USING ARCHAEOLOGICAL REMAINS TO DOCUMENT REGIONAL FISH PRESENCE IN PREHISTORY; A CENTRAL CALIFORNIA CASE STUDY

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ABSTRACT: The aquatic ecosystems of California were dramatically altered by humans over the past 150 years. The introduction of numerous exotic fish species has made most native freshwater ecosystems of the Central Valley unrecognizable with the replacement of native endemics by alien species. Credible fisheries surveys often postdated environmental alteration and make it difficult to know what the "natural" ecosystems were like. Because of these types of problems, habitat and faunal restoration projects may depend on intuitive guesswork. In this paper I demonstrate the value of the archaeological record in helping to establish which fish species inhabited the waterways of California before late-Holocene habitat alterations. Case studies include data from archaeological sites on Marsh Creek in Contra Costa County, Putah Creek in Yolo County and an encouraging comparison of ichthyological survey records with the archaeological record of sites beside Cache Creek in Yolo County and Clear Lake in Lake County, California. The archaeological record is a valuable and potentially accurate resource that can be used to document the native fishes that existed prior to European contact.

Key words: California freshwater fishes, delta smelt, hardhead, restoration, Cache Creek, Clear Lake, Marsh Creek, Putah Creek

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In a 21-year study of the fishes of the Suisun Marsh in the San Francisco estuary that commenced in 1979, Matern et al. (2002) captured 13 native anadromous or freshwater species, 15 native marine or estuarine species, and 25 alien species. Because of the introductions of exotics of all kinds, Cohen and Carlton (1998) consider the San Francisco Bay and Delta ecosystem to be perhaps the most invaded estuary in the world. The introductions include 29 freshwater fishes. Nichols et al. (1986) chronicled the substantial changes the estuary has been subjected to beginning with the Gold Rush in about 1850. Due to the environmental alterations, California has the dubious distinction of having more endangered fishes than any other state (Warren and Burr 1994). These issues raise the serious question for fisheries management: what is the "natural" state of affairs? This is an important question when considering management objectives that include faunal restoration.

The archaeological record can provide information on the prehistoric location (and perhaps relative abundance) of freshwater fishes where baseline data are nonexistent or postdate the impacts of Euroamericans (Gehlbach and Miller 1961, Gobalet 1990, Gobalet and Wake 2000, Gobalet et al. 2004). This may be the only source we currently have to establish a credible "control" for environmental monitoring and reestablishment of aquatic communities to a state that preceded late-Holocene environmental perturbation by humans.

Numerous studies were completed on the fish remains recovered from sites in the Central Valley of California and synthesized by Gobalet et al. (2004). The fish remains recovered during recent excavations of archaeological sites CA-CCO-548 along Marsh Creek and CA-YOL-197H on Putah Creek (Fig. 1) contribute to what is already a substantial database. Three archaeological sites along Cache Creek, serve to illustrate how well the data from excavations reflect the native fishes as determined by ichthyological surveys and probably represent the "pristine" fish assemblages extant in the freshwater streams of California prior to late-Holocene environmental perturbation.

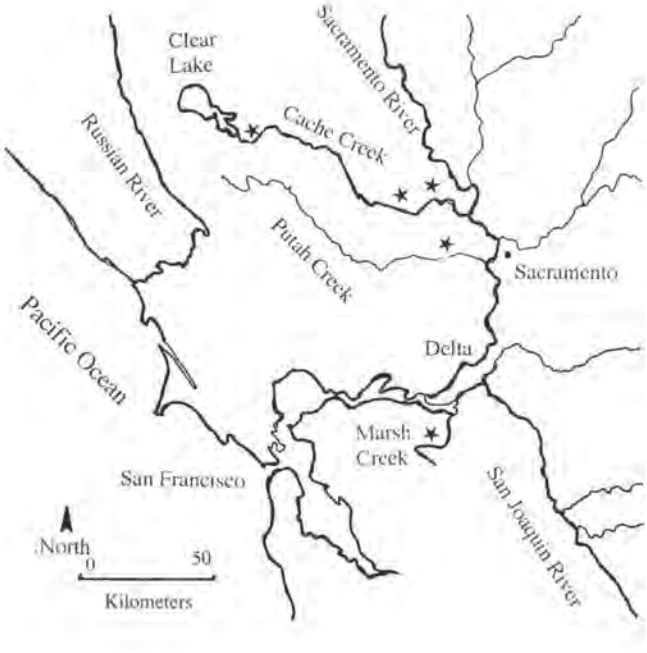

Figure 1. Central California aquatic habitats. Archaeological sites are indicated with stars.

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METHODS AND MATERIALS

Different archaeologists were responsible for the excavation, dating and disposition of the fish remains from the sites considered here.

CA-YOL-69

Holman and Associates Archaeological Consultants, 3615 Folsom St. San Francisco, California 94110, excavated CA-YOL-69. The site is located on Cache Creek near Madison, Yolo County, and was excavated using 1/16", 1/8", and 1/4" screens. The site was dated at the time of Spanish contact (1769).

CA-YOL-187

Eric Wohlgemuth excavated CA-YOL-187 for Far Western Anthropological Research Group, Inc., 2727 Del Rio Place Suite A, Davis, California 95616. The site is in Yolo, Yolo County on Cache Creek, and was excavated using 1/16", 1/8", and 1/4" screens. The occupation postdated 1500 A.D.

CA-YOL-197H

Randy Milliken studied CA-YOL-197H for Pacific Legacy 3801 Alhambra Drive, #208, Cameron Park, California 95682. The site occupies the current location of the Mondavi Center near Putah Creek on the Campus of the University of California, Davis and was excavated using 1/8", and 1/4" mesh screens. The site was dated between 1500-1700 A.D.

CA-LAK-386

California Archaeological Consultants, 39 First St., Woodland, California 95695, excavated and reported on CA-LAK-386 (McCarthy and Orlins 1991). CA-LAK-386 is located 2.5 km upstream from Cache Creek Dam in Lower Lake, Lake County and about 4.0 km from the current shore of Clear Lake. It was sampled using screens of mesh sizes 40/inch, 20/inch, 1/16", 1/8", and 1/4." and was occupied after 1000 A.D.

CA-CCO-18

Glenn Farris of the State of California Department of Parks and Recreation Archaeology Lab, 2572 Port St., West Sacramento, California 95691, excavated CA-CCO-18. The site is on the grounds of John Marsh State Historic Park near Brentwood, Contra Costa County on Marsh Creek. It was probably sampled using 1/8" and 1/4" mesh screens and was occupied from 1000-1500 A. D.

CA-CCO-548

Holman and Associates Archaeological Consultants excavated CA-CCO-548. The site is in the John Marsh State Historic Park and was sampled using 1/8" and 1/4" mesh screens. The remains have been dated from 7550 B. C. to 550 B. C. with limited materials postdating 1000 A. D.

The comparative collection of fish skeletons housed at the Department of Biology, California State University, Bakersfield served as the basis of all the identifications reported here. Of the suspected species, only a complete skeleton of the thicktail chub (*Gila crassicauda*) was lacking. The thicktail chub is extinct and the only known complete skeleton is housed at the Museum of Zoology at the University of Michigan (UMMZ catalog number 87277). Basioccipitals, pharyngeals and a few other elements of thicktail chub recovered from other archaeological sites and identified based on the University of Michigan specimen and partial skeletons at the California Academy of Sciences were utilized. Jereme Gaeta identified the bulk of materials from CA-CCO-548 and CA-YOL-69. To provide the recommended corroborating second opinion (Gobalet 2001), Gobalet confirmed the challenging and problematic identifications Taxonomic nomenclature follows Nelson et al. (2004) except for California roach (formerly *Hesperoleucas symmetricus*), which is *Lavinia symmetricus* (Moyle 2002).

RESULTS

Nine of the expected large native species of the central valley floor were identified among the materials recovered from the excavation of CA-CCO-548: white or green sturgeon (*Acipenser* sp.), Pacific trout or salmon (*Oncorhynchus* sp.), thicktail chub (*Gila crassicauda*), hitch (*Lavinia exilicauda*), Sacramento blackfish (*Orthodon microlepidotus*), Sacramento pikeminnow, Sacramento sucker (*Catostomus occidentalis*), Sacramento perch (*Archoplites interruptus*), and tule perch (*Hysterocarpus traski*) (Table 1). Six of these species were also identified at CA-YOL-197H: Pacific trout or salmon, thicktail chub, Sacramento blackfish Sacramento pikeminnow, Sacramento sucker, and Sacramento perch. Chinook salmon (*O. tshawytscha*) and hardhead (*Mylopharodon conocephalus*) were found at CA-YOL-197H, but not at CA-CCO-548. Schulz and Simons (1973) and Moyle (2002) described the biology of these fishes.

DISCUSSION

CA-CCO-548 and CA-YOL-197H

The fish remains recovered from CA-CCO-548 and CA-YOL-197H are reflective of the native fauna of the floor of the Central Valley and are similar to that found at another archaeological site also in the drainage of Marsh Creek within John Marsh State Historic Park (CA-CCO-18, Table 1). At CA-CCO-548, CA-CCO-18, and CA-YOL-197H the number of fish elements recovered was small so it was not surprising to find sturgeon, hardhead, splittail,

Table 1. Number of elements of fishes from archaeological sites in central California.

	CCO-548	CCO-18[a]	YOL-197H	YOL-69[b]	YOL-187[b]	LAK-386[c]
Acipenser sp.	20	24		45	2	
white or green sturgeon						
Hypomesus transpacificus				1		
delta smelt						
Oncorhynchus sp.	2		5	662	4	
Pacific salmon and trout						
O. tshawytscha			32	18	21	
Chinook salmon						
Cyprinidae	72	197	65	2,573	227	21
carps and minnows						
Gila crassicauda	11	14	10	279	9	
thicktail chub						
Lavinia sp.			14			
L. exilicauda	3	2		49	1	8
hitch						
L. symmetricus				3		
California roach						
Mylopharodon conocephalus		1	2	1		8
hardhead						
Orthodon microlepidotus	3	4	4	155	9	7
Sacramento blackfish						
Pogonichthys macrolepidotus		3		19		
splittail						
P. ciscoides						3
Clear Lake splittail						
Ptychocheilus grandis	10	15	6	56	6	1
Sacramento pikeminnow						
Rhinichthys osculus				1		
speckled dace						
Catostomus occidentalis	35	10	78	737	56	13
Sacramento sucker						
Gasterosteus aculeatus				41	7	14
threespine stickleback						
Cottus sp.				2		
C. asper						1
prickly sculpin						
Archoplites interruptus	139	137	34	625	52	28
Sacramento perch						
Hysterocarpus traski	1			231		49
tule perch						

[a] Gobalet (1992)

[b] Gobalet et al. (2004)

[c] Gobalet (1989)

hitch, Chinook salmon, and tule perch not represented at all three locations. Collectively, however, the species list is more complete. Several species that are never large as adults failed to be recovered from either Contra Costa County site or CA-YOL-197H: California roach, speckled dace (*Rhinichthys osculus*), smelt family (*Osmeridae*), threespine stickleback (Gasterosteus *aculeatus*), and sculpins (*Cottus* sp.). Large numbers of specimens and sampling techniques utilizing small mesh screens are necessary for maximizing representation of a variety of species and individual specimens of all sizes (Casteel 1976, Gobalet 1989, James 1997). Micro-technique was not used during the excavation of CA-CCO-548, CA-CCO-18, or CA-YOL-197H.

Two hundred twenty-four elements were identified to at least genus at CA-CCO-548, 210 at CA-CCO-18, and171 at CA-YOL-197H. At the Contra Costa County sites, Sacramento perch was the species with the greatest number of elements. This has also been the case collectively throughout the Central Valley where 45.7% of over 29,000 remains are from Sacramento perch (Gobalet et al. 2004). Thicktail chubs and Sacramento suckers constituted 20.5% of the sample identified at least to genus at CA-CCO-548 and 51.5% at CA-YOL-197H. For the entire Sacramento River drainage the value was 29.3%. The 20 (8.9% of the sample) sturgeon elements found at CA-CCO-548 are high for the Central Valley where 1.9% are from sturgeons. This does not suggest any extraordinary focus of attention of the Native Americans at CA-CCO-548 on sturgeon as was case in western Contra Costa County (Gobalet 1994). The sample size is far too small for such speculation. No sturgeon elements were found at CA-YOL-197H. In general, these findings are consistent with numerous prior studies with respect to the spe-

Table 2. Literature documentation of fishes of the Clear Lake Basin, Lake County, California. "X" indicates presence and "E" are documented and extinct.

	Jordan & Gilbert (1894)	Murphy (1951)	Cook et al. (1966)	Hopkirk (1973)	Taylor et al. (1982)	Moyle (2002)
Lampetra sp.					X	
L. tridentata	X			X		E
L. richardsoni						X
Oncorhynchus mykiss	X	X	X	X	X	X
Cyprinidae						
Gila crassicauda	X	X		E		E
Lavinia exilicauda	X	X	X	X		X
L. grandipinnis				X		
L. symmetricus		X		X	X	X
Orthodon microlepidotus	X	X	X	X		X
Pogonichthys macrolepidotus	X	X	X			
P. ciscoides				X		E
Ptychocheilus grandis	X	X	X	X	X	X
Catostomus occidentalis	X	X	X	X	X	X
Gasterosteus aculeatus	X			X	X	X
Cottus asper		X	X	X		X
C. gulosus	X					
Archoplites interruptus	X	X	X	X		X
Hysterocarpus traski	X	X	X	X		X
Introduced species number	4			15	5	18

cies represented, the relative abundance of the materials representing each species, and the site-to-site variation.

Cache Creek Archaeological Sites

Cache Creek flows out of Clear Lake southeast towards the Central Valley where it joins the Sacramento River in route to the delta of the Sacramento and San Joaquin rivers and has a modest catchment basin of its own. High gradient sections of Cache Creek have isolated Clear Lake from the Central Valley floor leading to considerable endemism of the fishes (Hopkirk 1973). Jordan and Gilbert (1894 in Rutter 1908) reported 12 native and four exotic species from Clear Lake, Cook et al. (1966) reported 9 native species, and Murphy (1951 in Cook et al. 1966) reported 11 native species (Table 2). In a comprehensive study, Hopkirk (1973) found 14 native species and 15 introduced species in the Clear Lake basin. One was a new species within an established genus (Clear Lake splittail *Pognichthys ciscoides*), and 3 subspecies endemic to the Clear Lake basin (Clear Lake hitch *Lavinia exilicauda chi,* Clear Lake tule perch *Hysterocarpus traski lagunae*, and Clear Lake prickly sculpin *Cottus asper* subsp.). Hopkirk (1988) also added *Hesperoleucus (=Lavinia) grandipinnis* the Clear Lake roach to the list of endemic Clear Lake species. Nelson et al. (2004) recognize this as *H. symmetricus*. Hopkirk (1973) also located several additional native species not found in Clear Lake in Cache Creek outside the Clear Lake Basin itself: white sturgeon *Acipenser transmontanus*, Chinook salmon, hardhead, speckled dace, and riffle sculpin *Cottus gulosus*. Taylor et al. (1982) focused on tributary streams of the Clear Lake Basin and found 6 native and 5 exotic species. Moyle (2002) recorded 14 native (3 of which are extinct) and 18 alien species in the Clear Lake basin, and 28 native (3 of which are extinct) and 40 alien species in the entire Central Valley.

The valley fishes listed by Moyle (2002) have excellent representation among the fish remains from CA-YOL-69 and CA-YOL-187 (Table 1). All native cyprinids are represented including the tiny speckled dace and California roach. Other species that are diminutive as adults, threespine stickleback, a sculpin, and delta smelt (*Hypomesus transpacificus*) were present in the remains. The delta smelt population today currently is centered in the Sacramento-San Joaquin River Delta and Suisun Bay (Moyle 2002). Since 1992 the abundance of delta smelt has fluctuated widely between years and surveys (Sweetnam 1999). Finding evidence of delta smelt at CA-YOL-69 along Cache Creek so far from its current range is reasonable because they move up and down the system according to river flows. In dry years they would have taken advantage of upstream locations farther from the delta as refugia (P.B. Moyle, University of California, Davis, personal communication). This finding of prehistoric delta smelt remains is definitive evidence of its status as a California native and not an introduced species as opponents argued during the debate surrounding its listing as endangered.

Absent from the faunal remains on Cache Creek in Yolo County are lamprey (*Lampetra* sp.), longfin smelt (*Spirinchus thaleichthys*), steelhead (*Oncorhynchus mykiss*), tidewater goby (tiny and restricted to lagoons), or a sculpin identified to species. Lampreys have no bony parts and have never been noted among archaeological materials in California. Steelhead remains may be included among those identified only as *Oncorhynchus* sp. The most commonly recognized fish elements surviving decomposition are vertebrae. Distinguishing among *Cottus* species and cyprinid genera based on vertebrae is problematic. The identification of prickly sculpin at CA-LAK-386 was based on an otolith (Gobalet 1989). Fish remains data from archaeological sites CA-YOL-69 and CA-YOL-187 are consistent with the results of surveys undertaken by fisheries biologists (Table 2) and numerous archaeological surveys (Gobalet et al. 2004).

The archaeological record at CA-LAK-386 reflects the numerous fish species documented in Clear Lake (Table 1). Only missing are lampreys, thicktail chub, California roach, and rainbow trout. Considering the sample size of only 153 elements at CA-LAK-386, the representation is extraordinarily diverse.

Gobalet (1989) reported eight hardhead elements among the fish remains from CA-LAK-386. No hardhead were documented in surveys of the fishes of the Clear Lake basin (Table 2). These data, however, support findings of fossils and other archaeological materials. Hopkirk (1988) reported a hardhead pharyngeal from an archaeological site north of the exit of the lake into Cache Creek and Casteel et al. (1979) and Casteel and Rymer (1981) found hardhead fossils within the basin.

Hopkirk (1973) collected hardhead from the north fork of Cache Creek in Lake County. CA-LAK-386 is located beside Cache Creek and not Clear Lake itself. Given the proximity of the site to Clear Lake it is difficult to image that hardhead would not also have been in Clear Lake. Because hardhead are riverine (Moyle 2002) and Clear Lake has a connection with the Sacramento Valley via Cache Creek and formerly was connected to the Russian River (Anderson 1936, Brice 1953, Hodges 1966) where hardhead are also found (Hopkirk 1973), it is quite reasonable that hardhead were once residents of the lake itself.

This evidence suggests that hardhead were native to Clear Lake and were extirpated prior to the survey of Jordan and Gilbert (1894). Five of the 8 elements Gobalet (1989) used for identification were tiny cyprinid vertebrae that are notoriously difficult to tell apart, a 2-mm long pharyngeal tooth, a small epihyal, and a

parasphenoid. Gobalet (1989) only used large comparative specimens for his evaluation. Consequently, having additional supportive materials would strengthen the evidence.

The archaeological record was also used to document thicktail chub in the Pajaro-Salinas river system where they had been missed in surveys prior to their extinction (Gobalet 1990, 1993; Schulz 1995) and an entire fauna in prehistoric Lake Cahuilla of the Salton Basin (Gobalet and Wake 2000).

These findings from sites along Cache Creek affirm that archaeological results are consistent with records of fish surveys for Clear Lake and Cache Creek for the Sacramento Valley floor. The archaeological record then may provide an estimate of the baseline "natural" fishery in locations where early fish surveys are lacking. These estimates may prove useful in restoration projects. Potential stream restoration projects that would benefit from this information could be on Marsh Creek, Putah Creek, Salinas River, or the Sunflower Valley in northwestern Kern County where Gobalet et al, (2004) found archaeological evidence of five native Central Valley species that occupy slow-moving waters. Well-drained grazing land currently is found in that location.

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