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Some Thoughts on Great Basin Fisheries

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A review of Great Basin fish biology, aboriginal fishing technologies, and archaeological evidence for the use of fish reveals that (1) only four genera of fish were significantly exploited; (2) fishing was more widespread than previously appreciated; (3) the use of fish increased substantially in late prehistory, with sometimes locally significant consequences for settlement patterns, social organization, and other behaviors; yet (4) fishing remained of limited economic importance in all but perhaps a few places.

A REVIEW OF GREAT BASIN FISHING WOULD seem, at first blush, unnecessary. Surface water is limited over most of the area and much of it is eutrophic and subject to seasonal temperature extremes, neither of which is particularly favorable to fish. Exceptions occur along the western and eastern edges of the Great Basin, where water is more abundant and supported more bountiful fisheries. The most notable of these were in the Truckee Basin, Utah and Bear lakes, and their associated river systems, the ethnographic and prehistoric significance of which has been reviewed in several authoritative treatments (e.g., Fowler 1989, 1990, 2002; Fowler and Bath 1981; Janetski 1986, 1990, 1991, 2010; Janetski and Smith 2007; Lindstrom 1992; Wheat 1967). But aboriginal fishing was by no means restricted to these well-watered places, being of widespread occurrence as conditions allowed. Where it occurred, fishing may have influenced things as varied as settlement patterns, social organization, and even the keeping of domestic dogs. Yet for all this, fishing was of secondary importance to other subsistence activities, given its rudimentary technology and limited evidence for its intensive pursuit in all but a few localized places. This is amply demonstrated when the biology and ethology of Great Basin fish, aboriginal fishing technologies, and archaeological evidence of fishing and fish remains are collectively assessed (e.g., Cleland 1982), instead of reliance being placed primarily on ethnographic accounts.

THE FISH

The Great Basin is home to a surprising number of fish. These include no fewer than 47 native species of 18

genera (Table 1), along with a still debated number of unique subspecies (Deacon and Williams 1984; La Rivers 1962; Moyle 1976; Sigler and Sigler 1987). If historically introduced fish are included, the list grows even longer, incorporating minimally 111 species of 53 genera and 16 distinct families. Other native and introduced fish are added if externally draining watersheds are incorporated in the inventory, though they are of limited concern here. While this is an impressive list, only a few of these fish were of importance to Great Basin people. Most were too geographically restricted to be of widespread or even local significance (e.g., endemic killifish), so small and elusive that they were never pursued (e.g., many of the dace and sculpin), or were just difficult to catch. The latter group includes non-schooling species like mountain whitefish, those that inhabit deep water during most or all of the year (e.g., cui-ui or Lahontan cutthroat), and fish that feed primarily on vegetal matter and tiny invertebrates, making them difficult to catch on hook and line (e.g., suckers or reddsides).

Some of these constraints can be circumvented with appropriate technologies (see below), and some are seasonally suspended during spawning runs or periods of low water, but most have a pervasive influence on the economic utility of different species. Fish, more than other creatures, are more or less exploitable, depending on their ethology and the available technology. This is amply illustrated in both prehistoric and modern contexts, where fish are differentially targeted depending on their ease of capture and economic return. Many of the large tuna and billfish, for example, were minimally harvested until efficient twentieth-century purse seine

Table 1**NATIVE GREAT BASIN FISH (AFTER SIGLER AND SIGLER 1987)**

Suckers (Catostomidae)	
Tahoe sucker	<i>Catostomus tahoensis</i>
Utah sucker	<i>Catostomus ardens</i>
Mountain sucker	<i>Catostomus platyrhynchus</i>
Owens sucker	<i>Catostomus fumeiventris</i>
Desert sucker	<i>Catostomus clarki</i>
Bridgelip sucker	<i>Catostomus columbianus</i>
Bluehead sucker	<i>Catostomus discobolus</i>
Largescale sucker	<i>Catostomus macrocheilus</i>
Warner sucker	<i>Catostomus warnerensis</i>
Cui-ui	<i>Chasmistes cujus</i>
June sucker	<i>Chasmistes liorus</i>
Minnows (Cyprinidae)	
Tui chub	<i>Gila bicolor</i>
Utah chub	<i>Gila atraria</i>
Alvord chub	<i>Gila alvordensis</i>
Borax Lake chub	<i>Gila boraxobius</i>
Leatherside chub	<i>Gila copei</i>
Pahranagat roundtail chub	<i>Gila robusta</i>
Speckled dace	<i>Rhinichthys osculus</i>
Longnose dace	<i>Rhinichthys cataractae</i>
Lahontan redbside	<i>Richardsonius egregius</i>
Redside shiner	<i>Richardsonius balteatus</i>
White River spinedace	<i>Lepidomeda albivallis</i>
Big Spring spinedace	<i>Lepidomeda mollispinis</i>
Desert dace	<i>Eremichthys acros</i>
Relict dace	<i>Relictus solitarius</i>
Least chub	<i>lotichthys phlegethontis</i>
Chiselmouth	<i>Acrocheilus alutaceus</i>
Northern pikeminnow	<i>Ptychocheilus oregonensis</i>
Trouts (Salmonidae)	
Cutthroat trout	<i>Oncorhynchus clarki</i>
Rainbow trout	<i>Oncorhynchus mykiss</i>
Golden trout	<i>Oncorhynchus aguabonita</i>
Mountain whitefish	<i>Prosopium williamsoni</i>
Bonneville whitefish	<i>Prosopium spilonotus</i>
Bear Lake whitefish	<i>Prosopium abyssicola</i>
Bonneville cisco	<i>Prosopium gemmiferum</i>
Sculpins (Cottidae)	
Mottled sculpin	<i>Cottus bairdi</i>
Paiute sculpin	<i>Cottus beldingi</i>
Bear Lake sculpin	<i>Cottus extensus</i>
Utah Lake sculpin	<i>Cottus echinatus</i>
Killifishes (Cyprinodontidae)	
Devils Hole pupfish	<i>Cyprinodon diabolis</i>
Amargosa pupfish	<i>Cyprinodon nevadensis</i>
Owens pupfish	<i>Cyprinodon radiosus</i>
Salt Creek pupfish	<i>Cyprinodon salinus</i>
White River springfish	<i>Crenichthys baileyi</i>
Railroad Valley springfish	<i>Crenichthys nevadae</i>
Pahrump killifish	<i>Empetrichthys latos</i>
Sticklebacks (Gasterosteidae)	
Threespine stickleback	<i>Gasterosteus aculeatus</i>

Note: Bold font denotes economically important species.

and longline technologies were developed. Conversely, formerly important but now artisanal fisheries for species like Atlantic eel, lamprey, and many herring have all but disappeared. The same applies to prehistoric and ethnographic Great Basin fisheries that selectively targeted just a few species, leaving others untouched.

The ease with which various fish could be stored may have likewise influenced fishing strategies (Janetski 2007a), although its role is unclear. Ethnographic accounts from the Great Basin and elsewhere differ on whether oily or lean fish were more easily dried and successfully stored (Fowler 1989, 2002; Fowler and Bath 1981; Lindstrom 1992). In fish-dependent economies of the Pacific Northwest and elsewhere, typically oily species like salmon, lamprey, and eulachon were more frequently stored than lean-fleshed species like suckers, though the size and predictability of catches influenced storage (Kroeber and Barrett 1960; Rostlund 1952). If Great Basin archaeological data are believed, nearly all of the heavily exploited fish were dried and stored to some extent, but tui chub more so than others. This may reflect the abundance of seasonal catches and the effort required to process fish of different species and size. Both ethnographic and experimental observations note that small fish are efficiently dried as caught or simply eviscerated and dried without further processing, while large fish must be split or filleted and carefully monitored during the lengthier drying process (e.g., Fowler 1989, 2002; Lindstrom 1992; Raymond and Sobel 1990; Wheat 1967). This is amply illustrated by comparing the low-investment drying of mass-captured anchovies, bay shrimp, and other tiny species (e.g., Bonnot 1932; Marcus et al. 1999) with the less efficient, heavily-capitalized industry that developed around highly-processed salt cod (Kurlansky 1998). This is consistent with Great Basin fish caches and most faunal inventories that are composed predominantly of small schooling-size fish that could have been captured in bulk and easily dried (Butler 1996; Nauta 2000; Raymond and Sobel 1990). But regardless of whether or not storage factored significantly in fishing decisions, only a few seasonally abundant, easily captured species were actually exploited in the Great Basin.

Fish routinely harvested by Great Basin foragers and Fremont farmers alike included cutthroat trout, sucker/cui-ui, and chub, with other taxa (dace, redbside, whitefish, etc.) so poorly represented in the record

that they probably reflect incidental “by-catch” or paleontological specimens (Table 2).¹ In fact, out of 95,393 archaeologically-recovered fish bones identified to genus or species, only 100 (0.1%) belong to fish other than trout, sucker/cui-ui, or chub. Chub are more common in western (86%) and sucker in eastern (62%) Great Basin samples, likely reflecting differences in regional hydrology and their availability or ease of

capture. The limited number of trout (2%) and cui-ui (2%) from sites in the Lahontan Basin likewise suggests a limited use of these lacustrine taxa versus shallow water species like tui chub.

Cutthroat Trout (*Oncorhynchus clarki*)

At least three subspecies of cutthroat trout were native to the Great Basin, but the large Lahontan (*O. c. henshawi*)

Table 2

ARCHAEOLOGICAL FISH REMAINS FROM THE GREAT BASIN

Region/Site	<i>Gila</i> spp.	<i>Psychroctellus oregonensis</i>	<i>Rhinichthys</i> spp.	<i>Richardsonius</i> spp.	Cyprinidae	<i>Galostomus</i> spp.	<i>Chasmistes</i> spp.	Cyprinidae/ <i>Galostomidae</i>	<i>Oncorhynchus clarki</i>	Salmonidae	<i>Cottus</i> spp.	Indeterminate	Total	Reference
Oregon Lakes														
Peninsula Site	1,493	–	–	–	–	357	–	–	–	–	–	5,934	7,784	Eiselt 1997
Headquarters Site	462	10	–	–	26	89	–	5	–	–	–	27	619	Aikens and Greenspan 1988
Hog Wallow Spring	17	40	–	–	12	117	–	33	–	–	–	115	334	Greenspan 1990
35LK1016	94	–	–	–	–	–	–	–	–	–	–	69	163	Toepel and Greenspan 1986
Karlo	2	–	–	–	–	4	20	–	10	–	–	–	36	Follett 1980
Secret Valley	20	–	–	–	–	7	–	–	9	–	–	30	66	McGuire 1997
Fort Rock Valley	1,236	–	–	–	–	–	–	–	70	–	–	1,452	2,758	Singer 2004
Subtotal	3,324	50	–	–	38	574	20	38	89	–	–	7,627	11,760	
Lahontan Basin														
Spirit Cave	26	–	3	–	–	28	–	–	–	–	–	640	697	Eiselt 1997
Honey Lake	248	–	–	–	–	75	–	2	6	–	3	403	737	Milliken and Hildebrandt 1997
Hidden Cave	9,280	–	–	34	–	13	210	–	88	–	–	–	9,625	Smith 1985
Stillwater Marsh	5,759	–	–	–	44	262	–	–	–	–	–	5,990	12,055	Greenspan 1988
Stillwater Marsh	1,222	–	–	–	5,259	259	–	2,270	–	–	–	–	9,010	Butler 1996
Falcon Hill Cave	240	–	–	–	–	472	20	–	357	–	–	–	1,089	Follett 1982
Lovelock Cave	749	–	5	–	–	68	85	–	–	–	–	–	907	Follett 1967
Lovelock Cave	151	–	–	–	–	1	37	–	–	–	–	–	189	Follett 1970
Tommy Tucker	2	–	–	–	–	–	–	–	1	–	–	–	3	Riddell 1956
Winnemucca Lake	2	–	–	–	12	1	1	–	14	–	–	–	30	Follett 1974
Thea Heye Cave	–	–	–	–	–	1	19	–	–	–	–	–	20	Follett 1977
Subtotal	17,679	–	8	34	5,315	1,180	372	2,272	466	–	3	7,033	34,362	
Bonneville Basin														
Smoking Pipe	73	–	–	–	–	1,327	30	–	742	–	–	–	2,172	Janetski 1990
Woodard Mound	192	–	–	–	–	84	–	–	4	–	–	–	280	Janetski 1990
Fox Site	264	–	–	–	–	27,432	–	22,844	13	–	–	48,629	99,182	Janetski and Smith 2007
Herron Springs	1,057	–	–	–	–	5,264	–	14,569	65	52,300	–	1,131	74,386	Janetski and Smith 2007
Sandy Beach	319	–	–	–	–	5,688	–	–	117	–	–	2,243	8,367	Janetski and Smith 2007
Goshen Bay South	10,918	–	–	–	135	2,386	–	22,774	1,393	–	–	33,139	70,745	Janetski and Smith 2007
Goshen Bay North	1,680	–	–	–	6	1,602	–	1,700	135	–	–	17,979	23,102	Janetski and Smith 2007
Levee	–	–	–	–	–	–	–	–	–	–	–	392	392	Lupo and Schmitt 1997
Orbit Inn	–	–	–	–	–	–	–	–	–	–	–	1,937	1,937	Lupo and Schmitt 1997
42Wb32	–	–	–	–	–	–	–	–	–	–	–	1,061	1,061	Lupo and Schmitt 1997
Injun Creek	–	–	–	–	–	–	–	–	–	–	–	537	537	Lupo and Schmitt 1997
Subtotal	14,503	–	–	–	141	43,783	30	61,887	2,469	52,300	–	107,048	282,161	

(Continued on following page)

Table 2 (Continued)

ARCHAEOLOGICAL FISH REMAINS FROM THE GREAT BASIN

Region/Site	<i>Gila</i> spp.	<i>Ptychocheilus oregonensis</i>	<i>Rhinichthys</i> spp.	<i>Richardsonius</i> spp.	Cyprinidae	<i>Catostomus</i> spp.	<i>Chasmistes</i> spp.	Cyprinidae/ <i>Catostomidae</i>	<i>Oncorhynchus clarki</i>	Salmonidae	<i>Cottus</i> spp.	Indeterminate	Total	Reference
Utah Uplands														
Mickey's Place	-	-	-	-	-	-	-	-	1,129	-	-	2,159	3,288	Janetski 2010
Moon Ridge Area 1	-	-	-	-	-	-	-	-	112	-	-	67	179	Janetski 2010
Moon Ridge Area 2	-	-	-	-	-	-	-	-	7,128	-	-	10,344	17,472	Janetski 2010
Moon Ridge Area 3	-	-	-	-	-	-	-	-	1,776	-	-	1,557	3,333	Janetski 2010
Moon Ridge Area 4	-	-	-	-	-	-	-	-	4	-	-	4	8	Janetski 2010
Subtotal	-	-	-	-	-	-	-	-	10,149	-	-	14,131	24,280	
Owens River System														
Alabama Gates	52	-	2	-	218	436	-	551	-	-	-	1,000	2,259	Butler 1999
Ash Creek	1	-	-	-	-	37	-	96	-	-	-	102	236	Butler 2000
Partridge Ranch	-	-	-	-	-	-	-	-	-	-	-	2	2	Bettinger et al. 1984
Fish Slough Cave	4	-	-	-	11	23	-	19	-	-	-	73	130	Nelson 1999
Manzanar-Independence	12	-	3	-	10	19	-	67	-	-	-	33	144	Butler 2011
Birch Creek	2	-	-	-	8	54	-	102	-	-	-	52	218	Butler 2012
Blackrock	11	-	-	-	-	4	-	9	-	-	-	15	39	Butler 2002
Lubkin Creek	-	-	-	-	-	-	-	-	-	-	-	15	15	Basgall and McGuire 1988
Subtotal	82	-	5	-	247	573	-	844	-	-	-	1,292	3,043	
Grand Total	35,588	50	13	34	5,741	46,110	422	65,041	13,173	52,300	3	137,131	355,606	

and Bonneville (*O. c. utah*) varieties were the most extensively exploited. These fish inhabited both lakes and streams, with the Lahontan cutthroat found in the Truckee, Carson, and Walker rivers, Donner Creek, and Pyramid, Walker, Donner, Independence, and Summit lakes. Appreciably less is known about the distribution of Bonneville cutthroat trout, many populations of which were locally extirpated before they were adequately described. In lake habitats, cutthroat trout spend most of the year in comparatively deep water, where adult fish feed primarily on tui chub and other minnows. This made them difficult to target aboriginally with anything but hook and line, though the aggressive feeding behavior of larger fish made them comparatively easy to bait.

A different situation occurred during the winter (Lahontan cutthroat only) and more common spring spawning runs, when large, lake-bound cutthroat moved into shallow water and ascended tributary streams to breed. This made them more susceptible to capture with spears, nets, weirs, or some combination thereof. In fact, annual spawning runs probably accounted for most of the prehistoric and certainly historic-era cutthroat harvest.

Townley (1980) estimated that anywhere from 60,000 to 200,000 pounds of trout were commercially harvested from the Truckee River between 1860 and 1900, with Behnke (1974, cited in Sigler and Sigler 1987) placing the figure closer to one million pounds. Either way, the behavior of these fish suggests that they were most profitably exploited when spawning and secondarily by lake anglers targeting large fish (40–80 cm. total length [TL]) of the size typically recovered in archaeological contexts (Follett 1980; Smith 1985).

Cui-ui (*Chasmistes cujus*)

The cui-ui and closely related June sucker (*C. liorus*) are members of the sucker family (Catostomidae), with the cui-ui endemic to Pyramid Lake, the now dry Winnemucca Lake, and the Truckee River that supplied them, and the June sucker unique to Utah Lake and its tributaries. As with Lahontan cutthroat, cui-ui spend most of the year in lake habitats of significant depth (Sigler and Sigler 1987), making them difficult to capture with aboriginal netting and spearing technologies (La Rivers 1962; McClane 1965). Unlike trout, however, cui-ui

and June suckers feed on zooplankton, aquatic insects, and algae, making them nearly impossible to catch with a hook and line, unless snagged with a modern, lead-weighted treble hook or grapple (Wheat 1967). But as with Lahontan cutthroat trout, cui-ui annually ascended the Truckee River to spawn, and mature fish (30–60 cm. TL) could be speared or caught in various nets and weirs, as indicated by the large size of most archaeologically-recovered specimens (Follett 1980; Smith 1985).

Sucker (Catostomus spp.)

No fewer than nine species of sucker inhabit Great Basin waters. Some are endemic to a limited watershed (e.g., Owens [*C. fumeiventris*] and Warner [*C. warnerensis*] sucker), but others are of wider distribution and were of correspondingly greater significance to Great Basin fisheries. These include the Tahoe (*C. tahoensis*) and Utah (*C. ardens*) sucker of the Lahontan and Bonneville basins, and perhaps the smaller mountain sucker (*C. platyrhynchus*) that primarily inhabits upland streams throughout the area.

As with cui-ui, suckers feed chiefly on algae and small invertebrates, making them difficult to catch on hook and line. Mature fish (20–60 cm. TL) in both lake and stream habitats typically seek deep water during daylight hours, congregating in sometimes considerable numbers in streams where deep pools are limited. This benthic behavior makes suckers difficult to net or spear under all but a few circumstances. One is at night, when fish move into shallow water to feed and can be speared by torch light (e.g., Barter 1990; Evans 1990). The second occurs in certain streams, where suckers congregate under banks or boulders during the day and/or prior to the winter freeze. Under these conditions, fish can be herded into nets or speared by chasing them from their sanctuaries with a stick or pole. Finally, the most productive and predictable occasion for taking large suckers is during the spring spawning period when fish enter tributary streams and lake shallows to breed (Moyle 1976; Sigler and Sigler 1987).

Native populations over much of western North America took advantage of the annual sucker spawning run, netting or spearing sometimes enormous stockpiles of fish (e.g., Garth 1953; Kroeber and Barrett 1960; Ray 1933; Spier 1930; Spier and Sapir 1930; Voegelin 1942). This continued in historical times, when Mormon

populations in the Utah Valley and Bear Lake areas established commercial fisheries around the annual sucker run (Janetski 1986; Sigler and Sigler 1987, and references therein). Although most productively harvested when spawning, juvenile suckers often congregate in weedy shallows during the summer (Moyle 1976; Sigler and Sigler 1987) and can be easily netted there. The advantage of this approach is that the fishing season is longer than the spawning period, and processing costs for small, juvenile fish are appreciably less than for spawning adults that must be cleaned or filleted before consumption or drying.

Depending on circumstances and scheduling, then, suckers could be exploited by one of three strategies: (1) a highly efficient, but short-lived and harvest-limited targeting of large spawning fish; (2) a less lucrative, but protracted and potentially more productive harvest of juvenile fry; or (3) a combination of the two approaches that would have tethered people to aquatic habitats from the spring spawning season until lower water temperatures drove juvenile fish to deeper water in the fall. This differs from both cutthroat and cui-ui, exploitation of which was confined primarily to mature fish during the annual spawning cycle.

Chub (Gila spp.)

Chub are one of several native Great Basin minnow genera, with tui and Utah chub (*G. bicolor* and *G. ataria*) the most widely distributed and economically important species. Tui chub are found throughout the Lahontan Basin, Owens and Mojave rivers, and central Great Basin system. They are replaced in the eastern Great Basin by the similarly cosmopolitan Utah chub of the Bonneville Basin, and they played an important role in aboriginal fisheries there (Janetski 1990; Janetski and Smith 2007). Both tui and Utah chub inhabit a wide range of stream and lacustrine environments, but are most common in weedy lake shallows and slower portions of streams and rivers, where juvenile fish (<16 cm. TL) often congregate (Moyle 1976; Sigler and Sigler 1987). Larger chub and those belonging to the *G. b. pectinifer* subspecies inhabiting lakes typically prefer deep water during daylight hours, as do juvenile tui and Utah chub in colder months. The shallow schooling behavior of juvenile chub makes them especially susceptible to mass capture with nets and fishing with simple hand or trot lines as well,

Table 3**SIZE OF ARCHAEOLOGICAL TUI OR UTAH* CHUB (AFTER RAYMOND AND SOBEL 1990)**

Site	Context	Remains	Number	Size Range (cm.)	Mean	Reference
Stick Cave	–	Dried Fish	916	7.5–12.0	9.9±0.83	Orr 1952
Humboldt Cave	Cache 6	Dried Fish	100	8.0–22.0	14.9±2.6	Heizer and Krieger 1956
	Secs. 4, 7, 9, 11	Dried Fish	15	9.0–20.0	17.0	Heizer and Krieger 1956
Lovelock Cave	Cache 9	Dried Fish	116	4.3–13.0	7.5±2.4	Loud and Harrington 1929
	Midden	Dried Fish	several	8.0–11.0	–	Loud and Harrington 1929
	Midden	Dried Fish	3	5.2–13.0	–	Follett 1967
	Midden	Bones	22	14.0–38.0	–	Follett 1970
	Coprolites	Bones	298	3.8–23.9	98% <13.9 cm	Follett 1967
	Coprolites	Bones	97	4.5–13.0	–	Follett 1970
Hidden Cave	–	Bones	9,280	10.0–14.0	–	Smith 1985
Falcon Hill Cave	–	Bones	240	<39.0	–	Follett 1982
Stillwater Marsh	–	Bones	74	5.2–14.3	8.9±1.9	Butler 1996
Manzanar-Independence	–	Bones	2	18.0	18.0±0.0	Butler 2011
Goshen Island*	Archaic	Bones	65	5.7–25.9	13.0±6.0	Nauta 2000
Goshen Island*	Late Prehistoric	Bones	144	9.1–50.6	23.0±7.4	Nauta 2000

given their propensity to take baited hooks (Moyle 1976; Sigler and Sigler 1987). Evidence for this is attested by the consistently small size of tui chub recovered in archaeological contexts, nearly all of which are school-size juveniles less than 15 cm. in length (Table 3).

In summary, only a few Great Basin fish were routinely exploited by native people, and most of these under a probably narrow set of circumstances conditioned by species behavior, habitat, and available fishing technologies (see below). Mature trout, cui-ui, and other suckers were most effectively harvested during winter and spring spawning runs, juvenile suckers and chub most efficiently captured when schooling in shallow water during summer months, and both trout and chub secondarily caught on hook and line at other times of year.

An important point that emerges from the above discussion is that fish may be more or less efficiently captured at different points in their seasonal/life cycle depending on various conditions and the available technology. Under proper conditions, small schooling fish may be netted or otherwise mass-captured at significantly higher return rates than larger fish of the same or different species (e.g., chub) that must be individually caught (Limp and Reidhead 1979; Raven 1990). Similarly, certain large fish that are easily taken during seasonal spawning or low-water periods (e.g., cui-ui) may be all but impossible to catch at other times, and therefore of

correspondingly minimal value (Cleland 1982). Still a third group of fish are efficiently mass-captured at one point in their life cycle and more lucratively pursued as individual fish at another time (e.g., suckers and cutthroat trout). Thus, the return rates and probably broader desirability of various fish are conditioned by numerous factors, including fish behavior at various times of the year and life cycle, seasonal and other habitat conditions, fishing technology, storability, and probably other, less discernible, determinants. Though generalizations regarding such situationally-dynamic economic calculi are fraught with peril, both ethnographic and modern fishing practices suggest that the efficient mass capture of both small and large fish is typically favored for its higher return over other fishing practices (Cleland 1982; Kroeber and Barrett 1960; Rostlund 1952). It is probably no mistake, in fact, that chub and suckers so overwhelmingly dominate Great Basin archaeological assemblages (see Table 2), given their susceptibility to mass capture as compared to trout, cui-ui, and other native species.

THE TECHNOLOGY

Much has been written about ethnographic (e.g., Fowler 1989, 1990, 2002; Fowler and Bath 1981; Lindstrom 1992; Rhode 1988; Wheat 1967) and prehistoric Great Basin fishing technologies (e.g., Heizer and Krieger 1956;

Loud and Harrington 1929; Raymond and Sobel 1990; Steward 1933, 1941; Stewart 1941; Tuohy 1990), although information on them is likely incomplete (Fowler 1990; Fowler and Fowler 1990). Both reveal that fishing equipment was comparatively simple, yet reasonably efficient, for exploiting particular species under narrowly specific circumstances, with more labor-intensive or permanent facilities and equipment generally lacking. Moreover, many of the techniques employed in late prehistoric and ethnographic times may have been recent borrowings from groups to the north and west, though the evidence for this is inconclusive.

While the list of traditional fishing technologies is extensive, it can be collapsed into four basic categories when rare or dubious techniques are excluded. Widely employed technologies included (1) angling with hook and line; (2) the use of spears and harpoons; (3) the use of nets of various types; and (4) the construction of weirs, traps, and other impounds. Various ancillary technologies could be added to the list (e.g., fishing platforms, tule balsas, or weaving equipment), but are of tangential importance to the basic productivity of the aboriginal fisheries.

Hook and Line

The use of hooks and lines is documented over much of the ethnohistoric Great Basin (Fowler 1989, 1990; Fowler and Bath 1981; Steward 1933, 1941; Stewart 1941; Wheat 1967), and archaeological examples of such equipment are reported from several sites in the Lahontan Basin (Heizer and Krieger 1956; Loud and Harrington 1929; Ting 1967, 1968; Tuohy 1990). Fishing lines were typically fashioned of dogbane (*Apocynum* spp.) and varied in diameter and strength depending on the intended catch (Fowler and Bath 1981; Heizer and Krieger 1956; Wheat 1967). Heavier leaders snelled to large hooks ranged from 1.0–2.5 mm. in diameter with a breaking strength of 10–45 pounds to finer leaders and mainlines rigged with smaller hooks from 0.5–0.75 mm. in diameter with a breaking strength of 4–15 pounds (Loud and Harrington 1929:81). This suggests the former were intended for large trout and the latter for small trout or chub.

Although hooks have been classified into numerous types (e.g., Heizer and Krieger 1956; Ting 1968; Tuohy 1990), all are of basically three designs and one of two sizes (Fowler 1989). First are simple gorge hooks or

bipointed pieces of bone, with sometimes grooved or expanded mid-sections for line attachment on large examples (Fig. 1a). Archaeological specimens illustrated by Tuohy (1990:Figs. 8, 9) are of two sizes, with the larger ($n=6$) ranging in length from 45.5 to 66.7 mm. ($\bar{x}=53.0\pm 7.9$ mm.) and the smaller specimens ($n=16$) from 23.3 to 39.0 mm. in length ($\bar{x}=33.8\pm 4.4$ mm.). As is the case with line diameter/strength, the statistical distinction between large and small gorge hooks implies that some were used for catching large trout and others for small trout or tui chub. Other bone artifacts illustrated by Tuohy (1990) are likely too long (>110 mm.) to have served as gorges for even the largest cutthroat (see Tuohy 1990:Fig. 10), or have only one pointed end and a second frequently beveled and/or grooved end (see Tuohy 1990:Fig. 8, 9), indicating use as part of a composite hook.

The first of two composite hook types consists of a wood (or occasionally bone) shank 58.0–95.0 mm. in length, with a bone point of a similar to slightly shorter length hafted at an acute angle to the base of the shank (Fig. 1b). Bone points can be unbarbed or barbed on either the inner (i.e., gap) and/or the outside of the hook, with the difference in barb placement functionally unclear. Given the large size of these hooks and the heavy line attached to archaeological specimens, there can be little doubt that they were used for taking large trout, probably in lake habitats. This conclusion is supported by numerous end-beveled and often grooved bone hook components collected from the shores of Pyramid Lake (Ting 1967, 1968; Tuohy 1990), the wooden shanks of which have rotted away. Still further support for this interpretation is afforded by the recovery of numerous “net” or line weights from Pyramid Lake (Ting 1966; Tuohy 1968, 1990:Fig. 16–20), many of which are too heavy and/or cumbersome to affix to net bottoms, yet are too light to properly secure trotline or net ends. This implies that many of these were line weights that would be needed to keep composite hooks and fiber fishing lines from floating uselessly on the surface.

The second type of composite hook is substantially smaller (13.0–25.0 mm.), and was often (always?) used on trotlines, if surviving ethnographic and archaeological examples are believed (e.g., Fowler 1990:Fig. 1a, 1b; Loud and Harrington 1929:Plate 51; Tuohy 1990:Fig. 11). Hooks of this type are constructed of a sharpened bone splinter measuring 12.0–25.0 mm. in length that is mounted

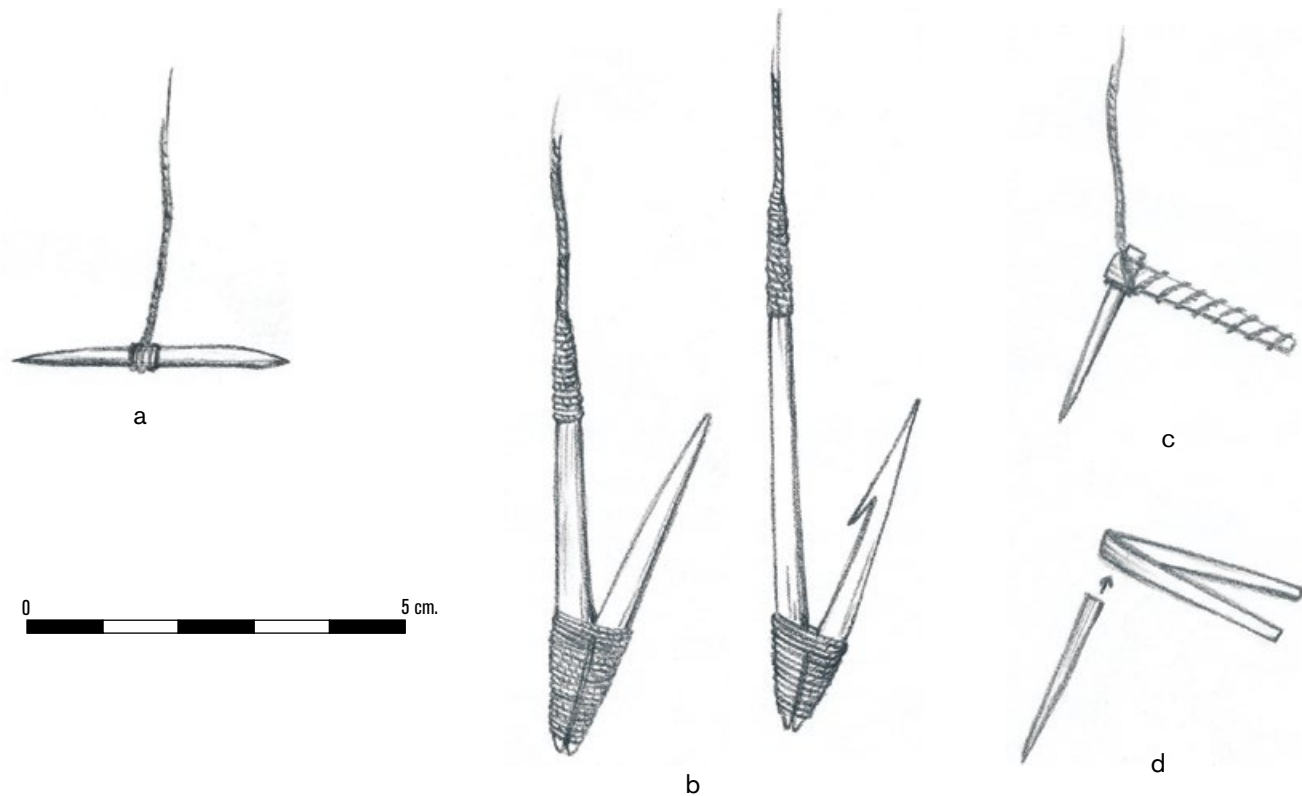


Figure 1. Great Basin Hooks. a. gorge; b. large composite hook; c–d. small composite hook.

at an obtuse angle to a split or folded twig or wood shank of similar length (Fig. 1d) and then wrapped with cordage (Fig. 1c). Surviving archaeological examples have anywhere from 12 to 183 of these hooks suspended on short snoods from lightweight trotlines measuring 6.7–36.6 m. in length. These would have been weighted or staked at either end in order to sink the line and avoid the disastrous tangles that occur when fish are hooked on improperly secured trotlines with too much play. The size of these hooks and use of trotlines suggest that they were employed for catching schooling tui chub in lake or other slow-water habitats, although Northern Paiute consultants claimed that trout were also caught in this fashion (Fowler 1989). Fowler (1990) suspects that these small (and possibly the large) composite hooks may be of recent, Northern Paiute derivation; confirmation of the hypothesis will require better dating of archaeological examples.

Spears and Harpoons

The use of spears and harpoons is reported for many ethnographic Great Basin groups (Steward 1941; Stewart

1941), and archaeological examples of spears have been recovered from Pyramid Lake and Utah Valley (Janetski 1990; Janetski and Smith 2007; Martin and Janetski 1992; Ting 1967, 1968; Tuohy 1990). The nomenclature used to describe these weapons varies, but all are either simple barbed spears or toggling harpoons. The use of true leisters that grip or hold fish between prominent barbs instead of impaling them (Fig. 2a) has been widely reported, but cannot be ethnographically or archaeologically substantiated. Indeed, the ethnographic distribution of leisters lies well to the north (Driver and Massey 1957; Rostlund 1952), although archaeological specimens of what appear to be small leisters have been recovered at Middle Period (ca. 4,000–1,500 B.P.) sites in interior central California (Bennyhoff 1950; Schenk and Dawson 1929), where they too disappear from the technological repertoire after that time.²

Simple spears, known primarily from archaeological contexts, are of several forms. These include both unilaterally-barbed and unbarbed bone and antler tines, measuring anywhere from 10–30 cm. in length. Barbed examples from Pyramid Lake have 3 to 19 shallow barbs

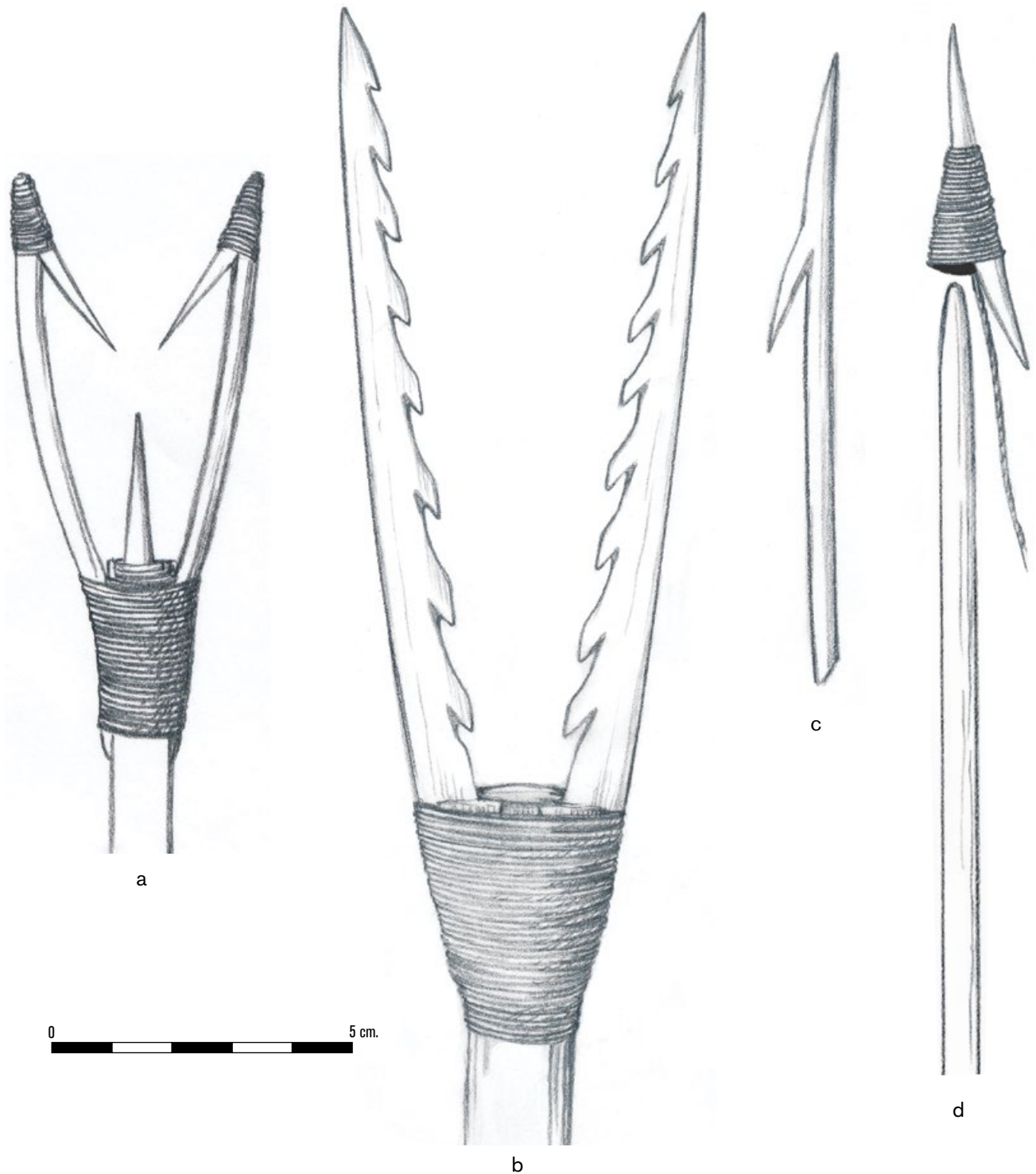


Figure 2. Spears and Harpoons. a. leister; b. simple spear; c. Utah Valley spear; d. toggling harpoon.

that rarely project much beyond the tine's diameter (Fig. 2b), while those from Utah Valley have more prominent barbs that extend well beyond the shaft (Fig. 2c). Whether spears of this type were individually

hafted or mounted in groups with two or three tines set 180 or 120 degrees apart is unclear. However, unbarbed examples were almost certainly hafted in pairs or threes to keep even small fish from pulling free, as evidenced

by their typically beveled proximal ends set to direct the tines outward (Ting 1968). Even barbed specimens were probably used as paired or tri-pointed spears, as the shallow barbs would easily tear from fish before they could be lifted from the water. The more prominently barbed Utah Valley spears would have held fish more securely and may have been individually hafted, particularly if rigged as detachable harpoons. There is, however, no evidence for any type of line attachment to indicate use of the Utah Valley specimens as harpoons (cf. Bennyhoff 1950; Mason 1902). Whether individually or multiply hafted, there is little doubt that simple spears of this sort would have been effective for only small fish of perhaps 30 cm. or less, with anything larger virtually impossible to keep from wriggling free. This may have included small tui chub and juvenile cutthroat trout that seasonally school and ply the shallow margins of Pyramid Lake and (formerly) other Great Basin lakes and marshes, where such spears have been recovered archaeologically. That they have survived in open air contexts, but not in rockshelters, would seem to imply a typically late prehistoric age for such spears, though this cannot be confirmed.

True or toggling harpoons with detachable heads (Fig. 2d) are ethnographically documented among various western Great Basin groups, especially those in the Lahontan Basin (Fowler 1989, 2002; Stewart 1941; Stewart 1941; Wheat 1967). No archaeological specimens or reasonably identifiable components of such have been reported, however, implying a likely recent, even ethnographic age for this weapon. This is certainly true in California, where toggling harpoons were ethnographically widespread, but archaeological examples are restricted to late prehistoric deposits in the northwestern corner of the state, where they appear to have diffused from maritime- and riverine-based economies to the north (Bennyhoff 1950).

Ethnographic information on the Great Basin use of harpoons is limited, but appears to be much like that in California and the Pacific Northwest, where they were employed chiefly in streams for spawning salmonids. In fact, slender, heavily-scaled or armored fish like suckers and cui-ui would have been difficult harpoon targets, compared to deep-bodied, lightly-scaled cutthroat trout. It seems likely, therefore, that significant use of toggling harpoons was a recent phenomenon restricted to the few

Great Basin locales with significant cutthroat spawning streams. It is, in fact, noteworthy that 12 of 14 Northern Paiute groups with some access to spawning streams reported the use of harpoons (Stewart 1941), compared to only 2 of 18 Nevada Shoshone groups (i.e., Snake River and Battle Mountain) living near major rivers (Stewart 1941).

Nets

Nets were employed throughout the Great Basin for both fishing and hunting, with their use spanning the entire cultural sequence (Adovasio et al. 2009). Less is known, however, about the particular types and situations where nets were employed specifically for fishing. This is important in that high-return net, weir, and/or trap technologies are essential to most economically-significant fisheries that cannot rely on exclusively low-return techniques like angling and spearing (Driver and Massey 1957; Kroeber and Barrett 1960; Rostlund 1952). The use of A-frame lift or dip nets resembling those found along most of the Pacific Coast is ethnographically documented (Fowler 1989:Fig. 11c; Fowler and Bath 1981; Speth 1969) and archaeologically reported in the Great Basin from a contact-era find at Hidden Cave, which was purportedly repaired with commercially manufactured twine (Ambro 1966). This suggests that such lift nets may be a recent addition to Great Basin fishing gear (Fowler 1990), although a fragmentary “dip net,” measuring 6 by 10 feet was reported by Loud and Harrington (1929) from Lovelock Cave and might have been used in this fashion.

The use of gill nets is also reported in the literature, but their aboriginal employment was probably restricted to a few locations at most. One of the reasons for this is the dark, easily visible color of traditional fiber nets (Loud and Harrington 1929) that limits their efficacy for gill netting during daylight hours (Memphis Net and Twine Company 2012). A second reason is the fact that net weights of appropriate size and net floats critical to the deployment of gill nets (Bahen et al. 1980) are either lacking (floats) or are of insufficient number (weights) in most of the Great Basin to substantiate extensive gill netting (Hunter 1991; McKibbin 2000; Ting 1966; Tuohy 1968, 1990). A third reason is the size of most fish recovered archaeologically. Butler (1996) convincingly demonstrated that the clustered size of tui chub from Stillwater Marsh indicates they were culturally, not

naturally, deposited. But both hers and other archaeological data reveal greater variability in fish size (Table 3) than would be captured with gill nets, which are extremely selective with respect to fish size (Hovgard and Lassen 2000; Jensen 1986, 1990). Indeed, experimental gill netting of tui chub by Raymond and Sobel (1990) produced more consistently-sized fish than archaeological samples from even individual cache pits, with their catches varying quite predictably in response to net mesh size.

In keeping with the above, the mesh of ethnographic and archaeologically documented nets is predominantly (81%) 30 to 50 mm. in “bar mesh” size (Fig. 3a), with few examples (14%) exceeding 50 mm. and fewer still (5%) smaller than 30 mm. in size (Fig. 4). If employed as gill nets, the 30–50 mm. specimens would be expected to capture fish between roughly 24 and 40 cm. in length, or substantially larger than the tui chub and most other fish reported from western Great Basin sites, where most of the netting occurs. Nets greater than 50 mm. in mesh size would “gill” even larger fish, exceeding any routinely reported from archaeological contexts. Finally, the smallest nets (<30 mm.) would be capable of gill netting chub and other fish of archaeologically reported size, but account for a negligible fraction of the netting. This indicates that gill nets were rarely, if ever, used aboriginally for taking smaller fish like tui chub and juvenile suckers.

Larger nets may have been used for rabbits, birds, or other game, as the bar mesh size of ethnographic rabbit nets was between 50 and 75 mm., or the “size of a rabbit’s head” (Adovasio

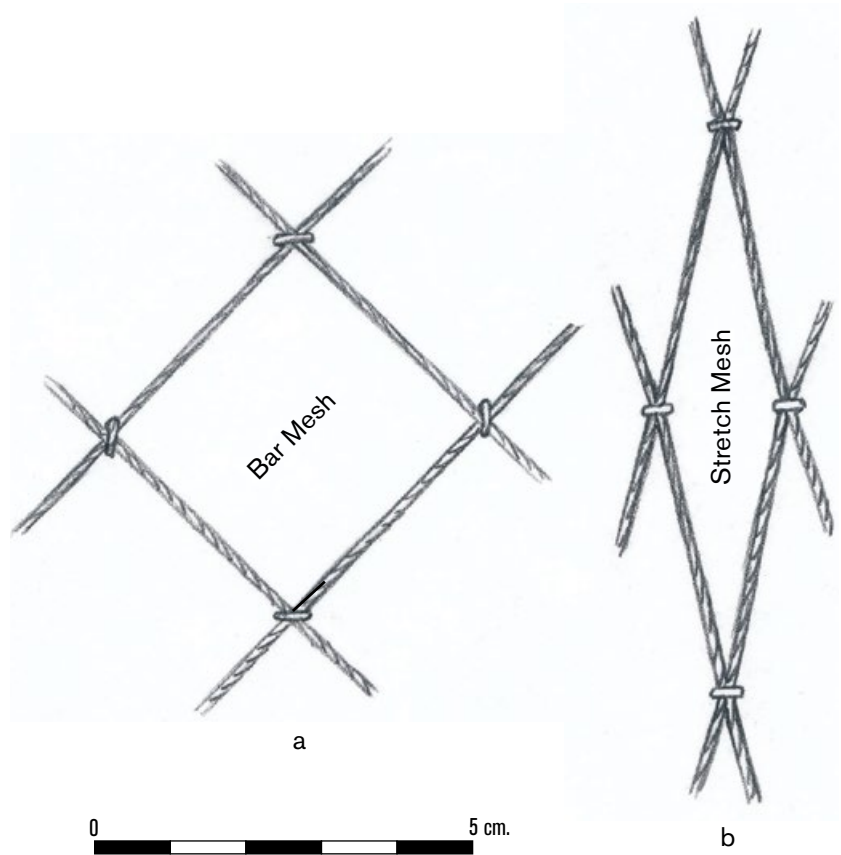


Figure 3. Net Measurements. a. bar mesh; b. stretch mesh.

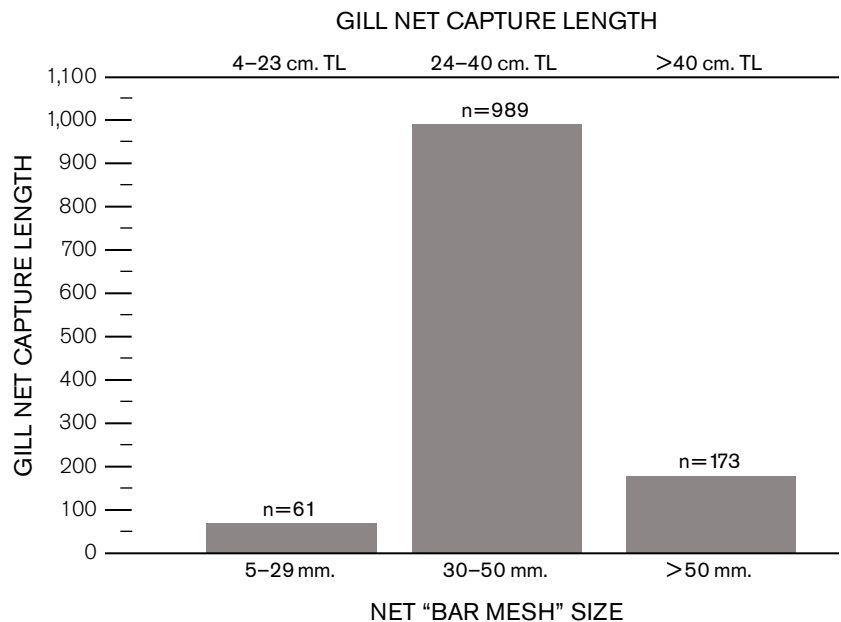


Figure 4. Mesh Size of Great Basin Nets.

et al. 2009; Fowler 1990). They may also have been used to gill net large cutthroat trout in lake habitats, which is the only place gill nets are specifically mentioned in ethnographic accounts (Fowler 1989; Speth 1969). Indeed, setting and managing gill nets at night, when they would have been effective, would be easier in current-free lakes than fast-flowing streams, where nets are easily fouled, ripped, and lost when snagged by floating debris. Still another possibility is that many of the smallest and more common 30–50 mm.-mesh nets were employed as seines, not gill nets. This ancient, globally widespread technology has many advantages, including its ability to capture fish of varied size. The only restriction is a minimum fish size equal to the “stretch mesh” or twice the bar mesh size of the netting employed (Figs. 3a–b). Thus, the most common 30–50 mm. Great Basin nets would be capable of seining fish from 6–10 cm. in length or larger, matching the size of most archaeologically recovered fish. That seines were regularly employed in the Great Basin is amply attested by ethnographic accounts (e.g., Follett 1982; Fowler 1989, 2002; Fowler and Bath 1981), and by the varied size of the fish recovered in discrete cache and other contexts (Table 3).

Other benefits of seines are their utility in different aquatic habitats (i.e., lakes, streams, and marshes) and the ease with which they are deployed and emptied, reducing capture costs and extensive wear-and-tear to valuable nets if used to “gill” fish. The latter is particularly critical for untreated plant fiber nets that must be properly dried immediately after use to avoid mildew and rot (Bonnot 1932), as evidenced by the revolution in commercial and sport fishing that followed the introduction of rot-resistant synthetic nets and fishing lines in the 1950s. In short, the use of gill nets was probably restricted to taking large cutthroat trout in lakes, and other nets were probably employed principally as seines to capture smaller, schooling fish (e.g., chub and sucker) more productively than through angling or spearing.

Weirs and Traps

Virtually all that is known about Great Basin use of fish weirs and traps is from ethnohistoric sources, summarized in detail by Fowler (1986, 1989, 1990, 2002; Fowler and Bath 1981) and others (Janetski 1991; Lindstrom 1992; Rhode 1988; Speth 1969). Thus, little can be added here, save a few observations on the

circumstances where these techniques would have been most effective. Weirs of woven, often portable, willow fencing and possibly rock were employed with either traps and/or netting/spearing platforms on the Truckee, Walker, Provo, Jordan, and other lacustrine spawning streams of the western and eastern Great Basin. These would have been most effective during winter-spring cutthroat and sucker spawning runs, when large, otherwise difficult to catch lacustrine species entered comparatively shallow waters.

Although few sites have been excavated along spawning streams, those that have indicate that fish were extensively exploited (Janetski 2007b; Zeier and Elston 1986). As in other parts of western North America and elsewhere, the construction, use, and maintenance of weirs and traps likely would have required numerous individuals and a more complex social organization than typified Great Basin households (Bath 1978; Janetski 2007c; Lindstrom 1992). In this sense, fishing weirs may be analogous to the terrestrial game-drive facilities that have sparked a considerable debate concerning their sociopolitical significance and antiquity (e.g., Hockett et al. 2013; Jensen 2007; Pendleton and Thomas 1983). In the case of weirs, however, the limited availability of suitable locations and the age of associated archaeological deposits and fishing technologies (i.e., harpoons, lift nets) suggest the practice was a comparatively recent phenomenon, coinciding with other evidence for late prehistoric resource intensification.

Finally, brief mention should be made of small, basket fish traps, collected in the early twentieth century, that were “staked in shallow water” to capture dace and redbreast (Fowler 1989; Fowler and Bath 1981). Inasmuch as neither of these minnows appear to have been prehistorically exploited (see Table 2), and no evidence for such traps has been recovered from archaeological contexts, it seems likely that they are a historical phenomenon that may be related to the catching of bait fish for the modern forms of angling that led to the inadvertent spread of both native and introduced bait species into most Great Basin waters (Moyle 1976; Sigler and Sigler 1987).

In sum, Great Basin fishing technologies were of fairly rudimentary nature (hook and line, simple spears, seines), with some gear (e.g., harpoons, fish traps, and—possibly—weirs and lift nets) of likely recent arrival. This should not be taken to suggest that these technologies

were inefficient or unproductive. Even small-scale seining and spearing can produce remarkable catches when fish congregate to spawn or fry school in shallow water. What is significant about these technologies are the restricted spatial, temporal, and seasonal circumstances where they are effective, which would have limited the overall productivity of aboriginal Great Basin fisheries.

THE ARCHAEOLOGICAL BIAS

Despite recent strides in the recovery and analysis of archaeological fish remains (e.g., Butler 1996, 1999; Butler and Delacorte 2004; Greenspan 1988, 1990; Janetski 1986, 1990; Janetski and Smith 2007; Smith 1985; Toepel and Greenspan 1985; Zeier and Elston 1986), earlier field methodologies have clouded our understanding of where, when, and why people fished in the Great Basin. Perhaps nowhere is this more apparent than in the Owens Valley, where years of excavation by numerous researchers failed to recover even a single fish bone. The first archaeologically recovered fish remains were two tiny vertebrae from flotation samples at a Middle Archaic site (Delacorte 1984). These were followed in the next few years by three bones from another Middle Archaic deposit (Bouscaren 1985) and 15 more picked from 1/8 inch (3 mm.) screens at the Lubkin Creek site (Hildebrandt 1988). This gives a total of just 20 fish out of nearly 32,000 identified faunal elements from Owens Valley by the early 1990s, although fish were locally available and ethnographically exploited (Chalfant 1933; Steward 1933).

All of this changed in 1992 with the excavation of twelve sites near the lower Owens River. This resulted in the recovery of 364 fish bones, or an 18-fold increase in the regional sample of fish remains (Delacorte et al. 1995). This was easily “explained” at the time by the site’s proximity to the river, given that conventional 1/4-inch (6 mm.) and 1/8-inch (3 mm.) recovery screens were employed on the project. The real epiphany came five years later when Virginia Butler persuaded us to employ finer, 1/16-inch (1.5 mm.) mesh screens to process a sample of sediments from some of the same sites during subsequent excavations. This resulted in the recovery of 1,885 fish bones, nearly half of which (n=931) were retrieved from just 0.15 m.³ of sediment wet-screened through 1/16-inch mesh. This converts to a density of

more than 6,000 fish bones per cubic meter of sediment, as compared to a project-wide average of just over 14 bones/m.³ recovered with 1/4-inch and 1/8-inch screens. To be sure, most of the finely processed sediments came from house floor and other deposits with abundant fish remains, but the difference in recovery was even greater in these contexts (Butler 1999).

Clearly, the importance of fish at these riverine sites was substantially greater than previously realized, highlighting the critical importance of fine-mesh screens for the recovery of Great Basin fish remains. Work at what is now dozens of sites throughout the Owens Valley confirms this, recovering fish at more sites than not, including many far from the river (Basgall and Delacorte 2011, 2012). Similar results have occurred in other parts of the Great Basin, where the wet screening and laboratory sorting of sediments have produced astonishing increases in fish-bone recovery (e.g., Janetski and Smith 2007; Kelly 2001; Raven and Elston 1988; Zeier and Elston 1986). This suggests that fishing, especially for small fry, may have been of greater and more widespread importance than previously appreciated in at least the latest part of the prehistoric sequence.

WHAT THE RECORD SUGGESTS

Although much of the evidence for Great Basin fishing dates to the latest part of the sequence, there is ample indication that fish were consumed from the early Holocene onward. The evidence includes the remains of small minnows in the fecal boli from the 9,400 B.P. Spirit Cave mummy (Eiselt 1997), similarly ancient remains from other Lahontan Basin and northwestern Great Basin sites (Greenspan 1994; Orr 1974; Singer 2004), and bones of primarily large sucker from several early to middle Holocene deposits in Owens Valley (Butler and Delacorte 2004; Delacorte 1999; Delacorte et al. 1995). Middle Holocene fishing has been identified at Falcon Hill and Hidden caves (Follett 1982; Hattori 1982; Smith 1985; Thomas 1985) and many sites in the northwestern Great Basin. Finally, evidence for late Holocene use of fish is documented at numerous rockshelter and open air sites throughout the Great Basin (see Table 2).

Accepting the fact that older archaeological deposits are generally under-represented in the record and have typically poor organic preservation, the data nevertheless

suggest that fishing increased substantially over time. This is particularly true for the last two to three millennia of the sequence and most notably the last 1,500 years, judging by the records from Utah and Owens valleys and Stillwater Marsh (Delacorte 1999; Janetski and Smith 2007; Kelly 2001). An expanded use of fish in Owens Valley was accompanied by an increase in the number of species exploited to include both sucker and chub, and by a significant reduction in fish size (Butler 1999; Delacorte 1999; Delacorte et al. 1995). This might be explained by climatically-induced changes in aquatic habitats favoring small, rapidly reproducing fish like tui chub (Butler 1999; Butler and Delacorte 2004). Once established, however, a reliance on small chub and sucker persisted unchanged despite pronounced shifts from purportedly hyper-arid to cooler-wetter conditions that should have resulted in corresponding changes in fish catches. The local presence of three endemic fish—Owens sucker (*Catostomus fumeiventris*), Owens pupfish (*Cyprinodon radiosus*), and Owens tui chub (*G. b. snyderi*)—shellfish, and other unique aquatic/wetland species (Macey and Papenfuss 1991; Moyle 1976) likewise provides indisputable evidence for the persistence of aquatic habitats throughout the Holocene, as do pollen and other studies of shallow lakes at both northern and southern ends of the Owens Valley watershed (e.g., Batchelder 1970; Mehlinger and Sheppard 1978). This suggests that changes in the size and kinds of fish exploited may have been related less to environmental than to cultural factors.

An alternative explanation for the change in Owens Valley fish is that it reflects a broader intensification in regional resource use (Basgall and Delacorte 2011; Basgall and McGuire 1988; Bettinger 1989). This included an expanded reliance on waterfowl, seeds of bulrush, cattail, and other aquatic plants, and freshwater mussels (Basgall and Delacorte 2003; Delacorte 1999; Nelson 1999). Coinciding with this was a greater use of pine nuts, acorns, and other upland and alpine resources, and the mass processing of unripe lowland seed crops (Basgall and Delacorte 2003; Basgall and Giambastiani 1995; Bettinger 1989, 1991). All of this speaks to a broadening of the diet and an increasingly intensive land use that proceeded apace despite climatic shifts from mesic to arid conditions and back again. Given these circumstances, the mass capture of small fish that were available throughout the

summer and early fall may have produced greater catches overall than the higher return, but seasonally restricted, pursuit of large spawning suckers in earlier times. This is consistent with the seasonality of late prehistoric sites containing fish, where paleobotanical and faunal remains and mussel shell increment data indicate summer through fall, but little or no spring, occupation. That evidence of spring occupation, when fishing was potentially the most productive, is absent, probably reflects the overriding importance of early-ripening seed crops that were harvested in bulk and stored at sites away from the river.

Whether the expanded use of fish over much of the late prehistoric Great Basin was related to climatic or to cultural factors, it would still have had consequences for the groups involved. The highly localized nature of fish and the specialized equipment needed to exploit them require a substantial commitment to the enterprise. This is particularly true with regard to settlement patterns and the scheduling conflicts that would arise in conjunction with the intensive exploitation of seasonal spawning runs that would limit or preclude other activities. This is amply attested in the ethnographic record in other regions (Kroeber and Barrett 1960; Spier 1930; Spier and Sapir 1930), and is implicit in the archaeological record in many Great Basin localities. In Utah Valley, for instance, Janetski and Smith (2007) make a compelling case for seasonal shifts in late prehistoric settlement locations in order to more efficiently exploit fish at varying levels of intensity during different times of the year. In the Owens Valley, the early to middle Holocene exploitation of spawning suckers had a similar influence on the annual travels of wide-ranging foragers, who arrived at fishing locations from different points of the compass, judging by the clustered distribution of various far-flung toolstone materials within sites (Delacorte 1999).

A similar situation occurs at the Vista site along the lower Truckee River (Zeier and Elston 1986), where substantial house and cache features and the remains of cutthroat trout, tui chub, and possibly cui-ui indicate a primarily winter occupation focused on the exploitation of winter-early spring fish runs. Notably absent are any spring-ripening seeds, though extensive flotation was conducted and milling equipment was abundant at the site. This suggests that fishing created a scheduling conflict with spring seed harvesting that was mediated by shifting late spring/early summer residence to the adja-

cent Pah Rah uplands, where seeds and roots ripened later in the season and could be harvested after the fish runs. Support for this hypothesis comes from the contemporaneity of both Vista and upland site patterns, evidence for intensive spring-summer plant procurement, processing, and storage in the uplands, and the recovery of fish bones at upland sites (Delacorte 1997). Although appreciably less is known about the area, a strikingly similar pattern may be reflected at the Black Mountain/Pistone Complex above the Walker River fishery to the south, where upland land-use patterns appear similar to those in the Pah Rah Range.

Elsewhere, the influence of fishing on settlement patterns and scheduling decisions is reflected in the caching of fishing gear and dried fish in various rock-shelters and caves situated sometimes miles from any body of water. The same applies to the more widespread recovery of fish bones at sites far from the nearest fishery. This is certainly true for places like Secret Valley and other locations in the Oregon Lakes, Lahontan Basin, and Owens Valley, where sites with fish bones are sometimes found miles from the nearest fishing location. Thus, fishing was in some respects akin to the intensive harvesting of such geographically-localized plant foods as pine nuts, in requiring its own technology and a scheduling commitment to a particular place at a specific time of year. This may explain why fishing and the use of other seasonally or technologically constrained resources (e.g., pine nuts, root crops, and waterfowl) expanded only in late prehistoric times, when settlement patterns and group mobility contracted and diets broadened over much or all of the Great Basin (Delacorte and Basgall 2012).

While even limited fishing would have influenced settlement patterns to some extent, the more intensive fishing indicated for the latest part of many regional sequences may have had significant consequences for local social organization as well. One of the reasons for this is that most intensive fishing techniques require several individuals to implement. This is particularly true for seining, fish drives, and the construction/installation of weirs, traps, and fishing platforms that require cooperative groups (e.g., Evans 1990; Rhode 1988; Speth 1969). In this respect, intensive fishing may have been akin to communal hunting, requiring the temporary or seasonal formation of multi-household groups or fishing cliques (Speth 1969). This was common among

subarctic groups, where families dispersed in pursuit of game for much of the year, but formed larger groups or bands during the spring/summer fishing season. As is the case with subarctic hunting, Great Basin seed and other plant procurement were inherently competitive activities that were most efficiently pursued by one or a few individuals or families working independently (Steward 1970). Intensive fishing, by contrast, would have required a regular pattern of seasonal group fusion and fission to accommodate the different elements of the annual subsistence pattern. This is supported by the disparity in site size, richness, and number of house structures in areas with significant fisheries, when compared to those in immediately surrounding habitats where other resources were exploited (e.g., Kelly 2001).

Nascent control of favorable fishing locations may have coincided with the need for seasonally cooperative groups. This would be particularly true when labor-intensive facilities like weirs and fishing platforms were erected at one of a few suitable river locations (Fowler 1989; Speth 1969). The same may have applied to certain lakeshore areas, where water depth, bottom structure, and seasonal fish concentrations produced better fishing (Speth 1969); this is true today when significant labor or other investments and economic returns from fishing are involved (Cole 1978). In either case, such control of resources or the means of production is at odds with the characteristically unrestricted access to resources that typified most localized Great Basin groups (Steward 1938).

In addition to its seasonal influence on settlement patterns and social organization, intensive fishing likely had other consequences. As Dansie (1990) has noted, domestic dogs in the Lahontan Basin occur archaeologically with significantly greater frequency near wetlands and sites with fish remains. The same is true for the Bonneville Basin (Lupo and Janetski 1994) and other parts of the Great Basin (e.g., Livingston 1997; Sampson 1985); it is also true for such other regions in North America as California (Byrd et al. 2013 and references therein), the Midwest (Morey and Wiant 1992), and the Northeast (Ritchie 1965), where dogs and dog burials appear at different times in the past, but always in conjunction with intensive fishing. This is variously attributed by Dansie (1990) and others to the ease of feeding dogs on fish and other bulk wetland

resource offal; the human consumption of dogs during times of famine; the incidental use of domestic canids to eliminate camp waste; and a more direct use of dogs in hunting, as companions, and for protection from predators/scavengers.

Many of these factors may have contributed to the increased number of dogs in proximity to Great Basin fisheries, particularly the availability of feed. But the consistency of this pattern across much of the continent and in varied environments at different points in time suggests there was more involved. One of the obvious things that accompanies intensive fishing and the keeping of dogs is a greater intensity and duration of site occupation. Labor-intensive fishing facilities and equipment and some preservation and caching of seasonally abundant catches were often part and parcel of this in the Great Basin and elsewhere. These would have put fisher-folk at greater risk of trespass, attack, or theft by both human and animal scavengers, against which dogs would have provided unparalleled protection. Indeed, the energetic cost of keeping dogs—when they are put to only minimal use in hunting or as beasts of burden, and when they consume the same resources as their masters (Byrd et al. 2013)—is difficult to explain except in terms of their value as guard animals. In much of eastern North America and in areas surrounding the Great Basin, the appearance of dogs coincides with initial evidence for significant skeletal trauma and violence in human populations (e.g., Ritchie 1965; Sampson 1985). Although evidence of violence is limited in the sparsely populated Great Basin, dogs would have dissuaded more benign trespass, poaching, or theft by animal scavengers attracted to the smell of drying fish and the nets used to procure them; the frequency of dog burials and presumably the esteem attached to them as guard animals (Dansie 1990) supports this suggestion. Here again is evidence that intensive fishing may have had a number of cultural consequences.

HOW IMPORTANT WAS FISHING?

As Fowler and Fowler (1990) and others have observed, we know less about the aboriginal use of aquatic habitats in the Great Basin than others because wetland areas received less attention from early ethnographers. The same is true for archaeological investigations that historically focused on cache caves and employed field

and analytical methods that overlooked smaller fish and other marshland resources. This is amply apparent in the protracted debate surrounding the adaptive significance of aquatic habitats that has continued with varying intensity for more than half a century now. Resolution of this dispute may never come, but a few observations can be offered on the significance of native fisheries. First, archaeological data leave little doubt that only a few Great Basin fish were regularly exploited, with tui chub being the most important over most of the western Great Basin, and sucker and cutthroat trout being more prevalent in the east. This probably is of minimal behavioral significance, simply reflecting regional differences in hydrology and the availability and ease with which various fish could be exploited. A review of ethnographic and prehistoric fishing technologies reveals that most were comparatively simple, low-yield approaches (i.e., spears, hook and line, seines), some of which appear geographically limited and of likely recent introduction (Fowler 1990). Thus, the spatially and seasonally restricted nature of Great Basin fisheries suggests that they were of limited importance to all but a few highly localized groups.

A similar conclusion is suggested by ethnographic groups specifically identified as fish, trout, cui-ui, and salmon “eaters” (Steward 1938; Wheat 1967). These appellations speak volumes about the special nature of these groups and the handful of places that had lakes and streams that could adequately sustain truly reliable fisheries. It is significant, in fact, that the *Toidikadi* or Cattail-eaters of the Carson Sink, who extensively exploited tui chub as marsh conditions allowed (Butler 1996; Fowler 2002; Greenspan 1988), were named for a wetland plant that was undoubtedly more dependable than the minnows they sometimes consumed (see also Greenspan 1990). The existence of fish-named groups suggests, by the same token, that their distinctive adaptations were likely of some time-depth, as has been archaeologically confirmed. Practically speaking, however, the development of these specialized lifeways and their attendant technologies and sociopolitical organization was probably precluded until the latest part of the cultural sequence (ca. 3,000–2,000 B.P.), when group mobility appears to have declined throughout the Great Basin (Delacorte and Basgall 2012; Janetski 2007c; Kelly 2001; McGuire and Hildebrandt 2005).

An arguably different conclusion might be reached given the growing number of places where fish remains have been found archaeologically with improved field techniques. The actual number of fish bones in most of these cases, however, pales in comparison to that of other creatures and to the range and ubiquity of paleobotanical remains recovered. This implies that fish, though more widely exploited than once thought, likely comprised a minor element of the diet in most places. Much the same is suggested by the consistently late intensification of fishing, which speaks to the limited returns or value attached to fish until economic need or conditions demanded. If fish were a widely productive resource, one might expect to see more intensive use of them earlier in time, and the development or borrowing of appropriate fishing technologies to match. Neither of these things appears to be true, with the record consistently indicating a limited emphasis on fishing prior to the last one or two thousand years.

Perhaps a final argument for the restricted significance of aboriginal fishing is the recent history of Great Basin fisheries. A good rule-of-thumb for how earlier people hunted and fished can be found in contemporary fish and game regulations. Prohibited equipment and methods are likely similar to those employed in the past, because they work—often too well to be sustained today. In fact, at the present time nets, spears, trotlines, and weirs are—with few exceptions—universally outlawed for the taking of native Great Basin fish, many of which are severely threatened. I think the same holds true for Great Basin fisheries. If one wants to know where fishing was aboriginally important, one can look to the handful of places that supported commercial fisheries in the early historic period; i.e., the lower Truckee and Columbia River tributaries, Utah and Bear lakes, but nowhere else. However, even these once bountiful fisheries were rapidly depleted and collapsed when they were efficiently exploited for more than local consumption, thus providing a probably reasonable estimate of the extent and scale of prehistoric Great Basin fishing and why it never amounted to more than it did.

WHAT WE STILL DON'T KNOW

As the foregoing hopefully demonstrates, we know a great deal about ethnographic and (increasingly)

prehistoric Great Basin fishing, but the record is both temporally and spatially biased. We know less, for example, about earlier than later parts of the cultural sequence, and most of our information derives from a few areas with uniquely rich aquatic habitats. Other places with potentially significant fisheries still remain poorly understood (e.g., Bear and Walker lakes; J. Janetski, personal communication 2014), given the limited archaeological investigation that has occurred. The same holds true for areas farther from fishing grounds, where typically less has been done to recover minute fish bones that may or may not exist, but that comprise important information. Further research needs to be done, as well, on the dating and distribution of net and other fishing technologies in order to explore the evolution of fishing within broader land-use and other behavioral patterns. Finally, all of these endeavors would benefit from additional experimental and biogeographical investigations of fishing returns and species distributions to inform our past, present, and future understanding and management of Great Basin fisheries.

NOTES

¹Janetski (personal communication, 2014) suggests that the under-representation of whitefish in Utah archaeological collections may be due in part to a lack of comparative skeletal material for analysis.

²Both large and small leisters of seemingly comparable age have been recently reported from the lower Feather River (J. Rosenthal, personal communication 2014).

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