Comparative Reproductive Success of Caught-and-Released and Unplayed Hatchery Female Steelhead Trout (*Salmo gairdneri*) from the Clearwater River, Idaho

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ABSTRACT

This investigation evaluated the ability of adult female steelhead trout to spawn successfully at a hatchery after being hooked, played, and released by anglers on the Clearwater and Snake rivers, Idaho. Spawning was done under standardized conditions (air spawning) and an unplayed female provided a control. Eggs from experimental pairs were fertilized by the same males and the percentage of eyed eggs were compared. The eyed egg percentages did not differ statistically (t-test, $P > 0.05$) between caught-and-released steelhead (86.5%) and control fish (86.2%) in 24 tests.

Steelhead trout (*Salmo gairdneri*) stocks in many river systems of the western states and British Columbia have been reduced to remnants of their former levels due to increased angling pressure, commercial and Indian fisheries, hydroelectric development, and destruction of spawning and rearing habitat. To protect endangered steelhead runs in the upper Snake River drainage and still allow sportsmen to utilize the resource, the Idaho Fish and Game Commission permitted anglers to fish for summer-run steelhead on a catch-and-release basis for the first time in 1975. Fisheries workers in Idaho had found that adult steelhead trout that were released after capture could successfully return to their wild or hatchery spawning grounds (Pettit 1976; Reingold 1975). Other workers in British Columbia on the Dean (Hemus 1974) and Vedder rivers (Usher 1975) reported that 19% (n = 678 tags) and 30% (n = 196 tags) of adult steelhead tagged and released by anglers were captured a second time.

To cope with increased fishing pressure and reduce angler-caused mortality, fish managers began establishing various forms of catch-and-release regulations after World War II. Increased use of the restrictive regulation also called for further information on the delayed effects of fatigue and other physiological stress. Recent hooking mortality studies have concerned themselves largely with the stresses placed on the blood chemistry and osmoregulatory functions (Bouck and Ball 1966; Marnell and Hunsaker 1970; Wydoski et al. 1976). To date there has been little attention given to the long term effects of hooking and releasing on the reproductive ability of adult, spawning steelhead. Marnell and Hunsaker (1970) reported that prespawning cutthroat trout not immediately killed by mechanical injury may be expected to survive long enough to spawn after release. Special no-kill regulations have been used in the successful management of endangered trout populations (Johnson and Bjornn 1975), but in most instances, the restricted regulations include an opening date subsequent to the spawning period. It is possible that in a female steelhead's struggle to escape the hook, the maturing gonads are damaged so that subsequent spawning is not successful and eggs fail to develop after fertilization. It was the goal of this study to determine whether or not differences existed between the survival of eggs from played and unplayed hatchery steelhead.

STUDY AREA

Dworshak National Fish Hatchery is located at the confluence of the North Fork Clearwater River and main Clearwater River below Dworshak Dam (Fig. 1). Adult hatchery steelhead returning to this station originated from North Fork Clearwater brood stock trapped at the base of Dworshak Dam. Returning adult, summer-run steelhead enter

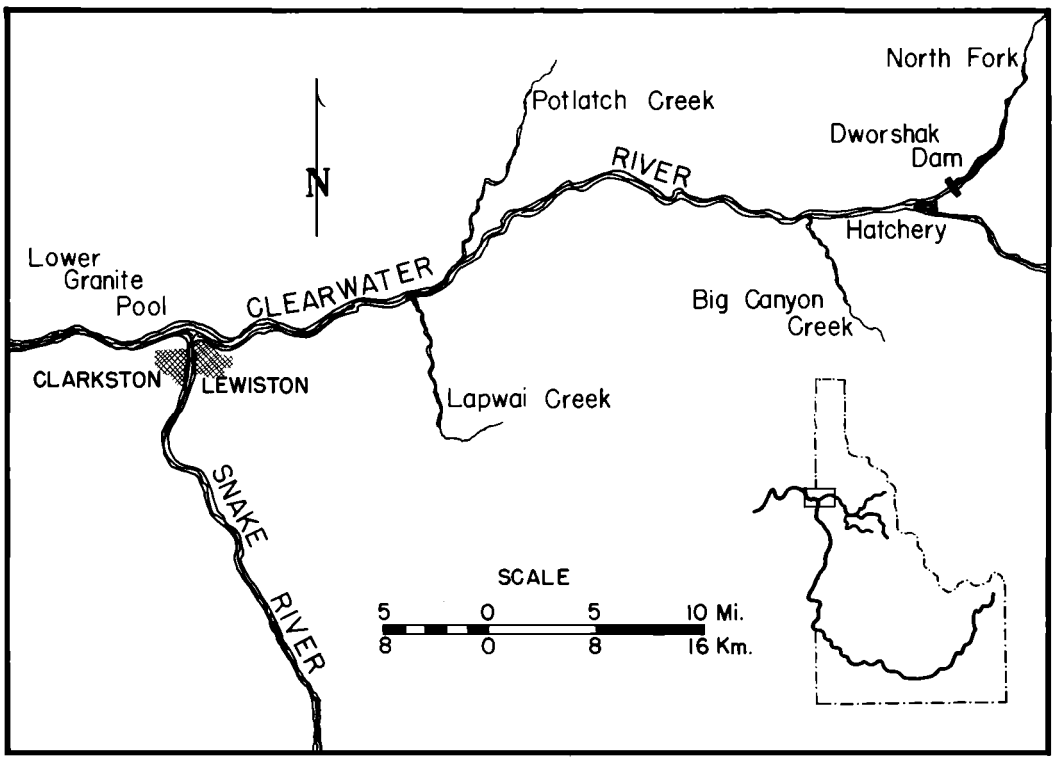

FIGURE 1.—*Map of lower Clearwater River and Snake River, Idaho. Impounded slack water crested by Lower Granite Dam extends 5.6 km on the Clearwater and 13 km above the confluence on the Snake River.*

the Clearwater River beginning in September and most hatchery fish overwinter in the lower Clearwater below the North Fork prior to spawning in the spring. Some hatchery fish overwinter in the Snake River above the slack water created by Lower Granite Dam located 52 km downstream from Lewiston, Idaho. Hatchery steelhead which have spent the winter months in the Snake River above Lewiston migrate back downstream and enter the Clearwater River on their return to Dworshak Hatchery in the spring (Pettit 1976).

METHODS

Adult hatchery steelhead were caught by hook and line using conventional spinning and fly-fishing tackle. Between 1 October and 30 November 1975, 219 adult steelhead were caught, tagged, and released in the Clearwater River by project personnel and cooperating anglers. Of these, 152 were identified as of hatchery origin by means of fin erosion and other external marks. Steelhead were played until exhausted, and depending on whether the angler was fishing from shore or boat, beached or netted in order to tag the fish. Prior to release, a Monel-metal jaw tag was secured to the mandible for identification and recovery purposes. Anglers recorded the sex, length, origin (hatchery or wild), date, and capture site prior to releasing each fish. Anglers caught 11 steelhead which already had tags placed on their lower jaws by National Marine Fisheries Service workers at Lower Granite fish ladder. We did not re-tag these fish and relied on the NMFS tag for identification purposes.

Idaho Department of Fish and Game personnel tagged and released an additional 55 adult steelhead from the Snake River above slack water (river km 236–249) between 15 December 1975 and 21 February 1976. We determined 36 of the overwintering fish to be of Dworshak Hatchery origin.

Adult Recovery and Egg Incubation Trials

The North Fork of the Clearwater River serves as the target spawning stream for returning Dworshak Hatchery steelhead. Fish may enter the hatchery via a ladder located on the North Fork side of the hatchery or are collected from a trapping facility located at the base of Dworshak Dam. Returning adults were sorted for ripeness at least once each week during the 1976 spring spawning period (March–May) at which time department personnel carefully examined each fish for jaw tags.

Tagged females, determined to be ripe, were spawned individually. An untagged female of similar size served as a control. The eggs from played and unplayed fish were air-spawned (Wharton 1957) into separate containers; then fertilized by the same two males. The sperm from both males was mixed and used to fertilize each female of the experimental pair. Eggs were allowed to water-harden, then placed in marked Heath incubation trays immediately next to each other in the same stack. The number of developing and blank eggs were counted at the eye-up stage.

The eye-up percentages from both the played and unplayed females were then recorded and statistically analyzed. A t-test for paired comparisons was used to test whether the mean of sample differences between pairs of eye-up percents was significantly different from zero. We also compared the eye-up percentage of the experimental fish to that of the hatchery average for a particular egg take.

RESULTS

Hatchery Tag Recoveries

Tagged steelhead which had been caught and released by anglers began returning to Dworshak in early March and continued entering the hatchery through May 1976. A total of 75 (40%) tags were recovered during the hatchery spawning operations. We recovered 56 (37%) tags from the 152 fish released on the lower Clearwater River, and 19 (53%) from the 36 hatchery steelhead released in the Snake River above the Clearwater confluence. The overall sex ratio of returning caught-and-released fish was 1:1.8 (♀:♂). This was identical to the tagging ratio of male and female hatchery fish.

TABLE 1.—*Percentage of eyed eggs for experimental pairs of played and unplayed female steelhead during the 1976 spawning return at Dworshak National Fish Hatchery. Experimental pairs were spawned with the same males.*

Trial number	Played percentage	Unplayed percentage
1	96.2	78.6
2	97.4	94.3
3	94.0	92.0
4	95.2	96.8
5	95.7	97.9
6	96.0	97.6
7	94.0	99.2
8	94.3	98.8
9	51.3	90.7
10	97.7	56.4
11	97.7	98.5
12	33.3	40.0
13	95.0	88.4
14	98.3	44.1
15	92.5	98.0
16	97.1	99.0
17	90.2	80.0
18	65.0	95.8
19	94.6	96.6
20	92.0	99.0
21	96.4	95.2
22	25.0	78.7
23	95.4	64.0
24	90.0	88.7
Mean	86.5	86.2

The peak recovery period occurred in mid-April when 32 marked fish entered the hatchery during a 10-day period. The maximum number of days between capture and recovery at the hatchery was 228 days, while the minimum recovery period was 45 days. The mean number of days between original capture and recovery at the hatchery for the experimental females was 152, and ranged between 45 and 205 days.

Egg Incubation Trials

We spawned 24 of the 26 returning catch-and-release females separately along with unplayed female controls. The first experimental steelhead was spawned on 13 April and the final female on 11 May. The average number of green eggs per experimental female was 5,880 and 7,830 eggs per fish for the controls. The air-spawning technique used at Dworshak Hatchery leaves approximately 10% to 14% of the eggs within the body cavity.

Paired comparisons for the percentage of

eyed eggs between played and nonplayed female steelhead produced mean differences that did not significantly differ from zero (t-test, $P > 0.05$) during the incubation trials. The mean number of eyed eggs counted was 5,180 per experimental female and 5,330 eyed eggs per control fish. The mean eye-up percent for the catch-and-release female was 86.5% and ranged from 25.0% to 98.3% (Table 1). The mean eye-up percentage for the unplayed females was 86.2% and ranged between 40.0% and 99.2%.

DISCUSSION

The nonsignificant difference in the viability or development of eggs between female steelhead trout which were caught and released and unplayed fish indicates that barring gross injury, released females can return to their target spawning streams and reproduce successfully. Although the experiment dealt only with hatchery-reared steelhead, I believe that native, wild steelhead released by anglers would demonstrate similarly successful spawning capabilities. The holding-pond environment and weekly automated sorting procedures used at Dworshak Hatchery are most likely comparable to the rigors of natural reproduction in the wild. Some females at Dworshak Hatchery are subjected to as many as 8 successive weeks of handling prior to spawning. Hooking and releasing can cause an initially greater physiological stress on hatchery fish than on wild rainbow trout (Wydoski et al. 1976). However, returning adult summer steelhead to the Snake River system have encountered severe selective processes and any physiological differences between hatchery and wild fish should be considerably reduced.

Several experimental pairs and individual females from both groups had unusually low eyed percentages during the trials. We carefully examined all females during the spawning process and failed to observe any gross abnormalities in their reproductive organs or products. However, the quality of sperm from hatchery males used during the trials was questionable at times. Due to the critically low number of returning adults during the 1976 run, project personnel were unable to be as selective as desired in choosing experimental males. On several occasions, bloody sperm was encountered during the fertilization of experimental pairs. It is the author's opinion that sperm viability was most likely responsible for the low values recorded for several experimental pairs. However, sperm quality was not recorded during the fertilization of experimental pairs.

It was not the scope of this manuscript to report on hooking mortality, but the somewhat high percentage of non-returns deserves mention. Although a degree of angling-caused mortality certainly existed, I do not believe that it accounted for a major part of the 60% non-return experienced during the study. Regulations which required the use of single barbless hooks and the elimination of bait fishing appeared to reduce significantly the occurrence of gross injury during capture. Of the 320 adults (wild and hatchery) caught, tagged and released during the 1975–1976 tagging period, only three were reported killed by anglers. During the 1975 catch-and-release season no steelhead carcasses, tagged or not, were observed by project personnel or reported by sportsmen.

I believe that the occurrence of straying and angler misidentification between hatchery and wild fish accounted for a substantial percentage of the non-returns. Workers on the Clearwater River have documented straying by Dworshak-reared steelhead past the hatchery and to other river drainages (Ball and Pettit 1974; Pettit 1976). To add to the occurrence of straying, adults returning in spring 1976 were released as smolts in the main Clearwater River rather than in their target stream, the North Fork (Fig. 1). Increased discharge from Dworshak Reservoir during the release period in 1973 caused lethal gas supersaturation levels in the North Fork below the dam. I believe that a significant number of tagged fish did not return to the hatchery because of a failure in their homing behavior, for whatever reasons.

Anglers who tagged steelhead for the study had been instructed to recognize hatchery fish by a deformed or eroded dorsal fin. However, I became aware during the

study that many of the cooperating anglers were interpreting damage to the dorsal fin caused by gill nets as a sign of hatchery origin on wild fish. This may have caused bias resulting in an exaggerated number of tagged hatchery steelhead. During the 1976–1977 tagging investigation, cooperating anglers were informed of this problem, and returns to the hatchery were greater than 70%.

As problems of steelhead trout management become more complicated and angler attitudes change in the western states and British Columbia, catch-and-release regulations should gain in popularity. No-kill restrictions applied to steelhead fisheries also may be a necessity to conserve endangered wild populations, especially in the Snake River tributaries of Oregon, Washington, and Idaho. Once anglers are taught to recognize differences between wild and hatchery reared steelhead, catch-and-release regulations could be used to protect fish of wild stocks, yet permit the harvest of hatchery fish.

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LITERATURE CITED

BALL, K., AND S. W. PETTIT. 1974. Evaluation of game and rough fish populations below Dworshak Dam and relationship to changes in water quality. Dworshak Stud. Performance Rep. DSS-29-4. Idaho Dep. Fish Game, Boise. 122 pp.

BOUCK, G. R., AND R. C. BALL. 1966. Influence of capture methods on blood characteristics and mortality in the rainbow trout (*Salmo gairdneri*). Trans. Am. Fish. Soc. 95(2):170–176.

HEMUS, D. 1974. Dean River summer steelhead-observations on life history, population and the fishery in 1973. Unpublished file report. B.C. Fish Wildl. Branch, Nanaimo. 48 pp.

JOHNSON, T. H., AND T. C. BJORNN. 1975. Evaluation of angling regulations in management of cutthroat trout. Job Performance Report: F-59-R-6. Univ. Idaho Coop. Fish. Res. Unit, Moscow. 46 pp.

MARNELL, L. F., AND D. HUNSAKER. 1970. Hooking mortality of lure-caught cutthroat trout (*Salmo clarki*) in relation to water temperature, fatigue and reproductive maturity of released fish. Trans. Am. Fish Soc. 99(4):684–688.

PETTIT, S. W. 1976. Evaluation of game and rough fish populations below Dworshak Dam and relationship to changes in water quality. Dworshak Fish. Stud. Job Completion Rep. DSS-29. Idaho Dep. Fish Game, Boise. 120 pp.

REINGOLD, M. 1975. Effects of displacing, hooking, and releasing on migrating adult steelhead trout. Trans. Am. Fish. Soc. 104(3):458–460.

USHER, J. B. 1975. Vedder River tagging program 1974–1975. Unpublished file report. B.C. Fish Wildl. Branch, Nanaimo. 28 pp.

WHARTON, J. C. F. 1957. A preliminary report on new techniques for the artificial fertilization of trout ova. Victoria Fish. Contrib. 6. Snob's Creek Fish. Res. Stn., Victoria. 17 pp.

WYDOSKI, R. S., G. A. WEDEMEYER, AND N. C. NELSON. 1976. Physiological response to hooking stress in hatchery and wild rainbow trout (*Salmo gairdneri*). Trans. Am. Fish. Soc. 105(5):601–606.