, San Luis Obispo County, California. Report on file at the California Department of Transportation, Davis.

Jones, T. J. 1992. Settlement trends along the California coast. *In* T. J. Jones, editor. Essays on the prehistory of maritime California. Center for Archaeological Research, Davis

Krieger, D. E. 1988. Looking backward into the middle kingdom: San Luis Obispo County. Windsor Publications, Inc, Chatsworth.

Pauly et. al. 1997. Fishing down marine food webs. *Science,* 279.5352: 869-863.

Rick, T. C., and J. M. Erlandson. 2008. Archaeology, marine ecology, and human impacts on marine environments. *In* T. C. Rick and J. M. Erlandson, editors. Human impacts on ancient marine ecosystems: a global perspective. University of California Press, Berkeley.

Rick et al. 2008. Historical ecology and human impacts on coastal Santa Barbara region, California. *In* T. C. Rick and J. M. Erlandson, editors. Human impacts on ancient marine ecosystems: a global perspective. University of California Press, Berkeley.

Rienecke, S. J. 2006. An analysis of the rockfish and lingcod fishery along the south central coast of California from 1988-2004. Senior project. California Polytechnic State University, San Luis Obispo.

Robertson, J. 2012. Commercial catch data for the port of Morro Bay for the years 1977-1999. Personal Communication. California Department of Fish and Game.

Salls, R. A. 1988. Prehistoric fisheries on the California bight. Doctoral dissertation. University of California, Los Angeles.

Table 1: Annual Landings by Species for the Port of Morro Bay, 1947-2010

Figures 1a/b, 2