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Technical Report: No. 75-2

April, 1975

RESULTS OF TRANSFERRING ADULT STEELHEAD ABOVE MIGRATION BARRIERS TO SPAWN IN THE HURON RIVER, BARAGA COUNTY 1967-1970

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SUMMARY

The benefits of transferring adult steelhead above natural stream barriers to spawn was studied through a series of steelhead transfers on the Huron River, Baraga County from 1967 through 1970.

This report details the transfer operations and presents the data obtained on the numbers of juvenile steelhead produced. It discusses fry emergence and growth, estimated numerical and biomass production, production rates, and downstream migration of juvenile steelhead.

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INTRODUCTION

In many Lake Superior tributaries where spawning migrations of steelhead (rainbow) trout occur, access to the spawning grounds is blocked by natural stream barriers. The question arises that if these fish were physically transported above the barrier, would the production of young fish be sufficient to justify such a project? If so, many miles of additional spawning area could be put into production.

To answer this question, adult steelhead captured at the U.S. Fish and Wildlife Service electrical sea lamprey weir on the Huron River, Baraga County, were transferred above natural barriers to the West Branch of the Huron River to spawn. Transfers were made each spring for four years (1967-1970) and this report presents the data collected on production, growth, and downstream migration of the juvenile steelhead produced.

MATERIALS AND METHODS

Adult steelhead captured at the U.S. Fish and Wildlife Service lamprey weir were held in live boxes in the river until sufficient numbers were available to transfer. The transfer site was about 13 miles upstream from the weir on the West Branch of the Huron River beyond two waterfalls which are barriers to fish migration (Fig. 1). Adult steelhead were transported from the weir to the transfer site by a 3/4 ton 4-wheel drive pick-up truck equipped with a single fish tank capable of holding about 20 adult steelhead. The fish tank was equipped with an aerating device. Time required to complete a transfer was 1 - 2 hours, and fish mortality was negligible. The sex ratio was usually near 1:1.

Frequent visual surveys of the transfer area were made until the date of fry emergence. Then the young fish were sampled monthly with electrofishing gear until December to study their growth.

In late August and September, population estimates of the juvenile steelhead were made at representative sites throughout the transfer area. A Peterson-type mark and recapture estimate was completed at each station, and the calculated density of fish per square yard was used to compute the total population of juvenile steelhead.

The downstream migration of young steelhead was studied in 1969 with a small-mesh fyke net connected to a floating trap box by a 6-inch diameter tube. The net blocked only a portion of the stream and was fished from late May to August. A similar attempt was made in 1970, but vandals destroyed the net.

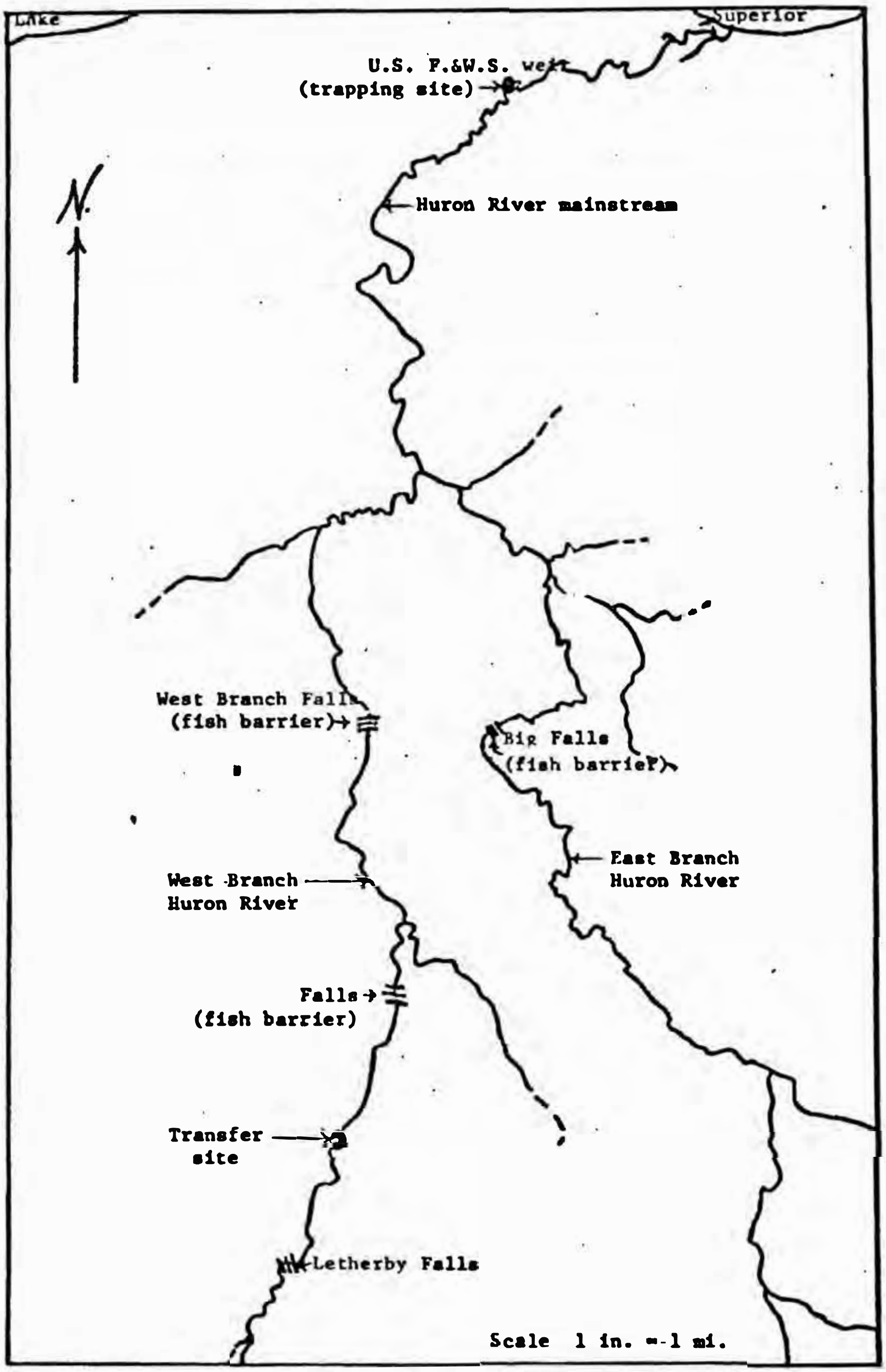

Figure 1 Huron River system with adult steelhead trapping and transferring sites shown

DESCRIPTION OF THE TRANSFER AREA

The transfer area was 4.5 miles long and was located between two waterfalls which are fish barriers (Fig. 2). One small waterfall (Letherby Falls) is located within the transfer area but it is not a barrier for steelhead.

This section of the West Branch of the Huron River runs through a remote hardwood and conifer area. The stream averages about 20 feet in width and the depth ranges from a few inches in riffle areas to nearly four feet in some pools. Sixty to eighty percent of the stream bottom is composed of gravel suitable for steelhead spawning. The remainder is large rubble and pools. The only resident fish in this area prior to the steelhead transfers were very small populations of wild brook trout, sculpins, and blacknose dace.

Complete data on the stream's physical characteristics of stations 1 - 3 (Fig. 2) is presented in Table 1. A seive analysis of the gravel at the transfer site is also presented. The 13.7% of fine materials passing through a seive with an opening of 0.84 mm in August shows the gravel in the area is sufficiently permeable to have a high oxygen concentration in the intragravel water which is conductive to good survival of steelhead eggs.

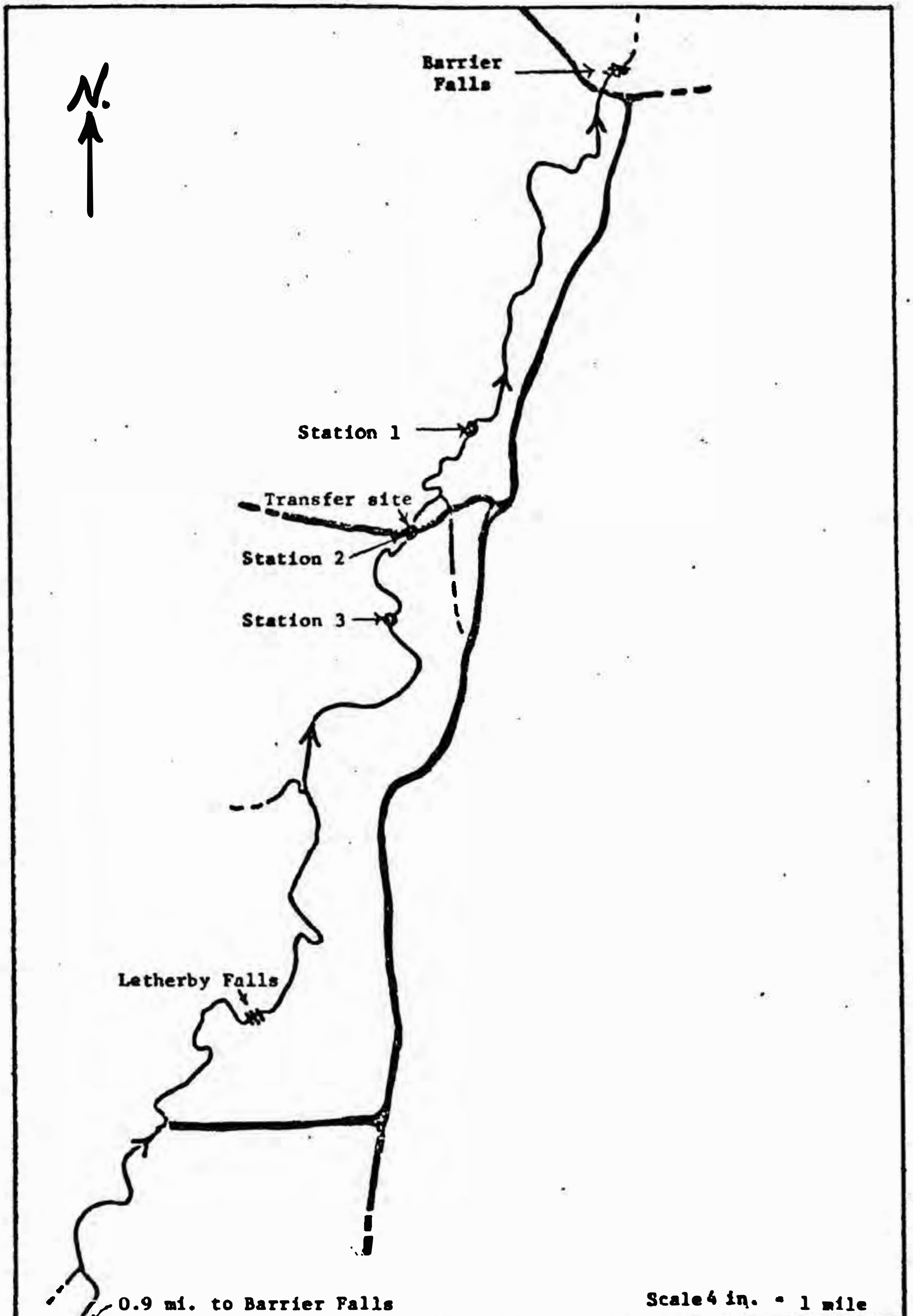

Figure 2 Adult steelhead transfer area on West Branch of the Huron River (T. 51 N. R. 30W. Sec. 22, 27, 34) stream survey stations shown

Table 1 Stream survey data from Stations 1-3
August 24, 1968, West Branch Huron River

	Location		
	Station 1	Station 2	Station 3
Average width (ft.)	18	17	13
Average depth (in.)	7	5	6
Velocity	moderate	moderate	moderate
Volume (c.f.s.)	3.67		
Gradient (ft./mi.)	40	41	30
Water Temp. (°F.)	56	56	59
Color & Turbidity	colorless & clear	colorless & clear	colorless & clear
Stream stage	summer low	summer low	summer low
Pools:			
No./ft.	4/300	7/600	6/300
Size	stream width	small pockets	stream width
Type	mod. depth & cover	shallow-mod. cover	mod. depth & cover
Cover	fair (logs & rocks)	fair (logs & rocks)	good (logs & under cut banks)
Shade (%)	50	20	80
Bottom type:			
% silt	5	3	3
% sand	10	5	7
% gravel	40	60	40
% rubble	45	32	50
Vegetation	algae on rocks	algae on rocks	algae on rocks
Bottom fauna	mayfly & caddisfly	mayfly, caddisfly diptera & stonefly	mayfly & caddisfly

Gravel Analysis (Sample size: 6 in. diameter X 6 in. deep)

	% of total volume retained by seive with opening (in mm.) of								% settling from suspension	% passing 0.84 sieve
Location	25.4	12.7	6.35	3.36	2.0	0.84	0.50	0.25		
Station 2	49.6	11.2	7.50	6.40	4.8	7.00	5.00	7.60	1.1	13.7

ADULT STEELHEAD TRANSFERS

A goal of transferring approximately 100 adult steelhead (50 females and 50 males) to the West Branch of the Huron River was established because it was felt that many fish would adequately seed the spawning area. Whether the steelhead were "ripe" and ready to spawn or "hard" and would not spawn for some time was not a criterion for selecting fish to transfer because availability of fish, road conditions, and other project commitments precluded such detailed planning.

In 1967, 62 adult steelhead were transferred between May 12 and May 24 (Table 2). Because of the lateness of the transfers, most of the fish were "ripe" females. To balance the sex ratio (1:1), it was necessary to return 20 males on May 24 that had previously been taken from the Huron River weir to the Marquette Hatchery for spawn collection purposes. Although the males were partially spent, it was felt they would still be suitable for spawning.

In contrast to the previous year, road conditions in 1968 allowed early access to the transfer site. Between April 9 and April 22, 94 steelhead were released into the West Branch of the Huron River. Because they came from the early part of the run, most of the fish were "hard" and would not spawn for some time. Male steelhead were difficult to collect in sufficient numbers, so the sex ratio favored females (1.41:1).

In 1969, 119 steelhead were transferred between April 27 and May 27. The transfers encompassed most of the spawning season, so both "ripe" and "hard" fish were involved. Again, males were in short supply, which is reflected by the 1.43:1 sex ratio.

Male steelhead apparently ascended the Huron River later in the season in 1970 because a nearly equal sex ratio was achieved (59 females; 60 males). The transfers were made between April 17 and 29. Nearly all of these early steelhead were "hard".

The steelhead involved in the transfer operation ranged from 18 to 29 inches in length and were from three to eight years old. The average fish was approximately 22 inches long and weighed 3.5 pounds.

Table 2 West Branch Huron River
adult steelhead transfers
1967 - 1970

Transfer date	1967		1968		1969		1970	
	No. of males	No. of females	No. of males	No. of females	No. of males	No. of Females	No. of males	No. of females
4-9			0	6				
4-10			2	6				
4-14			7	9				
4-16			4	8				
4-17			8	6			10	5
4-18			10	10				
4-21							17	16
4-22			8	10				
4-24							9	15
4-27					20	35	14	12
4-29							10	11
5-1					6	12		
5-2					1	6		
5-12	3	7						
5-15	1	9						
5-16	1	4						
5-18	4	5						
5-20					9	0		
5-22	2	5						
5-24	20	1						
5-27					13	17		
Totals	31	31	39	55	49	70	60	59
	(62)		(94)		(119)		(119)	

FRY EMERGENCE AND GROWTH OF JUVENILE STEELHEAD

Visual surveys from 1967 to 1970 showed that steelhead fry emerged between June 11 and July 10 depending on weather conditions (Table 3). July 1 was about the average emergence date.

When the young steelhead first appeared, they were 0.8 to 1.2 inches long and weighed 0.1 to 0.3 grams. The small variation in length of recently emerged fry indicates that probably most of the fry emerged in a period of about one week. Collections of young fish each month until December showed the major growth period was July and August. The young steelhead gained 1.1 to 1.3 inches in length during that period, from an average emergence size of 1.0 inch. From September through November, the fish grew 0.1 to 0.7 inches. The average size of young steelhead by December way 2.6 inches and 3 grams.

Table 3 Fry emergence and monthly growth of steelhead fry
in the West Branch Huron River 1967 - 1970
(Sample sizes in parenthesis)

Collection date	Year of collection and (date of fry emergence)							
	1967 (7/7-10)		1968 (6/11-17)		1969 (7/8)		1970 (6/22-23)	
	Length (in.)	Weight (grms)	Length (in.)	Weight (grms)	Length (in.)	Weight (grms)	Length (in.)	Weight (grms)
6-17			1.0 (16)	0.2				
6-26							1.1 (8)	
7-8					1.2 (7)			
7-11	1.2 (17)	0.3						
7-24							1.7 (7)	
7-26			1.5 (18)	0.8				
8-11	2.1 (11)	2.0			2.0 (5)			
8-19			2.3 (6)	2.4				
8-20							2.1 (30)	
9-11	2.2 (14)	2.3			2.5 (27)			
9-22							2.4 (18)	
10-8			2.4 (15)	2.8				
~~11-4~~							2.5 (15)	
11-11	2.9 (16)	5.2						
11-26			2.2 (15)	2.2 (1)				

(1) Apparent decrease in average size due to small sample size

ESTIMATED NUMERICAL PRODUCTION OF JUVENILE STEELHEAD IN THE TRANSFER AREA

To estimate the production of juvenile steelhead in the transfer area, five sampling stations were chosen for population estimates. The stations were located in such a manner that the resultant population estimates would be representative of the varying fish densities throughout the transfer area. After population estimates were completed at the various stations, the numerical estimate was converted to the density figure of fish per square yard.

In order to estimate the total fingerling production in the transfer area, it was necessary to expand the density estimates to cover larger segments of the stream (Fig. 3). This was done as follows: Stream Segment A was established as extending from the downstream limit of fish production (found by electroshocking) upstream to a point midway between the location of the first and second population estimates. The density of fish estimated at Station 1 was then expanded to encompass all of stream Segment A. Segment B was established as extending from the upstream end of Segment A to a point midway between the location of the second and third population estimates.. The density of fish estimated at Station 2 was then expanded to all of Segment B. This procedure was continued to the upstream limit of fish production (again located by electroshocking). Thus, five stream segments were established (A-E) and point estimates of fish density were made near the center of each segment which were expanded to estimate the total production in each segment. By summing the estimated number of fingerlings in each segment, it was possible to roughly estimate total fingerling production in the transfer area.

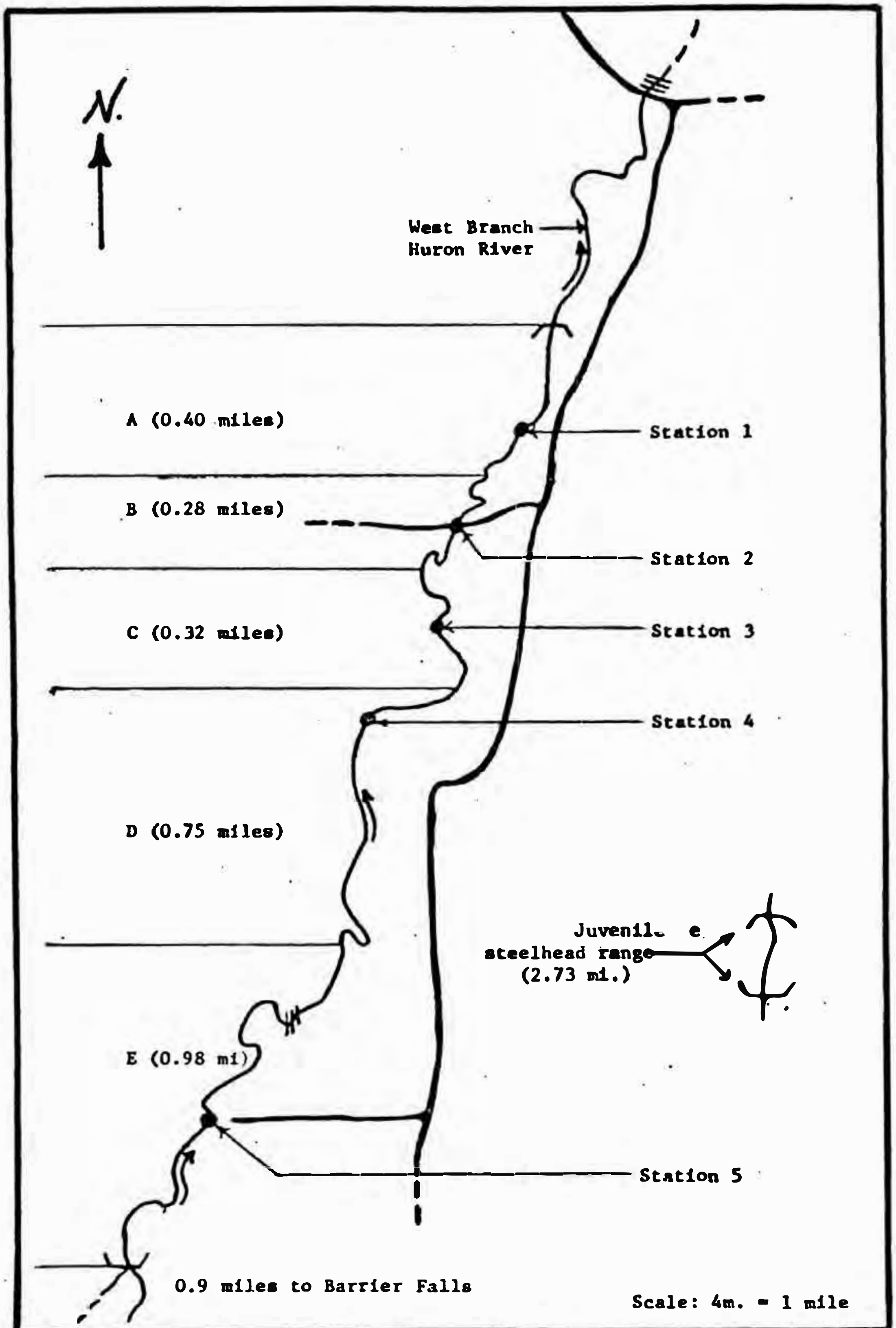

Figure 3 Juvenile steelhead population estimate stations and stream segmentation plan used to estimate total fish production

Because sufficient time and manpower were not always available, population estimates were not completed at each station each year. Estimates were completed each year at Stations 1 through 3. Station 4 was sampled in 1968 and Station 5 was sampled in 1969. Stations not sampled in a particular year were prorated so that an estimation of the total fry production could be made each year. In 1967, 1968, and 1970 all unsampled stations were prorated to a 50% reduction in fish density of the next downstream station. In 1969 fish density in Station 4 was prorated to be equidistant between Station 3 and 5, both of which had been sampled (Table 4). It was decided that prorating on this basis would give the best possible estimate because fingerling density was usually highest at Stations 2 and 3 and decreased up and downstream from those areas.

Due to improvement of equipment during the study, it became possible to considerably increase the length of the population estimate stations in 1969 and 1970. Therefore, the best point estimates of fish density were made in those years. The most reliable fingerling production estimate was made in 1969 because the prorated section was located between rather than beyond sampled areas.

In 1967, an estimated 10,312 steelhead fingerlings were present in the transfer area in late August when the population estimates were made (Table 5). Stations 1 through 3 were shocked with electrofishing gear and Stations 4 and 5 were prorated to obtain this estimate. In the 1,200 feet of stream shocked, 1,579 fish were estimated present - which is equivalent to 0.66 fish per square yard or 1,320 fish per 1,000 lineal feet of stream. Over the entire transfer area, a density of 0.39 fish per square yard or 720 fish per 1,000 feet of stream was estimated.

In 1968, population estimates were made in late October at Stations 1 through 4 and Station 5 was prorated. These estimates indicated that there were 908 fingerling and 232 yearling steelhead in the 1,400 feet of stream shocked. Expansion of the data yielded an estimate of 6,910 fingerlings and 2,350 yearlings in the entire transfer area. In terms of density, there were 0.32 fingerlings per square yard (649 per 1,000 feet) and 0.08 yearlings per square yard (165 per 1,000 feet) in the population estimate areas and 0.26 fingerlings (479 per 1,000 feet) and 0.09 yearlings per square yard (163 per 1,000 feet) in the entire section.

The largest estimate of fingerling steelhead production occurred in 1969 (19,387). Stations 1 through 3 and Station 5 were shocked in late August and Station 4 was prorated to obtain this estimate. In addition to the fingerlings, an estimated 1,622 older juvenile steelhead were present. In density units, this equals 0.73 fingerlings per square yard (1,345 per 1,000 feet) and 0.06 older juveniles per square yard (113 per 1,000 feet).

In 1970, 8,686 fingerlings and 2,593 older juvenile steelhead were estimated to be in the transfer area in mid August when the population estimates were conducted. Stations 1 through 3 were shocked and Stations 4 and 5 were prorated to obtain the estimates. In the 1,800 feet of stream shocked, a population of 1,740 fingerlings and 349 older juveniles was estimated. This is equivalent to 0.48 fingerlings per square yard (967 per 1,000 feet) and 0.10 older juveniles per square yard (194 per 1,000 feet). In the entire transfer area, the density was estimated at 0.33 fingerlings per square yard (603 per 1,000 feet) and 0.10 older juveniles per square yard (180 per 1,000 feet).

Table 4 Years population estimate stations were sampled (X) and prorating schedule of unsampled stations.

Station	Year station was sampled 1967	1968	1969	1970
1	X	X	X	X
2	X	X	X	X
3	X	X	X	X
4	Prorated (50% of Sta.3)	X	Prorated (midway between Sta. 3 & 5)	Prorated (50% of Sta.3)
5	Prorated (25% of Sta.3)	Prorated (50% of Sta. 4)	X	Prorated (25% of Sta.3)

Table 5 Index station population estimates and estimated total numerical production of juvenile steelhead in the West Branch Huron River 1967 - 1970

Year	Sta.	Sta. lgth. (ft.)	Sta. area (yd²)	Population estimate and 95% confidence limits: fry	Population estimate and 95% confidence limits: older trout	Fry per yd²	Older trout per yd²	Corresponding stream segment	Area of segment (yd²)	Est. fry production	Est. no. older trout present
1967	1	300	600	183 (135-231)		0.31		A	2,956	916	
	2	600	1200	988 (688-1288)		0.82		B	2,956	2,424	
	3	300	600	408 (298-415)		0.68		C	4,014	2,730	
	4					0.34*		D	8,448	2,872	
	5					0.17*		E	8,058	1,370	
Totals		1,200	2,400	1,579 (1313-1845)					26,432	10,312	
1968	1	350	700	240 (138-348)	65 (25-105)	0.34	0.093	A	2,956	1,005	275
	2	350	700	207 (133-281)	38 (22-54)	0.30	0.054	B	2,956	887	160
	3	350	700	266 (166-366)	54 (32-76)	0.38	0.077	C	4,014	1,525	309
	4	350	700	195 (95-295)	75 (168-296)	0.28	0.110	D	8,448	2,365	929
	5					0.14*	0.084*	E	8,058	1,128	677
Totals		1,400	2,800	908 (712-1104)	237 (168-296)				26,432	6,910	2,350
1969	1	600	1,200	1,156 (780-1, 532)	104 (74-134)	0.96	0.087	A	2,956	2,838	257
	2	600	1,200	1,552 (1,000-2,104)	87 (39-135)	1.29	0.073	B	2,956	3,813	216
	3	600	1,200	1,200 (818-1-582)	92 (72-112)	1.00	0.077	C	4,014	4,014	309
	4					0.67*	0.068*	D	8,448	5,660	574
	5	600	1,200	457 (361-533)	40 (18-62)	0.38	0.033	E	8,058	3,062	266
Totals		2,400	4,800	4,365 (3,711-5,019)	323 (263-383)				26,432	19,387	1,622
1970	1	600	1,200	504 (258-750)	125 (89-161)	0.42	0.104	A	2,956	1,242	307
	2	600	1,200	496 (336-656)	70 (40-100)	0.41	0.058	B	2,956	1,212	171
	3	600	1,200	740 (466-1, 014)	154 (112-196)	0.62	0.128	C	4,014	2,489	514
	4					0.30*	0.097*	D	8,448	2,534	819
	5					0.15*	0.097*	E	8,058	1,209	782
Totals		1,800	3,600	1,740 (1,348-2,132)	349 (285-413)				26,432	8,686	2,593

*Prorated estimates

ESTIMATED BIOMASS PRODUCTION OF JUVENILE STEELHEAD IN THE TRANSFER AREA

Numerically, production of steelhead fry was high in 1967 and 1969, and low in 1968 and 1970. To gain insight on this production periodicity, the numerical data were converted to absolute and relative biomass (pounds and pounds per acre). Table 6 shows the results of the data transformation. Part A of the Table shows the biomass of steelhead in the entire transfer area, and Part B shows biomass in the sampling stations with the highest fish densities.

Relative biomass of steelhead in the entire transfer area ranged from a low of 6.9 pounds/acre in 1967 to a high of 23.7 pounds/acre in 1969. Yearly periodicity in terms of total pounds per acre was not noted. After the establisment of a population of older fish (1968-1970), relative biomass stabilized between 22.6 and 23.7 pounds of steelhead per acre.

Relative biomass in the sampling stations with the highest fish densities (Stations 2 and 3) was much higher than the averages for the entire transfer area. A low figure of 16 pounds per acre was recorded in Station 2 in 1967 and a high of 38.8 pounds per acre was recorded in the same station in 1969. Again, relative biomass tended to stablize in the areas of highest fish density after the establishment of a population of older fish. A range of 27.1 to 38.8 pounds/acre was noted from 1968 to 1970. Implications of these data are explored in the discusaion of this report.

Table 6 Biomass production of juvenile steelhead in various sections of the adult steelhead transfer area

Part A. in entire transfer area (2.73 miles)

Year	No. of spawning females	Age of fish	Avg. length (in.)	Avg. weight (lbs.)	Absolute biomass (lbs.)	Relative biomass (lbs./acre)
1967	31	fingerling	2.2	.004	41.2	6.9
1968	55	fingerling	2.4	.006	41.3	6.9
		older juveniles	4.6	.040	94.0	15.7
					135.3	22.6
1969	70	fingerling	2.2	.004	77.5	12.9
		older juveniles	4.8	.040	64.9	10.8
					142.4	23.7
1970	59	fingerling	2.2	.004	34.7	5.8
		older juveniles	4.6	.040	103.4	17.2
					138.4	23.0

Part B. in population estimate station with highest fry density

Year & (station)	Age of fish	Absolute biomass (lbs.)	Relative biomass (lbs./acre)
1967 (2)	fingerling	4.0	16.0
1968 (3)	fingerling	1.6	11.4
	older juveniles	2.2	15.7
		3.8	27.1
1969 (2)	fingerling	6.2	24.8
	older juveniles	3.5	14.0
		9.7	38.8
1970 (3)	fingerling	3.0	12.0
	older juveniles	6.2	24.8
		9.2	36.8

PRODUCTION RATES

Since no redd counts were made in the transfer area, it was not possible to estimate the actual number of eggs deposited and, therefore, no estimation of survival rates was attempted. However, from the known number of female steelhead transferred and the estimated fall fingerling production, the production rate in terms of total number of juvenile steelhead produced per female was calculated. While these data are not precise because it was not known exactly how many female steelhead successfully spawned in the transfer area, the figures are useful in establishing a production range which the fishery manager could use as a guideline for steelhead transfers in similar streams.

In 1967, an estimated 333 fall fingerling steelhead were produced from each female transferred. In 1968, 1969, and 1970, the production rates were 126:1, 277:1, and 174:1 respectively. Thus, in a stream similar to the West Branch of the Huron River, one might expect a production of 300± fall fingerling steelhead from each adult female transferred if the stream is relatively free from competing species or 200± fall fingerlings per female in a stream where some competition with other trout exists.

DOWNSTREAM MIGRATION OF JUVENILE STEELHEAD

In 1969, a smallmesh fyke net connected to a trap box by a 6-inch deameter tube was fished from May 23 to July 28 to monitor the downstream migration of juvenile steelhead from the transfer area. The net was fished without leads but wing deflectors constructed of rocks and logs were used to constrict the stream channel so that most of the water flow was funneled into the net. To further increase the net's effectiveness, it was always positioned immediately below a rapids or small waterfall to take advantage of the increased water velocities there. We felt these efforts enabled us to capture most of the downstream migrants.

From May 23 to June 2, the net was located immediately below the transfer area. The net was damaged by vandals at this location, and on June 9 it was relocated in a remote area about two miles downstream.

In addition to the juvenile steelhead, we hoped to catch "spent" adults returning to Lake Superior from the transfer area in the same traps so a survival estimate for spawning fish could be made. This effort met with little success, however, because only two spent adults were captured. Since the last steelhead transfer to the West Branch was completed on May 27, five days after the downstream trap was in place, we knew that at least those fish should be vulnerable to the downstream trap even if all of the fish from the earlier transfers had previously migrated downstream. Therefore, we concluded that many of the adults either died after spawning or were killed as they traversed the falls on their migration downstream. Due to the placement of the trap, it was not conceivable that a high percentage of the fish could avoid it and some evidence of death after spawning was found in 1967 when a few carcasses of adult steelhead were observed in the transfer area.

Young steelhead (Age I) were first captured on May 26 and they continued to be taken until July 24 (Table 7). Most of the fish (67 percent) were captured between June 10 and June 20. A total of 121 fish were taken during the sampling period. These fish were apparently not migrating to Lake Superior, however, because none of the fish were captured in an identical trap being fished coho salmon smolts several miles downstream. Since most young steelhead enter Lake Superior as Age II fish, we assumed that the majority of Age I migrants were merely seeking a more favorable rearing area. This is also a possible explanation as to why no Age II steelhead were captured, i.e., there were very few above the trap because they had previously migrated out of the area as Age I fish or they had already smolted and had begun their migration toward Lake Superior.

Monitoring of downstream migrants was again attempted in 1970, but vandals destroyed the trap and efforts were discontinued. To gain further information on the timing of downstream migration, information was gathered from U. S. Fish and Wildlife Service weir records between 1967 and 1970. Although the weir is an upstream trap, many young fish appear to be disoriented after passing through the electrical fields and are captured in the trap boxes.

From 1967 to 1970, most downstream migration at the weir occurred from late May to mid-July (Table 8). This corresponds closely with the peak migration period observed in 1969 with the fyke net.

Table 7 Downstream trap catches in the West Branch Huron River, 1969

Date	Number of steelhead	Average size	Fin clip
5-23	Trap in (T. 51N., R. 31 W., NE 1/4 Section 22)		
5-26	3	2.5"	
5-28	1	3.7"	L. pectoral
6-2	Trap damaged and removed		
6-9	Trap relocated (T. 51N., R. 31 W., SW 1/4 SE 1/4 Section 10)		
6-10	7	4.5"	L. pectoral (3 clipped)
6-11	30	4.4"	
6-12	8	3.9"	Anal
6-16	1	20" + spent female(1)	
6-17	22	3.9"	Anal
6-20	20	3.7"	Anal (15 clipped)
6-23	1	3.4"	Anal(2)
6-27	6	4.2"	Anal
7-2	4	4.2"	Anal(2)
7-3	8	4.2"	Anal(2)
7-10	2	5.6"	Anal
7-11	8	4.5"	Anal
7-24	1	1.8"	Anal
7-28	Trap removed		
Totals	121	4.0"	4 L. Pectoral 72 Anal

(1) Another "spent" adult steelhead was captured on May 23 in an identical trap several miles downstream

(2) One fish marked in 1968 (recaptured from upstream)

Table 8 Downstream movement of juvenile steelhead at the U. S. Fish & Wildlife Service lamprey weir (Huron River 1967-1970)

	Number of fish (12" -)			
Period	1967	1968	1969	1970
4/1-7	0	3	0	0 (1)
4/8-14	7	2	0	0 (1)
4/15-21	1	6	4	8
4/22-28	0	0	9	6
4/29-5/5	3	1	7	3
5/6-12	2	3	2	3
5/13-19	0	3	2	3
5/20-26	3	12	10	1
5/27-6/2	3	6	53	7
6/3-9	4	10	60	8
6/10-16	11	28	44	15
6/17-23	13	93	92	6
6/24-30	6	71	225	2
7/1-7	11	89	86	9
7/8-14	13	161	(3)	3 (2)

(1) Not full week periods. Weir started on 4/6/67, 4/4/68, 4/20/69, 4/15/70.

(2) Weir off on 7/13/67, 7/13/68, 7/15/69, 7/13/70.

(3) Data missing.

DISCUSSION

From this study, some points concerning the success of transferring adult steelhead above barriers to spawn became apparent. Also, some insights into the dynamics of juvenile steelhead populations were gained. In regards to the latter, this study revealed areas of needed future research to more clearly understand survival and production rates, downstream migration patterns of juvenile fish, and carrying capacities of Lake Superior tributaries.

Throughout this study, capturing adult steelhead for the transfers was a simple matter because the U. S. Fish and Wildlife Service lamprey weir on the Huron River was in operation, and we did not have to operate our own trapping facility. However, since most of the lamprey weirs are no longer in operation, the additional time and expense of capturing adult fish would have to be incurred in future transfer operations.

In order to obtain the desired results of transferring adult fish (i.e., to produce a roughly calculable number of juvenile fish) one must be able to estimate both the production rate of the adults and the carrying capacity of the stream. To stock a stream in excess of its carrying capacity or to understock when more adult fish are available misuses both manpower and production capabilities. Our study indicates that additional investigation of the dynamics of juvenile steelhead populations is needed to obtain more accurate estimates.

Our production of steelhead fingerlings was inconsistant from year to year in terms of the number of fingerlings produced compared to the number of adult females transferred. Many interrelated factors (egg potential, stream carrying capacity, juvenile and adult fish migration, and climatic conditions) combine to obscure the data. Based on the numbers of female steelhead transferred, the years of best production in decreasing order would be: 1969, 1970, 1968, 1967. Instead, the following order was observed: 1969, 1967, 1970, 1968. The apparent conclusion from these data is that numbers of female steelhead alone cannot be used to estimate production.

Climatic conditions could have a great effect on survival. Severe flooding resulting from a rapid spring break-up or unseasonable weather at any time before fall population estimates were made could adversely affect the survival rate. During the study period, however, no climatic extremes were observed that would correlate with the low survival rates of 1968 and 1970.

Adult migration out of the transfer area before spawning is a possible explanation of low fry production in 1968 and 1970. In 1967, only "ripe" fish which were ready to spawn were transferred to the West Branch. In 1968, all of the transferred adults were "hard" and would not have spawned until a later date. Both "hard" and "ripe" fish were transferred in 1969, and most "hard" fish were transferred in 1970. The apparent conclusion from these data is that more "hard" fish tended to migrate out of the transfer area before spawning than did "ripe" fish and, consequently, fewer adult steelhead remained to produce the 1968 and 1970 year classes than remained to produce the 1967 and 1969 year classes. There is no way of proving or disproving this theory, however. Recent work by Stauffer (1971), who completed yearly juvenile steelhead population estimates on five Lake Superior tributaries from 1967 on (project still underway) shows that in three of his five study streams he had high fingerling populations in 1967 and 1969 and low productions in 1968 and 1970. His averages for the five streams combined show a tendency toward high fingerling production in odd years. Therefore, while migration from the transfer area prior to spawning is a possible explanation of the low fingerling production in 1968 and 1970, the variation in population density of juvenile steelhead in the West Branch of the Huron compares closely with variations in other streams of the area during the same time period.

The carrying capacity of the stream itself may be responsible for the variations in fry density. When the transfers of adult fish were made to the West Branch, it was not known how many juvenile fish the area could produce or support and the number of steelhead transfered was often largely influenced by the availability of fish. If the stream was seeded below carrying capacity, one would expect to see a variation in juvenile fish biomass which reflects the variation in reproductive potential. In terms of pounds per acre of fish, the total biomass would not be expected to be uniform from year to year. If, however, the stream was seeded at or above its carrying capacity, one would expect similar totals of biomass each year if the carrying capacity of the stream remained relatively stable. In other words, mortalities or migrations of young fish would be expected until juvenile fish densities approximated the stream's carrying capacity. This latter case appears to be what we observed in the West Branch.

From 1968 on, after the establishment of a population of older trout, the relative biomass of steelhead in the stream stabilized between 22.6 and 23.7 pounds/acre. This would indicate that the stream had been seeded to its carrying capacity or was at least at its carrying capacity for that time of the year. If this assumption is correct, the following explanation of varying fingerling densities is plausible. In 1967, only 6.9 pounds per acre of steelhead fingerlings were present. The high production of fingerlings in 1967 probably resulted from seeding below carrying capacity in a stream nearly free from competing species. In 1968, the carry-over population from

1967 plus the larger steelhead transfer in 1968, exceeded the carrying capacity of the stream. The 1968 fingerlings being unable to successfully compete both between and within age groups, either suffered a mortality or a portion of them migrated out of the area to bring the population density down to the stream's carrying capacity. In 1969, a small carry-over population resulted in increased fingerling production which again brought the stream up to carrying capacity. In 1970, the reverse procedure occurred, and fingerling production was low (the majority of the biomass consisted of older juveniles).

With the limited data available, conclusions about biomass shifts between age groups from year to year resulting in the observation of high fingerling production in odd years can only be theorized on. However, of the reasons discussed for varying fingerling densities, this one seems to most closely explain the situation, and it can be compared to other streams where this phenomenon may be occurring naturally.

Another question of interest arises from transferring adult steelhead. How many steelhead smolts are produced from a transfer? Unfortunately, our experiment was not geared to determine this but some information about migration dates and carry-over populations of juvenile steelhead after peak migration periods was gained. In 1969, we monitored the downstream migration of juvenile steelhead from the transfer area. A total of 121 Age I migrants were captured, but no Age II smolts were observed. The two main reasons, I believe, for our observation of so few fish are the timing of the downstream migration and the fish holding ability of the transfer area.

Spring flood conditions on the Huron River necessitate installing downstream traps late in the spring (5/23/69). Several researchers have reported that different sizes of smolts migrate at different times, the larger fish migrating first. Since the downstream trap was not installed until late May, there is a possibility that any larger (Age II) fish in the area migrated out before the trap was in place. The Age I fish captured were probably the last fish to leave the area and may have been migrating towards Lake Superior or merely seeking more favorable rearing area in the river itself.

The ability of the West Branch of the Huron in the transfer area to hold fish of larger than fingerling size may be a reason for the low trap catch. This area of the West Branch is mainly a spawning channel. While some deep pools exist, there is definitely a lack of adequate rearing area for larger juveniles. Competition for food and living space may force many of the larger fish into downstream areas where the river widens and deepens.

Although our population estimates were always made after the peak downstream migration period, we do have an estimate of the number of residual fish in each age group which did not migrate (Age I fish which will apparently remain in the stream to Age II or III before smolting, etc.). The numbers of "Older Trout Present" in Table 5 (population estimates) essentially represents the number of residual Age I fish since the numbers of Age II fish were always low and only a few individuals of Age III were observed. An average breakdown of the age composition of residual juveniles would be: 95% Age I, 5% Age II, and less than 1% Age III. Expressed in terms of "older trout per 1,000 feet of stream," the average for the period 1968 through 1970 is about 155 fish. This compares favorably, although slightly lower than, estimates obtained by Stauffer in his study streams. What this means in terms of smolt production is unknown, but it does show that we produced fish at a rate comparable to natural populations in other Lake Superior tributaries.

Is an adult steelhead transfer operation economically justifiable? From our findings we cannot show how many fish were produced to enter Lake Superior, but we have shown that production of fingerling fish can be expected in a magnitude comparable to streams presently supporting good steelhead runs. Perhaps until studies are completed regarding the homing of wild fish and actual smolt production from known numbers of adults, it would be more economically sound to extend spawning ranges via barrier removal or bypass with fish ladders. If it can be demonstrated that wild fish home to their parent stream more readily than hatchery reared fish, then it definitely would be sound management to transfer adults to bolster small steelhead runs or to create new runs in popular areas (whether fish barriers are involved or not).

An ideal stream for a steelhead transfer operation is one which has few barriers, has them located near the stream mouth, and has as much rearing as spawning area. If the barriers are few and near the stream mouth, less is involved in transferring the adults and they could return to the lake with the least mortality. While adequate spawning area is necessary, rearing area is also essential if smolt-sized fish are to be produced. A spawning channel type of stream without adequate pools, cover, and food will produce fingerlings but as the young fish grow, they will tend to move downstream to seek rearing areas. If none exist, presumably they would be forced to enter the lake where, at a size of less than 6 inches, they would be subject to very heavy mortality.

A by-product of this study was the verification of age and growth data previously extrapolated from adult steelhead by scale reading. Actual measurements of length, weight, and growth compare closely with the calculated length-weight relation for steelhead in the Huron River and the growth rates of juveniles are nearly identical to back-calculated growth rates from adult fish.