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The Use of Tui Chub as Food by Indians of the Western Great Basin

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ON the following pages we explore the harvesting and processing of tui chub by aboriginal people in the western Great Basin. Existing archaeological, ethnographic, and biological data identify the most common method of tui chub acquisition, processing, and consumption. The data guide 12 experiments where we document the effort required to harvest and initially process tui chub for food. We calculate the number of food calories returned per hour of fishing and processing effort. The experiments help rank tui chub relative to other food resources in the Great Basin (cf. Simms 1984). However, we make no assertions about optimal foraging behavior of Great Basin aboriginal people. Rather, we simply demonstrate that tui chub are an abundant, easily harvested resource that provides high calories and protein with relatively little effort. And the Indians of the western Great Basin took advantage of this.

BIOLOGY

The tui chub (*Gila bicolor*) is a minnow (Fig. 1) that inhabits the Great Basin drainages of California, Oregon, and Nevada. In the Lahontan Basin the fish has adapted to many environments: from the cold, clear waters of Lake Tahoe to the alkaline waters of Pyramid Lake. The fish swims the Truckee, Carson, Walker, Quinn, and Humboldt rivers as well as the ponds and sloughs of Stillwater Marsh (Fig. 2). The adaptability of tui chub has produced several subspecies. *G. b. obesa* and *G. b. pectinifer* are the two most commonly recognized morphs in the

Lahontan Basin. *G. b. pectinifer* is restricted to the open water of large lakes while *G. b. obesa* also swims streams and marshes. Morphologically the two subspecies can be distinguished by the number of gill rakers and pharyngeal teeth (La Rivers 1962:410-421; Gialat and Vucinich 1983).

Tui chub reproduce rapidly. A Pyramid Lake chub will produce as many as 68,900 eggs a year, with an average of 23,300 (Kimsey 1954; Sigler and Sigler 1987:169). Chub spawn over sandy bottoms or beds of vegetation in shallow water. All eggs do not ripen at the same time, so multiple spawning probably is common (Moyle 1976:169). The fish larvae hatch and begin feeding in less than nine days. Rapid reproduction contributed to a population explosion of tui chub in Carson Sink when it flooded from 1983 to 1987. An estimated 15 million tui chub swam the 200,000-acre lake in 1987 (Stillwater National Wildlife Management Area 1988). The Sink was dry in 1982 and 1988.

Increasing springtime water temperature (60°-65° F.) triggers spawning, schooling, and movement to shallow waters. Depending on the body of water, spawning occurs as early as late April or as late as early August. The springtime reappearance of tui chub in lakes is sudden and spectacular. At Pyramid Lake:

On May 20 the weather suddenly settled and became warm. . . . About 2 o'clock the following morning there was heard a vigorous lapping of the water, which in the quiet air appeared entirely without cause until it was found to accompany the leaping of vast numbers of fishes. Far out and up and down the shores the

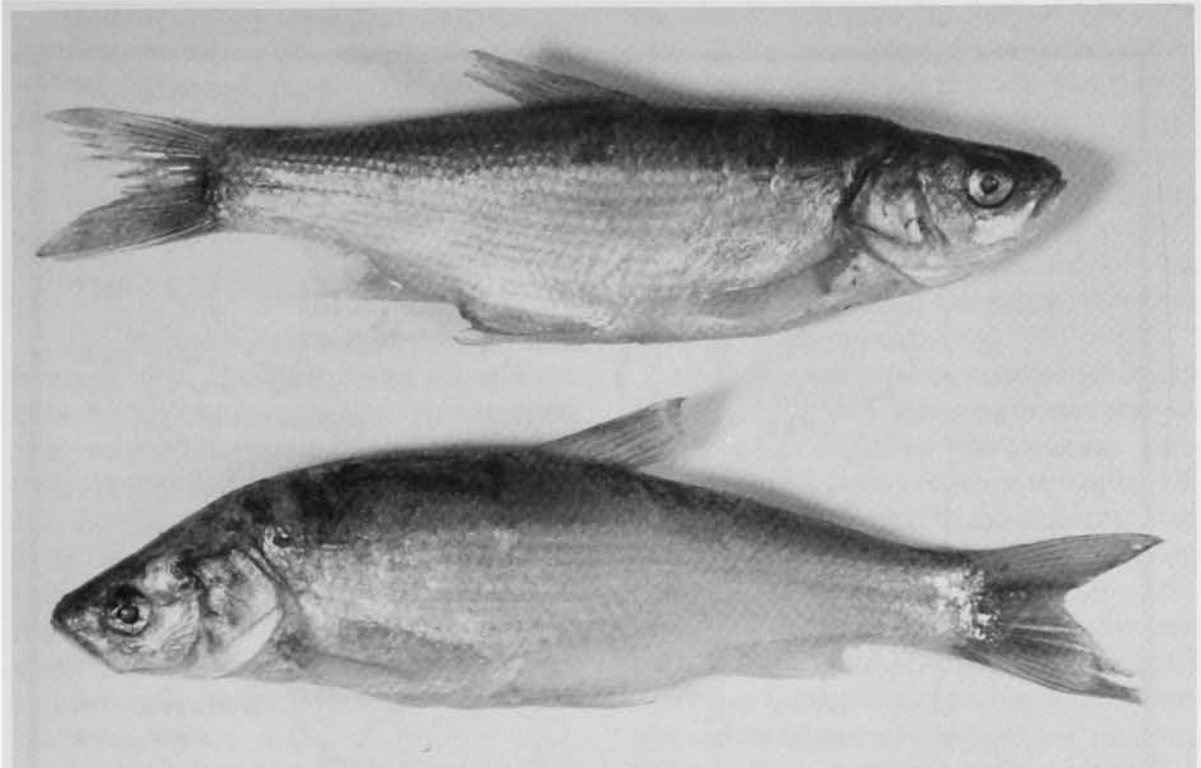


Fig. 1. Tui chub, *Gila bicolor*. 10.0 cm. and 9.0 cm. in length.

surface of the water fairly boiled. Spring had come, and with it, in the dim light of early morning, myriads of fishes from the depths of the lake. Daylight revealed them [tui chub] everywhere, along the shore, among the boulders, and in the algae, hovering in enormous schools over the bars and moving about in the clear water of the sheltered bays [Snyder 1917:66-67].

Growth is rapid during the first summer of life, the chubs reaching 22-42 mm. in length. By the end of their second summer the chubs are typically 37-98 mm. long. In subsequent summers they add 20-50 mm. depending on the body of water. Old age is reached at seven years. The length of a mature adult is 20-25 cm. with 30-40 cm. lengths found in large lakes (Moyle 1976:167).

The nature and behavior of tui chubs make them easy to capture. The filling of a formerly dry playa for even a few years could

mean a bountiful chub supply as it did in Carson Sink in the mid-1980s. Tui chub form large schools, some (in Pyramid and Walker Lake) over 100 yards across. Although cold temperatures and large waves will drive some chub to deeper water, younger, smaller chub prefer to school in shallow water close to shore. Thus large schools can be found easily from late spring to mid-autumn. Lacking direct observation, the Indians could have located them by monitoring the behavior of fish-eating birds. We have watched American white pelicans herd schools of tui chub across shoals and into bays where they scoop up and devour the minnows (see also Knopf and Kennedy 1980). Tui chub schools in shallow water are easy prey for people, armed with mass-harvesting equipment such as gill or dip nets, and working from shore or in light-duty (tule) boats.

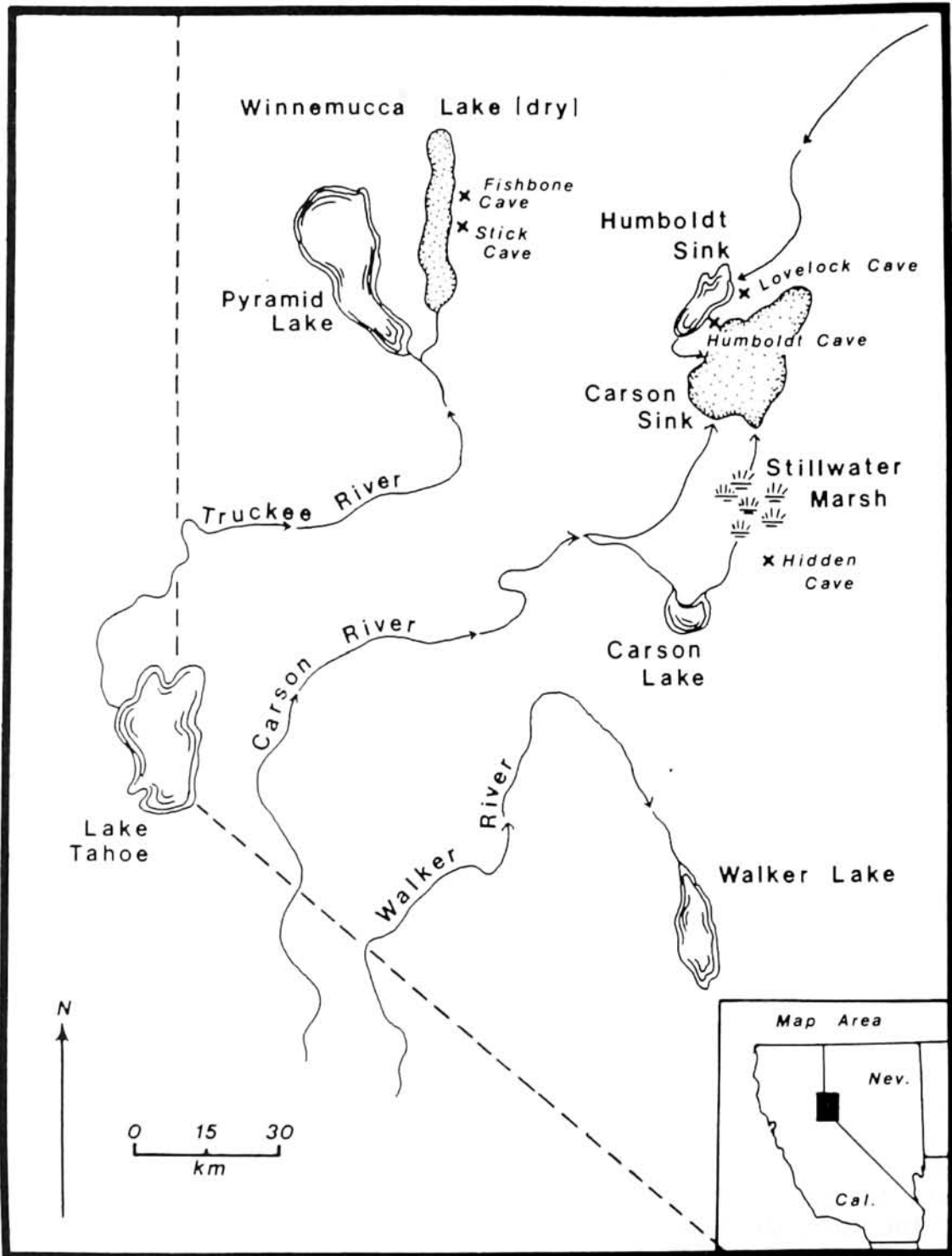


Fig. 2. Major habitats and archaeological sites with tui chub.

Modern fishery biologists describe tui chub as "sweet and palatable" (Snyder 1917:62), although bony. The postcranial skeletal structure pervades much of the meat. Tui chub do not yield bone-free fillets like the familiar trout (K. Johnson, personal communication 1990).

THE ETHNOGRAPHIC RECORD

The Northern Paiute fished for tui chub in many ways, including baited set and trot lines, basket traps, and weirs. However, dip nets and gill nets (Table 1) were the primary tools (Fowler and Bath 1981; Fowler 1989:30-34). Northern Paiute gill nets were about 20-25 m. long and a meter deep. Tule floats, willow sticks, and stone weights suspended the nets, unattended, in shallow water. A fine-gauge twine rendered the net relatively invisible under water. Mesh size ranged from 1 to 4 cm. square.

"In their tule boats" the Toedökadö of Stillwater Marsh "fished with their nets . . . for the very tiny fish [tui chub], like the sardines; there were so many of them" (Stone 1987-1988:42-44).

Willard Park reported (Fowler 1989:33) that among the Walker River Paiute:

[Gill] nets were used more than anything else to catch fish in the [Walker] lake. The nets are 25 yards long, 4-5 feet high. A net was owned by one man. Sticks were put in the bottom of the lake in shallow water near shore. The net was placed on these stakes. It was left all night. The fish were taken out of the nets each morning and evening.

Dip nets approximate rectangles in shape, usually 3-4 m. by 3-6 m. The net is attached to two long poles. The fisherman stands above a muddy stream or lake and scoops fish out of the water as they swim by. In historic times the Stillwater Paiute used a dip net to harvest chub from a canal (Fowler MS). Mesh size ranges between 1 and 7 cm. square (Fowler and Bath 1981; Fowler 1989:32-33;

see also Curtis 1926:75; Stewart 1941:370-371). Gill nets and dip nets select fish differently. Gill nets entrap fish within a narrow size range. Tui chub too small to be caught by their gills swim through a gill net. Large chub simply back out of the net before getting caught. On the other hand, a dip net will harvest fish in a variety of sizes. All fish with a diameter larger than the net mesh will be scooped into a dip net.

Shallow areas of lakes, ponds, and sloughs which accommodate spawning or schooling tui chub are best exploited with fish nets. Successful use of a dip net requires strength, skill, and active participation by the person fishing. A gill net, in contrast, is a passive fishing tool. Once an appropriate place has been identified, almost anybody can deploy, monitor, and harvest a gill net. However, ethnographic reports of fishing cliques and joint net ownership indicate that the technology and sociology behind gill-net fishing is not a casual affair (Speth 1969:234). Likewise, the manufacture, maintenance, and repair of a gill net command considerable time and a skilled hand. But gill nets are easy to use. The person fishing simply sets the net and retrieves the fish or net several hours later. The same location can be harvested for weeks (Speth 1969:234). During the height of spring activity a gill net will become saturated with tui chub in a few hours. At other times, the net must set for 24 hours to intercept the daily schedule of the chub. But the person fishing must harvest the net on a regular basis. Leaving an unharvested net in the water for days will not increase the catch. Some chub eventually wiggle free of the gill net. And tui chub schools and individuals will avoid a gill net containing numerous struggling fish (M. Sevon, personal communication 1989).

The Toedökadö ate small, whole, fresh tui chub after baking them in packets of cattail leaves in the ashes of the cooking hearth

Table 1
NON-FRAGMENTARY ETHNOGRAPHICAL, ARCHAEOLOGICAL,
AND EXPERIMENTAL FISH NETS

Number	Length (m.)	Depth/Width (m.)	Twine Size (mm.)	Mesh Size (cm.)	Material	Comment
Ethnographic Gill Nets^a						
MPM21711	dna ^b	dna	0.6	2.9-3.1	Milkweed	For chub
MPM21714	44.8	0.96	dna	6.5	Native twine	For trout
L-1-4479	18.5	dna	0.5	2.75-3.0	dna	For suckers?
H13.3835	50.4 ^c	0.56 ^c	0.2	3.0	dna	
H13.4425	40.0 ^c	0.80 ^c	0.6	4.0	<i>Apocynum</i>	
H13.4185	58.0	0.60 ^c	0.5	4.0	dna	For chub
Ethnographic Dip Nets						
MPM21712	2.9	2.85	dna	1.3-1.5	dna	For chub
H13.3834	6.3	3.08	1.6	2.0	dna	For chub
MPM21713	4.6	1.40	dna	4.0	Milkweed	
H13.4186	4.0	3.60	dna	1.3-1.5	<i>Apocynum</i>	For chub
Archaeological Dip Nets^d						
L1-39988	3.6	2.5	0.7-1.8	0.7-1.6	<i>Apocynum</i>	
L1-39889	2.7	2.2	0.6-1.9	0.5-1.6	<i>Apocynum</i>	
Experimental Gill Nets						
A	10.3	1.5	0.28	1.9	Monofilament	
B	11.0	1.3	0.38	1.27	Multifilament nylon	
C	37.0	3.0	dna	1.9-3.8	Multifilament nylon	

^a Data on ethnographic nets provided by Catherine Fowler on specimens at Milwaukee Public Museum (MPM), Lowie Museum (L) and Museum of the American Indian (H). Nets recovered from Truckee, Walker, and Carson River sumps.

^b dna = data not available.

^c Estimated measurement.

^d Data on historic archaeological nets from Ambro (1966).

(Fowler MS; see also Kelly 1932:97; Stone 1987-1988:44). Some Northern Paiute groups pounded and ground dried chub in preparation for eating (Barrett 1910:252; Stone 1987-1988:44), others did not (Kelly 1932:97; Stewart 1941:376). The Toedökadö sun-dried tui chub on cleared ground. The fish were then sacked in tule bags and either hung up in the shade or stored in pits lined with cattail leaves and capped with willows and mud. The Toedökadö boiled the minnows in soup which softened their bones so they could be eaten whole (Fowler MS).

All Northern Paiute groups dried for storage the fish that could not be eaten immediately (Stewart 1941:376). Among the Toedökadö, "since there were so many of

them [tui chub], they dried the rest and kept them for the winter months" (Stone 1987-1988:44). One spring in the late 1840s Chief Winnemucca assembled his people at Carson Sink to discuss the encroachment of white immigrants. Winnemucca suggested a retreat to the mountains (apparently the Stillwater Range): ". . . if the emigrants [sic] don't come too early we can take a run down and fish for a month, and lay up dried fish. I know we can dry a great many in a month. . . . In that way we can live in the mountains all summer and all winter too" (Hopkins 1883: 15). Evidently they would have subsisted in the mountains on pinyon nuts, jackrabbits, and dried fish (including, presumably, tui chub).

THE ARCHAEOLOGICAL EVIDENCE

Archaeological data provide insight on the use of tui chub as food by the Indians of the western Great Basin. It is an old practice. At Fishbone Cave on the northeast shore of Winnemucca Lake, fish net fragments were dated at $7,830 \pm 350$ years B.P. Desiccated tui chub were found in associated levels (Orr 1974:50). Caches, middens, and coprolites have yielded the remains of tui chub at many Great Basin sites. The middens at open sites in Stillwater Marsh have yielded thousands of tui chub bones (Greenspan 1988). We limit our discussion here to sites where information on chub size and chub processing is available.

At Stick Cave, overlooking Winnemucca Lake, Orr (1974) discovered several cache pits containing small dried fish. One of these caches, which was wrapped in layers of thick

moss (algae?) and buried in grass (Orr 1952), contained 916 desiccated tui chub (Fig. 3). Our examination of the cache revealed that the dried chub range between 7.5 and 12 cm. in length; but the vast majority are the same size. A sample of 79 fish had a mean length of 9.58 cm., with a standard deviation of 0.83 cm. (Table 2). The cache suggests that Indians, using a gill net with an approximate 1.4-cm. mesh, harvested young, schooling tui chub on a single fishing trip (perhaps over a few days). Caches 2, 6, and 31, and midden deposits in Humboldt Cave also contained dried tui chub (Table 2). Heizer and Krieger (1956:93) found 100 desiccated tui chub, many nearly complete, in Cache 6 (Fig. 4). We examined 66 of these fish. They exhibit more size variability than the tui chub cache at Stick Cave. The Humboldt Cave chub from Cache 6 range between 9 and 22 cm., and average



Fig. 3. A sample of the 916 dried tui chub from a cache in Stick Cave, Winnemucca Lake. The minnows are 10 cm. long.

Table 2
TUI CHUB FROM ARCHAEOLOGICAL SITES IN THE WESTERN GREAT BASIN

Site	Reference	Deposit	Remains	Number	Size Range (cm.)	Comments
Stick Cave	Orr 1952	Cache	Dried chub	916	7.5-12.0	79 fish examined at Nevada State Museum. Mean length 9.9 ± 0.83 cm.
Humboldt Cave	Heizer and Krieger 1956:91	Cache 2	Dried chub	1?	--	Small fragments.
	Heizer and Krieger 1956:93	Cache 6	Dried chub	100	8.0-22.0	54 chub examined at Lowie Museum. Mean length 14.9 ± 2.6 cm.
	Heizer and Krieger 1956:101	Cache 31	Dried chub	1	16.0	
	Heizer and Krieger 1956	Secs. 4, 7, 9, 11	Dried chub	15	9.0-20.0	Mean size is 17 cm. Examined at Lowie Museum.
Lovelock Cave	Loud and Harrington 1929:36	Cache 9	Dried chub	116	4.3-13.0	51 chub examined at Museum of the American Indian. Mean length 7.5 ± 2.4 cm.
	Loud and Harrington 1929:36	Midden	Dried chub	Several	8.0-11.0	
	Follett 1967:96	Midden	Dried chub	3	5.2-13.0	
	Follett 1970:168	Midden	Bones/parts	22	14.0-38.0	Several charred specimens.
	Follett 1967:95, 99	30 whole coprolites	Bones	298	3.8-23.9	98% less than 13.9 cm. in length.
	Follett 1970:167, 168	14 half coprolites	Bones	97	4.5-13.0	Like the 1967 collection, numerous pharyngeals bear complete series of teeth indicating fish were swallowed whole.
Hidden Cave	Smith 1985	Midden	Bones	9,280	10.0-14.0	Approximately 85% of the bones represent chub 10 to 14 cm. in length. Number is quantity of bone; number of individuals was not calculated.

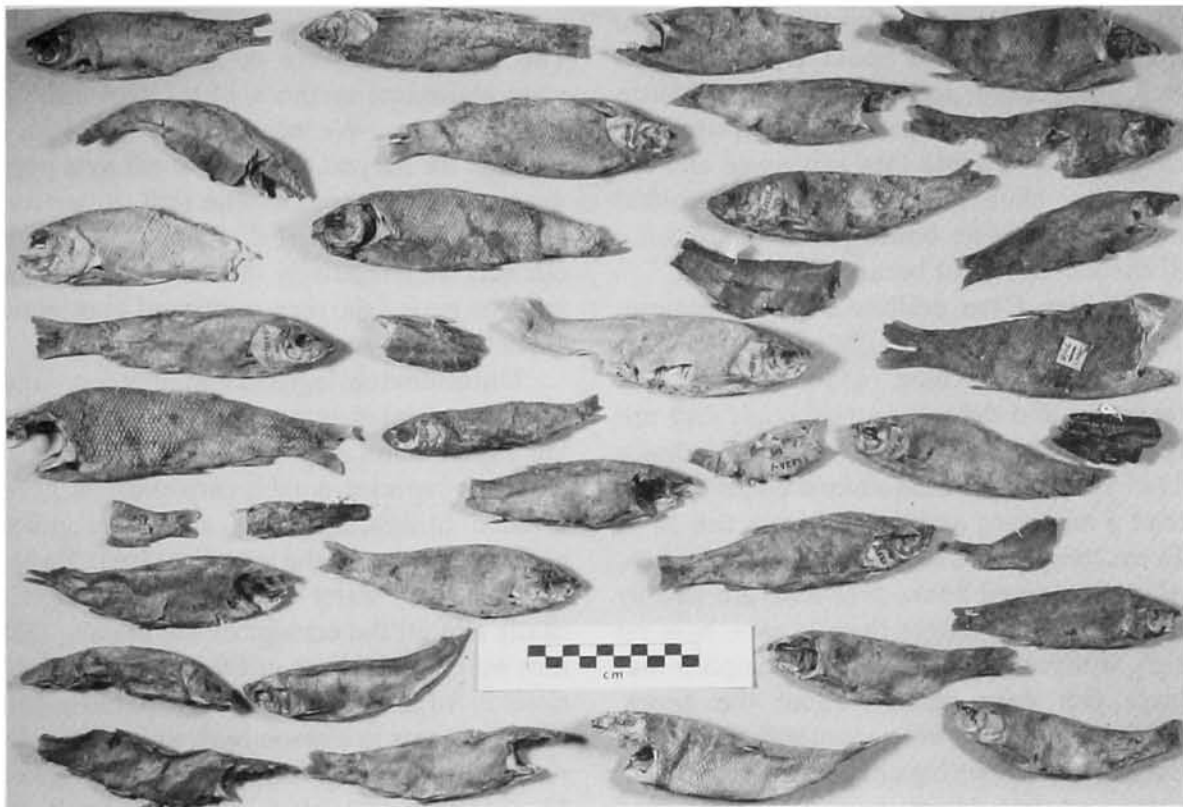


Fig. 4. A sample of the 100 tui chub from Cache 6 in Humboldt Cave.

14.8 cm. in estimated total length. If the minnows from Cache 6 represent the catch from a single fishing episode, a gill net is not implied. Perhaps the Indians used a dip net with a mesh small enough to select fish of a variety of sizes.

Mass harvesting of tui chub also is indicated at Lovelock Cave. Pit 9 contained a cache of 116 "small dried fish" (Loud and Harrington 1929:11, 36) later identified as young to half-grown tui chub (Follett 1958). Of these, 51 were available for examination (Table 2). The tui chub range between 4.5 and 13.0 cm., and average 7.5 cm. in estimated total length. Like Cache 6 at Humboldt Cave, the size variation of chub in the Pit 9 cache implies a harvest technique with something other than a uniform-mesh gill net.

Tui chub bones recovered from coprolites and midden at Lovelock Cave also come from young, small fish (Table 2). Desiccated whole

chub scattered throughout the Lovelock Cave midden range between 8 and 11 cm. in length (Loud and Harrington 1929:36). In a Lovelock Cave sample of 60 coprolites, 33 contained bones representing 395 individual tui chub. The fish ranged from an estimated 3.8 to 23.9 cm. in length, but the vast majority were small. In 19 of these coprolites 298 tui chub were represented. Among them, 98% ($n = 292$) were tui chub less than 13.9 cm. long. The mean length was not calculated (Follett 1967:95).

The Lovelock Cave coprolites contained numerous tui chub pharyngeals (the delicate jaw bones) complete with teeth. The survival of pharyngeals in coprolites implies that at least the heads and probably entire tui chubs were swallowed whole, with little chewing (Follett 1970:169). In contrast, the Lovelock Cave midden contains the remains of chub markedly larger (mean size 17 cm.) than the

chub represented in coprolites (Table 2). Many of the midden bones are charred as well, suggesting roasting. The evidence suggests that the Indians swallowed small tui chub whole, whereas they processed and ate larger tui chub in a manner that avoided ingestion of large bones. The bones were discarded into what became the midden.

Hidden Cave exhibits a similar pattern. Tui chub bones in the Hidden Cave midden bear staining, etching, and other signs of ingestion and defecation (although they are not deposited in obvious coprolites; Smith 1985:173). Most of the stained bones are less than 5 mm. long and derived from fish 10 to 14 cm. long. These small bones are unbroken, whereas stained bones 5-11 mm. are usually broken. Bones longer than 11 mm. bear no sign of digestion. The evidence implies that large fish were eaten without the bones. Medium-sized fish were eaten with the bones, but after some cutting or chewing. Small fish, those less than 14 cm. long, were swallowed whole with minimal cutting and chewing (Smith 1985:173-176).

Among archaeological tui chub remains, small fish are abundant and large fish are scarce. Perhaps the prehistoric people of the western Great Basin preferred small tui chub. Or perhaps the archaeological record masks harvest and consumption of large chub. Filleting of large chub at water's edge would preclude the occurrence of some bones in coprolites and habitation middens. Drying and pounding of fish (reported ethnographically by Stone [1987-1988:44] and Kelly [1932:97]) would render handling of tui chub almost invisible in the archaeological record.

EXPERIMENTS IN GILL-NETTING TUI CHUB

At Stillwater Marsh, Nevada, we conducted experiments in harvesting and initial processing of tui chub to determine the

number of calories returned per unit of effort. The experiments were designed to approximate aboriginal methods of tui chub fishing and processing. We targeted small (8-14 cm.) tui chub for harvest. We chose gill nets over dip nets because we lack the skill to operate a dip net in an aboriginal manner. Although our nets were relatively short and made from modern materials, they mimicked aboriginal gill nets in size, shape, and function (Table 1).

Unfortunately, logistics and environmental change prevented us from conducting our fishing experiments in classic tui chub habitat. Nonnative species, notably carp and bass, have invaded Stillwater Marsh and most other bodies of water in the western Great Basin, and upstream water diversions have significantly altered the ecology of the marsh. Gill nets were set six times in Carson Sink and six times in S-Line pond. We participated in two of the net sets in Carson Sink which were directed by Mike Sevon (Stillwater Wildlife Management Area 1985, 1988). S-Line Pond was selected for experiments because it does not contain exotic fish. This 5-ft. deep, 10-acre pond is a good analog for the smaller ponds in Stillwater Marsh about 10 miles away. But S-Line Pond does *not* experience schooling of large numbers of tui chub like larger lakes and marsh ponds in western Nevada.

Table 3 displays the results of the gill-net experiments. It shows that 20-45 minutes of handling time results in 500-4,500 g. of tui chub. Handling time is the sum of pursuit and processing time (Simms 1985). Here, handling time refers to the time required to set the net, retrieve the net, and remove the minnows. Processing time was negligible because the fresh, whole chub were simply put out to dry in the sun or immediately eaten (aboriginally).

Variation in the grams of fish returned from the net sets depends upon the season, body of water, and size of net mesh (Fig. 5).

Table 3
EXPERIMENTS IN GILL NETTING TUI CHUB

Location	Date	Net	Number of Chub	Net Hours	Total Grams	Grams Chub	Mean Length (cm.)	Handling Time (min.)
S-Line Pond	12/07/88	A	15	6	585	39	14.5	20
S-Line Pond	12/12/88	A	34	25	1,485	44	14.5	40
S-Line Pond	03/22/89	B	25	23	450	18	11.0	45
S-Line Pond	04/15/89	B	31	24	569	18	10.1	30
S-Line Pond	05/19/89	B	84	24	1,385	16	10.0	42
S-Line Pond	06/15/89	B	60	24	972	16	10.0	40
Carson Sink S. ^a	08/08/84	C	24	24	936	39	14.0	30
Carson Sink S.	08/08/84	C	17	23	714	42	14.5	30
Carson Sink N.	08/08/84	C	95	22	3,705	39	14.0	45
Carson Sink N.	08/08/84	C	112	20	5,152	46	15.0	50
Carson Sink #16	02/17/87	C	72	3	4,176	58	19.5	45
Carson Sink #17	02/17/87	C	54	3	3,078	57	19.0	35

^a Weights of chub from Carson Sink are estimated.

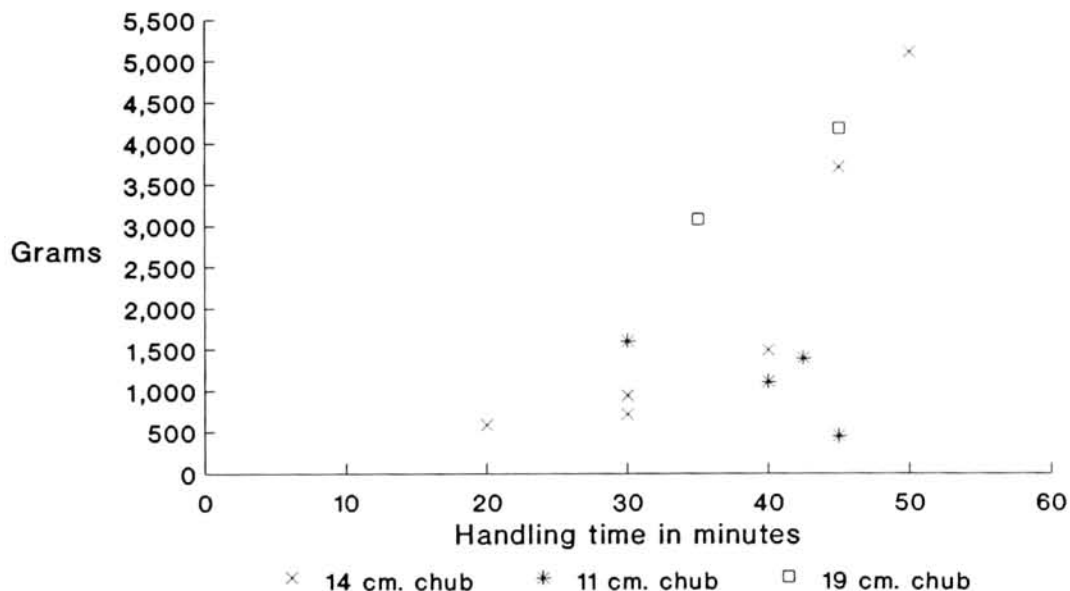


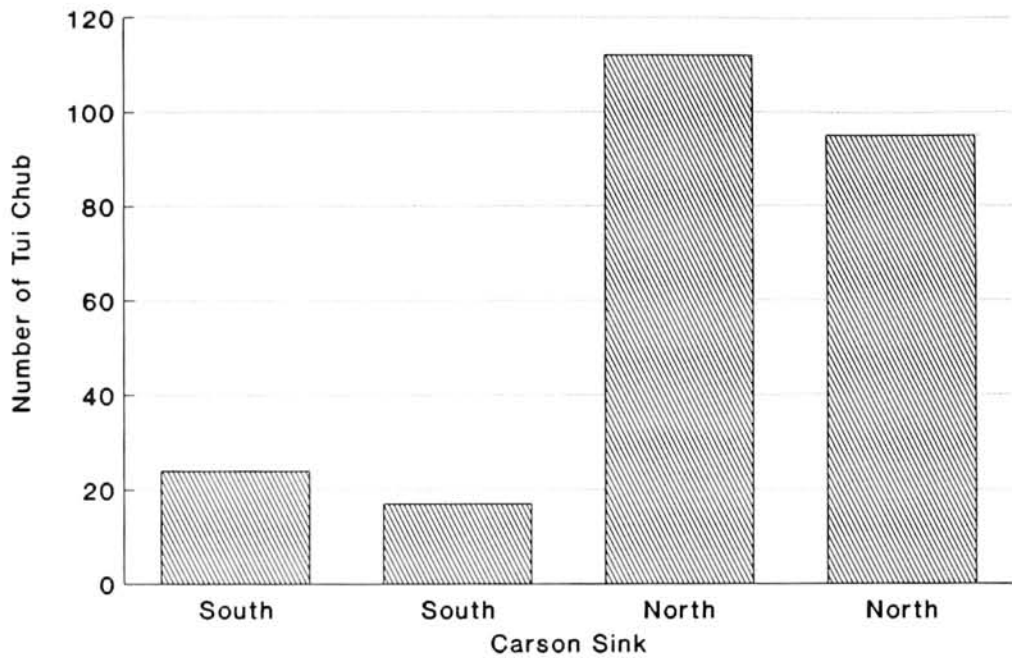
Fig. 5. Results of experimental tui chub harvests.

When larger fish are targeted (by using a gill net with a larger mesh) more grams of fish are returned per unit of handling time. Carson Sink returned more fish than S-Line Pond because as a larger, deeper body of water it supports a higher density of tui chub. Within the Sink on the same day, gill-net returns varied greatly. Nets set in the north end of the lake intercepted a school (we think), while nets in the south end did not

(Fig. 6). S-Line Pond showed a steady increase in number of chub caught from early spring to summer (Fig. 7).

Caloric Return of Tui Chub Harvests

Tui chub samples were sent for nutritional analysis to Ford Chemical Laboratory, Inc., in Salt Lake City (Ford Chemical Laboratory, Inc. 1989). The results (Table 4) show that tui chub contain calories and protein at levels



All chub 14.5 cm. long

Fig. 6. Tui chub gill-net catches at four places in Carson Sink on 8/8/84.

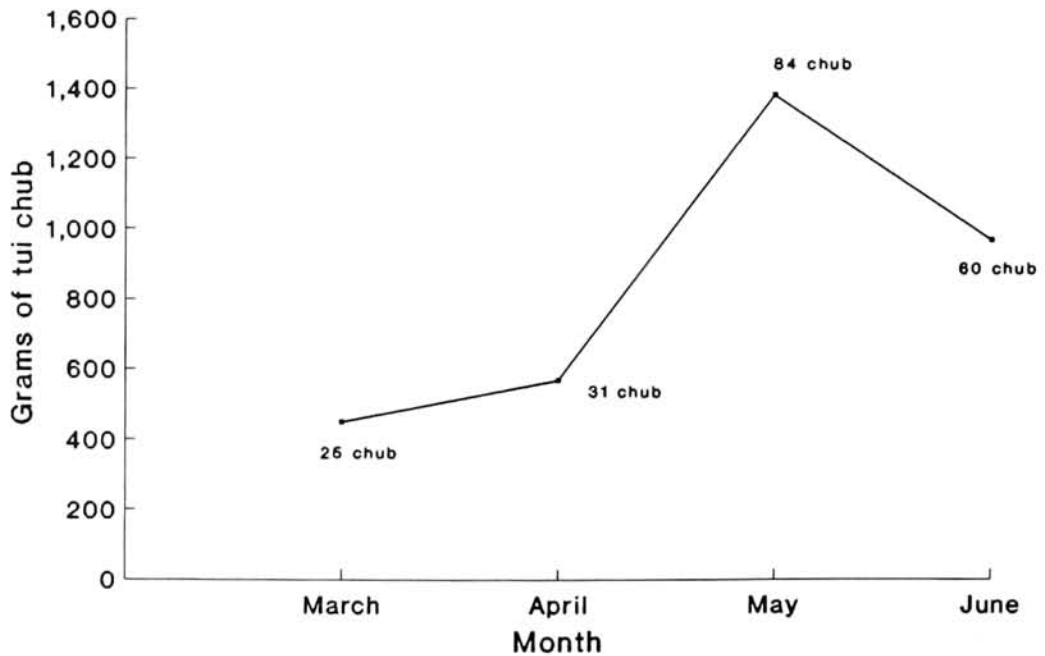


Fig. 7. Tui chub catches with a gill net in S-Line Pond, Carson Desert, Nevada.

Table 4
NUTRITIONAL COMPOSITION OF TUI CHUB

Tui Chub	cal./kg.	Protein	Carbohydrates	Fat	Ash	Moisture
Whole, fresh	1,250	18.5%	0.9%	4.7%	4.1%	71.9%
Whole, sun-dried	3,950	60.6%	5.6%	12.9%	11.4%	9.7%
Gutted, fresh	920	16.8%	0.6%	1.9%	3.0%	77.6%
Fillet, fresh	980	17.4%	0.5%	2.4%	2.1%	77.7%

Table 5
CALORIC RETURN RATES FOR FRESH WHOLE TUI CHUB

Location	Number of Chub	Chub Length (cm.)	Total Grams	Handling Time		Return Rate cal./hr.
				Minutes	g./hr.	
S-Line Pond	15	14.50	585	20	1,755	2,194
S-Line Pond	34	14.50	1,485	40	2,228	2,784
S-Line Pond	25	11.00	450	45	600	750
S-Line Pond	31	10.05	569	30	1,138	1,423
S-Line Pond	84	10.00	1,385	42	1,977	2,473
S-Line Pond	60	10.00	972	40	1,458	1,823
Carson Sink S.	24	14.00	936	30	1,872	2,234
Carson Sink S.	17	14.50	714	30	1,428	1,785
Carson Sink N.	95	14.00	3,705	45	4,631	5,789
Carson Sink N.	112	15.00	5,152	50	6,011	7,514
Carson Sink #16	72	19.50	4,176	45	5,220	6,625
Carson Sink #17	54	19.00	3,078	35	4,463	5,579

similar to those of other meat sources used by Great Basin foragers (cf. Simms 1984:89). As can be expected, dried whole fish concentrate more calories and protein per unit of weight than fresh whole fish. However, it takes about three dry 10-cm. chub to equal the weight of one fresh 10-cm. chub. The table also shows that gutting and filleting reduces protein by 25% and calories by 6% to 11%.

When we combine the nutritional data (Table 4) with time required to harvest and process the chub (Table 3), we generate the caloric return per unit of handling time (Table 5). Tui chub return 750 to 7,500 calories per hour of handling time.

Caloric return rates vary for the same reason as the weight of the total catch (Fig. 8). The mean return rate of the eight gill net sets capturing fish smaller than 14.5 cm. in a *nonschooling* situation is 1,927 calories per hour. This is reasonable estimate of the typical return achieved aboriginally in small

marsh ponds. At such a rate, tui chub rank below most small game but above most plant resources in the Great Basin (Simms 1984:93). However, in large marsh, pond, or lake environments, the caloric return is much higher. The experiments in Carson Sink returned a mean rate of 6,651 calories per hour from two gill nets of 14.5 cm. chub that probably were schooling. Other researchers (M. Sevon, personal communication 1989; Lindström 1990) report that the take from schooling chub could be much higher.

DISCUSSION

Tui chub were an important food resource for the aboriginal people of the western Great Basin. Apparently the most common harvest and processing procedure targeted small tui chub. Through careful observation of the environment and fish behavior, the people identified the places and timing of schooling tui chub. A series of shallow, near-shore

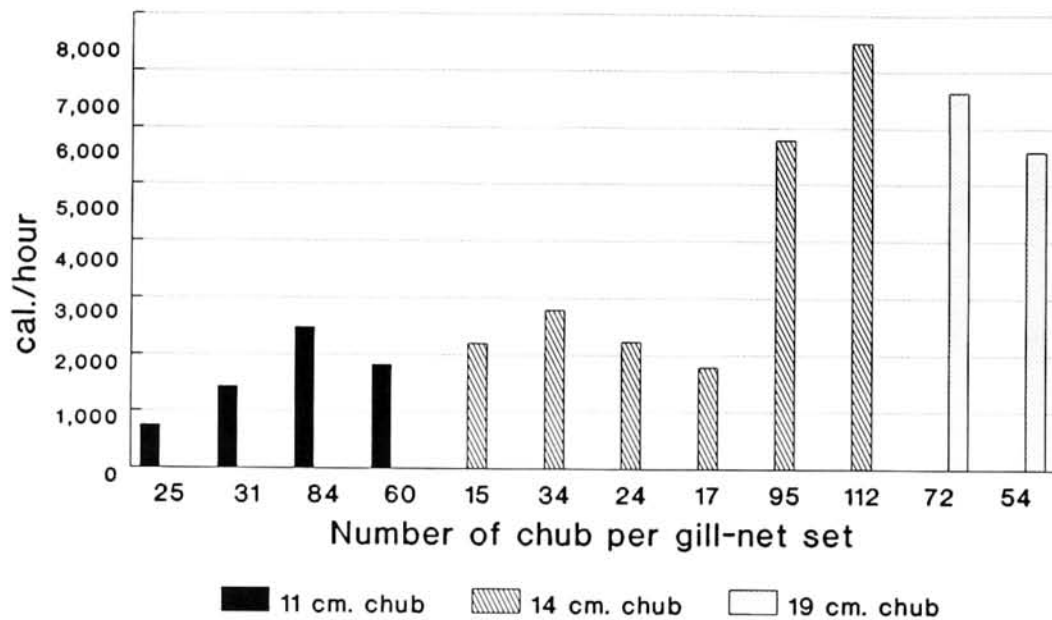


Fig. 8. Caloric return rate of 12 tui chub gill-net catches, consumed fresh.

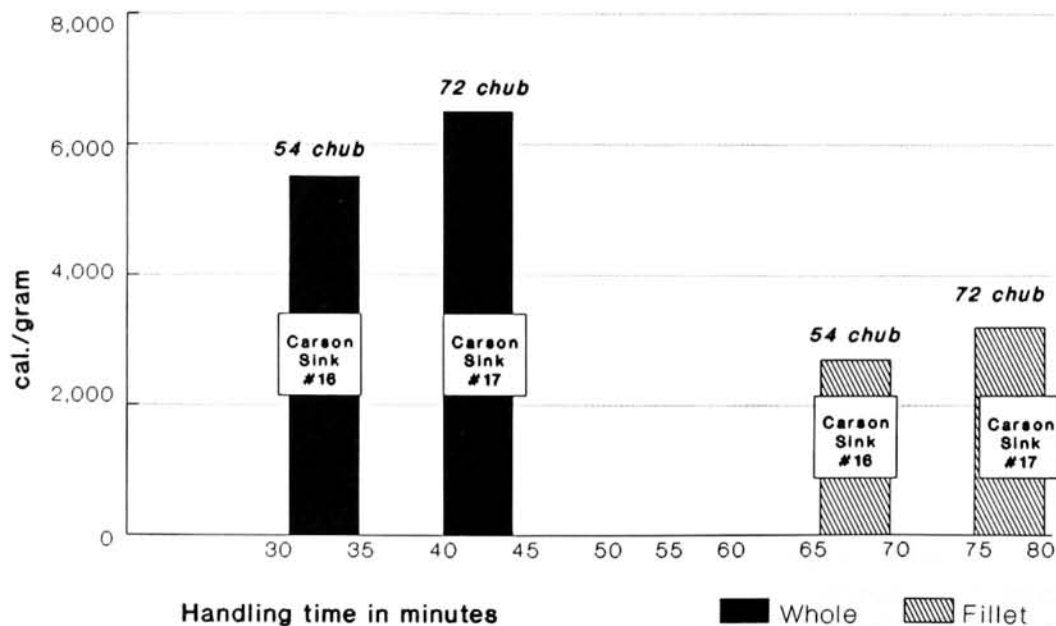


Fig. 9. Caloric return of handling whole 19-cm. tui chub versus fillets of 19-cm. tui chub.

locations in lakes and marshes were fished through the spring, summer, and fall. The people deployed gill and dip nets from tule balsas and shoreline fish camps. Several netting sessions were carried out over the course of a few days to a few weeks at each location. The nets intercepted schools of small (8-14 cm.), young (1.5-3 yr.) tui chub. Fresh tui chub were swallowed whole with little chewing or processing that would damage the bones. Many tui chub were dried and stored for later consumption.

This research indicates an aboriginal preference for small tui chub. This preference *may* partially stem from a desire to acquire calories efficiently. Large tui chub must be filleted before consumption because the large bones are difficult to swallow. And, complete drying of large chub requires evisceration and splitting or they will spoil. Notwithstanding the hassle and change in taste, such processing reduces the caloric return. If we allot 30 seconds to gut and fillet a 19-cm. chub, then the handling time in the Carson Sink #16 and #17 net sets would increase about 30 minutes each. This would significantly decrease the grams of chub handled per hour, and, given the lower caloric yield a chub fillets, halve the number of calories returned (Fig. 9). Why go to the effort to harvest large chub only to be saddled with the chore of filleting and gutting, when small tui chub can be eaten directly? And calories aside, we suspect the little fish—with a tinge of viscera, tiny bones, and tender skin—are more tasty than the filets of their larger, older brethren.

Simms (1984, 1985) calculated the harvest and processing time and caloric return of many Great Basin terrestrial resources. These are useful data because they provide a common currency to help evaluate the reasons for addition and deletion of foods in the aboriginal diet. This research shows that tui chub make an attractive food choice because

they return high protein and calories per unit of harvest and processing time. But we suspect other factors, besides calories, also influenced decisions about fishing for tui chub. Quite simply, the structure of the tui chub resource (cf. Greenspan 1990) also confers its attractiveness as food. Tui chub are abundant and available throughout the year. For the five warm months of the year, predictable, easily fished locations hold an almost inexhaustible supply of the minnows. Many places can be fished for days with little change in the catch. During cooler months, a small harvest of tui chub is still possible. And the Paiute of Humboldt Sink fished through ice in winter (Loud and Harrington 1929:156). Our research suggests that, with net fishing in summer and storage for winter, tui chub was frequently eaten by the native people of the western Great Basin. Of 186 prehistoric coprolites analyzed from Lovelock and Hidden caves, 112 contained tui chub bones (Cowan 1967:25, 28; Roust 1967:55, 65, 71). If each coprolite is the daily waste of one individual using the caves, then 60% of the time tui chub was part of the daily fare when the caves were in use.

The easy, abundant, and reliable harvest of tui chub might explain the following comment by a Pyramid Lake Indian: "When all other foods fail they fall back on fish" including tui chub (Fowler 1989:30). Perhaps this statement implies that, despite high caloric return, Great Basin people ranked fish relatively low? We need archaeological research to document the proportion of tui chub in the prehistoric diet. By focusing on the size distribution of the fish represented, analysis of archaeological tui chub bones can determine whether mass harvesting took place. Experiments in roasting, boiling, drying, and storing tui chub can produce control sets of bones for comparison with archaeological specimens. Did the minnows

fill the hundreds of presumed storage pits that dot sites in Stillwater Marsh (Raymond and Parks 1990)? Did tui chub (along with waterfowl, another seemingly inexhaustible resource) encourage a permanent sedentary occupation of the marsh? Or were people forced to use marsh foods when other more desirable foods, high caloric return or not, became scarce elsewhere (Kelly 1990)?

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