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**Self-sustaining Rainbow Trout (*Salmo gairdneri*) Population
in McConaughy Reservoir, Nebraska**

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Self-sustaining Rainbow Trout (*Salmo gairdneri*) Population in McConaughy Reservoir, Nebraska

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ABSTRACT

A self-sustaining rainbow trout population has developed in the North Platte River drainage. This population inhabits McConaughy Reservoir and reproduces successfully in tributary streams of the North Platte River located approximately 113 to 145 km above the reservoir. Fall and spring spawning populations migrate from the reservoir.

Scale analysis indicated 92% of the juveniles had spent 1 yr and 8% had spent 2 yr in the stream before the spring migration to the reservoir as 175–250 mm smolts. In the 1965–1969 spawning populations 13 life history categories were present. The spawning runs were composed of 76% maiden spawners, 22% second-year spawners and 2% third-year spawners. The sex ratio of the spawning runs ranged between 2.0–2.2 females per male.

The rainbow trout population is subjected to a variety of conditions in tributary streams of the North Platte during summer including flooding, irrigation return water and high water temperatures. However, spawning rainbow trout utilize these groundwater streams from November through April. In addition the coldwater habitat in the reservoir is restricted throughout the summer, especially during August.

The established rainbow trout population survived better in this environment than hatchery rainbow trout.

McConaughy Reservoir provides an important regional sport fishery. The self-sustaining rainbow trout (*Salmo gairdneri*) fishery in the reservoir is unique for the Great Plains area. Rainbow trout in McConaughy Reservoir sustain themselves through natural reproduction in tributary streams of the North Platte River approximately 113 to 145 km above the reservoir. In addition to the rainbow trout population this reservoir also provides an excellent warmwater fishery and meets the requirements of a "two-story" reservoir as described by Kirkland and Bowling (1966). The ecology and fishery management of the reservoir was described by McCarragher, Madsen and Thomas (1971).

The popularity of rainbow trout fishing in McConaughy Reservoir increased rapidly during the early sixties. To maintain this quality reservoir fishery and the popular rainbow trout stream fishery which exists in the spawning streams, basic life history data had to be collected and a management plan developed. This paper describes the self-sustaining rainbow trout population and the environmental conditions under which it exists.

STUDY AREA AND METHODS

McConaughy Reservoir, Keith County, Nebraska is located on the lower North Platte

River approximately 193 km downstream from the Nebraska-Wyoming state line (Fig. 1). Created in 1941 by the construction of Kingsley Dam, the 14,000-ha irrigation storage reservoir is the largest body of water in Nebraska. The maximum depth of this reservoir is 43 m.

Some streams in the upper North Platte River drainage in western Nebraska support self-sustaining rainbow trout populations (Fig. 1). Nine Mile Creek (mean flow 124 cfs 1963–1968) contains the best spawning habitat and supports the largest run of rainbow trout from McConaughy Reservoir. Red Willow Creek and Tub Springs are the other major spawning streams.

My field data were collected between 1965 and 1969. Fyke nets, electrofishing, and an electrical weir were used to sample the rainbow trout population. Rainbow trout 305 mm total length and over were classified as adults. Individuals under 305 mm were recorded as juveniles.

Adult rainbow trout were sampled in the spawning streams and the reservoir. The 1965–1966 rainbow trout runs from McConaughy Reservoir were monitored by stream sampling. The 1967–1969 spawning runs were sampled at the Lewellen electrical weir and fish trap in the North Platte River im-

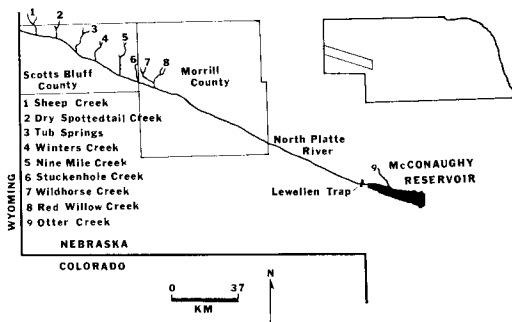


FIGURE 1.—McConaughy Reservoir streams which support self-sustaining rainbow trout populations in the Upper North Platte River drainage, Nebraska.

mediately above the reservoir where it was possible to separate the fall and spring spawning populations (Fig. 1). The operation and description of the electrical weir and fish trap was described by Madsen (1973). Age and growth data were collected randomly when sample sizes were large. Sexual maturity of the adult spawners was classified according to gonad condition. Rainbow trout were recorded as sexually mature when the sex products were visible after gentle pressure was applied along the underside of the body. Age determinations were made by two independent scale interpretations. Scale interpretation was used to determine migration patterns and to classify the life history categories. Designations for life history categories were modified from Shapovalvo and Taft (1954) and Hartman (1959).

Juvenile rainbow trout were captured throughout the drainage. Those of about 102–203 mm were finclipped to determine migration patterns and to verify age determinations. Marked rainbow trout were recaptured in the reservoir, at the Lewellen trap, and in the spawning streams when they returned to spawn.

I monitored the trout habitat in McConaughy Reservoir by dissolved oxygen and temperature data during the summers of 1969–1970 with the oxygen and temperature criteria described by Kirkland and Bowling (1966). Trout supporting water was defined as 21.1 C or colder, containing at least 3.0 mg/liter oxygen. Oxygen and temperature data were collected bimonthly during the mid-day period at three permanent sampling stations during June through September.

RESULTS

Life History

Thirteen life history categories were identified from fish in the 1965–1969 spawning runs (Table 1). The predominant life history category (1/2) described 58% of the spawning population; these trout were spawning for the first time after spending one growing season in the stream as juveniles and two growing seasons in the reservoir. Spawning runs were comprised of 67% 3-year-old, 24% 4-year-old, 8% 2-year-old and 1% 5-year-old rainbow trout.

TABLE 1.—*Life history categories represented in the 1965–1969 spawning runs of McConaughy Reservoir rainbow trout*

Life history category	Spawner classification	1965–1969 Spawning runs						Totals	
		1965	1966	1967	Fall 1968	Spring 1969	Fall 1969	Number	Percent
1/1 ^a	Maiden	4	18	32	4	1	14	73	8.4
1/1.1S	2nd year	33	19	2	2	2	7	65	7.5
1/1.2S	3rd year	6	4	2	—	—	2	14	1.6
1/2	Maiden	119	73	68	86	64	98	508	58.3
1/2.1S	2nd year	16	29	7	15	12	35	114	13.1
1/2.2S	3rd year	—	—	—	—	1	1	2	.2
1/3	Maiden	4	5	4	4	2	8	27	3.1
1/3.1S	2nd year	—	1	—	—	—	—	1	.1
2/1	Maiden	1	—	2	—	—	7	10	1.1
2/1.1S	2nd year	9	1	1	—	—	1	12	1.4
2/2	Maiden	14	4	6	7	2	7	40	4.6
2/2.1S	2nd year	1	—	—	—	1	2	4	.5
2/3	Maiden	—	—	—	—	—	1	1	.1
Totals		207	154	124	118	85	183	871	100.0

^a The number of years of stream life are to the left of /. The sum of the numbers to the right of the / are the years spent in the reservoir. The number and the letter S to the right of the period indicates the number previously completed spawning runs not including the present one.

The 1965–1969 spawning populations contained 76% maiden spawners, 22% second year spawners and 2% third year spawners (Table 1). All the third year spawners had been 1-year-old smolts. Analysis of scales from spawners indicated 20% of the fish had spent only one growing season, 77% spent two growing seasons, and 3% had spent three growing seasons in the reservoir before maturation and entering the first spawning migration. At the Lewellen trap none of the fall run, but 54% of the spring run, was sexually mature when sampled. In the 1965–1969 spawning runs 92% of the rainbow trout had been 1-year-old smolts and 8% had been 2-year-old smolts before downstream migration to the reservoir. The sex ratio during the three fall spawning runs (1967–1969) and the 1969 spring run averaged 2.2 females per male (range 2.0–2.2).

Growth data indicated rainbow trout 2 years old which spent 1 yr in the reservoir averaged 394 mm and weighed 0.7 kg (Table 2). After 2 yr in the reservoir the fish averaged 526 mm long and 1.7 kg in weight. After 3 and 4 yr they averaged 571 mm and 2.2 kg and 559 mm and 1.6 kg, respectively. Growth in the reservoir between the first and second spawning runs averaged 94 mm, excluding the small sample size data (Table 3).

Anglers voluntarily returned 22% of the tags affixed to 448 rainbow trout during the 1967–1969 spawning runs. Of this 22% return the stream fishery accounted for 65% and the lake fishery 35%.

Migration

Juvenile rainbow of 175–250 mm migrated to the reservoir during spring. Marked ju-

TABLE 2.—Mean lengths and weights of rainbow trout life history categories represented in the 1965–1969 spawning runs

Life history category	Mean total length (mm)	Sample size	Mean weight kg	Sample size
1/1	391	73	.7	61
1/1.1S	521	65	1.6	61
1/1.2S	553	14	1.8	14
1/2	528	508	1.7	348
1/2.1S	569	114	2.2	87
1/2.2S	564	2	—	—
1/3	584	27	2.4	21
1/3.1S	546	1	1.6	1
2/1	406	10	.7	9
2/1.1S	518	12	1.5	12
2/2	508	40	1.5	30
2/2.1S	587	4	2.4	3
2/3	630	1	3.1	1

veniles averaged 236 mm when captured in the reservoir during April and May in 1967 and 1968. Just prior to downstream migration from the spawning streams, juveniles lost their parr marks and turned from light gray to bright silvery white. Also the tips of the dorsal and the caudal fin turned nearly black and the body became more streamlined. This population apparently goes through a smolt stage similar to that of rainbow trout populations in larger inland lakes, as described by Greeley (1933), Rayner (1941) and Hartman (1957).

There were two distinct rainbow trout spawning migrations from McConaughy Reservoir. The larger fall run began during September and continued until late November while the smaller spring run extended from March into April (Table 4). Spawning of rainbow trout from McConaughy Reservoir can be observed in streams from November through April. December, the most active spawning period, represents the peak spawning period of fall run trout. March is the

TABLE 3.—Growth of the life history categories in McConaughy Reservoir

Years of stream life	Years of reservoir life before entering spawning runs	First spawning run, mean length (mm)	Growth difference (mm)	Second spawning run, mean length (mm)	Growth difference (mm)	Third spawning run, mean length (mm)
1	1	391 (1/1) ^a	130	521 (1/1.1S)	32	553 (1/1.2S)
1	2	528 (1/2)	41	569 (1/2.1S)	-5	564 ^b (1/2.2S)
1	3	584 (1/3)	-38	546 ^b (1/3.1S)	—	—
2	1	406 (2/1)	112	518 (2/1.1S)	—	—
2	2	508 (2/2)	79	587 ^b (2/2.1S)	—	—
2	3	630 ^b (2/3)	—	—	—	—

^a Life history categories.

^b Sample size less than 10 individuals.

TABLE 4.—*Adult rainbow trout sampled at the Le-wellen trap, 1967–1970*

Fall run		Spring run	
Operation dates	Number captured	Operation dates	Number captured
4 October– 27 November 1967	100 ^a	8 March– 1 April 1968	21 ^b
18 September– 15 November 1968	665	31 March– 21 April 1969	208
8 October– 13 November 1969	635	21 March– 8 April 1970	29 ^b

^a Initial design and beginning operational difficulties accounted for the lower number of rainbow trout captured.

^b Low catch due to adverse weather conditions.

most active spawning period for the spring run.

Spring run rainbow trout were larger than those in the fall run. In the 1969 spring run they averaged 546 mm compared to 521 mm for the 1968 fall run. In this spring run the sex ratio was 2.1 females per male as compared with 2.2 in the fall run.

McConaughy Reservoir contains rainbow trout which originated from the spawning streams but did not return to spawn. This became evident during the early spring of 1967 and 1968 when sexually mature rainbow trout were captured and tagged along the dam and rocky shoreline areas of the reservoir. Ovaries of some of these females examined upon recapture later the same spring showed signs of egg absorption which indicated these trout apparently had not spawned or left the reservoir. All the tag returns by anglers during the next two years (23% of the 89 rainbow tagged) came from the reservoir; none were from the spawning streams. These tagged fish were not of hatchery origin because all rainbow trout stocked in the drainage since 1963 were marked.

Environmental Conditions

The spawning streams are annually subjected to a variety of conditions. During the agricultural growing season (May through September) these spawning streams with a base flow of groundwater, are subjected to flooding, irrigation return water, and releases of water from the numerous canals in the intensively farmed North Platte Valley. Turbidity of the spawning streams is higher during this period than in winter. Water tem-

peratures exceeding 24 C for a short duration are common in many spawning streams during summer. In the best spawning area of Nine Mile Creek temperatures ranged between 12 and 21 C in a 24-hr period during the summer of 1967. Rainbow trout 50–100 mm long which have hatched during the previous winter and spring survive these summer conditions.

At the end of the irrigation season (October through April) the streams clear and stream flow becomes constant. Water temperatures during winter range between 5 and 10 C.

The spawning riffles available represent a divergence from the usual rainbow trout spawning habitat. In Nine Mile Creek the spawning riffles are composed of a hard compressed clay referred to as Brule clay. As the stream eroded the Brule clay formation, clay broke off in pieces approximately 25–100 mm in diameter. This clay has persisted because it is much more resistant to erosion than the other soils in the watershed.

Oxygen and temperature conditions restrict the coldwater habitat for rainbow trout in the reservoir during the summer only. Trout habitat began decreasing in June and continued until the most critical period which was sometime during the first three weeks in August. During August the coldwater trout habitat was restricted to a vertical depth of 3 m and 4,694 ha in 1969 and 7 m and 5,342 ha in 1970. Extreme critical conditions lasted approximately two weeks and then the amount of trout-supporting water began to increase. The wind, which is nearly always blowing, undoubtedly helps keep this reservoir suitable for rainbow trout survival during the summer. No known summer kill of trout has occurred in the reservoir.

History

The origin of the rainbow trout population remains uncertain. Other than stocking records practically no information concerning the rainbow trout population was recorded until the mid-fifties when biologists began inventorying the streams in the North Platte River drainage.

Rainbow trout were first stocked into the

North Platte River drainage in Nebraska during 1911. Many of the present day spawning streams were stocked periodically from 1915 through 1967. It is not known if trout were present in the streams before the original stocking or if natural reproduction resulted from these early introductions. Periodical rainbow trout introductions were made directly into the reservoir during the 1947–1967 period.

During the mid-forties there were reports of large rainbow trout in some of the streams in the drainage. One of the best documented rainbow trout runs occurred in Ottar Creek, a small stream emptying directly into McConaughy Reservoir. In March 1948 the Nebraska State Rock Creek Hatchery and the Crawford National Fish Hatchery collected eggs from rainbow trout that migrated into this stream. At this time rainbow trout were present in this stream from December through April. These runs diminished during the 1950's and have only recently been reestablished. By the late forties and early fifties frequent catches of large rainbow trout were reported from the present day spawning streams.

Hatchery vs. Wild Trout

An evaluation of the rainbow stocking program in the drainage was conducted for a 7-yr period. During the 1963–1967 period 32,548 hatchery reared rainbow trout stocked in the spawning streams and 7,595 wild rainbow trout captured in the spawning streams were finclipped when they were 102–203 mm. Spawning runs from the reservoir were sampled to determine the contribution of these marked fish. During the recapture period (1963–1970) only 9 marked adult hatchery rainbow trout were examined as compared to 85 marked wild rainbow trout. Stocking of hatchery trout appeared to contribute very little to the spawning runs from the reservoir so this practice was terminated. The present management plan emphasizes habitat development and use of rainbow trout progeny from McConaughy Reservoir to develop spawning runs in additional streams within the drainage.

DISCUSSION

Although this rainbow population survives conditions in a setting unlike that of many other populations, the growth rate, especially during the first year of life in the streams, is rapid enough to cause a high percentage of 1-year-old smolts. The 92% 1-year-parr or stream life reported in this study is higher than in other spawning populations reported from inland lakes. Dodge and MacCrimmon (1970) and Greeley (1933) reported less than 10% of the downstream migrants were 1 yr old. Kwain (1970) reported 38% and Stauffer (1972) reported 68% of the downstream migrants were rainbow trout with 1 yr of parr life.

It appears progeny from a fall spawning trout would have a survival advantage over progeny from a spring spawning trout in the drainage. The fry from the fall run begin showing up in the streams during mid-February. These fish have from February until the irrigation season in mid-May to grow and adapt to the stream environment. In comparison the spring run fry become evident in the stream during the last part of April and have a relatively short time to adapt before the onset of the irrigation season and its influences. Although no distinction between fall and spring run juveniles were made in the spawning streams the spring run juveniles were several months younger so were probably the smallest individuals. This would undoubtedly contribute to a higher mortality upon migration into the reservoir. These two factors would certainly favor the perpetuation of the fall spawning type.

From either the mass stocking of rainbow trout in the Nebraska portion of the drainage or the presence of rainbow trout introductions somewhere higher in the North Platte River drainage, or a combination of both, has evolved a rainbow trout population that has taken advantage of the available environment and established itself to a point where it is now better adapted to the drainage than the hatchery product. This population is a prime example of the ability of rainbow trout to successfully adapt under a variety of environmental conditions.

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