FISHERY RESEARCH

HISTORY OF RESIDENT HATCHERY RESEARCH BY IDAHO DEPARTMENT OF FISH AND GAME, 1957-2011

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ANNUAL REPORT

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TABLE OF CONTENTS

Page

Table of Contents, continued.

Page

EXECUTIVE SUMMARY

The Idaho Department of Fish and Game (IDFG) was created in 1899, and in 1907 the state legislature authorized IDFG to construct and operate a fish hatchery. Over the next several decades, the few IDFG employees there were in the state worked mostly at raising fish at state hatcheries. After World War II, angling pressure increased greatly in Idaho and across the US. Due in part to increased demand for the hatcheries to produce quality fisheries, Department fisheries biologists (what are now known as regional fisheries managers) began conducting formal evaluations of some stocking programs. In the mid-1980s, an amendment to the federal Dingell-Johnson Act expanded the sources of revenue to the states for fisheries management, and by the early 1990s, a formal "Hatchery Trout Evaluation" subproject was formed to focus Department studies on hatchery trout performance at a statewide level. Twenty years later, this project continues to evaluate the performance of resident hatchery salmonids.

The research IDFG staff has conducted on hatchery trout has been expansive. In the earliest years (starting in the late 1950s), studies focused on diet, size at stocking, timing of stocking, exercise conditioning of stocked fish before they were released, and fin condition, in order to assess how these factors affected fish performance (usually evaluated with creel programs). By the 1980s, strain evaluations were being conducted, and a re-evaluation of size at stocking (fingerlings vs. catchables) was initiated for lentic waters. Two 'training' studies (food and predators) and a selective breeding study were initiated in an attempt to improve survival and catchability of stocked fish. In more recent years, the focus of IDFG hatchery trout research has been on triploid fish, which were produced to protect native fish (by circumventing hybridization issues) and potentially improve performance (i.e., the 'hybrid vigor' notion). The comparative performance of triploids (relative to diploid fish) was evaluated in streams, lakes and reservoirs, and high lakes.

This report summarizes IDFG's research on the performance of resident hatchery trout stocked in Idaho waters. Although the studies outlined within cover a vast array of successful and unsuccessful research projects, the following list is a highlight of the most relevant findings:

Streams

- **Fin erosion:** Based on IDFG research, fin quality is probably not important for hatchery fish stocked in lentic environments or flat-gradient streams, but in higher gradient streams, fin absence or deformation (termed "fin erosion") probably will impair a fish's ability to feed and hold position in the water column, which appears to result in faster mortality and lower return to creel. See page 12 for details.

- **Survival and dispersal:** Work by IDFG biologists (and others) has shown that most hatchery catchable rainbow trout stocked in streams, regardless of strain, do not persist for more than a few weeks or a month. They also do not move more than about 1km from the stocking location. Recommendations were to stock streams throughout the fishing season (since they so often perish quickly), within 1km of the best fishing access locations. See pages 22 and 33 for details.

- **Diploid vs Triploid:** IDFG studies suggest that triploid catchable rainbow trout perform as well as diploid catchables in streams. Based on this finding, stream stocking in Idaho of rainbow trout is now generally done with triploids in order to avoid hybridization issues with native stocks. See page 32 for details.

Lakes and Reservoirs

- **Spring fingerlings:** Spring-stocked fingerlings in lakes and reservoirs exhibit the lowest cost/fish in the creel and sometimes produce good fisheries, suggesting they may be the most cost-effective choice for stocking if they can actually produce a fishery. Despite this conclusion, fingerlings are currently (in 2011) only stocked in a few dozen lentic waters, whereas catchables are stocked in over 500 waters, mostly in lentic environments. This is because fingerling stockings often fail completely, due to predatory issues or because water carryover is lacking. See page17, 21, and 27 for details.

- **Fall fingerlings:** Fall fingerling plants have generally not been effective at providing any fisheries in Idaho waters. Although IDFG studies in the 1950s generally showed this to be true (see page 8), it was revisited in the 1990s because maximization of rearing space suggested that stocking some fingerlings in the fall would create space to then continue raising the remaining fish for catchables the following year (see page 17). However, both studies showed that fall fingerlings generally failed to produce fisheries.

- **Fingerling stocking rate:** Stocking rates for fingerlings should not exceed 350 fish/hectare for 75-100 mm trout or 200 fish/hectare for 150-175 mm trout. See page 21 for details.

- **Fingerlings and zooplankton:** Because fingerlings rely heavily on zooplankton, fingerlings should be stocked at 150-300/acre when ZQI is >0.60, at 75-150/acre when ZQI is 0.25-0.60, and not stocked (use catchables instead) when ZQI is <0.25. See page 18 for details.

- **Fingerlings and predators:** Fingerlings in Idaho can be expected to perform especially poorly in water bodies with large numbers of predators such as bass and northern pikeminnow. Even training fish in raceways to recognize predators produced no measurable increase in performance, although strong conclusions cannot be drawn because sample fish were not recaptured in this study due to poor study design (this may be a topic to re-investigate if a better method of marking or collecting fingerling test fish is ever developed). Nevertheless, conclusions can be made that in water bodies with high numbers of predators, catchables are probably the only choice for stocking. See pages 21 and 27 for details.

- **Catchable exercise training:** A series of investigations by IDFG staff in the 1960s suggests that exercise training of hatchery fish may improve the performance of stocked fish, especially in streams. However, these studies were somewhat inconclusive, and this would be better investigated if many plantings (in streams and lakes) were included in one large study design, and training periods were 30-40 days in length rather than the shorter length of exercise (15 days) in these studies. This concept is probably worth re-investigating with further research. See pages 9-10 for details.

- **Strain evaluations:** The Hayspur strain of rainbow trout was shown to perform (in terms of angler creel surveys) as well or better than most other available strains of hatchery rainbow trout when released as fingerlings in reservoirs, and better than two other strains in flow-through reservoirs when released as catchables. Based on these results, IDFG staff concluded that Hayspur strain rainbow trout should be used for general fingerling and catchable programs in Idaho. However, these studies were far from conclusive, so it is difficult to conclude that use of alternate strains affect hatchery performance. Depending on other priorities, it may be worth re-evaluating strain performance at some point, especially with the new tool available for evaluating performance of catchables (i.e., the Tag Reporting Hotline and Website). The difficulty would be evaluating fingerlings, for which sampling test fish is currently very difficult. See pages 14-16 for details.

- **Size at stocking:** Two studies in the 1990s suggested that the largest fish in any given raceway might return to creel at a much higher rate than the smaller fish. However, neither study was conclusive. If such a difference were shown to be substantial, this could have ramifications for hatchery rearing strategies (i.e., size grading), stocking strategies, feed purchase, etc. This may be a topic partly answered with the new Fish Tag Reporting Hotline and Website, and is an avenue of potential future research. See page 25 for details.

- **Diploid vs triploid catchables:** It appears that diploid catchable rainbow trout will grow and survive better in reservoirs subject to low water levels and that have many other species of fish present, whereas triploid catchables will perform equal to diploids in good habitat conditions. These findings are fortuitous because triploids appear suitable in higher quality habitats where they pose no threat to native trout, whereas diploids are better suited for reservoirs with degraded habitats where native wild trout are usually absent. See page 36 for details.

- **General conclusions in lentic water bodies:** In reservoirs that maintain an adequate pool of water for annual trout carryover, triploid fingerlings will survival as well as diploid fingerlings, and triploid catchables will survive as well as diploid catchables. Whether to use fingerlings or catchables will depend on factors such as the availability of catchables, the growth rate of fingerlings, zooplankton abundance and quality, the presence of predators such as pikeminnow and bass, regulations at the water body, the expected number of years with no drawdown, and other factors that will influence whether fingerlings can grow large enough to eventually provide quality angling opportunities. In contrast, diploid catchables should be stocked in lowland lakes subjected to greater drawdown and with high species diversity where they pose little to no threat to substantive native trout populations. See pages 17, 21, 27, and 36 for details.

High lakes

- **Size and timing of stocking:** Rainbow trout or a subspecies of cutthroat trout should be stocked in July and August, at sizes from 25-50 mm in total length, at densities of 50-200 fish/acre, and on a rotation of every two to four years. See pages 29-30 for details.

- **Diploid vs. Triploid:** All-female triploid fish raised from Troutlodge eggs performed substantially better (in angler and gillnet catch) than diploid and triploid fish from Hayspur, and diploid Hayspur fish outperformed triploid Hayspur fish by an almost 4-fold difference. Based on these results, most IDFG managers now request all-female triploids from Troutlodge for alpine lake stocking. See page 33 for details.

ANNUAL REPORT

ABSTRACT

The Idaho Department of Fish and Game (IDFG) began construction of its first hatchery in 1907 and began stocking mostly fingerlings (5 million annually) at 3-8 cm in length. By the late 1940s, it was apparent that fingerlings often contributed little to the fisheries where they were stocked, and at this time catchables (200-300 mm in length) started being released. Research by IDFG began in the late 1950s to investigate ways to improve hatchery trout return to the creel, but it was not until the late 1980s that a formal statewide research program was developed that specifically focused on research questions regarding resident hatchery trout performance in the hatchery and the field. Numerous studies have been conducted by IDFG in the last several decades, including studies on how survival or harvest is related to hatchery diet, ability to recognize predators, ability to recognize natural food, exercise, fin quality, size at stocking, time of stocking, strain, availability of zooplankton, and ploidy level. This report summarizes the research conducted by IDFG staff on resident hatchery trout performance, the conclusions drawn from this research, and the questions these studies have raised or not answered adequately, and that may be appropriate for future IDFG hatchery research.

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INTRODUCTION

In 1890, Idaho was admitted to the Union as the 43rd state, and in 1899, the fifth state legislature established the Idaho Department of Fish and Game (IDFG). In 1907, the legislature authorized the Department to erect and maintain a fish hatchery in the state for the purpose of artificially propagating and distributing food and commercial fishes. That same year, the Department constructed its first fish hatchery at Hayspur, and in 1908, it was followed by hatcheries at Sandpoint and Warm River. Over the next several decades, the few IDFG employees in the state mostly worked to raise fish at these state hatcheries. At this time, IDFG generally released about 5 million annually, with most fish ranging from 3-8 cm in length.

After World War II, angling pressure increased greatly in Idaho and across the US. The modern era in Idaho fishery management and research started in 1946 when the Department hired Jim Simpson to head the Fisheries Division as the state fish culturist. He was the first trained scientist employed by IDFG. By 1949, the Department had five fisheries biologists, two as fisheries biologists and three as area fisheries biologists (what are now known as regional fisheries managers). Around this time, IDFG was beginning to raise and stock catchable-sized trout (200-300 mm in length; 300,000 released in 1949) based on evaluations conducted by these newly-hired biologists, who found that fingerlings were often contributing little to the fisheries in which they were released.

The Dingell-Johnson (D-J) Act (also called the Federal Aid in Sport Fish Restoration Act) was passed by Congress in 1951, resulting in federal excise tax dollars being distributed to all states for fish restoration and management plans and projects. This allowed Idaho to place area (regional) fisheries biologists in six areas of the state. With this expansion, fisheries investigations began within regions. Most of the early work in the 1950s was focused on Idaho salmon and steelhead runs or the Lake Pend Oreille kokanee population, but by the late 1950s, studies were initiated to identify ways of maximizing return to creel for hatchery trout.

By 1950, Idaho operated 17 resident fish hatcheries, 5 of which were seasonal stations that produced small numbers of fry and small fingerlings. These hatcheries produced 246,540 pounds of fish, including 882,000 catchables. The very first resident hatchery trout study reported in Idaho by IDFG staff was conducted by none other than Ted Bjornn, who in 1957 studied the relationship between the hatchery diets of catchable trout and their return to creel in Stanley Lake and the Yankee Fork of the Salmon River. The first comparison of fingerling vs. catchable performance was conducted by James Keating in 1959 on several water bodies in the Lewiston region. Resident fisheries research for the next three decades continued to be primarily concentrated on water-specific questions around the state. Resident hatchery evaluation projects occurred regularly in the 1960s and early 1970s, but afterwards most regional investigations were focused on wild fish populations, and few hatchery return to creel evaluations were made. Catchable stocking rose from 882,000 in 1950 to 2.7 million in 1960. By 1975, IDFG was operating 13 hatcheries, two of which were seasonal stations that produced small numbers of fingerlings. Total production at this time had risen to 957,588 pounds of fish, including 3.1 million catchables.

A 1984 amendment to the D-J Act expanded the sources of revenue to the states for fisheries management. At the 1985 IDFG fishery managers meeting, a group decision was made to create regional fish biologists with the additional funding. This allowed each regional program to conduct studies on wild or hatchery fisheries within their region. The D-J funded research projects were then directed to focus on broader questions with statewide implications. By 1988, this transition was complete, and new research projects were prioritized based on the collective needs of the regional fish managers. A “Wild Trout” subproject was formed first, but by the early 1990s, a formal “Hatchery Trout Evaluation” subproject was formed, and Greg Mauser and Jeff Dillon were the first research biologists to focus their studies on hatchery trout performance at a statewide level.

This report summarizes IDFG’s research on resident hatchery fish performance or stocking success, usually expressed as return to creel. The report starts with early work done on a regional basis, and then transitions to the more recent research conducted from a statewide perspective. The research is generally organized chronologically, but at times studies are grouped together more by topic than chronology, with topics such as “Evaluations in Lakes and Reservoirs,” or “Relative Performance of Diploids and Triploids.”

This report should serve as a historical reference for each particular study, including a compilation of reports and publications that were produced. In place of a Literature Cited section, the most relevant report (usually the job completion report) is noted within each research project, as well as any peer-reviewed publications stemming from the research. However, it is important to note that, in many instances, many progress reports were also written on these subjects before the final report was produced. It is hoped that this summary will help biologists manage Idaho fisheries better and help guide future resident hatchery trout research in Idaho.

EARLY REGIONAL-BASED RESEARCH IN IDAHO

1950s – Relationship between diets of hatchery trout and return to creel

Purpose: In 1957 and 1958, Ted Bjornn initiated the first reported study by IDFG staff on resident hatchery trout by testing whether the performance of hatchery trout fed regular 'production' diet was equal to that of fish fed a newly developed commercial pellet diet, in an effort to compare return to creel for anglers.

Methods: Hatchery trout raised at Mackay Hatchery were fed either a new pellet diet, or the state's normal production diet that consisted of 2.1% beef liver, 83.0% beef lung, 2.2% horse meat, 2.8% salmon viscera, and 10.2% state pellets. Fish were differentially fin-clipped (dorsal and adipose clips), then stocked in Stanley Lake and Yankee Fork in 1957 and 1958. Fish size at stocking was on average 2.6 fish/lb for pellet-fed fish and 3.5 fish/lb for the production diet. Creel surveys were used to assess differences in performance.

As background information, hatchery fish diets before the late 1950s were primarily red meat or "wet diets." Commercially available animals, local farm animals, and fresh roadkills were ground at several IDFG hatcheries, as well as viscera not suitable for human consumption. American Falls, Hagerman, and Eagle were the main "killing" hatcheries. There was a mild panic in the early/mid-1950s when supplies of horsemeat were dwindling. Workers began to seine and grind rough fish to supplement the red meat diets. This put pressure on finding alternative sources of protein for fish food.

The 'production' diet probably had the consistency of hamburger as it was ground and then spooned into the raceways from large tubs. The 'pellet' feed was probably the dry, steam-pressed pellet developed and manufactured at the time by Rangen, Inc. Red meat on its own was a poor fish feed. It took 8-10 lbs of the wet diet to make 1 lb. of fish, which is a terrible conversion rate compared to what can now be accomplished by the dry pellet feeds of today. It is common now to get close to a 1:1 conversion for dry pellet feed, and, depending on the fish species and hatchery conditions, e.g. schooling fish like kokanee, conversions can be better than 1:1.

Findings: Returns to creel on average were 11% higher for fish fed pellet diets than those fed the production diet. Statistical comparison of the means revealed there was less than one chance in twenty that the differences were caused by chance alone.

Conclusion: The reason for the higher return was not determined, but Bjornn speculated that the difference in size was a likely explanation. The fish not only grew faster on the pellet diet, but the cost to produce a pound of trout was also lower for the pellet diet ($0.18/lb.) compared to the production diet ($0.26/lb.).

Project completion report: Bjornn, T. 1959. Tests for increasing the returns of hatchery trout. Project F-32-R-1. Idaho Department of Fish and Game, Boise.

Publication: None.

1950s – Survival of planted trout to creel as related to their size and time of planting

Purpose: In many heavily fished waters, it was necessary to plant fish at frequent intervals to maintain satisfactory fishing. However, where more moderate fishing pressure occurred, a series of studies were conducted to determine the effect that size at stocking and timing of planting had on angler return to creel.

Methods: Catchables were stocked in several waters throughout the state, including Stanley Lake, Yankee Fork, Toponce, and Pebble creeks, and Kelso and Spirit lakes. Stocking occurred either (1) at the start of the season, or (2) in several equal plantings throughout the season. Other studies compared relative return to creel of fingerlings stocked in the fall and catchables stocked in the spring.

Findings: Returns were higher for catchables stocked at the beginning of the season or even a month before the season than for those stocked later in the season, and this was true for both streams and lakes. The authors concluded that the increased returns occurred because when all fish were stocked before or at the beginning of the season, they were exposed to angling pressure for a longer period of time. Fishing pressure was also highest in May and decreased in successive months. When stocking was spaced throughout the fishing season, those stocked later in the year were exposed to much less angling pressure because angling pressure waned substantially after the season opener.

The many years of fingerling vs. catchable research suggested that in general, fingerlings planted in the fall did not survive well through the following year and contributed poorly to the creel of anglers.

Conclusions: Despite the findings that total returns are often better for catchables stocked early in the season, subsequent years of investigation suggested that mid-summer plants were needed to augment an otherwise slow period of fishing, and that such plants did maintain angling success at a relatively high level. Recommendations were to stock catchables periodically throughout the fishing season to increase catch rates during mid- and late-summer. And despite the conclusion that fall fingerling plants were unsuccessful, this was re-evaluated again by IDFG biologists in the mid-1990s (see below), possibly because they were unaware of this earlier work.

Project reports: Bjornn, T., P. Cuplin, P. Jeppson, R. Pirtle, and M. Richards. 1959. Tests for increasing the returns of hatchery trout. Project F-32-R-1. Idaho Department of Fish and Game, Boise.

Richards, M., P. Jeppson, J. Keating, and S. Gebhards. 1962. Tests for increasing the returns of hatchery trout. Project F-32-R-4. Idaho Department of Fish and Game, Boise.

Publication: None.

1960s - Exercise training hatchery rainbow trout to increase angler return to creel

Purpose: During the late 1960s, a series of studies were conducted independently by several IDFG fisheries biologists to examine the effect of exercise training on return to creel rates of catchable size hatchery rainbow trout.

Methods: Fish were conditioned by pulling the dam boards at the end of a raceway to lower the water to about one foot of depth, thereby increasing water velocity. No attempts were made to measure water velocity, since this varied with the density of fish in the raceway, inflow rate, and relative position of the fish during the exercise period, and because the study was initiated with hatchery practicality in mind. The daily exercise period was set for 15 minutes a day. Hatcheries exercised fish for 5 or 10 days. Equal numbers of jaw tagged fish from the experimental (exercised) and control (non-exercised) groups were stocked into several streams and reservoirs (see Table 1).

Findings: Overall, IDFG biologists individually interpreted their data as rarely resulting in a significant increase in returns due to exercise training.

Table 1. Return rates for catchable-size rainbow trout from unexercised, moderate-duration exercised (15 min per d for 5 d), and high-duration exercised (15 min per d for 10 d) groups stocked during 1967. Return rates are summed across stocking dates.

	# Stocked			# Returned			Return Rate			% increase	Difference
Stocking Location	Control	5 day	10 day	Control	5 day	10 day	Control	5 day	10 day	from training	(10 day to control)
Portneuf River	1,500		1,500	390		415	26.0		27.7	6.5	1.7
MF Boise River	3,000		3,000	624		730	20.8		24.3	16.8	3.5
Big Wood River	2,500		2,500	336		337	13.4		13.5	0.7	0.1
Little Salmon River	2,918	2,981	3,000	963	1,226	1,692	33.0	41.1	56.4	70.9	23.4
Spring Valley Reservoir	500	500	500	138	144	131	27.6	28.8	26.2	-5.1	-1.4
Waha Lake	500	500	500	79	80	83	15.8	16.0	16.6	5.1	0.8
Blackfoot River[a]	2000	2000	2000	110	127	151	5.5	6.4	7.6	37.3	2.1
St. Joe River	900	900	900	23	33	32	2.6	3.7	3.6	39.1	1.0
St. Joe River	600	600	600	15	9	11	2.5	1.5	1.8	-26.7	-0.7
Average							16.4		19.7	16.1	3.4

[a]Exercise training periods were longer (23 and 28 days) due to high water precluding stocking the fish on time.

Conclusion: In actuality, these studies should have been combined for analyses. When viewed together, the control and high duration groups returned at 16.4 and 19.7%, respectively, which equaled an average absolute difference of only 3.4% but a relative percent increase of 16.1% (Table 1). Although the CIs around the bounds of these estimates contain zero, the sample size (n = 9) was relatively small and thus there was little power to detect a true effect. In addition, the training regimen was very short; most other studies in the literature have trained fish continuously for at least 30-40 d at ≥1.5 body lengths/s (Kozfkay 2004).

The difference was larger for river stocking (mean effect = 20.7%) than for reservoirs (mean effect = 0%), and this is not surprising since training may have a greater effect for fish stocked in flowing water where energy expenditures are greater. Taken together, it appears that exercise training may have merit, especially for streams, and this would be better investigated if many stockings (in streams and lakes) were included in one large study design, and training periods were 30-40 days in length.

Project completion reports:

Casey, O., W. Webb, J. Mallet, T. Holubetz, T. Welsh, D. Corley, K. Ball, and P. Jeppson. 1968. Tests for increasing the return of hatchery trout. Project F-32-R-10. Idaho Department of Fish and Game, Boise.

Kozfkay, J. 2004. Exercise Training -- A review of recent literature and past IDFG research projects. Unpublished white paper.

Welsh, T., O. Casey, J. Mallet, W. Webb, R. Bell, P. Jeppson, and D. Corley. 1969. Tests for increasing the returns of hatchery trout .Project F-32-R-11. Idaho Department of Fish and Game, Boise.

Publication: None.

1965 – Effects of scattering catchables with a barge to increase return to creel

Purpose: A small study was conducted in American Falls Reservoir to assess whether scattering catchables with a barge (rather than releasing them at a boat ramp) would improve return to creel.

Methods: A total of 12,500 catchable rainbow trout were given pelvic fin clips (left clip for barge release, right clip for boat ramp release) and stocked in April 1965 at an average of 2.3 fish/lb. A creel census was conducted to determine the return of marked fish.

Findings: The creel census included 4.1% of the catchables released at the boat ramp and 3.4% of the catchables released from the barge. The remainder of the creel was either wild trout, hatchery trout from earlier years of planting, or fingerlings stocked simultaneously with the catchables for this study (these fingerlings made up a very small percentage of the creel, and were deemed unsuccessful). Growth rates for both groups were practically identical, averaging 273 mm at planting and 413 mm by July 15.

Conclusion: Barging catchables away from the boat ramps did not improve return to creel, but barging of catchables and fingerlings continued in later years, with haphazard evaluation. Barging was never shown to improve return to creel and was eventually discontinued. However, none of these studies were rigorously designed, so whether barging may improve return to creel was never definitively decided. This may explain why the practice continued well after the inconclusive results from this work.

Project completion report: Casey, O. E. 1966. Tests for increasing the returns of hatchery trout. Project F-32-R-8, Job No. 2. Idaho Department of Fish and Game, Boise.

Publication: None.

1970s - Effects of fin erosion and removal on catchable performance

Purpose: To test the hypothesis that fin mutilation affects the rate of return of hatchery trout to the creel in varying degrees in different types of aquatic environments.

Methods: In the first experiment in 1970, all of the hatchery trout for the study were reared at the Hagerman Fish Hatchery and later delivered to the McCall Hatchery. The proportion of fish missing various fins or with no fin deformation was classified; missing was classified as absent or badly clubbed. Metal jaw tags were attached to a control group of fish and to another group of fish with deformed pectoral fins. From the last group of tagged fish, all existing paired fins were removed, as was the dorsal fin, if present. Tagged fish were planted in a steep gradient stream, a flat gradient stream, and a natural lake. No special effort was made to contact anglers, and the bulk of the returns came through the mail.

A second study was undertaken many years later (in 1979) in the Portneuf River as part of a Master's Thesis at Idaho State University that was never completed, although the fieldwork was. In this experiment, hatchery fish were sorted and jaw-tagged based on whether they had fully developed pectoral fins or no pectoral fins at all; thus, no fin clipping was conducted.

Findings: In the first experiment, test fish on average were about 9.6 inches in fork length. One or more of the paired fins were deformed on 84, 72, and 49% of the study waters. Tag returns from anglers ranged from 3.0 to 8.8%. In all three study waters, fewer tags were returned for fish having no paired fins.

In the second experiment, there was no difference in the number of fish caught (by anglers or with electrofishing) with or without pectoral fins.

Conclusion: The first study concluded that the lower return of fish resulted from loss of paired fins that reduced a fish's ability to occupy desirable feeding positions in streams and being less able to capture food items in both lake and stream environments. The authors suggested the most adverse effects of having no paired fins might occur for those fish planted in steep gradient streams and the least effects in flat gradient streams and lake environments.

The second experiment concluded that fish without pectoral fins were equally able to maneuver in the water column for effective foraging and holding behavior. However, the authors noted that the Portneuf River, with its low gradient and abundant food supply, offered a relatively benign environment. They suggested that under more demanding physical conditions, the lack of pectoral fins may be more detrimental.

Project completion report: Welsh, T., O. Casey, W. Webb, R. Bell, P. Jeppson, D. Corley, and J. Heimer. 1970. Tests for increasing the returns of hatchery trout. Project F-32-R-12, Idaho Department of Fish and Game, Boise.

Publication: Heimer, J. T., W. M. Frazier, and J. S. Griffith. 1985. Post-stocking performance of catchable-sized hatchery rainbow trout with and without pectoral fins. North American Journal of Fisheries Management 5:21-25.

1970 – Returns of catchables stocked in early spring

Purpose: Because some sporting groups were requesting that the Department stock catchables in early spring, a study was undertaken to evaluate return to creel of fish stocked before high water.

Methods: In 1968 and again in 1970, jaw-tagged catchables were stocked in the Salmon River in March.

Findings: Returns were 6.5% in 1968 and 0.7% in 1970.

Conclusion: Returns were determined to be too low to justify stocking fish before high water. This practice, although rare to begin with, was dismissed entirely, due to low returns to anglers.

Project completion report: Corley, D. 1971. Early spring plantings of tagged trout in the Salmon River near Challis, Idaho, 1970. Idaho Department of Fish and Game, Boise.

Publication: None.

STRAIN EVALUATIONS IN IDAHO LAKES AND RESERVOIRS

Mid-1980s – Performance of alternate strains of fingerling rainbow trout in reservoirs

Purpose: A multiyear study was undertaken to evaluate the suitability and performance (both in-hatchery and in reservoirs) of several strains of fingerling rainbow trout for release in Idaho lakes and reservoirs.

Methods: From 1982 to 1986, fingerlings from seven strains of rainbow trout (five domestic strains - Hayspur, Mt. Shasta, Mt. Lassen, Mt. Whitney, and Kamloops, and two wild strains - McConaughy and Eagle Lake) were released in various combinations in three reservoirs (Magic, Anderson Ranch, and Mormon). See Partridge (1986) for extensive details on each hatchery strain. Reservoir performance included harvest estimates, growth rates, and distribution of the individual strains. Hatchery performance included survival, growth, and incidences of precocialism. Each strain was also held in the hatchery for an extended period (4-6 months) to evaluate in-hatchery performance. Grit dye was used to mark fish that were released to the reservoirs, and angler creel surveys were used to evaluate performance.

Findings: Due to a combination of reasons, returns of marked fingerling rainbow trout to anglers throughout the study were low, ranging from zero to 3.3%, which reduced our ability to evaluate differences in strains. Low reservoir survival was caused by record water flows in 1983 and 1984 and by significant losses during stocking in 1985. Strain identification was also affected by variable quality and retention of the fluorescent grit marks. The Hayspur strain had similar return rates compared to other strains in Magic Reservoir and significantly better returns in Anderson Ranch Reservoir. In Magic Reservoir, the Mt. Lassen strain was harvested in greater proportion by bank anglers, and the Mt. Shasta strain was caught in greater proportion by boat anglers. In Mormon Reservoir, the Eagle Lake and Mt. Shasta strains returned in equal percentages, which were better than the McConaughy strain returns. Emigration in outlets showed higher numbers of Mt. Shasta and McConaughy strains than Eagle Lake rainbow trout. Growth rates of all strains were generally similar in reservoirs. In hatcheries, the most significant difference in performance was between domestic and wild strains. The McConaughy and Eagle Lake strains had slower growth rates and higher mortality rates, resulting in higher rearing costs.

Conclusion: The resident Hayspur strain, which had never been evaluated against other strains, performed as well or better than other strains when released as fingerlings into reservoirs. These findings were similar to those of Maiolie (1987), where catchable-size Hayspur rainbow trout provided generally superior return rates to the angler over the Mt. Lassen and Sand Creek strains in a flow-through hydroelectric reservoir. Based on these combined results, it was concluded that the Hayspur strain rainbow trout should be used for general fingerling and catchable programs in Idaho.

Project completion report: Partridge, F. 1988. Lake and Reservoir Investigations. Subproject 3, Study 2: Alternative Fish Species and Strains for Fishery Development and Enhancement. Job 1: Alternate Species for Lake and Reservoir Fisheries. Report 069 (Article 17). 75 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

Mid-1980s – Performance of alternate strains of catchable rainbow trout in reservoirs

Purpose: Building off earlier work on fingerling strain evaluations, a study was undertaken to evaluate the suitability and performance of several strains of catchable rainbow trout for release in Idaho lakes and reservoirs.

Methods: Nine strains of rainbow and cutthroat trout were evaluated for their potential to enhance the Ashton Reservoir fishery: (1) Bear Lake cutthroat trout, (2) Finespotted cutthroat trout, (3) Henrys Lake cutthroat trout, (4) Hayspur rainbow trout, (5) Mt. Shasta rainbow trout, (6) Sand Creek rainbow trout, (7) Kamloops rainbow trout, (8) Mt. Lassen rainbow trout, and (9) generic rainbow trout. The histories and origins of these strains are described in Maiolie (1987).

Findings and Conclusion: Hayspur rainbow trout exhibited better return rates than other trout strains in two out of three comparative evaluations. The one test in which they did not perform well was conducted during the summer of 1986. Even during this test, they had the best performance for the first four weeks. After the fourth week, a second group of 2,000 of each strain was stocked. It was after this stocking that Hayspur trout did not outperform other strains, which suggests that problems occurred with this group of fish. The authors hypothesized that they were less aggressive feeders, or encountered problems while being transported.

Hayspur fish were also preferred because they had a higher harvest rate by bank anglers. This was a desirable attribute because bank anglers were generally less effective than boat anglers and comprised 69% of the fishing effort in Ashton Reservoir. Hayspur trout should be the first choice of fish to stock. They are especially preferable to finespotted cutthroat trout or generic rainbow trout and could reduce the number of fish needed by 50%. Hayspur trout were deemed more desirable because of their immediate vulnerability after stocking and an apparent low dispersion rate. Finespotted cutthroat behaved differently, moving quickly from the point of stocking, resulting in more gradual returns over time. Both factors likely contributed to their low overall returns.

Generic trout (Mt. Lassen strain) gave variable results. They performed well during the summer of 1986 with a 46% return rate, but did less well during the two other tests, with return rates of 25% and 13%. Variability may have been due to differences in the quality of the eggs. Eggs from older or later maturing fish may be of lower quality and thus are sold by hatcheries at a lower price. Eggs bought for this study could have been from a variety of lots, thus resulting in variable results. A logical extension of this study would be to test this hypothesis and other variations within strains, such as pond versus raceway rearing.

Project completion report: Maiolie, M. A. 1987. Ashton Reservoir fishery enhancement evaluation, Job Completion Report. Idaho Department of Fish and Game, Boise.

Publication: None.

1993 – Synopsis on rainbow trout strain evaluation in lakes and reservoirs

Purpose: In the early 1990s, IDFG commonly raised up to 13 strains of rainbow trout for stocking statewide. In most fisheries, the benefits of strain selection are unclear. Available literature on hatchery and field performance of various rainbow trout strains were reviewed to describe the expected benefits of strain selection for individual fisheries and for statewide use.

Methods: Journal articles, published and unpublished papers, agency reports, and other related materials were reviewed for information on rainbow trout strain evaluations. Information was summarized under the following categories: behavior, vulnerability, growth, return/harvest, survival, reproduction, and cost.

Findings: Past strain evaluation experiments show that fishery performance (survival, growth, returns) can vary markedly among rainbow trout strains. Many strains outperformed another particular strain in a particular body of water, but results were completely reversed in a separate study. However, most evaluations reviewed included few spatial or temporal replications, and no strains have been evaluated over a broad geographical area. Variability in broodstock quality, size of fish stocked, time and date of stocking, and the fishery environment can also influence the performance of a particular strain. Strain selection appears to be more important for fingerlings (where long-term survival and growth is required) than for catchable programs. Domesticated strains typically do not survive well under natural conditions, whereas wild strains generally show superior survival and growth, and may be longer-lived than domesticated fish. Late-maturing stocks may have particular application in waters managed for trophy trout.

Conclusion: The authors recommended that IDFG fish managers not consider using alternate rainbow trout strains as a method for improving fisheries. If strains are ordered, they should be considered experimental and evaluated against our standard Hayspur broodstock. For catchable programs, it was recommended that broodstock production should be expanded, and reliable commercial egg sources (regardless of strain) should be found to supplement instate production. For fingerlings, it was recommended that development of a wild lacustrine broodstock should be considered, or wild genes should be infused into the Kamloop rainbow trout broodstock.

Project completion report: Dillon, J. C., and D. Megargle. 1994. Put-and-Grow Trout Evaluations. Job 1: Synopsis of Information on Put-and-Grow Trout Management. Job 2: Put-and-Grow Versus Put-and-Take Stocking Experiments. Job 3: Hatchery Capabilities. Job 4: Rainbow Trout Strain Synopsis. Report No. 94-08. 90 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

GENERAL HATCHERY EVALUATIONS IN IDAHO LAKES AND RESERVOIRS

Mid 1990s - Fingerling/catchable tradeoffs in Idaho lakes and reservoirs

Purpose: The performance of 72 fingerling and catchable plants in 20 lakes and reservoirs was evaluated to develop a more efficient stocking program. Although much fingerling and catchable work had been done already by IDFG staff (see above), this attempt was the first to set up such a large sample size and investigate this concept at a programmatic level.

Methods: Each study water received plants of catchable and fingerling rainbow trout. Catchables were stocked in the spring and ranged in size from 200 mm to 250 mm total length. Fingerlings were planted in both spring and fall periods and ranged in size from 75 mm to 175 mm. Stocking densities for each group were not standardized and were based on manager requests. After release, the relative success of each plant was evaluated using creel surveys. Harvest estimates from creel surveys, planting records, and production costs were used to estimate cost per fish creeled for each plant. Production costs were assumed to be $1.61 per pound (IDFG 1997). Total plant costs for each stocking event were estimated by multiplying the pounds of fish stocked by the production costs. Cost per fish creeled was estimated by dividing the total plant cost by the number of fish harvested. Growth of each release group was monitored by recording total length and weight of creeled fish. In some waters, electrofishing and gillnet surveys were also used to increase sample sizes for growth analysis and help distinguish planting groups. Growth among plant groups was compared by estimating mean monthly increase in total length during the first 12 months of reservoir life.

Findings: Overall, spring fingerlings were the most cost-efficient plant at $2.05 per fish creeled, followed closely by catchables ($2.61) and fall fingerlings ($12.24). The high cost for fall fingerling plants was caused by very poor returns during drought years. During drought years, cost per fall fingerling creeled was $23.20, compared to only $1.32 in normal or high water years. Spring fingerlings also exhibited the best growth rates, with a mean of 0.62 mm/d, compared to fall fingerling average of 0.53 mm/d and catchables at 0.40 mm/d. For managers desiring to use fall fingerlings, detection of July zooplankton >2 mm in length successfully predicted the failure or success of fall fingerling plants in most cases. No counting or quantification was necessary to employ the technique, which would allow biologists to minimize stocking failures.

Conclusion: Because spring fingerlings typically exhibited the lowest cost/fish in the creel, the conclusion was they were the most cost-effective to stock. Recommendations were to use spring fingerlings in most Idaho lentic waters. These recommendations have not necessarily been implemented, however, as fingerlings are currently stocked in only a few dozen waters, whereas catchables are stocked in over 500 waters, mostly in lentic environments.

Project completion report:
Dillon, J. C., and C. B. Alexander. 1997. Project 8: Hatchery Trout Evaluations. Report No. 97-35. 21 pp. Idaho Department of Fish and Game, Boise.

Teuscher, D., C. B. Alexander, J. C. Dillon, and D. J. Schill. 1998. Hatchery Trout Evaluations. Project 8. Job Performance Report. Subproject 1. Fingerling and Catchable Evaluations. Subproject 2. Sterile Trout Investigations. Report No. 98-45. 43 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

1998 - Zooplankton quality index for Idaho lakes and reservoirs

Purpose: Measures of primary and secondary production are frequently used to predict fish yield, growth, and stocking densities, and may influence survival and return-to-creel of stocked fingerling rainbow trout. For example, results from IDFG zooplankton monitoring showed that the presence of *Daphnia* spp. >2 mm was related to the success of fingerling plants (Dillon and Alexander 1995), and a similar study in Wyoming showed that zooplankton ratio index (ZPR) explained much of the variation in carryover survival of hatchery rainbow trout in Wyoming lakes and reservoirs. However, a limitation of the ZPR model is a failure to consider zooplankton abundance. This research described a simplified method to account for this abundance.

Methods: Zooplankton were collected using three Wisconsin-type nets: small (153µ); medium (500 µ); and large (750µ) mesh. The nets had a 0.5 m mouth opening and were 1.5 m deep. The nets represented 1) total zooplankton production potential (153µ), 2) the proportion of zooplankton large enough to be captured in the gill rakers of rainbow trout (500µ), and 3) the proportion of very large zooplankton that are preferred prey items (750µ). Samples were preserved in denatured ethyl alcohol and after several days, phytoplankton was removed by refiltering through a 153µ mesh sieve. The remaining zooplankton were blotted dry with paper towels and weighed to the nearest 0.1 g.

The Wyoming Game and Fish Department (WGFD) established these standards for ZPR:
ZPR <0.25 - stock only catchables
ZPR = 0.25-0.60 - stock moderate (75–150 per acre) densities of fingerlings
ZPR >0.60 - stock between 150 to 300 fingerlings per acre

A zooplankton quality index (ZQI) was developed as a modification of ZPR, to account for zooplankton abundance. ZQI does this by multiplying the sum of the zooplankton weight collected in 500µ and 750µ nets by the ZPR ratio.

Findings: Based on the above WGFD standards, and modified for the new ZQI calculations, fingerlings should be stocked with the following guidelines:
ZQI >0.60 - Competition for food unlikely; stock fingerlings from 150 to 300 per acre
ZQI = 0.10-0.60 - Competition may be occurring; stock fingerlings from 75 to 150 per acre
ZQI <0.10 - Forage resources are limited; stock <75 fingerlings per acre, or use catchables

Conclusion: Collecting data needed to calculate the index is simple and inexpensive and can be done on multiple waters in a single day. The new ZQI may be a better index of forage availability for fingerlings because it indexes both zooplankton abundance and size structure.

Project completion report: Teuscher, D. 1999. Job Performance Report. Project 8-Hatchery Trout Evaluations. Subproject 1: Sterile Trout Investigations. Subproject 2: Zooplankton Quality Index. Subproject 3: Effects of Size at Stocking and Return-to-Creel. Report No. 99-23. 28 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

Mid-1990s - Trophy trout investigations for lakes and reservoirs

Purpose: IDFG manages most hatchery-supported waters as consumptive trout fisheries but manages several lakes and reservoirs for trophy trout opportunities. In the mid-1990s, several lakes were stocked with various combinations of fingerling and catchable-size fish, to determine if reduced stocking rates increased survival, growth, and altered population size structure.

Methods: Growth, fish condition, abundance, and survival estimates were obtained for stocked fish. Correlation analysis was used to examine relationships among variables representing lake productivity, water levels, angling effort, fish community, trout growth, and return rates. Those variables correlated with a chosen dependent variable (e.g. growth, return to creel) were used in regression analysis to test for relationships among lake characteristics and return data for each stocked group.

Findings: Results suggest that Daniels Reservoir growth is slow due to present stocking rates, and it was recommended that stocking rates be reduced. Estimates of fingerling and catchable rainbow trout survival were developed for future stocking modeling efforts.

Conclusion: Stocking rates for trophy trout waters should be no more than half the rate used for similarly productive yield fisheries.

Project completion report: Dillon, J. C., and C. B. Alexander. 1996. Project 8: Hatchery Trout Evaluations. Report No. 96-28. 85 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

SYNOPSES ON HATCHERY FISH PERFORMANCE AND STOCKING GUIDELINES

1990 - Hatchery capabilities to meet the demands of fish managers

Purpose: Hatchery records and manager stocking requests were used to assess how well the current request/production system functioned.

Findings: Results showed that stocking requests (in terms of size or time) were not met in a majority of instances, and that manager requests were often unattainable by the hatchery system. In 1990, catchable requests were met completely in 22% of the waters while fingerling requests were met completely in 5% of the waters. The records used did not reflect undocumented changes in requests, or local conditions that precluded planting. Production tradeoffs between fingerlings and catchables were difficult to quantify.

Conclusion: Recommendations included standardizing production costs, switching to a two-year advance request process, and developing a five-year hatchery management plan in concert with the fish management plans. Other recommendations included the possibility of allocating annual hatchery production to regions based on fishing effort, or redistributing back to the regions any long-term monetary savings as a result of improved stocking efficiency and decreased hatchery costs. A more realistic long-term request process to help plan and prioritize hatchery fish production is needed. Continued emphasis on broodstock development is needed to decrease our dependence on unreliable out-of-state egg sources and help stabilize production.

Project completion report: Dillon, J. C., and D. Megargle. 1994. Put-and-Grow Trout Evaluations. Job 1: Synopsis of Information on Put-and-Grow Trout Management. Job 2: Put-and-Grow Versus Put-and-Take Stocking Experiments. Job 3: Hatchery Capabilities. Job 4: Rainbow Trout Strain Synopsis. Report No. 94-08. 90 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

1993 - Synopsis of information on fingerling trout management

Purpose: This report provided a synopsis of available information on managing hatchery fingerling trout. Because Idaho had no established guidelines for stocking fingerling trout at the time of this report, the information was used to propose preliminary guidelines for fish size and stocking rate.

Methods: A comprehensive review of the literature was conducted on fingerling trout management. Of specific interest was describing lake characteristics associated with success or failure of fingerlings, and the relationships between stocking densities, size, predation, competition, growth, and survival. Biologists in other states were contacted regarding their stocking guidelines and strategies, including stocking densities, size of fish at stocking, and timing of stocking. Data from existing IDFG reports was summarized to describe relationships among fingerling rainbow trout stocking rates, catch rates, returns, and effort.

Findings: Species and strain stocked, size and condition at stocking, lake productivity, forage availability, predation and competition can interact to affect stocking success. The degree to which these factors are important in Idaho fisheries is unclear. Fingerlings are unlikely to yield cost effective returns where predators and competitors are abundant. Periodic assessment of predator populations in put-and-grow trout waters would help determine appropriate sizes to plant. Existing stocking guidelines from other states and Canada are probably not directly applicable to Idaho waters. They can, however, be used to characterize put-and-grow waters and provide general bounds for appropriate stocking rates.

Conclusion: Stocking rate guidelines based on lake characteristics (productivity and fish community) were proposed for Idaho waters using these results. For 75-100 mm trout, stocking rate should not exceed 350 fish/hectare, and stocking rate for 150-175 mm trout should not exceed 200 fish/hectare, even in productive trout-only waters. At the time of the report, stocking rates in some waters exceeded 1,900 fish/hectare. Ongoing evaluations of put-and-grow trout fisheries will be important to document cost-effectiveness of stocking and the factors influencing growth and returns. Stocking guidelines should be modified as new data become available.

Project completion report: Dillon, J. C., and D. Megargle. 1994. Put-and-Grow Trout Evaluations. Job 1: Synopsis of Information on Put-and-Grow Trout Management. Job 2: Put-and-Grow Versus Put-and-Take Stocking Experiments. Job 3: Hatchery Capabilities. Job 4: Rainbow Trout Strain Synopsis. Report No. 94-08. 90 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

1991 - Synopsis of information and guidelines for management of catchables in streams

Purpose: Historical census data from Idaho streams was used to evaluate effects of stocking rates and angler effort on hatchery rainbow trout harvest and return rates.

Methods: Relationships between stocking rates and fishing quality were developed from IDFG creel census data.

Findings: Harvest rates of hatchery rainbow trout increased with density of fish stocked per kilometer in Idaho streams. Rate of increase, however, appeared to decline as stocking rates exceed 200-300/km. In contrast, return of hatchery fish to the creel declined as number stocked per kilometer increased. Harvest rates appeared to decline, and return-to-creel increased as angler effort increased. Increases in number of hatchery rainbow trout stocked per hour of estimated angling effort produced increasing harvest rates and declining return rates.

Conclusion: It was recommended that stocking 280 fish/km at effort levels of 224 h/km would optimize both return rate (fish harvested/fish stocked) and harvest rate (fish/hour) at about 0.4. This equates to a recommended stocking rate of about 1.25 fish/angler hour. A literature review conducted on nationwide studies of stocking concluded that fish should be stocked every 1-3 weeks at sites every 1-3 km along the stream. Stocking sites should be publicized as opposed to our past policies on not "hot-spotting." Attempts should be made to develop a more catchable stock of fish for the put-and-take program. Dispersal monitoring suggested that 97% of hatchery catchables remained within 1.5 km of their release site.

Project completion report: Mauser, G. 1992. Hatchery Trout Evaluations. Subproject V, Study I: Put-and-Take Stocking Relations Rock Creek Size Experiment, Salmon River Census. Report F-73-R-14. 37 p. Idaho Department of Fish and Game, Boise.

Publication: None.

1994 - Developing stocking guidelines for management of catchables in streams

Purpose: Building off the 1991 synopsis of information on stocking catchables in streams, an effort was made to develop hatchery catchable stocking models by relating water size, stocking levels, and fishing pressure to harvest.

Methods: Fishery data came from IDFG creel census information collected over the last 37 years. Information used for model development consisted of the total number of hatchery rainbow trout stocked just prior to and during the period of time each census was conducted, and estimated fishing pressure and harvest. Stocking data came from IDFG reports and stocking records. Separate regression models were developed from data for flowing and standing waters. Return to creel and angler success (fish/h) was predicted for various stocking levels by running stocking rate and water size information through regression formulas.

Findings: Multiple regression modeling results indicated that stocking Idaho streams less than 9 m wide and lakes smaller than 50 ha may provide the highest potential for achieving harvest rates of 0.5 fish/h and returns of 40% or better for catchable size (>15 cm) hatchery rainbow trout. Stocking density was never defined, but presumably for streams this was at 280 fish/km; it is unknown what density was assumed for lakes, but may have been about 340 fish/ha. Implementation of these guidelines would reduce the number of waters managed as put-and-take trout fisheries, and stocking levels would need to increase approximately 50% for the remaining streams. Most standing waters would be managed as put-grow-and-take fisheries. Lake and reservoir stocking would decrease 10% on a limited number of waters managed for put-and-take fishing. Angler success (fish/h) and returns of stocked fish could potentially increase due to elimination of stocking from areas poorly suited for put-and-take programs.

Conclusion: Larger waters – streams >9 m wide and lakes >50 ha in size – are unlikely to meet return and harvest objectives for catchables.

Project completion report: Mauser, G. 1995. Project 9: Put-and-take Trout Evaluations. Subproject 1. Stocking Guidelines. Subproject 2. Angler Distribution and Knowledge. Report No. 95-34. 52 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

EXPERIMENTS ON HOW HATCHERY REARING CONDITIONS AFFECT PERFORMANCE

1995 - Food training experiment for catchable trout

Purpose: Return to creel of put-and-take trout in streams can be influenced by several factors, including angling effort, stocking rate, stream size, survival, and catchability of planted fish. In-hatchery training of fish to natural food, predators, or physical conditions has met with some success to improve post-stocking performance. This study was undertaken to test whether the catchability of hatchery put-and-take trout could be enhanced if they recognized a typical bait item (nightcrawlers) as potential food.

Methods: At IDFG's Grace and Hagerman fish hatcheries, equal numbers of catchable-sized Hayspur strain rainbow trout were placed in adjacent raceways as treatment and control groups. For five to seven days prior to planting (June 30-July 1), the treatment groups were hand fed a half ration of standard pellet food and an equal weight of night crawlers (approximately 4 lbs. of each). Nightcrawlers were purchased from a commercial distributor and cut into small pieces for feeding. Control groups were fed a full ration of pellets. All fish were held off feed for one to three days prior to planting. Fish were measured, jaw-tagged, and stocked into 10 southern Idaho streams in IDFG's Magic Valley and Southeast regions.

Findings: Total tag returns in individual streams were low, ranging from 33 (6.6%) in the lower Blackfoot River to 111 (22.2%) in the upper Portneuf River. A total of 785 tags were returned, with 411 from trained fish (16.4% return) and 374 from control fish (15.0% return). Thus, numerically, 10% more trained fish returned to the creel than control fish overall, but this difference was not significant at the 0.10 level. Timing of returns for trained and control fish varied among streams, but plots of cumulative returns (all streams combined) indicated that most of the return advantage by trained fish occurred the first week after stocking, with returns relatively equal for trained and control fish thereafter.

Conclusion: Results suggested a short-term increase in catchability of trained fish, but benefits were not sufficient to justify the added costs of training. It was argued that training regimens, which could include a variety of bait items, may have been more successful if the fish were to be stocked in fisheries where bait fishing comprised most of the angling effort.

As background information, this study hit national and international news wires, resulting in a story on the front page, above the crease, in the Wall Street Journal, and interviews on NPR and Japanese radio.

Project completion report: Dillon, J. C., and C. B. Alexander. 1996. Project 8: Hatchery Trout Evaluations. Report No. 96-28. 85 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

Mid 1990s - Effects of catchable size-at-stocking on return to creel

Purpose: Recent IDFG studies compared performance of catchables in relation to size-at-stocking, including Mauser (1994) and Teuscher (1999), to determine if stocking fewer, larger fish would net an overall improvement in stocking success.

Methods: Mauser (1994) stocked fish in three streams in the Wood River drainage at either a large size (30 cm) or normal size (24 cm). A stocking rate of one large to two small fish was used to approximate the same production weight and cost of hatchery rainbow trout. Both sizes of fish came from IDFG's Hayspur Fish Hatchery. Census clerks asked anglers to rate the quality of fishing on a 1-10 scale to determine possible effects of stocking fewer, larger fish.

Teuscher (1999) used tag returns and rearing costs to evaluate the performance of standard (mean TL = 9.3 in) and large (mean TL = 11.2 in) catchable rainbow trout in 19 Idaho streams.

Findings: Mauser (1994) found that anglers returned 1.2 times more jaw tags from large compared to small catchables. Estimated returns were 51% for large fish and 41% for small fish; differences were greater (48% and 29%) when only considering effort near stocking locations.

Teuscher (1999) found that total tag returns were 14.9% and 13.1% for large and small catchables, respectively; the difference was not significant. Production costs were $0.34 and $0.15 per fish for the large and standard groups, respectively, thus the cost (127% more expensive) far exceeded the benefit (14% increase in tag returns) of stocking larger catchables.

Conclusion: Mauser (1994) concluded that a hatchery can rear half the number but the same weight of large fish compared to small fish. If results were representative of other Idaho streams, stocking large fish would result in a 38% reduction in number of trout harvested. However, fewer but larger fish may be acceptable to anglers, since over 63% of anglers fishing the test streams preferred to catch one large rather than two small fish. Where on-site effort was equal, anglers harvested large fish sooner after stocking, so relative catchability and benefits of stocking larger fish may be greater than demonstrated by season-long returns. Based on angler responses during creel surveys, the author concluded that stocked fish should be at least 23 cm long to be acceptable to anglers.

Teuscher (1999) concluded that his experimental design might have influenced why his conclusion (no benefit from releasing larger catchables) was different than Mauser's finding. Mauser (1994) sorted large and small fish from raceways to make his comparison, so the largest fish from the raceways were compared to the smallest fish from the same raceways. Teuscher (1999) compared tag returns from fish reared in separate raceways - no sorting – and increased rearing time to make the large catchables. When analyzed within one raceway, Teuscher found that tag returns from the smallest catchables in a raceway were 5% compared to almost 25% for the largest fish from the same raceway. This finding may be worth re-investigating more completely in future IDFG research by size grading raceways.

Project completion reports: Mauser, G. 1994. Job 2: Effects of Fish Size, Hook Size, and Angler Distribution. Report No. 94-34. 48 p. Idaho Department of Fish and Game, Boise.

Teuscher, D. 1999a. Job Performance Report. Project 8-Hatchery Trout Evaluations. Subproject 1: Sterile Trout Investigations. Subproject 2: Zooplankton Quality Index. Subproject 3: Effects of Size at Stocking and Return-to-Creel. Report No. 99-23, 28 pp. Idaho Department of Fish and Game, Boise.

Publication: None.

1999/2000 – The effects of in-hatchery fish health on performance of catchables

Purpose: The purpose of this study is to determine if there were consistent differences in return to angler return to creel rates of catchable rainbow trout stocked from IDFG's largest production hatcheries, namely Nampa, Hagerman (both Riley and Tucker water sources), and American Falls. Fish health was also evaluated to determine if fish health at stocking was a useful predictor of return-to-creel.

Methods: Fish health prior to stocking was examined, using an organismic index, autopsy-based assessment, to determine if prestocking fish health was related to post-stocking performance (relative tag returns) for Kamloops rainbow trout raised to catchable size. Jaw-tagged rainbow trout were stocked concurrently in 16 lakes and reservoirs located throughout south-central Idaho in 1999 and 2000.

Findings: Generally, American Falls Hatchery trout provided relatively high total returns (X = 18.9% in 1999 and 21.0% in 2000), including higher carryover (4.5% from 1999 to 2000 and 1.1% from 2000 to 2001). Nampa Hatchery trout performed well in 1999 in terms of total returns (17.5%), but relatively poorly in 2000 (12.8%); therefore, the overall comparative performance of Nampa trout was inconclusive. Hagerman trout consistently provided 12.5-13.8% returns, which on average was lower than the other hatcheries. Prestocking fish health was not related to return rate, and the Goede Health Index did not appear to be a useful predictor of eventual angler return.

Conclusion: The disparity of returns among hatcheries suggests the hatchery environment can affect the performance of stocked trout; however, the differences among hatcheries were inconsistent. This suggests some hatchery influences were neither predictable nor hatchery specific. The conflicting results suggest fish health effects on angler return may require many years of research and a sizeable monetary investment to fully address the issue. The consistent higher returns from the American Falls facility resulted in a recommendation to test the effect of lower rearing densities on eventual angler returns. This is now being tested, starting in 2011.

Project completion report: Kozfkay, J. R., and D. J. Megargle 2002. Hatchery Trout Evaluations. Subproject 1: Improving Vulnerability of Rainbow Trout-A Selective Breeding Experiment. Subproject 2: Sterile Trout Investigations. Subproject 3: Fish Health and Performance Study. Report No. 02-47. 62 p. Idaho Department of Fish and Game, Boise.

Publication: None.

2004 - Predator training of fingerling rainbow trout to increase post-release survival

Purpose: Hatchery fingerlings often provide almost no increase in angler catch rates, presumably in part because, once stocked, they may be consumed by predators. The ability of hatchery juvenile salmonids to learn to recognize predators and avoid them in aquaria has been well established, but field evaluations are sparse. In this evaluation, research was designed to test whether the survival and eventual return to creel rate of fingerling rainbow trout could be increased by exposing them to piscine predators prior to release.

Methods: Hatchery rainbow trout raised to 300 mm in total length served as potential predators on fingerlings, and were introduced into production raceways at Nampa, Hagerman, and Grace fish hatcheries for 15 days prior to release of fingerlings during spring 2004. Approximately equal numbers of predator trained and control fingerlings were stocked into Lucky Peak, Lake Walcott, and CJ Strike reservoirs, as well as Hayden Lake, during May 2004.

Findings: Gillnetting and boat electrofishing sampling of these four water bodies during spring 2005, spring 2006, and fall 2006 yielded no recaptures of marked test fish.

Conclusion: Since no test or control fish were captured after release, there was no way to judge the merits of this study. However, one thing this study may have highlighted is that stocking fingerlings in water bodies that contain large numbers of predators may produce so much predation that survival of the stocked fish is too low to measure because no fish can be recaptured. If a better method of marking or capturing stocked test fish is developed, this topic could be re-investigated, because predator training has been shown to work in other species.

Project completion report: Koenig, M. K. 2007. Project 4: Hatchery Trout Evaluations. Subproject 2: Sterile Trout Investigations. Subproject 3: Predator Training. Report No 07-32, 39 p. Idaho Department of Fish and Game, Boise.

Publication: None.

2001/2002 - Improving catchability of trout by selectively breeding the easy-to-catch fish

Purpose: A series of fishing trials conducted on Hayspur-strain rainbow trout broodstock determined that individual fish possess varying levels of vulnerability to angling. Fish caught three times or more were used to create an experimental group of "highly" vulnerable fish to test whether return to creel could be increased through selective breeding.

Methods: Return to creel rates and number of days to harvest were compared for two groups of catchable rainbow trout: (1) normal Hayspur-strain broodstock, and (2) Hayspur-strain broodstock that exhibited high levels of vulnerability to angling. Ninety-four 1 h fishing trials were conducted, and capture frequency for each fish was recorded. Fish caught three or more times were retained as vulnerable broodstock. The normal broodstock was formed with other, randomly selected, Hayspur-strain brood fish that had not been subjected to fishing trials. Equal numbers of progeny from normal and vulnerable broodstocks were spawned, raised, tagged, and stocked into 16 water bodies during 2001 and an additional 16 water bodies during 2002.

Findings: In 2001, mean return rate for the vulnerable group (12.7 ± 3.5%) was not statistically different from the normal group (11.7 ± 3.8%). The mean time to harvest was 46.4 ± 9.8 d for the vulnerable group and 50.6 ± 10.7 d for the normal group, and this disparity was also not statistically different. For fish stocked during 2002, mean first year return rate for the vulnerable group (7.2 ± 2.5%) was not different from the normal group (7.4 ± 2.7%), nor was there a difference in mean time to harvest for the normal group (36.0 ± 8.0 d) and vulnerable group (38.7 ± 7.3 d). Thus, no performance benefit in terms of increasing return to creel or reducing time to harvest was achieved through selective breeding.

Conclusion: The lack of an increase in vulnerability in this study contradicts earlier work on artificially selecting for specific behavioral traits in other species, such as largemouth bass (Garrett 1993). However, previous studies often examined the difference between low and high expressions of a behavior. Due to space constraints and a desire to run this test at a viable production scale, this study only compared the difference between normal Hayspur brood fish progeny and those whose parents showed high angling vulnerability. It is possible that selection for more vulnerable catchables occurs, but the effect was not large enough for test fish compared to normal fish. Also, the brood fish for some of the previously mentioned studies were selected from wild or naturalized populations, where individuals likely possess more genetic diversity than the Hayspur broodstock. Although a difference in vulnerability to angling was not shown for Hayspur brood fish (Teuscher 1999), trials were conducted while fish were strictly confined (raceways) and subjected to intense fishing effort (94 h). In contrast, Garrett (1993) observed differences in vulnerability to angling with 40 h of fishing effort, and fishing trials were conducted in a 0.25-ha pond. Thus, differences in experimental design could explain the disparate results of the present effort compared to other studies.

Project completion report: Kozfkay, J. R., and D. J. Megargle 2002. Hatchery Trout Evaluations. Subproject 1: Improving Vulnerability of Rainbow Trout-A Selective Breeding Experiment. Report No. 02-47. 62 p. Idaho Department of Fish and Game, Boise.

Publication: Kozfkay, J. R., D. J. Schill, and D. M. Teuscher. 2004. Improving vulnerability to angling of rainbow trout: a selective breeding experiment. Pages 497–504 *in* M. J. Nickum, P. M. Mazik, J. G. Nickum, and D. D. MacKinlay, editors. Propagated fish in resource management. American Fisheries Society, Symposium 44, American Fisheries Society, Bethesda, Maryland.

MANAGEMENT OF HATCHERY TROUT IN IDAHO'S HIGH MOUNTAIN LAKES

1996 - Synopsis on nationwide management strategies in high mountain lakes

Purpose: IDFG has stocked about 1/3 of Idaho's 2,000 or so alpine lakes with native and exotic salmonids. Although alpine lakes comprise a small part of IDFG's overall fisheries agenda, this program rates highly in terms of angler satisfaction and helps meet the statewide fisheries management goal of increasing and diversifying sport fishing opportunities for the public. However, the operations of the program are based on very little data, so a comprehensive synopsis of alpine lake programs across the country was conducted to compare Idaho's program to other states.

Methods: State biologists were contacted nationwide for information on their high mountain lake fisheries programs. Of specific interest was information on stocking criteria, rates, timing, frequency, and models; size of fish, species, and strains stocked; and monitoring procedures. These practices were compared with those used in the current IDFG program.

Findings: The synopsis indicated that management practices are quite similar nationwide. Other states stock fish as fry or fingerlings at rates of 100-250 fish/acre, while Idaho stocks fingerlings at <200 fish/acre. Other states stock from July to September, depending on ice conditions and fish availability, whereas IDFG usually stocks in August or September. Rotation intervals of 2-4 years are used by other states, whereas IDFG typically uses a 3-year rotation.

Conclusion: Recommendations were to continue categorization of lakes into fishery management classifications based on geology, lake surface area, geometry of the lake, presence of zooplankton and aquatic invertebrates, fish composition including the presence of naturally reproducing populations, and other characteristics (see report). Stocking practices should be refined by developing models based on productivity and fish population characteristics. Without such data, recommendations were to stock at 200 or less fingerlings/acre; stock every 2 to 4 years depending on access, fishing pressure, lake productivity, and angler preference. Lakes should be surveyed at least every 5 years when changes in a fishery are expected. A goal was set to develop a high mountain lake database and assessment manual by 2000.

Project completion report: DerHovanisian, J. A. 1997. Hatchery Trout Evaluations. Synopsis of Nationwide Strategies for High Mountain Lake Management. Job Performance Report, Report No. 97-03. 22 p. Idaho Department of Fish and Game, Boise.

Publication: None.

2006 – Multi-state high mountain lake summary

Purpose: Fisheries management of high mountain lakes (HMLs), most of which were historically fishless, has come under ever-increasing scrutiny due to the ecological impacts of introduced fish (usually salmonids) on native species in these settings. In 2006, IDFG organized a meeting of fisheries managers from the western United States, where past experience, current direction, and future courses of action in HML management were presented and discussed.

Methods: Seven states attended the meeting (see Table), which involved 1-2 presentations by representatives from each state as well as a discussion session for any remaining as-yet uncovered topics. In addition, management plans, research results, and state policy directives were also shared in a variety of formats.

Findings: Of the nearly 29,000 HMLs within the 7 states at the meeting, salmonids are present in about 6,900 lakes (24%), and about 2,750 HMLs (10%) are currently stocked with fish (see Table). Nearly all western states have in recent years reduced or eliminated exotic introductions (especially brook trout), reduced the number of lakes being stocked, terminated stocking where natural reproduction occurs, and preserved or augmented the number of fishless lakes. At least three states (CA, ID, WA) have formal fishless lake policies, and some states are researching methods to convert fish-bearing HMLs to fishless lakes with the use of chemicals, netting, and sterile fish predators. Most states indicated high satisfaction among anglers fishing HMLs.

For those HMLs that continue to be stocked, most states stock either rainbow trout or a subspecies of cutthroat trout in July and August, at sizes from 25-50 mm in total length, and densities of 50-200 fish/acre, and on a rotation of every two to four years. These details have changed little since the nationwide review by DerHovanisian (1997). Several states are developing HML management plans to steer management decisions. There is an emphasis on answering questions such as (1) which lakes have naturally reproducing fish populations, (2) which lakes contain amphibian populations, and (3) can exotic species such as brook trout be eliminated to protect native species, or be reduced in numbers to prevent stunting.

Table 2. Summary of high mountain lake stocking strategies across seven Western states.

State	Approximate number of HMLs: Total	Containing fish	Currently stocked	Species currently stocked[a]	Size of fish stocked (mm)	Dates of stocking	Stocking rotation (years)	Stocking density (No./acre)	Comments
California	17,889[b]	2,393	378	GT, RT, CT	35-40	Jul-Sep	2	120-150	Stocking conditions vary for northern CA vs. Sierra Nevada
Idaho	> 3,000	1,039	684	RT[c], WCT, AG, GT, YCT	40-60	Aug	2-5	200	Nearly all RT stocked in ID are pressure treated to induce sterility
Montana	> 2,300	~ 900	~ 400	WCT, YCT, AG, RT, GT	40-60	Jun-Aug	2-4	50-100	AG, RT, and GT comprise <5% of statewide HML stocking.
Nevada	36	21	8	LCT	25-50	Jul-Aug	3		Two HMLs are managed by Great Basin National Park.
New Mexico	50	32	9	RCT	25-50	Aug-Sep	4	250	Nearly all HMLs have not been stocked since 1999.
Oregon	877	720	470	RT, CT	50-60	Jul	2	100	Cascade HMLs stocked in 5-6 days with device holding fish for 30 lakes/trip
Washington	4,700	1,760	800	RT, CT	45-55	Jul-Sep	3-4	50-100	Many HMLs stocked by organized voluteer groups

[a]GT=golden trout, RT=rainbow trout, CT=cutthroat trout, AG=arctic grayling, YCT=Yellowstone cutthroat trout, WCT=westslope cutthroat trout; LCT=Lahontan cutthroat trout, RCT=Rio Grande cutthroat trout.

[b]Includes all lakes and ponds on 7.5 min USGS maps above 1,520 m M.S.L. in the Sierra Nevada, and above 1,220 m for lakes in Northern California

[c]Comprise the bulk of stocking in Idaho

Project completion report: Meyer, K. A., and D. J. Schill. 2007. Multi-state High Mountain Lake Summary. Report No. 07-55. 87 p. Idaho Department of Fish and Game, Boise.

Publication: None.

DEVELOPMENT AND EVALUATION OF STERILE FISH IN IDAHO

Recipe development for producing sterile fish in Idaho

Purpose: In 1995, IDFG began refining methods to induce triploidy in hatchery rainbow trout in an attempt to convert its entire resident hatchery program to production of sterile trout, which would virtually eliminate the risk of genetic interaction between stocked hatchery trout and native trout. Over the next 15 years, sterilization methods for several other species were developed.

Methods: IDFG started with heat baths and later added and converted entirely to hydrostatic pressure treatments. Starting points for treatments were identified from similar studies in the primary literature. Key variables evaluated included water temperature, pressure level, minutes after fertilization (MAF) before eggs were treated, and the duration of the treatment.

Findings: The following table highlights the most effective heat and pressure treatments to achieve the highest sterility and egg-to-fry survival rates for a variety of species for which IDFG staff have developed recipes.

Table 3. Summary results for IDFG heat and pressure-shock experiments for inducing triploidy.

species/ strain	Treatment type	Intensity	MAF	Duration (min)	Ambient water temp (°C)	Treatment survival to EE (%)	Control survival to EE (%)	Triploidy induction (%)
Brook	heat	29.4°C	18	7	7.5	62	89	100
	pressure	9,500 psi	40	5		59	72	100
Henrys Lake hybrids	heat	28.0°C	15	20	7.5	29	60	100
	pressure	10,000 psi	40	5		43	39	100
Rainbow	heat	26.0°C	20	20	11.4	91	95	96
	pressure	9,500 psi	33	5		90	95	100
Westslope cutthroat	heat	28.0°C	10	10	11.4	41	54	96
	pressure	9,500 psi	26.3	5		52	54	99
	pressure	9,500 psi	30	5	10	27	31	100
Lake trout	heat	29.4°C	18	7	9.3	40	65	63
	pressure	9,500 psi	32	5		53	62	100
Kokanee	heat	27.0°C	20	20	9	49	77	98
	pressure	9,500 psi	17.2	5	9.5	54	79	100
	pressure	9,500 psi	36	5	9.7	40	49	100
Walleye	pressure	9,500 psi	4	10	-	54	46	95
	pressure	9,500 psi	4	15	-	21	67	100

Project completion report: Too many to cite individually, but see Dillon and Alexander 1997; Teuscher et al. 1998; Teuscher 1999; Teuscher 2000; Dillon et al. 2000; Megargle and Teuscher 2001; Kozfkay and Megargle 2002; Kozfkay 2003, 2004; Kozfkay et al. 2004, 2005, Kozfkay and Koenig 2006; Koenig 2007; Koenig and Ellsworth 2008.

Publication: Kozfkay, J. R., J. C. Dillon, and D. J. Schill. 2006. Routine use of sterile fish in salmonid sport fisheries: are we there yet? Fisheries 31:392-401.

Kozfkay, J. R., E. J. Wagner, and D. Aplanalp. 2005 Production of triploid lake trout by means of pressure treatment. North American Journal of Aquaculture 67:93-97.

1997 - Performance of diploid and triploid rainbow trout in streams

Purpose: After developing methods to produce triploid fish, field studies were initiated to compare the relative performance of triploids and diploids after stocking, since few evaluations have made this direct comparison in sport fisheries.

Methods: Mixed-sex triploid and diploid rainbow trout eggs were purchased from Mt. Lassen Trout Farms, Inc., (Red Bluff, California) and reared to catchable size. Three hundred triploid and 300 diploid fish were jaw-tagged and stocked into each of 18 streams throughout Idaho and tag returns were used to assess relative return to creel and timing of returns for the two groups.

Findings: In all, 1,849 tags were returned by anglers, 931 from triploid fish and 918 from diploid fish. Overall returns were not significantly different between groups, nor was mean time to harvest (29 days). Mean tag return rate was 17%, which was uncorrected for tag reporting rate.

Conclusion: These results suggest that triploid catchables can provide stream angling opportunity equal to that provided by fertile diploid fish. Although there are other concerns regarding the stocking of hatchery trout in streams containing native trout, these results suggest that using triploid rainbow trout in stream-stocking programs can help balance the demands for both consumptive fishing opportunity and conservation of native stocks.

Project completion report: Teuscher, D. 1999. Job Performance Report. Project 8-Hatchery Trout Evaluations. Subproject 1: Sterile Trout Investigations. Subproject 2: Zooplankton Quality Index. Subproject 3: Effects of Size at Stocking and Return-to-Creel. Report No 99-23. 28 pp.

Publication: Dillon, J. C., D. J. Schill, and D. M. Teuscher. 2000. Relative return to creel of triploid and diploid rainbow trout stocked in eighteen Idaho streams. North American Journal of Fisheries Management 20:1-9.

Dillon, J. C., D. J. Schill, D. M. Teuscher, and D. Megargle. 2000. Triploid hatchery programs in Idaho–meeting public demand for consumptive angling. Pages 105–108 *in* D. J. Schill, S. Moore, P. Byorth, and B. Hamre, editors. Wild Trout VII: management in the new millennium, are we ready? Yellowstone National Park, Wyoming.

2006 - Survival and dispersal of hatchery catchable triploid rainbow trout

Purpose: Catchable rainbow trout are commonly released into streams to improve angler catch and harvest rates, but returns are often less than 50% and the fate of unharvested catchables is largely unknown. Survival and dispersal of triploid catchables was investigated using snorkel and telemetry techniques to quantify the persistence and dispersal of catchables.

Methods: Nine hundred catchables (all-female Kamloops strain from Troutlodge) were tagged with T-bar anchor tags and stocked in the Middle Fork Boise River, and snorkeling was used to determine longevity and movement. In addition, radio transmitters with mortality sensors were implanted in 54 catchables over the course of the summer to track movement and monitor mortality.

Findings: Dispersal of catchables with anchor tags 30 d post-stocking was generally downstream of the stocking point (median dispersal = 100 m). The median values of the maximum known downstream and upstream dispersal distances for catchables with radio transmitters were 5.0 and 1.2 km from the stocking point, respectively. Only four transmitter-implanted catchables were still alive on November 1, when the study ended. On average, 85% of catchables with radio transmitters were presumed dead at 30 d post-stocking (average persistence = 14.3 d). A similar rate of decline was observed for T-bar-tagged catchables. Exact reasons for the mortalities were generally not known, but anecdotal evidence suggests most perished due to avian and mammalian predation and starvation.

Conclusion: Similar to previous work done in Idaho (by Mauser) and elsewhere, catchables did not persist long and moved very little. Therefore, managers wishing to maximize return-to-creel rates of sterile catchables in streams might do so by limiting stocking events to within 3 weeks of expected needs and limiting the stocking locations to within 1 km of areas frequented by anglers.

Project completion report: High, B. 2007. Wild Trout Competition Studies. Subproject #1: Competition between Wild and Hatchery Rainbow Trout Subproject #2: Fate and Survival of Sterile Hatchery Rainbow Trout in a Stream Environment. Grant F-73-R-27.

Publication: High, B., and K. A. Meyer. 2009. Survival and dispersal of hatchery triploid rainbow trout in an Idaho river. North American Journal of Fisheries Management 29:1797-1805.

Late 1990s - Performance of diploid and triploid rainbow trout in lakes and reservoirs

Purpose: This research project examined the relative performance of 2N and 3N rainbow trout in Daniels and Treasureton reservoirs, as a continuation of similar work on streams. However, the difference between the earlier study on streams was that this evaluation was on fingerlings rather than catchables.

Methods: Equal numbers of 2N and 3N fingerling rainbow trout (purchased from Troutlodge, raised at Nampa) were stocked in 5 water bodies. However, survival and subsequent fish capture was only adequate enough to compare relative returns in two waters (Daniels and Treasureton). Shoreline electrofishing and gillnetting were used to compare relative survival and growth of 2N and 3N trout over a 4-year period.

Findings: Relative survival was higher for triploid rainbow trout, with ratios of total catch (3N:2N) being 1.4:1 and 1.9:1 in the Treasureton and Daniels reservoirs, respectively. Growth of the two groups was equal.

Conclusion: Managers should not expect higher growth from triploid fish as suggested in some previous work in the literature. However, increased longevity of triploid fish may allow them to be susceptible to the fishery for longer periods of time and thus provide better return to creel for anglers over the course of the fish's entire lifetime. However, it should be noted that Treasureton and Daniels reservoirs have tremendous carryover of hatchery trout from one year to the next, and this is not necessarily typical of most Idaho reservoirs. This point can be seen in research a few years later where catchables were stocked in more typical Idaho reservoirs (see below).

Project completion report: Megargle, D., and D. Teuscher. 2001. Hatchery Trout Evaluations Project 4. Subproject 2: Sterile Trout Investigations Subproject 3: Fish Health and Performance Study. Annual Performance Report. Report No 01-49. 48 pp. Idaho Department of Fish and Game, Boise.

Publication: Teuscher, D. M., D. J. Schill, D. J. Megargle, and J. C. Dillon. 2003. Relative survival and growth of triploid and diploid rainbow trout in two Idaho reservoirs. North American Journal of Fisheries Management 23:983-988.

2001 -2007 - Performance of diploid and triploid rainbow trout in high mountain lakes

Purpose: Continuing field evaluations of triploid rainbow trout, this project examined the relative performance of diploid and triploid rainbow trout in high mountain lakes across central Idaho by stocking equal numbers of marked fish in 2001 and 2003.

Methods: In two different experiments, trials were run to compare 1) mixed-sex diploid (2N) and triploid (3N) rainbow trout produced from 1:1 pairings at IDFG's Hayspur Fish Hatchery, and 2) the same comparison with the addition of a treatment of all-female triploid Kamloops (AF3N) raised from eggs purchased from Troutlodge, Inc. A total of 31 lakes were stocked in 2001 (1^{st} experiment) and 2003 (2^{nd} experiment), and relative survival was determined 2-4 years later with angling and gillnetting catch.

Findings: Results of this study suggest that catch of 2N rainbow trout far exceeded that of 3N rainbow trout in alpine lakes. On average, 2N rainbow trout made up 3.6 times the proportion of 3N trout across both stocking events. However, the catch of the AF3N stock far exceeded that of both the 2N and 3N rainbow trout groups from the 2003 planting. On average, the AF3N group made up 3.6 times and 9.0 times the proportion of the 2N group and 3N groups, respectively, far exceeding the catch of either of the Hayspur stocking groups.

Two confounding factors in this study may have affected the magnitude of the differences. First, the AF3N stock was marked with adipose fin clips, while the 2N and 3N stocks were given ventral fin clips. Second, the 2003 stocking group, the mean length of the AF3N fish (65 mm) was slightly greater than that of the 2N and 3N groups (62 mm) at the time of stocking. While both these factors probably inferred an advantage to the AF3N group, based on studies in the literature, these factors could not entirely account for the magnitude of difference observed in this study.

Conclusion: Despite the confounding factors, this study provided evidence that AF3N fish raised from Troutlodge eggs performed substantially better (in terms of angler and gillnet catch) than 2N and 3N fish from Hayspur, but also that 2N Hayspur fish outperformed 3N Hayspur fish by an almost 4-fold difference. Based on these results, most IDFG managers now request AF3N fish for alpine lake stocking. Moreover, these results called into question earlier results that suggested 3N performed well in lowland lakes relative to 2N fish. One of the confounding factors in this study (potential differences in survival from differential fin clipping) is currently being investigated by Koenig on the Hatchery Evaluation project.

Project completion report: Koenig, M. K., and K. Ellsworth. 2008. Project 4: Hatchery Trout Evaluations. Subproject 2: Performance of Sterile Kokanee in Lowland Lakes and Reservoirs. Subproject 2: Performance of Sterile Rainbow Trout in High Mountain Lakes. Report No 08-14, 39 p. Idaho Department of Fish and Game, Boise.

Publication: Koenig, M. K., J. R. Kozfkay, K. A. Meyer, and D. J. Schill. 2011. Performance of diploid and triploid rainbow trout stocked in Idaho alpine lakes. North American Journal of Fisheries Management 31:124-133.

2008 - Re-evaluation of diploid and triploid performance in lowland lakes and reservoirs

Purpose: Because 3N were outperformed by 2N fish in high lakes, and previous reservoir studies were limited in scope, we re-evaluated 3N relative performance in lowland reservoirs. The main reason for another study was that the previous 2N vs. 3N study in lowland reservoirs was conducted on fingerlings. However, a more careful subsequent review of the IDFG stocking program indicated that fingerlings are stocked in a low number of waters, whereas the vast majority of lowland reservoir trout fisheries are the result of catchable stocking.

Methods: Survival, growth, and returns of diploid and triploid all-female catchable rainbow trout (purchased from Troutlodge, raised at Hagerman) was evaluated in 13 lakes and reservoirs across southern Idaho over two field seasons.

Findings: Most reservoirs showed higher returns of 2N rainbow trout to anglers. In 2008, 3N rainbow trout returned on average at only 72% and 81% of the rate of 2N trout for gill nets and snout collection boxes, respectively. Carryover to 2009 was low or zero in most reservoirs, but where there was carryover, returns suggested 3N rainbow trout returned to anglers at 71% of 2N rainbow trout in the second year after planting. Both groups were similar in length, weight, and dressed weight. The disparity in returns was more pronounced in locations subjected to greater drawdown and with greater species diversity; in locations with less drawdown, little by-catch, and few species other than trout, returns were equivalent.

Conclusion: It appears that 2N fish will grow and survive better in reservoirs subject to low water levels and that have many other species of fish present, whereas 3N fish will perform equal to 2N fish in good habitat conditions. These findings are fortuitous because triploids likely perform better in higher quality habitats where they pose no threat to native trout, whereas 2N trout are better suited for reservoirs with degraded habitats where native wild trout are likely absent.

These findings and earlier work suggest that in reservoirs that maintain an adequate pool of water for annual trout carryover, 3N fingerlings will survival as well as 2N fingerlings, and 3N catchables will survive as well as 2N catchables. Whether to use fingerlings or catchables will depend on factors such as the availability of catchables, the growth rate of fingerlings, regulations at the water body, the expected number of years with no drawdown, and other factors that will influence whether fingerlings can grow large enough to eventually provide quality angling opportunities. In contrast, 2N catchables should be stocked in lowland lakes subjected to greater drawdown and with high species diversity where they pose no threat to substantive native trout populations.

Project completion report: Koenig, M. K. 2011. Project 4: Hatchery trout evaluations. Subproject 1: Use of tiger muskellunge to remove brook trout from high mountain lakes. Subproject 2: Performance of sterile kokanee in lowland lakes and reservoirs. Subproject 2: Production of sterile trout, westslope cutthroat trout. Report No. 10-06. 71 p. Idaho Department of Fish and Game, Boise.

Publication: Koenig, M. K., and K. A. Meyer. 2011. Relative performance of diploid and triploid catchable rainbow trout stocked in Idaho lakes and reservoirs. North American Journal of Fisheries Management. In Press.

2005 - Performance of sterile kokanee in lowland lakes and reservoirs

Purpose: While triploid kokanee would obviously be a poor alternative to increase natural production, their increased longevity could be beneficial in extending recreational fisheries opportunities over the long term. Enhanced longevity could provide additional sportfishing opportunity in subsequent years after semelparous diploids would have already perished. Greater longevity could also result in increased yield and size, since kokanee are believed to be increasingly susceptible to angling as length increases. The objective of this study was to assess whether the benefits of stocking triploid kokanee in put-grow-and-take fisheries would outweigh the detriments of lower egg eye-up rates and poor initial survival, via enhanced longevity (at least one year).

Methods: Test groups were spawned using eggs collected at the Deadwood River weir. Triploid kokanee eggs were produced using a heat bath at 27°C at 20 minutes after fertilization (MAF) for 20 minutes. Eggs were reared at Mackay Fish Hatchery with 2N production egg lots. Kokanee fry were marked with calcein, and approximately equal numbers of kokanee fry from the 2N and 3N groups were stocked into five study waters in 2005. Kokanee were sampled using a combination of gill nets and net curtains.

Findings: The number of kokanee caught in each study location during 2007 was highly variable, with catch-per-unit-effort ranging from 0.8 to 4.9 fish/hr of netting. Overall, 1,208 kokanee were captured, with the majority being unmarked non-test fish (95%). Fifty-six test fish were identified (5%) based on fin clips and calcein-marked otoliths. Diploid kokanee accounted for a higher percentage (61%, 34 fish) of the total marked kokanee captured. Eleven fin-clipped kokanee were captured, with six having right ventral clips (triploid) and five with left ventral clips (diploids). Ten of these clipped fish had visible calcein marks present in their otoliths, suggesting a 91% mark retention rate for calcein in otoliths two years after stocking.

Conclusion: Capture totals of marked kokanee were too low to make definitive conclusions about the performance of triploid kokanee. Due to lengthy processing time and uncertainty in interpreting the mark (both while in the field and in the lab), it was recommended that calcein should not be used as a mass-mark for long-term paired release evaluations because of inefficient effort to distinguish test fish from unmarked fish. Whether stocking sterile kokanee would improve fisheries was unanswered by this evaluation, and further work may soon be initiated by the Hatchery Evaluation project.

Project completion report: Koenig, M. K., and K. Ellsworth. 2008. Project 4: Hatchery Trout Evaluations. Subproject 2: Performance of Sterile Kokanee in Lowland Lakes and Reservoirs. Subproject 2: Performance of Sterile Rainbow Trout in High Mountain Lakes. Report No 08-14, 39 p. Idaho Department of Fish and Game, Boise.

Publication: Elle, F. S., M. K. Koenig, and K. A. Meyer. 2010. Evaluation of calcein as a mass mark for rainbow trout raised in outdoor hatchery raceways. North American Journal of Fisheries Management 30:1408-1412.

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