Production Characteristics of Rainbow Trout, *Oncorhynchus mykiss*, and Brook Trout, *Salvelinus fontinalis*, Under Seasonal Pond Conditions

Shawn D. Coyle
James H. Tidwell

ABSTRACT. The production characteristics of juvenile rainbow trout, *Oncorhynchus mykiss*, and brook trout, *Salvelinus fontinalis*, were compared under winter pond conditions. Juvenile rainbow trout (55.1 ± 1.5 g) and brook trout (28.9 ± 0.4 g) were stocked at a density of 8,750 fish/ha into six 0.04-ha ponds. After 163 days, survival, growth, and feed conversion were similar (P > 0.05). The results of this study suggest that brook trout may attain growth rates similar to rainbow trout under winter pond conditions in temperate regions of North America. *[Article copies available for a fee from The Haworth Document Delivery Service: 1-800-342-9678. E-mail address: <getinfo@haworthpressinc.com> Website: <http://www.haworthpressinc.com>]*

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INTRODUCTION

Of the many species of trout found in North America, the rainbow trout, *Oncorhynchus mykiss*, is the most extensively cultured species. Production of food size rainbow trout in the United States is approxi-

Shawn D. Coyle and James H. Tidwell, Aquaculture Research Center, Kentucky State University, Frankfort, KY 40601.

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mately 55 million pounds per year and has remained relatively stable for the past 10 years (Johnson 1998). Freshwater availability and environmental constraints have apparently capped trout production capacity (Johnson 1998). Winter pond culture in temperate regions may be a method of increasing trout production in areas that do not have sufficient spring water for raceway culture.

In temperate regions of North America the culture of rainbow trout in ponds is limited to the period from mid-November to early April by water temperature (Tidwell and Mims 1990; Tidwell et al. 1991). One primary factor affecting the economic viability of winter pond production in these areas is that rainbow trout do not feed actively at temperatures below 8°C, which may represent 60-90 days of the production period (Tidwell et al. 1991).

The brook trout, *Salvelinus fontinalis*, is an endemic salmonid of North America found in eastern Canada and the northeastern United States (Smith 1985). In Canada, brook trout farming has been practiced for many decades, both for sport fisheries enhancement and food fish production (Guillou et al. 1995). Most culture in the United States has been by state and federal hatcheries for stock enhancement purposes. Research on grow-out techniques has received little attention. Several attributes make brook trout an attractive alternative to rainbow trout in temperate regions. In Canada, brook trout reportedly have good growth rates and less size variability compared to other salmonids (Dumas et al. 1995). Brook trout have a higher tolerance for low dissolved oxygen (DO) concentrations and tolerate a greater range in pH (4.0 to 9.8) than rainbow trout (McClane 1974).

The optimum temperature for raising brook trout is 7.5-12.5°C compared to 10-16°C for rainbow trout (Piper et al. 1982). Tidwell et al. (1991) recorded an average water temperature of 7.2°C over a winter culture period in Kentucky. A winter production trial at Virginia State University revealed that brook trout fed better under cold water conditions than rainbow trout (Newton 1997). If brook trout feed more efficiently at lower temperatures, total production should be higher under winter pond conditions when water temperatures are below optimum for rainbow trout. The objective of this study was to compare growth rates of rainbow trout and brook trout under winter pond conditions in Kentucky.

MATERIALS AND METHODS

Approximately 1,000 rainbow trout were obtained from a local producer (Powder Mill Trout Farms Inc., Campbellsville, Kentucky[1]). Approximately 1,000 brook trout were obtained from the Fisheries and Aquaculture program at the State University of New York at Cobleskill, Cobleskill, New York. On October 18, 1996 rainbow trout (55.1 ± 1.5 g) and brook trout (28.9 ± 0.4 g) were stocked separately at a density of 8750 fish/ha into three 0.04-ha earthen ponds at the Aquaculture Research Center, Kentucky State University, Frankfort, Kentucky.

The ponds used in this study were approximately 1.5 m deep and supplied with water from a reservoir filled with rain run-off. Water levels were maintained by periodic additions to replace losses to evaporation. Water temperatures and dissolved oxygen (DO) were measured in each pond twice daily (0900 and 1600 hours) at a depth of 0.5 m using a YSI Model 57 oxygen meter (YSI, Yellow Springs, Ohio). Mechanical aeration was supplied if the DO was predicted (by graph) to fall below 5 mg/L during the night (Boyd 1990). A spectrophotometer (HACH DREL/2000, HACH, Loveland, Colorado) was used to measure ammonia, nitrite, and pH once weekly (1600) in each pond.

All fish were fed to satiation twice daily with a commercially prepared floating diet (Silver Cup; Nelson and Sons, Inc., Murray, Utah) containing 45% crude protein and 12% crude fat. Floating feeding rings (1.8 m in diameter) were used in all ponds to prevent feed from drifting ashore. Rings were made from 6-cm diameter plastic pipe and had a 0.58-cm plastic mesh skirt extending 20-cm below the water surface. If ice cover prevented feeding in any pond, fish were not fed in other ponds. Fish were not fed for 26 days of the production period, due to ice cover. Fish were harvested after 163 days. Fish were bulk weighed at harvest to determine total number and weight of fish in each pond.

Ten fish were randomly sampled from each pond for dress-out analysis. Fish were prepared by removing the viscera (dressed with head), by removing head and viscera (dressed without head), and by removing muscle tissue and skin from frame (fillet with skin). Weight of each dressed carcass was reported as a percentage of the whole fish.

Final average fish weights were compared by analysis of covariance

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1. Use of trade or manufacturers name does not imply endorsement.

(ANCOVA), with initial weight at stocking as the covariate. Student *t*-tests ($P = 0.05$) were used for comparisons of percent survival, specific growth rate (SGR) (% body weight per day), and food conversion ratio (FCR) for rainbow trout and brook trout (Zar 1984). SGR was calculated as: $[100(1nW_t - 1nW_i)/T]$ where W_t is the weight of fish at time t, W_i is the weight of fish at the time they were stocked into ponds, and T is the culture period in days. FCR was calculated as: total diet fed (g)/total wet weight gain (g). All data were analyzed using Statistics 4.1 (Analytical Software 1994) for significance among treatments.

RESULTS AND DISCUSSION

There were no significant differences ($P > 0.05$) in measured water quality variables between treatments, and conditions were considered adequate for growth of salmonids compared to published standards (Piper et al. 1982). Over the duration of the study the overall means ± SE for the six ponds were: dissolved oxygen, 11.9 ± 2.3 mg/L; temperature, 7.7 ± 11.8°C; un-ionized ammonia, 0.007 ± 0.001 mg/L; nitrite, 0.06 ± 0.03 mg/L; and pH, 7.8 ± 0.4.

At harvest, after adjusting for initial weight differences by ANCOVA, there was no significant difference in final weights of rainbow trout or brook trout ($P > 0.05$) (Table 1). There were no significant differences (*t*-test; $P > 0.05$) between fish in specific growth rate (%), survival (%), or feed conversion ratio (Table 1). Percentage weight gain was significantly higher ($P < 0.05$) for brook trout (856%) than for rainbow trout (698%) but was influenced by the smaller stocking size of the brook trout. There was no significant difference (t-test; $P > 0.05$) in monthly diet consumption (percent body weight/day) between rainbow trout and brook trout (Figure 1). Rainbow trout had higher ($P < 0.05$) fillet yield than brook trout (Table 2), probably due to the different body conformation of the larger fish. There was no significant difference ($P > 0.05$) in percent visceral fat, or whole dressout percentages.

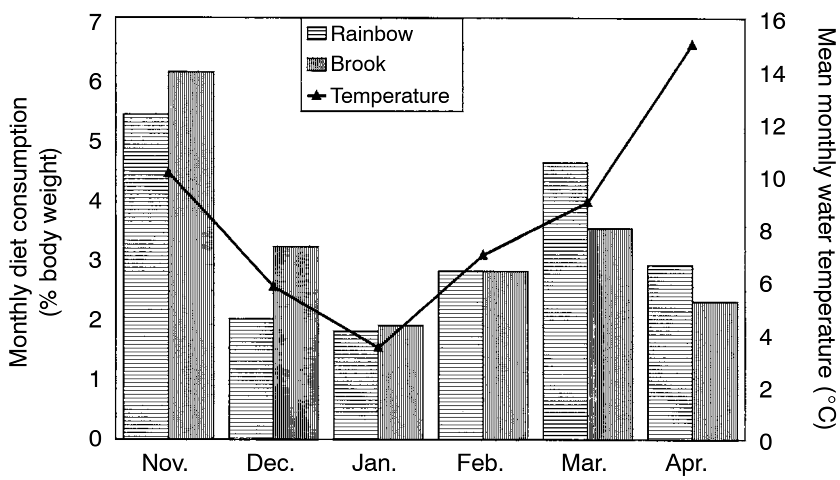
Growth rates in this study were considered good, as both species reached harvestable weights of >225 g (Bardach et al. 1972). Based on specific growth rate, if stocking weights of both species were standardized on the rainbow trout stocking weight (56 g), brook trout could have potentially achieved an average harvest weight of 465 g

TABLE 1. Mean ± SE individual weight, percentage survival, feed conversion ratio (FCR), specific growth rate (SGR), and unit production of juvenile rainbow trout and brook trout fed for 163 days in ponds. Means in a row followed by different letters were significantly different ($P < 0.05$).

	Rainbow trout	Brook trout
Stock weight (g)	55.1 ± 1.5a	28.9 ± 0.4b
Harvest weight (g)[1]	439.3 ± 59.5a	276.8 ± 21.0a
Weight gain (%)	698.1 ± 131.0b	856.9 ± 93.2a
Survival (%)	94.7 ± 2.0a	87.1 ± 8.4a
Feed conversion ratio[2]	1.6 ± 0.1a	1.7 ± 0.0a
Specific growth rate (%)	1.3 ± 0.1a	1.4 ± 0.1a
Gross yield (kg/ha)	3152 ± 458a	1854 ± 252b

[1] Not significantly different when initial weights are considered (analysis of covariance).
[2] FCR was calculated as: (total diet fed, g)/(total wet weight gain, g).

FIGURE 1. Overall monthly diet consumption for rainbow trout and brook charr at different water temperatures over a 163-day culture period.



compared to 439 g actually achieved by rainbow trout. SGR for rainbow trout (1.3%) were higher than those reported by Tidwell et al. (1991) with similar sized rainbow trout (0.7%) also fed to satiation in ponds. Mean weight gain per fish was also higher in this study for rainbow trout and brook trout (384.2 g and 247.8 g, respectively) than

TABLE 2. Mean ± SE for visceral fat weight (% whole weight), dressed with head (%), dressed with head off, and fillet with skin from rainbow trout and brook trout grown in ponds for 163 days. Means in a row followed by different letters are significantly different ($P < 0.05$).

	Rainbow trout	Brook trout
Visceral fat (%)	2.10 ± 0.64a	2.72 ± 0.12a
Dressed with head (%)	80.23 ± 2.84a	79.37 ± 5.39a
Dressed without head (%)	73.43 ± 1.83a	70.45 ± 1.72a
Fillet with skin (%)	30.41 ± 0.56a	27.94 ± 0.90b

that reported by Tidwell and Mims (1990) with rainbow trout (177.0 g) under similar conditions for 199 days.

Rainbow trout and brook trout fed actively, especially at water temperatures above 8°C. Brook trout fed better during the decreasing temperatures of early-winter, while rainbow trout fed better during the increasing temperatures of late winter (Figure 1). Some feeding continued for both species at water temperatures as low as 4°C. Newton (1997) found that brook trout fed more actively under low temperature conditions than rainbow trout. The results of this study suggest that rainbow trout and brook trout feed similarly at low temperatures.

This study indicates that the growth of rainbow trout and brook trout is similar under winter pond conditions. Rainbow trout are the principal cold freshwater fish cultured for food usage in the United States (Brown and Gratzek 1980). Rainbow trout culture is mature and efficient, with product competitively priced at $2.47-2.72 per kg live weight (Johnson 1998). Brook trout may sell for a higher price as a specialty product in local niche-markets, and domestication of brook trout through selective breeding will probably improve growth rates.

These results suggest that brook trout can be cultured in ponds during winter months in temperate regions of North America with production yields comparable to rainbow trout. Brook trout may provide trout farmers an alternative to rainbow trout for niche markets.

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