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THE REPRODUCTIVE ECOLOGY OF THE TAHOE SUCKER, *CATOSTOMUS TAHOENSIS*, IN PYRAMID LAKE, NEVADA

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Abstract.— The Tahoe sucker spawns in Pyramid Lake from April to August at lake temperatures of 11.7 to 22.7 C. The spawning population is comprised of a large lake spawning group and a numerically smaller river running group. The river running group is smaller in length and was not considered during this study.

The sex ratio of sampled suckers significantly favored the females. This is the result of the longer life of females and greater mortality of males during spawning.

Pyramid Lake Tahoe suckers reach sexual maturity at two to three years of age; however, those in Lake Tahoe do not mature until four or five years of age. The size at sexual maturity is different in both populations, which suggests that size or rate of growth rather than age determines sexual maturity.

The fecundity of Tahoe suckers is positively correlated with fork length, weight, and age. Additional analysis showed that a better correlation occurred between fish size (either length or net weight) and total ovary weight. We believe that fish size is primarily correlated with total reproductive tissue produced and secondarily with fecundity. A comparison of the Pyramid Lake population and the Lake Tahoe population demonstrated that size, not age, is the most important determinant of Tahoe sucker fecundity.

The Tahoe sucker, *Catostomus tahoensis*, is found in the Lahontan drainage system of western Nevada and eastern California. Within the Truckee River system, it comprises a major portion of the fish population (LaRivers 1962). It is of little direct economic value, but it does provide a significant food source for trout in Pyramid Lake and Lake Tahoe (Miller 1951) and probably contributes to the food of brown trout in the Truckee River. Its current status in rapidly desiccating Walker Lake is unknown.

Although *C. tahoensis* is one of the most common fishes of the Lahontan drainage, very little is known about its reproductive ecology. Snyder (1917) gave a brief description of spawning behavior, and Willsrud (1966) presented fairly extensive data on the reproductive biology of the Tahoe suckers in Lake Tahoe. The objectives of our study were to describe the reproductive ecology of the Tahoe sucker in Pyramid Lake and to compare it with other species of suckers. Special emphasis was given to comparisons between the Lake Tahoe population (Willsrud 1966) and the Pyramid Lake population.

Methods

Tahoe suckers were collected monthly from November 1975 through March 1977 through the use of bottom-set 1.83 × 76.2 m variable mesh gill nets. These were comprised of ten 7.6 m panels of 12.7, 19.05, 25.4, 31.75, 38.1, 44.45, 50.4, 63.5, 76.2, and 88.9 mm bar mesh netting. Fyke nets constructed of 12.7 mm mesh netting over 1.22 m diameter hoops were also used. The net was 4.8 m long, with a 15.24 m lead.

Sex ratios were obtained from a monthly subsample of the Tahoe suckers collected. During the spawning season, secondary sexual characters were used after verification by internal examination.

Ovaries were removed from 53 freshly killed Tahoe suckers for fecundity determination. Each ovary was weighed to the nearest 0.001 gram, and ten ova diameters were measured to the nearest 0.1 mm. The fork length of each fish was measured to the nearest mm, and each fish was weighed to the nearest gram. Scales were also taken for age determination.

Three replicate subsamples of approx-

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imately one gram of eggs were taken from each ovary, weighed to the nearest 0.001 gram, and preserved for later counting. Fecundity was then estimated by direct proportion per ovary.

Linear and nonlinear (log_{10}) regressions were used to examine the interrelationships between fecundity, egg size, body weight, fork length (FL), and age. The analyses that involved fish weight used net weight; that is, body weight minus ovary weight.

Results and Discussion

Reproductive Cycle.— Nuptial tubercles first appeared on males in December and by January were very pronounced, forming definite rows along the rays of the anal and caudal fin. The females usually had no tubercles, but a few had them on the anal fin. The females exhibited a characteristic distended vent. Mature males were collected through the spring and summer and as late as September.

During March and April 1976, an estimated 5500 Tahoe suckers ascended the Marble Bluff fishway or the Truckee River to spawn. The river spawning run of Tahoe suckers occurred when the mean lake surface temperature was 10 C, and the water temperature in the river 9 to 12 C. This corresponded to earlier observations on Pyramid Lake (LaRivers 1962). LaRivers (1962) further reported that *C. tahoensis* ascending the Truckee River from Pyramid Lake were all small (< 305 mm) which our data also support. Geen et al. (1966) found that spawning migrations of longnose suckers (*Catostomus catostomus*) began at 10 C and peaked at 12.3 C, and those of white suckers (*Catostomus commersoni*) peaked at 13.5 C. Spawning runs of *C. catostomus*, from western Lake Superior, peaked at 13 C over a seven-year period (Bailey 1969). Willsrud (1966) noted separate river and lake spawning populations of Tahoe suckers in Lake Tahoe, California-Nevada, which suggests they may be genetically different strains. The Utah sucker (*Catostomus ardens*) also exhibits river and lake spawning populations in Bear Lake, Utah-Idaho (McConnell et al. 1957). Preliminary electrophoretic tissue analysis on *C. ardens* from Bear Lake indicates no significant difference between the two groups (Klar, unpublished data).

The river spawning run coincided with the peak of the gonadal somatic index (14 percent) of the suckers collected in the lake. The GSI of the lake spawning fish (Fig. 1) remained high in April and May, and 95.4 percent of the fish collected in June were sexually mature. This decreased to 85.7 percent in July and to only 5.8 percent in August (August GSI = 1.5 percent). Catch rates reveal that general activity patterns decrease over the spring to a low point in July and August (Fig. 1). In July spent fish were stressed and inactive; therefore, we sampled a higher percent but actually lower numbers of ripe fish, which is reflected in reduced catch rates. As Tahoe sucker activity patterns are associated with spawning behavior (Vigg, unpublished data), we believe the GSIs and percent ripe fish, in this case, represent biased results. Thus, lake spawning activity commenced in April and was essentially completed by July, at water temperatures of 11.7–22.7 C.

The protracted spawning period, from April to August, that we observed for *C. tahoensis* has also been found for *C. discobolus* (Andreasen and Barnes 1975) and by Willsrud (1966) for Tahoe suckers in Lake Tahoe. Spawning activity in Pyramid Lake commences as both water temperature and photoperiod begin to increase and is drawn out over a period of several months. Andreasen and Barnes (1975) speculated that both water temperature and photoperiod combine to trigger spawning activity, but Kaya and Hasler (1972) reported that fishery scientists found a heterogeneity of responses to experimental conditions with different species. Changes in water temperature and photoperiod are so closely linked in Pyramid Lake that determining the relative importance of either to initiation of spawning may be impossible without controlled experiments.

Sex Ratio.— Of 1,557 Tahoe suckers sexed from November 1975 through February 1977, 740 were males and 817 were females. This ratio, 1:1.10, significantly differs from the expected 1:1 ratio ($P<0.05$). The larger number of females in the population is attributable to the longer life of females and greater mortality of males. Age and growth studies have shown that females in Pyramid Lake live to age five, but no males have been collected that were older than four (Robertson, unpublished data). A similar occurrence has been noted in white suckers (Geen et al. 1966, Scott and Crossman 1973). Willsrud (1966) noted a greater decrease in growth rate and a proportionately greater decrease in the number of males in older size groups in Lake Tahoe. Male suckers exhibit reproductive activity for a greater portion of the year in Pyramid Lake and Lake Tahoe and tend to remain in the spawning areas for a greater time span than the females. This may result in higher mortality for males from either stress or predation.

Sexual Maturity.— The majority of the male suckers mature at two years of age, and all are mature by age three. A few of the females are mature at two, and the majority mature at three (Table 1). Most individuals were from 212 to 324 mm long at the onset of sexual maturity. Willsrud (1966) reported that Tahoe suckers in Lake Tahoe mature at lengths of 147 to 200 mm and at

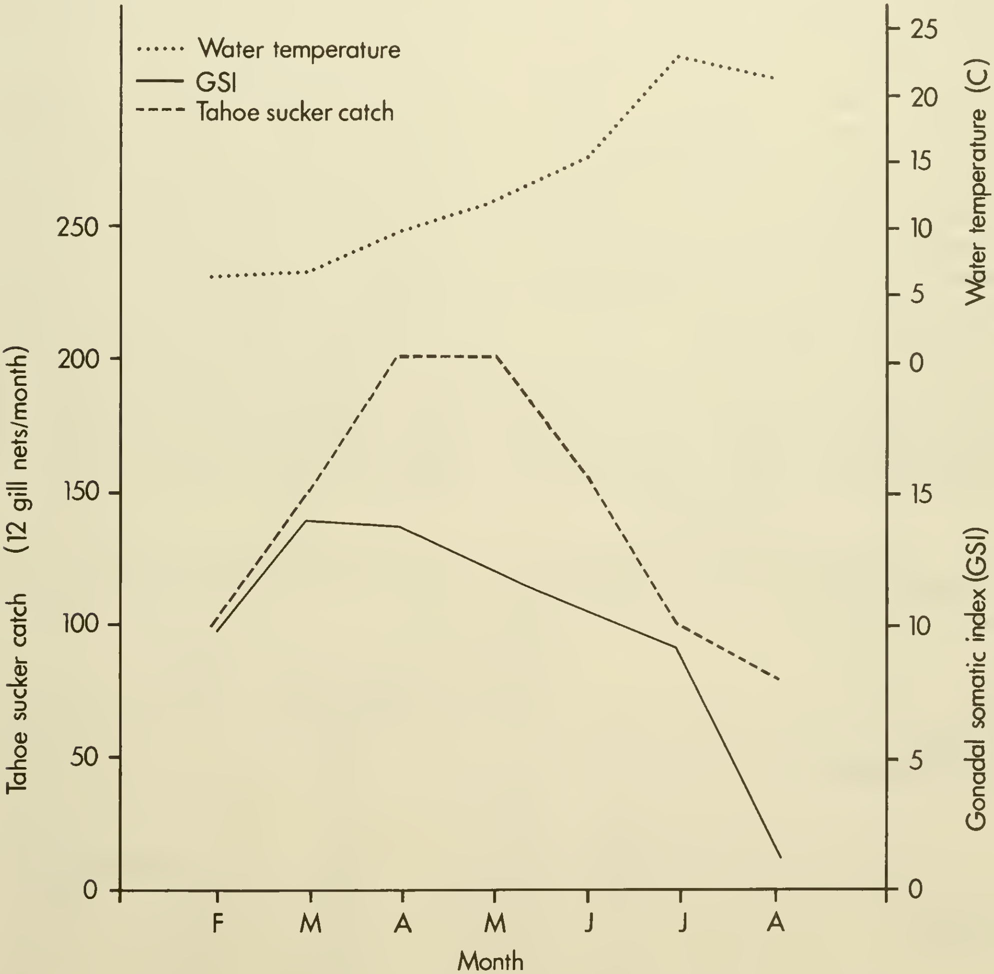

Fig. 1. Monthly changes in Tahoe sucker catches and gonadal somatic indexes in Pyramid Lake in 1976. Water temperatures are the monthly surface averages.

four or five years of age. These data show that both size and age influence sexual maturity. Since Pyramid Lake suckers reach sexual maturity at a much younger age (and larger size), size seems more important than age in determining the onset of sexual maturity.

EGG SIZE.— The mature egg diameter for Tahoe suckers varied from 1.5 to 2 mm ($\bar{x}=1.8$). Willsrud (1966) reported similar egg size for the Tahoe suckers from Lake Tahoe (Table 1), and Andreasen and Barnes (1975) reported mature ovum diameters of approximately 2 mm for *C. ardens* and *C. discobolus.* Lack (1948) proposed the existence of an egg size/fecundity relationship that stabilized the average fecundity of the population through a differential survival rate for different size fry. This is supported by Dahl (1918–19, cited by Bagenal 1971) and Gray (1926, 1928, cited in Bagenal 1971), who showed that larger eggs produce larger fry. However, we did not find a significant relationship between ovum diameter and age or fecundity ($F=3.67$ and 1.80, respectively). Either our sample size was inadequate or some other mechanism exists that maintains a stable average fecundity in the Pyramid Lake population.

FECUNDITY.— The mean fecundity of Tahoe suckers from Pyramid Lake was 20,550 eggs per female. This is less than was found for *C. ardens* and is roughly comparable to *C. discobolus* (Andreasen and Barnes 1975). The mean fecundity of the larger *C. catostomus* was 26,000 (Bailey 1969), but the fecundity of fish of the same size was greater for Tahoe suckers. The white (*C. commersoni*) had more eggs per female in all size groups than Tahoe suckers (Vessel and Eddy 1941). The $\log_{10}$ regression for number of eggs produced by a female Tahoe sucker is significantly related to age ($F=47.87$, $P<0.05$) fork length ($F=107.52$, $P<0.05$), and net weight ($F=86.99$, $P<0.05$). There is much disagreement concerning the relative importance of each of these variables to the fecundity of fish. The size of the fish, length and weight, determines the amount of energy that can be expended for the production of reproductive tissue, and space available within the body cavity. From a practical point of view, it matters little whether weight or length is used as a predictor variable of fecundity. For Tahoe suckers, both length and net weight are highly correlated with fecundity ($r=.79$ and .82, respectively, $P<0.05$). In both cases the relationship had a significant linear fit but was best described by a $\log_{10}$ equation. A reexamination of Willsrud's data (1966) showed a similar high correlation between fecundity and fork length ($r=.92$, $P<0.05$). He did not present his data in a manner that will allow an analysis of the weight-fecundity relationship. An analysis of the relationship between fork length and weight and ovary weight of

TABLE 1. Comparison of Lake Tahoe suckers from Lake Tahoe, California-Nevada (eggs numbers estimated from log equation) and Pyramid Lake, Nevada.

Location	Age	$\bar{x}$ Fork Length (mm)	$\bar{x}$ Total Weight (grams)	$\bar{x}$ Ovum Diameter (mm)	$\bar{x}$ Fecundity
Lake Tahoe	IV	147	45		2,510
(from Willsrud 1966)	V	170	72		3,502
	VI	201	118		5,164
	VII	229	172	1.90	7,204
	VIII	249	222		8,995
	IX	277	304		11,230
	X	310	426		14,822
	>X	363	680		21,857
Pyramid Lake	II	291	304	1.88	13,213
	III	330	453	1.87	19,000
	IV	360	590	1.80	26,229
	V	433	998	1.77	59,268

Pyramid Lake Tahoe suckers showed that length and weight are highly correlated with ovary weight. In fact, the r values were higher than those for fecundity ($r = .85$ and .79, respectively). This further supports our belief that fish size is directly related to the total amount of reproductive tissue that can be produced under a given set of environmental conditions. Fecundity in turn is related to the total ovary weight and ovum size as was shown by Kucera and Kennedy (1977).

The interrelationships of fish size (length and weight) and age and fecundity for Tahoe suckers are more difficult to analyze. The Lake Tahoe population has radically different growth rates and age structure. For example, the oldest sucker we have collected was 5 years old, and Willsrud collected several that were 15 years of age. The length-weight relationship for both populations is similar.

A one-way analysis of covariance demonstrated that the slopes of the fork length-fecundity relationships are significantly different ($F = 9.04$, $P < 0.05$). We feel this is due to differences in the growth rate. Examination of these relationships (Fig. 2)

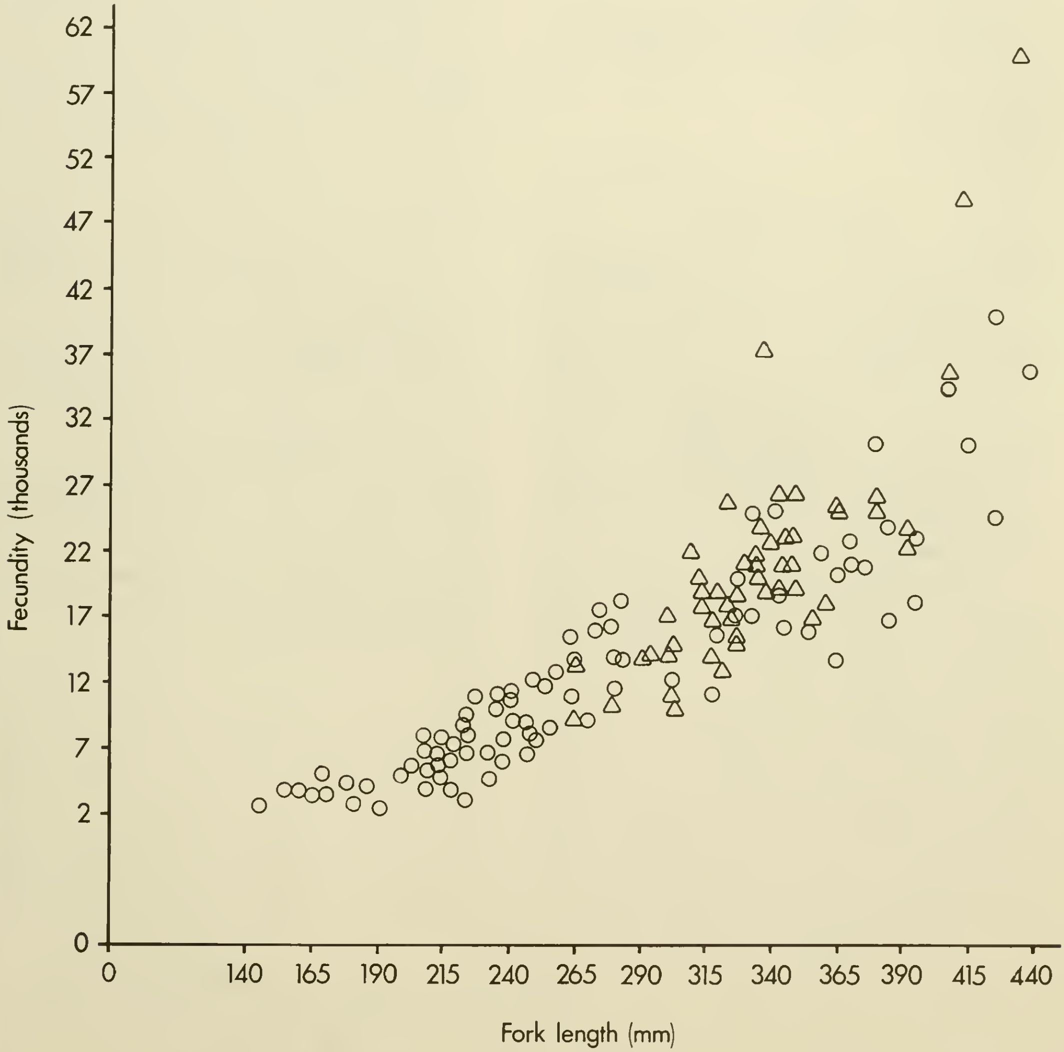

Fig. 2. Comparison of Tahoe sucker fecundities from Pyramid Lake (Δ) and Lake Tahoe (0).

shows there is significant overlap. Furthermore, comparison of mean fecundities over similar ranges in fork length (265 to 440 mm) by a one-way analysis of variance indicates no significant differences in the means ($F = 1.63$, $P > 0.05$). Comparison of the mean fecundity for a given weight fish from either population shows close agreement (Table 1). This leads us to believe that Tahoe sucker fecundity is related to size and that age is a secondary influence.

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Literature Cited

ANDREASEN, J. K., AND J. R. BARNES. 1975. Reproductive life history of *Catostomus ardens* and *C. discobolus* in the Weber River, Utah. Copeia 1975(4):643–648.

BAGENAL, T. B. 1971. A short review of fish fecundity, p.89–111. *In*: S. B. Gerking (ed.), The biological basis of freshwater fish production. Blackwell Sci. Publ., Oxford and Edinburgh.

BAILEY, M. M. 1969. Age, growth, and maturity of the longnose sucker *Catostomus catostomus* of Western Lake Superior. J. Fish. Res. Bd. Canada 26(5):1289–1299.

DAHL, K. 1918–19. Studies of trout and trout waters in Norway. Salm. Trout Mag. 17:58–79;18:16–33. (Cited in Bagenal 1971).

GEEN, G. H., T. G. NORTHCOTE, G. F. HARTMAN, AND C. C. LINDSEY. 1966. Life histories of two species of catostomid fishes in Sixteenmile Lake, British Columbia, with particular reference to inlet stream spawning. J. Fish Res. Bd. Canada 23(11):1761–1788.

GRAY, J. 1926. The growth of fish: I. The relationship between embryo and yolk in *Salmo fario*. Br. J. Exp. Biol. 4:215–225. (Cited in Bagenal 1971).

______. 1928. The growth of fish: II. The growth rate of the embryo of *Salmo fario*. Br. J. Exp. Biol. 6:110–124. (Cited in Bagenal 1971).

KAYA, C. M., AND A. D. HASLER. 1972. Photoperiod and temperature effects on the gonads of green sunfish, *Lepomis cyanellus* (Rafinesque), during the quiescent winter phase of its annual sexual cycle. Trans. Amer. Fish. Soc. 101(2):270–275.

KUCERA, P. A., AND J. L. KENNEDY. 1977. Evaluation of a sphere volume method for estimating fish fecundity. Prog. Fish-Cult. 39(3):115–117.

LACK, D. 1948. The significance of litter size. J. Anim. Ecol. 17:45–50.

LARIVERS, I. 1962. Fishes and fisheries of Nevada. Nevada State Fish and Game Comm. 782 p.

MILLER, R. G. 1951. The natural history of Lake Tahoe fishes. Ph.D. dissertation. Stanford Univ. 160 p.

MCCONNELL, W. J., W. J. CLARK, AND W. F. SIGLER. 1957. Bear Lake: its fish and fishing. Utah State Dept. of Fish and Game, Idaho Dept. of Fish and Game, Wildlife Manage. Dept. of Utah State Agri. Coll. 76 p.

SCOTT, W. B., AND E. J. CROSSMAN. 1973. Freshwater fishes of Canada. Fish. Res. Bd. of Canada Bull. 184:538–543.

SNYDER, J. O. 1917. The fishes of the Lahontan system of Nevada and northeastern California. U.S. Bur. Fish. Bull. 1915–16(35):31–86.

VESSEL, M. F., AND S. EDDY. 1941. A preliminary study of the egg production of certain Minnesota fishes. Fish. Res. Rep. 26. Minnesota Dept. of Cons. Div. of Game and Fish. 26 p.

WILLSRUD, T. 1966. A study of the Tahoe sucker *Castostomus tahoensis* Gill and Jordan. M.A. thesis. San Jose State Coll. 96 p.