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A STUDY OF MIGRATORY LAKE RUN TROUT IN THE BRULE RIVER, WISCONSIN

Part II

RAINBOW TROUT

By

Wallace Niemuth

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150-92

Photograph of a Brule River Catch of Rainbow.

INTRODUCTION

This study was conducted to obtain information on migratory trout of Lake Superior. Both the brown and the rainbow trout are migratory here. Part I published in 1967 covered the brown trout and this report (Part II) covers the rainbow trout. The work was planned for and carried out in the Brule River because this is Wisconsin's largest trout stream tributary to Lake Superior and the stream is heavily utilized by migratory (lake-run) trout. Even though the rainbow and brown trout spawn at different times of the year, there is considerable overlapping in their movement and presence in the river. Quite frequently we were handling and collecting data on both species simultaneously.

The physical characteristics and the outline map of the Brule River were presented in Part I, and therefore will not be repeated here.

MIGRATORY RAINBOW TROUT BACKGROUND AND HISTORY

The exotic rainbow trout was imported from the Pacific Coast and introduced into the Great Lakes region in the late 1800's. The records show that the rainbow was first introduced into the Brule River in 1892 when a plant of 30,000 rainbow trout fry was made, (O'Donnell, 1945). Through the years rainbow trout in various numbers and sizes have been planted in the Brule River (Table 1). Through stocking and the adaption of the rainbow trout to a new environmental location, a thriving population of very sporty and very popular trout species has evolved.

The strong natural migratory habits of the rainbow trout also resulted in pronounced spawning runs into suitable rivers and streams tributary to the Great Lakes. The Brule River is one of the streams where annual rainbow trout spawning runs have occurred for many years. Historically this fact was reported by James Nevin (former director) in May 1921 issue of "The Wisconsin Conservationist". Local residents reported that the Brule River was full of large rainbows (5 to 20 pounds) which came up the river from Lake Superior in the spring to spawn. Migratory rainbows fresh from Lake Superior are bright silvery or lustrous steel blue in color and are commonly called "Steelheads" by many trout fishermen. The attraction of the "steelhead" and the very popular sport fishery associated with its annual migratroy runs has resulted in not only exciting and memorable fishing but also heavy fishing pressure. Over the years, much of the recognition the Brule River has received as a trout stream can be attributed to the migratory rainbow trout fishery. In recent years the migratory brown trout has shared some of the sport fishery spotlight. However, it is clearly evident that the "steelhead" is still the prime target of fishermen and still draws the heaviest fishing pressure.

FISH SAMPLING METHODS AND PROCEDURES

The fish sampling methods, namely the fish weirs and the electro-fishing gear, used in capturing migratory brown trout were also used to capture migratory rainbows. The location, description and the operational efforts for both the "Winnie" and "Highway 2" fish weirs were discussed in detail in Part I. The same electro-fishing gear (boat mounted boom shockers and the stream shocker unit) were also used. Through necessity, greater emphasis was placed on the electro-fishing

Table 1. Rainbow trout stocking record for the Brule River.

Year	Total Number Stocked	Size or age of Trout Stocked.
(1890-1894	55,000	Size or age not given.
(1895-1899	94,500	" " " " "
(1900-1904	45,250	" " " " "
(1905-1909	47,500	" " " " "
1. (1910-1914	126,000	" " " " "
(1915-1919	232,200	" " " " "
(1920-1924	77,400	" " " " "
(1925-1929	205	" " " " "
(1930-1934	13,455	" " " " "
(1935-1937	119,442	" " " " "
(1938	225	Yearlings
(1939	94,809	(87,312 fgls.)-(6,880 yearlings)-(617 adults)
(1940	266,940	(222,128 fgls.) -(44,514 yearlings) -(298 adults)
(1941	123,000	Fingerlings
(1942	17,965	(17,882 fingerlings) - (83 adults)
(1943	1,192	Adults
(1944-1952		No rainbow trout stocked.
2. (1953	37	Yearlings
(1954		None stocked
(1955	4,000	Yearlings - 6-9 inches.
(1956	6,000	Yearlings - 6-9 inches.
(1957	7,500	Yearlings - 6-9 inches.
(1958	40,000	(35,000 fry) - 5,000 Yearlings 6-9 inches.
(1959) ( ) (1966)	4,000	Stocked annually - yearlings 7-10 inches.

1. From - O. Donnell - (1945) Page 282.

2. From the Northwest Area file Brule River Stocking record.

method for sampling rainbows. A decline in the rainbow catch at the upstream weirs plus the development of a suitable D.C. (direct current) boom shocker unit prompted greater use of this sampling method. Most of the migratory rainbows captured in 1964 and all of the rainbows captured in 1965 were taken with the D.C. boom shocker.

The highly energetic rainbow trout were anesthetized and then measured, weighed, sexed, and a scale sample removed when captured. The fish were also tagged or marked and then released in the direction of travel or in the immediate proximity of capture. Other pertinent information recorded was the outward appearance and physical characteristics to determine the sex of the fish. Rainbows were not as easy to sex as were the brown trout because rainbows captured in the fall were several months away from the spawning period and sexual characteristics were not as pronounced. Many of the rainbows captured were actually immature, precocious fish. The 11 to 15 inch size group were extremely difficult to sex with any degree of reliability and therefore were usually not sexed.

Most of the rainbows captured during the course of this study were tagged. However, trout tagging was temporarily suspended in late October in 1961 due to a public relations problem. This problem developed as a result of the mortality which occurred among the migratory brown trout. As explained in Part I of this report, the loss of brown trout was due primarily to disease. As a result, 165 rainbows captured at the "Winnie Weir" were not tagged.

Another exception in our tagging program was sublegal rainbows (fish less than 13 inches) that were captured. Because of their smaller size these fish were not tagged, but were marked with an identifying fin clip. Most of the rainbows were tagged with Peterson disk tags. A few rainbows were tagged with aluminum jaw tags for comparison of results. Early in the study migratory trout were tagged in various places on the body in an effort to determine the most desirable area to place the tag. Some trout were tagged posterior and below the dorsal fin while others were tagged anterior to the caudal fin. However most trout were tagged toward the anterior end of the dorsal fin and immediately below it as this proved to be the most suitable area. In this study rainbows were tagged with yellow disk tags whereas red tags were used on the brown trout. The yellow tags were readily visible in clearer, shallower water and were also very conspicuous to the angler catching tagged trout.

ENTRY AND MOVEMENT OF MIGRATORY RAINBOW TROUT

Normally, wild or native rainbows spawn in the spring. In numerous situations pre-spawning runs occur. Trout migration from a lake or ocean environment into a spawning stream may occur at different times of the year. Hartman (1959) in his work on rainbow trout in the Finger Lakes in New York sampled spawning fish during the peak of the migration which occurred in mid-March. Hallock et al., 1961 found that the peak of the rainbow run in the Sacramento River system occurred in the fall toward the end of September.

In the Brule River migratory rainbows are known to enter at different times. Some rainbows move into the river in the spring while others enter the river during the fall. In this study, survey work was conducted in an attempt to evaluate the magnitude of both the spring and fall runs. Unfortunately there is little previous factual background information on trout movement into the Brule River. Therefore comparison of previous rainbow runs with current information is impossible.

Spring Migration

The geographical location and water regimen of the Brule River is such that in the winter months the lower Brule becomes completely and heavily ice bound. Based upon observations and weir operations in the upper Brule River it was noted that there was little trout movement where heavy ice conditions developed or existed. From the appearance of ice conditions at the mouth, it is very doubtful that any trout move into the river during the winter months.

The Brule River begins to open up around the latter part of March or during early April, depending on the weather. As the main river channel opens trout movement both up stream and downstream take place, with rainbows moving upstream to spawn and brown trout moving downstream to Lake Superior. Trout movement continues throughout the spring months as spring run rainbows move in and spawned out rainbows move back to Lake Superior.

In recent years the free movement of spring run rainbows has been impeded to some extent by the sea lamprey weir. Each spring as the lower Brule becomes relatively ice free this weir is put into operation (Table 2). As was pointed out earlier, this weir when in operation constitutes a virtual barrier to all upstream fish movement. Only those desirable species captured in the weir fish traps were passed upstream. This was the intended purpose and design of the weir in the earlier phases of the sea lamprey control program.

Many trout fishermen have expressed concern over the blocking effect of this weir and its influence on the spring rainbow run. Some of the "old timers" who have fished the Brule for many years, maintain that the spring rainbow run has declined since the sea lamprey weir has been operated on the Brule River. The fishermen further contend that with the sea lamprey population reportedly down in Lake Superior, and with the use of selective chemicals for control, the sea lamprey weir should be removed. Although this weir is still effective in blocking and capturing sea lampreys, it's present use is primarily aimed at providing an index as to the comparative status of adult spawning sea lampreys.

In the process of collecting information on migrating rainbows, a number of spring shocker surveys were conducted in the lower Brule River. From these surveys we had an opportunity to evaluate to some extent the magnitude of the spring rainbow run. One drawback to early spring work was getting into the river with our shocker equipment. In spite of this difficulty a number of unscheduled surveys were made (Table 3).

Although few rainbows were captured during the spring shocker operations, most of the fish were fresh migrants from Lake Superior. From the fisherman's point of view all of the rainbows captured were legal size (13 inches and over) but many of the smaller fish were questionable spawners.

Considering the blocking effect of the sea lamprey weir, the shocker surveys showed no indications of buildups or concentration of rainbows below the weir. However, large concentrations of migratory brown trout have occurred here, in 1958-59-60 when sea lamprey control operations were extended into late August and early September.

Similar shocker surveys were conducted in the spring of 1959 to determine if migratory rainbows were being blocked. On April 8, eleven rainbows ranging from 12.9 to 25.9 inches were captured - no significant concentration. On May 20, 77 rainbows ranging from 14.0 to 26.9 inches were captured. Of all the trout captured only one ripe female was noted. The other rainbows were spawned out fish returning to Lake Superior.

Table 2 Annual operational dates for the sea lamprey weir used in the Brule River by the U.S. Fish and Wildlife Service.

Year	Starting Date	Ending Date
1957	May 18	July 19 (Flood waters damaged the weir)
1958	March 27	August 29
1959	March 27	September 8
1960	April 4	August 23
1961	March 24	July 12
1962	March 26	July 14
1963	March 30	July 13
1964	April 17(1)	July 17
1965	April 14(2)	July 16
1966	April 4	July 13

(1) Starting date delayed at the request of the Wisconsin Conservation Department.

(2) Starting date delayed because of late spring and ice breakup.

Table 3 The results of boom shocker surveys conducted below the sea lamprey weir in the spring of the year in the Brule River.

Date	Number of Rainbows Captured	Size of Fish Captured
March 25, 1961	0	
March 31, 1961	4	14.3 - 18.3 - 19.7 - 22.8
April 27, 1962	1*	20.5
April 5, 1963	8	14.5 - 14.7 - 15.0 - 16.0 - 17.4 - 18.9 - 23.6 - 23.7
April 11, 1963	14	13.0 - 14.4 - 14.7 - 15.1 - 15.3 16.1 - 16.5 - 17.4 - 17.6 - 18.1 19.5 - 24.6 - 27.0
April 25, 1963	7	13.1 - 22.0 - 23.2 - 23.6 - 25.1 25.9 - 26.0
May 2, 1963	3	14.3 - 19.1 - 22.1
April 20, 1964	7	14.0 - 16.5 - 17.6 - 21.4 - 21.6 22.4 - 24.0
April 24, 1964	1	19.3 (spawned out)
April 23, 1965	7	14.2 - 14.4 - 18.9 - 20.8 - 21.0 23.7 - (28.0 spawned out)

* Five (5) other rainbow trout observed but not captured due to the dense concentrations of other species (smelt - longnose suckers and common suckers) in the river below the weir.

A review of the lamprey weir daily catch records for each year of operation also indicates a minimal spring rainbow run. The greatest number recorded for the month of April was in 1966 when 61 rainbows 12 inches and over were captured. The catch for May (1966) was even greater with 215 fish (12 inches and over) recorded. These catch figures may be somewhat misleading because by late April or early May spawned out rainbows are often captured. In fact, most of the rainbows captured in May are spent fish returning to Lake Superior. All fish moving downstream at a time when the weir is in operation have to pass through the electrical fields comprising the weir. Even though this weir is designed to catch fish moving upstream, it is known that many trout (large and small, both browns and rainbows) passing through the weir will temporarily reverse direction and end up in the fish traps. It is ordinarily possible to distinguish between fresh run rainbows and fish that have been in the river for any length of time by the contrast in coloration and overall condition. No such distinction was made for the rainbows captured at the sea lamprey weir, although occasional reference was made to the fact that some fish had already spawned. Regardless of whether the rainbows captured had spawned or not, the best spring catch recorded was relatively small. Even if all of the rainbows captured had been moving upstream to spawn and had been passed upstream, the number still would not constitute a significant spring spawning run for a stream the size of the Brule River. Although there is no long term comparative data on spring rainbow runs for the Brule River, spring runs appear to be critically low.

At the same time other smaller tributary streams are known to have good spring rainbow spawning runs. For example, a stream survey was conducted in Pikes Creek, Bayfield County on May 4-5, 1965. Pikes Creek is a comparatively small stream. The lower one mile of the stream, where this survey was made, averages about 15 feet in width and has an average depth of about 10 inches. On this particular survey 48 migratory rainbows were captured ranging in size from 13.0 to 27.5 inches and 0.8 to 8.4 pounds. The trout averaged 19.9 inches and 2.9 pounds and most of them were spawners. Whereas Pikes Creek has a spring rainbow run it reportedly does not have a fall run.

Fall Migrations

Exactly when fall rainbow migrations first started in the Brule River has not been precisely or historically documented. In 1945 O'Donnell (1954), recommended the enactment of a fall trout fishing season to take advantage of the fall run of rainbow trout. Even though documented information is not available we can assume that significant fall rainbow migrations were occurring in the early 1940's or even prior to that time. The potential, sport fishing for trophy steelheads, was recognized in the fishing season recommendations. Since the inception of the first fall trout season in 1948, a very popular and important trout fishery has evolved.

Current information of fall rainbow runs was obtained mainly through boom shocker surveys - conducted in the lower Brule River, Table 4. From these surveys, data on time of entry and migration periods, size of the migratory trout, and some indication of the magnitude of the run was obtained. These surveys were conducted on a random basis or as time and available help permitted. The area covered was comparatively small and restricted to the lower 1½ miles of river. The success of the surveys was dependent on our ability to locate and capture any trout in this section of the river at a particular time. In this type of operation not all of the fish observed were always captured.

Table 4. Migratory rainbow trout captured in the Lower Brule River with electro (boom shocker) fishing gear.

Time Period	1961	1962	1963	1964	1965
Aug. 8 - 15	1-(2)	0-(2)	--	0-(1)	--
Aug. 16 - 23	0-(1)	0-(2)	--	0-(1)	--
Aug. 24 - 31	12-(4)	0-(2)	1-(1)	0-(2)	--
Sept. 1 - 7	--	0-(1)	9-(1)	--	
Sept. 8 - 15	4-(2)	5-(2)	1-(1)	3-(2)	2-(1)
Sept. 16 - 23	8-(1)	--	31-(3)	16-(2)	9-(2)
Sept. 24 - 30	--	0-(1)	--	7-(1)	12-(2)
Oct. 1 - 7	11-(1)	--	8-(2)	26-(2)	22-(1)
Oct. 8 - 15	--	--	--	22-(2)	23-(3)
Oct. 16 - 23	--	--	13-(1)	22-(2)	33-(2)
Oct. 24 - 31	--	--	1-(1)	10-(2)	18-(2)
Nov. 1 - 7	--	--	--	10-(2)	--
Nov. 8 - 15	9-(1)	--	--	9-(2)	4-(2)
Nov. 16 - 23	--	--	--	4-(1)	1-(1)
Nov. 24 - 30	--	--	--	--	--

Number in parenthesis indicates number of survey trips made during the time period.

The fall "steelhead" run usually commences around the middle of September (Figure 1). Occasional migratory rainbows were captured in August or prior to mid-September but these early fish were few and far between. From mid-September on, the number of incoming rainbows increased with the peak of the fall run occurring around the middle of October. By late October and through November there was noticeable decline in the number of incoming fish. Some anglers maintain that a late season run of large size rainbows occurs in the Brule River. Survey operations conducted in November of 1964-65 did not substantiate this view.

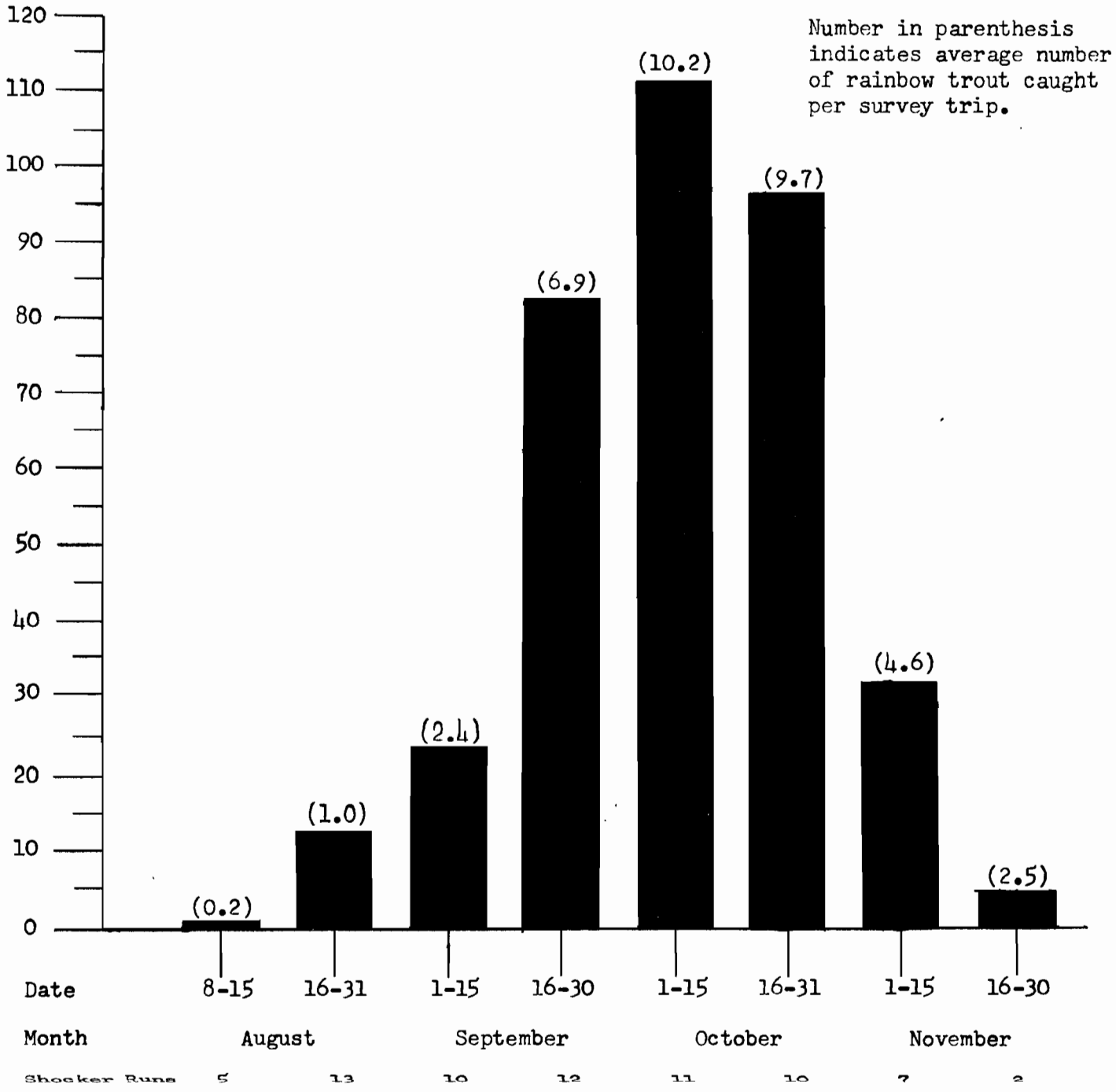
The fall rainbow migratory run was found to be significantly greater than the spring run. At the present time, fall run rainbows constitute the backbone of the spawning population in the Brule River. There has always been considerable speculation as to the reason for the fall migratory rainbow run, especially when spawning takes place in the spring. Perhaps a migratory run at this time of year is only natural since many of the Pacific Coast steelhead strains migrate in the fall. Many anglers feel that the rainbows merely follow migratory browns into the river to feed on eggs which drift downstream past the redds during the spawning act. This is a reasonable assumption since confirmed reports (Hallock et al., 1961) from the West Coast studies indicate that steelheads found in the vicinity of salmon spawning redds do consume available eggs. Fishermen also realize that cured or preserved salmon eggs, trout spawn, or a reasonable imitation of either of these make good steelhead bait. Regardless of the thinking, observations of brown trout spawning activity resulted in sighting little or no predation of eggs by migratory trout in the upper river. Further observations as well as weir trapping records also indicate that relatively few migratory rainbows were present in the spawning ground while brown trout were spawning. At the same time numerous small stream trout were seen in the vicinity of the brown trout redds - presumably feeding on any available trout eggs.

Some anglers are of the opinion that fall migratory rainbows spawn in the fall. This is a reasonable assumption because some of the steelheads caught in the fall exhibit advance development of the sexual organs. However, from the work conducted and the many observations made, no fall rainbow spawning was noted in the upper Brule. It should be pointed out that hatchery reared rainbows stocked in the Brule River come from a fall spawning strain. This may account for the advanced condition of the sexual organs in some trout. Although there is little or no evidence of fall spawning at present, fall spawning could occur in the future.

Another possible factor is the size and condition of each individual stream. The Brule River, by local comparison, is a relatively large stream. This river has the necessary size, volume and capacity to adequately hold and maintain sizeable numbers of large trout over winter. Some of the smaller streams that have very limited fall runs or only spring runs do not have the size or carrying capacity to hold many large trout over a prolonged winter period. Many of these small streams are very shallow, especially during dry periods which often occur in the fall. In spring added water from runoff and rains increases the normal water level, and improves conditions for these larger trout.

In the Brule River rainbow spawning takes place rather early in the spring. While the river in the spawning areas may be completely ice free, parts of the lower river and particularly near the mouth may be still heavily ice bound. Early spring ice conditions may be a deterrent to spring migration. Fall run rainbow spend the winter in the river awaiting the spring spawning period.

Figure 1 Record of migratory rainbow trout entry into the Lower Brule River by monthly periods, 1961 - 1965.



Upon entering the river, migratory rainbows tend to move gradually upstream. Since spawning is not an immediate objective, upstream progression is generally much slower in comparison to that of the brown trout.

During the fall period (1961-1965), 367 migratory rainbows were tagged in the lower limits of the Brule River. Information on the pattern of movement and upstream advancement was obtained through angler tag returns, Figure 2. The information received from the angler provided either the precise or the approximate location of where a tagged fish was caught in the river. Like the brown trout, rainbow trout movement was also very erratic as shown in the catch records. Some fish move upstream rather rapidly for several miles, while others proceed fairly slowly or even linger in a suitable pool or desirable location for an extended period. Tagging and handling did not seem to bother some fish as they were caught only a day or few days later. The tag returns also showed that some rainbows were still in the lower reaches of the river 35 to 40 days after tagging. Tag returns further showed that all of the fish except one were caught below the Coop Park bridge, which is only 16 miles upstream.

From experience and observations of fishermen activity, upstream movement seems to be from pool to pool or from one run (area of deeper water) to another. Fish activity and movement is usually greater during times of subdued light (cloudy days or towards dark) or at night. Movement is also more prevalent during higher water amd more turbid conditions.

The overall pattern of movement observed is supported by the tag returns and weir catches. Only one tagged and few untagged rainbows were taken in the upstream weirs in the fall. The one tagged rainbow recaptured was taken in the "Winnie Weir" on November 12, 1961, 93 days after being captured, tagged and released in the vicinity of the sea lamprey weir.

THE CATCH OF RAINBOWS AT THE UPSTREAM WEIRS

Winnie Weir - Upstream Catch

The catch of migratory rainbows at the "Winnie Weir" was surprisingly good considering the fact that its location was quite far upstream. In the fall of 1961 a total of 331 rainbows was captured (Table 5). The first migratory rainbow was captured in late August. In September, 47 rainbows were taken, in October 156 fish. The October catch the largest, represented 47 percent of the seasons total. The November catch dropped to 118 fish but represented 36 percent of the total catch. In December, ten fish were captured before the weir washed out due to ice conditions.

The rainbows captured at the Winnie Weir ranged in size from 11.5 to 28.3 inches in length (Table 6). Because of the close spacing of the rods in the weir screen, smaller migratory rainbows were captured. The percentage of smaller fish captured decreased from September through November. In September, 70 percent of the rainbow captured were smaller than 17 inches. In October and November, the percentage of smaller fish dropped to 41 and 36 percent respectively. Overall, 43 percent of the rainbows caught at the Winnie Weir were smaller than 17 inches.

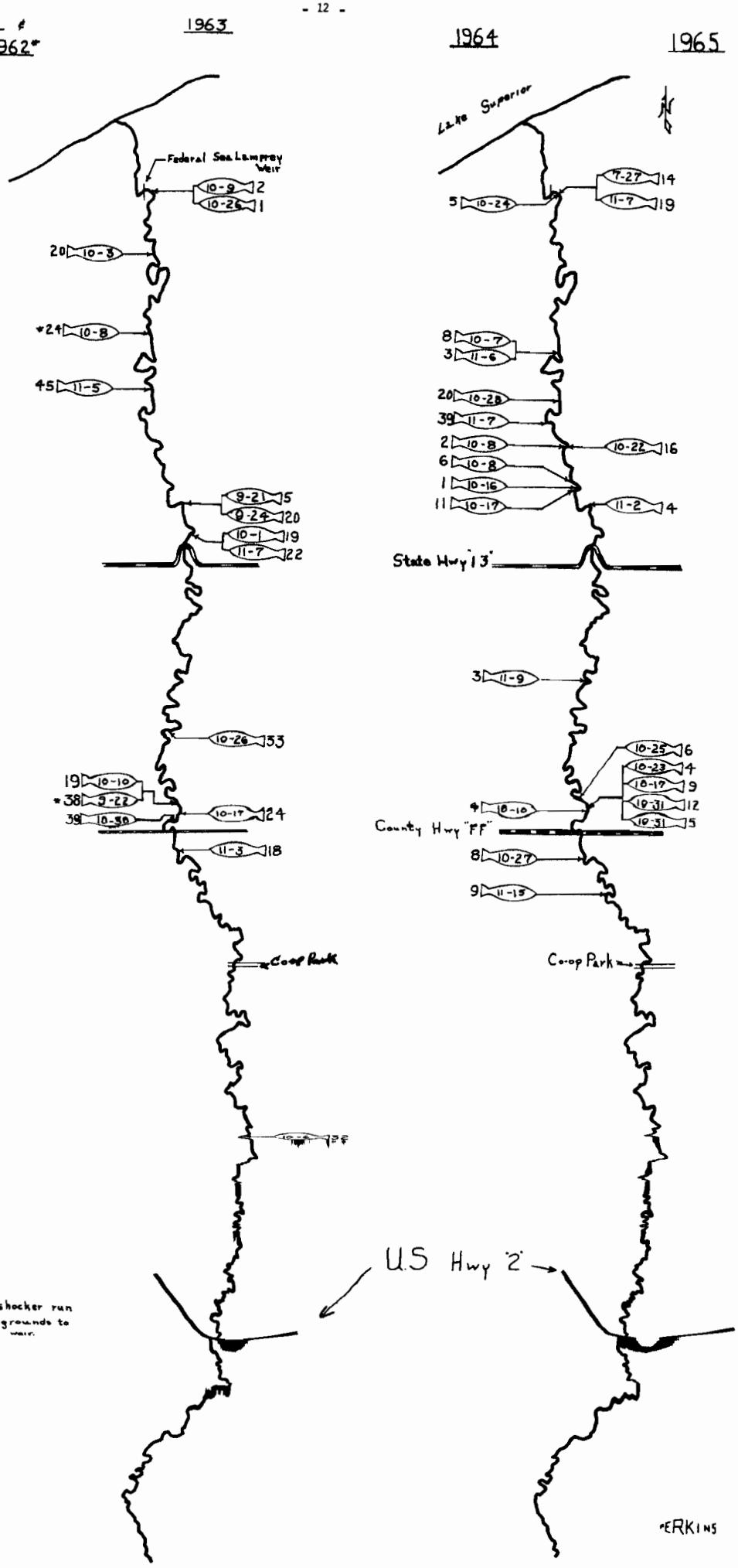


Figure 2 Upstream location of angler-caught migratory rainbow trout tagged in the lower Brule River during survey operations. (Date of capture is presented inside of the fish symbol, number outside is interval in days from time of tagging to capture).

* Tagged on shocker run from campgrounds to sea lamprey weir.

Table 5 The monthly catch of rainbow trout captured in the upstream traps at the fish weirs operated on the Brule River.

	Upstream											
	Winnie Weir			Highway "2" Weir								
Year	1961			1962			1963			1964		
Sex	Male	Female	Unknown	Male	Female	Unknown	Male	Female	Unknown	Male	Female	Unknown
January												
February												
March							10	17				
April							4	11	3		5	
May												
June												
July								1				
August		1						2	1			
September	10	5	32					2				
October	58	32	65	10	10		4	7	1	1	1	
November	44	31	43				1			9	5	1
December	5	3	2	3	4	1						

Table 6 Length frequency distribution of migratory rainbows - captured in the upstream weirs in the fall,

Size Interval	Winnie Weir 1961 Sept.	Oct.	Nov.	Dec.	Highway "2" Weir 1962 Sept.	Oct.	Nov.	Dec.	1963 Sept.	Oct.	Nov.	Dec.	1964 Sept.	Oct.	Nov.	Dec.
11.0-11.9	2		1													
12.0-12.9	4	5	1													
13.0-13.9	17	24	13	1												
14.0-14.9	6	22	14	1												
15.0-15.9		10	10							1						
16.0-16.9	4	3	3													
17.0-17.9	1	9	11	3		1								1		
18.0-18.9	4	18	10	2		1		1			1			1		
19.0-19.9	2	15	15	1		3			1	2					2	
20.0-20.9	3	20	16			2				3					2	
21.0-21.9	1	19	12	1						1					3	
22.0-22.9	1	3	6			3				1					3	
23.0-23.9		3	3			2									3	
24.0-24.9		3	2	1		3		2		1						
25.0-25.9			1			3		3	1	3					1	
26.0-26.9		1				1		2							1	
27.0-27.9	1															
28.0-28.9	1	1				1										
29.0-29.9																
30.0-30.9																
TOTALS	47	156	118	10		20		8	2	12	1			2	15	

Winnie Weir washed out in early December

Rainbows caught in July - 19.3 inches, August-15.3 inches, 23.3 inches, 25.5 inches

Highway 2 Weir - Upstream Catch

The catch of migratory rainbows at the Winnie Weir indicated that there was a significant movement of fish quite far upstream during the fall period. When the upstream weir was rebuilt in 1962, it was located farther downstream. It was anticipated that the catch of both browns and rainbows would possibly increase or at least remain comparable to the Winnie Weir catch. Surprisingly this was not the case. The catch of rainbows declined drastically in 1962 and declined even further in 1963 and 1964.

Some reduction in the catch and the change in the size of fish caught at the Highway 2 Weir could have occurred as a result of changes made in the weir. In the fall of 1962, alternate rods were removed in several of the weir gates toward the upstream end of the weir. This increased the spacing in the weir screen to about 1-3/8 inches. The wider spacing would have allowed some of the smaller fish to possibly pass through the weir if they so desire.

There were also times when the weir was not in full operation. When other duties such as electro-fishing operation or collection of dead brown trout were carried out the weir was left unattended. At such times, several of the gates were raised especially during periods of heavy leaf fall. However, the gates were usually open during the day time when trout movement was low. There were also a few times when high water prompted the lifting of the gates. There could have been upstream movement on these occasions. The effect of these changes, in the weir and the weir operations, on the catch of fish were not fully determined.

In the fall of 1962, only 28 rainbows were captured. All of the fish captured were larger fish - 17 inches and over. The lack of smaller fish such as were captured at the Winnie Weir suggested that if fish of this size were moving upstream they were perhaps getting through the weir. The large fish captured ranged in size from 17.5 to 28.1 inches and averaged 23.2 inches.

The few rainbows captured were taken in October (20 fish) and early December (8 fish). No fish were captured in November. The disappointingly poor catch of even the larger rainbows at the Highway "2" Weir caused some speculation as to possible reasons. Questions that came to mind (1) were the rainbows just not moving upstream this far at this time of year even though the new weir was located farther downstream than in 1961; (2) were there fewer fish (particularly larger fish) in the run; (3) were rainbows "bunching up" below and merely fighting the weir and refusing to enter the trap. To partly answer this question a shocker run was conducted on November 27 below the weir. Approximately 2/3 of a mile of river was surveyed. In this section, 12 migratory rainbows ranging in size from 14.2 to 28.3 inches were captured. These fish averaged 21.4 inches in length.

During this survey not all of the rainbows observed were captured but the work did show there was no abnormal concentration of fish below the weir. The 12 trout captured during this survey were tagged and released in the immediate area. Although eight rainbows were trapped at the Highway "2" Weir in early December, none of the 12 fish previously tagged were recaptured.

In spite of almost continued weir operations during the fall of 1963, the catch of migratory rainbows showed a further decline. The rainbow catch for the fall of 1963 was only 19 fish. As in 1962 these were again larger rainbows, ranging in size from 15.3 to 25.7 inches and averaging 21.5 inches.

Twelve of 19 rainbows caught were trapped in October which coincides with the greatest movement found in other years. One 19.3 inch female rainbow was captured in July but it was questionable whether this fish had even left the river.

In the fall of 1964 only 17 rainbows were captured at the Highway "2" Weir. Due to adverse weather conditions the weir was operated only periodically in September so some fish could have been missed. However, in other years the September catch at this weir was low so it is doubtful if many rainbows went through. The usual October catch did not materialize in 1964 even though the weir was operated almost continually during the month. Only two rainbows were captured in October of 1964. Fifteen rainbows were captured during November even though weir operations were suspended for the season on November 20. A school-type movement of fish was noted as nine of these fish were captured on the same day. Again the fish were all larger size, ranging from 17.7 inches and 2.2 pounds to 26.3 inches and 7.5 pounds. The fall rainbows average 21.7 inches and 4.2 pounds.

In comparison to the weir catch of migratory brown trout the catch of migratory rainbows was discouragingly if not alarmingly low. Even though fall rainbow movement this far upstream was not motivated by an immediate spawning urge, as was the brown trout, a greater movement and catch was anticipated. Instead a continued decline was noted during each of the four years of weir operation.

Early spring observations of rainbows in the upstream spawning areas indicated that movement to these sites took place during the winter or in early spring. Unfortunately weir operations at that time of year were very limited. The best available data on upstream movement in the spring was obtained during Highway "2" Weir operations conducted in 1963. In 1963 the weir was operated February 5 through the 8th and then on the 13th and 20th. The water temperature on these dates was 34 degrees. Discontinuous weir operations were necessary because of the danger of ice damage to the weir. No trout movement occurred during the February operations.

The weir was again placed in operation on March 4 and operated through March 8. The weir was also operated March 15 - and from March 20 through March 30. However, no trout were captured until March 23 at which time the water temperature increased from 34 to 36 degrees to 39 degrees. The water temperature remained in the low 40's during this period and upstream rainbow movement took place. During the March operations 27 rainbows were captured. Here again all of the rainbows captured were larger - spawning size fish. The fish ranged from 17.0 inches and 2.0 pounds to 20.0 inches and 7.8 pounds. These trout averaged 23.4 inches and 4.7 pounds.

High water in early April curtailed weir operations, but the weir was operated from April 8 through the rest of the month. During the April operations 18 rainbows were captured, and all but three of the 18 fish were taken prior to April 16. Undoubtedly there was a good upstream movement of rainbows during the high water period March 31 to April 7 when the weir was not operated. The strong stimuli of a rise in water level as well as the nearness of the spawning period were certainly conducive factors for rainbow trout movement at this particular time.

The rainbows captured in April were also large fish with one exception. The fish ranged from 12.8 inches and 0.8 pounds to 26.8 inches and 6.8 pounds. Including the small 12.8 inch rainbow, the fish averaged 22.2 inches and 3.8 pounds.

In rather restricted weir operations in April of 1964 - five rainbows were captured migrating upstream. Even during a period of continuous operation from April 7 through April 11 - only four rainbows were captured. The fish captured ranged from 18.0 inches and 2.1 pounds to 21.8 inches and 3.4 pounds. The rainbows averaged 20.3 inches and 3.0 pounds.

SIZE OF MIGRATORY RAINBOW TROUT

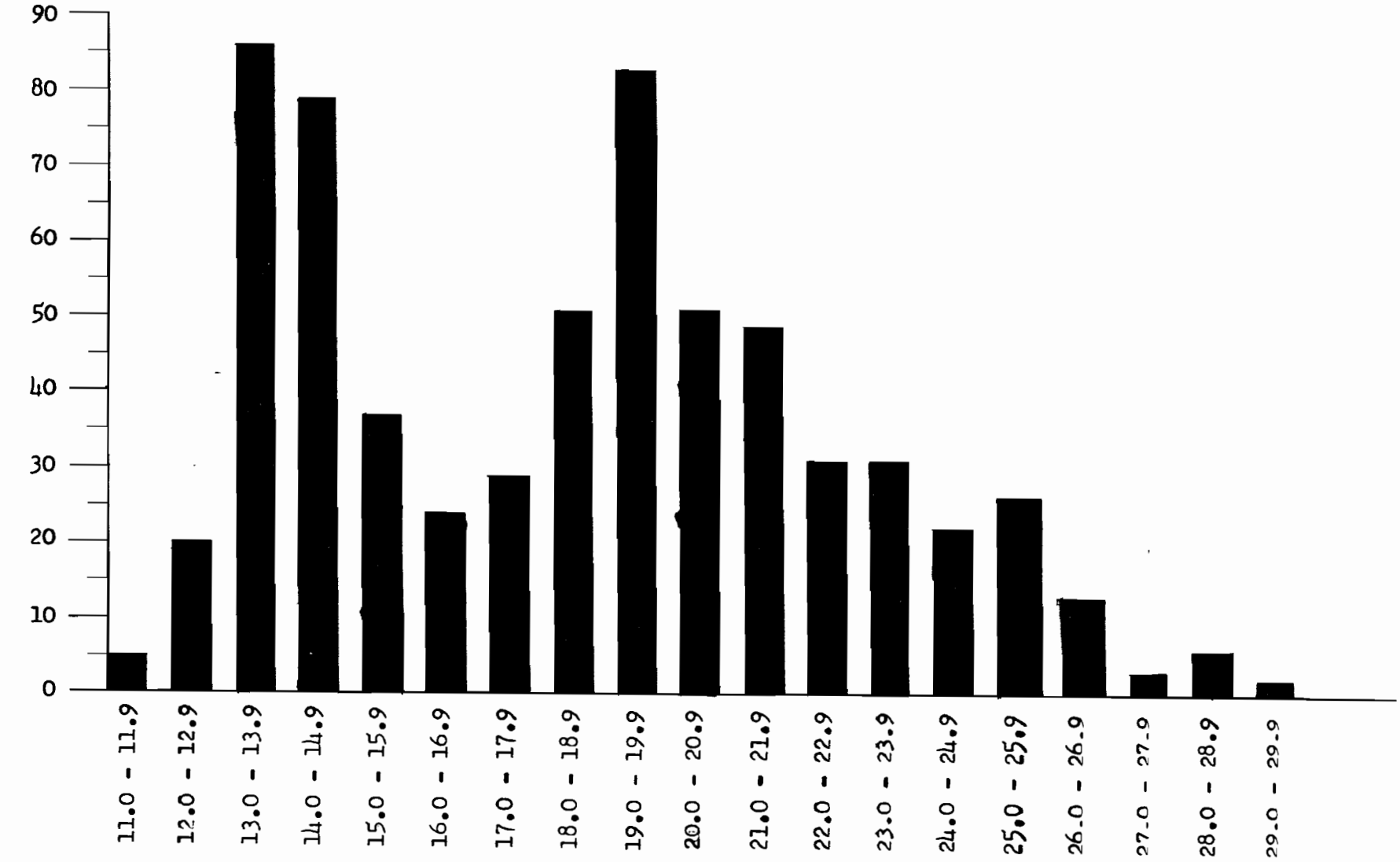
To obtain size data each fish captured was measured to the nearest 0.1 inch and weighed to the nearest 0.1 pound. The size of migratory rainbow trout captured in the Brule River through our sampling efforts ranged from a minimum of 11.0 inches up to 29.8 inches. However, angler caught rainbows were measured up to 31.8 inches. Based upon a sample of 795 specimens, the rainbows averaged 20.4 inches and 2.96 pounds. Hallock et al., (1961) reported that "steelheads" in the Sacramento River system average about three pounds and that fish up to eight pounds are common, while fish over 13 pounds are rare. The largest fish he recorded weighed 15½ pounds. The sizes reported by Mr. Hallock generally applies to the size of the "steelhead" found in the Brule River, although in recent years fish up to six pounds would be a more realistic figure for the common size group.

Some anglers may challenge the idea that steelheads over 13 pounds in the Brule River are rare. However, for many years the Wisconsin angling record for a rainbow trout was 12 pounds 3 ounces. This fish was caught May 17, 1939 in the Brule River. This record stood until October 28, 1963 when a 13½ pound rainbow was caught in the Brule River. In all this time, no larger rainbow trout was ever officially reported, although rumors of larger fish were often circulated by anglers. As this report is being written, rainbow trout far surpassing any rainbow reported or observed from the Brule River or the Wisconsin waters of Lake Superior are being caught in Wisconsin waters of Lake Michigan. Rainbow trout up to 18 pounds, 15 ounces were caught during the summer of 1967. Expectations are that rainbows up to or exceeding 20 pounds will be caught in the near future.

The average size of the migratory rainbow was slightly smaller than lake-run brown trout. The brown trout averaged 22.5 inches and 4.5 pounds whereas the rainbows averaged 20.4 inches and just under three pounds. Migratory browns first entered the run as four year old fish with a minimum size of around 15 inches. In the rainbow run many immature and precocious "skip jack steelheads" (fish 11 to 16 inches) participate. A characteristic of the rainbow migrations is to have many smaller fish. "Skip jack" size fish made up 37 percent of the fish in our rainbow sample.

Further information on the size of migratory rainbow trout in the Brule River run is provided in Figures 3 and 4. In the length frequency presentation, (Figure 3), all of the rainbows in the sample were combined. Because fewer rainbows were captured, compared to the number of brown trout, the fish are shown in one inch intervals instead of the one-half inch interval used for the brown trout. Two very pronounced modes are shown, one at 13-14 inches and another at the 19-inch size interval.

Figure 3. Length frequency and size distribution of migratory rainbow trout captured in the Brule River.



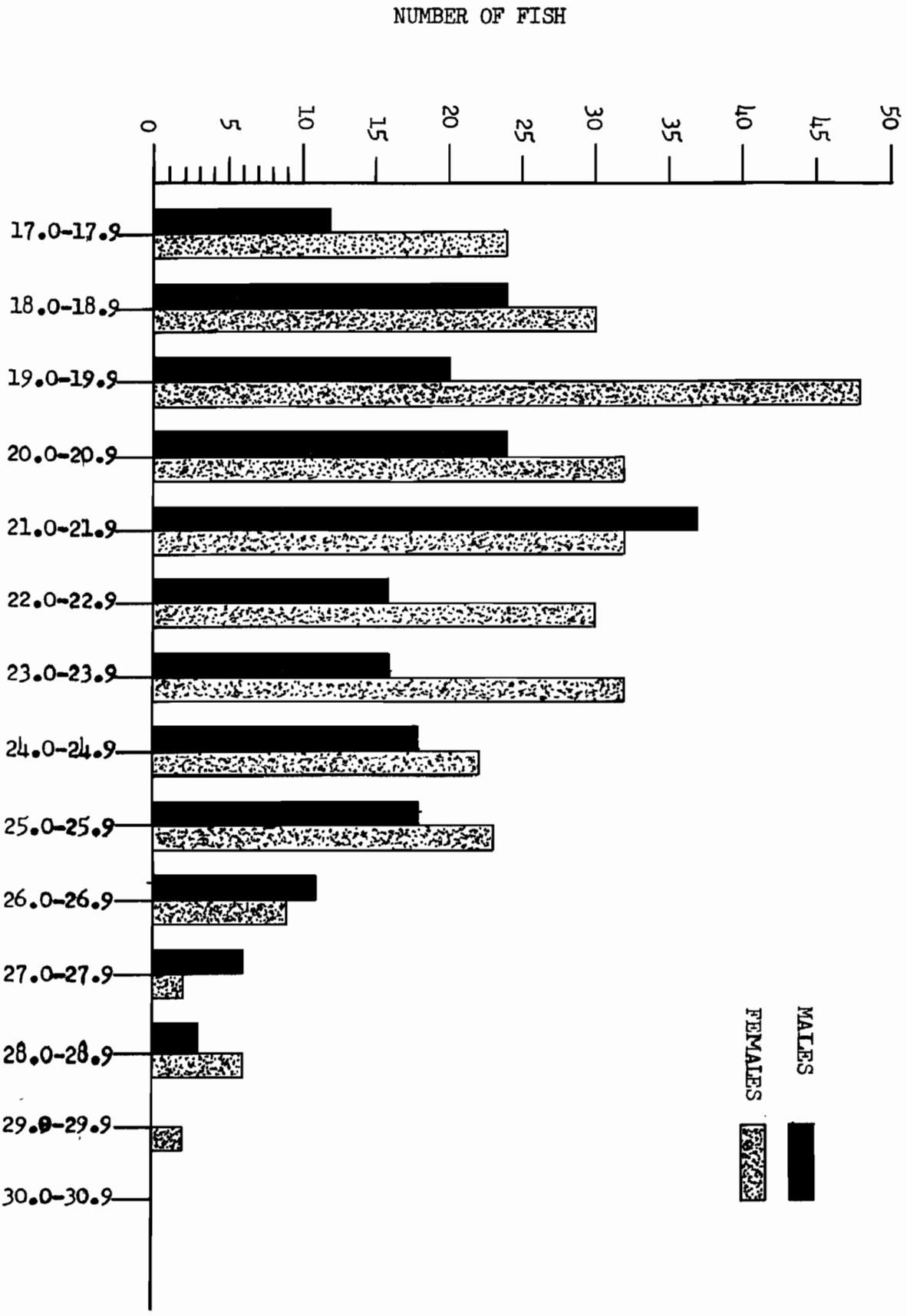


Figure 4 Length frequency and size distribution of sexed migratory rainbow trout captured in the Brule River.

In Figure 4, the length-frequency-size distribution is categorized by sex. Most of the rainbows 17 inches and over were sexed so it was possible to present their size-frequency relationship in this manner. Fish smaller than 17 inches were more difficult to sex accurately. Many of these smaller fish were actually immature. Furthermore, the bulk of the rainbows collected were taken in the fall long before the spawning season and long before physical sexual characteristics had fully developed or were as evident.

The female rainbows showed a very definite modal peak at 19 inches, while the male fish showed a more pronounced peak at a 21 inch size.

The length-weight relationship of the rainbow trout is presented in Table 7 and Figure 5. Here again fish in the smaller size groups were not differentiated as to sex. Therefore, the data presented represents all fish captured for each of these size intervals. For the sexed fish there was very little difference in the average weight of males compared to females in each size group. Where there were more than a single fish represented in the sample, the variation in average weight between the sexes was only 0.1 to 0.3 of a pound. However, in some of the individual size groups, there was considerable variation.

The weight range for male and female fish in the size groups from 17 inches through 23 inches was relatively small. For male rainbows the minimum difference in the weight range was only 0.7 pounds, while the greatest variation was 1.4 pounds. For female fish the minimum difference was 1.0 and the maximum variation was 2.1 pounds.

In the size groups larger than 23 inches the range in weights was considerably greater. For example, there was as much as 3.6 pounds in the weight range for female rainbows in 24 inch size group. This again is a reflection of various shapes and sizes of the many individuals comprising the run.

Comparing the average weights of migratory rainbows with comparable size migratory browns, the rainbows were in most instances lighter. The difference in weight varied from 0.1 of a pound to as much as 1.0 pound. Considering only those size groups where there were at least several fish in the sample, there was only one size group, the 20.0 - 20.9 males, where the average weight of 3.6 pounds was the same for both browns and rainbow.

AGE AND GROWTH

Age determinations were made from an examination of scales, a method used by many workers for aging migratory salmonoids.

Scale samples were collected and read from a majority of the rainbows captured in the river. Scales were normally taken from an area above the lateral line and just posterior of the dorsal fin. If the scales in this area did not appear suitable, scales from an adjacent area were selected. As in the brown trout, scales from smaller fish as well as female trout were easier to remove. Removal of scales from larger males was more difficult, but not near as laborious as scale removal from big male brown trout.

There were some scales that could not be used because of regeneration, wash out centers, poor or indistinct outer margins and the like. A total of 659 scale samples was used. The scales collected were imprinted onto cellulose acetate material under heat and pressure and the resulting impressions rather than the scale were read.

Table 7. Length-weight relationship of migratory rainbow trout captured in the Brule River during the fall migration periods of 1961 through 1965.

Length	Number of Fish	Average Weight Sexes Combined	Sex	Average Weight by Sex	Weight Ranges in Pounds
11.0 - 11.9	5	0.6 lbs.			0.5 - 0.8
12.0 - 12.9	20	0.9 "			0.6 - 1.5
13.0 - 13.9	85	1.0 "			0.7 - 1.9
14.0 - 14.9	77	1.2 "			0.9 - 1.7
15.0 - 15.9	37	1.4 "			1.1 - 2.0
16.0 - 16.9	25	1.7 "			1.4 - 2.1
17.0 - 17.9	27	2.2 "	9 males 18 females	2.1 2.2	1.8 - 2.5 1.7 - 3.0
18.0 - 18.9	47	2.5 "	22 males 25 females	2.6 2.6	2.0 - 3.0 2.1 - 3.1
19.0 - 19.9	60	2.8 "	18 males 42 females	2.7 2.9	2.2 - 3.6 2.1 - 3.6
20.0 - 20.9	49	3.4 "	19 males 30 females	3.6 3.3	2.9 - 4.2 2.5 - 4.0
21.0 - 21.9	47	3.7 "	25 males 22 females	3.6 3.9	3.0 - 4.4 3.2 - 4.8
22.0 - 22.9	30	4.3 "	10 males 20 females	4.4 4.2	3.6 - 5.0 2.9 - 5.0
23.0 - 23.9	31	4.6 "	9 males 22 females	4.5 4.6	3.8 - 5.0 3.8 - 5.5
24.0 - 24.9	21	5.3 "	8 males 13 females	5.5 5.2	4.6 - 7.1 3.8 - 7.4
25.0 - 25.9	25	6.1 "	9 males 16 females	6.0 6.1	4.6 - 8.0 4.4 - 7.5
26.0 - 26.9	13	7.1 "	6 males 7 females	7.0 7.2	6.6 - 7.3 5.0 - 8.2
27.0 - 27.9	3	7.9 "	2 males 1 female	7.8 8.1	7.3 - 8.2 -- --
28.0 - 28.9	6	9.2 "	1 male 5 females	10.0 9.0	-- -- 8.2 - 10.5
29.0 - 29.9	2	12.9 "	0 males 2 females	-- 12.9	-- -- 12.8 - 13.0

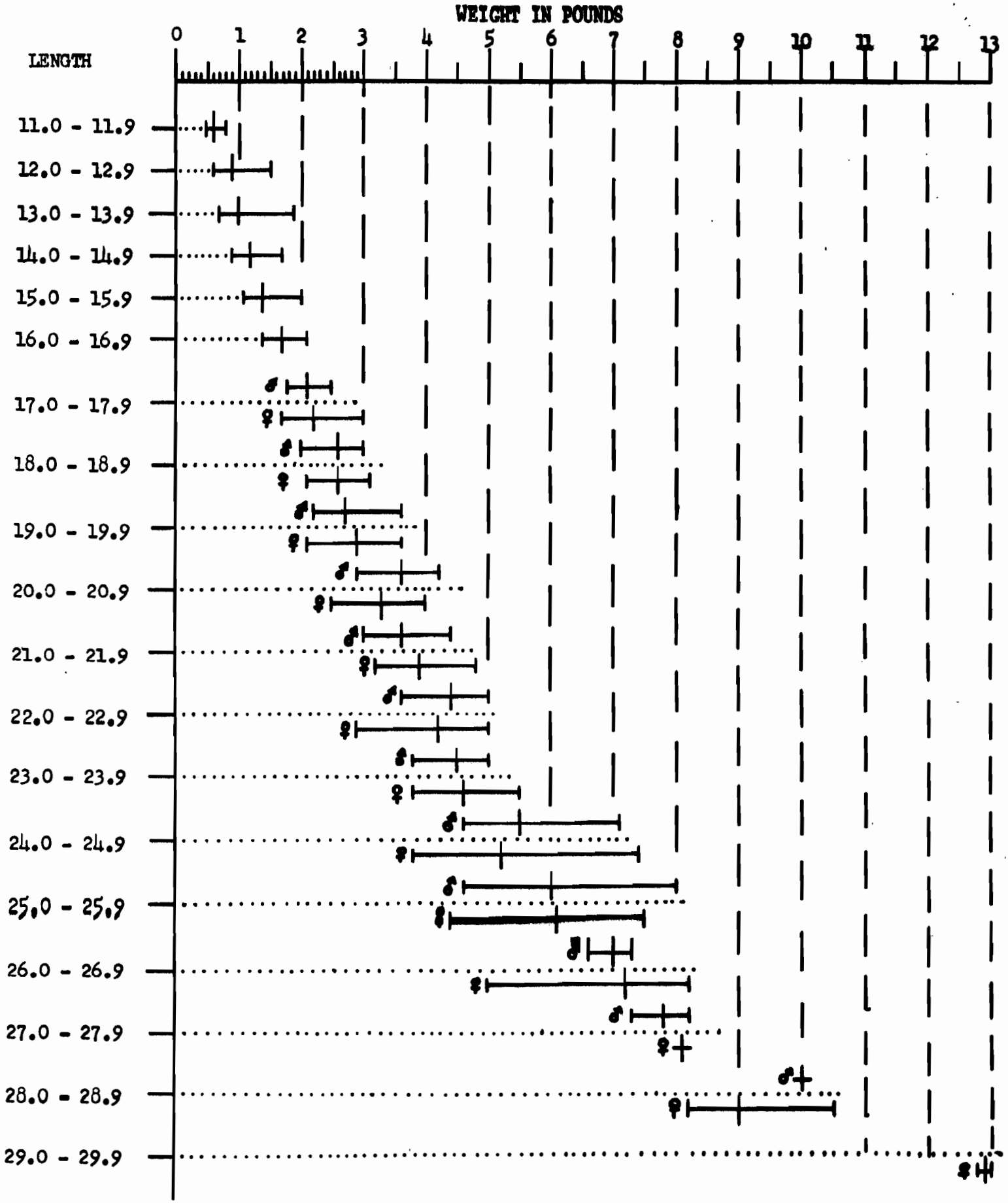


Figure 5 Weight range and average weights of migratory rainbow trout captured in the Brule River. Information is presented by sex for fish 17 inches and over.

Age was determined by the number of annuli present on a given scale but the ages presented in Figures 6, and 7 are expressed in summers of growth. However, at the time the scale samples were collected, annual growth for the season was normally completed anyway.

Some of the rainbow scale samples displayed what was considered to be an accessory growth check or false annulus. This growth check occurred early in the third season of growth and was located about seven or eight circuli beyond the last annulus. This would indicate that some seasonal growth had occurred in the stream prior to the formation of this check. Accelerated growth was resumed after the check was laid down as indicated by the wider spacing of the circuli.

The location of this accessory growth mark deviated considerably from the normal position of the third annulus. Greeley (1933) in his work on growth rates of rainbow trout in Michigan reported a similar growth pattern. He referred to such a mark as a migration check. He also reported that all fish whose scales showed such growth interruptions, had this mark at such a distance from the true annulus to indicate that transformation occurred during late spring. Rich (1920) also presented evidence in which scales of some young chinook salmon showed growth interruption checks formed by reason of changes in growth rate with migration from stream to estuary. More recently, Koo (1967) reported growth checks in scale samples of Columbia River chinook salmon.

Other workers have also reported growth checks or false annuli development in other trout species. Hatch (1961) reported the occurrance of false annuli in brook trout populations in several reclaimed Adirondack lakes. Cooper (1951) reported the formation of false annuli in stream brook trout. Hatch (et al.) indicated that conditions of water temperature may cause check marks to occur on the scale. Cooper (et al.) reported that a mid-simmer rise in water temperature to near lethal limits of the species was accompanied by the formation of a false annulus.

The exact reason for the occurrance of this growth check in some of the rainbows was not definitely established. Water temperatures may be a factor. Some parr rainbows leave the Brule in late spring and throughout the summer when, as Smith (1962) showed, water temperatures in the lower Brule River get rather warm (Table 8). In contrast water temperatures in Lake Superior remain relatively cool even in mid summer (Table 9).

Third year fish were quite evident in the migratory rainbow spawning run. However, as previously stated many of these fish are not active spawners. This age group was not represented at all in the migratory brown run. In the brown run, the bulk of the mature spawners were four and five summer fish. There were a few six year old fish and only an occasional seven year old fish. The age structure of the Brule River rainbow run generally agrees with that found by Hallock et al. (1961) in the Sacramento River; Pautzke and Meigs (1940) of angler caught steelheads in the Green River, Washington; and Hartman (1959) in his Finger Lake studies.

The combined annual samples of randomly collected fish showed the rainbow population to consist of: (203) or 31 percent three year fish; (179) or 27 percent four year fish; (227) or 34 percent five year fish; (48) or seven percent six year fish; and (2) or 0.3 percent seven year fish.

Figure 6 Length frequency of male rainbow trout for separate age groups.

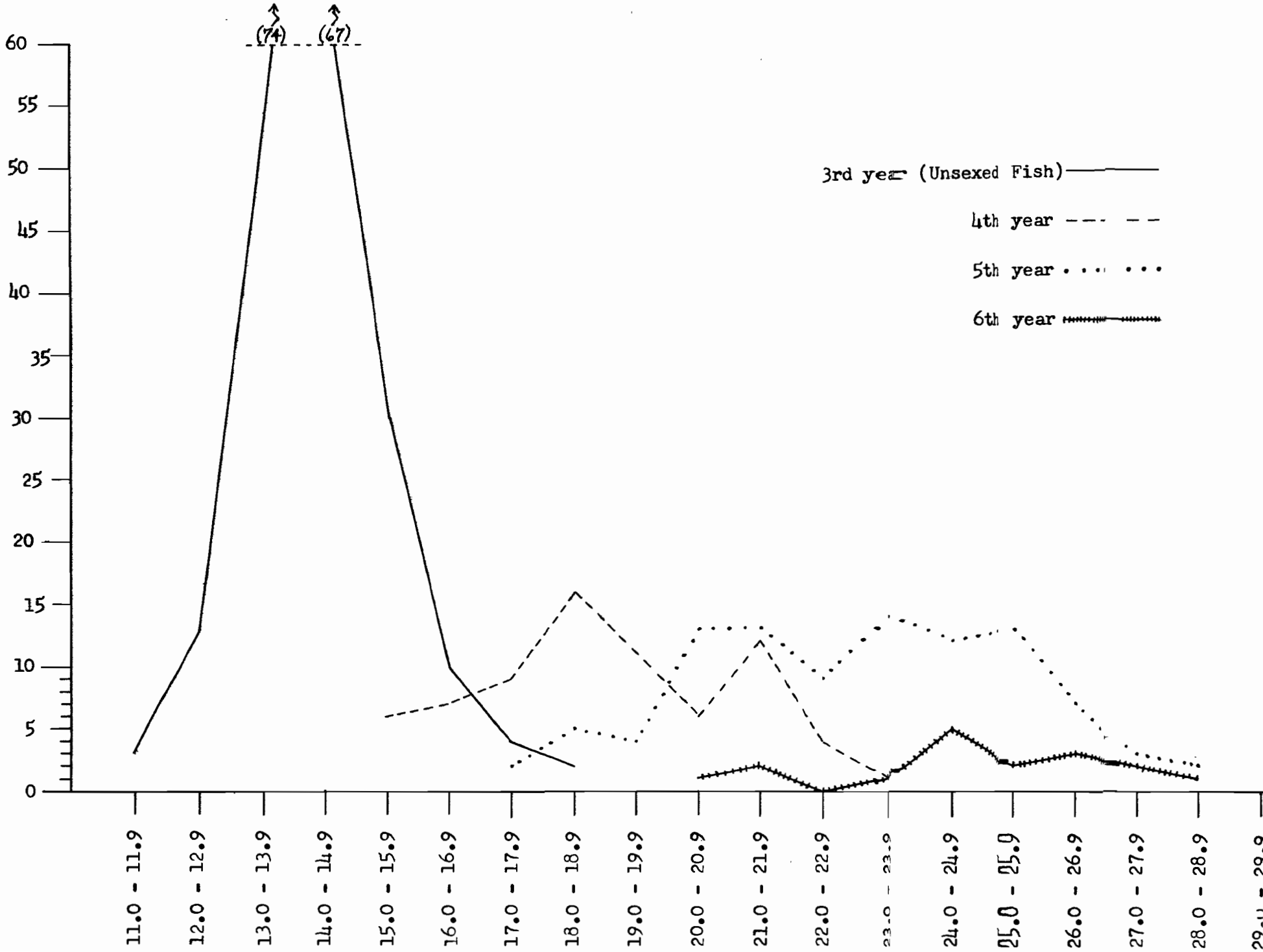


Figure 7 Length frequency of female rainbow trout for separate age groups.

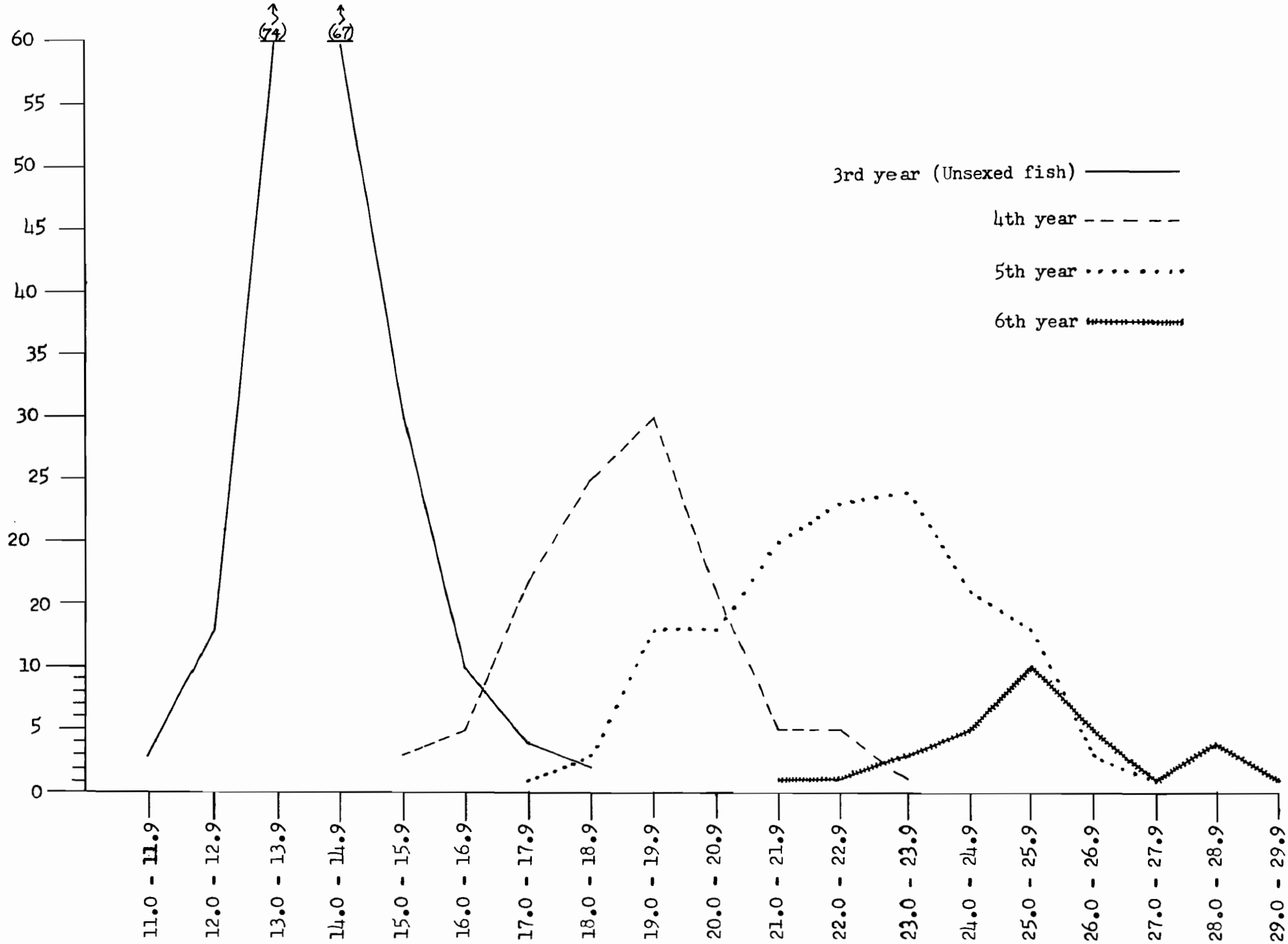


Table 8 Average water temperature (°F.) by 10 or 11 day periods in the Brule River, Douglas County, Wisconsin, 1957-60.

(Thermometer readings were taken near mouth at weir site, Section 10, T49N, R10W.)

Period	1957	1958	1959	1960	Average
April					
1 - 10		38	40		39
11 - 20		50	43		47
21 - 30		44	47	46	46
May					
1 - 10		50	53	46	50
11 - 20		59	53	57	56
21 - 31	54	57	56	59	57
June					
1 - 10	57	57	67	62	61
11 - 20	61	61	65	65	63
21 - 30	61	63	61	67	63
July					
1 - 10	67	61	65	69	66
11 - 20	64	66	68	71	67
21 - 31		70	73	74	71
August					
1 - 10		71	70	71	71
11 - 20		67	65	69	67
21 - 31		59	66		63

* Table as presented by B. Smith (1962)

Table 9 Lake Superior water temperatures taken near the mouth of the Brule River--by D.N.R. personnel

Date	Water Temperature
July 18, 1967	64° F.
19, 1967	59°
20, 1967	59°
August 9, 1967	60°
15, 1967	64°
16, 1967	66°
June 27, 1969	52° to 57° (taken 7 times throughout the day)
June 28, 1969	54° to 58° (taken 3 times throughout the day)

Comparing this composite sample with that of an annual sample, the percentage composition was slightly different. For example, the 1964 fall sample ran 21 percent three year fish; 29 percent four year fish; 43 percent five year fish; and 6 percent six year fish. The variation between the annual sample and the combined sample was a decrease in the three year fish (21 percent compared to 31 percent), and an increase to 43 percent for the five year fish.

The growth patterns of migratory rainbows is very similar to that exhibited by the lake run brown trout. Like the browns, the rainbow parr generally spend the first two years of their life in the parent stream. The young trout leave the stream either toward the end of their second year or early in the third year. During the first two years of life in the stream, growth is slower as indicated by the closer spacing of the circuli and annuli. Growth rates are greatly accelerated when the trout move from the stream to the lake environment. Growth is especially rapid in the third and fourth years; but tends to taper off somewhat in the fifth and sixth years of life. Growth is considered to be rather good recognizing the fact that Lake Superior is a large, deep cold and comparatively infertile body of water. Even though growth in the Lake Superior drainage system is good it can in no way compare with the phenomenal growth attained by rainbows in Lake Michigan (Daly, 1967). These fish ranged from seven to nine inches in length at the time of release in their second summer of life. One year following their release, these fish were 17.0 inches and 1.5 pounds in weight. Two years later the fish had attained a size of 25 inches and a weight of 5 to 6 pounds. Daly further reported that a 5 pound fish in May will increase to eight pounds by August or a gain of two to three pounds in four months. This exceptional growth is attributed to the super abundance of alewives populating Lake Michigan.

Alewife are found in certain areas of Lake Superior but their overall abundance is small apparently due to environmental conditions in Lake Superior.

A physical comparison of rainbow trout from these two ecosystems would show contrasting differences. The Lake Superior rainbow would appear thinner-flatter and more racy while the Lake Michigan rainbow would be more plump, deeper through the middle, and conspicuously fatter looking.

A comparison of age, growth, size range and growth increment for both male and female trout are presented in Table 10. The data for sexed fish in the 4th and 5th year age groups shows very similar growth increments. In the sixth year the female trout show a somewhat greater increase in both length and weight.

There was considerable variation in both the size and weight range for male and female fish in a given age group. There was an eight pound difference in weight between the lightest and heaviest male rainbow in the five year old group. There was a difference of 11.5 inches in length between the smallest and largest male in the same age group. The smallest weight variation was in the fourth year males and females.

As in the migratory browns this again shows that there is considerable variation in growth, body shape and condition of these trout. It further emphasizes that it is not necessarily the largest trout that are the oldest fish in the run or in the population.

Table 10 Range and average lengths and weights of migratory rainbow trout of various ages (age group 3 sex combined).

Age Group	3rd Year	4th Year		5th Year		6th Year		7th Year
Sex	Fish Unsexed	Males	Females	Males	Females	Males	Females	Females
Size Range (Inches)	11.3 to 18.2	15.3-23.8	15.0-23.6	17.1-28.6	17.7-27.6	20.8-28.3	21.8-29.8	28.3-29.5
Weight Range (Pounds)	0.5 to 2.5	1.2- 4.8	1.2 - 5.5	2.0-10.0	2.0- 7.8	3.6- 8.0	3.4-13.0	8.5-12.8
Average Length (Inches)	14.2 inches	19.0	19.1	22.8	22.6	24.8	25.6	28.9
Sample Size	203 fish	72	107	97	130	17	31	2
Average Weight (Pounds)	1.2 pounds	2.6	2.7	4.3	4.3	5.8	6.7	10.7
Sample Size	203 fish	72	107	97	130	17	31	2
Length Increment		4.8 inches	4.9 inches	3.8 inches	3.5 inches	2.0 inches	3.0 inches	3.3 inches
Weight Increment		1.4 pounds	1.5 pounds	1.7 pounds	1.6 pounds	1.5 pounds	2.4 pounds	4.0 pounds

LAMPREY SCARRING AND OTHER ABNORMALITIES

In the process of handling these rainbows, each fish was examined closely for any marks and abnormal or unique features. The occurrence and the nature of any such features were recorded. As in the brown trout the incidence of lamprey scarring was one feature that received particular attention. Like the migratory brown trout, the rainbow too spends time in Lake Superior and is therefore exposed to possible sea lamprey attack.

The incidence of lamprey scarring was found to be very low among the rainbows comprising our sample. During the entire study periods only nine of the 700-plus migratory rainbows handled bore lamprey scars or wounds. However, two of the nine fish had sea lampreys still attached when captured. These two fish were captured on separate occasions; one on August 25, 1961 and the other on September 19, 1963. Both fish were captured in the lower river during electro-fishing survey operations. Upon capture the lampreys detached themselves almost immediately from their host. It was obvious from the condition and depth of the wound that these lampreys had been attached for some time. These fish evidently had been attacked by lampreys out in the lake and carried the attached parasite along. The limited amount of scarring that was observed among the rainbow was confined primarily to larger size fish. Scarred fish ranged in size from 17 to 28 inches and averaged 21.3 inches.

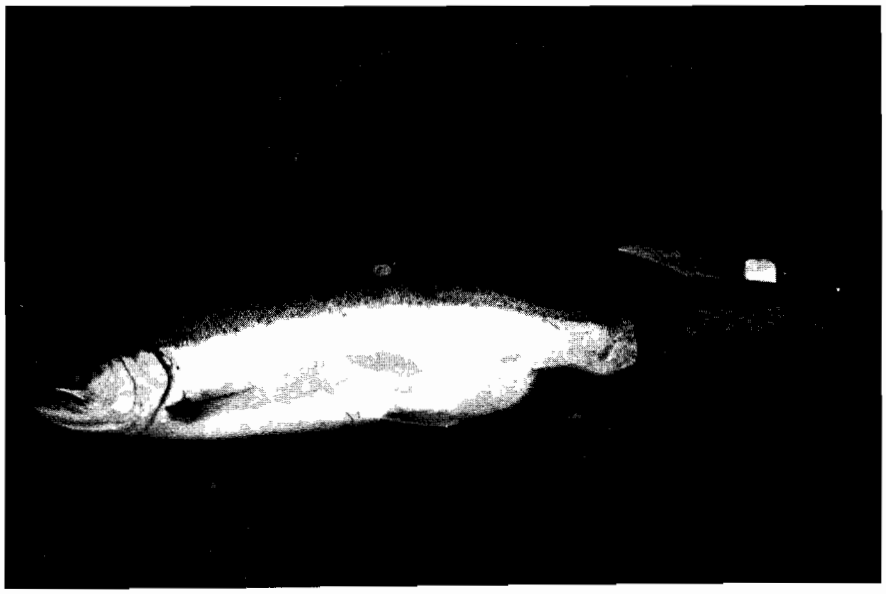
Factors which may account for the comparatively low incidence of lamprey scarring among rainbows are: (1) the catch of adult sea lampreys at the Brule River lamprey weir showed a significant decline during this study and (2) the predominance of smaller fish in the rainbow sample. The decline in lamprey was better illustrated in the migratory brown trout sample where more fish and more scarred fish were handled. This sharp reduction was attributed to the results of the chemical treatment of streams tributary to Lake Superior by the U. S. Fish and Wildlife Service. Younger-smaller fish would have spent less time in Lake Superior than older fish. This would in effect reduce their exposure time to lamprey attack. The effect of a sea lamprey attack on a smaller size fish in Lake Superior is not known. Dees (1950) states that a small fish is frequently killed, whereas a larger fish, if it escapes, bears the scars of an attack. This is a reasonable assumption and if this is the case, smaller fish would show little evidence of scarring, whereas larger fish would carry tell-tale scar.

If the sea lamprey is held in check, lamprey predation should not be a limiting factor in the development of the migratory rainbow trout population.

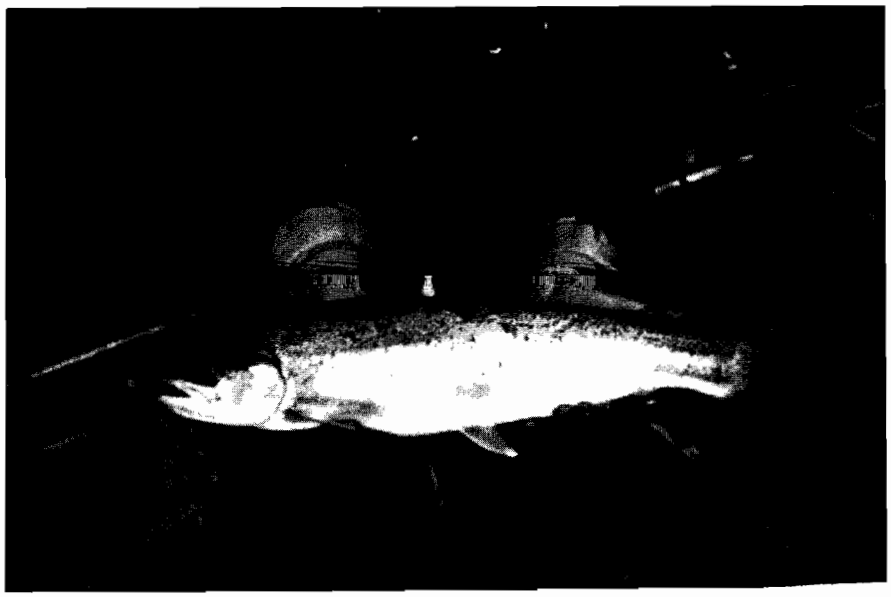
Another abnormal feature that was noticable in some of the rainbows was an apparent injury to vertebral column, which resulted in deformed fish, Figure 8. The location of this abnormality in most of the deformed fish was the section of vertebral column between the caudal peduncle, forward to the posterior end of the dorsal fin. Most commonly it occurred below the adipose fin. Overall, approximately six percent of the rainbows captured had vertebral injuries. In 1964 fall sample, nine percent of the rainbows had such a deformity and in 1965, 10 percent of the fish were deformed.

In most cases, the deformity did not seem to materially reduce the vigor of the fish or severely impair its ability to swim. However, such a deformity did distract from the overall appearance of the fish. Such deformities were obvious and of concern to the fishermen as many anglers reported catching deformed fish. Many anglers felt that the operation of electrical sea lamprey weir was the cause. Although this weir was not in operation during the fall migration it was in operation in the spring when the rainbows were returning to Lake Superior. On their downstream migration the rainbows have to pass through

Figure 8 An example of a deformed migratory rainbow trout captured in the Brule River. A normal migratory rainbow is shown for comparison.



Deformed Migratory Rainbow Trout



Normal Migratory Rainbow Trout

the electrical field of the weir. The electrical current being used at this weir is certainly strong enough to knock out the fish as they pass through and perhaps even cause some injury to the fish. This is certainly true of the alternating current field. Fish coming in close contact with the A.C. electrode could be injured. Trout stunned by the electrical weir have been observed floating through the barrier. Dead trout, both rainbows and browns have been recovered below the weir. After spending the winter in the river and then going through the rigorous activities of spawning these fish are not in the best of condition. The addition of this hazard to their downstream journey could certainly injure or even kill some fish.

Another possible cause of deformities among rainbows has been related to disease by Hoffman (1966) who reported that "whirling disease" caused by Myxosoma cerebralis resulted in crippling or death of fish so affected (Figure 9). However, to the best of our knowledge whirling disease was not present here and not the cause of deformed fish found in the Brule River.

Another source may lie in stocking thousands of trout. Enough deformed fish could be stocked to eventually show up in small percentages.

In handling these fish a number of other deformities and unique features were observed. Several fish captured at the Highway "2" Weir had broken jaws. These were larger males captured in the spring after spawning. In these cases the injury was believed to have been a result of fighting during the spawning period.

Quite a number of the rainbows handled had deformities around the maxillary region of the mouth. Deformities of this type were usually caused by a hooking injury. Such injuries occur when sub-legal or legal but undesirable size fish are caught and released or a larger fish escapes after being hooked.

Another interesting miscellaneous injury observed was a deep flesh wound on a male rainbow as shown in Figure 10. This fish was captured at the Highway "2" Weir in the spring of 1963. The exact cause of this particular type of wound was not determined. In spite of this injury, the fish was able to survive and when captured was very active. Although deep, the location and extent of the wound was such that it just missed the spinal column and the fish was able to swim with little apparent affect.

It is not unreasonable to expect injuries of various types to occur among these fish. In the smaller confines of the river these migratory trout are subjected to a number of perils, which would not occur in the expanses of the lake environment.

SPAWNING AREAS AND SPAWNING ACTIVITIES

Spawning Areas and Time of Spawning

The major spawning areas for migratory rainbows are located south of U. S. Highway 2. More precisely the rainbows utilize almost identically the spawning areas used by the migratory brown trout. This makes the available spawning areas south of Highway 2 doubly important. The spawning areas that are crowded with brown trout in the fall are occupied, but to a somewhat lesser degree, with rainbows in the spring. In addition to the prime spawning areas as shown in Figure 13 of Part I of this report, several other spawning areas are also used. In the suitable gravel riffles both up and down stream from the

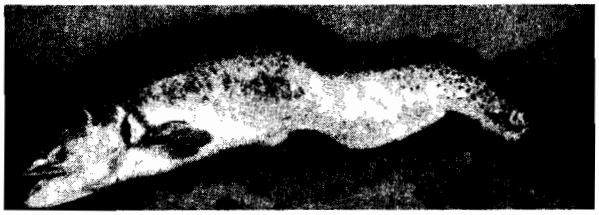


Figure 9 An illustration showing the deformitive effects of whirling disease in rainbow trout as presented by Mr. Glenn Hoffman.

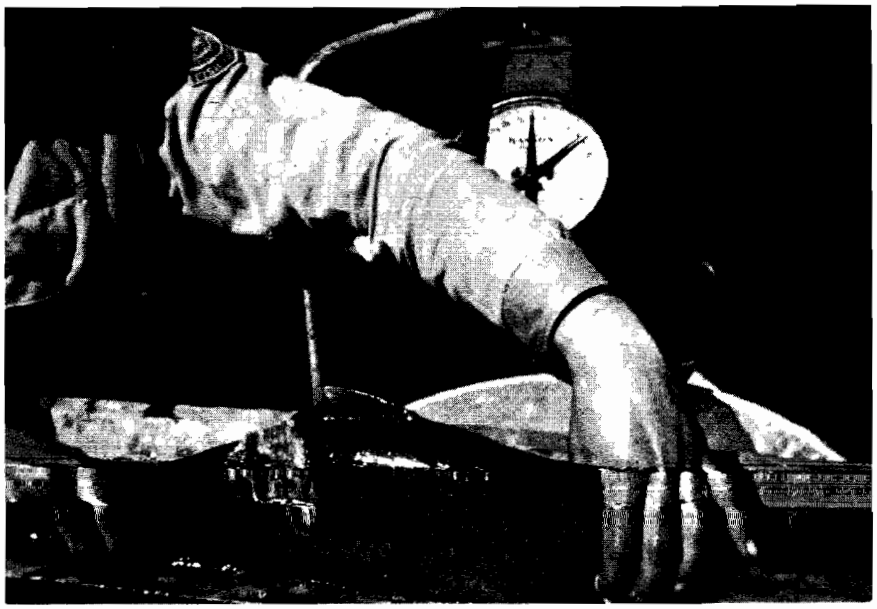


Figure 10 A male rainbow trout captured at the Highway "2" Weir in the spring of 1963 with a deep body flesh wound.

old Coop Park Bridge some spawning activity has been observed. Even farther downstream there are good gravel areas that appear suitable for spawnings and perhaps receive some use. However, because of the usually turbid condition of the river during the spring runoff period, it was difficult to determine the extent of spawning in this lower region of the river.

There is also evidence that rainbows move farther upstream to spawn than do migratory brown trout. Observations of trout movement through a fish weir located at Stones Bridge, as reported by Fallis and Niemuth (1962), showed some upstream movement of migratory rainbows in this area. In the spring months (March-April-May) of 1959, 1960, 81 and 111 rainbows respectively were passed upstream through this weir. A majority of these fish were considered to be spawners. This movement was heaviest in April and was coincidental with the rainbow spawning period. The exact spawning sites in the area of the river above Stones Bridge were not located.

There is evidence that some spawning takes place in Wilson Creek. This small feeder stream is located near the headwaters and flows into the Brule River from a northerly direction. Rainbow trout fingerlings, resulting from natural reproduction, were captured during various surveys and rainbows larger than six inches were virtually absent in the stream. This indicated that rainbows produced in the stream migrated from the creek in a similar pattern as the rainbows produced in the Brule River itself.

Reportedly spawned out migratory rainbow trout have been caught in Wilson Creek at the start of general trout season further indicating their presence and their utilization of the stream for spawning. A migratory rainbow tagged in the Big Lake area of the Brule River in March of 1962 was found dead in Wilson Creek sometime later that same spring.

In addition to the spawning areas in the Brule River some spawning takes place in the major tributary streams Nebagamon-Blueberry Creek system and the Little Brule River. A few migratory rainbows run these streams and spawn successfully.

Lagler (1956) states that rainbows spawn between early winter and the beginning of summer depending on climate, elevation and genetic strain. Through the development of various strains, the spawning period for rainbow trout has become quite variable. For example, in Wisconsin and other places, a strain of rainbows has been developed that spawn in the fall. The development of fall spawners has been primarily for hatchery production.

In the stream survey conducted during the late fall of 1963 a few hatchery rainbows were captured. A couple of the fish handled were male fish in a ripe condition. These fish had been marked and stocked in the spring as 18 month old fish averaging about nine inches. Even though a few ripe male fish were found no rainbow spawning activity was observed at this time or at any other time during the study. Some male rainbows of hatchery origin may reach maturity in the fall but it seems as though most of the hatchery stocked rainbows revert back to spring spawning characteristics when stocked in lakes and streams.

In Wisconsin waters the rainbow trout is considered to be a spring spawner and to date this has been the pattern in the Brule River. As for many fish species, spawning activities to some extent are responsive to prevailing weather conditions and resulting water temperatures. Therefore, spawning may vary slightly from year to year. Rainbow spawning activity usually starts toward the end of March or early April and continues on through April and into May. By the middle of May, most of the rainbow spawning has been completed. The peak of spawning occurs in April with the greatest activity occurring during the first two or three weeks depending on the weather. Water temperatures during the spawning period usually range from the high 30's in late March to the low 60's by mid-May. During the period of greatest spawning activity, the water temperatures range from the low 40's to the mid 50's.

Migratory rainbow spawning sites in the upper Brule River almost duplicates those of the migratory browns. In prime areas large concentrations of fish occur. This results in fish spawning in close proximity to one another with redds constructed close together. Some fighting and other spawning commotion takes place, but the fish seem to tolerate each other and the closeness of other neighboring fish does not seem to cause antagonism. It is not uncommon to see a hundred or more spawning rainbows in a relatively short stretch of the river having good spawning gravel. The spawning riffles starting just above Salsich summer cabin downstream to old south shore railroad crossing and the area from Winnebojou downstream to Nebagamon Creek are good examples of spawning grounds having heavy fish concentrations.

Many of the rainbow trout redds observed were typical well defined nests. However, as reported for brown trout spawning there were larger redds observed where it appeared as though a number of individual fish used the same area and constructed what has been termed a community redd. In these cases, several fish and usually larger fish were using the same spawning gravel area to complete a redd.

The water in the upper spawning grounds remains fairly clear and transparent even during the spring breakup and runoff period. In spite of this fact, it is not uncommon to see considerable spawning activity during the daylight hours. Even on bright sunny days the fish can be found in mid stream and in the shallower waters spawning. Close approach to the fish is possible before they dart for cover. Spawning activity resumes once the danger or disturbance has passed. As in the fall, mans activities in this part of the river are minimal and temporary disturbances are not a serious problem. Fishing in this part of the river is prohibited until early May and spring canoeing is usually light. However some people do avail themselves of an opportunity to observe these large fish by canoeing through the area when the fish are present.

Rainbows spawning in the lower part of the river below Highway 2 are exposed to the hazards of man. A special spring trout season that starts around the first of April makes any fish over 13 inches in this part of the river fair game and vulnerable to the fisherman.

Creel census checks during the early season have indicated that spawning fish are caught. A number of anglers have been interviewed, who have taken a male and female trout from a spawning bed or from an escape pool located close to a spawning area. In the spring the water in the lower river is usually quite turbid as a result of runoff from the clay soil. This often results in anglers walking through or into redds without knowing such redds are even there. The effects of angling or possible redd destruction by the anglers on natural reproduction in this part of river is not really known. Some limited survey work has

shown that there is fairly good rainbow reproduction in places in the lower river in spite of man's activities.

In summary comments by R. G. McMynn, who at the time was Chief Fisheries Biologist in British Columbia, stated that work thus far on steelhead and similar Pacific salmon has shown that from 80 to 90 percent of a run may be harvested and that the remaining 10 to 20 percent is sufficient to repopulate a river to its productive capacity. He also emphasized the fact that if future runs are to be maintained protection and survival of young downstream migrants is essential.

Unfortunately in this study we were unable to determine what percentage of the rainbow run was being harvested or what percentage of fish escaped to spawn. However at this present time and under the present management system, with the fishing season closed in the upper spawning area during the peak of the spawning season, there appears to be enough escapement of adult migratory rainbows to produce a good crop of fingerlings through natural reproduction. It should be remembered that the Brule River and its available spawning grounds are used to produce both migratory rainbows and brown trout. The competition or interaction of these two migratory species on each other throughout their life cycle was not determined during this study. Such a study would be desirable.

Except for some stragglers, the rainbow spawning period is of rather short duration. Once spawning starts its all business with these fish. Spawning grounds loaded with fish and busy with activity one day may be completely vacated and devoid of fish only a few days or a week later.

After spawning is completed most of the fish retreat into deeper pools and areas affording more protective cover. The fish also become more wary. Some fish remain in this part of the river for sometime. A few even remain long enough to be caught when the regular trout season opens and the entire river is open to fishing. Some indications of the dispersal and movement of migratory rainbows in the spring was obtained from fishermen tag returns (Figure 11). Some of the tagged fish caught in late March or very early April probably had not spawned. These fish were perhaps either going to spawn in that particular area or were caught while moving further upstream.

A majority of the spawned-out fish start migrating downstream and back toward the lake. Operation of the Highway "2" Weir in the spring of 1963 captured spawned-out fish moving downstream from mid-April on into early May (Table 11). Down stream movememt might have been more rapid had the weir not been there. A survey in early May of the pool immediately upstream from the weir showed a number of migratory rainbows present. The last migratory rainbows caught moving downstream in 1963 was on May 31.

Spawned-out fish continue to move downstream. Observations at the sea lamprey weir and survey operations below the weir have shown spawned-out rainbows in this area by late April and early May. Fishermen also catch spawned-out rainbows throughout the section of the river open to fishing in the early spring. Under the present circumstances spawned-out rainbows furnish the bulk of the fishing during the special spring trout season.

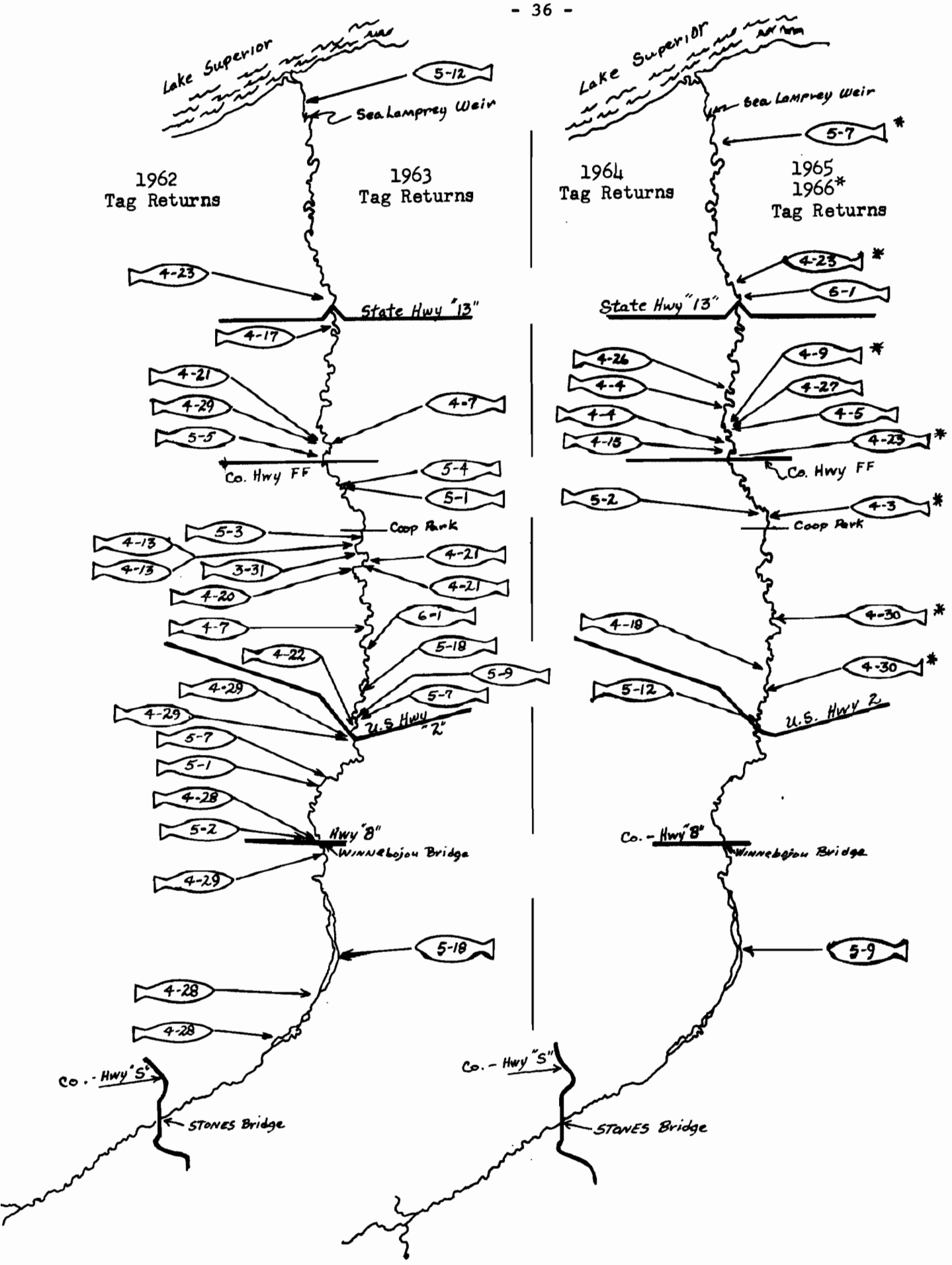


Figure 11 Reported locations of tagged migratory rainbows caught by anglers during the spring trout season.

Table 11 Downstream catch of migratory rainbows at the Highway "2" Weir.

Highway "2" Weir

YEAR	1962			1963			1964		
Sex	Male	Female	Unknown	Male	Female	Unknown	Male	Female	Unknown
January									
February									
March									
April				20	2	3		1	
May				16	6	1			
June									
July									
August									
September									
October									
November									
December									

FECUNDITY OF MIGRATORY RAINBOW TROUT

Information on fecundity of migratory trout is rather limited. In this study fecundity data was obtained from ovaries taken from fish during the fall migration period. Insofar as possible an attempt was made to obtain fish of various sizes so as to determine any differences in egg production. The fish used for this purpose were angler-caught so unfortunately, larger specimens were not readily available. Larger size rainbows were captured during fish collection operations but none of these fish were sacrificed. We had hoped to get the desired specimens from cooperating anglers. Due to a lack of ovaries from larger fish, our data was not as complete as we had planned. The fish used only ranged in size from 16.8 to 22.1 inches. The direct method of counting all of the eggs in a given ovary was used. The results of the egg counts from fish in this sample are summarized in Table 12.

The counts showed that egg production generally increased as the size of the fish increased. In those fish where the ovaries were differentiated, the counts showed that the left ovary contained more eggs. This characteristic was similar to that found in the migratory brown trout. The difference in number of eggs between ovaries was not great and as recorded ranged from a minimum of 66 to a maximum of 162. Some variation could have resulted from error on the part of the counter as the eggs were only counted once. In comparison, it was easier to make the brown trout egg counts than the rainbow egg counts. The reason for this was the brown trout egg samples were taken closer to spawning and the eggs were more fully developed and advanced. Ovary development of most rainbows was not very far advanced in the fall. The eggs were smaller and were held together more tightly in the ovaries. Although a limited number of egg counts were made, the data does provide some indication of the reproductive potential of these migratory rainbows.

The egg counts recorded generally agreed with those presented by Carlander (1953) for fish of comparable sizes. However, the counts were somewhat below those reported by Rounsefell (1957), which were based upon readings from a regression curve published by Shapovalow and Taft (1954) for Scott Creek, California.

CONDITION OF SPAWNED-OUT TROUT

In the migratory brown trout report it was shown that the condition of the trout changed noticeably after spawning. A comparison of individual fish handled both before and after spawning showed the body weight loss for female brown trout to average 20 percent and male trout four percent. It was possible to compile this information through the recovery of an adequate sample of tagged trout after spawning. Many of the fish used in obtaining these data were tagged fish that had died and were subsequently recovered.

Unfortunately because of the unavailability of an adequate sample of rainbow trout similar data could not be compiled with the same precision as for brown trout. Some information was received from fishermen tag returns but such information was not always detailed or reliable enough to use in this respect.

Table 12 Fecundity of female migratory rainbow trout from the Brule River.

Total Length in Inches	Weight of Fish in Pounds	Egg Count Ovary I	Egg Count Ovary II	Ovary Difference	Total Egg Production
16.8	2.0	1037	1162	125	2199
17.1	2.0	(Ovary counts not differentiated)			2130
19.0	(No weight Recorded)	1067 (Right Ovary)	1141 (Left Ovary)	74	2208
20.2	3.5	1138 (Right)	1213 (Left)	75	2351
20.5	(No weight Recorded)	1514	1658	144	3172
21.0	3.0 (Dressed)	1862 (Right)	1928 (Left)	66	3790
21.5	3.0	1517 (Right)	1679 (Left)	162	3096
22.1	4.1	1829 (Right)	1976 (Left)	148	3804

However, during the study enough migratory rainbow were observed both in the fall and in the spring to make a general comparison regarding their condition. Observations then indicated a change in their overall condition. Rainbow trout fresh out of Lake Superior were in prime condition and exhibited remarkable energy in their actions. Rainbow trout observed in the spring after spawning were noticeably thinner and far more sluggish in their actions.

Mottley (1937) reported an average percentage loss of weight of 16.7 percent for male and 25.2 percent for female rainbows in Paul Creek, British Columbia. He ascribed the loss to two main causes, (1) the shedding of the reproductive products and (2) utilization of stored materials to produce energy needed during spawning activities. He reported the loss of weight just from the shedding of reproductive products as 16 percent for females and two percent for males. These percentages of body weight loss correspond fairly well with those found for the migratory brown trout. Body weight loses somewhere in this range would undoubtedly be very applicable to migratory rainbows in the Brule River.

Mottley (1937) also reported a calculated average body weight loss per day before spawning of 0.49 percent for males and 0.34 percent for females due to the expenditure of body energy. This loss was based on a period of 26 to 28 days prior to actual spawning when the activity of the fish is quite intense. Even though migratory rainbows spend a long time in the Brule River (fall to spring) much of this time is during the winter months. Water temperatures in the river get quite low during the winter and fish activity is undoubtedly very minimal so that the expenditure of energy is reduced.

Here again the normal body weight loss due to spawning and the prolonged stay in the river may not seem important in the management of migratory rainbow trout. However, these fish provide much of the fishing during the special spring trout season as the fish migrate from the spawning grounds downstream to Lake Superior.

Even though many anglers realize that these fish are in poorer condition in the spring, this factor does not deter their efforts. The overall size and trophy type qualities seem to be more important than the potential body weight or condition factor. Although most of the rainbows move downstream rather rapidly, they do bite and provide some good angling. The only drawback is that the river may be so high and turbid from the spring runoff that the stream may be difficult if not impossible to fish at certain times.

RAINBOW TROUT NATURAL MORTALITY

Although dead migratory rainbows were observed and also recovered throughout the Brule River, the mortality was not as great as reported for the migratory brown trout. One of the major causes for the high mortality among the browns was the out break of furunculosis within the population. Even though the peak of the brown mortality occurred at the same time migratory rainbows were entering the river the rainbows were not affected. Snieszko (1958) reports that transmission of furunculosis can occur through water contaminated by bacteria from lesions or feces from infected fish. In the Brule River, the potential for spreading or transmission of the disease was certainly present. Snieszko (et al.) reported that among the salmonoid fishes the rainbow trout is most resistant. Davis (1953) reported that the rainbow trout is considered to be more immune to furunculosis disease but that epidemics of furunculosis have been reported among young steelhead trout at hatcheries. Davis (et al.) also reported that there is considerable evidence that the disease may be endemic among Pacific salmon and rainbow (steelhead) trout.

Rainbow trout in Wisconsin waters are considered to be relatively free of furunculosis disease. Rainbow trout reared in Department hatcheries and distributed both in the Brule River and in Lake Superior have never shown any symptoms of this particular disease.

During the recovery of dead brown trout, one 8.5 inch rainbow trout was picked up with a noticeable lesion on its body. A bacterial culture showed a positive reaction substantiating the presence of the disease. This fish was found near the upper spawning grounds where exposure to the disease was very possible because of dying brown trout. In rare instances, a rainbow trout may die from furunculosis but at the present time this is not considered to be a serious problem among the rainbows.

Even though disease was not an important factor, there was some mortality among the migratory rainbows during their prolonged spawning run. The extent of the natural mortality was not fully determined mainly because of a lack of intensive coverage of the river in the spring. Even in the fall, the intensive coverage was confined more to the upper part of the river and to the short section below the sea lamprey weir.

Fishermen often reported dead fish they had observed while fishing and traversing the stream. This information was helpful because it usually came from an area of the river that was not covered during the course of our work. In the fall, dead rainbows were uncommon and the fish reported were generally in good condition. The death of rainbows at this time of year usually resulted from angling injuries. In the spring, if the water was not too turbid, fishermen often reported finding dead, spawned-out fish. On several occasions, dead rainbows were observed early in the spring just as the ice was going out. Due to the cold water, it was often difficult to tell just when these fish had died.

The best information we were able to obtain regarding the rainbow natural mortality was in the spring of 1963. Because of more favorable conditions the Highway "2" Weir was operated periodically that year. This enabled us to collect dead or dying rainbows that floated downstream from the upper spawning areas. Visibility was also better so that dead fish were also collected by making canoe runs. From late March through early June, 43 dead migratory rainbow trout were recovered. Of the fish recovered 29 were males and 14 were females. The males ranged from 14.0 to 29.4 inches and from 1.1 to 10.0 pounds and averaged 24.4 inches in length and 5.1 pounds in weight. The females ranged from 16.5 to 31.4 inches and from 1.5 to 11.7 pounds and averaged 22.9 inches and 4.2 pounds.

Most of these fish were spawned-out and rough looking physically so perhaps a combination of factors caused these fish to succumb.

A post mortem examination of dead rainbows recovered in the Brule River revealed that some of the fish were quite heavily infected with small parasitic worms. Fishermen also reported catching worm-infected rainbows. These parasitic worms were small ranging from ¼ to ½ inch in length, white in color, and were found firmly attached to the intestinal tract of the fish. Positive identification was not pursued. Such parasitism was not prevalent in the few specimens examined in 1944 by Fischtal (1947). Fischtal commented that Brule River fishes were lightly parasitized.

Dr. Leonard Allison, fish pathologist with the Michigan Department of Natural Resources suggested that the parasite might be acanthocephala or the proboscis roundworm and probably the species Echinorhynchus salmonis. This particular species is reportedly common to salmonoids in the Great Lakes. Ward (1918) reported that Echinorhynchus salvelini was found in lake trout in Lake Michigan.

The abundance of these parasitic worms in some of the fish examined was so great that the intestinal tract was noticeably irritated and inflamed. It is believed to be another contributing factor to mortality particularly at spawning time. In the future positive identification of this parasite should be made and its possible effects determined.

In connection with the subject of natural mortality, predation would have to be considered. Although not specifically determined an interesting case was reported which indicates some potential loss. Mr. Wm. Weiher, area fish manager, reported observing an otter take a six and four pound rainbow trout from the same pool on January 5, 1968 at the Brule Ranger Station. The larger trout was captured and dragged out on the ice in the morning and left there and later that same day, the smaller four pound trout met a similar fate. The loss of two rainbows seems small but the size of the fish taken by this predator is impressive. They prove the otter is a very capable fisherman and with these larger trout confined more to pools during periods of ice cover they could easily fall prey to this predator. Cold water temperatures in the winter undoubtedly make these fish less active and probably easier for the otter to catch.

Several other reports were also received from people finding dead fish which were apparently killed by otter. Otter are known to frequent the Brule River as these animals and their tell-tale signs have been observed at various times and places throughout the stream. This author observed a family of four otter during a canoe run from Stone's Bridge to Winnebejou in the fall of 1961.

Although the recovery of dead rainbows was comparatively small in numbers, it was recognized that there was some loss of fish due to various causes during the spawning run. From the anglers standpoint, many of the dead fish recovered would be "bragging" size and a few would even be considered real "trophy" fish.

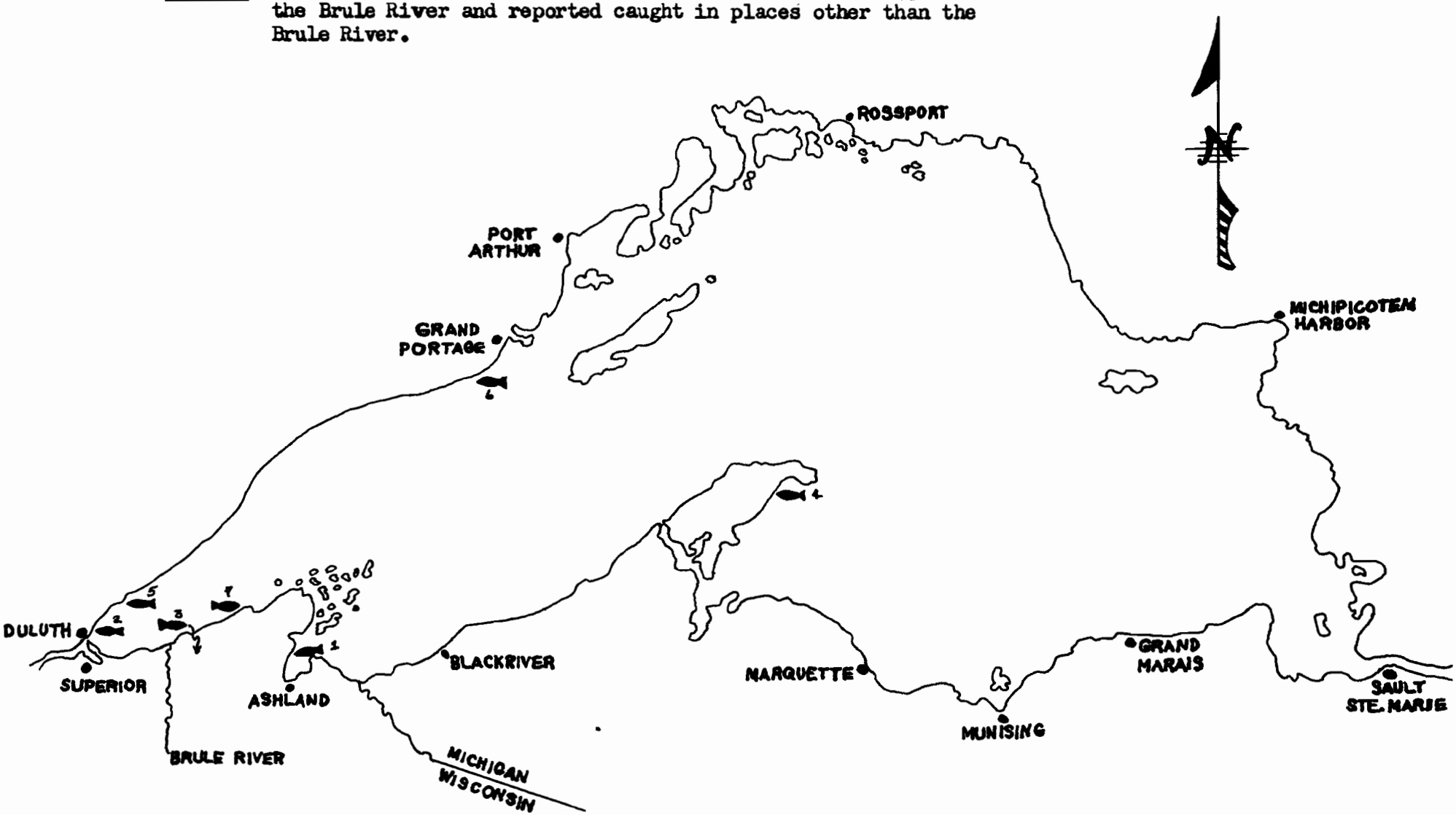
DISPERSAL OF RAINBOW TROUT IN LAKE SUPERIOR

After the rainbows leave the confinement of the Brule River and return to Lake Superior, the fish are free to spread throughout the expanses of the lake environment. Some indication on movement of these fish was obtained from a limited number of angler tag returns. Similar information was obtained for angler caught brown trout. The data showed that migratory brown trout upon leaving the river generally moved toward the east into the bay areas along the south shore and in and around the Apostle Islands.

The rainbow tag returns showed a more scattered pattern of movement with some fish traveling a considerable distance from the Brule River (Figure 12 and Table 13.) On a straight line measurement, the tagged rainbow caught in the Traverse River in Michigan travelled over 200 miles from the Brule River. It is over 100 miles to the mouth of the Kodonce River where another of the tagged fish was caught. Hansen (1960) reported that migrations of 100 miles or more were common among tagged hatchery reared rainbow trout stocked both in and off the mouth of several selected streams in Michigan. Most of these tagged fish were caught either in another stream or around the mouths of other streams.

Fish number 3 (tag-409) apparently left the Brule River sometime after it was tagged in the fall of 1963 as this fish was caught the following spring in the nearby Flag River. The Flag River is another south shore trout stream located approximately 12 miles east of the Brule River.

Figure 12 The geographic location of migratory rainbow trout tagged in the Brule River and reported caught in places other than the Brule River.



The number adjacent to the fish symbol in the figure corresponds to the number of the fish presented in Table 13.

Table 13 Reported locations of tagged migratory rainbow trout caught in places other than the Brule River.

Fish Number	Tag Number	Date Tagged	Tagging Location	Date Caught	Location
1.	162	10/16/61	Winnie Weir	10/9/62	Trolling off the mouth of the Big Sioux River
2.	288	4/5/63	Below Federal sea lamprey weir	4/11/64	Caught in Lester River, Minnesota
3.	409	9/23/63	Area of sea lamprey weir	4/19/64	Caught in the Flag River, ¼ mile below the Forks
4.	508	4/20/64	Below Federal sea lamprey weir	7/3/65	Taken in Traverse River Keweenaw County, Michigan
5.	639	4/29/65	Below Federal sea lamprey weir	10/6/66	Caught in or off the mouth Knife River, Minnesota
6.	677	10/6/65	Area of sea lamprey weir	8/31/66	Caught at mouth of Kodonce River, Minnesota
7.	721	10/19/65	Area of sea lamprey weir	5/22/66	Caught trolling Lake Superior on the Herbster side of Bark Point

Even though some rainbows strayed considerable distances from the Brule, many of the fish do return to the river as evidenced by a number of tagged or finclipped fish observed or reported.

MIGRATORY RAINBOW TROUT SPORT FISHERY

The migratory rainbow run into a historically famous trout stream such as the Brule River has created an appealing and important sport fishery. Because of the popular fishery associated with migratory trout runs, fishing regulations over the years have been adopted and modified to take advantage of the availability of these fish while in the tributary streams (Table 14).

The records show that as early as 1936, trout seasons in the counties bordering Lake Superior; namely Ashland, Bayfield, Douglas, and Iron opened on May 1 or 15 days prior to the regular statewide trout season. This earlier opening was the first in a series of modifications in fishing regulations which provided the angler with an opportunity to fish for migratory rainbow trout.

As more information became available relative to the habits of the migratory rainbows and their migration runs into tributary trout streams, further changes in regulations were proposed and adopted. As a result of O'Donnell's study in the early 1940's a recommendation was made to have a special fall trout season. In 1948, an experimental 30-day fall season was established. This season ran from October 15 through November 15. Designated portions of a number of tributary streams were open to fishing. Periodic checks indicated that fishing pressure as well as angler success was comparatively low even on the more popular streams. However, recorded comments from a number of participating fishermen showed that angler enthusiasm and acceptance of the special trout season had been firmly established.

Since the first experimental fall season proved successful and popular with the anglers, a proposal was made to extend the fall season. In 1951, the special fall season opened October 1 and ran through November 15, thereby providing a 46-day season. This extended fall season coincided quite well with the major period of rainbow migration into the Brule River. In the early to mid 1950's the brown trout gained some prominence as a migratory trout species. The migratory brown with its early seasonal migration habits necessitated a further change in the special season regulation. In 1954, the fall season was modified to open the day after the close of the regular trout season. With this change, the fall season more adequately covered the migration periods of both the brown and rainbow trout and also provided ample opportunity for the angler to fish for these trout.

In 1957, a special spring fishing season was established, opening on the Saturday nearest April 1. The opening date as established has remained unchanged through the years. The special season runs through early spring to the opening date of the regular trout season. The early spring season has provided more opportunity for fishing migratory rainbows, but as explained in the brown trout report, it also affords an excellent chance to fish for out-going brown trout. From comparatively limited interest in the first special trout season, angler participation has increased tremendously over the years. Anglers interviewed during the first fall seasons showed that a majority were either local fishermen, property owners along the streams or fishermen who had fished for migratory trout or salmon in other states or places. The word soon spread among the trout fishing fraternity that large trophy size trout were available during the special season. As a result angler interest steadily increased as both expert and novice trout fishermen travelled to these streams to fish.

Table 14 Chronology of changes in Wisconsin trout fishing regulations affecting the migratory trout fishery.

Years	Trout Fishing Season Changes	Effect on Migratory Trout Fishery	Bag Limit	Minimum Size Limit
1935 through 1945	Trout season opened on May 1 in counties bordering Lake Superior (Ashland-Bayfield-Douglas-Iron Counties)	Earlier open season - (15 days prior to opening of general statewide trout season)	15 Fish	7 inches
1946 1947 1948	Trout season opened on Saturday nearest May 1 in designated tributary trout streams (late April opening dates)	Earlier open season - (varying 20-21 days prior to regular statewide trout season)	15 Fish	7 inches
1948 1949 1950	Special trout season in designated tributary trout streams. (Fall season October 15 through November 15)	Trout season open during a period of the fall migration - changes in bag limit	1948-49 (5 Fish) 1950 (10 Fish)	13 inches
1951 1952 1953	Special trout season in designated tributary trout streams. (Fall season October 1 through November 15)	Extension of open trout season during fall migration period	10 Fish	13 inches
1954 1955 1956	Special trout season in designated tributary trout streams. Fall season continued after closing of regular trout season - (Fall season September 6 through November 15)	Further extension of open season during fall migration period. Changes in bag limit.	1955-56 (10 Fish) Not more than 10#'s & one fish	13 inches
1957 through the present time 1965	Special spring trout season in designated tributary trout streams. Opening date on Saturday nearest April 1. General trout season extended to September 16 in 1965 (Fall season September 16-November 15 from 1965 on)	A 30 to 45 day earlier trout season extension of trout season during spring migration. Reduction in bag limit of rainbows to two fish from 1965 on during both spring and fall special trout seasons.	5 Fish 1957 through 1964 1965, 5 fish of which only two maybe rainbows	13 inches

Angler interviews show that fishermen from throughout Wisconsin as well as neighboring states (particularly Minnesota) currently fish the streams for migratory trout during the special seasons. Because of the close proximity of the Brule River to the twin port cities of Duluth-Superior much of the day to day fishing pressure emanates from this area (Figure 13). However with continued improvement in highways, more available time and money and the increased use of various types of mobile camper units, more and more fishermen from further away are fishing for migratory trout.

Comparatively speaking, rainbows seem to be somewhat easier to catch than migratory brown. Many anglers also feel that the fresh run "steelhead" provides a much more spectacular show and greater challenge when hooked. Added to these factors there is always the incentive and possibility of catching a real trophy trout--be it rainbow or brown.

Information on the early migratory rainbow trout sport fishery is rather limited. The earliest information was from a creel census conducted on the Brule River during the 1936 trout season under the direction of Otis Bersing. During the 1936 season (May 1 - August 31) periodic checks were made covering the entire stream. Mr. Bersing's report showed that in May (particularly early May) a number of large rainbows were checked. The fish ranged in size from 16.0 to 28.5 inches. Although not specifically stated in the report, it is safe to assume that these large rainbows were migratory fish.

A creel census conducted in the early 1940's also provided some information on the migratory rainbow trout sport fishery. At the time the trout season ran from May 1 through September 7. With this type of season the best opportunity for catching migratory rainbows occurred in early May after the season opened. O'Donnell mentioned this in his report, stating "The principal attraction of the Brule River during the early season is the presence and possibility of catching one or more of the large rainbow trout which migrate from Lake Superior." The main purpose of this creel census work was to determine fishing intensity, rate of catch and the return of tagged or marked stocked trout to the creel. Information on the harvest of rainbow trout is best presented in a figure taken from Mr. O'Donnell's (1945) report (Figure 14). This shows the rainbow catch for the 1940 season based on data collected from fishermen contacted throughout the season. The bulk of the rainbow catch (74%) was fish ranging in size from seven to twelve inches. The rest of the catch would generally be considered migratory trout with fish ranging up to 30 inches. The data presented naturally represents a minimum harvest.

The late fall trout seasons started in 1948 on an experimental basis. To evaluate the outcome of this new seasonal fishery, some creel census work was conducted. Although ten tributary streams were open, the fishing pressure was concentrated on three streams; namely, Fish Creek, and the Sioux and Brule Rivers. The Brule River received the bulk of the fishing pressure. Periodic checks were made throughout the season with creel census clerks contacting as many fishermen as possible. O'Donnell (1948) reported that in eight days of census work, 137 fishermen were contacted on the Brule River. These anglers had fished a total of 449 hours and caught 16 rainbow trout. The fish observed ranged in size from 14.5 to 30 inches.

During the 1949 fall season, another creel census was conducted, but again the sampling effort was limited. Random checks covering both weekends and weekdays were made throughout the fall season usually by one or two census clerks. Brasch (1950) reported that on the Brule River 237 fishermen were contacted who had fished 1,137 hours and caught a total of 80 migratory trout of which 63 were rainbows. With an increase in both fishing pressure and the catch of trout in 1949, it was apparent that the popularity of the fall season had grown.

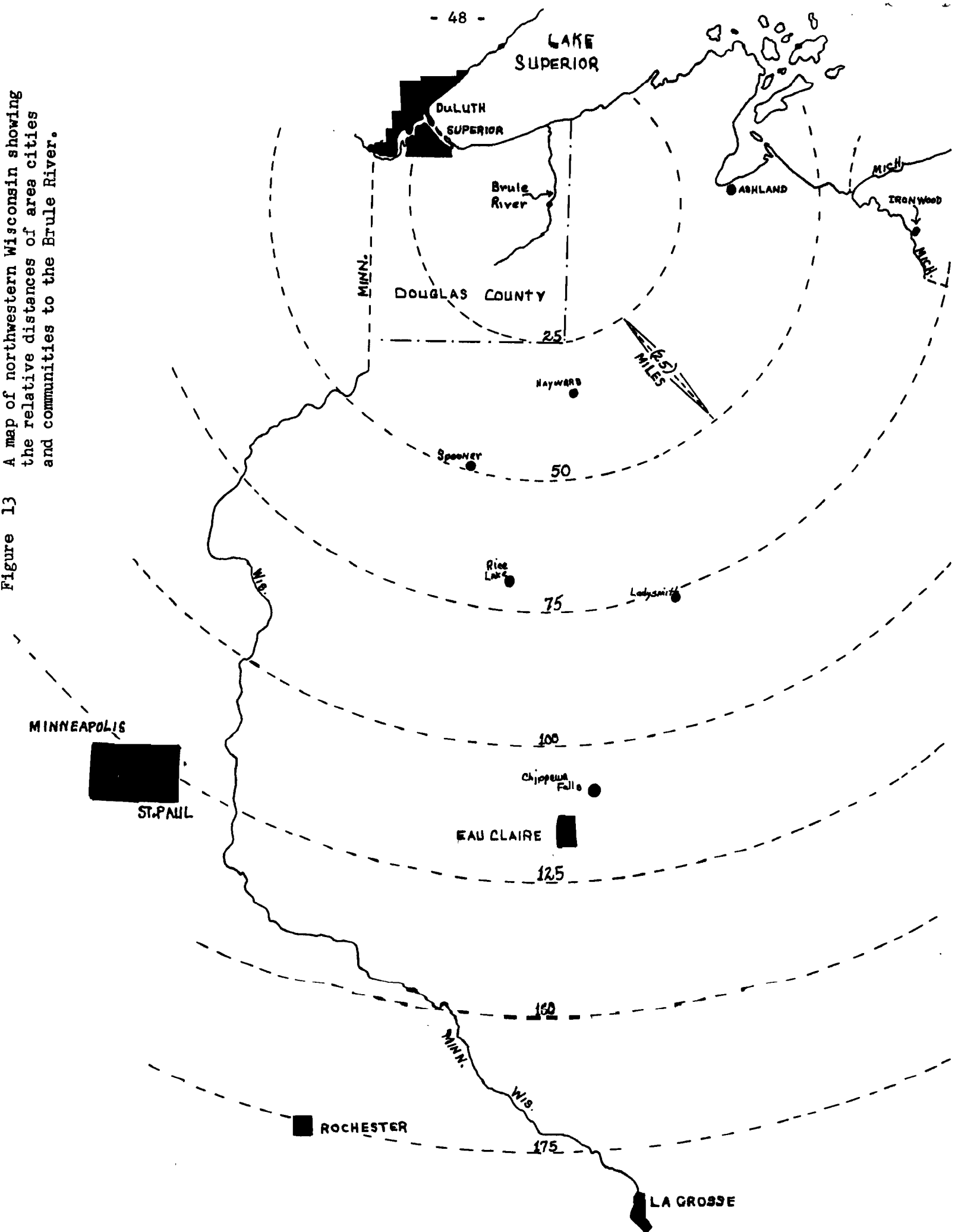


Figure 13 A map of northwestern Wisconsin showing the relative distances of area cities and communities to the Brule River.

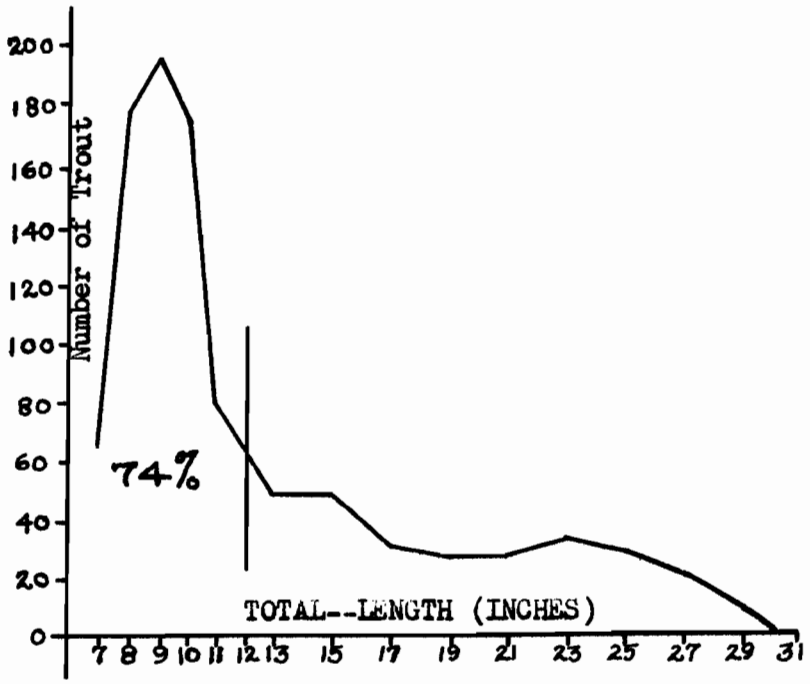


Figure 14 A copy of the catch record of rainbow trout taken in the Brule River during the 1940 fishing season as presented by O'Donnell in his report.

In 1954 Daly conducted a creel census on the Brule River with the primary objective of evaluating the harvest of migratory brown trout. However, the efforts of this creel census was extended to include all trout observed. A census clerk was assigned to cover the entire portion of the stream open to fishing on a day to day basis. As many fishermen as possible were contacted and their angling results recorded. In 1954 the special fall season opened on September 8 the day after the close of the regular trout season and ran through the established closing date of November 15. Because of the emphasis in the migratory brown trout harvest, this creel census actually started on August 28 and thereby included the last week of the regular trout season. All of the trout checked during the last week of the regular season were separated into two categories using 13 inches as a dividing point. This dividing point was used because this was the minimum size limit in effect during the special seasons. This census checked 1,236 anglers, who fished a total of 4,779 hours and creeled 277 rainbow trout 13 inches and over. Even though there was a more concentrated census effort throughout the fall season, the figures presented do not represent a total harvest. Daly estimated the creel census coverage was 85 percent complete. In the opinion of this writer, this estimate would seem rather high for this type of census on this type of stream. Nevertheless the creel census did show an increasing interest among anglers in the fishery offered during the special fall season.

A creel census was conducted as a part of this study. The methodology of this creel census was presented in detail in Part I of this report. The census was voluntary system of trout registration stimulated by cash awards. Anglers were requested to record trout they caught at registration stations located in Brule and Superior. Weekly as well as seasonal cash awards were offered to help encourage angler registration of fish. The money for these awards over the three-year period was provided through the interest and generosity of Douglas County Fish and Game League of Superior.

Facts as reported included date of catch, species of trout, length and weight of the fish and the zone of the river which the fish was caught. The portion of the Brule River open during the special fall season was divided into three near equal sections. A map showing these divisions was provided at the registration stations. In this way, the angler could properly identify the zone in which the fish was taken.

As stated in Part I, the response of the fishermen to this creel census was quite good. However, as in other types of creel census, voluntary reporting has its weaknesses such as inadequate reporting by highly successful fishermen.

The results of the voluntary creel census as obtained from the angler registration of trout is presented in Table 14. For comparative purposes both the rainbow and brown trout catch is presented. The reported catch of migratory rainbow was 380, in 1962, 312 in 1963, and 246 in 1964 or a total of 938 fish in the three-year period. The weight of the 938 rainbows reported was 3,458.4 pounds. This figure does not represent the exact total weight because some fish were field dressed prior to being registered. Based upon this information, these rainbows averaged 3.7 pounds. The average weight of the brown trout was 4.4 pounds. The average weight of the rainbows caught by the anglers was slightly higher in comparison to the average weight obtained from the sample of fish captured at the weirs and through electro-fishing efforts. The average live weight for the latter group (795 fish) was 2.96 pounds.

Table 14 The harvest of migratory trout as reported by anglers during the voluntary creel census conducted on the Brule River over a three-year period--1962 through 1964.

YEAR	RAINBOW TROUT Number of Fish	RAINBOW TROUT Reported Weight of Fish	BROWN TROUT Number of Fish	BROWN TROUT Reported Weight of Fish	RAINBOW Average Weight	BROWN Average Weight
1962	380	1,494.7	134	588.3	3.9	4.4
1963	312	1,030.0	195	843.8	3.3	4.3
1964	246	933.7	104	457.5	3.8	4.4
TOTALS	938	3,458.4	433	1,889.6	3.7	4.4

The number and size of the migratory rainbows registered during the creel census is shown in Figure 15. Comparing the number of fish caught in the various size categories by the angler with the fish captured during survey operations there were some noticeable differences (Figures 3 and 15). The comparatively large number of rainbows captured in the 13-14 inch size groups in sampling operations were not as evident in the angler catch. Generally these smaller fish (13-15 inches) bite more readily than larger trout so they are caught. Some anglers are known to release 13 and 14-inch fish if they are not badly injured. The overall results of the voluntary creel census may have been somewhat biased due to the registration of larger specimens.

The average length for the rainbows reported in 1962 was 21.3 inches. The largest rainbow registered was 31.0 inches and 11.25 pounds. In 1963, the average length dropped to 19.9 inches. Again the largest rainbow reported was 31.0 inches but this fish weighed 13.5 pounds. In 1964, the average length was 21.1 and the largest rainbow reported was 31.8 inches in length and weighed 12.7 pounds. These reports demonstrate that there are some real trophy fish present in these migratory rainbow runs.

A look at the comparative catch of migratory brown and rainbow trout will show that these two species tend to compliment each other in providing trophy fishing. As the reader will recall, (in Part I) the migratory brown enter the Brule River in early to mid-July, reaching a peak in August and gradually tapering off in early to mid-September. The rainbows normally start their fall migration in early to mid-September with a peak in October and a gradual tapering off in November. This pattern of fish activity is reflected in the angler's catch as shown in Figure 16. Because of a difference in the length of the creel census in 1962, as compared to the other two years, standard monthly time periods were used. Only those trout reported caught within the monthly periods used were included. An analysis of Figure 16 shows that when the brown trout catch declined, there was an upsurge in the rainbow harvest. From a high in September, the brown trout catch declined to a low level in October with a slight recovery in November. In comparison, the rainbow fishery started in September, reached a pronounced peak in October and either leveled off or declined in November.

These highs and lows can be attributed to the following reasons. In October, many of the migratory browns are upstream spawning. The upstream spawning areas are closed to fishing so temporarily these fish are unavailable to the anglers. The catch of spawned-out brown trout accounts for the slight upsurge in November. With the influx of rainbows in September and October angler interest and fishing effort dramatically switches to "steelhead" fishing. Fishing pressure really increases in October and so does the catch of rainbows. Weather and condition of the river are important factors in the outcome of the fishery. High water and severe flooding in early September of 1964 reduced fishing pressure and the catch of fish. Not a single rainbow was registered during the September 1-15 time period in 1964. Normally a few rainbow are caught this early in the season as indicated by the registration catch in the previous two seasons. Even the catch of brown trout was down during this period. The catch of both species increased in late September (16-30) after fishing conditions became more favorable.

Cold weather is also a deterrent and can materially affect the fish harvest. By late October, weather conditions can become periodically unfavorable to angling thus reducing the fishing pressure. This in turn often results in a drop in the harvest during the later part of the season particularly in November. In 1964, the rainbow catch remained quite stable in the later part of the season. Poor fishing conditions early in the 1964 season prompted more fishing effort later in the season thereby keeping the rainbow catch at a higher level.

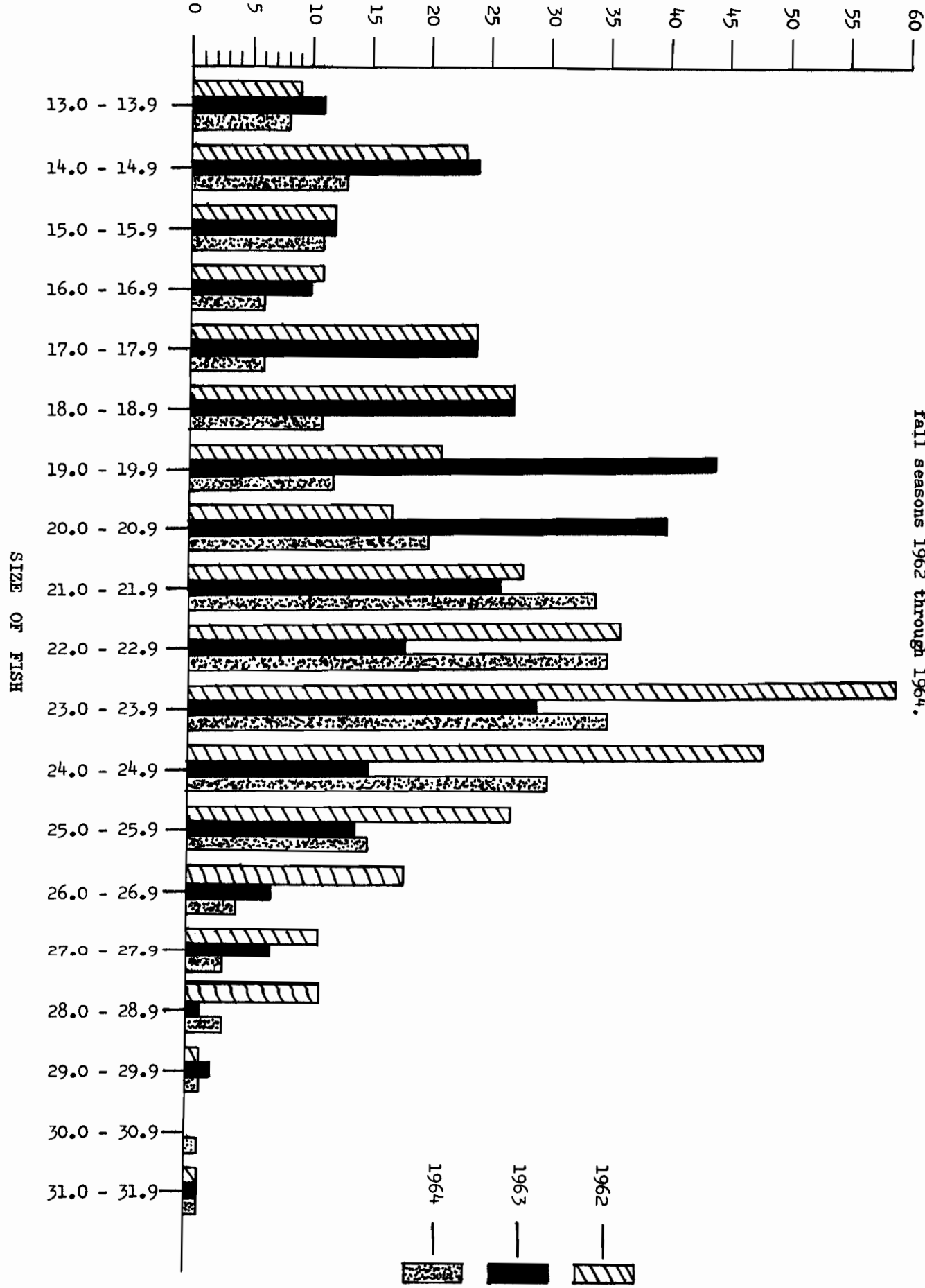
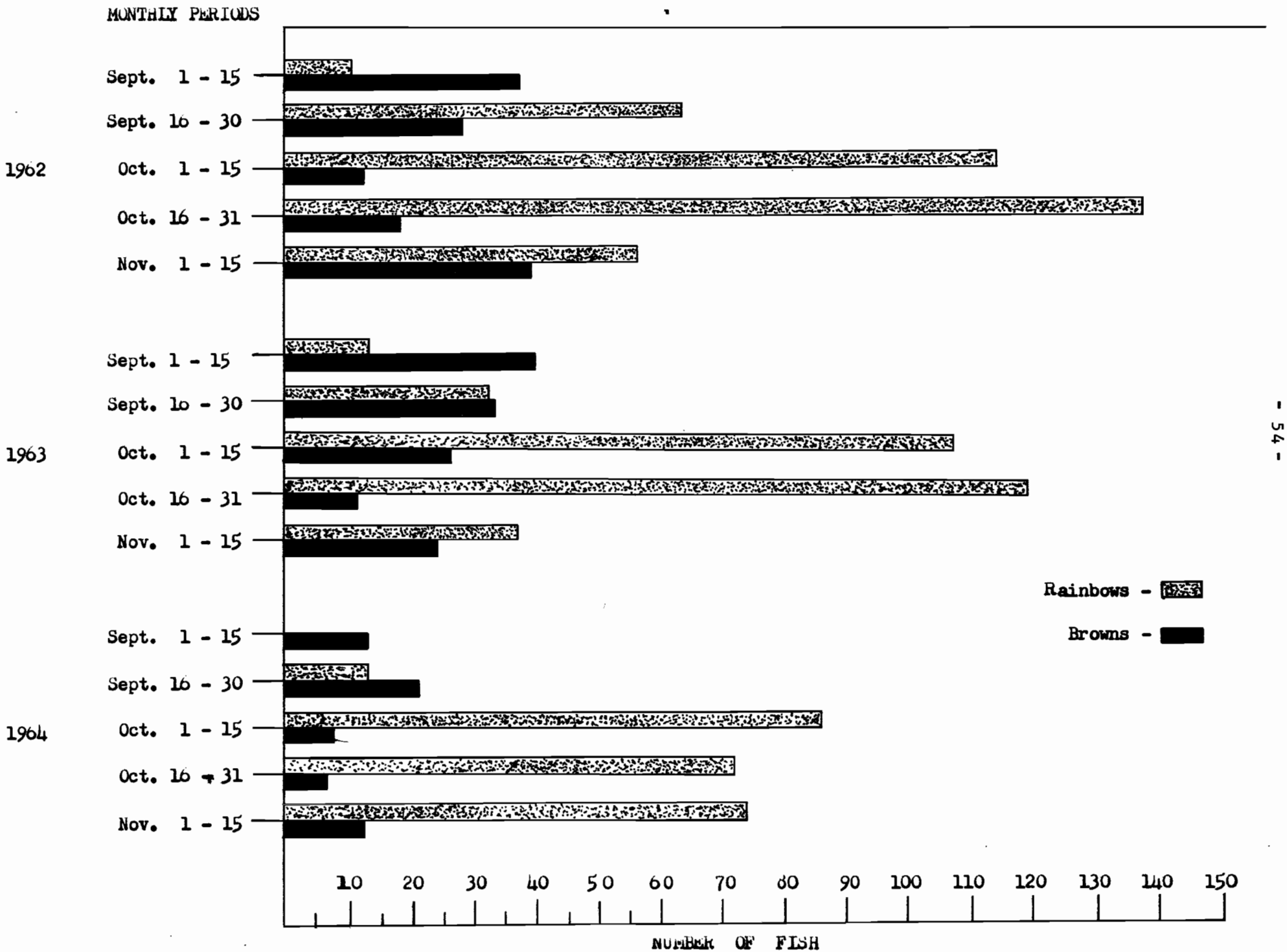


Figure 15 Number and size of migratory rainbow trout as reported by anglers in the voluntary creel census conducted on the Brule River during the special fall seasons 1962 through 1964.

Figure 16 A comparison of the registered catch of migratory brown and rainbow trout during the three year voluntary creel census for the monthly time periods shown.



In registering their trout anglers were requested to indicate the zone in which the trout were taken. The three zones used were the same as described in the brown trout report with zone 1 the farthest downstream and closest to Lake Superior. In the three year period, 36 percent of the rainbows reported were caught in zone 1, 44 percent in zone 2 and 20 percent in zone 3, Figure 17. By comparison zone 3 had the highest percentage of the reported brown trout catch.

In the fall season, steelhead anglers tend to fish the lower sections of the river more heavily. This undoubtedly accounts for the greater catch in the lower two zones. Reasons are (1) the lower river has some excellent habitat for rainbows and attractive fishing waters, which are recognized by the anglers and (2) rainbows fresh out of the lake still exhibit the bright silvery coloration and lots of energy and fight. These are very appealing factors to many steelhead fishermen. Many anglers also feel they have a better chance of catching a fresh run rainbow than a fish that has been in the river for awhile. These fish become quite wary from the disturbances of the anglers trying to catch them and once they become accustomed to the confines of the river, they seem harder to catch. Although there is no urgent or rapid upstream migration, incoming rainbows tend to spread out. The more the fish spread out, the harder it is for the angler to locate them. An overall evaluation of the creel census work conducted on the Brule River strongly supports the fact that the migratory ("Steelhead") rainbow has long provided a very popular and attractive fishery to the trout fisherman.

MOVEMENT OF SMALL (PARR) RAINBOW TROUT

The rainbow trout has a natural tendency to migrate if the opportunity presents itself within a given environment. Once developed, this migratory instinct is passed on to the offspring from generation to generation. This very definitely is the characteristic existing in the rainbow population of the Brule River. There is a natural movement of parr trout from the parent stream into the associated lake environment and a return migration as the trout reach adult or maturity size.

Although the major emphasis during this study was the collection of data on the adult fish population, information on parr trout was collected as the opportunity presented itself. When in operation and under the limitations of the operation, small trout were collected at both the Winnie and Highway 2 Weirs (Table 15). The Winnie Weir had a barrier screen with spacings close together to collect all but the very small two-three inch fingerling trout. Since the Winnie Weir washed out in the winter of 1961, the only information available was from the fall operation. There was some indication of a downstream movement in October when 32 small rainbows were recorded, but the overall sample was too limited to determine any trends.

The Highway 2 Weir was operated most extensively in 1963. Based upon the results of this operation, there was evidence showing a rather strong downstream movement in May and early June. A catch of 264 small rainbows in May and 43 in June was accomplished with only part of the screen on the downstream side capable of deflecting small trout into the trap.

A review of the daily catch record for May shows no massive downstream surge of small rainbows. The downstream movement could best be described as a continual trickling of fish. The largest daily catch occurred on May 18, when 26 rainbows were recorded. The daily catches normally ranged between 3 to 12 fish. The heaviest movement occurred between May 18-23 when 40 percent of the monthly catch was recorded.

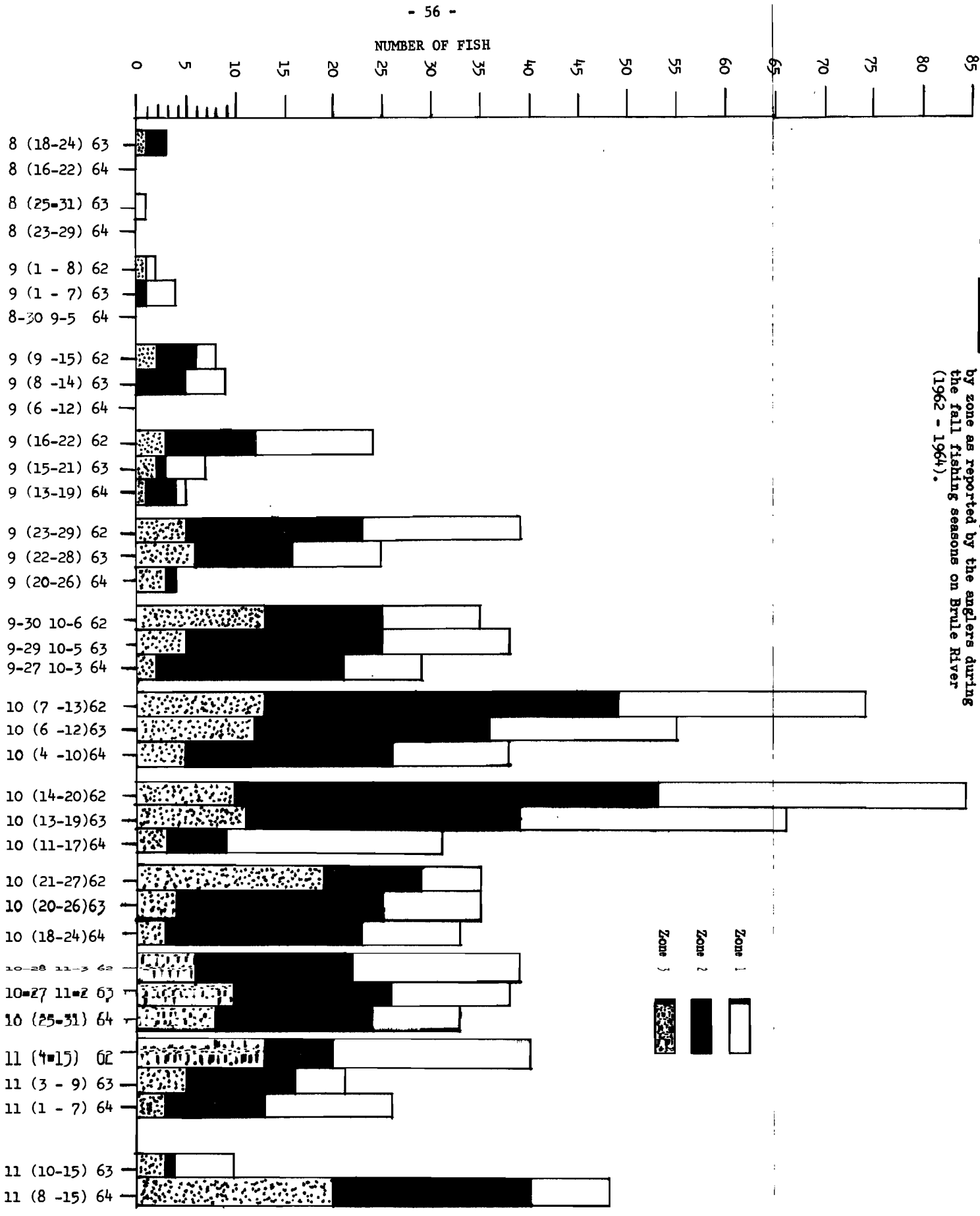


Figure 17 Record of the weekly catch of rainbow trout by zone as reported by the anglers during the fall fishing seasons on Brule River (1962 - 1964).

Table 15 Downstream catch of small rainbow trout in the Brule River weirs.

MONTH	WINNIE WEIR (1961)		HIGHWAY "2" WEIR (1963)	
	Number	Size Range	Number	Size Range
January				
February				
March			2	8.6 - 8.7
April			3	8.0 - 8.8
May			264	7.2 - 10.8
June			43	6.2 - 10.5
July			2	7.2 - 7.5
August			3	7.8 - 8.5
September	7	6.7 - 8.9	1	8.0
October	32	6.0 - 8.5	1	7.3
November	6	8.1 - 8.7		
December	8	7.2 - 8.7		

The small rainbows captured at the Highway "2" Weir in the spring of 1963 ranged from 7.1 to 10.8 inches. A sample of 112 fish averaged 9.0 inches. Greeley (1933) in his work on migratory rainbows in Michigan streams reported a calculated average length of 9.8 inches for a sample of 61 spring parr migrants. The fish in his sample ranged from 7.3 to 13.1 inches. A majority of these fish were two years old and just starting their third year of life.

Additional information on the downstream movement of smaller rainbow trout was obtained from the operational records of the sea lamprey weir, observations and survey operations in the lower river. Even though the sea lamprey weir was not designed to capture fish moving downstream many fish passing through the weir do end up in the traps. As pointed out in the brown trout report some of the fish passing through the electrical field will reverse their direction and swim upstream into the traps. This characteristic, strange as it may appear, has been proven through the recapture of both tagged and finclipped fish.

The weir records definitely show a downstream migration of small rainbow trout beginning in the spring and continuing on into the summer months (Table 16).

Andrews in a study of the seaward movement of smolt steelhead trout in the Alsca River, Oregon reported that the downstream movement was related with water temperature and stream flow. He reported that his daily trapping counts increased with rising temperatures and decreased with lowering temperatures. Maximal movement occurred with a mean water temperature of about 51 degrees Fahrenheit and with declining flows.

Although the collection of water temperature and water level datum was not complete, such information was taken once daily at both the Highway "2" and the sea lamprey weir. A check of the daily weir records shows some similarity in the downstream movement pattern based upon the factors mentioned by Andrews. However, the maximal downstream movement of smolts in the Brule River was not as precisely related to the 51 degree water temperature reported. The records showed greater activity at water temperatures in the 56 to 68 degree range. Very limited activity was noted when water temperatures were below 48 degrees. The movement activity was greater at times of declining water levels as suggested by Andrews. Although the size range and average size of the small rainbows captured at the sea lamprey weir was not determined, personal observations of some of the rainbows captured at this weir indicated that the size of the fish coincided quite well with that reported for downstream migrants captured at the Highway "2" Weir.

Although the peak of the exodus for parr rainbows occurs in May, June, and early July, there seems to be a continual trickling of fish downstream. Based upon our survey operations this movement continues throughout the summer and into the fall months. A sample of 263 rainbows captured during survey operations conducted throughout the study period in the lower river between July 25 and October 20 ranged from 5.8 to 11.5 inches and averaged 8.2 inches. Some of these late summer and fall migrants were fish in their second summer of life. Compared to the earlier spring migrants the fall fish were slightly smaller in size.

The magnitude of future steelhead runs depends on the survival of these smaller fish. Because these fish are scattered throughout the river, or moving through certain areas of river at certain times, they are vulnerable to angling mortality.

Table 16. Small rainbow trout (fish less than 12 inches in length) captured at the Brule River sea lamprey weir.

MONTH	1963 Number of Fish	1964 Number of Fish	1965 Number of Fish	TOTALS
April	13	45	78	136
May	263	545	341	1,149
June	529	525	517	1,571
July*	274	183	236	693

*Sea Lamprey operations discontinued for the season around mid July.

Fishermen using salmon eggs, roe or night crawler's are particularly plagued with the problem of smaller fish taking their bait. Dedicated steelhead fishermen realize the value of these small fish to the future of their sport. Therefore, many experienced anglers adjust their fishing habits and techniques to avoid catching these smaller fish or carefully release them if they are accidently hooked.

STREAM SURVEY OF THE UPPER BRULE RIVER

As related in Part I, a stream survey was conducted through a portion of the Upper Brule River in November of 1963. The details of this work were outlined in the brown trout report so only a few pertinent highlights will be repeated. The area surveyed was the 13 miles of river between old U. S. Highway "2" and Stone's Bridge. Conventional stream survey methods were used. In this operation a 3-phase, 230 volt, portable A.C. generator supplied the electrical power. Three hand electrodes were used in an attempt to get better coverage in this larger size stream. Because of certain natural limitation, some sections of the river within this specified area could not be covered with stream survey equipment. This was particularly true for parts of Big Lake, Lucuis Lake and an area above Cedar Island , where size, depth and/or bottom type made wading impossible. Some limited boom shocker work was carried out in such areas.

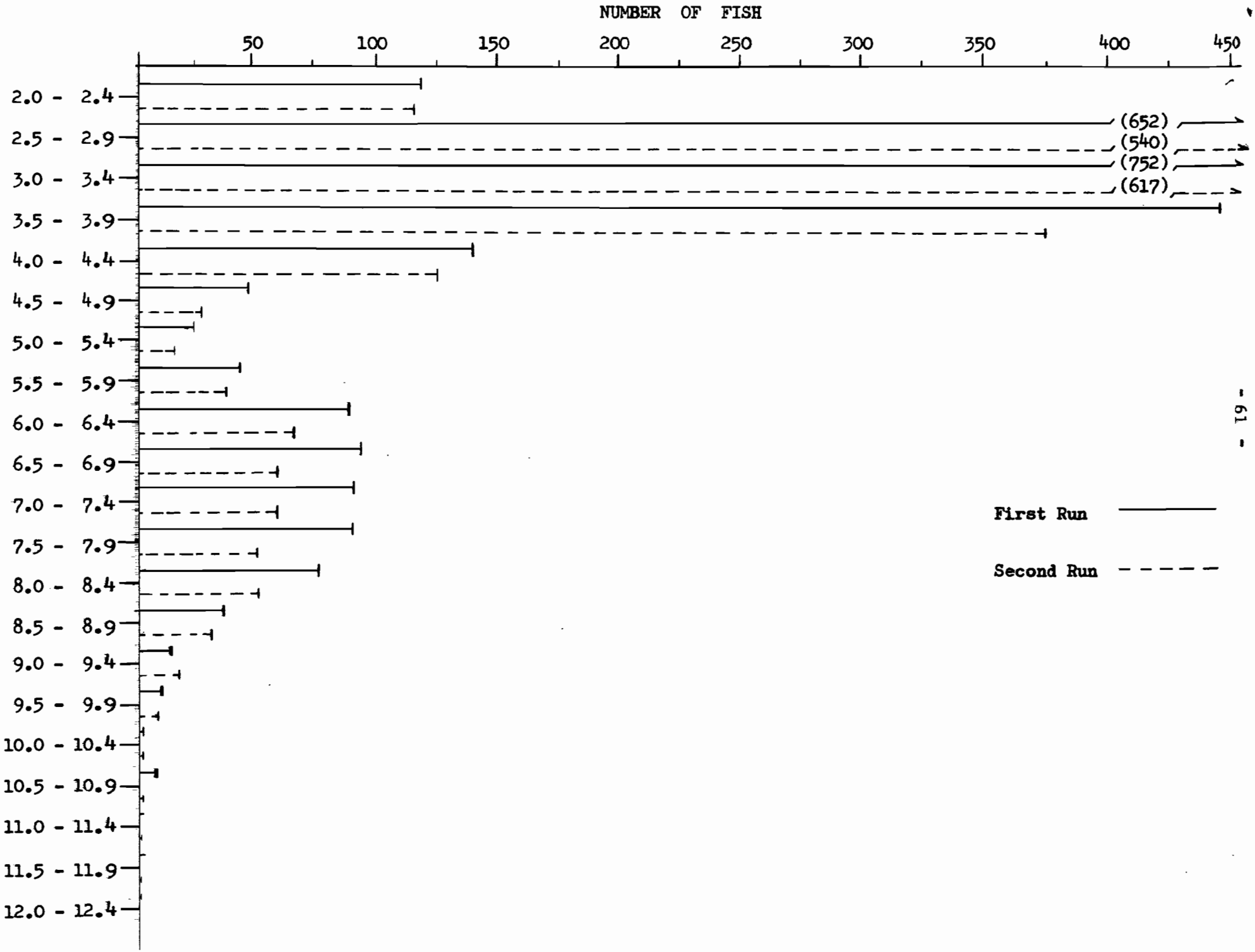
The objectives of this survey were to determine the composition and characteristics of the trout population in this part of the river at this time of year and to collect enough fish to make population estimates. In order to obtain the required data to make population estimates, it was necessary to survey this part of the river twice. All trout (other than migratory fish) captured on the first run were appropriately marked for identification on the second run and provide the necessary recapture ratio.

On the initial run 2,650 rainbow trout were captured. All trout collected were measured total length to the nearest 0.1 inch. The fish ranged from 1.9 to 12.2 inches in length. The few trout less than two inches were included in the two inch group in the length frequency histogram Figure 18. A majority of the rainbows captured, 2,123 or 80 percent, were fingerling trout or fish less than six inches in length. In addition, 527 rainbows six inches and over were captured. No rainbows larger than 12.2 inches were captured. By comparison, 46 brown trout ranging from 12 to 18.2 inches were collected in this section of the river. These larger browns were identified as stream fish. This indicates that there is a more stable population of resident brown trout than rainbows in this stretch of the river.

The second run produced 2,382 rainbows. This total included 160 recaptures (120 fish less than six inches and 40 trout six inches and over). There was little change in the size range as the rainbows captured in the second run, ran from 1.9 to 11.6 inches. As in the initial run, 1,855 or 83 percent of the fish were less than six inches in size.

A comparison of length frequency histograms showed that the brown trout fingerlings ran slightly larger than the rainbows. The bulk of the rainbow fingerlings ranged from 2.5 to 4.0 inches, whereas, the majority of the brown fingerlings ranged from 3.0 to 4.9 inches.

Figure 18 Length frequency distribution of rainbow trout captured during stream survey operations conducted in a section of the upper Brule River.



In this survey, six inches was used as a dividing point and all trout captured were grouped accordingly. Population estimates were determined for each respective group as a whole. Grouping the fish was necessary because of the limited number of fish captured in some size categories and the overall limited number of recaptures. The brown trout length frequency showed a natural break at six inches. The rainbow length frequency showed a more natural break at five inches. To keep the data on a more comparative basis, the six inch dividing point was used for both species. A secondary reason for selecting this particular dividing point is the fact that this is the minimum legal size for trout during the regular trout season when this part of the river is open to fishing.

A Peterson (1896) population estimate was made using the data obtained from the survey runs. The number of marked fish (recaptures) recovered was rather limited. To some extent, this was anticipated when the survey was set up. It was difficult to ascertain what the outcome would be or how effectively this part of the river could be surveyed. Nevertheless, the survey was carried out with the following results.

The rainbow trout population of fish six inches and over for this stretch of the river was estimated at 5,362 fish. This estimate was based on a recapture rate of 9.8 percent. Confidence limits at the 95 percent level, place the population range at a low of 4,047 and a high of 6,919 trout -- (Snedecor, 1946). The estimated population (5,362 fish) of larger rainbows was greater than the estimated population of larger brown trout (3,137 fish). The estimated populations gave densities of 412 legal rainbows and 241 legal browns per mile of stream. In the course of this survey, it was noted that certain areas of the river had abundant numbers of trout either brown or rainbow or both, and other areas had very limited numbers of trout. This is to be expected in 13 miles of river having diversified conditions and habitat. The quality of the available habitat was reflected in the number of trout found in a given part of the stream. This varied to some extent between the two species in that more rainbows were found in the areas of faster flowing water, while the browns were found in areas having good protective cover and deeper pools.

Even though the population of larger rainbows in this part of the river was relatively good for this time of year, its stability was unlikely. As this report has shown, there is a strong tendency for fish of this size and age to migrate from the parent stream. The absence of large size rainbows (over 12 inches) attest this fact. The migration of legal or catchable size rainbows from the upper river greatly reduces the availability of naturally reared fish to the angler. This factor does have an impact on the fishery and therefore, becomes a management consideration.

The population of smaller rainbows (fish less than six inches) was estimated at 34,941 fish based upon a recovery rate of 6.5 percent. The range in the estimated population at the 95 percent confidence level ran from a low of 24,952 to a high of 38,458 fish. The estimated figure of 34,941 fish gave a density of 2,688 fingerlings per mile of river. Based upon the calculated estimates, the number of smaller brown and rainbow trout were very similar. The estimated population for smaller brown trout was 35,867 compared to 34,941 for the rainbows. Applying these figures, the combined density of smaller trout for this section of the river would be 5,447 fish per mile.

Admittedly, the population estimates presented for both the brown and rainbow trout were based upon relatively low recovery rates of marked fish. However, the information obtained does provide some indication of the production of native fingerlings in the Brule River. This information will also serve as a basis of comparison for any future work of this type.

MANAGEMENT CONSIDERATIONS AND RECOMMENDATIONS

For many years angling has been permitted during the fall migration period. In spite of this fact, there is still enough escapement of adult fish to insure a suitable spawning population. However, this population is flexible and the relative stability of the present spawning population could change one way or the other in the future. Thus, review of management developments is in order.

The recent introduction of the exotic coho salmon into the waters of Lake Superior could eventually have an impact on the management of the migratory trout fishery. Although Wisconsin is currently rearing coho salmon in some of its trout rearing facilities, to date Wisconsin has not stocked coho salmon in Lake Superior. However both neighboring states namely Michigan and Minnesota have planted coho salmon. These states have planted cohos directly into selected streams or in the immediate vicinity of the mouths of some tributary streams.

The coho salmon is considered to be a homing species and exhibits strong homing tendencies. However some cohos from the earlier Michigan plants have already strayed into Wisconsin waters of Lake Superior. Moreover some adult coho salmon have been caught in the Brule River and other tributary trout streams during recent fishing seasons. A few dead adult salmon have been found in some of the streams including the Brule River. As yet no pronounced coho spawning run has developed in the Brule River. The eventual development of a spawning run into the Brule and other Wisconsin streams is highly probable.

One reason Wisconsin has refrained from stocking coho salmon in Lake Superior is to avoid or delay intra-species competition with existing and developing trout populations. For example, through management the lake trout has made a remarkable recovery in the Wisconsin waters of Lake Superior. Intra-species competition could occur not only in the lake but more importantly in the streams as well. As already iterated Wisconsin tributary spawning streams and the spawning areas within these streams are limited and heavily utilized. Although somewhat speculative at this time, competition for or additional use of both the spawning areas and living space within a stream could result in marked changes in migratory trout populations.

Current information shows that growth rates of coho salmon in Lake Superior are comparable to those of the migratory brown and rainbow. The phenomenal growth attained by coho salmon in Lake Michigan waters has not materialized in Lake Superior.

Another factor that has to be taken into consideration is that most coho salmon succumb naturally after completing a relatively short life span of three years. It has been shown that migratory browns and rainbows can potentially attain an age of up to seven years. Many of these trout live at least four and five years. The additional year or two of life can result in larger specimens which is a desirable feature in the eyes of the angler.

Because of the current popularity of the coho salmon it is anticipated that continued and perhaps increased and expanded stocking of this species will occur. Therefore continued surveillance of the development of coho salmon populations in Wisconsin waters of Lake Superior is recommended. Should coho salmon spawning runs develop, a decision will have to be made as to the management of this species. Studies should be initiated to determine precisely what effects coho salmon have on trout populations within a local stream ecosystem.

As a result of this study certain management recommendations have been made that have already been initiated. In 1965 the bag limit for rainbow trout taken during the special trout seasons was reduced to two fish per day. This change was made in an attempt to get a better distribution of the catch of these larger trout among the participating anglers.

Because this study showed that the spring run of rainbow trout into the Brule River was very low, efforts have been undertaken to bolster the run. Rainbow trout yearlings originating from spring spawning brood stock have been stocked in the Brule River. More recently some rainbow trout eggs were obtained from the State of Washington. These eggs were taken from wild steelheads having a late spring spawning period. Taking into consideration the difference in climatic conditions between the two states, these fish in Wisconsin waters would be considered summer run steelheads. If these special stocking efforts prove fruitful and strong spring and/or summer spawning runs materialize the steelhead fishery would be greatly improved and extended.

The stocking of rainbow trout yearlings into the Wisconsin waters of Lake Superior has also been increased. This has been done in an attempt to establish better rainbow trout fishing in Lake Superior and potentially increase the rainbow runs into tributary streams. Appropriate studies should be conducted to evaluate rainbow yearling stocking, with particular emphasis on the distribution of these stocked fish in the lake and also into tributary streams.

Migratory rainbow spawning stocks should be assessed periodically to make sure there is adequate escapement and protection of spawning fish.

The management recommendations presented in Part I relative to improving the value of the Brule River and the fishery should be emphasized once again. Any benefits derived from any future improvements, management practices or studies would be applicable to both species of migratory trout.

SUMMARY AND CONCLUSIONS

This study showed that in addition to the run of brown trout there is also a good fall run of migratory "steelheads" rainbow trout into the Brule River. On the other hand the spring run of rainbows into the Brule River is critically low at the present time.

A few rainbows move into the river in late August. Normally the run starts in early September and increases in magnitude during the month. The peak of the fall run occurs in October. The run gradually tapers off in November with relatively few fish coming in after mid November.

Like the lake-run brown, migratory rainbows moved into the river under seemingly adverse conditions. Such conditions as low flow and shallow water at the mouth, a shift in the location of the river opening and the action of wind and waves on the mouth did not deter the movement of migratory trout into the Brule River.

Even though there is a good fall run of rainbows into the Brule no fall spawning activity was noted. Available information suggests that upstream movement is not rapid and that a majority of the fish do not move far upstream in the fall. Upstream movement is erratic and tends to scatter the fish throughout the river, particularly in the area open to fishing.

The catch of rainbows at the Winnie Weir in the fall of 1961 was rather good. The catch of rainbows at the Highway "2" Weir was disappointingly poor during the three succeeding years. The poor catch at the upstream weirs prompted greater sampling effort in the lower river with electro-fishing gear.

Limited operation of the Highway "2" Weir in the spring showed some upstream movement in late March and early April. These were rainbows that had been in the river over winter and were merely moving further upstream into the major spawning grounds. This spring movement coincided with the spawning period which prompted the upstream movement.

The rainbows comprising this run ranged in size from 11.0 to 31.8 inches in length and from 0.5 to 13.5 pounds in weight. A significant part of the run was made up of smaller fish (11 to 15 inches). Fish of this size were not present in the brown trout run. These smaller, so called "skip jacks," rainbows were generally immature fish making a prespawning run.

The average size of the rainbows in our sample was 20.4 inches and 2.96 pounds. The migratory rainbows were smaller in average size compared to the lake run brown which averaged 22.0 inches and 4.5 pounds.

Although the bulk of the rainbows in the run ranged from one to four pounds there were some real trophy fish present. Each year a number of fish in the seven to ten pound class are caught. Occasionally even a 12 or 13 pound fish is reported. Rainbows up to 13 pounds were captured in our sampling efforts.

Age and growth patterns of migratory rainbows were similar to those of the lake-run brown. Age analysis showed these fish were not very old or very long lived fish. Rainbows collected during the Brule River study showed that the overall sample was composed of 31 percent three year old fish; 27 percent four year fish; 34 percent five year fish; seven percent six year fish; and 0.3 percent seven year old fish. Fish in their fourth and fifth year of life made up the bulk of the actual spawners.

Examination of scale samples provided information on the growth pattern of these migratory rainbows. Most of the rainbows spend two years in the parent stream before migrating to Lake Superior. Growth in the stream is considerably slower than in the lake environment. Growth is greatly accelerated in the lake especially in the third and fourth years of life. Growth in ensuing years is slower.

Rainbow spawning activity in the Brule River starts toward the end of March and continues on into May. The spawning peak usually occurs in early to mid-April depending on weather conditions and the spring break-up. Spawning activity is concentrated in the primary spawning grounds located south of U. S. Highway 2. The major spawning grounds heavily utilized by the brown trout in the fall are heavily used by the rainbows in the spring. Some spawning does occur in the tributary stream. Some spawning also takes place downstream in and around the Coop Park area.

No estimate of the rainbow spawning population was made because an inadequate sample of fish was captured. However the number of fish observed on the major spawning grounds indicates that under present management there is enough escapement of fish to insure an adequate spawning population.

Fecundity of these fish was determined through a number of egg counts, but the fish used only ranged up to 22 inches in length. Total egg production ranged from 2,200 eggs for a 16.8 inch female to 3,800 eggs for a 22.1 inch fish. The average egg production based upon the fish in our sample was 2,843 eggs. At this rate, 500 females would produce well over one million eggs.

Some of these migratory rainbows spend a considerable amount of time in the river. Fish arriving in the fall (September-October) do not leave again until the following spring (April-May). After spawning the fish tend to move downstream out of the spawning areas and eventually out of the river. By late April or early May spawned-out fish are moving out of the river in fairly good numbers. Fish returning to the lake provide the bulk of the fishing during the spring fishing season. After spending six to seven months in the stream and then going through the rigorous activities of spawning, these fish are not in the best of condition at this time of year.

Although there was some natural mortality among the migratory rainbows the loss of fish was small in comparison to the loss of migratory brown trout. Even though fall run rainbows are fully exposed to the potential hazards of the bacterial disease (furunculosis) the brown trout killer, these fish remained immune. The rainbow mortality was greater in spring and was in part attributed to spawning activities. From a fisherman's view point the loss was especially significant because it was usually the large trophy size fish that died.

A number of the rainbows handled exhibited a conspicuous deformity. Overall, six percent of the fish in our sample were so effected. In the 1964 and 1965 sample nine percent or more of the fish were so effected. The deformity occurred in the vertebral column and was situated forward of the tail and in the immediate region of adipose fin. This condition prompted considerable speculation and concern among the anglers as to the reason. Many felt the electrical sea lamprey weir was the cause.

While in Lake Superior migratory rainbows are susceptible to attack and predation by sea lamprey. On two different occasions rainbows were captured in the lower river with sea lampreys still attached. However, the overall incidence of lamprey scarring among the rainbows handled in this study was very low.

Information obtained on the dispersal of rainbow trout in Lake Superior was rather limited. The few tag returns received from rainbows caught outside the Brule River showed a widely scattered distribution. Extreme distances travelled (straight-line measurement) were 100 and 200 miles from the Brule River.

Angler interest in the fishery associated with these rainbow runs has always been high. Special seasons have been set to take advantage of the availability of these migratory trout. Fishing pressure has shown a continual increase through the years.

A voluntary creel census conducted during the 1962-63-64 fall fishing seasons resulted in the registration of 938 rainbows. As reported, these fish weighed a total of 3,458 pounds. The average size of the rainbows registered was 20.8 and the average weight was 3.7 pounds. The largest rainbow registered was 31.8 inches and the heaviest fish was 13.5 pounds. This indicates that there are some real trophy fish present in these rainbow runs.

A majority of the rainbows hatched and raised in the Brule River eventually leave the parent stream. Most of these fish leave after completing two years of life in the stream. The downstream migration of rainbow smolts is heaviest in May and June. There is some limited downstream movement throughout the summer and into the fall months. The outgoing fish ranged in size from 5.8 to 11.5 inches and averaged 8.2 inches.

A stream survey of the upper Brule River (Highway 2 to Stone's Bridge) was conducted to obtain information on the fish population of this portion of the river. The rainbow population for fish six inches and over was estimated at 5,362 fish or a density of 412 larger rainbows per mile. No rainbows larger than 12.5 inches were collected indicating a low resident population of larger rainbows and strongly supporting the fact that most of these fish leave the stream.

The population of rainbow fingerling and/or fish smaller than six inches was estimated at 34,941 fish or a density of 2,688 fingerlings per mile.

This stream survey also showed that some parts of this section of the river have a very low trout population. This was primarily a reflection of the available habitat or water quality.

Management recommendations called for a reduced bag of rainbow trout to two per day in recognition of the trophy character of this species. The growing amount of coho salmon stocking maybe competition with the rainbows, and studies of inter-relationships are in order. Rainbow trout and brown trout with their longer life spans and potentially larger size maybe a better angler trophy. Operation of the sea lamprey weir needs examination to note its apparent effect on spring runs.

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REFERENCES

Andrews, Rupert Earle
1957. An abstract of the thesis of the author on seaward movement of smolt steelhead trout in the Alsea River, Oregon. Oregon State College Department of Fish and Game Management. 2 pp. mimeo.

Brasch, John
1950. A creel census report of recent special trout seasons on certain streams of the Lake Superior south shore watershed. Wisconsin Conservation Department, Division of Fish Management Investigational Report No. 604 pp. mimeo-unpublished.

Carlander, Kenneth D.
1953. Handbook of freshwater fishery biology with the first supplement. Wm. C. Brown Co., Dubuque, Iowa, 429 pp.

Cooper, Edwin L.
1951. Validation of the use of scale of brook trout Salvelinus fontinalus for age determination. Copeia, June No: 2, pp. 141-148.

Daly, Russel
1954. Brule River creel census report. File report of the Department of Natural Resources, Northwest District Headquarters, Spooner, Wisconsin.

1968. Preliminary notes on management of the rainbow trout in Western Lake Michigan. Wisconsin Department of Natural Resources, Bureau of Fish Management. 5 pp. mimeo.

Davis, H. S.
1953. Culture and diseases of game fishes. University of California Press, Berkeley and Los Angeles, 332 pp.

Dees, Lola Tidwell
1950. Sea lamprey of the Atlantic Coast and Great Lakes. United States Department of Interior Fish and Wildlife Service Fishery Leaflet 360, 4 pp.

Fallis, H. J. and Wallace E. Niemuth
1962. Sucker removal operations and observations on trout movement through a two-way weir in the Brule River, Douglas County. Wisconsin Conservation Department, Fish Management Division Northwest Area Invest. Memo. No: 4, 8 pp. mimeo.

Fischtal, Jacob H.
1947. Parasites of Brule River fishes. Wis. Acad. Sci., Arts and Letters 37 (1945), pp 275 - 278.

Greeley, John R.
The growth rate of rainbow trout from some Michigan waters. Trans. Am. Fish Soc. Vol. 63, p. 361-378.

Hallock, R. J.; Wm. F. Van Woert, and Leo Shapovalov
1961. An evaluation of stocking hatchery-reared steelhead rainbow trout (Salmo gairdnerii gairdnerii) in the Sacramento River System. State of Cal. Dept. of Fish and Game, Fish Bulletin No. 114, 74 pp.

Hansen, Martin J.
1960. Recoveries by anglers of hatchery-reared rainbow trout stocked near the mouths of Great Lakes Tributaries. Abstract No: 172, Institute for Fisheries Reserach Report No: 1607, pp. 1-2, Michigan Dept of Conservation.

Hartman, W. L.
1959. Biology and vital statistics of rainbow trout in the Finger Lake region, New York. New York Fish and Game Journal, Vol. 6 - No: 2, pp. 121-177.

Hatch, Richard W.
1961. Regular occurrence of false annuli in four brook trout populations. Trans. Am. Fish. Soc. Vol. 90 - No: 1, pp. 6-12.

Hoffman, Glenn L.
1966. Effects of whirling disease. Prog. Fish Culturist, Vol. 28, No: 3, p. 151.

Koo, T. S. and Andhi Isarankura
1967. Objective studies of scales of Columbia River chinook salmon Oncorhynchus Tshawytscha (Walbaum). Fishery Research Institute, College of Fisheries, Unv. of Washington, Seattle, Washington Fishery Bulletin: Vol. 66, No: 2, pp. 165-180.

Lagler, Karl F.
1956. Freshwater fishery biology. Wm. C. Brown Company, Dubuque, Iowa, 2nd edition, 421 pp.

McMynn, R. G.
1955. Steelhead in British Columbia. Typed summary report, 4 pp.

Mottley, C. McC.
1937. Loss of weight by rainbow trout at spawning time. Trans. Am. Fish Soc. Vol. 67, pp. 207-210.

Nevin, James
1921. Fish in Brule River. The Wisconsin Conservationist, May 1921, p. 2.

O'Donnell, John D.
1945. A four-year creel census on the Brule River, Douglas County, Wisconsin - Brule River Survey Report No: 7. Trans. of the Wisc. Acad. of Sciences, Arts and Letters, Vol. 37, pp. 279-303.

Pautzke, C. F. and Robert C. Meigs
1940. Studies on the life history of the Puget Sound steelhead (Salmo gairdnerii). Washington Dept. of Game Biol. Bull. No: 3, 24 pp.

Peterson, C. G. T.
1895. The yearly immigration of young plaice into the Limford from the German Sea. Report of Danish Biol. Station 6, 77 pp.

Rich, W. H.
1920. Early history and seaward migration of chinook salmon in the Columbia and Sacramento Rivers. Bull. U. S. Bur. Fish, Vol. 37, pp. 1-74.

Rounsefell, G. A.
1957. Fecundity of North American salmonidae. United States Fish and Wildlife Service, Fishery Bulletin 122, Vol. 57, pp. 451-468.

Smith, Bernard R.
1962. Spring and summer temperatures of streams tributary to the south shore of Lake Superior, 1950-60. United States Fish and Wildlife Service Special Scientific Report - Fisheries 410 Washington D. C. 1962, 57 pp.

Snedecor, George W.
1946. Statistical methods. Iowa State College Press, Ames, Iowa.

Snieszko, S. F.
1958. Fish furunculosis. Dept. of Interior Fish and Wildlife Service, Bur. of Sport Fisheries and Wildlife, Fishery Leaflet No: 467, 4 pp.

Ward, H. B. and George Chandler Whipple
1940. Fresh-water biology. John Wiley and Son, Inc., New York, 1,111 pp.

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