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Evaluation of Two Hybrid Trout Strains in Henry's Lake, Idaho, and Comments on the Potential Use of Sterile Triploid Hybrids

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Abstract. —Cutthroat trout *(Salmo rlarki) x* rainbow trout *(Salmo gairdneri)* hybrids were introduced in Henry's Lake, Idaho, to produce a trophy fishery. The performance of two strains of F_1 hybrids (cutthroat trout *x* rainbow trout and cutthroat trout *x* steelhead [anadromous S. *gairdneri])* was monitored. Growth rates of both strains were comparable, but cutthroat trout *x* rainbow trout hybrids were caught in greater numbers than the other hybrid during the third and fourth years of life. Hybrid trout are considered to be an excellent sport fish with value as a trophy species. However, hybrid trout are fertile and potentially could spawn with native cutthroat trout in this lake. Initial heat-shock experiments showed that several time—temperature regimes effecttively induced triploidy in F_1 hybrids. Stocking sterile triploid hybrids would maintain the genetic integrity of the indigenous cutthroat trout.

Hybrids of freshwater fishes have potential value to the fishery manager (Ihssen 1976), but it is well documented that all strains of a given fish species may not perform equally well in a specific environment (Cordone and Nicola 1970; Trojnar and Behnke 1974; Brauhn and Kincaid 1982). This intraspecific variability is potentially an important management tool for the improvement of freshwater fisheries, and performance evaluations of differences among strains are necessary if fisheries biologists are to optimize the management of a fishery.

Researchers at the University of Washington (Hines 1976) and in Manitoba (Ayles and Baker 1983) have demonstrated heterosis for growth in intraspecific rainbow trout *(Salmo gairdneri) hy*brids. Webster and Flick (1981) showed improved growth in intraspecific brook trout *(Salvelinus fontinalis)* hybrids. Interspecific fish hybrids also may show desirable traits (Fraser 1980; Chevassus 1983). For example, Laarman (1979) found offspring of adult female green sunfish *(Lepomis cyanellus) x* male bluegills *(Lepomis macrochirus)* raised in ponds had reduced reproductive potential. Interspecific hybrid sunfish are used in habitats where problems occur due to overpopulation and stunting.

Although hybrid fish may have a reduced reproductive potential, any potential ability to interbreed with native, wild species may be a significant drawback to hybrid stocking. Behnke and Zarn (1976) discussed how incidental hybridization of wild trout stocks with introduced species resulted in the alteration or loss of unique gene pools of indigenous trout species in the western United States.

Techniques involving heat-shock treatment of eggs shortly after fertilization have been developed recently to effectively induce triploidy in salmonids (Chourrout and Quillet 1982; Lincoln and Scott 1983; Scheerer and Thorgaard 1983). Triploid trout appear to be sterile (Thorgaard and Gall 1979; Lincoln and Scott 1984) because triploid females have undeveloped ovaries and triploid males produce little or no milt from normal-appearing testes. Sterile trout could be useful for (1) reducing or eliminating spawning of hatchery salmonids with wild stocks, (2) eliminating the high mortality sometimes associated with spawning, (3) increasing growth potential of salmonid stocks by redirecting energy otherwise needed for gonad production into growth, and (4) eliminating stunting due to overpopulation.

The purposes of this study were to evaluate the growth and return to the creel of two strains of interspecific F, hybrid crosses (cutthroat trout *[Salmo clarki] x* rainbow trout and cutthroat trout x steelhead [anadromous *S. gairdneri])*

planted in Henry's Lake, Idaho, and to identify effective treatments for inducing triploidy in the hybrids.

Study Area and Stocking History

Henry's Lake is a shallow, eutrophic reservoir located at an altitude of 1,857 m above mean sea level in eastern Idaho. The reservoir covers about 2,632 hectares at full storage. Prior to the construction of a dam at the outlet in 1922, Henry's Lake was approaching extinction (Irving 1953). Kemmerer et al. (1923) found the lake had a mean depth of about 1.5 m and a maximum depth of approximately 2 m. The reservoir now has a mean depth of 3.7 m and a maximum depth of 6.4 m at full capacity.

Despite the shallow depth, this lake has supported an outstanding salmonid fishery (Irving 1953; Jeppson 1972; Rohrer 1983). In addition to the indigenous cutthroat trout *(Salmo clarki),* other salmonids in the reservoir include brook trout (Spateholts 1984) and hybrid trout (cutthroat x rainbow trout). These hybrid trout are a popular sport fish at Henry's Lake. The hybrid trout's sporting characteristics and fast growth rate make it ideal for a trophy fishery, a primary management goal for this lake.

Hybrid trout were first planted in Henry's Lake in 1950, and an intensive stocking program was maintained from 1961 to 1972. The stocking of hybrids was discontinued in 1972 because there was a strong concern that the cutthroat trout gene pool should not be further diluted. Hatchery superintendents had noticed (and we documented) an increased variability in meristic characteristics of cutthroat trout (Rohrer 1981). Hybrids interbred with native cutthroat trout; consequently, the cutthroat trout genotype has been altered. Although there had been some hybridization of Henry's Lake cutthroat trout in the past (both intra- and interspecific), the present genotype is relatively "pure" (Wallace 1978; Wallace and Rourke 1978), primarily because of the dominance of the cutthroat trout population and the discontinuation of the hybrid stocking program in 1972. It is essential to the management program for this lake that potential long-term impacts of stocking fertile hybrid trout with resident cutthroat trout are eliminated.

In 1975, the Idaho Fish and Game Commission directed that Henry's Lake be managed as a trophy fishery and that cutthroat x rainbow trout hybrids be reintroduced. The management plan of the Idaho Department of Fish and Game (1983) stated that the department shall "experimentally sterilize hybrids to determine merits and feasibility" of such programs.

Methods

Hybrid crosses were made in 1976 and 1977 by fertilizing the eggs of Henry's Lake female cutthroat trout (461 mm mean total length [TL]) either with sperm from wild rainbow trout males (220 mm TL) from Henry's Fork or from steelhead (800 mm mean TL) from Dworshak National Fish Hatchery (Idaho). The two groups of progeny were reared to about 100 mm TL at the department hatcheries and released as young-of-the-year fish into Henry's Lake via Hatchery Creek.

About 100,000 fish of each cross were stocked into the lake each year (1976 and 1977). Prior to release, one-half of the fish in each group were marked by removing a fin. The right ventral fin (RV) was removed from the cutthroat x steelhead group and the left ventral fin (LV) was removed from the cutthroat x rainbow trout cross.

A stratified random creel census (Rohrer 1981; Malvestuto 1983) was used to evaluate the return to the creel of hybrid trout in 1978, 1979, and 1980. Possible differential returns to the creel were evaluated by chi-square. Random samples of hybrid trout from angler catches were measured to the nearest millimeter and weighed to the nearest 28 g by the clerk.

Heat-shock experiments designed to induce triploidy in fertilized eggs were conducted at Henry's Lake in 1983 and 1984. Eggs from Henry's Lake cutthroat trout were fertilized by sperm from wild rainbow trout from Henry's Fork at 6°C in all experiments. In 1983, eggs were heat-shocked 10 min after fertilization, following the procedures of Scheerer and Thorgaard (1983). One test group was immersed in a warmwater bath for 10 min at 29°C, and a second group was immersed for 10 min at 28°C. After embryos reached the eyed stage, they were shipped on ice to Washington State University for chromosome analysis. Chromosome preparation techniques were those described by Thorgaard et al. (1981). Heat-shocking was done in 1984 under varying time and temperature regimes, including longer duration (25 min) and lower temperature (25–27°C) treatments (Chourrout and Quillet, 1982).

Results

Creel Census and Growth

Return to the creel and growth were the two primary criteria used to evaluate performance of

TABLE 1.—Number of cutthroat × rainbow trout and cutthroat trout × steelhead hybrids recovered in the creel census at Henry's Lake, Idaho, 1978–1981. Asterisks indicate the significantly higher numbers of creeled hybrids (χ^2; $P \leq 0.05$*).

Census year	Cutthroat × rainbow trout	Cutthroat trout × steelhead
1978	93	107
1979	85*	44
1980	35*	20
1981	5*	0
Total	218	171

TABLE 3.—Mean total length (TL) and weight of cutthroat trout × steelhead and cutthroat × rainbow trout hybrids sampled from Henry's Lake, Idaho, 1978–1980.

	Cutthroat × rainbow trout			Cutthroat trout × steelhead		
Census year	*N*	Mean TL (mm)	Mean weight (kg)	*N*	Mean TL (mm)	Mean weight (kg)
1978	52	379	0.66	58	358	0.62
1979	85	447	1.28	44	445	1.10
1980	35	516		20	499	

the hybrid strains in Henry's Lake (Hudy and Berry 1983). No significant differences in returns to the creel (P = 0.95; N = 200) were found between the two strains of hybrid trout in 1978, but survival to the creel was significantly better for the cutthroat x rainbow trout hybrids in 1979 through 1981 than for the other cross (Table 1). The number of returns of spawning adults to Hatchery Creek was much greater for cutthroat x rainbow trout hybrids than for the other cross for 1979 through 1982, which probably is an indication of better survival to maturity (Table 2).

No differences were identified in growth rates between the hybrid trout strains (Table 3). Growth appeared to be slightly better for cutthroat x rainbow trout hybrids than for the other hybrids in 1978 and 1980; however, this was attributed to sampling bias—more of the former hybrids were sampled later in the year after a full season's growth. In 1979, growth was very similar between hybrid strains when they were compared by monthly intervals (Table 4). Mean weights of cutthroat x rainbow trout hybrids were higher than those of cutthroat trout x steelhead hybrids in most census intervals.

About equal percentages of the fish sampled from the two groups reached trophy size (arbitrarily set at a minimum of 550 mm TL); however, more cutthroat x rainbow trout hybrids of trophy size were actually creeled because of the better long-term survival of that hybrid (Table 5).

TABLE 2.—Number of adult cutthroat x rainbow trout and cutthroat trout x steelhead hybrids returning to Hatchery Creek at Henry's Lake, Idaho, 1979-1982.

Year	Cutthroat x rainbow trout	Cutthroat trout x steelhead
1979	73	18
1980	179	23
1981	361	56
1982	27	3
Total	640	100

Inducement of Triploids

Triploidy was induced in 1983 in six of nine embryos tested in the 29°C heat-shocked group but no triploids were found in 10 embryos from the lot treated at 28°C. Survival to eyed stage was 59 and 66% for the 28 and 29°C groups, respecttively; survival to the eyed stage for the control group was 92%.

We obtained high incidences of triploidy in several test lots in 1984 (Table 6). Best survival to the eyed stage in a group with a high incidence of triploidy was obtained after a treatment at 27°C for 25 min. We had found previously that we also could produce triploidy in embryos obtained by fertilizing eggs from Henry's Fork rainbow trout with sperm from Henry's Lake cutthroat trout. Treatment duration was 10 min at 29°C begun exactly 10 min after fertilization (Rohrer 1982).

Discussion

The cutthroat trout x rainbow trout hybrid was, for management purposes, considered the better performing of the two hybrid strains stocked in Henry's Lake. Growth rates and maximum sizes attained were similar between strains, but returns to creel were better for the cutthroat x rainbow trout hybrids than for the cutthroat trout x steelhead hybrids during years 3 and 4. In addition, the cutthroat x rainbow trout hybrids returned to Henry's Lake hatchery (area of imprinting) in much greater numbers, which also indicated better survival to maturation (Rohrer 1981). We do not know why a difference in return to creel occurred between the strains. Both strains were caught in equal numbers in 1978; therefore, differential

TABLE 4.-Monthly mean total length (TL) and weight of cutthroat x rainbow trout and cutthroat trout x steelhead hybrids sampled at Henry's Lake, Idaho, 1979.

	Cutthroat x rainbow trout				Cutthroat trout x steelhead			
Census interval	N	Mean TL (mm)	N	Mean weight (kg)	N	Mean TL (mm)	N	Mean weight (kg)
26 May–22 Jun	33	433	20	1.12	20	451	11	1.32
23 Jun–20 Jul	18	407			10	404	2	1.10
21 Jul–17 Aug	11	478	4	1.41	5	**457**	1	0.95
18 Aug–14 Sep	9	450			3	467		
15 Sep–31 Oct	14	485	11	1.52	6	472	4	0.97
All	85	447	35	**1.28**	44	445	18	1.20

catchability between strains was probably not a factor.

Researchers at the University of Washington (Hines 1976) found that rainbow trout x steelhead hybrids migrated to the ocean from Lake Washington, a characteristic of the parental steelhead stock. Henry's Lake is a relatively closed system because of the location of the outlet. Therefore, mass migration of cutthroat trout x steelhead hybrids from the system was ruled out, but changes in physiology and behavior during the sexual maturation process could have resulted in greater mortality in this hybrid and accounted for the difference in returns to the creel.

Both hybrid strains attained excellent maximum growth (up to 750 mm TL and 6 kg weight at age 4+) in Henry's Lake during the test period and were extremely popular with the sportsmen. Cutthroat trout at age 4+ reached a maximum size of 525 mm TL and weighed 2 kg in Henry's Lake, considerably less than either hybrid strain.

The successful induction of triploidy in Henry's Lake cutthroat trout x Henry's Fork rainbow trout hybrids has important management implications.

TABLE 5.-Numbers and proportions of trophy-size hybrid trout (at least 550 mm total length, TL) harvested from Henry's Lake, Idaho, 1979-1980.

Hybrid, measure	1979	1980
Cutthroat x rainbow trout		
Number sampled	85	35
Number >_550 mm TL	5	8
Percent of sample >_550 mm TL	5.9	22.9
Estimated total trophy catch	47	60
Cutthroat trout x steelhead		
Number sampled	44	20
Number >_550 mm TL	3	4
Percent of sample >_550 mm TL	6.8	20.0
Estimated total trophy catch	23	29

The Idaho Department of Fish and Game management plan (1978) stated that priority will be given to "native wild trout in decisions involving resident fish." Our heat-shock treatments showed that sterile hybrids could be produced. Production of sterile hybrids potentially could enable Henry's Lake to be stocked with highly desirable F_1 hybrid trout, while maintaining the integrity of the native cutthroat trout genotype.

One consideration in producing triploid hybrids is that the progeny will have 2/3 of the genetic material from the female parent and '/3 from the male parent; normal hybrids have 50% of the genes from each parent. We do not know if this difference will affect heterosis. Further research will be needed to answer this question.

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TABLE 6.-Results of experimental heat-shock treatments on eggs of cutthroat x rainbow trout hybrids at Henry's Lake. Idaho. 1984.

Treatment					Survival to eyed stage t°~)
Temperature (°C)	Starting delay[a] (min)	Duration (min)	Triploids %	Triploids Number	
25	25	25			70
26	25	25	0	5	63
27	25	25	85	20	83
28.5	10	10	100	5	48
29	10	10	100	10	55
29.5	10	10	100	5	64
30	10	10			31
Untreated fish			0		92

[a]Time between fertilization and start of the heat-shock treatment.

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